



AUTOMAIN

Augmented Usage of Track by Optimisation of Maintenance, Allocation and Inspection of Railway Networks

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► D2.1 High level breakdown of maintenance activities

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Document Summary Sheet

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Executive Summary

The AUTOMAIN project has the primary objective to increase capacity for freight by reducing the time and capacity required to carry out maintenance activities, this is key to achieving the European Commissions to increase the modal share of freight onto the rail network.

The purpose of this deliverable is to identify the high level breakdown of which maintenance activities have the greatest impact on capacity. This report has identified tamping and grinding to be the maintenance activities with the greatest impact defining the longer possessions. It is accepted that renewal work will also have a major impact on capacity; however, renewal work is outside of the scope of the AUTOMAIN project. It has also been established that inspection still has the greatest volume of hours spent on track compared to all of the other maintenance activities although inspections can generally be condensed in shorter possessions between trains, however, as demand on capacity grows this will become more difficult to achieve. Development work has been carried out by infrastructure managers and maintainers to develop automated and visual imaging inspection systems and remote condition monitoring and this remains and automated inspection systems remains a topic of high priority.

This report also identifies the timescales in the possession planning process and also has identified different patterns in maintenance work carried out and differences in the average possession length in different countries. It has been found that the very long timescales for booking machinery and possession slots results in tamping and grinding activities being planned based on either MGT or potentially obsolete geometry data. The effectiveness of these activities could be vastly improved either by lean optimisation of the planning process so that the timescale is shortened between the decision being made to carry out this activity and when it is actually carried out. The other alternative is to be able to reduce the minimum possession time required for tamping and grinding activities so that it can be fitted into the white space in the current timetable, this would give much greater flexibility to be able to plan maintenance in shorter timescales.

Deliverable 2.2 will help to identify the root causes of some of the differences between the lengths of possessions and the time of day that they are carried out, as part of the value stream mapping exercises and the observation of possessions being carried out; this will identify the time taken to carryout sub-activities within a possession and identify which of these are non-value adding and hence the greatest opportunities for lean improvement.

This deliverable has also addressed the issues of the value of availability and has proposed a cost of capacity based on the capital costs for building new lines which will be required if the European Commission's targets for modal shift of 50% of road freight travelling over 300km is shifted to rail and waterways by 2050.



Introduction

The European Commission funded AUTOMAIN project has the overall objective of increasing capacity on the European rail networks to allow for increased freight traffic, this will be achieved by reducing the impact of maintenance possessions on the timetable. The Strategic Rail Agenda 2020, published in 2007, predicted that by 2020 the demand for rail passenger traffic would increase by 70% and that rail freight would double its market share. These ambitions for increased modal shift from roads to railways are also highlighted in the European Commission's White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, 2011 which has the target of a modal shift of 30% of road freight over 300km should shift to rail or waterborne transport by 2030 and 50% modal shift by 2050, this equates to 3 times as much rail freight by 2030 and 4 times as much by 2050. To accommodate this modal shift will require far greater utilisation of the existing infrastructure and periods to maintain the railway will be severely reduced. For many key corridors across Europe access for maintenance and renewal activities is already restricted due to existing capacity constraints and it has been estimated that new infrastructure to accommodate this capacity will cost approximately €1.5 trillion [European Commission TEN-T / Transport infrastructure, 2011].

This deliverable aims to identify the maintenance tasks which currently have the greatest impact on the availability of the railway and provide some background data into the financial value of these possessions as well as the current maintenance planning processes across Europe. This deliverable is split into the following sections; maintenance tasks with the greatest impact on availability, maintenance decision making and planning process including compatibility of tasks and economic impact of unavailability due to maintenance.

This deliverable will provide the priorities for research and development for the AUTOMAIN project and these same priorities should also feed into future European rail research strategies as development in these areas will be vital for the railway organisations of Europe to meet the demands as set out in the White Paper. Deliverable D2.1 will also feed background information into work packages WP04 and WP05.

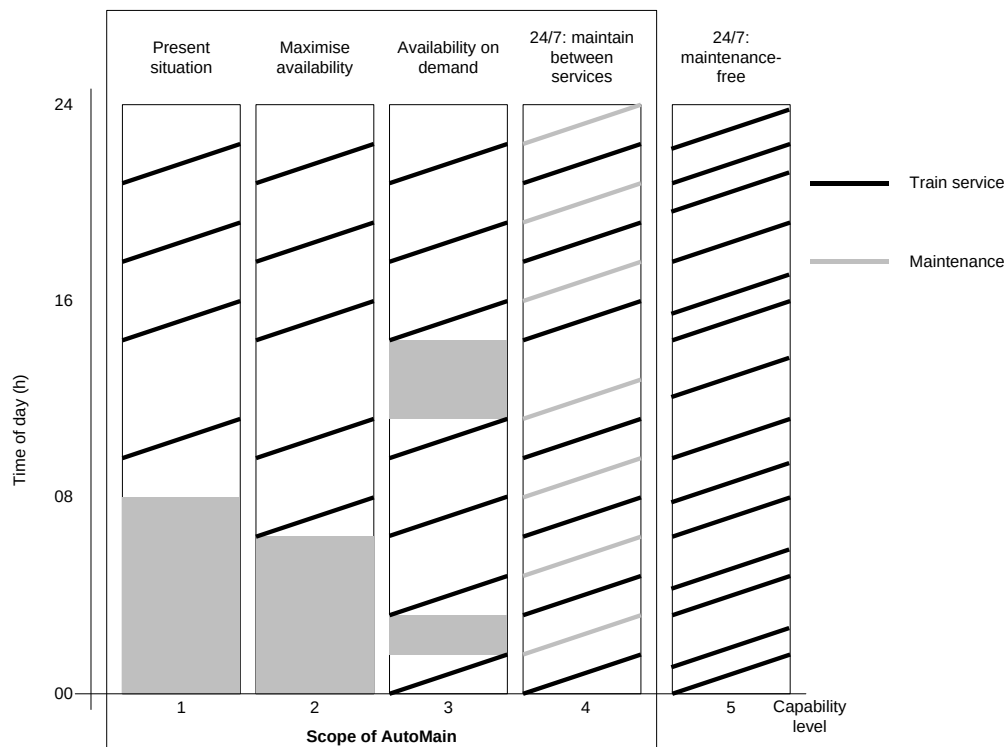


Background

The AUTOMAIN project aims to create capacity to satisfy increasing freight demand by reducing the time required for maintenance activities.

It is envisaged within the project that there will be three different steps to making this happen. The first short term step will be about maximising availability by squeezing down current track possession time to a minimum or squeezing more maintenance work into a single possession in order to reduce the number of maintenance possessions required. It is expected that this will be the initial step in optimisation of possessions and will revolve around adopting best practice, lean optimisation, better planning and asset management and combining activities. This is expected to be delivered in the short term, with analysis of best practice and asset management policies being carried out as part of WP1 in this project.

WP2, deliverable 2.2, will address the lean optimisation of possessions and WP5 will address planning and optimisation through improved planning tools.



The second step to further improve utilisation of the railway is create availability on demand, and this is enable availability for traffic as it is demanded. So the maintenance work fits in around the demands from freight and passenger traffic, this will result in much shorter possessions and a single maintenance task will be very specific to tackle an individual fault. This may result in an overall increase in cost and effort however, it will reduce the impact on traffic. This will also be assessed as part of the maintenance planning tool developed within WP5.



The third step is to advance maintenance so that it can be carried out between traffic and have no overall impact on the railway capacity and can deliver a 24/7 railway; this is a very long term ambition and will require radical changes to how tasks are currently carried out. There will be minimal amounts of manual tasks, inspection will be automated and carried out either from in-service vehicles or as line-side remote condition monitoring equipment and this will be addressed in WP3 of this project. Much of the slower maintenance tasks will need to be revolutionised or the infrastructure will require radical modification, so that maintenance can be carried out at speeds nearing line speed, this will need research to address these requirements. WP4 will look at the requirements for high speed tamping, grinding and modular switch and crossings; studying novel techniques which could be adopted from other industries.

The principle of the 24/7 railway which requires minimal or zero maintenance due to development of more sustainable infrastructure and low impact vehicles is being developed in a parallel European Commission funded FP7 project; SustRail.

This report will identify which maintenance tasks will be the greatest blockers to achieving the ambitions of the 24/7 railway and therefore the priorities for this project going forward.



1. Maintenance tasks with the greatest impact on availability

Introduction

AUTOMAIN work package 2 has the principle task to identify the maintenance tasks which have the greatest impact on availability and those that have the greatest impact on night time capacity for freight. Various methods have been used to achieve this, firstly to look back at the InnoTrack project deliverable D1.4.6 was reviewed, as part of this deliverable workshops were carried out with ADIF, Banverket, CD, Network Rail and ÖBB to establish which maintenance tasks have the greatest costs to the infrastructure managers, this should be a guideline as to the tasks which are carried out in the greatest volumes and hence a large impact on availability. Also specific data has been gathered from Network Rail and ProRail and within the questionnaire carried out with Work Package 1 in AUTOMAIN, participants were asked to identify by expert opinion the top 3 activities with the greatest impact on capacity.

Results from the FP7 project, InnoTrack

The InnoTrack project had the aim to reduce life cycle costs of railway maintenance by 30% and as part of this project the deliverable D1.4.6 prioritised which maintenance activities had the biggest impact on maintenance costs. This identified the following track problems as the most important with regard to cost impact:

1. Rail - cracks and fatigue
2. Track - bad track geometry
3. S&C – wear in switches
4. Rail – Corrugations
5. S&C – Cracked manganese crossings
6. S&C – Geometry maintenance
7. Substructure – unstable

The actual maintenance tasks that were found to have the highest costs were as follows:

Track Maintenance Cost Percentages in Descending Order of Size										
ADIF		Network Rail		CD		Banverket		ÖBB		Overall Summary
Maintenance Item	Percentage of Overall Track Maintenance Cost	Maintenance Item	Percentage of Overall Track Maintenance Cost	Maintenance Item	Percentage of Overall Track Maintenance Cost	Maintenance Item	Percentage of Overall Track Maintenance Cost	Maintenance Item	Percentage of Overall Track Maintenance Cost	Average Percentage Cost in Descending Order of Importance
Re-sleeper	28	Plain line tamping	24	Inspection	22	S&C	27	S&C	28	18.4
Rail changing	25	Inspection	19	Ballast cleaning	20	Inspection	21	Inspection	19	18.2
Plain line tamping	17	Rail changing	18	S&C	18	Rails	14	Rail Alignment (tamp)	18	16.8
Wet bed removal	13	S&C	15	Rail change	16	Tamping	11	Rail replacement	11	15.2
Inspection	10	Ballast re-profiling	8	Re-sleeper	14	Sleepers	9	Gauge clearance	10	12.8
S&C	4	Re-sleeper	8	Tamping	9	Grinding	7	Re-sleeper	9	4.8
Grinding	3	Weld repairs	5	Grinding	2	Joints	5	Grinding	5	2.8
		Wet bed removal	3			Vegetation	4	Rail pad replacement	3	
		Flank plate oiling	2			Lubrication	2			
		Insulated joint renewal	1							
	100		100		100		100		100	

This data demonstrated that across Europe the expert opinions of maintenance tasks with the greatest impact on cost are: S&C maintenance, inspection, rail changing, tamping, re-sleeper, grinding and wet beds.



However, the most expensive tasks may not necessarily be those tasks that take the longest time on track, greater expense may be experienced due to cost of machinery and larger work crew requirements for certain tasks or conversely some tasks may require more time on track than their cost would imply due to increased complexity or because it is a very manual, labour intensive task.

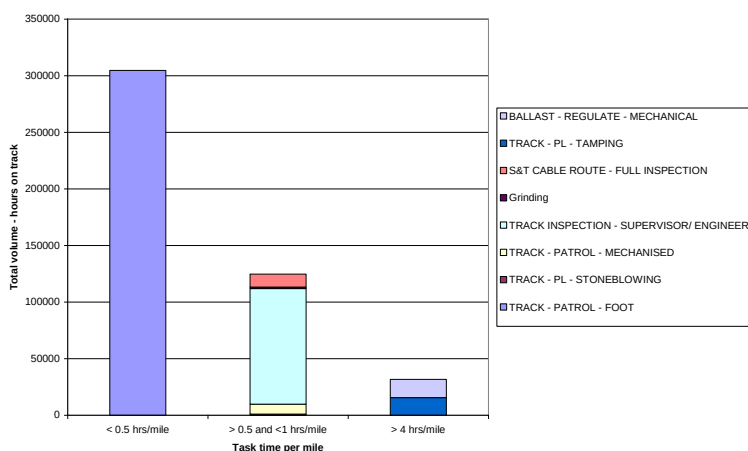
Therefore, to better understand the which tasks have the greatest impact on availability of track Work Package 2 has collected data from Network Rail and ProRail regarding which maintenance tasks overall have the greatest requirements of capacity and subdividing these into tasks which can be carried out within short possessions and those which require longer possessions. This analysis has excluded renewal tasks and has concentrated simply on maintenance activities.

Data collected as part of AUTOMAIN WP2

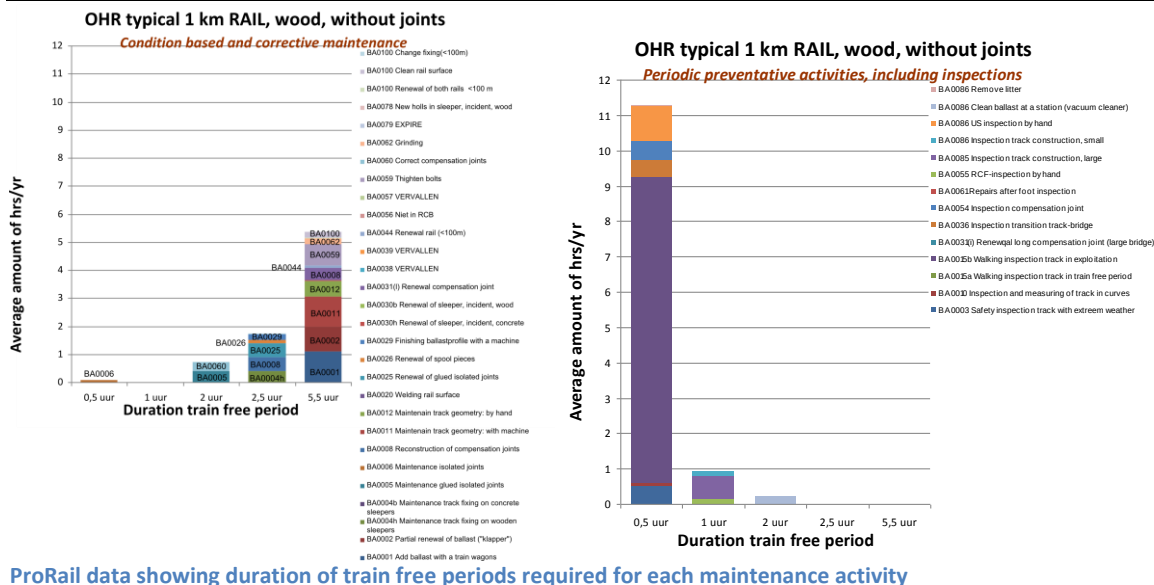
The ProRail data was calculated from the total annual task cost per km of track, this cost was divided by the hourly rate of the contractor workers and then divided by the typical crew size required, gives an average shift length for each task. The volumes or number of the total number of hours for each task can then be calculated as the number of times each activity is carried out

The Network Rail data is based on recorded annual volumes for the work multiplied by standard task times which are used for planning and accounting purposes. The Network Rail standard task times are also validated regularly through the maintenance reports and on track timings.

The Network Rail and ProRail data below shows the total track hours required for each maintenance task against the time required to carry out that task. So for example tasks that can be carried out in short maintenance possessions are to the left of the graph and the tasks which require longer maintenance possessions to the right of the graphs.



Network Rail data – task time and total volumes for the network for year 2010/2011.



ProRail data showing duration of train free periods required for each maintenance activity

These charts demonstrate that for both Network Rail and ProRail manual track patrol inspections are by volume the task which requires the most track access. However, it is also a task that can be carried out within shorter possessions and therefore has the potential to be fitted in between traffic. Additionally, within the longer possessions, both Network Rail and ProRail have very large volumes of different work activities of firstly correcting track geometry through grinding or stone blowing and also grinding. These are some of the activities with the greatest impact on track availability and as they require longer possessions they are more difficult to fit within the timetable.

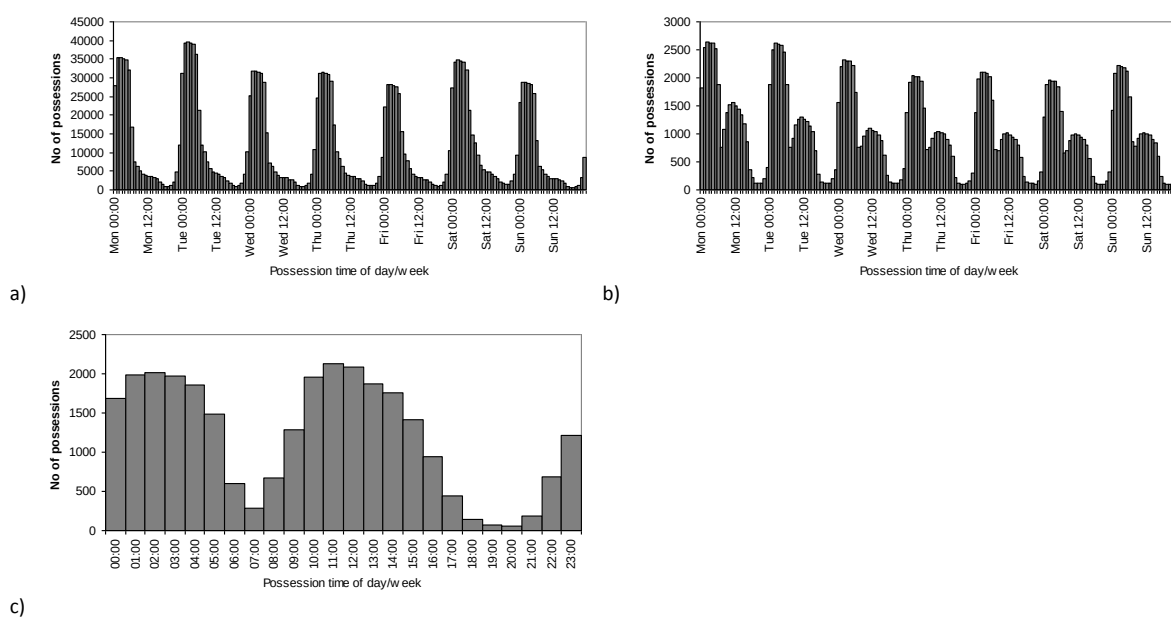
The questionnaire also asked the infrastructure managers to name their top three performance killer activities. DB named renewal of track and components, grinding and tamping as their top three performance killers.

Therefore, for maintenance activities grinding and tamping are the greatest performance killers due to their long possession and these are the greatest challenges to the railway maintenance contractors when moving from the current regime of longer single possessions towards maintenance within the timetable and even further to maintenance between trains.

Time of day and typical possession lengths

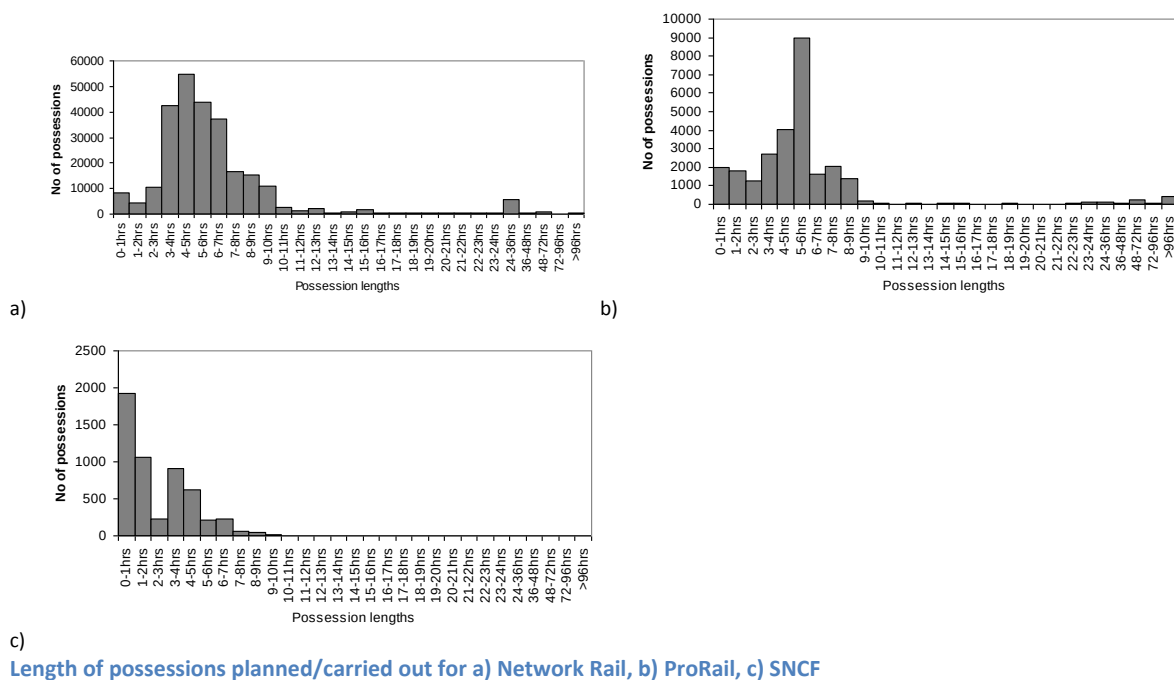
As part of D2.1 data has been collected from ProRail, Network Rail and SNCF with the start and end times for a sample of possessions. The principle here is to determine whether there is any fundamental difference at present between the methods and timings that possessions are planned and carried out and where best practice from different countries may help to deliver different parts of the AUTOMAIN project.

The data collected from SNCF is based on planned possessions for 2013, whilst the Network Rail and ProRail data is based on the historical data of actual possession for 2010/2011 and contain data for all types of planned possessions.



c)
Time of day that possessions were carried out/planned for a) Network Rail, b) ProRail, c) SNCF

The data displays a clear difference in the time of day that possessions are carried out, with Network Rail possessions carried out mainly during night time train free periods and very small quantise during the day, the ProRail data displays some additional possessions being carried out during the day time compared to Network Rail's data, whilst with SNCF there is an even balance between night time and day time possessions. All three show a significant drop in possession numbers around early evening corresponding to the evening rush hour traffic.



The data also displays a significant difference in the typical possession length between SNCF compared to ProRail and Network Rail who typically have longer 3-6hrs possession lengths, whilst the SNCF data shows that the greatest volume of possessions are shorter with a cluster of up to 2hrs and then another cluster around 3-5hrs long.

This data suggests that SNCF are able to carry out more maintenance within shorter possessions between traffic during day time hours and may be due the nature of their network. However, more detailed analysis will be possible from the work carried out during deliverable 2.2 which will study detailed mapping of the subtasks and the time for each sub-task.

Future trends

The questionnaire the infrastructure managers and maintainers were questioned on what the future trends will be for railway maintenance.

Most of the infrastructure managers expect to see increased traffic demand and consequently an increase in maintenance requirements due to greater damage on the track, in many cases this will lead to greater night time work and increased safety measures and costs required for out of service operation. Costs will also rise due to the fragmentation of maintenance activities; however, these increasing costs can be countered with a greater proportion of preventative maintenance that can be planned into longer possessions that can be well planned with greater efficiencies, within SNCF this trend is called “Massification” of maintenance possessions.



Conclusions

Part 1 of this deliverable has clearly identified the tasks with the greatest impacts on capacity. Overall inspection is the task that accounts for the greatest number of hours that is currently carried out within possessions. However, it can currently be fitted into short possession times and so it is currently possible to fit this in between trains. It is expected that as traffic density increases this will become more difficult to schedule, also trends for improving worker safety and improving productivity will drive the development of automated inspections systems and remote condition monitoring.

This deliverable has also identified tamping and grinding as tasks that demand a large proportion of the longer possessions and are therefore key blockers to achieving improved capacity.

The data gathered as part of this deliverable also shows that there are very clear differences in the distribution of the time of day and the average length of possessions between the UK, Netherlands and France. This data provides useful background for comparing best practices within work package 1 of AUTOMAN and the value stream mapping within Task 2.2 will identify the differences in how a tamping operation is carried out in the UK, Sweden, the Netherlands, France and Germany, as part of that detailed study differences in site protection and logistics and other required sub tasks pre and post tamping. This will help to identify the causes for the differences in average possession length and will determine the best practices for obtaining shorter possessions or potentially longer more efficient possessions.



2. Maintenance decision making process and planning process

Background information on the decision making and planning process for track maintenance has been gathered as part of a questionnaire which has been completed by all of the infrastructure managers involved in the project and also by Strukton and the full answers to the questionnaire can be found in Appendix 4.

The infrastructure managers were questioned to establish the time lines at which decisions are made during the possession planning and the basis for what drives the decision to carry out a particular maintenance activity, how work is typically bundled together, the planning tools used and the variability in planning. The University of Birmingham have also created a social network map describing the interaction between the various actors in the Network Rail planning process.

Results from questionnaires

Responses to the questionnaire were received from TrafikVerket, SNCF, ProRail, Strukton, Deutsche Bahn and Network Rail. A further questionnaire was by some of the partners on task compatibility and the basis on which tamping and grinding activities are planned.

Possession planning timescales

The questionnaires demonstrate that across the European railway infrastructure managers questioned all have to plan longer maintenance periods 18 months to 2 years in advance of the annual or 6 monthly time table being written. This is to allow the work to be written into the timetable, which allows for minimal disruption to passengers and provision of alternative transport during periods of longer maintenance activities. The planning of passenger traffic and sales of freight slots can then be arranged and negotiated for around the maintenance or renewal work. This long term planning is also necessary for the planning of maintenance machines such as tamping machines and grinders. However, shorter possessions can be planned to react to observed degradation at shorter timescales and emergency correction work within 24 or 48 hours, however, through increased access charges or penalties for interrupting traffic these short term possessions are discouraged.

	Long possession (significant interruption to traffic)	Short possession (within current white space in timetable)
ProRail	Planning starts 2 years prior to timetable– fixed 21 weeks prior to work	Fixed 11 weeks prior to work
Deutsche Bahn	Planning starts 2 years prior to timetable	Fixed 14 weeks prior to work
TrafikVerket	Planning starts 18 months prior to timetable	
SNCF	Planning 18 months to 2 years ahead of work	



Network Rail	Planning starts 80 weeks prior to timetable - fixed 38 weeks prior to work	Fixed 12 weeks prior to work
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Time scales for planning long and short possessions

Possession planning tools

There are a range of planning/scheduling systems used by the different infrastructure managers to aid the planning of possessions, most of these tend to be database type tools; MS access and SQL in the case of ProRail, DB using SAP R3, BBP and Granit for financial planning, Network Rail has a broad range of different databases for different data types, Trafikverket has it's train plan database and contractors have their own systems for planning machinery and resources and SNCF have their own software for the long term possession planning software. It has been noted by Network Rail and Deutsche Bahn that current databases are not all compatible and do not exchange data automatically; Network Rail currently has a plan of work to improve compatibility between databases. But this current system increases the need for manual intervention and manual transferring of data.

It is also apparent that most of the software used for possession planning is database type software, for recording failures, past maintenance activities, planned maintenance activities rather than automated planning tools and therefore most of the decision making is still carried out manually. The longer range planning (greater than 18months prior to the task) for the longer possessions based on estimated needs from either past experience, knowledge of known problem sites or is frequency based, either by fixed time intervals or by traffic volumes, such as million gross tonnes of traffic or based upon models to predict degradation. The exception is ProRail who have their TRS methodology to optimise maintenance activities based on the interruptions to traffic and the social impact of this against the whole life cycle costs.

Inspection and condition based data is much more likely to influence the maintenance/repair activities carried out at short notice within the 24hrs - 14 weeks prior to the maintenance activity taking place.

All of the infrastructure managers responded that an automated planning and scheduling tool would be useful and would save time and money during the maintenance planning process. The responses also regard that the short term planning 1-3 months ahead of the possession is where there is potentially the most benefit for an automated planning tool, where it can create a detailed plan for the possession, make better use of measurement and inspection data to bundle in activities to optimise the possession. However, it was also noted that better tools at the 1-3years ahead of the possession would also be useful to the infrastructure managers, at this stage good degradation tools and asset management tools are required, as well as tools to optimise the resource planning and integration into the timetable as well as better tools to help visualise all of the concurrent activities. It is expected that asset management and infrastructure degradation tools will be developed as part of a project in the European Commission FP7 2012 Sustainable Surface Transport Call; Next Generation Tools For Asset Management.

The University of Birmingham have completed a social network analysis of the Network Rail planning process, this represents all of the communications and flow of data between the various people involved during the possession planning process, from 18 months before the timetable is set until the day of the possession and this has been based on the Network Rail standards for possession planning. Full details of the Social Network Analysis can be found within Appendix 1.

Determination of which activities are carried out

Grinding

Grinding frequencies are based on MGT, the results of track recording car data for rail corrugation and also NDT and visual inspection for head checks, the UK also can use the



TrackEx tool to model and predict RCF crack growth and can determine grinding frequencies from this model and specific locations to prioritise grinding. However, it has been noted that in UK that maintenance grinding is still carried out using the simple rules below:

- every 15MGT for radii <2500m
- every 45MGT for radii >2500m

This simple rule is used to simplify the planning of the tamping possession and booking of machines from up to 2 years ahead of the possession. In Sweden a cyclic methodology is also used for planning maintenance grinding, with fixed frequencies. In Sweden there is also a rule to grind within 5MGT of the new rail being installed to correct the rail profile, this is similar in the UK. This is the main use of the grinding trains for the planned fixed frequency grinding possessions.

Hand grinding or corrective grinding may also be required to correct track defects, such as RCF or severe corrugation, depending upon the severity these must be corrected within short timescales and unless a grinding possession is planned these must be corrected by manual interventions.

The requirements for grinding in Sweden are:

- Longitudinal (30-80 mm) Short pitch corrugation; (80-300mm) short waves shall be removed completely and the grinding shall reach at least a depth of 0.1 mm under the surface in the troughs;
- Medium and long waves: (0.3-1,0 m) and (1,0 - 3.0 m)
- Travers head profile shall be within +/- 0.3 mm or +/- 0.5 mm in relation to the nominal profiles

The UK requirements for grinding are:

Track location	Target Profile (Profile definition angle range)	Tolerances for: (Tolerance angle range)	Minimum metal removal (MMR to be achieved in the angle range)
High Rail	NR HR 1 (-5° to 50°)	+0.3 to -0.3 mm (-5° to 50°)	0.2 mm (see footnote 2) (0° to 45°)
Low Rail	NR 113A (-5° to 50°)	+0.3 to -0.3 mm (-5° to 50°) (see footnotes 1 and 3)	0.1 mm (see footnotes 1 and 2) (0° to 45°)
Straight Track - Both Rails	NR 113A (-5° to 50°)	+0.3 to -0.3 mm (-5° to 50°) (see footnote 3)	0.1 mm (see footnote 2) (0° to 45°)
Corrugated Track - Both Rails	NR HR1 or NR 113A (-5° to 50°)	+0.3 to -0.3 mm (-5° to 50°) (see footnote 3)	0.2 mm (0° to 45°)

Seasonal restrictions on planning grinding possessions

In the northern Sweden, grinding activities are not undertaken during winter period due to snow, this period is between Nov-April.

Tamping

Tamping regimes tend to be based on ride quality data gathered from measurement cars and then prioritised within the possession plans, however, due to the long timescales of up to 2 years for planning the possession and access to the tamping machine, the plain line tampers in the UK will be booked based on assumed degradation rates of the track geometry, known problem spots and the track geometry data showing where problems are emerging. This predetermined list is based condition and current performance of the track



against required performance which will be route specific. This will produce a list priority locations which can be reviewed as further track recording data is measured running up to the possession.

Seasonal restrictions on planning tamping possessions

Seasons are also an important factor for planning tamping in Sweden, where typically tamping must take place during the summer months due to the frost and winter conditions, based on track recording car data that is gathered during the spring, the track position is then validated again during autumn.

Within the UK tamping may only be carried out when the temperature is less than 32°C for the 5 day period following the tamping operation, due to the risk of rail buckling. Due to the long timescales to book the tamping machines and plan the possessions, this excludes planning tamping during the hottest summer months. Tamping must also not be carried out at temperatures below -7°C due to the ballast freezing, so again due to the long timescales for planning tamping possessions tamping activities are also not planned for the coldest winter months in the UK.

Availability of plant and equipment can also be a major factor, DB will plan maintenance around the availability of large plant and group possessions together to reduce the movements of machinery. However, for other countries this will be the responsibility of the contractor carrying out the work to optimise as they see fit.

Bundling activities into a possession

Bundling activities in to possessions is currently best practice especially for longer possessions and all infrastructure managers questioned try to maximise the amount of work carried out in an individual possession. SNCF and DB experience states that bundling works best in possessions of longer than 5hours and less well in shorter possessions during reactive maintenance. Other infrastructure managers also have experience of combining activities that has worked well, where maintenance machines are available and can be accommodated within the possession. Movement of plant machinery within a possession can be some of the largest constraints to combining activities, also some activities are fundamentally incompatible, whereas, it is generally always possible to combine some off track activities such as vegetation management and drainage maintenance into larger track possessions.

Bundling activities within a possession also makes the possession more complex, both in the planning and during the management of the possession, this can increase the risk of accidents and movements of machinery within the work site, reliability and performance of the machinery can also have a negative impact and can make the possession schedule less robust.

However, it has also been noted from TrafikVerket that it is difficult to incentivise primary contractors to combine extra work into the possessions that they are managing, this has also



been found from UK experience during privatisation, where before maintenance was brought in-house back to Network Rail there was little incentive for a principle contractor to combine more activities into their possession especially if it increased the risk of a possession overrunning which would result in penalties. However, in the Netherlands ProRail make the planning of the large maintenance activities one year in advance, although the contractor then has the flexibility to combine further activities at the detailed planning stage 11 weeks before the activity.

Network Rail experience of planning possessions and bundling activities, is that the initial planning process is based around a single primary activity and other tasks are bundled into the possession nearer the start of the possession, to fit in with the opportunities that available, there is no formal methodology for bundling tasks with in Network Rail and it is simply the experience of the planners and engineers to combine tasks with their knowledge of compatibility, this same methodology seems to be fairly consistent across Europe. However, ProRail do have a specific methodology, TRS, to optimise the effectiveness of the train free period, this optimises the need to carry out work based on life cycle costs against the social costs of the unavailability of the track for maintenance and the social costs due to unplanned availability of failures and errors.

Task compatibility

Further information has been gathered from Network Rail, SNCF and ProRail regarding the compatibility of different tasks within a grinding and tamping possession. This data has been gathered primarily as an input into the planning and scheduling tool being developed in WP05. However, there are some key differences between the results from the different and similarities infrastructure managers. Full details of the task compatibility results can be found in appendix 3.

The purpose of this activity was to use the Network Rail high level task categories (approximately 103 categories) to compare whether these activities can be carried out at the same time and on the same track as a tamping or grinding process, on the same track but before or after tamping and whether the task can be carried out on a neighbouring parallel track to a tamping or grinding process. The very high level task categories have been used for simplicity, if this process were to drill down into sub-tasks the number of categories that Network Rail has on its standard job list is 4703 categories.



Task	Can be carried out on the same line at the same time as plain line tamper	Can be carried out on the same line prior to plain line tamper If YES how much time is required between task finishing and the tamping machine being able to run on the same line	Can be carried out on the same after the plain line tamper If YES how much time is required between tamping machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line tamper	Can be carried out in the same possession as a plain line tamping operation	Minimum time required for task including setup times	Comments
Adjustment - Switches	N	Y	Y	N	Y		Cannot be carried out on a parallel line due to vibration effecting switch adjustment
Arc Repairs	N	Y	Y	N	Y		Cannot be carried out on a parallel line due to vibration effecting welding
Ballast Regulating	N	Y	Y	Y	Y		
Cable Work	N	Y	Y	Y	Y		Can be carried out on a parallel track as long as not in the 6ft between tracks

Example of part of a compatibility table for the Network Rail tamping process

Most of the responses were similar between the different infrastructure managers, with some tasks naturally proceeding or following on from the maintenance activity, for example sleeper changes or track other track are not compatible after a tamping or grinding operation.

However, a fundamental difference between the compatibility of tasks within the UK compared to France and the Netherlands is that due to the smaller gauge envelope between the tracks, for many tasks it is not possible to carry out activities on a parallel line whilst a large machine is running due to the safety issues of the track workers. The reduced gauge also makes some other tasks impossible on parallel tracks due to vibration from the tamping machine or the risk of sparks from the grinder.



Variability in task duration and effectiveness

The questionnaire identified a number of factors which have an influence on the duration and effectiveness of possessions:

Seasons:

Winter conditions can make some maintenance tasks impossible due to snow coverage and freezing of tracking components. For example in Sweden maintenance work is only carried out during the summer. Weather conditions such as rain, frost and extreme temperatures can extend preparation times, making working conditions more difficult and hence slower and can cause the maintenance activity or machinery to fail.

Night time/daytime working:

Generally there is greater access to the track during night time, however, it can in some cases increase costs due to labour working unsociable hours and decrease efficiency (SNCF estimate by approximately 20%).

Track topology and location:

Track topology and location can have a large impact on the logistics of getting equipment and personnel to site, with potential problems for maintenance trains and access points for specific road rail devices. Certain locations can also have very little space capacity for maintenance and requires smart planning to coordinate the maintenance within these locations.

Region:

Region can influence some of the mobility constraints for personnel, but also can affect the geology, soil conditions and traffic mix.

Line type:

Lines which have volumes of mixed traffic tend to be more difficult to gain access, and a lack of capacity for stabling machines can also be problematic. Passenger only lines have greater opportunities for maintenance during the night time periods and single line track can also be problematic especially for operations which need simultaneous possession, single line track can also make diversions much more difficult

Conclusions

The initial conclusions that can be drawn from the questionnaires on possession planning and further data provided is that the infrastructure managers who have participated in the questionnaire all see that improvements can be made in possession planning process with greater automation or as minimum the current databases becoming compatible for easy exchange of data. However, decision making tools to help combine and plan tasks and the resources required would be of great benefit to all of the infrastructure managers who responded to the questionnaire.



The possession planning process is broadly similar between the infrastructure managers with similar long time scales planning the larger maintenance activities, with flexibility nearer to the possession to fit in smaller items of work around the primary maintenance task. However, this long 2 year lead time for planning tamping and grinding possessions results in the planning being based around regular frequencies for grinding processes and using the data on which the tamping processes are planned could become obsolete by the time that the possession occurs. A lean possession planning process could reduce the time between decisions being made on where to deploy the machines and the actual maintenance process, this has the potential to massively increase the effectiveness of these interventions by targeting the maintenance to the precise locations where it is required. Also if the tamping and grinding processes can be condensed into shorter shifts of less than 2 hrs these can be planned into the white space of the timetable at much shorter timescales, this would allow the track maintenance engineer the flexibility to plan the work in their area outside of the long possession planning process.

There has been a lot of experience with bundling tasks together and generally at present every opportunity is taken by Infrastructure Manager to bundle tasks together for making best use of the available access to track, however, increased bundling may present problems that if the possession is not well planned the additional complexity may cause a reduction in efficiency and potentially a greater risk of possession overrun.

It is also clear that a number of external factors will influence the timings and efficiency of the maintenance possession. This will be studied in greater detail within Task 2.2 as part of the value stream mapping study.

The social networking diagram shows all of the interactions between different interested parties during the possession planning process. This is based on the standards for this possession planning process, so may not actually match the actual interactions. However, it does clearly demonstrate the large number of communications required throughout the process and the complexity of planning the possessions into the timetable and negotiations with the train operating companies over setting the timetable and also planning the resources for the maintenance tasks. It is clear that many of these manual interactions have the potential to be automated and combined with decision making tools for greater optimisation of the possession planning process.



3. Economic impact of unavailability

This report also aims understand the economic impact of the unavailability of the railway, there are several ways to consider this value. The first is the measure of the compensation that is paid by the infrastructure managers to train operating companies and freight companies as a result of the disruption to customers, it can also consider the additional cost that it would take to increase capacity by building new infrastructure, the value of the additional capacity to the freight market and also the value that infrastructure managers would put on the capacity in terms of how much additional money would they be prepared to spend on maintenance to free up capacity.

Compensation to train operators and customers

The compensation that is paid by the infrastructure managers to train operating companies and freight companies as a result of the disruption to customers can be considered one measure of the cost of capacity and interruption. Both ProRail and Network Rail calculate such compensation based on minutes delay of passenger disruption and additional costs to the train operating company or freight company for operating on longer diversionary routes. In the UK Network Rail pays out schedule 4 payments for compensation for planned disruption and schedule 8 payments for unscheduled disruption. During 2009-2010 Network Rail paid a total of £149m in such compensation payments, the actual amount paid out for an individual incident is a value that is agreed contractually with the train operators, based on the delay minutes for the passengers and trains affected, however, the costs can vary from route to route.

ProRail does not actually pay out this compensation, but uses it in internal calculations to determine the overall optimum solution. ProRail calculates their (virtual) compensation payments as below:

Depending on the corridor the value of 1 hour possession can vary. This is caused by:

- Number of trains affected
- Number of passengers in that trains
- The type of trains affected: passenger and / or freight trains
- The average delay of the trains due to the possession
- The actual time of the day the possession is done

ProRail calculate a value of € 7,50 per passenger per hour delay. An hour delay for a freight train costs € 1000.

Compensation cannot be considered a true cost of capacity, but rather a cost of unplanned interruption to passengers and freight customers and as such it cannot truly represent a cost of infrastructure capacity.

Incentives and bonuses with regard to overrunning and under running of possessions

Network Rail as the maintenance service provider as well as the infrastructure manager is incentivised by the penalties that it must pay directly to the train operating companies. But



has no additional benefit from completing a possession early as it would not be possible to utilise that timetable slot. It is incentivised though to compress as much work into as fewer possessions as possible as this allows Network Rail to sell the additional train slots.

For ProRail they can give sub-contractors a 0-5% bonus or penalty based on their utilisation of possessions and overruns. In the Netherlands the proposed number of possessions is also a factor in the tendering of maintenance contracts. DB also has a penalty system for their service providers if they overrun possessions.

No such bonus system exists in Sweden or in France.

However, the cost of overruns is not a true measure of capacity, but again this reflects the cost of unexpected interruptions rather than actual capacity.

Track access charges

Across Europe a system of track access charges exists and these track access charges should reflect today's market price for the track capacity utilised by the train paths negotiated as part of that access charge. However, using this as a capacity cost measure presents two problems; this cost is based on today's market price with no correction for the increases in freight and passenger traffic as outlined in the European Commission's white paper on transport, and the costs of track access are often part of the contracts of the train operators and in some cases these figures are not publically known.

Value of additional capacity to the freight industry and additional cost of maintenance to deliver increased capacity

A study carried out in the UK and published within Network Rail's 2007 Strategic Business Plan for a Seven Day Railway estimated from data provided by EWS and freightliner that an additional £105m per annum of freight market could be established by increased capacity available by making the current infrastructure available 7 days per week. This was estimated to rise £210m per annum by 2030. The same report estimated that the additional cost of using novel methods to carry out the maintenance would cost Network Rail an additional £90m per annum to operate new methods such video based inspection, new technology for rapid maintenance techniques. But on top of this a significant capital investment would be required for infrastructure enhancements including remodelling and additional cross-overs, bi-directional signalling, modified isolation and earthing arrangement on electrified lines.

Such studies do represent a valid market value and the basis of a business case for introducing new technology and methods for reducing the impact of maintenance on capacity. However, each study is unique to a particular country and is based on assumed market growth figures for the rail freight industry and to carry out meaningful studies of this type across the European countries involved in the AUTOMAIN project is beyond the resources allocated to this project.



Cost of increasing capacity by building new lines

The compensation values detailed above do not account for the potential value that the maintenance possession slots can be sold for or the value of this capacity in the future. If the European Commission's targets for trebling rail freight by 2030 and quadrupling rail freight by 2050 do come to fruition, then the value of these maintenance slots will be vastly more valuable. In this case the value of these maintenance possession slots should be compared with the cost of building new railway infrastructure, in which case the extra capacity generated should be equated to for example £17billion (approx for the potential cost of the high-speed line planned for London-Birmingham or the €1.5 trillion that is expected to be required to be spent across Europe [European Commission TEN-T / Transport infrastructure]. This is a true cost of capacity, the costs of building new lines is generally well published and can be normalised to a capital cost per km, however, the cost of building a new line varies vastly depending upon the line classification, maximum speed and location where it is being built. However, examples of similar types of lines can be used to establish a representative cost for the different countries and locations involved in this project.

Railway	Date	Type of system	Cost per km	Distance	Comments
Madrid-Albacete, Spain	2010	High Speed line	€9.57 million	304km	
Soul-Gimpo, Korea	2010	Airport line	\$98.1 million	20.4km	
Yichang-Wanzhou, China	2011	Main line	\$9.1 million	377km	278km in tunnels or bridges
Haikou-Sanya, China	2010	High Speed line	\$10 million	308km	

[Examples of completed rail projects and cost \[Railway Technical Web Pages\]](#)

Review of capacity costs and methodology for calculating capacity cost within AUTOMAIN

The economic impact of unavailability can be based on different factors such as track access charges, delay minutes, possession overrun penalties, the additional market to freight or the cost of building new lines to accommodate traffic.

The aim of the AUTOMAIN project is create capacity through reducing maintenance possession time, to avoid or reduce the need to build new track. It is therefore reasonable to base the cost of capacity against the equivalent cost of new track that would be required to absorb that capacity.

A suitable measure of capacity impact of a maintenance task is track length effected by the task multiplied by the number of hours that it is effected for.

Capacity impact of maintenance task = annual sum (km x hours taken in possession)



The equivalent cost of a building a new track is calculated from the capital cost of building a new track and convert that into cost per km, this is divided by the hours in a year and multiplied by the annual capacity impact of the particular maintenance task.

Cost of building the equivalent capacity for a particular maintenance task = cost per km of an equivalent new line x Capacity impact of maintenance task / [365 x 24]

For example:

UK volumes of plain line tamping for 2010/2011 – 3,884 mile (6250 km)

The typical rate for plain line tamping from Network Rail's standard job list is 4hrs/mile (2.49hr/km)

Capacity impact of plain line tamping = 3,884 x 4 = 15,536 miles hrs

Using the example of proposed London – Birmingham high speed line at £17billion for 110miles of double track

The cost of capacity due annual tamping = £17billion x 15,535/(2 x 110miles x 365 x 24) = £137million

This could be further extended by adding in the annual maintenance costs of additional lines too, using the same methodology.

This provides a simple method for calculating the value of capacity, which can utilise readily available data using examples that available from across Europe and worldwide.



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Appendix 1 – Social Network Analysis of the Aligned Planning Process for Track Maintenance

Introduction

The Aligned Planning Process diagram shows a large network of tasks performed by certain actors which are necessary for planning a track possession according to the Network Rail standards around possession planning. The aim of this task is to extract the social connections of this process to glean some understanding of the social structure using social network analysis (SNA) techniques. This will also help to identify all of the different players within the possession planning process and their relationships to one another.

Method

Using the diagram, connections between actors were logged in a spread sheet which was then used to generate a matrix containing the total number of connections between each actor in the network. The connections are directional based on the perceived information flow for the process i.e. if actor 1 is providing actor 2 with some information that is necessary for the process to continue. Assumptions have been made about the nature of some communications where it was not apparent in the process diagram however in a bid to maintain accuracy a track maintenance expert was consulted when possible.

SNA metrics

Weighted Indegree:

Indegree shows the number of communication links going into a node/actor relative to the other nodes in the network. Actors with high indegree

Weighted Outdegree:

Outdegree shows the number of communication links leaving a node relative to all other nodes.

Actors with a high level of indegree are absorbing information and are referred to as information 'sinks'. Actors with a high level of outdegree are referred to as 'generators' as they are sending information back into the network.

Social Network Diagram & Analysis

Below is the social network diagram showing the communications between identified roles/actors from the process planning diagram and also a table explaining the acronyms used. Beneath this, table 1 shows the sociometrics of the individual roles in the network. The highlighted cells show the scores which are above average for the network. Roles with above average scores for both indegree and outdegree – in theory; according to the standard - are particularly important in the movement of information during the planning of a track possession.



Appendix 2 – Further questionnaire results on determining when to carry out grinding and tamping

TrafikVerket

Grinding

Factors that determine when and where to carry out a grinding operation

- Traffic load for preventive grinding
- Defect size for preventive & corrective grinding
- Longitudinal & traverse measurement extent and when size exceeds limit
- After new rails been installed in track

Inspection data – condition based

Please describe the inspection data that is used to determine where and when to grind. Please state what limits are used on the data collected, how the data is collected and how these limits and the time to correct vary depending upon line type (eg mixed traffic, freight only, mainline, rural line). Please include actual numerical limits and reference to the relevant standard.

Grinding requirements

- Longitudinal (30-80 mm) Short pitch corrugation; (80-300mm) short waves shall be removed completely and the grinding shall reach at least a depth of 0.1 mm under the surface in the troughs;
- Medium and long waves: (0.3-1,0 m) and (1,0 - 3.0 m)
- Travers head profile shall be within +/- 0.3 mm or +/- 0.5 mm in relation to the nominal profiles

Traffic data (MGT) – predetermined maintenance

If grinding is based on predetermined figures based on curve radii and MGT, please state these figures and again how this varies based on line. Please include actual numerical values and references to relevant standards.

Preventive grinding is used for new rails within one year after installation or after maximum 5 MGT traffic load. Later on the grinding continues in a cyclic manner depending on the defect sizes & this preventive type of grinding is called maintenance grinding.



Seasons

Do seasons and weather have an impact on the ability to grind? Are there any particular seasons where this activity is not possible, please state the start and end dates of the periods when this maintenance activity is impossible and describe how it varies based on location.

In the northern Sweden, grinding activities are not undertaken during winter period due to snow. The period is between Nov-April.

Other

Please describe any other factors that impact on the ability to carry out grinding operations

In Sweden, the Contractor plays an important role, as they are free to come and perform longitudinal and traverse measurements, when the defects are given without the extent and sizes.



Network Rail

Grinding

Factors that determine when and where to carry out a grinding operation

Inspection data – condition based

Please describe the inspection data that is used to determine where and when to grind. Please state what limits are used on the data collected, how the data is collected and how these limits and the time to correct vary depending upon line type (eg mixed traffic, freight only, mainline, rural line). Please include actual numerical limits and reference to the relevant standard.

In terms of the large plain line grinding machines these will be booked based on the MGT figures below. However, manual intervention may be required to correct the track based on the following requirements.

Track geometry requirements:

Inspection frequency

Table 1 – Ultrasonic Testing Frequencies

Track Category	Pedestrian UT Inspection Interval (weeks) Plain Line	Pedestrian UT Inspection Plain Line Maximum Interval Between Inspections (weeks)	Pedestrian UT Interval S&C, Adjustment Switches, Level Crossings, Tunnels, Joints (see 4.3). (weeks)	Pedestrian UT Inspection S&C, Adjustment Switches, Level Crossings, Tunnels, Joints (see 4.3). Maximum Interval Between Inspections (weeks)	Interval (weeks) UTU	Maximum Interval UT Inspection (weeks) Plain Line UTU Compliant Routes
1A	13	15	8	10	8	10
1	26	30	13	15	8	13
2	52	56	26	30	16	26
3	104	112	52	56	26	34
4	104	112	52	56	26	34
5	104	112	52	56	26	34
6	104	112	104	112	52	78

NOTE: These maximum intervals need only be applied to the track category of segments of a route, not whole routes.

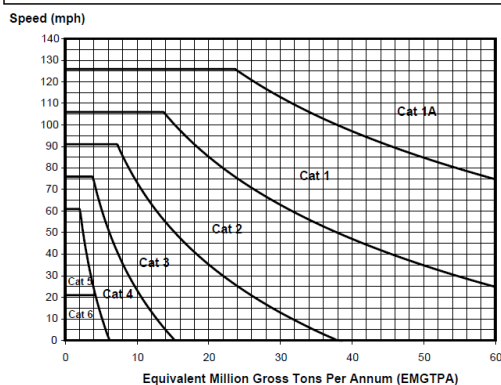




Table 2 – Verification Timescales – ultrasonic test unit (UTU) Routes

Suspect priority	Nominal suspected defect type	Reported by Sperry	Verification timescale				Mitigation Where not verified in specified timescale
			Cat 1A, 1 & 2	Cat 3, 4, 5, & 6	Where suspect lies within pedestrian segment		
					Cat 1A, 1 & 2	Cat 3, 4, 5 & 6	
P1*	Any crack passing through a bolt-hole, or significant horizontal crack in head	As soon as identified or no later than 4hrs after start of analysis shift	4 hrs	24 hrs	8 hrs	36 hrs	Impose 20 mph ESR to cover ±110 yards of reported mileage
P1	1A, 2A (36hr removal defects)	As soon as identified or no later than 8hrs after start of analysis shift	8 hrs	24 hrs	16 hrs	36 hrs	Impose 20 mph ESR to cover ±110 yards of reported mileage
P2	1B, 2B, 2C*, 3B (7 day removal defects)	Within 48hrs of start of analysis shift	7 days	14 days	14 days	28 days	Apply for dispensation through PMSE
P3	3H, 2C, 3C, 2F, 3F, 3G (13 week removal defects)	Within 48hrs of start of analysis shift	14 days	28 days	28 days	56 days	Apply for dispensation through PMSE
P4	Defects below reporting limits, provided for information only	Within 48 hrs of start of analysis shift	For information only				
NARMO	Features where the ultrasonic signature remains unchanged	Within 48 hrs of start of analysis shift	For information only				
IFC shall log the suspect and advise the RME or on-call delegated person of all P1* and P1 suspects reported by Sperry.							

Rails containing rolling contact fatigue with cracks that have propagated to a vertical depth greater than 5 mm cannot be treated by hand grinding and shall be replaced. The depth of grinding shall be measured as the vertical reduction in the overall height of the rail.

Train-based grinding

The principal objectives of grinding rail are as follows:

- a) to achieve the required transverse profile and produce a regular and consistent running band towards the crown of the rail to manage conicity and reduce forces at the wheel rail interface;
- b) to correct and impose a transverse profile that reduces contact stresses on the gauge corner and shoulder of the rail;
- c) to remove localised misalignment at welds and other track features;
- d) to remove the fatigue damaged surface of the rail, which has or is likely to initiate rolling contact fatigue cracks.
- e) to control the longitudinal profile of the rail to control the formation an growth of corrugation.

D2.1 High level breakdown of maintenance activities

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Table 9 – Plain line profile tolerances and minimum metal removal

Track location	Target Profile (Profile definition angle range)	Tolerances for: (Tolerance angle range)	Minimum metal removal (MMR to be achieved in the angle range)
High Rail	NR HR 1 (-5° to 50°)	+0.3 to - 0.3 mm (-5° to 50°)	0.2 mm (see footnote 2) (0° to 45°)
Low Rail	NR 113A (-5° to 50°)	+0.3 to - 0.3 mm (-5° to 50°) (see footnotes 1 and 3)	0.1 mm (see footnotes 1 and 2) (0° to 45°)
Straight Track - Both Rails	NR 113A (-5° to 50°)	+0.3 to - 0.3 mm (-5° to 50°) (see footnote 3)	0.1 mm (see footnote 2) (0° to 45°)
Corrugated Track – Both Rails	NR HR1 or NR 113A (-5° to 50°)	+0.3 to - 0.3 mm (-5° to 50°) (see footnote 3)	0.2 mm (0° to 45°)

Footnotes:

In track sections where clearance for the grinding stones is limited due to the presence of trackside equipment such as conductor rails and axle counters etc. the railhead assessment of transverse profile can be reduced from 50° to 45°

1: Total passes for the low rail of a curve shall be equivalent to the total passes required to produce the high rail target profile. If the target NR 113A cannot be achieved on the low rail within this total number of passes the minimum metal removal of 0.1 mm between 0° to 45° shall be achieved.

2: In order to maximize productivity, Network Rail will instruct, on a site and/or route specific basis, where the profile, but not the minimum metal removal, need to be achieved. Where necessary this may result in little or no metal removal from the centre of the railhead. For in-traffic one pass grinding the above criteria might not be reached in one grinding cycle.

3: Due to severe rolling contact fatigue (RCF) and corrugation, it is permissible to use NR HR1 for high rail and NR 113A on low rail and straight track with a tolerance of +0 to -0.6 mm except on the centre of the rail where it is +0.3 to -0.3 mm. To get a more aggressive grind to the same target profile, the aim is to keep the profile close to the lower (-0.6) tolerance. The need for grinding as above has to be agreed with NDS.

Minimum actions

Minimum Actions To Be Taken Upon The Discovery Of Rail Defects In All Steels

Table B.6 – Rolling contact fatigue (RCF) in machined rail			Track Cat 1A, 1, 2 and 3		Track Cat 4, 5 and 6	
Defect Type	Defect Description	Dimensions / Threshold	Within FPL	Outside FPL	Within FPL	Outside FPL
6	Light and moderate RCF in machined rail	Visual Crack Length	Y26 Visual Only	Y26 Visual Only	Y52 Visual Only	Y52 Visual Only
6	Heavy and severe RCF in machined rail	No Ultrasonic Response	R4	R4	R8	R8
6	Heavy and severe RCF in machined rail	≤5mm deep measured using USA	4R4	4R4	4R4	4R4
6	Heavy and severe RCF in machined rail	>5mm deep measured using USA	1B	1B	1B	1B

Notes;

- Machined rail refers to the portion of a switch blade or adjustment switch which cannot be fully tested using U15 due to rail head profile.
- Light and moderate RCF in machined rail requires only a visual inspection to be undertaken at the above frequencies as specified in Table B2.
- Heavy and severe RCF in machined rail requires both a visual and ultrasonic inspection using USA to be undertaken at the above frequencies.
- A 4R4 action requires that a 40 mph TSR is applied and the rail replaced or defects ground out up to 5mm maximum vertical depth, retest at 4 weekly intervals until replaced or ground out. If defects are removed completely run at linespeed and retest as normal. If defects have not been removed completely after 5mm has been removed (i.e. if the defect is found to be more than 5mm deep during grinding) impose 20mph ESR and change rail as soon as practicable.
- The depth of any transverse defect to be measured using USA procedure.
- Where multiple defects are detected within 5m on the same rail the most onerous MAC shall be applied to all defects less than 5m apart. Defects that only require a retest or are below actionable limits need not be actioned with the more onerous MAC.
- MAC timescales may need to be shortened along with the implementation of additional mitigations if local track conditions are poor.



Minimum Actions To Be Taken Upon The Discovery Of Rail Defects In All Steels

Table B.7 – Rolling contact fatigue (RCF) in full head section rail			Track Cat 1A, 1, 2 and 3		Track Cat 4, 5 and 6	
Defect Type	Defect Description	Dimensions / Threshold	Within FPL	Outside FPL	Within FPL	Outside FPL
7	Light and moderate RCF in full head section rail	No ultrasonic response >1.5 divisions on the timescale	Y26	Y26	Y52	Y52
7	Light and moderate RCF in full head section rail	>1.5 divisions on the timescale and 0 to 25% FSH from any probe or combinations of probes	3C	2C	3K	2K
7	Light and moderate RCF in full head section rail	>1.5 divisions on the timescale and >25 to 50% FSH from any probe or combinations of probes	3H	3H	3C	2C
7	Light and moderate RCF in full head section rail	>1.5 divisions on the timescale and >50% FSH from any probe or combinations of probes	1A	1A	1B	1B
7	Light and moderate RCF in full head section rail	U15 untestable, >50mm long with >50% loss of FSH from rail bottom signal with 6dB gain added	1A	1A	1B	1B
7	Heavy RCF in full head section rail	No ultrasonic response >1.5 divisions on the timescale	R8	R8	R26	R26
7	Severe RCF in full head section rail	No ultrasonic response >1.5 divisions on the timescale	R4	R4	R26	R26
7	Heavy and severe RCF in full head section rail	>1.5 divisions on the timescale and 0 to 25% FSH from any probe or combinations of probes	3C	2C	3C	2C
7	Heavy and severe RCF in full head section rail	>1.5 divisions on the timescale and >25 to 50% FSH from any probe or combinations of probes	3B	2B	3H	2H
7	Heavy and severe RCF in full head section rail	>1.5 divisions on the timescale and >50% FSH from any probe or combinations of probes	1A	1A	1B	1B
7	Heavy and severe RCF in full head section rail	U15 untestable, >50mm long with >50% loss of FSH from rail bottom signal with 6dB gain added	1A	1A	1B	1B

Tables B.15 – Minimum action codes (MAC)

Code	Minimum action to be taken		Applicability Guide
0	Block the line		
1	Impose 20mph ESR and fit emergency clamped fanplates where possible		
2	Fit emergency clamped fanplates		
3	No emergency action required		
4	Impose a 40mph TGR (as soon as possible after publication in the weekly operating notice)		
5	Impose 5mph ESR		
7	Appoint Watchman		NR/L2/TRK/G54
9	Ban to Facing moves		NR/L2/TRK/G53
A	Remove defect	within 36 hours	
B	Remove defect	within 7 days	
C	Remove defect	within 13 weeks	
C'	Remove defect	within 7 days if clamping is not possible	
D1	Weld repair	within 7 days	
D2	Weld repair	within 2 weeks	
E	Thermit weld	within 7 days	
F1	Weld repair	within 7 days	NR/L2/TRK/G53
F4	Weld repair	within 4 weeks	
F13	Weld repair	within 13 weeks	
G	Retest	within 13 weeks	
H	Remove defect	within 4 weeks	
I	Remove defect	within 26 weeks	
L	Remove defect	within 52 weeks	
M	Retest (Ultrasonic)	to specified frequency	
M0	Retest (Ultrasonic)	Daily	RCF
M1	Retest (Ultrasonic)	weekly	RCF
M4	Retest (Ultrasonic)	every 4 weeks	RCF
M13	Retest (Ultrasonic)	every 13 weeks	RCF
N	Ultrasonic test	within specified interval	
N0	Ultrasonic test	within 36 hours	RCF
N1	Ultrasonic test	within 7 days	RCF
N4	Ultrasonic test	within 4 weeks	RCF
N4 (USA)	Ultrasonic test using USA	within 4 weeks	RCF
P	Reprofile or Weld Repair and retest or remove	within 4 weeks	
R1	Retest (Visual & Ultrasonic)	weekly	RCF
R4		every 4 weeks	RCF
R8		every 5 weeks	RCF
R13		every 13 weeks	RCF
R26		every 26 weeks	RCF
R39		every 39 weeks	RCF
R52		every 52 weeks	RCF
R104		every 104 weeks	RCF
4R4		Apply 40mph TGR and retest every 4 weeks	RCF
S13	Straighten and/or profile or remove	within 13 weeks	NR/L2/TRK/G32
S26		within 26 weeks	NR/L2/TRK/G32

Table B.15 – Minimum action codes (MAC) (concluded)

Code	Minimum action to be taken		Applicability Guide
V	Remove defect	Timescale determined by the Principal Maintenance Support Engineer (Track) (within 13 weeks max.)	
W	Grind / Reprofile / Dress / mm repair	no timescale	TRK/132
W#	Grind to correct profile	within 3 days	NR/L2/TRK/G53
W1	Grind to correct profile	within 7 days	NR/L2/TRK/G53
W1 Y4	Grind + Re-inspect	Grind within 7 days, Re-inspect every 4 weeks	NR/L2/TRK/G53
W2	Grind to correct profile	within 14 days	NR/L2/TRK/G53
W13	Grind	within 13 weeks	NR/L2/TRK/G53
W26	Grind	within 26 weeks	NR/L2/TRK/G53
W52	Grind	within 52 weeks	NR/L2/TRK/G53
X0	Change rail or S&C component	within 36 hours	NR/L2/TRK/G53
X1		within 7 days	NR/L2/TRK/G54
X4		within 4 weeks	
X13		within 13 weeks	
Y0	Re-inspect	Daily	NR/L2/TRK/G54
Y#	Re-inspect	twice weekly	NR/L2/TRK/G54
Y1	Re-inspect	weekly	NR/L2/TRK/G54
Y4	Re-inspect	every 4 weeks	RCF & NR/L2/TRK/G54
Y8	Re-inspect	every 8 weeks	RCF & NR/L2/TRK/G54
Y13	Re-inspect	every 13 weeks	RCF
Y26	Re-inspect	every 26 weeks	RCF
Y52	Re-inspect	every 52 weeks	RCF
Notes			
i. The numeric prefixes for emergency actions can be applied in combination. E.g. 57 would indicate the requirement to impose a 5 mph ESR and appoint a watchman.			
ii. The codes for monitoring or remedial action can be applied in combination. E.g. W1 Y4 would indicate grind within 7 days and re-inspect every 4 weeks.			
iii. The Applicability Guide indicates the subject area where the code is most likely to be applied. This does not preclude the code being used in other situations. A blank in this column indicates that the code is for general use.			

Traffic data (MGT) – predetermined maintenance

If grinding is based on predetermined figures based on curve radii and MGT, please state these figures and again how this varies based on line. Please include actual numerical values and references to relevant standards.

Maintenance grinding is carried out at the following frequencies

- every 15MGT for radii <2500m
- every 45MGT for radii >2500m

Due to the long lead times for booking grinding machines maintenance grinding is carried out based primarily on MGT rather than inspection data.



Seasons

Do seasons and weather have an impact on the ability to grind? Are there any particular seasons where this activity is not possible, please state the start and end dates of the periods when this maintenance activity is impossible and describe how it varies based on location.

No seasonal restrictions on grinding operations in the UK, only exceptionally dry weather may cause a restriction where the fire risk of line side vegetation is too great.

Other

Please describe any other factors that impact on the ability to carry out grinding operations



Tamping

Factors that determine when and where to carry out a tamping operation

Inspection data – condition based

Please describe the inspection data that is used to determine where and when to tamp. Please state what limits are used on the data collected, how the data is collected and how these limits and the time to correct vary depending upon line type (eg mixed traffic, freight only, mainline, rural line). Please include actual numerical limits and reference to the relevant standard.

Inspection data identifies the areas of priority with the track geometry measurements providing a ranking of the quality of the track in terms of good, satisfactory, poor, very poor and if the value exceeds the very poor maximum value, it is classed as super red. This track geometry data allows the track engineers and asset managers to prioritise tamping and stoneblowing, based upon their targets for their different lines. Due to the need to plan tamping machines and possessions up to 2 years ahead track geometry data collected in the intermediate period will valid or otherwise the tamping strategy and in the cases where unacceptable speed restrictions may be applied take short term possessions and reprioritise the tamping schedule.

Table 6 – Geometry Quality Band standard deviation values (in mm)																
Speed band		35 m wavelength filter								70 m wavelength filter						
		Top				Line				Top			Line			
↓	Speed range mph	Good	Satis	Poor	Very Poor	Good	Satis	Poor	Very Poor	Good	Satis	Poor	Good	Satis	Poor	
1	10–20	5.2	7.4	8.3	9.9	3.0	5.0	5.6	9.9							
2	25–30	4.3	6.1	7.0	7.7	2.7	4.5	5.2	8.6							
3	35–40	4.1	5.8	6.7	7.2	2.5	4.1	4.7	7.9							
4	45–50	3.8	5.4	6.3	6.7	2.2	3.7	4.5	7.3							
5	55–60	3.5	5.0	5.9	6.3	2.0	3.3	4.2	7.0							
6	65–70	3.0	4.3	5.4	6.0	1.7	2.9	3.6	6.7							
7	75–80	2.7	3.8	4.8	5.7	1.5	2.5	3.1	6.3	3.7 †	5.7 †	6.3 †	3.0 †	5.2 †	5.7 †	
8	85–95	2.2	3.2	4.0	5.3	1.3	2.1	2.7	6.0	3.3	5.1	5.6	2.6	4.5	5.0	
9	100–110	1.9	2.7	3.4	5.0	1.1	1.8	2.3	5.7	2.9	4.5	5.0	2.2	3.8	4.3	
10	115–125	1.7	2.4	3.0	4.7	1.0	1.6	2.0	5.0	2.4	4.0	4.4	1.8	3.2	3.7	

† These values apply to 80 mph track only.

† These values apply to 80 mph track only.

Table 7 – Maximum eighths inspection timescales	
Speed Band of the Eighth	Inspection timescales
1 to 5 (5 mph to 60 mph)	21 days
6 to 8 (65 mph to 95 mph)	14 days
9 and 10 (100 mph to 125 mph)	7 days

Eighths within the Maximum band (“SuperReds”)

Where standard deviations within the Maximum (often referred to as “SuperRed”) band are measured, the following measures shall be put in place.



Maximum eighths shall be inspected by the Section Manager (Track) or Track Maintenance Engineer within to establish a regime of monitoring and/or mitigation measures commensurate with the underlying track geometry and site conditions.

The regime shall be reassessed at each subsequent analogue trace review whilst the eighth remains within the Maximum band.

The Section Manager (Track) shall review the integrity of the regime with the Track Maintenance Engineer for each eighth at least every six months. All adverse trends identified shall be reported for further review with Principal Maintenance Support Engineer (Track).

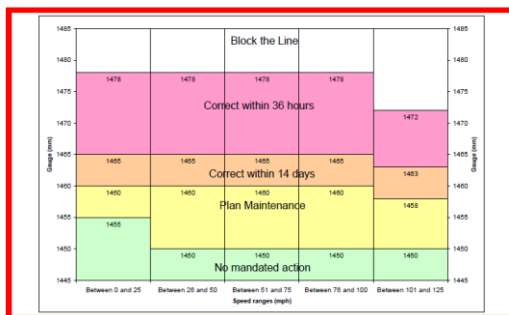


Figure A.1 – Wide gauge limits

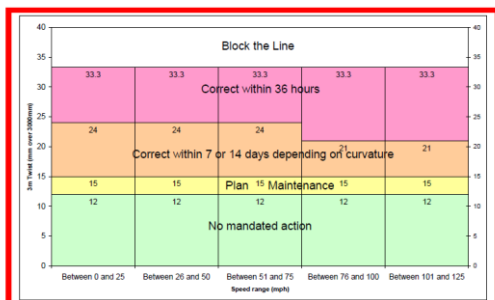


Figure A.2 – 3 m Twist limits

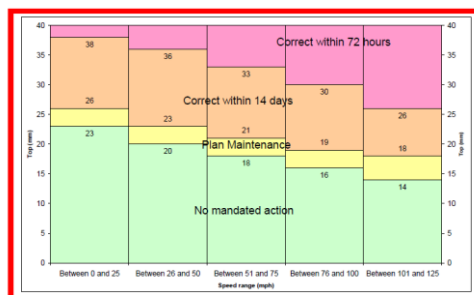


Figure A.3 – Top limits

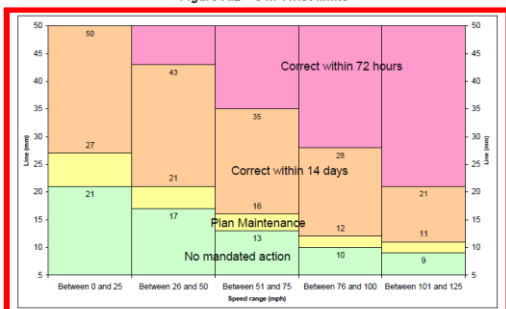


Figure A.4 – Line limits

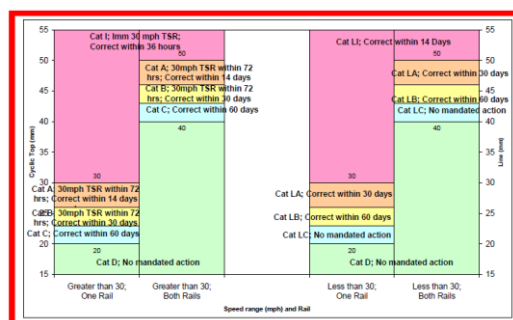


Figure A.5 – Cyclic Top limits

Traffic data (MGT) – predetermined maintenance



If tamping is based on predetermined figures based MGT and location, please state these figures and again how this varies based on line. Please include actual numerical values and references to relevant standards.

Although MGT is not specifically used to identify tamping sites, due to the long planning timescales for the tamping machines, the plain line tampers will be booked based on assumed degradation rates of the track geometry, known problem spots and the track geometry data showing where problems are emerging. This predetermined list is based condition and current performance of the track against required performance which will be route specific.

Seasons

Do seasons and weather have an impact on the ability to tamp? Are there any particular seasons where this activity is not possible, please state the start and end dates of the periods when this maintenance activity is impossible and describe how it varies based on location.

Tamping may only be carried out when the temperature is less than 32degC for the 5 day period following the tamping operation, due to the risk of rail buckling. Due to the long timescales to book the tamping machines and plan the possessions, this excludes the hottest summer months.

Tamping must also not be carried out at temperatures below -7degC due to the ballast freezing.

Other

Please describe any other factors that impact on the ability to carry out tamping operations and determine when tamping should be carried out.

Tamping operations are also limited by structure clearances in the UK, eg in tunnels where tamping may lift the track enough to create gauging issues.

Also in the UK tamping is considered as part of an overall asset management policy in combination with stoneblowing. Once stoneblowing has been used on a site that site should not be tamped. It is also considered that stoneblowing is better for older sites with degraded ballast.



Appendix 3 – Task compatibility results

ProRail

Plain Line Grinding

AUTOMAIN WP2

Within the same possession, which tasks can be combined with plain line grinding, please mark compatibility with a 'Y' for compatibility or a 'N' for definitely no compatibility.

Task	Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Adjustment - Switches	n	y 60 min	y 60min	y	n		
Arc Repairs	n	n	n	y	n		bridge repairs?
Ballast Regulating	n	n	n	y	n		
Ballast Replenishment	n	n	n	y	n		
Cable Work	n	y 60 min	y 60min	y	n		
Change Longitudinal Timbers	n	n	n	y	n		
Changing Sleepers & Timbers	n	n	n	y	n		
Continuously Welded Rail Stress Management	n	n	n	y	n		
Drainage Work	n	y 60 min	y 60min	y	y		
DTS (Dynamic Track Stabiliser)	n	y 60 min	y 60min	y	n		
Earthwork	n	n	n	y	y		
Eradication Of Wet Beds	n	n	n	y	n		
Flail Mowing Machine	n	y 60 min	y 60min	y	y		
Ground Investigation/Automatic Ballast Sampling	n	y 60 min	y 60min	y	y		
Hand Rail Grinding	n	y 60 min	y 60min	y	y		
Level Crossing Work	n	y 60 min	y 60min	y	n		
Level Crossing Work Signalling & Telecoms	n	n	n	y	n		
Level Crossing Work Track	n	y 60 min	y 60min	y	n		
Litter / Graffiti Clearance	n	y 60 min	y 60min	y	n		
Load / Unload Other Materials	n	y 60 min	y 60min	y	n		
Manual Correction	n	y 60 min	y 60min	y	n		
Mechanical Reballast (Maintenance Only/Gopher)	n	y 60 min	y 60min	y	n		
Mechanical Tamp	n	y 60 min	y 60min	y	n		
MOBC (Medium Output Ballast Cleaner)	n	y 60 min	y 60min	y	n		
Motorised Patrolling	n	y 60 min	y 60min	y	n		
Move Materials	n	y 60 min	y 60min	y	n		
MP & I Station Works	n	y 60 min	y 60min	y	n		
Off Track Work	y	y	y 60min	y	n		
Other Electrification & Power Work	n	y 60 min	y 60min	y	n		
OTP Ballast Regulator	n	y 60 min	y 60min	y	n		
Overhead Line Inspection	n	y 60 min	y 60min	y	n		
Overhead Line Renewals Work	n	y 60 min	y 60min	y	n		
Overhead line Work	n	y 60 min	y 60min	y	n		
Patrolling	n	y 60 min	y 60min	y	n		
Permanent Way Inspection	n	y	y	y	n		
Plain Line Grinding Train	n			y	n		
Plain Line Stoneblowing	n	y 60 min	y 60min	y	n		
Plain Line Tamping	n	y 60 min	y 60min	y	n		
Platform / Structures Gauging	n	y 60 min	y 60min	y	n		
Platform Enhancements	n	y 60 min	y 60min	y	n		
Points Inspection	n	y 60 min	y 60min	y	n		
Rail Adjusting	n	y 60 min	y 60min	y	n		



D2.1 High level breakdown of maintenance activities

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Task	Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Rail Changing	n	y 60 min	y 60min	y	n		
Rail Lubricators	n	y 60 min	y 60min	y	n		
Reballast - Trax	n	y 60 min	y 60min	y	n		
Reballast ABC	n	y 60 min	y 60min	y	n		
Reballast ABC - High Output	n	y 60 min	y 60min	y	n		
Reballast Formation - Trax	n	y 60 min	y 60min	y	n		
Remove Rail Defects	n	y 60 min	y 60min	y	n		
Renew Pads / Nylons	n	y 60 min	y 60min	y	n		
Rerail - Both Rails	n	y 60 min	y 60min	y	n		
Rerail - One Rail Only	n	y 60 min	y 60min	y	n		
Rerail Reballast - Trax	n	y 60 min	y 60min	y	n		
Rerail Resleep Reball Form - Trax	n	y 60 min	y 60min	y	n		
Rerail Resleeper - High Output	n	y 60 min	y 60min	y	n		
Rerail Resleeper (Concrete)	n	y 60 min	y 60min	y	n		
Rerail Resleeper (steel)	n	y 60 min	y 60min	y	n		
Rerail Resleeper Reballast - ABC	n	y 60 min	y 60min	y	n		
Rerail Resleeper Reballast - Trax	n	y 60 min	y 60min	y	n		
Rerail Resleeper Reballast (Maintenance Only)	n	y 60 min	y 60min	y	n		
Resignalling Work	n	y 60 min	y 60min	y	n		
Resleeper - High Output	n	y 60 min	y 60min	y	n		
Resleeper Reballast - ABC	n	y 60 min	y 60min	y	n		
Resleeper Reballast - Trax	n	y 60 min	y 60min	y	n		
Resleeper Reballast Form - Trax	n	y 60 min	y 60min	y	n		
Road Rail Vehicle Access Point Work	n	y 60 min	y 60min	y	n		
S&C - Abandonment	n	y 60 min	y 60min	y	n		
S&C - Complete Renewal	n	y 60 min	y 60min	y	n		
S&C - Drainage	n	y 60 min	y 60min	y	n		
S&C - Partial Renewal	n	y 60 min	y 60min	y	n		
S&C - Reballasting	n	y 60 min	y 60min	y	n		
S&C - Remodelled	n	y 60 min	y 60min	y	n		
S&C Grinding Train	n	y 60 min	y 60min	y	n		
S&C Maintenance	n	y 60 min	y 60min	y	n		
S&C Retimber	n	y 60 min	y 60min	y	n		
S&C Stoneblowing	n	y 60 min	y 60min	y	n		
S&C Tamping	n	y 60 min	y 60min	y	n		
Safety & Environment Work	n	y 60 min	y 60min	y	n		
Scrap Removal	n	y 60 min	y 60min	y	n		
Signalling & Telecoms Axle Counters	n	y 60 min	y 60min	y	n		
Signalling & Telecoms Track Circuits	n	y 60 min	y 60min	y	n		
Signalling & Telecom Work	n	y 60 min	y 60min	y	n		
Signalling & Telecoms Points	n	y 60 min	y 60min	y	n		
Station Work	n	y 60 min	y 60min	y	n		
Steel Sleeper Relay	n	y 60 min	y 60min	y	n		
Structures Examination	n	y 60 min	y 60min	y	n		
Structures Work	n	y 60 min	y 60min	y	n		
Survey Work	n	y 60 min	y 60min	y	n		
Tamp And DTS (Dynamic Track Stabiliser)	n	y 60 min	y 60min	y	n		
Test Train Operation	n	y 60 min	y 60min	y	n		
Third Rail Inspection	n	y 60 min	y 60min	y	n		
Third Rail Renewal	n	y 60 min	y 60min	y	n		

D2.1 High level breakdown of maintenance activities

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Task		Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Third Rail Work	n		y 60 min	y 60min	y	n		
Track Maintenance	n		y 60 min	y 60min	y	n		
Tunnel Examination	n		y 60 min	y 60min	y	n		
Tunnel Work	n		y 60 min	y 60min	y	n		
Ultrasonic Rail Flaw Detector Operator Inspections	n		y 60 min	y 60min	y	n		
Under Track Work	n		y 60 min	y 60min	y	n		
Unload Ballast	n		y 60 min	y 60min	y	n		
Unload Continuously Welded Rail	n		y 60 min	y 60min	y	n		
Vegetation Clearance (Non-Flail)	n		y 60 min	y 60min	y	n		
Verse Testing	n		y 60 min	y 60min	y	n		
Washer Maintenance	n		y 60 min	y 60min	y	n		



Network Rail

Plain Line Grinding

AUTOMAIN WP2

General comments: No work can be carried out on a line parallel to that on which grinding is taking place due to the risk of sparks and fire risk

General comments on times before and after grinding. No work can be carried out immediately behind the grinding train due to the grinder perhaps having to reverse to extinguish fires or the need to reverse for multiple passes.

No speed restrictions are generally applied after plain line grinding

Within the same possession, which tasks can be combined with plain line grinding, please mark compatibility with a 'Y' for compatibility or a 'N' for definitely no compatibility.

Task	Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Adjustment - Switches	N	Y	Y	N	Y		
Arc Repairs	N	Y	Y	N	Y		
Ballast Regulating	N	Y	Y	N	Y		
Cable Work	N	Y	Y	N	Y		
Change Longitudinal Timbers	N	N	N	N	Y		
Changing Sleepers & Timbers	N	Y	N	N	Y		
Continuously Welded Rail Stress Management	N	Y	Y	N	Y		
Drainage Work	N	Y	Y	N	Y		
DTS (Dynamic Track Stabiliser)	N	N	N	N	Y		
Earthwork	N	Y	Y	N	Y		
Eradication Of Wet Beds	N	Y	N	N	Y		
Flail Mowing Machine	N	N	Y	N	Y		
Ground Investigation/Automatic Ballast Sampling	N	Y	Y	N	Y		
Hand Rail Grinding	N	N	N	N	Y		
Level Crossing Work Signalling & Telecoms	N			N	Y		
Level Crossing Work Track	N	Y	Y	N	Y		
Litter / Graffiti Clearance	N	Y	Y	N	Y		
Load / Unload Other Materials	N	Y	Y	N	Y		
Manual Correction	N	N	Y	N	Y		
Mechanical Reballast (Maintenance Only/Gopher)	N	Y	N	N	Y		
MOBC (Medium Output Ballast Cleaner)	N	N	N	N	Y		
Motorised Patrolling	N	Y	Y	N	Y		
Overhead Line Inspection	N	Y	Y	N	Y		
Overhead Line Renewals Work	N	Y	Y	N	Y		
Overhead line Work	N	Y	Y	N	Y		
Patrolling	N	Y	Y	N	Y		
Permanent Way Inspection	N	N	Y	N	Y		
Plain Line Grinding Train	N	N/A	N/A	N	Y		
Plain Line Stoneblowing	N	Y	N	N	Y		
Plain Line Tamping	N	Y	N	N	Y		
Platform / Structures Gauging	N	Y	Y	N	Y		
Points Inspection	N	Y	Y	N	Y		
Rail Adjusting	N	Y	N	N	Y		
Rail Changing	N	Y	N	N	Y		
Rail Lubricators	N	Y	Y	N	Y		
							Fire risk carrying out before grinding

D2.1 High level breakdown of maintenance activities

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Task	Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Reballast - Trax	N	Y	N	N	Y		
Reballast ABC	N	Y	N	N	Y		
Reballast ABC - High Output	N	Y	N	N	Y		
Reballast Formation - Trax	N	Y	N	N	Y		
Remove Rail Defects	N	Y	N	N	Y		
Renew Pads / Nylons	N	Y	N	N	Y		
Rerail - Both Rails	N	Y	N	N	Y		
Rerail - One Rail Only	N	Y	N	N	Y		
Rerail Reballast - Trax	N	N	N	N	Y		Always has it's own worksite
Rerail Resleep Reball Form - Trax	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper - High Output	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper (Concrete)	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper (steel)	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper Reballast - ABC	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper Reballast - Trax	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper Reballast (Maintenance Only)	N	N	N	N	Y		Always has it's own worksite
Resignalling Work	N	N	N	N	Y		Always has it's own worksite
Resleeper - High Output	N	N	N	N	Y		Always has it's own worksite
Resleeper Reballast - ABC	N	N	N	N	Y		Always has it's own worksite
Resleeper Reballast - Trax	N	N	N	N	Y		Always has it's own worksite
Resleeper Reballast Form - Trax	N	N	N	N	Y		Always has it's own worksite
Road Rail Vehicle Access Point Work	N	Y	Y	N	Y		
S&C - Abandonment	N			N	Y		Will not be in the same location as plain line grinding
S&C - Complete Renewal	N			N	Y		Will not be in the same location as plain line grinding
S&C - Drainage	N			N	Y		Will not be in the same location as plain line grinding
S&C - Partial Renewal	N			N	Y		Will not be in the same location as plain line grinding
S&C - Reballasting	N			N	Y		Will not be in the same location as plain line grinding
S&C - Remodelled	N			N	Y		Will not be in the same location as plain line grinding
S&C Grinding Train	N			N	Y		Will not be in the same location as plain line grinding
S&C Maintenance	N			N	Y		Will not be in the same location as plain line grinding
S&C Retimber	N			N	Y		Will not be in the same location as plain line grinding
S&C Stoneblowing	N			N	Y		Will not be in the same location as plain line grinding
S&C Tamping	N			N	Y		Will not be in the same location as plain line grinding
Scrap Removal	N	Y	Y	N	Y		
Signalling & Telecoms Axle Counters	N	Y	Y	N	Y		
Signalling & Telecoms Track Circuits	N	Y	Y	N	Y		
Signalling & Telecom Work	N	Y	Y	N	Y		
Steel Sleeper Relay	N	N	N	N	Y		
Structures Examination	N	N	N	N	Y		
Structures Work	N	N	N	N	Y		
Survey Work	N	Y	Y	N	Y		
Test Train Operation	N	N	N	N	Y		
Third Rail Inspection	N	Y	Y	N	Y		
Third Rail Renewal	N	Y	Y	N	Y		



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Task		Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Third Rail Work	N		Y	Y	N	Y		
Track Maintenance	N		Y	Y	N	Y		
Tunnel Examination	N		N	N	N	Y		
Tunnel Work	N		N	N	N	Y		
Ultrasonic Rail Flaw Detector Operator Inspections	N		Y	N	N	Y		
Under Track Work	N		N	N	N	Y		
Unload Ballast	N		N	N	N	Y		
Unload Continuously Welded Rail	N		N	N	N	Y		
Vegetation Clearance (Non-Frail)	N		N	Y	N	Y		Fire risk carrying out before grinding
Verse Testing	N		Y	Y	N	Y		
Washer Maintenance	N		N	N	N	Y		Can be carried out in sidings only

D2.1 High level breakdown of maintenance activities

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Plain Line Tamping

AUTOMAIN WP2

General comments: Due to the small distance between the tracks in the UK any activity that goes over the inside running rail cannot be carried out at the same time as tamping for safety reasons. However, many activities can be carried out on the cess side of a parallel track or within the cess of a parallel track.

General comments on times before and after tamping. During the period booked for a tamping possession, only tamping can be carried out due to the tamper having to carryout a measurement run and then reverse through to tamp and then travel back along the same line again for a post tamp measurement run. So other work can be carried out before the tamp begins it's first measurement run and after it's last measurement run.

Generally no speed restrictions are applied after a tamping operation, unless a speed restriction had been applied prior to grinding. If this is the case the speed restriction remains until after the measurement train has remeasured that piece of track to verify the correction.

Within the same possession, which tasks can be combined with plain line tamping, please mark compatability with a 'Y' for compatability or a 'N' for definitely no compatability.

Task	Can be carried out on the same line at the same time as plain line tamping	Can be carried out on the same line prior to plain line tamping If YES how much time is required between task finishing and the tamping machine being able to run on the same line	Can be carried out on the same after the plain line tamping If YES how much time is required between tamping machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line tamping	Can be carried out in the same possession as a plain line tamping operation	Minimum time required for task including setup times	Comments
Adjustment - Switches	N	Y	Y	N	Y		Cannot be carried out on a parallel line due to vibration effecting switch adjustment
Arc Repairs	N	Y	Y	N	Y		Cannot be carried out on a parallel line due to vibration effecting welding
Ballast Regulating	N	Y	Y	Y	Y		Can be carried out on a parallel track as long as not in the 6ft between tracks
Cable Work	N	Y	Y	Y	Y		
Change Longitudinal Timbers	N	N	N	N	Y		It does not make sense to replace sleepers after tamping on the same line. Also cannot carry out on a parallel line as it would mean entering the 6ft between tracks endangering personnel
Changing Sleepers & Timbers	N	Y	N	N	Y		
Continuously Welded Rail Stress Management	Y	Y	Y	Y	Y		On parallel line can do on cess side only
Drainage Work	N	Y	Y	Y	Y		
DTS (Dynamic Track Stabiliser)	N	N	Y	Y	Y		
Earthwork	Y	Y	Y	Y	Y		
Eradication Of Wet Beds	N	Y	N	N	Y		
Flail Mowing Machine	N	N	Y	N	Y		Cannot be carried out before due to vegetation on line may effect the tamper traction and effect the tacho positioning systems
Ground Investigation/Automatic Ballast Sampling	N	Y	Y	Y	Y		
Hand Rail Grinding	N	N	Y	Y	Y		On parallel line can do on cess side rail only
Level Crossing Work Signalling & Telecoms	N	N	N	N	Y		Level Crossing Panels will go over both tracks
Level Crossing Work Track	N	Y	Y	N	Y		
Litter / Graffiti Clearance	Y	Y	Y	Y	Y		Can be carried out on a parallel line as long as it doesn't go over the 6ft
Load / Unload Other Materials	N	Y	Y	Y	Y		
Manual Correction	N	N	N	N	Y		Difficult to carry out on a parallel line without going over the 6ft
Mechanical Reballast (Maintenance Only/Gopher)	N	Y	N	N	Y		
MOBC (Medium Output Ballast Cleaner)	N	N	N	N	Y		Demands it's own worksite
Motorised Patrolling	N	Y	Y	Y	Y		
Overhead Line Inspection	N	Y	Y	Y	Y		
Overhead Line Renewals Work	N	Y	Y	N	Y		
Overhead line Work	N	Y	Y	N	Y		
Patrolling	N	Y	Y	Y	Y		
Permanent Way Inspection	N	N	Y	N	Y		
Plain Line Grinding Train	N	N	Y	N	Y		
Plain Line Stoneblowing	N	N	N	N	Y		



D2.1 High level breakdown of maintenance activities

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Task	Can be carried out on the same line at the same time as plain line tamper	Can be carried out on the same line prior to plain line tamper If YES how much time is required between task finishing and the tamping machine being able to run on the same line	Can be carried out on the same after the plain line tamper If YES how much time is required between tamping machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line tamper	Can be carried out in the same possession as a plain line tamping operation	Minimum time required for task including setup times	Comments
Plain Line Tamping	N	N/A	N/A	Y	Y		
Platform / Structures Gauging	N	Y	Y	Y	Y		
Points Inspection	N	Y	Y	N	Y		
Rail Adjusting	N	Y	N	Y	Y		On parallel line can do on cess side rail only
Rail Changing	N	Y	N	Y	Y		On parallel line can do on cess side rail only
Rail Lubricators	N	Y	Y	Y	Y		On parallel line can do on cess side rail only
Reballast - Trax	N	Y	N	N	Y		Always has it's own worksite
Reballast ABC	N	Y	N	N	Y		Always has it's own worksite
Reballast ABC - High Output	N	Y	N	N	Y		Always has it's own worksite
Reballast Formation - Trax	N	Y	N	N	Y		Always has it's own worksite
Remove Rail Defects	N	Y	N	Y	Y		On parallel line can do on cess side rail only
Renew Pads / Nylons	N	Y	N	Y	Y		On parallel line can do on cess side rail only
Rerail - Both Rails	N	Y	N	N	Y		
Rerail - One Rail Only	N	Y	N	Y	Y		On parallel line can do on cess side rail only
Rerail Reballast - Trax	N	N	N	N	Y		Always has it's own worksite
Rerail Resleep Reball Form - Trax	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper - High Output	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper (Concrete)	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper (steel)	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper Reballast - ABC	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper Reballast - Trax	N	N	N	N	Y		Always has it's own worksite
Rerail Resleeper Reballast (Maintenance Only)	N	N	N	N	Y		Always has it's own worksite
Resignalling Work	N	N	N	N	Y		Always has it's own worksite
Resleeper - High Output	N	N	N	N	Y		Always has it's own worksite
Resleeper Reballast - ABC	N	N	N	N	Y		Always has it's own worksite
Resleeper Reballast - Trax	N	N	N	N	Y		Always has it's own worksite
Resleeper Reballast Form - Trax	N	N	N	N	Y		Always has it's own worksite
Road Rail Vehicle Access Point Work	N	Y	Y	N	Y		Will cross multiple tracks so cannot be carried out on parallel track at same time
S&C - Abandonment	N				Y		Will not be in the same location as plain line tamping
S&C - Complete Renewal	N				Y		Will not be in the same location as plain line tamping
S&C - Drainage	N				Y		Will not be in the same location as plain line tamping
S&C - Partial Renewal	N				Y		Will not be in the same location as plain line tamping
S&C - Reballasting	N				Y		Will not be in the same location as plain line tamping
S&C - Remodelled	N				Y		Will not be in the same location as plain line tamping
S&C Grinding Train	N				Y		Will not be in the same location as plain line tamping
S&C Maintenance	N				Y		Will not be in the same location as plain line tamping
S&C Retimber	N				Y		Will not be in the same location as plain line tamping
S&C Stoneblowing	N				Y		Will not be in the same location as plain line tamping
S&C Tamping	N				Y		Will not be in the same location as plain line tamping
Scrap Removal	N	Y	Y	Y	Y		On parallel line if does not go over into 6ft
Signalling & Telecoms Axle Counters	N	Y	Y	Y	Y		On parallel line if does not go over into 6ft
Signalling & Telecoms Track Circuits	N	Y	Y	Y	Y		On parallel line if does not go over into 6ft
Signalling & Telecom Work	N	Y	Y	Y	Y		On parallel line if does not go over into 6ft
Steel Sleeper Relay	N	N	N	N	Y		It does not make sense to replace sleepers after tamping on the same line. Also cannot carry out on a parallel line as it would mean entering the 6ft between tracks endangering personnel
Structures Examination	N	N	N	N	Y		Structures tend to cover multiple tracks
Structures Work	N	N	N	N	Y		Structures tend to cover multiple tracks
Survey Work	N	Y	Y	Y	Y		On parallel line if does not go over into 6ft
Test Train Operation	N	N	Y	N	Y		Vibration from tamping would affect test train
Third Rail Inspection	N	Y	Y	N	Y		
Third Rail Renewal	N	Y	Y	N	Y		

D2.1 High level breakdown of maintenance activities

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Task	Can be carried out on the same line at the same time as plain line tamper	Can be carried out on the same line prior to plain line tamper If YES how much time is required between task finishing and the tamping machine being able to run on the same line	Can be carried out on the same after the plain line tamper If YES how much time is required between tamping machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line tamper	Can be carried out in the same possession as a plain line tamping operation	Minimum time required for task including setup times	Comments
Third Rail Work	N	Y	Y	N	Y		
Track Maintenance	N	Y	Y	Y	Y		On parallel line can do on cess side rail only
Tunnel Examination	N	N	N	N	Y		
Tunnel Work	N	N	N	N	Y		
Ultrasonic Rail Flaw Detector Operator Inspections	N	Y	Y	Y	Y		On parallel line can do on cess side rail only
Under Track Work	N	N	N	N	Y		
Unload Ballast	N	N	N	Y	Y		
Unload Continuously Welded Rail	N	N	N	N	Y		On parallel line can do on cess side only
Vegetation Clearance (Non-Flail)	N	N	Y	Y	Y		Cannot be carried out before due to vegetation on line may effect the tamper traction and effect the tacho positioning systems
Verse Testing	N	Y	Y	Y	Y		On parallel line can do on cess side only
Washer Maintenance	N	N	N	N	Y		Carried out in sidings only



D2.1 High level breakdown of maintenance activities

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SNCF

Plain Line Grinding

AUTOMAIN WP2

Within the same possession, which tasks can be combined with plain line grinding, please mark compatibility with a 'Y' for compatibility or a 'N' for definitely no compatibility.

Task	Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder if YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder if YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Adjustment - Switches	Y	Y - 0'	Y - 0'	Y			
Arc Repairs	N	N	Y - 0'	Y			
Ballast Regulating	N	N	Y - 0'	Y			
Ballast Replenishment	N	N	Y - 0'	Y			
Cable Work	N	Y - 0'	Y - 0'	Y			
Change Longitudinal Timbers	N	N	N	Y			
Changing Sleepers & Timbers	N	N	N	Y			
Continuously Welded Rail Stress Management	N	N	N	Y			
Drainage Work	N	Y - 0'	Y - 0'	Y			
DTS (Dynamic Track Stabiliser)	N	Y - 0'	N	Y			
Earthwork	N	N	N	Y			
Eradication Of Wet Beds	N	N	N	Y			
Flail Mowing Machine	N	Y - 0'	N	Y			
Ground Investigation/Automatic Ballast Sampling	N	Y - 0'	Y - 0'	Y			
Hand Rail Grinding	N	N	N	Y			
Level Crossing Work							
Level Crossing Work Signalling & Telecoms	N	Y - 0'	Y - 0'	Y			
Level Crossing Work Track	N	N	Y - 0'	Y			Planking renewal
Litter / Graffiti Clearance	Y	Y - 0'	Y - 0'	Y			
Load / Unload Other Materials	N	N	Y - 0'	Y			
Manual Correction	N	N	N	Y			
Mechanical Reballast (Maintenance Only/Gopher)	N	N	N	Y			
Mechanical Tamp	N	N	N	Y			
MOBC (Medium Output Ballast Cleaner)	N	N	N	Y			
Motorised Patrolling	N	N	Y - 0'	Y			
Move Materials	N	N	Y - 0'	Y			
MP & I Station Works	?	?	?	?			
Off Track Work	Y	Y - 0'	Y - 0'	Y			
Other Electrification & Power Work	N	Y - 0'	Y - 0'	Y			
OTP Ballast Regulator	?	?	?	?			
Overhead Line Inspection	N	N	Y - 0'	Y			
Overhead Line Renewals Work	N	N	N	Y			
Overhead line Work	N	N	Y - 0'	Y			
Patrolling	N	Y - 0'	Y - 0'	Y			
Permanent Way Inspection	N	Y - 0'	Y - 0'	Y			
Plain Line Grinding Train							
Plain Line Stoneblowing	N	Y - 0'	N	Y			
Plain Line Tamping	N	Y - 0'	N	Y			
Platform / Structures Gauging	N	N	N	N			
Platform Enhancements	N	N	N	N			
Points Inspection	N	Y - 0'	Y - 0'	Y			
Rail Adjusting							



Plain Line Grinding

AUTOMAIN WP2

Within the same possession, which tasks can be combined with plain line grinding, please mark compatibility with a 'Y' for compatibility or a 'N' for definitely no compatibility.

Task	Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Rail Changing	N	Y - 45'	N	Y			
Rail Lubricators	N	N	Y - 0'	Y			
Reballast - Trax	N	N	N	Y			
Reballast ABC	N	N	N	Y			
Reballast ABC - High Output	N	N	N	Y			
Reballast Formation - Trax	N	N	N	Y			
Remove Rail Defects	N	Y	N	Y			
Renew Pads / Nylons	N	Y	N	Y			
Rerail - Both Rails	N	Y - 45'	N	Y			
Rerail - One Rail Only	N	Y - 45'	N	Y			
Rerail Reballast - Trax	N	N	N	Y			
Rerail Resleeper Reball Form - Trax	N	N	N	Y			
Rerail Resleeper - High Output	N	N	N	Y			
Rerail Resleeper (Concrete)	N	N	N	Y			
Rerail Resleeper (Steel)	N	N	N	Y			
Rerail Resleeper Reballast - ABC	N	N	N	Y			
Rerail Resleeper Reballast - Trax	N	N	N	Y			
Rerail Resleeper Reballast (Maintenance Only)	N	N	N	Y			
Resignalling Work	N	N	Y - 0'	Y			If limited intervention
Resleeper - High Output	N	N	N	Y			
Resleeper Reballast - ABC	N	N	N	Y			
Resleeper Reballast - Trax	N	N	N	Y			
Resleeper Reballast Form - Trax	N	N	N	Y			
Road Rail Vehicle Access Point Work							
S&C - Abandonment	N	N	N	Y			
S&C - Complete Renewal	N			Y			
S&C - Drainage	N			Y			
S&C - Partial Renewal	N			Y			
S&C - Reballasting	N			Y			
S&C - Remodelled	N			Y			
S&C Grinding Train	N			Y			
S&C Maintenance	N			Y			
S&C Retimber	N			Y			
S&C Stoneblowing	N			Y			
S&C Tamping	N			Y			
Safety & Environment Work	N	Y	Y - 0'	Y			
Scrap Removal							
Signalling & Telecoms Axle Counters	N	Y	Y - 0'	Y			
Signalling & Telecoms Track Circuits	N	Y	Y - 0'	Y			
Signalling & Telecom Work	N	Y	Y - 0'	Y			
Signalling & Telecoms Points	N	Y	Y - 0'	Y			
Station Work							

S&C not affected by plain line grinding. No technical incompatibility, but organisational pbs due to grinding speed vs long duration of works on S&C.



D2.1 High level breakdown of maintenance activities

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Task	Can be carried out on the same line at the same time as plain line grinder	Can be carried out on the same line prior to plain line grinder If YES how much time is required between task finishing and the grinding machine being able to run on the same line	Can be carried out on the same after the plain line grinder If YES how much time is required between grinding machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line grinder	Can be carried out in the same possession as a plain line grinding operation	Minimum time required for task including setup times	Comments
Steel Sleeper Relay	N	N	Y - 0'	Y			
Structures Examination	N	N	Y - 0'	Y			
Structures Work	N	Y	Y - 0'	Y			
Survey Work	N	Y	N	Y			
Tamp And DTS (Dynamic Track Stabiliser)	?	?	?	?			
Test Train Operation							
Third Rail Inspection							
Third Rail Renewal							
Third Rail Work							
Track Maintenance	N	N	Y - 0'	Y			
Tunnel Examination	N	N	Y - 0'	N			
Tunnel Work	N	N	Y - 0'	N			
Ultrasonic Rail Flaw Detector Operator Inspections	N	Y - 0'	Y - 0'	Y			
Under Track Work	N	N	N	Y			
Unload Ballast	N						Depends on the purpose of ballast unloading
Unload Continuously Welded Rail	N	N	N	N			
Vegetation Clearance (Non-Flail)	N	Y - 0'	Y - 0'	Y			Preferably before grinding
Verse Testing	?	?	?	?			
Washer Maintenance	?	?	?	?			



Plain Line Tamping

AUTOMAIN WP2

Within the same possession, which tasks can be combined with plain line tamping, please mark compatibility with a 'Y' for compatibility or a 'N' for definitely no compatibility.

Task	Can be carried out on the same line at the same time as plain line tamping	Can be carried out on the same line prior to plain line tamping If YES how much time is required between task finishing and the tamping machine being able to run on the same line	Can be carried out on the same after the plain line tamping If YES how much time is required between tamping machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line tamping	Can be carried out in the same possession as a plain line tamping operation	Minimum time required for task including setup times	Comments
Adjustment - Switches	Y	Y - 0'	Y - 0'	Y			
Arc Repairs	N	Y - 0'	Y - 0'	Y			
Ballast Regulating	N	Y - 0'	Y - 0'	Y			Depending on the purpose of ballast regulating
Ballast Replenishment	N	Y - 0'	Y - 0'	Y			
Cable Work	N	Y - 0'	Y - 0'	Y			
Change Longitudinal Timbers	N	N	N	Y			
Changing Sleepers & Timbers	N	N	N	Y			
Continuously Welded Rail Stress Management	N	N	Y - 0'	N			
Drainage Work	N	Y - 0'	Y - 0'	Y			Lateral drainage
DTS (Dynamic Track Stabiliser)	N	N	Y - 0'	Y			
Earthwork	N	Y - 0'	N	Y			
Eradication Of Wet Beds	N	Y - 0'	N	Y			
Flail Mowing Machine	N	N	Y - 0'	Y			Because of different moving speeds
Ground Investigation/Automatic Ballast Sampling	N	Y - 0'	N	Y			
Hand Rail Grinding	N	N	Y - 0'	Y			
Level Crossing Work							
Level Crossing Work Signalling & Telecoms	N	Y - 0'	Y - 0'	Y			
Level Crossing Work Track	N	N	Y - 0'	Y			Planking renewal
Litter / Graffiti Clearance	Y	Y - 0'	Y - 0'	Y			
Load / Unload Other Materials	N	N	Y - 0'	Y			
Manual Correction	N	N	N	Y			
Mechanical Reballast (Maintenance Only/Gopher)	N	Y - 0'	N	Y			
Mechanical Tamp							
MOBC (Medium Output Ballast Cleaner)	N	Y - 0'	N	Y			Tamping usually already included in ballast cleaning process
Motorised Patrolling	N	N	Y - 0'	Y			
Move Materials	N	N	Y - 0'	Y			
MP & I Station Works	?	?	?	?			
Off Track Work	Y	Y - 0'	Y - 0'	Y			
Other Electrification & Power Work	N	Y - 0'	Y - 0'	Y			
OTP Ballast Regulator	?	?	?	?			
Overhead Line Inspection	N	N	Y - 0'	Y			
Overhead Line Renewals Work	N	N	N	Y			
Overhead line Work	N	N	Y - 0'	Y			
Patrolling	N	Y - 0'	Y - 0'	Y			
Permanent Way Inspection	N	Y - 0'	Y - 0'	Y			
Plain Line Grinding Train	N	N	Y - 0'	Y			
Plain Line Stoneblowing	N	N	N	Y			No Stoneblowing and Tamping at the same location
Plain Line Tamping							
Platform / Structures Gauging	N	Y - 0'	Y - 0'	Y			
Platform Enhancements	N	N	N	N			
Points Inspection	N	Y - 0'	Y - 0'	Y			May be an obstacle to the progressing of tamping machine
Rail Adjusting	N	Y - 0'	N	Y			



D2.1 High level breakdown of maintenance activities

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Plain Line Tamping

AUTOMAIN WP2

Within the same possession, which tasks can be combined with plain line tamping, please mark compatibility with a 'Y' for compatibility or a 'N' for definitely no compatibility.

Task	Can be carried out on the same line at the same time as plain line tamping	Can be carried out on the same line prior to plain line tamping If YES how much time is required between task finishing and the tamping machine being able to run on the same line	Can be carried out on the same after the plain line tamping If YES how much time is required between tamping machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line tamping	Can be carried out in the same possession as a plain line tamping operation	Minimum time required for task including setup times	Comments
Rail Changing	N	Y - 0'	Y - 0'	Y			May be an obstacle to the progressing of tamping machine
Rail Lubricators	N	Y - 0'	Y - 0'	Y			
Reballast - Trax	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Reballast ABC	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Reballast ABC - High Output	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Reballast Formation - Trax	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Remove Rail Defects	N	Y - 0'	N	Y			
Renew Pads / Nylons	N	Y - 0'	N	Y			
Rerail - Both Rails	N	Y - 0'	N	Y			
Rerail - One Rail Only	N	Y - 0'	N	Y			
Rerail Reballast - Trax	N	Y - 0'	N	Y			
Rerail Resleep Reball Form - Trax	N	Y - 0'	N	Y			
Rerail Resleeper - High Output	N	Y - 0'	N	Y			
Rerail Resleeper (Concrete)	N	Y - 0'	N	Y			
Rerail Resleeper (steel)	N	Y - 0'	N	Y			
Rerail Resleeper Reballast - ABC	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Rerail Resleeper Reballast - Trax	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Rerail Resleeper Reballast (Maintenance Only)	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Resignalling Work							
Resleeper - High Output	N	Y - 0'	N	Y			
Resleeper Reballast - ABC	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Resleeper Reballast - Trax	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Resleeper Reballast Form - Trax	N	Y - 0'	N	Y			Tamping usually already included in reballasting process
Road Rail Vehicle Access Point Work							
S&C - Abandonment	N	N	N	Y			
S&C - Complete Renewal	N			Y			
S&C - Drainage	N			Y			
S&C - Partial Renewal	N			Y			
S&C - Reballasting	N			Y			
S&C - Remodelled	N			Y			
S&C Grinding Train	N			Y			
S&C Maintenance	N			Y			
S&C Retimber	N			Y			
S&C Stoneblowing	N			Y			
S&C Tamping	N			Y			
Safety & Environment Work	N	Y	Y - 0'	Y			
Scrap Removal							
Signalling & Telecoms Axle Counters	N	Y	Y - 0'	Y			
Signalling & Telecoms Track Circuits	N	Y	Y - 0'	Y			
Signalling & Telecom Work	N	Y	Y - 0'	Y			
Signalling & Telecoms Points	N	Y	Y - 0'	Y			
Station Work							

D2.1 High level breakdown of maintenance activities

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Task	Can be carried out on the same line at the same time as plain line tamper	Can be carried out on the same line prior to plain line tamper If YES how much time is required between task finishing and the tamping machine being able to run on the same line	Can be carried out on the same after the plain line tamper If YES how much time is required between tamping machine passing and work beginning on task	Can be carried out on a parallel line at the same time as a plain line tamper	Can be carried out in the same possession as a plain line tamping operation	Minimum time required for task including setup times	Comments
Steel Sleeper Relay	N	N	Y - 0'	Y			
Structures Examination	N	N	Y - 0'	Y			
Structures Work	N	N	Y - 0'	Y			
Survey Work	N	Y	Y - 0'	Y			
Tamp And DTS (Dynamic Track Stabiliser)	N	Y	N	Y			
Test Train Operation	?	?	?	?			
Third Rail Inspection							
Third Rail Renewal							
Third Rail Work							
Track Maintenance	N	Y	N	Y			
Tunnel Examination	N	N	Y - 0'	N			
Tunnel Work	N	N	Y - 0'	N			
Ultrasonic Rail Flaw Detector Operator Inspections	N	Y - 0'	Y - 0'	Y			
Under Track Work	N	N	N	Y			
Unload Ballast	N	Y	Y - 0'	Y			
Unload Continuously Welded Rail	N	N	Y - 0'	Y			
Vegetation Clearance (Non-Flail)	Y	Y	Y - 0'	Y			
Verse Testing							
Washer Maintenance							



Appendix 4 – Questionnaire results

Introduction

The AUTOMAIN project has been built up according to the system engineering principles. This includes the definition of overall results and objectives at the start of the project. One of the aspects in the first phase is to search for potential good practices and ideas that can be used later on in the project. We choose to make a questionnaire. The goal of the questionnaire is to provide an overview of good practices and ideas to the members of Automain. It can be used as a start for further investigations. Therefore the questionnaire contains high level questions and no questions for detailed data collection. The target group is the inframangers of Automain: Network Rail, SNCF, Deutsche Bahn, ProRail and Trafikverket. Finally after consultation with the WP1 leader also Strukton completed the questionnaire. The questionnaire provides input for all of the deliverables within Task 1.1: Functional requirements:

- T1.1.1: Asset management strategies, policies and performance
- T1.1.2: Maintenance and inspection processes
- T1.1.3: Integration of maintenance in the timetable
- T1.1.4: Comparison with automated maintenance in road networks
- T1.1.5: Definition of market and customer requirements

The process of making the questions is listed below:

- ProRail made a first proposal
- This proposal was reviewed by the members of WP1 and the other WP leaders
- The first proposal was updated and send to the Infra Managers
- The first proposal was used by DLR to make a questionnaire for road networks (results are reported separately)
- The answers were gathered by ProRail
- The first plan was to visit all the inframangers to get more detailed information. Due to costs, planning problems (summer holiday) and efficiency we decided to analyze the results and opt for a second round of (additional) questions by email.
- University of Birmingham and ProRail analyzed the results. It was clear that the initial questions were not specific enough to be the basis for defining the market and customer requirements (T1.1.5 Definition of market and customer requirements).
- WP2 leader formulated specific questions to be able to get started.
- The initial questions, additional questions and answers are in the appendix.
- Results of the additional WP2 questions are not part of this appendix. WP2 will report separately on these issues.



We decided not to present a short overview with highlights and best practices on each subject. This means we decided only to show the raw answers of the IM's. Each IM and work package member can look through the questionnaire and find what is relevant for him / her. When needed each work package can define additional questions to the different IM's.



Asset management strategies, policies and performance

What are the strategic company goals of the Infra Manager (IM)?

- Describe the background of each strategic goal
- Mention and explain the KPI's that are related to each strategic goal

IM	Answer
TV	Trafikverket (TV) is a governmental agency in Sweden whose responsibility is the strategic planning of roads, railways, ship transports and aviations. TV started its work 2010-04-01, at the same time as Banverket (The Swedish Rail Administration) and Vägverket (The Swedish Road Administration) were terminated. The railway network is divided into different line classes, based on the type of trafficoperating. The different classes are; City, Major Lines, Other Important Lines, Minor Lines and No or Little Traffic (Banverket 2010). Näringsdepartementet, The Swedish Ministry of Enterprise, Energy and Communications (The Ministry of Enterprise) is principal for TV. The Ministry of Enterprise controls TV by an annual appropriation letter, with mid-term goals and funds for reaching them. The mid-term goals are based on the overall goals and the objectives in the strategic plan for the transport system, which is settled by the government for ten year periods, with funding, as a governmental bill. The overall goals and objectives are broken down in a top-down manner through the organisation. Sub-goals and sub-objectives are formulated, facilitating the operational planning. Internal PIs and KPIs are used throughout the hierarchical levels to monitor the performance development according to the set plan. Since half the budget is spent on maintenance and renewals of the railway infrastructure assets, PIs for monitoring the condition of the track are of highest importance. TV is also using a scorecard model in their management, which is based on the balanced scorecard by Kaplan and Norton, but with five perspectives instead of four. The governmental goals are set on 10 years log term goals and those goals are then broken down into yearly governmental approval letters by the Ministry of Transport. In these letters, Trafikverket's tasks for the fiscal year are given. The letter starts with the overall goals, which provides a system of transport for the citizens and the business sector all over the country that is economically effective and sustainable in the long term. See figure 1 (ref. Ulla Juntti (Espling), "Maintenance Strategy for a Railway Infrastructure in a Regulated Environment", Doctorial Thesis, ISSN: 1402-1544, ISRN: LTU-DT—07/54 – SE, 2007:54 Luleå University of Technology, (2007)).

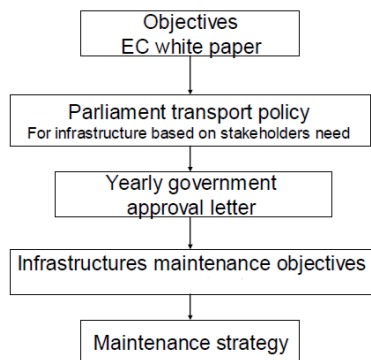


Figure 1. Railway infrastructure management

The objectives are then translated into the infrastructure management task. The maintenance strategy is formulated by considering the following

- Yearly funding according to governmental approval letter.
- A client/contractor organization with outsourced external contractors.
- Maintenance contract duration time which is longer than one year. Usually 3-4 years with options for continuation 1-2 years
- Different kinds of contracts with different duration time, scope, payment forms. Functional (performance) contracts are used today as a general strategy.
- Traffic operation agreements with the traffic companies, putting the focus on effectiveness and efficiency.
- Internal and external regulations.
- Safety demands.
- Demands in increased punctuality and train traffic availability in combination with competition of time on track between traffic operation and maintenance activities (daily work and re-investments)
- Asset with different complexity, age and standard
- Limited access to the track for maintenance work due to high utilization from train traffic needs
- Train planning scheduling process, not always synchronies, with budget process and maintenance and re-investment planning processes
- Life Cycle Cost (LCC), total asset cost management and train traffic planning routines with priority guidelines based on society economical principal judgments
- Public Procurement Act
- The maintenance strategy has five strategic challenges:
 - Energy efficient transport system
 - Good working transports (goods and passenger) in urban areas
 - Efficient industry transports
 - Robust and available infrastructure
 - High valuable utilization level per invested dollar

Goals

The main strategic goal and two subgoals have been settled for the transport system by the Ministry of Transport, whereas the main strategic goal is to:

“Ensure the economically efficient and sustainable provision of transport services for people and businesses throughout the country” – (Näringsdepartementet 2009)

And the two strategic sub-goals are the following:

“The Functional Goal – The design, function and use of the transport system will contribute to provide

everyone with basic accessibility of good quality and functionality and to development capacity throughout the country. The transport system will be gender equal, meeting the transport needs of both women and men equally.” – (Näringsdepartementet 2009)

“The Impact Goal – The design, function and use of the transport system will be adapted to eliminate fatal and serious accidents. It will also contribute to the achievement of the environmental quality objectives and better health conditions.” – (Näringsdepartementet 2009)

Background of the Strategic Goals

The Strategic goals of the Swedish transport system have been set in collaboration with industry and the IMs of roads, railways, aviation and maritime. This was before TV was launched, whose responsibility is the strategic planning of roads, railways, ship transports and aviations. Also investigations were carried out by SIKa (The Swedish Institute for Transport and Communications Analysis), now replaced by Trafikanalys (the Swedish Transport Analysis). See Figure 2 below for an overview of how the strategic goals and the strategic plan were developed. Also KPIs with annual quantitative objectives until 2021 are found for the operation and maintenance in the strategic plan.



Figure 2: Sketch of the development of the latest strategic plan.

KPIs Related to the Strategic Goals

TV’s operation and maintenance objectives can be found in the strategic plan of the transport system for 2010-2021, which are objectives to the political main goal and its two sub-goals. The objectives are the following six, called Delivery Qualities, or Operational Qualities; Punctuality, Robustness, Traffic Information, Comfortability, Safety and Usability (Banverket, Vägverket et al. 2009). The Delivery Qualities have three levels of accomplishment, “Base”, “+” and “++”. Each delivery quality has KPIs connected, where most of them have a quantitative value



established, i.e. quantitative objectives. For example, the values for Punctuality are 88 %, 90 % and 96 %. A punctual train is defined to be no later than five minutes. Another example is Comfortability, which is measured by the track geometry Q-number. The three subgoal levels for the Q-number are 65, 88 and 94. In addition to the Delivery Qualities, environmental consideration has to be taken into account in the operation and maintenance planning. See Figure 3 for the break down structure of strategic goals to operation and maintenance objectives

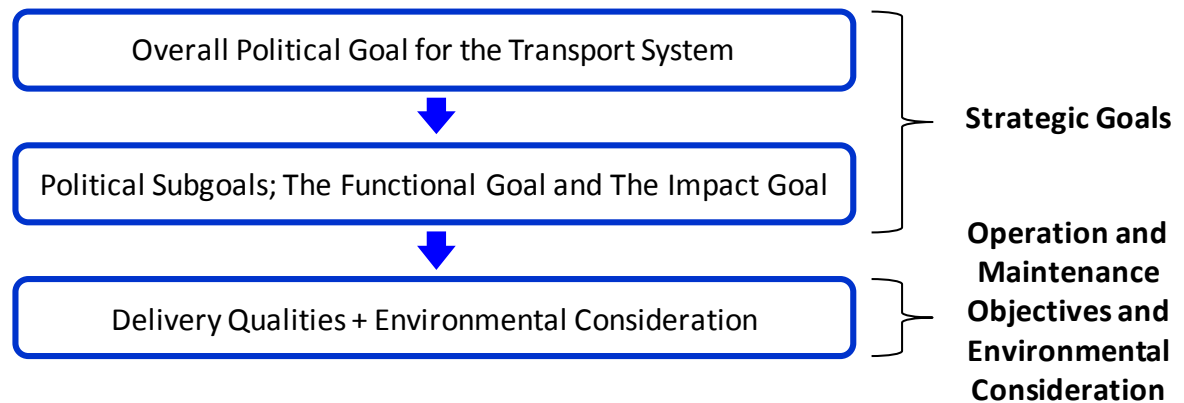


Figure 3: Top-down break down structure of strategic goals to operation and maintenance objectives.

The delivery qualities with KPIs are found in the following table, Table 1:

Table 1: Delivery qualities, or operational qualities and their underlying indicators used by Trafikverket.

Delivery Quality	Performance Indicator (KPI)	Unit
Punctuality	- Arrival Punctuality	%
	- Train Delay	h/Million-train-km
Robustness	- Downtime, or Restoration Time	h/days
Traffic Information	- Availability of the traffic information system	%
	- Passenger Satisfaction (NKI)	%
	- Trip-planner	Quantity
Riding Comfort	- Q-value	-
	- Passenger Satisfaction (NKI)	%
Safety	- Kills and Injuries	Quantity
	- Vehicle damages	Quantity
Usability	- Availability of Infrastructure	%

The environmental consideration does not have any overall quantitative values or objective established, instead there are several subgoals and objectives that are going to be meet during



	2010-2021 (Banverket, Vägverket et al. 2009). There is also a three step priority principle when planning for investments. It is as follows; first step is to prioritise measures that benefits in both environmental and economical aspects. Second step is to choose the most environmentally friendly action if the cost is the same for other similar actions. The third step is if there is an environmentally friendly choice but the cost is high, then one looks into the socioeconomic benefit and regulations. The delivery quality Safety together with environmental consideration facilitates for overall monitoring of the HSE (health, safety and environmental) aspects. The main environmental goals found in the long term plan are to reduce energy usage, clean polluted ballast, reduce noise from roads and railways and clear land near railways and roads (Banverket, Vägverket et al. 2009). The energy cost associated to lights, ventilation and heating of switches in the railway infrastructure is about 150 million SEK. This cost is estimated to be reduced with 44 million SEK when the planned actions are carried out. Some of the activities are changeover of light-bulbs to LED, rail grinding, improved heating system of switches and improve usage of light systems. The use of materials to roads that reduces the noise from vehicles is estimated to increase the maintenance cost up to six times. This makes it contradictive to other environmental goals, and raises the question that this subgoal of reducing noise maybe should be a goal within the comfortability goal of the Delivery Qualities. If it comes up a need to prioritise between the Delivery Qualities, punctuality and safety comes in first hand (Trafikverket 2010a).
PR	ProRail has 4 major strategic ambitions as described in our contract with the government ("Beheerplan 2011"): 1. 100 % delivery reliability and 0 % accidents The track is an open system that is directly exposed to weather and other external factors such as collisions, fallen trees, roadside fires, and even sabotage. Under these conditions, achieving the highest possible reliability and to minimize the likelihood and impact of disruptions is an everyday challenge. Making the track season proof has a high priority. We may not be surprised by hot summers (buckling of rail), autumn storms (leaves on the track), cold winters (frozen switches) or lightning. Besides a highly available and reliable railway, ProRail wants - despite intensification of track use - together with train operators work on the improvement of the punctuality. ProRail shall 2011 start with a differentiated approach per line by simplifying the infrastructure and optimize the control of the system. Smart logistics solutions are the basis of functionality change projects and 1:1 renewal projects. Too tight uniform company rules will in 2011 be gradually revised to make room for smarter solutions. Corporate social responsibility includes a strategy aimed at travel safe, work save and live save on and along the rail and covering its share in the total safety of the railway, as stipulated in the Third Rail security framework document of the national government. Travel safe means that train operators and passengers are safe on the track, meaning e.g. that signals are clearly visible, switches are working properly and a safely designed trainschedule. Live safe means that



nobody is at risk around the track. Railroad crossings are well organized and work well, the track is not free accessible and suicide on the track is actively reduced. Work safe means ProRail and contractors together ensure that anyone who works on the track is safe. Track workers can safely stand in the track that is out of service and the risks of their activities are controlled.

ProRail has the ambition to reduce the number of rail accidents to zero. Safety is determined by a combination of engineering, systems and human behavior. Through the Safety Management System (VMS) managing the security risks and meeting the company safety objectives is embedded in the daily business processes. ProRail is increasingly drawing attention to the behavior of people, because also without major investments in technology the security can increase. Employees are therefore even more aware of the risks and more focused on continuous control.

2. 20 % reduction of lifecyclecost per trainkilometre

Improvement of professionalism, efficiency and responsible use of public funds

3. 50 % more trains on the busiest corridors

The ambitions of the government and the railsector for growth on the track and the realization of high frequency traffic on the main corridors in the country are great. To enable train operators this growth in the short term, where possible, ProRail creates the possibility that more trains can run at high punctuality and where possible shorter travel times. On behalf of the Minister of Infrastructure and Environment ProRail works (from 2008) together with the train operators on the High Frequency Rail Program (PHS) to facilitate "timetable free travel". In the Longterm Program Infrastructure and Transport (MIRT), the Central Government funded the program for more than EUR 4.5 billion until 2020.

2020
Spoorboekloos reizen



4. Satisfied customers

ProRail wants satisfied customers - both passenger and freight train operators and governments. In the medium term the ambition of ProRail is to get an 8 out of 10 of its customers and relations. The target for 2011 is average of 7. We hope to achieve with services tailored to specific needs, business and market dynamics of our customers, and transparent pricing and quick delivery. Specifically for the freight train operators, we aim to ensure that the 2011 freight arrival punctuality on the main corridors improve, and working to improve communication about train free periods and a better process for ad hoc requests for rail capacity. In addition, we provide more transparency into the process of the application of environmental permits.

From the perspective of corporate social responsibility ProRail intends to be a good neighbor to the millions who daily as traveller, user of roads or neighbor to the track have to do with passing trains and / or construction. Therefore ProRail aims for a greater satisfaction of the customer group "Public".

To establish, maintain and protect the interests of local governments within ProRail our relationship managers increased contacts with our public partners. Priorities for 2011 are: fast response times, the exact articulate questions, needs, accurate offers and realistic leadtimes for projects.

The KPI's related to these strategic ambitions are mentioned with question 1.4.

NR

Network Rail is established as a not for dividend company, as the owner of the UK railway infrastructure. The goals of network rail are to operate and maintain the railway infrastructure



to meet the demands of our customers the rail and freight operators and the travelling public.

Network Rail's strategic goals are set through an agreement with the Office of Rail Regulation for a control period of 5 years. The Office of Rail Regulation is the independent safety and economic regulator for Britain's railways. The high level strategic goals are set based on benchmarking data and a drive to improve efficiency, safety and comfort, minimise disruption and improve capacity. These are influenced by the Strategic Rail Agenda 2020 (2007), a cross-industry TSLG (Technical Strategy Leadership Group) define future Rail Technical Strategy and has developed technology roadmaps (<http://www.futurerailway.org/Pages/home.aspx>).

The Office of Rail Regulation then monitors Network Rail's performance against their targets and budgets on a quarterly basis these monitor reports are publically available from (<http://www.rail-reg.gov.uk/server/show/nav.2280>).

The present control period CP4 (2009-2014) has the high level targets to:

- Improve efficiency – reduce costs by 22% over the 4 year period
- Increase safety – reduce the safety risk factor by 3% (the risk factor is made up from statistics)
- Maintain capability (eg line speed, gauge etc) at April '09 level
- Increase capacity – Improvements in capacity are defined by planned projects (eg. Thameslink project, Reading projects, Airdrie to Bathgate re-opening, Felixstowe-Nuneaton line upgrade for increased freight traffic).
- Improve availability – increase availability of the railway (keeping the railway open when people want to use it) by 37% for passengers and maintain current levels of availability for freight traffic
- Asset stewardship index – the ORR has an asset stewardship index using a large range of KPIs to measure the long sustainability of the management of the railway infrastructure ensuring that the assets are not degrading over each control period.
- Improve customer satisfaction – This comes from passenger satisfaction surveys

The goals that have the greatest impact on AUTOMAIN are improving efficiency, safety, performance and availability.

The responsibility for translating these high level targets into company goals and changes in working practice is the responsibility of Network Rail and these are cascaded down into the Network Rail Route Utilisation Strategies (<http://www.networkrail.co.uk/aspx/4449.aspx>) where the strategy is specifically tailored to routes and investment work. Within Network Rail's Engineering group, there are also technical strategies written for each of the asset types to define the future needs and what technology developments and research are required to meet the global objectives.

The KPIs related to the strategic goals upon which Network Rail is monitored and assessed include:

Network availability

Passenger Disruption Index (PDI-P)



	Freight Disruption Index (PDI-F) <u>Train performance</u> PPM (Passenger performance measure) Total PPM Long Distance London and South East Regional FPM (Freight performance measure) CaSL – Cancellations and Significant Lateness Long Distance London and South East Regional Delay minutes (actual delay minutes) Passenger (1000s of minutes) Freight (Normalised by per 100 train km) <u>Infrastructure</u> Number of asset failures <u>Customer satisfaction with Network Rail</u> Train Operating Company (mean satisfaction score) Train Operating Company (mean satisfaction score) <u>Finance</u> Controllable Opex Non-Controllable Opex Renewals Maintenance <u>Station Stewardship index for different station categories</u>
DB	<i>Safety</i> KPI's according to draft version of "Definition of common safety indicators and common methods to calculate economic impact of accidents" CSIsWG-SD – Annex 1-ver0.7, European Railway Agency 2007 Increase of safety at railroad crossings number of people involved in accidents <i>Climate protection</i> • Carbon emission – tons per year for infrastructure • Reduction of noise – installation of noise barrier • Management of vegetation – amount of herbicide and treated area <i>Reduction of LCC</i> LCC of new components, modules or systems, Operating profit <i>Management of dependencies</i> No direct KPI



Economic implementation of new laws and regulations

No direct KPI

Increase of quality and capacity

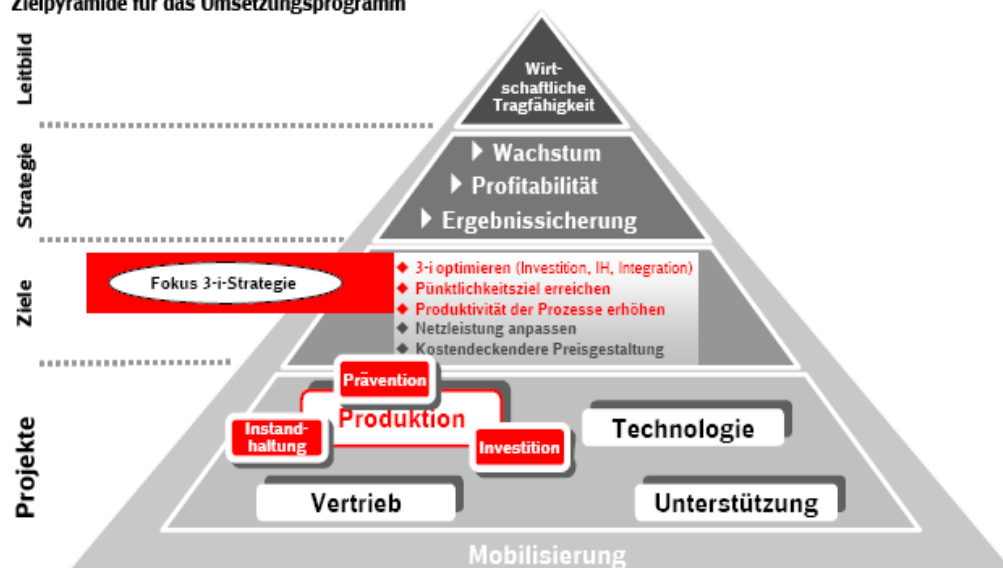
- Increase of reliability - Number of speed reductions
- Increase of track performance and availability - Delay minutes
- Increase of competitiveness - Operating profit
- Punctuality of trains
 - 81,5% for long-distance trains
 - 92,5% for regional trains
 - 80,0% for freight trains

At DB Netz, we have a 3-i-strategy, which directs the management processes of the investment and maintenance planning and control. The guideline for the 3-i-strategy consist of more than 150 pages and describes the bases of the strategy, the planning and the control of investment and maintenance for different assets like track, construction engineering and control and safety technique

The strategy also directs the interface between the operation/construction and time table

ProNetz Projekte in Produktion, Vertrieb, Technologie und Unterstützung stellen die Zielerreichung der strategischen Stossrichtungen sicher

Zielpyramide für das Umsetzungsprogramm



The 3-i-strategy is based on 10 core elements which are shown in the next figure (sorry in German).

The goals are

- to reduce the costs
- to keep the planned dates and
- to increase the quality.

10 Kernelemente der 3-i-Strategie



In the Service level and funding agreement (Leistungs- und Finanzierungsvereinbarung) between Deutsche Bahn and the government strategic goals with respect to the quality and the development of the infrastructure are described and KPI identified. For detailed information look at page 29 ff in the following document

http://www.eba.bund.de/nn_804166/DE/Fachthemen/LuFV/IZB/IZB_2010_Kurzfassung,templateId=raw,property=publicationFile.pdf/IZB_2010_Kurzfassung.pdf

Quality indicators related to the funding by the government are:

- Theoretical loss of travel time (Theoretischer Fahrzeitverlust)
- Number of defects of the infrastructure (Anzahl Infrastrukturmängel)
- Functionality of train platforms (Funktionalität Bahnsteige height of platforms, accessibility without stairs, weather protection)
- Assessment of asset quality (Bewertung Anlagenqualität)



	quality and visual appearance of platforms • Supply guarantee of power (Versorgungssicherheit Bahnenergie) Additional quality indicators are: • Number of faults and time for repair (Anzahl der Störungen und Störbestehenszeiten) • Mean age of important assets (Durchschnittliches Alter von wichtigen Anlagenarten der DB Netz AG) • Condition categories of bridges and tunnels (Zustandskategorien Brücken und Tunnel) Assesment indicators are: • Delay minutes (Verspätungsminuten) • Total track kilometre of trains (Trassenkilometer) • Number of train stops in platforms (Zughalte) • Traction energy (Traktionsenergie)
SNCF	On 3 November 2008 the State and Réseau Ferré de France signed a performance contract covering the main commitments from the Grenelle Environment Forum. This contract defines the infrastructure modernisation objectives and the methods for developing a new commercial offer for the network, in order to improve quality, services and safety as much as possible. With this contract, we make 33 commitments, progress on which will be monitored by a series of indicators. Making a commitment today... for tomorrow's network The company is preparing the conditions for the opening up of the passenger market from 2010 and puts the customer at the heart of its concerns: to provide fair access to the network; to improve the quality, flexibility and relevance of its "train paths" offer; to improve the performance of its services; to innovate in order to encourage new activities using rail transport; to develop sales revenues for a "fair price"; to modernise infrastructure. Making a commitment to... a better performing network €13 bn between 2008 and 2015 will be invested to renew 6,400 km of tracks and almost 2,500 line points. Réseau Ferré de France is committed to the management of costs and deadlines and also to project visibility so as to allow the companies carrying out works to anticipate needs and better respond to infrastructure development challenges. The French network will be equipped with the most recent technological advances (centralised control or telecommunications) developed in partnership with the European infrastructure management groups. Making a commitment to... a balanced, shared, sustainable business model The customers of the network and of its services will pay the "fair price" based on the full cost of the network, incorporating current operating charges, financial amortisations and return on capital.



The company is committed to developing its sales revenues: the proportion of the infrastructure cost financed by revenues will thus increase from 48% in 2008 to 60% in 2012.

We are strengthening our land and property policy to the benefit of local authorities, urban development projects and housing, especially social housing.

Making a commitment to... sustainable, local transport

The network must be used more intensively: this is the assignment given by the State to Réseau Ferré de France, to find answers to the mobility needs of all members of the public and companies.

To translate the commitments of the Grenelle Environmental Forum into action, we are committing ourselves to developing regional access points, adapting the network to lifestyles, introducing modern industrial practices, asserting ourselves as demanding, environmentally aware owners, and operating the railways within a sustainable business model.

Report on activities in 2010

- Improving territorial accessibility
 - Proportion of clockface train path applications
 - Volume of freight traffic on the freight-oriented network (in millions of train path/km)
 - RFF response rate to late train path requests within the deadlines promised to the client
 - Number of train path-days affected by unscheduled works possessions
 - Punctuality to within 5 minutes
 - Length of unused lines targeted by conservation projects in the year of their closure to traffic (km) (tourist trains, cyclo-rail, greenways, cycle tracks)
 - Number of stations accessible to people with reduced mobility (PRM)
 - Sum invested (in millions of €)
 - Number of last minute train paths created
- INTEGRATING THE NETWORK INTO LOCAL LIFESTYLES
 - Number of railway accidents
 - Deaths (other than suicides and attempted suicides)
 - Injured (other than suicides and attempted suicides)
 - Number of suicide "events"
 - Number of accidents on RFF worksites
 - Deaths
 - Seriously injured
 - Dangerous level crossings closed
 - Dangerous level crossings improved
 - Total investment in safety (in millions of €)
 - Number of noise black spots processed as part of the elimination programme
 - Population affected by noise black spot improvements
 - Aggregate investment in noise black spots (in millions of €)



- USHERING THE RAILWAY INTO THE MODERN INDUSTRIAL ERA AND FOSTERING INNOVATION
 - Cost of renewal on main track (k€/km)
 - Quality of contract management: percentage of operations completed on schedule, to time and standard
- EMERGING MORE STRONGLY AS AN ENVIRONMENTALLY-FRIENDLY LANDOWNER
 - Purchase of phytosanitary products (kg)
 - Conversion of equipment containing PCB (Number of items brought up to standard)
 - Quantity of asbestos eliminated (T)
 - Percentage of train-km with electric traction
 - Percentage of diesel hauled trains on the electrified network (regular train path-km)
 - Direct energy consumption per primary energy source (MWh)
 - Total weight of timber sleepers removed and treated
- CREATING A SUSTAINABLE BUSINESS MODEL FOR THE RAIL MODE
 - Revenue from sales (in millions of €)
 - Proportion of all costs covered from sales revenues
 - Percentage of investment on the existing the network (other than new development as a % of spend)
 - Length of line renewed (equivalent in km)
 - Amount spent on renewal (in millions of €)
 - Cost of train-km for maintenance (€/Train-km)
 - Land and property business plan (in millions of €)
 - Property disposals
 - Rental income
- OPENING TO COMPETITION AND STAKEHOLDERS
 - Proportion of freight revenues from new clients
 - Proportion of operations conducted by contract/project managers selected through competitive bidding



How strict do you use the separation between the Asset Owner, Asset Manager and Service Provider?

- Describe who has the role of Asset Owner, Asset Manager and Service Provider
- What are your major stakeholders
- Explain the advantages and disadvantages of this role model related to the allocation of train free periods

Additional questions

- Who are the main stakeholders, and what influence does each one have on determining the location and length of train-free periods in the timetable?
- How does the IM optimize the planning of maintenance possessions?
- How are the needs and wishes of the passenger and freight carriers taken into account?
- How could collaboration on maintenance plan development be improved between stakeholders (Infrastructure managers, maintenance providers, train and freight operating companies)?

IM	Answer
TV	The complexity of railway maintenance demands a holistic approach to both internal and external factors and processes that have direct or indirect influence on the operation and maintenance of railway infrastructure. While forming the maintenance strategy for railway infrastructure the manager must take in consideration the interacting parts in the maintenance systems, i.e. between wheel and rail, between pantograph and catenary, between signaling systems (on board and way side) and train control systems. The manager also have to consider if the methodology or strategy he/she chooses will put demands on the contractor to enhances her/his competence or invest in new machines or instruments. When the infrastructure manager enters into an operation and maintenance contract, he commits funds for three to five years for payment to contractor against executed work as agreed in contract. Infrastructure manager (IM) must also have a flexibility to cut down on the maintenance activities because sudden unexpected events such as extreme weather conditions and decreases in the government grant owing to political resolutions. While the IM is responsible for the asset, rail traffic possession time on track (track capacity) is sold out to the train operators. Trafikverket maintenance strategy is condition based maintenance in combination with predetermined maintenance. However, by using functional maintenance contracts, only the function of the track is measured and not how the maintenance is executed. The structure for the control system is based on the European standard EN 133306:2001. Problems are caused by lack of good functioning control systems. Systems to measure the assets condition and where the condition is on the degradation curve. The infrastructure manager is working in an organization for continuous improvement and increases the activities for elimination of failures especially those causing train delays. A forum for decreasing train delays are set up in Stockholm and Göteborg and Malmö regions (In Swedish Kraftsamling Mälardalen, Väst, Syd). Groups with key personnel from the traffic operators, infrastructure managers, contractor and traffic control comes together in meetings to discuss and solve problems that causes train delays. These working groups are focusing on re-investment priority actions and not so much on daily maintenance actions in the contracts.



	Regarding the maintenance contracts, the infrastructure manager and contractor often only meet to discuss changes or activities that must be addressed in order to fulfill their contract. This type of relationship has often been called “arm’s length” contracting and implies that each party is free to act independent of each other. Since 1998 several types of contacts has been tested on the railways, for example buying with fixed prices and specifying every work, buying a function.
PR	In the Netherlands a very strict separation is created between the asset owner, asset manager and the service providers. But also the asset users (train operators) is a separate entity with its own “contract” with the government (concessions) and access agreements with ProRail. Having 4 parties makes it difficult to get consensus on the possession times (train free period) for doing the maintenance activities. The asset users have a large influence on the planning of the train free periods. In some occasions the asset user even can uses a veto. In the Netherlands the safety regulations lead to an very high safety standard. Together with a rail infrastructure that reaches its maximum capacity this explains why reaching consensus on the balance between driving trains and maintenance / renewals is always difficult. For the new performance based contracts (small scale maintenance) the contractor has to claim the needed possessions before he gets the contract. After award of the contract he gets the time he claimed to do the activities he thinks are needed to meet the specifications. The advantage is that this procedure provides clear agreements on possessions needed for small scale maintenance. But the disadvantage is that the flexibility is less. To achieve a good balance between the running of trains (passenger and freight) and performing maintenance a formal agreement between ProRail and the train operators is necessary. In these consultations, the interests of the Asset Manager and Asset user are equal.
NR	Network Rail has the role as asset owner, asset manager and asset maintainer. This does have the advantage of a single organisation planning possessions in conjunction



with our customers (train and freight operators). Some maintenance tasks, renewal and upgrade work is carried out by sub-contractors but remains under Network Rail's planning.

Who are the main stakeholders, and what influence does each one have on determining the location and length of train-free periods in the timetable?

The primary stakeholders involved in the determination and location and length of train-free periods in the timetable is mainly Network Rail and the passenger train operating companies and freight operating companies. The negotiations for access begin with the 26 key route strategies, these strategies have been formulated between Network Rail and the train operating companies and freight operating companies, the "Rules of the Route" also define the levels of access that the TOCs and FOCs have to the infrastructure and the access that Network Rail has in order to carry out maintenance and renewal work, this is communicated to the TOCs as part of their bidding for a franchise. The National Access Unit which is part of Network Rail then negotiates with the TOCs and FOCs of the actual timetables of when these activities take place.

Meanwhile, the Network Rail track engineers create a national plan of required work for the year, which is based partly on experience of required maintenance volumes of previous years and also expectations of changes and infrastructure renewal projects. These are then submitted to the National Access Unit, which is part of Network Rail, 95-80 weeks before the timetable is set. Network Rail's National Delivery Unit then co-ordinated and optimises the maintenance requirements and produces a working time table. Then 60-45 weeks before the timetable is set the National Access Unit negotiates the access with the TOCs and FOCs. Weeks 38-26 before the possession the NAU confirms the Period Possession plan with the TOCs and FOCs for them to plan their services.

How does the IM optimize the planning of maintenance possessions?

Network Rail optimises the planning of maintenance possessions by have a central team to look at the national work plan, they can plan machine movements and possessions on a national basis to ensure optimum utilisation of machines. All the optimisation is currently done manually.

How are the needs and wishes of the passenger and freight carriers taken into account?

The needs and wishes of the TOCs and FOCs are considered at various stages during the planning process, however, access is largely defined as part of the Route Utilisation Strategies and the Rule of the Route.

How could collaboration on maintenance plan development be improved between stakeholders (Infrastructure managers, maintenance providers, train and freight operating companies)?

Collaboration on the maintenance plan could be improved by much closer working between Network Rail and the TOCs and FOCs from the earliest stages of the planning process, this will allow much better optimisation and planning of work to best suit the end users. It is expected that as Network Rail goes through devolution, each of the regions will work much more closely to the TOCs that operate on that route and the planning process is likely to become much more decentralised. This may create difficulties in the planning of large machines, but should make the planning much more closely aligned the needs of the TOCs and FOCs.

DB

Roles:

Asset owner	DB Netz
Asset Manager	DB Netz
Service provider	DB Netz and external companies
Major stakeholder	German State



The planning of the maintenance and the allocation of the train free periods is independent of the asset owner and manager and service provider. The asset manager is responsible for identification of the maintenance requirements and commission of internal or external service provider. The external service provider will get the same possession time.

Assumption: *the train free periods are periods with respect to the number and types of trains and a result of the original planning of timetable without maintenance*

- *Stakeholders and their influence on location and length of train free period*
 - *German state, the owner of the infrastructure, has no influence on the train free period*
 - *IM, responsible for the quality of infrastructure, has influence on the train free period in the case that the IM reports the need of maintenance to the creator of the time table*
 - *Maintenance provider (internal or external) has no marginal influence on the train free period*
 - *The creator of the time table takes into account the long- and mid-term need for maintenance*
- *The optimization of the planning of maintenance possession is done by a special educated assistant of the IM. The planning will be done with software and takes into account individual boundaries and tries to group maintenance activities in a region.*
- *Extensive maintenance activities will be published long time before the activities starts and will be included in the time-tables.*
Short-term maintenance activities that results in a disturbance of the trains are published for a three month period. DB Netz marketing supports the train operators during the booking of lines in case of heavy maintenance activities.
- *In Germany as a transit country it is very difficult to improve the planning process in general. In general DB Netz marketing knows the requirements of the train operators and tries to take them into account.*

The following table summarizes the different responsibilities of the stakeholder:

Production performance	Overall responsibility and coordination of planning and control process
Section manager	Support of production performance and link between supply management and 3-i-strategy
Planning and control	Coordination of the regional process for validation of proposed measures
Maintenance and asset manager	Prioritisation of technical demands on the basis of 3-i-strategy
Technical expert	Support asset manager to validate the measures
Coordinator for	Integration of validated measures in



	construction and operation	the time tables
	Asset planning	Planning of measures and project coordinator for investments
	Controlling	Financial issues
SNCF	The list and roles of the stakeholders is described on this web page: http://www.rff.fr/en/our-company/who-s-who-in-the-railway-sector The French railway network is structured around a group of companies and bodies that cater to the various organisational requirements: administration, management, operation, renovation, safety, development, etc. As the network owner and manager, Réseau Ferré de France plays a pivotal role among these organisations. The liberalisation of the railway market in terms of freight and passenger transportation has altered how the system is organised. To ensure a wider range of services, new organisations tasked with overseeing safety and the correct functioning of competition have emerged as part of a rationale of neutrality and transparency. • Structuring of the network - The government defines the network's general orientations, makes decisions on major works, participates in the financing of projects and the renovation of the network, etc. - The regions are taking on a growing number of responsibilities in the area of public transport. On 1 January 2002, they became regional transport organisation authorities. They make a significant contribution to defining transport policies and financing the development of the network, particularly under State/Region Strategic Plans (CPER). • Network operation and management - Réseau Ferré de France plays a key role within the railway system. As the owner and manager of the French railway network, it decides what targets to apply in terms of traffic management and how the network is run and maintained. Its main commercial activity consists of selling slots, i.e. allotting time periods during which trains can transit from one point to another. - The Department of Railway Circulation (DCF) has since 1 January 2010 been responsible for traffic and circulation management on behalf of Réseau Ferré de France. This independent entity, which forms part of SNCF, guarantees fair and completely transparent access to the network for all railway companies. - Railway companies are responsible for the transportation of passengers and goods. They pay fees to Réseau Ferré de France in order to be able to run their trains on the network. Since the network was opened up to competition, new passenger or freight transportation companies have been given approval to operate on the French railway network. RFF, the network manager, provides them with the slots and infrastructures that allow them to operate, in the same way as the SNCF.	



- Network maintenance and development
 - As the project owner supporting network amendments and development, Réseau Ferré de France delegates construction and modernisation work on its infrastructures to representative companies (SNCF, SCET, XELIS, SYSTRA, SETEC, etc.), which must meet its sustainable development requirements.
 - Réseau Ferré de France also employs companies that specialise in large infrastructure projects to carry out major construction work. As such, Eiffage, Vinci and Bouygues are involved in partnership or concession contracts, notably involving construction projects on high-speed railway lines (LGV).
 - Delegated by Réseau Ferré de France, activities involving the maintenance and renovation of the existing network are, by law, carried out by SNCF Infra.
- Safety and free access to the network
 - The Public Establishment for Railway Safety (EPSF) works on behalf of the Minister for Transport to ensure compliance with safety rules and consistency in technical conditions and operational safety for all railway companies.
 - The Railway Activities Regulatory Authority (ARAF), created by the Act on the Organisation and Regulation of Railway Transport in 2009, is an independent administrative authority tasked with guaranteeing equal treatment for all organisations involved in the railway system. It ensures that access to the national railway network is provided under equal conditions for all railway companies, and that the development of competition is not hindered by rules governing the pricing of infrastructures in particular.
 - European organisations (Commission, Parliament, Railway Agency) also help to define and ensure compliance with the rules imposed on all national companies.
 - European Infrastructure Managers (or EIMs) are also working on the gradual creation of an interoperable European network. The EIM Association is currently chaired by Mr Hubert du Mesnil, Chairman of RFF.

How does the IM optimize the planning of maintenance possessions?

In order to optimize the planning of maintenance possession, RFF fixes some rules in section 4.5 of the [National Rail Network statement](#) in order to schedule the cooperation between both the maintenance providers and the Train and freight operating companies. To build 2012 timetable, RFF introduced the project “WINDOWS OF AVAILABILITY 2012” to enhance the planning and scheduling of works.

RFF (National Rail Network statement – Annex 8.4 about “Windows of availability 2012”):

A substantial amount of work of different kinds has to be conducted on the national rail network: maintenance, renewal or modernisation. This vital work forms part of ambitious programmes (renewal plans under the performance contract signed with the State, central-regional government project contracts, national commitment to rail freight, etc.).

In the current context (growth in passenger demand, opening up to competition, large quantities of works, late requests for works possessions, proliferation of the network, etc.) RFF has decided to introduce a clear and well-structured capacity allocation policy easily understandable to its customers and partners and designed to boost network productivity.

Windows of availability for works operations are the counterpart of clockface timetabling for train paths. Both are designed to enable capacity to be allocated on a systematic basis and, thereby, enable timetables to be compiled well in advance in complete transparency, ensure that train paths offered meet optimum standards and improve



works possession scheduling.

"Windows" are constructed on an "all inclusive" basis. The different types of works are identified for each corridor then reclassified according to type in relation to their nature and the type of traffic expected. The timetable slots thus identified and available for reservation will be windows of availability for works. Outside these periods, capacity will be fully reserved for revenue service operations. The resulting train paths will therefore be one hundred percent certain.

Established track possessions (see section 2.1) for a line do not vary much from one year to the following. They can be revised when RFF or SNCF Infra show that a change can decrease the global cost (Reference document on infrastructure capacity sharing, section 5.4.3)

RFF optimizes all the track possessions required for maintenance (including also speed limits) by favouring main lines.

How are the needs and wishes of the passenger and freight carriers taken into account?

Framework agreements can be contracted between RFF and operating companies. Moreover, in relation to the National Commitment to Rail Freight (ENFF), whereby the impact of works possessions on paths on the freight-oriented network (ROF) must not exceed four hours.

RFF informs passengers and freight carriers of the track possessions scheduled as of January 15th Y-1.

During the construction of the timetable, there is a coordination procedure

Once the timetable is scheduled, RFF Service Centre (CDS) takes part in the timetabling process, in addition to the work already done in this connection by the Rail Traffic Department (DCF). The CDS' target is to resolve any conflicts between works possessions and train paths on certain days that may have come into existence since the preparation of the annual timetable. The Service Centre works in association with customers to find solutions and will offer proposals for each two-month period between 4 and 6 months in advance. Customers will be informed of progress in the train path-day allocation process for each two-month period via the GESICO application.

How could collaboration on maintenance plan development be improved between stakeholders (Infrastructure managers, maintenance providers, train and freight operating companies)?

-



Effect of flexible maintenance on the relation with service provider

One of the goals of Automain is flexible maintenance with a minimal effect for the train service. This will influence the relation with the Service Providers.

- Explain how the Service Provider gets the possession time for doing the work in the current situation.
- What does flexible maintenance mean for the relation with the Service Providers and for the process of getting the possession time on the right moment?

What effects do you predict for:

- the amount of outsourced work
- the type of outsourced work
- the type of contracts (think of balancing financial aspects, incentives and processes)
- costs per activity
- workforce of the IM
- workforce of the Service Provider

Additional questions

- explain how the service provider gets the possession time for doing the work in the current situation;
- what impact does flexible maintenance have on the relationship between the IM and the train operator
- what impact does flexible maintenance have on the ability to get a possession when required?

IM	Answer
TV	1. Explain how the Service Provider gets the possession time for doing the work in the current situation. The role model related to the allocation of train free periods are a process that take 18 month in planning. Budget and procedures/priorities for maintenance project (grinding) selections, act as input for this process. Tamping needs are included and decided by the maintenance contractor, Trafikverket only measure that the track condition is according to the track classes. This gives the network statement (EC-directive 2001/14/EC) and act as input for the train table construction, see BAP planning. In Sweden, TV is commissioned by the Swedish government to issue the Network Statement (JNB) according to the Railway Act 2004:519 (Näringsdepartementet 2004). The aim is to have a single source of relevant and non-discriminating information of railway networks. In the Network Statement one finds the principles governing the right to operate traffic, infrastructure information, regulations governing applications for capacity and fees related to operation of traffic. Major Engineering Works (PSB) are also found in the Network Statement, which is a part of the planning of engineering works. The annual planning has to be finished before the Network Statement (JNB) so it can be published together with it, which is one year before the final Annual Time Table. Before signing a traffic contract with the operator, Trafikverket has to negotiate with the train operators for putting in time for maintenance, rebuilding and renewal work. This is

called BAP – plan for all activities on track. The plan includes all activities except snow clearance and running or urgent repairs tasks. On the other hand, the infrastructure manager (if functional contract, the contractor self) have to put this plan BAP into their maintenance contract document so that the contractor can get an estimate of maintenance time available for each maintenance activity (tamping). Therefore the strategy for budget, maintenance and procurement selections must be closely linked (And also linked to “selling” strategy). Trafikverket has put both “selling of train traffic” and maintenance planning under the same organizational unit.

It is now easy to realise that all maintenance, performance measuring and other procedures must be planned and decided in an early stage. See Figure 4.

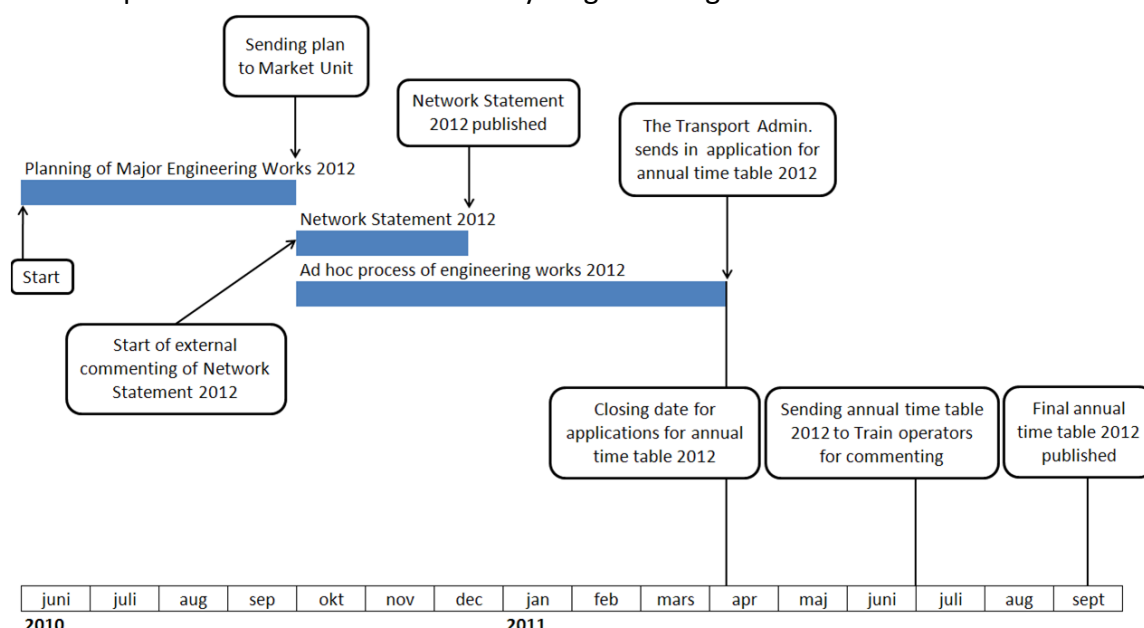


Figure 4: Sketch of the Planning of Engineering Works by TV. Planning starts one and a half year before Annual Time Table starts. Exact dates are left out.

The planning of engineering works is a main part of the organisational planning of TV. It is carried out on a yearly basis. Before the planning can start one has to collect data, analyse the infrastructure state, needs and requirements. The output from that analysis is the Maintenance Need Analysis (UBA), semi-literal translation. The Operation Department is responsible for the planning of engineering works. Within the Operation Department the Railway Division, Road Division and Technology Division assembles the need for reinvestments, maintenance and operation. The inquest is handed over to the Tactical Planning Division in the same department, whom does prioritisation of the engineering works. After prioritising, the former three divisions mentioned carries out optimisation of their future work according to the new plan and hands over the resulting plan to the Tactical Planning Division. The Tactical Planning Division does final prioritising and financial calculations. The output is a one to five years list of reinvestments, maintenance and operation work.

2. What does flexible maintenance mean for the relation with the Service Providers and for the process of getting the possession time on the right moment?



In order to achieve an efficient, flexible and effective maintenance decision support system, all involved parties must be included and fully updated in the whole process. This includes the main contract issues to be discussed, key factors such as safety, punctuality, availability, governmental (Trafikverket) goals and variables etc. and also presumed relationship amongst them. All this must be decided on and accepted by all involved parties along the maintenance planning process, see figure 5.

The methodology used is to inform and get clear about Trafikverkets goals and how Trafikverket handles the different interrelationships and clarifies them and try to solve them in a good way. It is vital to be selective and to decide which variables are most important, which contract actions are likely to be most meaningful, and as a consequence, what information should be collected and analyzed to verify the selected and performed actions. This feedback is to be reported back to IM.

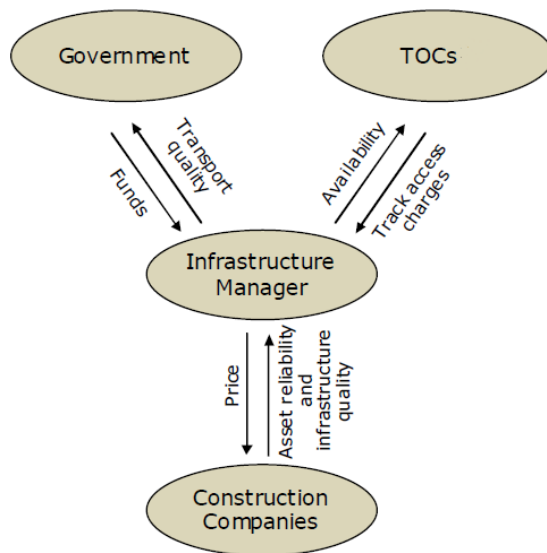


Figure 5. Parties involved in the process. TOC – Train Operating Companies

In these complex maintenance contracts, of interrelated engineering systems environment, with a number of different businesses constrains, large a large number of factors have to be considered, updated and distributed among involved stakeholders. This is an ongoing process for an 18 months planning period. Due to the actual traffic situation on the final day of planned maintenance execution, corrective daily maintenance planning usually take place by the train control centers.

Different planning decision support system helps to facilitate the management to be flexible in planning, however, the logistic, traffic situation, interlinked engineering systems, involvement of different organizations, budget updating etc. etc. gives almost no flexibilities left for maintenance actions.

What effects do you predict for:

- the amount of outsourced work

In Sweden, 100% of train traffic and maintenance work are outsourced. The flexibility is then believed to be achieved in that the operator and the contractor, on an open market, is set under pressure to come up with new ideas and to find new ways of increasing its flexibility. Each company then increases its own flexibility in constrain and frame of its own business goals. Hence, 100% outsource level should then give an increase flexibility. However, the increased



	number of contractors and operators needs to be synchronized in some way so that the <i>system flexibility</i> is achieved. Flexible system logistic synchronization with increased number of parties is very hard to achieve, leading to that the maintenance providers, in the process of getting the possession time on the right moment, is hard to fulfill with an increased amount of outsourced work. - the type of outsourced work Long technical life of rail assets need long time engineering strategy and safety condition control of the assets, in-between renewing and changing the maintenance contracts over time. Also, comparing costs of corrective and preventive maintenance, corrective maintenance cost is much higher and expensive than preventive maintenance due to loss of train “production” and higher labor cost. The potential for transferring “capacity killing” corrective maintenance to planned and predictive preventive maintenance is therefore high and must then be, in some way controlled by the IM to fulfill long term life, safety and cost management. Therefore, it is desired that the infrastructure managers should focus on a balanced combination of predictive and corrective maintenance strategy. However, today only rail grinding is controlled by the IM. All other work is decided by the contractor. - the type of contracts (think of balancing financial aspects, incentives and processes) See above text. The idea is that the market will give the lowest price with the highest quality. - costs per activity See above text. The idea is that the market will give the lowest price with the highest quality. - workforce of the IM Trafikverket have personnel for long/mid/short term strategies and planning, monitoring, procurement, contract managers and engineers. - workforce of the Service Provider Contractors have personnel for mid/short term planning, monitoring, contract managers and machines.
PR	1. Explain how the Service Provider gets the possession time for doing the work in the current situation. For the new performance based contracts (small scale maintenance) the contractor has to claim the needed possessions before he gets the contract. After award of the contract he gets the time he claimed to do the activities he think that are needed to meet the specifications. This results in a maintenance regime with a fixed timescale. The contractor gets and uses the slots he asked for. Renewal or new infra often leads to long possessions of frequently short possessions. The possessions are asked in advance (1,5 – 2 year). 2. What does flexible maintenance mean for the relation with the Service Providers and for the process of getting the possession time on the right moment? Flexible maintenance has no effect on our relation with the Service Providers. The process of planning a possession does not change. We expect that flexible planning of the possessions leads to an increase of the cost. The longer the planning horizon the lower the prize. So there must be relevant cost benefits for the Asset User to compensate for the



	increase of cost for the Asset manager (maintenance) due to flexible planning of the possessions.
NR	At present maintenance is carried out by Network Rail, who are also the infrastructure manager. Changes to working practices and hours would need to be managed, but this will be internal to Network Rail and should not alter commercial arrangements other than in the hire and operation of certain machines. Explain how the service provider gets the possession time for doing the work in the current situation? At present Network Rail gets the possession access as part of agreed access set out in the Route Utilisation strategy and the Rules of the Route. This is then defined in the time table with negotiation with the TOCs and FOCs. What impact does flexible maintenance have on the relationship between the IM and the train operator? There is a possibility to negotiate extra access to the track for more flexibility and this can be done up to 26 weeks before the possession, however, Network Rail will have to pay more to take access after the timetable has been set. There is also the possibility to take access to fit in around the white space in the timetable at much shorter notice. What impact does flexible maintenance have on the ability to get a possession when required? The current system is not very flexible, however, it expected that as part of the restructuring and devolution of Network Rail there will be much closer planning between Network Rail and the TOCs, this is expected to lead to less rigid systems and greater flexibility in planning and obtaining possessions as required.
DB	The possession time for the different maintenance activity are related to the type of work and the planning processes and handling time: • In case of a long planning period and handling time (up to 48 month) the non-availability of the track or track section is included in the timetable. Therefore long possession times days/weeks etc are possible. • In case of very short planning periods and handling time (days or weeks) the possession time is adjusted with the timetable. In case of double tracks the possibility of changing the track will be taken into account. In general all possession are at night. The problem of the right maintenance at the right moment is not only related to the track possession but also to the availability of the resources (machines, workers, etc). Therefore the planning of the maintenance activities is very important. Especially in big networks like DB the distribution of resources is a fundamental question. Most effects are difficult to predict. A flexible maintenance allows complete different strategies, approaches and processes. The cost per activity should go down to get the



	acceptance of IMs. Only in case of increase of availability, which is really needed by train operators, the cost per activity could increase. But in this case the IMs have to take into account also the life time of their assets.
SNCF	1. Renewals are scheduled three years earlier and the free periods for other maintenance operations are fixed one year earlier. The maintenance volume is assessed for each line. 2. Flexible maintenance cannot be applied without globally rethinking the maintenance policy. Contracting would be more difficult because flexibility induces more lead times. Therefore cost and complexity of the system are expected to increase. Explain how the service provider gets the possession time Windows of availability are finalized in April of year Y-2 and the schedule of the possession times is completed one year in advance. Therefore, all is discussed in an early pre-production phase. Preparatory work on requests for possessions is conducted in meetings organised by SNCF Infrastructure in year Y-2 also attended by RFF, and track possession applicants. These provide an opportunity for: • the applicants to comment on the potential alternatives; • RFF to put forward its first thoughts as regards the position it will adopt in reply to the formal applications it is likely to receive. Flexible maintenance Since the current policy is works to schedule the maintenance possession times as early and as “massively” as possible, effects of a really flexible maintenance are very hard to assess because all the process should be changed. However, a significant increase of costs is expected by both RFF and SNCF Infra.
Strukton	• We use the possession schedule as set up by ProRail. In this schedule each track or emplacement has a minimum possession time of 5½ hours for regular (small) maintenance activities. This schedule is fixed approximately 2 years in advance. Work which requires a longer possession time (cost-benefit analysis) will be discussed, requested and fixed 1½ to 2 years in advance. • This will result in variable workloads with peaks and troughs. More resources (both labour and equipment) will be needed in the peaks; and underuse of resources will occur in the troughs. This will inevitably result in poorly spread resource usage.



Key Performance Indicators

What Key Performance Indicators (KPI's) do you use related to planned and unplanned unavailability and possession time?

Give for each KPI the following information:

- Algorithm, how is it calculated
- On which level of detail is it used (object, region, country, track, corridor etc.)
- What are the mechanisms to control the level of each KPI?
- Do you use any incentives, bonuses or penalties regarding to the level of the KPI's?

Additional questions

- The IMs seem to have a lot of things that they call key performance indicators; but are they all really key? Please differentiate between key and non-key performance indicators.
- TV has different KPIs for different line categories. Do the IMs have similar arrangements?
- Can the IMs describe the main function of the KPIs? Are they for monitoring asset condition, or for helping to make decisions about what maintenance should be done, or a mixture of the two?
- When an IM has to make a decision about what maintenance to carry out, how does it decide which KPIs to use?

IM	Answer
TV	Broadly, PIs classified by Trafikverket are leading or lagging indicators. A leading, lead, or prospective indicator is a performance driver, i.e. a measure that drives the performance of the outcome measure. The outcome measure itself is simply the lagging, lag, or retrospective indicator, e.g. different financial measurements. Leading and lagging indicators are relate to strategy/goals, and therefore it is important not to mix means and ends. When Trafikverket develop PIs, the PI characteristics are: • For railway-the-shelf or Trafikverket tailor-made indicators: an important distinction when the indicators are to be used in benchmark, inside or outside Trafikverket organisation • Long- or short-term indicators: an important distinction when deciding how long a time the indicator measures have to be stored • Slow or fast changing rate indicators: an important distinction when performing trend calculations or deciding if slower/faster redundant indicators must be used or developed, often the case for environmental issues The relation between different PIs can be studied from three different perspectives, namely relationships through signal characteristics, decision characteristics, or signal and decision characteristics. PIs used by Trafikverket are scalable; i.e. it must be possible to use them locally at the same time as they can be aggregated and used globally or vice versa. Since the development process for PIs follows a top-down approach where Trafikverkets overall business objectives are cascaded down to specific PIs to be measured in the organization, the reporting and aggregation of PIs follow a bottom-up perspective. This approach also makes it possible to integrate fully the PI system into other performance management systems in use, for instance balanced score cards that Trafikverket use. (See Thomas Åhrén "Maintenance performance indicators (MPIs) for railway infrastructure: identification and

analysis for improvement”, Doctorial Thesis, ISSN: 1402-1544, ISRN: LTU-DT—08/19 – SE, 2008:19 Luleå University of Technology, (2008))

The KPI has a differentiation and use when it comes to different line categories. The KPI is based governmental agreements and interfaces and internal KPI are broken down in the organization using BSC. Interfaces to internal systems support IM in translating top-level KPI-agreements into daily business planning. The internal KPI-systems are instruments to monitor and control the assets' performance development considering also local conditions since approximately half the budget is spent for maintenance and renewal of superstructure. KPIs for track are of highest importance. See Figure 6 and 7.

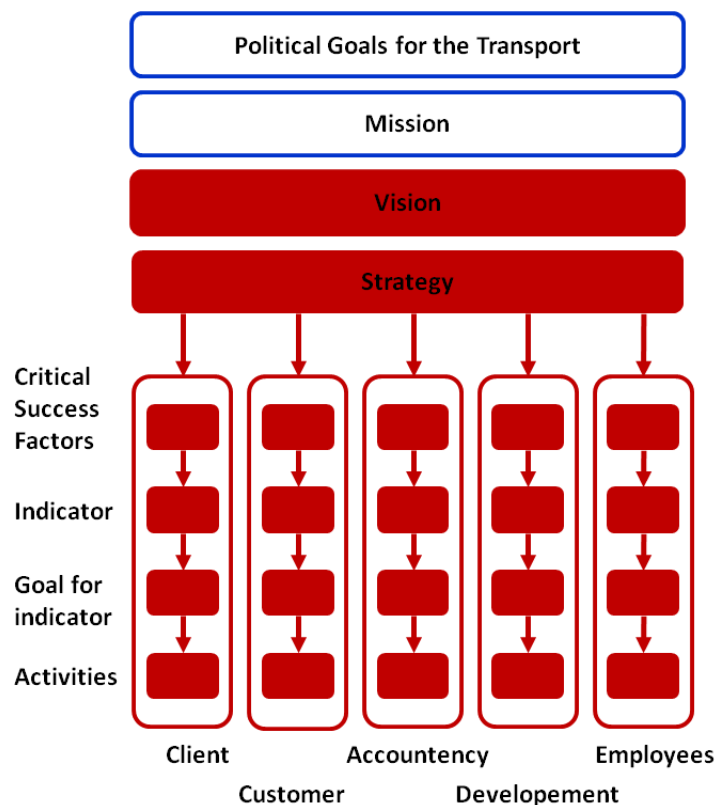


Figure 6: Overall sketch of the scorecard used by TV.

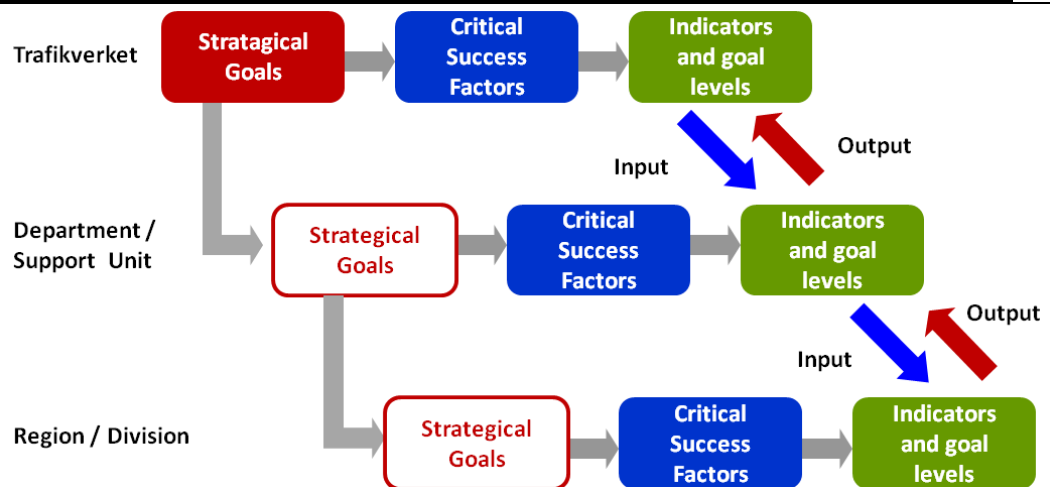


Figure 7: Overall sketch of the scorecard used by TV.

Trafikverket use 5 different line categories (1 – 5) to differentiate and prioritize the railway network, see figure 8. The criteria's are; traffic flows, number of trains per day, type of traffic and relative importance to society functions. Trafikverkets KPI breakdown and prioritization of activities are mostly differentiated according to the 5 line categories and then linked to maintenance and renewal prioritization. The five line class classification criteria are: economic importance, sensitivity to disruptions, ability to restore traffic after delays, regularity and frequency of traffic, established to support decision making and finally failure related target values linked to lines to manage maintenance activities.



Figure 8. The five different rail line categories in Sweden.

KPI differentiation according to line categories are presented in figure 9.

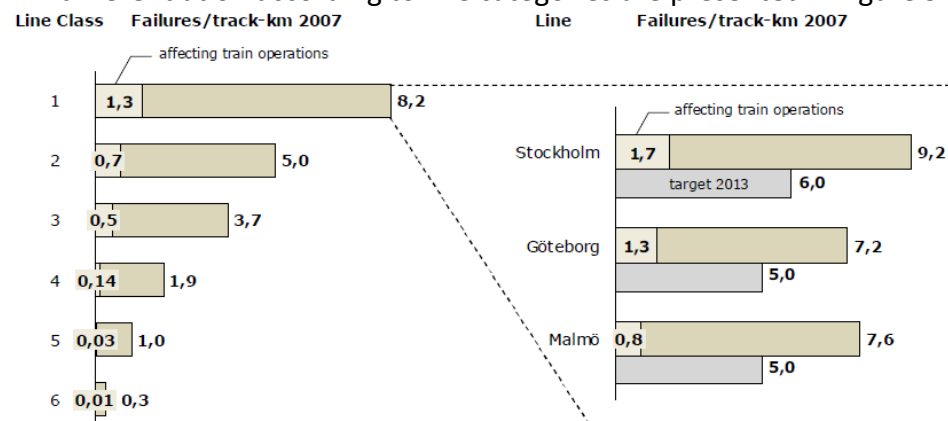


Figure 9. KPI differentiation. (5 and 6 are same classes from 2011)

Categories of top-level KPIs agreed with the government are: safety, network availability, asset reliability, quality and condition, finance, customer orientation and finally environment. See table 2.

Table 2. Categories of top-level KPIs.

First	level	Second level sub-	Maintenance	performance	Relationshi
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sub-goals	goals	indicators	p BSC
An accessible transport system	Improve the use of state infrastructure	- Capacity utilization - Capacity restrictions	Customers Customers
A high quality of transport	Decreased train delays Decreased freight traffic disruptions Increased rail network maintenance efficiency	- Train delays due to infrastructure - Hours of freight train delays due to infrastructure - Number of delayed freight trains due to infrastructure - Number of train disruptions due to infrastructure - Q-factor (degree of track standard) - Markdowns in current standard - Maintenance cost per track kilometer - Traffic volume	Processes Processes Processes Processes Processes Processes Processes Financial
Safe traffic	Reduced number of killed and injured persons	- Number of accidents involving railway vehicles - Number of accidents at level crossings	Customers Customers
A sound environment	Reduced energy consumption Effective natural resource consumption	- Energy consumption per area - Use of environmental hazardous material - Use of non-renewable materials	Financial Innovation Innovation

From 2011 we use operational quality as in table 2.

Track Class	Punctuality	Robust	Traffic information	Comfort	Safety	Usefulness
1	++	++	++	+	++	Base
2	++	++	++	++	++	Base
3	+	+	+	+	++	Base
4	Base	+	Base	Base	++	Base
6	Base	Base	Base	Base	Base	Base

From the table above, Table 2, it is found that the operational qualities punctuality, robustness and usability, or usefulness, are related to punctuality. The underlying indicators is found in the table below, Table 3.

Table 3: Delivery qualities, or operational qualities and their underlying indicators used by Trafikverket.

Delivery Quality	Performance Indicator (KPI)	Unit
Punctuality	- Arrival Punctuality	%
	- Train Delay	h/Million-train-km
Robustness	- Downtime, or Restoration Time	h/days
Traffic Information	- Availability of the traffic information system	%
	- Passenger Satisfaction (NKI)	%
	- Trip-planner	Quantity
Riding Comfort	- Q-value	-
	- Passenger Satisfaction (NKI)	%
Safety	- Kills and Injuries	Quantity
	- Vehicle damages	Quantity
Usability	- Availability of Infrastructure	%

The indicators related to availability from Table X above is:

- Arrival Punctuality [%]
- Train Delay [h/Million-train-km]Downtime [time]Availability of Infrastructure [%]

KPIs Related to Punctuality and Availability

In TV's, or former BV's annual report of 2009 one finds indicators of punctuality, delay and regularity.

Punctuality

A punctual train is no later than five minutes to its end station. The punctuality is presented over three and five years as the percent that is punctual for different types of traffic and different line classes. The traffic types are Passenger Trains, Freight Trains, Long Distance Trains, Express Trains, Regional Trains, Commuter Trains and Arlanda Line. And the line classes are City, Major Lines, Other Important Lines, Minor Lines and No or Little Traffic. (Banverket 2010)

The indicator used by TV is called Arrival Punctuality and is one of the underlying indicators for the six deliver qualities of Trafikverket with quantitative objectives for the different railway lines. Punctuality is presented in the latest strategic plan 2010-2021 of Trafikverket with objectives up to year 2021 (Banverket, Vägverket et al. 2009). Similar presentation over a five years period is found in the annual report of 2009 (Banverket 2010).



Train Delay

In the Swedish network, Train Delays due to Infrastructure can be found as an index over an eight years period and as an indicator in hours for passenger and freight over a three years period (Banverket 2010). Delay data can also be found in the monthly reports of TV, as well as punctuality, traffic volume and regularity. In TV's monthly report of December 2010, delay is presented over three years, in hours, with the owner of the cause to failure. The owners of the cause to failure are Operation Centrals, Infrastructure, Train Operator, Accidents & Mishap and Secondary Delays (five in total). Secondary delay occurs when a delayed train affects the next coming trains. (Trafikverket 2010b) Another work where the owners of train delay were examined was carried out by Nyström

Delay hours due to failures in infrastructure for different geographical regions for 2002-2005 can be found in the maintenance handbook of TV. TV stresses on the issue that this indicator does not take into account which time on the day the delay occurs and therefore it does not show the effect on passengers on there way to work in a good manner. Another issue to keep in mind is that the indicator does not take into account the cancelled trains. Indicators of regularity measure this issue. (BVH 800 2007)

Timetables are constructed with some slack so that trains can take back small delays that can occur during travelleing. This slack affects the delay, depending on how large it is, and should therefore be measured and compared with the delay. An indicator for measuring the timetable slack is the Slack over Total Travel Time (Goverde, Odijk 2002). This indicator has been redefined by Nyström to measure the availability due to slack, i.e. $1 - \text{Slack} / \text{Total Travel Time}$. It is then straightforward to define an indiactor for planned slack by using the planned travel time instead of the total travel time, i.e. $\text{Slack over Planned Travel Time}$ and $1 - \text{Slack} / \text{Planned Travel time}$.

Regularity

Regularity can be presented as the number of trains in percent that travels the whole planned distance, or as the number of cancelled train departures. The regularity indicator is found in TV's monthly report of December 2010 for passenger and freight over three years (Trafikverket 2010b), and cancelled train departures are found in TV's annual report of 2009 for passenger and freight over three years (Banverket 2010). These indicators are called Train Regularity and Cancelled Trains.

Availability

Availability of railway infrastructure is used as an indicator in the operation and maintenance scorecard Delivery Qualities by Trafikverket, called Availability (Banverket, Vägverket et al. 2009). Availability is defined as:



	$A = \frac{Uptime}{Uptime - Downtime} = \frac{MTBF}{MTBF + MTTR} \quad (1.1)$ Where: MTBF = Mean Time Between Failures MTTR = Mean Time to Recovery (or restoration) Note that TTR can stand for Time to Recover or Time to Repair. See Section 2.1 for TV's operation and maintenance scorecard Delivery Qualities. Reliability is related to availability and is the ability of an item to perform a required function under given conditions for a given time interval, i.e. a measure of probability (SS-EN 13306 2001). The reliability cannot be measured by any indicator but can be calculated for specific times by the use of failure data. Availability is a function of reliability, maintainability and maintenance supportability (SS-EN 13306 2001). Conclusion Availability is a function of Uptime and Downtime and is therefore related to the indicators Train Delay per Item and Downtime. It is possible to calculate various availabilities of different items but does not necessarily give any additional inputs than the related indicators, besides normalizing the range to zero and one. Nevertheless, one indicator has been identified: • Availability of Infrastructure [%] (or Network Availability, used by TV and SBB) • MTBF [h] • MTTRRecovery [h]s • MTTRRepair [h] Give for each KPI the following information: • Algorithm, how is it calculated. These are current developed during 2011. • On which level of detail is it used (object, region, country, track, corridor etc.) These are current developed during 2011. • What are the mechanisms to control the level of each KPI? These are current developed during 2011. • Do you use any incentives, bonuses or penalties regarding to the level of the KPI's? These are current developed during 2011.
PR	In the contract 2011 ("Beheerplan 2011") between the asset owner (government) and the asset manager the following top KPI's are mentioned. KPI Capacity distribution The extent to which ProRail is capable to honor the requested train paths by the asset users KPI Delivered trainpaths The percentage of the original planned train paths that ProRail allowed the asset users the use for their operation.



KPI Partially delivered trainpath

The percentage of the not realized trainpaths where the passenger train has passed a part of the planned the time table checkpoints.

Trainpath quality (all passenger carriers) (new)

This is the arrival punctuality of all trains on all scheduled passenger arrivals.

Punctuality (5 minutes, Main routes) (new)

This is the punctuality that the main passenger carrier (NS) has agreed to the ministry of transport

Major disruptions (main routes) (new)

The number of emergency days per year: This is the number of days per year that the main routes punctuality is below 75% and the main routes ridden trains drops below 90%.

Top 5 least performing train series from last year (new)

For top 5 least performing train series the trainpathquality is multiplied by the % delivered train paths. Here, only the series of train passenger carriers is considered with a minimum of 20 rides a day and not transnational. The KPI is the average of these five Lines.

Major disruptions (new)

The number of infrastructural disasters that result in the failure of a node. These are the number of infrastructure failures (no collisions and collisions).

KPI Passengers satisfaction on the cleanness of transfer

The percentage of the train passengers of NS that gives the cleanness of the transfer a rating of 7 out of 10 or higher.

KPI Passengers satisfaction on social security (daytime and evening)

The percentage of the train passengers of NS that gives the social security on the stations a rating of 7 out of 10 or higher.

KPI Passengers satisfaction with travel information during disruptions

The percentage of the train passengers of NS that gives the information supply to the passengers a rating of 7 out of 10 or higher.

KPI Accessibility

The extent to which Prorail delivered the accessibility measures, as described in the implementation plan "Accessibility", conform to plan.

KPI Availability

The availability of the infra during opening hours.

KPI Maintenance time

The percentage of time the infrastructure is not available for the trainservice, due to possessions for planned maintenance

KPI Downtime

The percentage of time the infrastructure is not available for the trainservice, due to a disturbance

All of the mentioned indicators are introduced to manage the contract between ProRail and the government. So they are all key performance indicators.

Up to now ProRail does not use different levels of the KPI's for the different type of lines ("infra concepts"). We intent to do so in the future and are working on it. In this project the main focus is on defining the infra concepts and the level of the performance and cost KPI's.

The 2011 targets for the KPI's:

Tabel 2: Overzicht Beheerconcessie met dienstengroepen en KPI's ProRail

Zorgplichtgebieden Conform artikel 6, lid 1, Beheerconcessie	Diensten Conform Netverklaring 2011	Prestatie-Indicatoren Conform artikel 6, lid 1, Beheerconcessie	Grenswaarde			Streefwaarde	
			2009	2010	2011	2012	2013 e.v.
Kwaliteit van de capaciteitsverdeling Beschikbaarheid en betrouwbaarheid van de hoofdspoorweg-infrastructuur	Treinpaden	Capaciteitsverdeling	99,5%	99,6%	99,6%	99,6%	99,6%
		Geleverde Treinpaden	-	97%	98%	98%	98%
		Deels gerealiseerde treinpaden	-	40%	60%	60%	60%
		Beschikbaarheid:	99,49%	99,53%	99,45%	99,45%	99,45%
Kwaliteit van de bijsturing	Treinpaden	Storingstijd	0,21%	0,21%	0,21%	0,21%	0,21%
		Onderhoudstijd	0,30%	0,26%	0,34%	0,34%	0,34%
		Reizigerstevredenheid over reinheid	55%	55%	55%	55%	55%
		Reizigerstevredenheid over sociale veiligheid:					
Reinheid, toegankelijkheid en sociale veiligheid van transervoorzieningen	Transferdiensten	overdag	86%	89%	90%	90%	90%
		's avonds	58%	58%	58%	58%	58%
		Toegankelijkheid	56%	71%	86%	96%	>96%
		Reizigerstevredenheid over reisinformatie bij ontregelingen	53%	56%	56%	57%	57%

ProRail has been translated its company goals into a balanced scorecard (BSC). In this BSC the objectives from different perspectives are translated into performance indicators and measures. ProRail deliberately chooses to steer on a combination of performance indicators and actions because the only steering on 'numbers' gives a one-sided focus. ProRail also works continuously to further develop his dashboard to ensure that the output and performance that we deliver matches with the expectation of the customers and our financiers. Besides the key performance indicators (KPIs) with min – max values that are represented in the figure above ProRail also uses a number of internal KPIs. These KPIs are also used to support and measure our strategic goals.



Tabel 1: Interne afspraken

	Waarde				
	2009	2010	2011	2012	2013 e.v.
Klanttevredenheid					
Reizigersvervoerders (reg., kernnet)	n.v.t.	7	7	>7	>7
Goederenvervoerders	n.v.t.	7	7	>7	>7
Regionale en lokale partners	n.v.t.	7	7	>7	>7
Publiek	n.v.t.	7	6,6	7	>7
Punctualiteit < 5 minuten	93%	93%	93%	93%	93%
Realisatie Intraprojecten					
Functiehandhaving	n.v.t.	10%	10%	10%	10%
Overige werkstromen	n.v.t.	20%	17,5%	15%	15%
Aantal botsingen trein-trein	3	3	2	2	2
Aantal ontsporingen	5	3	2	2	2
Aantal arbeidsveiligheidsincidenten	3	2	1	1	1
Life Cycle Costs (LCC) per treinkilometer	€ 9,58	€ 9,54	€ 9,25	€ 8,96	€ 8,65
Arbeidsmarktimage	72%	Top 50	Top 50	Top 50	Top 50
Medewerkerbetrokkenheid- en tevredenheid	75%	80%	80%	80%	80%
Contractopvolging omgevingswerken*	n.v.t.	n.v.t.	-	-	-

* In het Beheerplan 2011 zijn geen waarden vastgesteld voor de KPI Contractopvolging omgevingswerken.
De komende tijd zal ProRail deze KPI volgen en na het eerste halfjaar 2011 nader evalueren.

PR also uses KPI for safety (see next figure), some examples are:

- Collision train – train
- Derailment
- Accidents when on duty
- Electrocution
- Transfer incident
- Collision on level crossing
- Suicide

NR



KPIs - Performance

KPI	200	PPM	Percentage of franchised operator trains that arrive 'on time' at their destination (10 mins for Long Distance, 5 mins for Regional and London & South East)	Number of trains arriving within 5/10 minutes divided by total number of planned trains	Punctuality on the network; are we getting passengers to their destinations at the scheduled time
PI	201	Passenger Lateness	Average weighted lateness for passengers at their final destinations (taking into account cancellations and missed connections)	(Minutes late at each stop x number of passengers alighting from train) + (Minutes impact of cancelled trains and missed connections x number of passengers affected)	What is the actual impact of delays on the network to passengers arriving at their final train destinations
PI	202	Right Time	Percentage of trains arriving exactly on time or early at their final destinations	Number of trains arriving on time or early divided by total number of planned trains	Punctuality on the network; are we getting passengers to their destinations at exactly the scheduled time (or before)
PI	203	Delay Minutes	Accumulated loss of time compared to scheduled running times by individual trains at set monitoring points	Sum of minutes lost by all trains between monitoring points	Representation of how delay incidents impact on train services
PI	204	Cancellation and Significant Lateness	Percentage of trains cancelled or running 30 minutes or more late at their destinations	(Number of trains arriving 30 minutes or more late plus number of trains cancelled) divided by total number of planned trains	Severely disrupted services (although in a minority) have the greatest impact on people travelling and leaves a strong negative impression of the railway
PI	205	Cancellations	Percentage of trains which are cancelled	Number of trains cancelled divided by total number of planned trains	Cancelled services create a big disruption to passenger journeys and leave a strong negative impression
PI	247	Freight PPM	Percentage of freight operator trains that arrive 'on time' at their destination (ranging from 5 to 20 minutes depending on type of commodity being transported)	same as PPM	It is necessary to have separate PPM measure for freight
PI	252	Non-Franchised Cancellation and Significant Lateness	Percentage of non-franchised operator trains cancelled or running 30 minutes or more late at their destinations	Same as Cancellation and Significant Lateness	
PI	248	Non-Franchised PPM	Percentage of non-franchised operator trains that arrive 'on time' at their destination (10 mins for Long Distance, 5 mins for Regional and London & South East)	same as PPM	It is necessary to have separate PPM measure for non-franchised operators
PI	431	Public Performance Target (PPT)	PPT is a weighted average of PFM (Freight Performance Measure) and PPP (Public Performance Measure)	The basic calculation (expressed as a percentage) is $(PPM \% \times 0.9) + (FPM \% \times 0.1)$	It is intended to be a measure which more fully encompasses performance achievements by Network Rail, rather than individual elements of Passenger or Freight performance. As such, it is potentially a better



D2.1 High level breakdown of maintenance activities

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						indicator for bonus calculations.
	KPI	226	Network Availability	Measures the % of train schedules ran and disrupted (cancelled or replaced by buses vs. the permanent timetable) per weekend, per TOC	WTT compliance = (total no. of schedules planned and run as trains / (total no. of schedules planned and ran as trains + bus schedules vs. the permanent timetable + cancellations vs. the permanent timetable)) * 100% Class 1 and 2 services, per weekend, per TOC as reported in Trainplan	WTT compliance is the KPI aimed at measuring the reduction in usage of the replacement bus services and cancellations disrupting the railway during weekends. In order to incentivise better planning and delivery resulting in reduction of the disruption in the short term, it excludes long-term disruption (e.g. a 6 month replacement bus service introduced for a major renewal work) and focuses mostly on the effect of the typical maintenance and renewals possessions.
	PI	227	Possession Disruption Index for Passengers (PDI-P)	The economic value of the impact of possessions on excess journey time as experienced by passengers as a result of disruptive possessions	(Excess Journey Time x Busyness Factor) x (# Passengers x Time of Day Weighting x Economic Value of Time) divided by (Total Scheduled Passenger Km)	Incentivise Network Rail to minimise possessions which have the biggest value impact on passengers
	PI	228	Possession Disruption Index for Freight (PDI-F)	Track Kilometre availability weighted by relative levels of freight traffic operated over each ELR	(Average freight tonne km per SRS divided by Average freight tonne km for network) x (Track Km Available divided by Total Track Km)	Provides network availability measure with relative importance to freight operators
	PI	229	Rail Replacement Bus Hours	Measures the rail replacement bus service hours operated due to possessions	(Scheduled departure time - Scheduled arrival time) using TSDB code 'BR' summed over all TOCs	Bus hours not captured in excess journey time so this will ensure the impact of bus substitutions are minimised
	PI	244	Possession Notification	Percentage of disruptive passenger possessions notified prior T-12.	Number of disruptive passenger possessions that were entered into National Timetable database within 12 weeks before the date of the possession. Further splits for number of disruptive possessions that were: • incorporated in First Working Timetable • entered into National Timetable database within 12 weeks before the date of the possession • entered into National Timetable database within 12 weeks before the date of the possession divided by total number of disruptive passenger possessions	Network Rail should be incentivised to plan possessions as far in advance as possible Improves the planning of journeys by passengers as changes made before T-12 are not seen by the travelling public

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	PI	245	Late Possession Cancellations	Percentage of possessions that were cancelled after issue of the Weekly Operating Notice (WON).	Number of possessions per period that were cancelled after issue of the Weekly Operating Notice (WON) divided by the total number of possessions recorded in the relevant period	Cancellations published after the WON do not allow train operators time to re-schedule services that were previously cancelled
	PI	246	Possessions Involving Whole Line Block	Expresses the number of possessions recorded as 'whole route blockage' as a percentage of the total number of possessions.	Number of possessions recorded as 'whole route blockage' divided by the total number of possessions	Network Rail should be incentivised to take partial line blocks to allow more services to take place
	PI	232	Delay Minutes Due to Possession Overrun	Delay minutes per scheduled train kilometre due to possession overrun	Total delay minutes attributed to possession over-runs divided by scheduled train-km	To incentivise Network Rail to not simply take longer possessions with a greater chance of over running
	PI	233	Cancellation Minutes Due to Possession Overrun	% of trains cancelled due to possession overrun	Number of trains cancelled due to possession overrun divided by number of trains	To incentivise Network Rail to not simply take longer possessions with a greater chance of over running. (Using % of trains cancelled aligns with Cancellations and Significant Lateness performance measure)
	IPI	308	Maintenance Planning Efficiency	Percentage planning level multiplied by percentage plan attainment (i.e. how well we are planning our available resource, and how well we are then delivering our plans) % planning level = norm hrs planned in 4 wks/maximum hrs available for the same 4 wks % plan attainment = norm hrs of planned work delivered in 4 wks/norm hrs of work planned for delivery in the same 4 wks	Planned Delivery Efficiency % = % planning level x % plan attainment	This is as measure of how well we deliver plans that fully utilise the available resources.

Infrastructure Condition KPIs



Asset Group	Category	ICR Code	Measure
Track	Performance	Delay 1	COT TSRs
		Delay 2	Track Faults (including Broken Rails)
		Delay 3	Points Failures
	Asset Condition	Track 1	a. Track Geometry: Poor Track Geometry b. Track Geometry: Poor Track Geometry - S&C Eighths c. Track Geometry: Good Track Geometry
		Track 2	a. Track Geometry: L2 Exceedences b. Track Geometry: L2 Exceedences on lines over 40mph
		Track 3	Track Geometry: TGI (and SDs)
		Track 4	Track Geometry: Super Reds
		Track 8	Number of Broken Rails
		Track 9	a. Number of Rail Defects: Isolated Defects Discovered a. Number of Rail Defects: Remaining Isolated Defects b. Number of Rail Defects: Continuous Defects Discovered b. Number of Rail Defects: Remaining Continuous Defects
		Track 10	Number of Track Related Derailments (Running Lines)
		Track 11	Number of Track Buckles
		Track 13	Number of Points Failures
	Performance	Delay 4	Bridge Strikes
		Delay 5	Lineside Structure Failures
			c. Additional Inspections
	Asset Condition	Civils 4	Number of Earthworks Failures
Signalling	Performance	Delay 6	Track Circuit Failures
		Delay 7	Signalling System and Power Supply Failures
		Delay 8	Signal Failures
		Delay 9	Cable Faults (Signalling and Telecoms)
		Delay 10	Level Crossing Failures
		Delay 11	Other Signal Equipment Failures
		Delay 20	Axle Counters
	Asset Condition	Signal 1	Signalling Condition Index (YTD is last available annual return)
		Signal 2	a. Incidents of Signalling Failure Causing Delays b. Incidents of Signalling Failure Causing Delays in Excess of 10 minutes
		Signal 3	Number of Track Circuit Failures
		Signal 4	Number of Category B Technical SPADs
		Signal 5a/b	Signal Failures with a Hazard Rating of 20+ (by Type)
		Signal 5c	Signal Failures with a Hazard Rating of 50+
Operational Property	Asset Condition	Op Property 1	Station Stewardship Measure (YTD is last available annual return)
		Op Property 2	Light Maintenance Depot Condition Index (YTD is last available return)
Electrification and Plant	Performance	Delay 13	OLE/Third Rail Faults
	Asset Condition	E&P1	E & P Condition Index - AC Feeder (ytd is last available annual return) - AC Contact - DC Substation - DC Contact
		E&P8	Signalling Power Supply Failure Causing Delays in Excess of 10 minutes
		E&P5	Number of Signalling Power Supply Failures
		E&P7	Traction Power Failure Causing Delays in Excess of 10 minutes
		E&P6 AC	Number of AC Traction Power Supply Failures >300 mins
		E&P6 DC	Number of DC Traction Power Supply Failures >300 mins
		E&P4	Number of AC & DC Traction Power Supply Failures >500 mins
Telecoms	Performance	Delay 14	Telecoms Failures
	Asset Condition	Telecoms 6	Incidents of Telecom Failure Causing Delays in Excess of 10 minutes
		Telecoms 4	Safety Related Telecoms Failures with a Hazard Rating of 20+
DB	KPIs		



Number of speed reductions

- Only counting Database
- From region to whole network
- This KPI will also be monitored by the government

Number of delay minutes

- We asked for the algorithm.
- From region to whole network

Number of delayed trains (unplanned availability)

- Delayed trains will be monitored individually for long-distance, regional and freight trains
- See section 6 in “Schienennetz-Benutzungsbedingungen 2012” (SNB 2012) for the algorithm.

Service providers have to pay a penalty if they don't meet the possession time. Normally the SP breaks the maintenance to allow train operation. In case the SP can't break the activity (e.g. heavy maintenance at a bridge or renewal of track) the SP has to pay for the delay minutes.

The penalty depends on the train type and delay.

DB Netz has to pay penalties to the train operators if the assured percentage of punctuality will not keep during the year due to infrastructure reasons (see also 1.1 for assured punctuality).

The basis of the funding by the government are the following indicators, which are monitored by DB and the government;

Quality indicators related to the funding by the government:

- Theoretical loss of travel time
- Number of defects of the infrastructure
- Functionality of train platforms
height of platforms, accessibility without stairs, weather protection
- Assessment of asset quality quality and visual appearance of platforms
- Supply guarantee of power

Additional quality indicators:

- Number of faults and mean time to repair
- Mean age of important
- Condition categories of bridges and tunnels

Assesment indicators are:

- Delay minutes
- Total track kilometre of trains
- Number of train stops in platforms
- Traction energy

Additional the *delay minutes for the different train operators* will be monitored and compared with



	predefined limit values. DB has no different indicators for different lines. The maintenance of an asset is triggered by the inspection results and prioritized by the significance of the asset. The significance is build of income and actual/future traffic volume and influence of KPIs like delay minutes.
SNCF	To evaluate a tentative schedule: • The number of track possessions • The total volume (in km.h) for each line A posteriori evaluation of the maintenance efficiency : the train tardiness caused by infrastructure <i>Performance indicators of RFF are derived from the performance contract between RFF and the state (see question 1.1).</i> <i>Four high-level performance indicators are given in the infrastructure management agreement between RFF and SNCF (CGI 2007-2010, article 27):</i> • Quality, track geometry → Track level • Reliability → Number of train delays caused by the infrastructure • Reactivity of maintenance and exploitation (both under the responsability of SNCF Infra) → Total delay in minutes (sum of the length in minutes of the train delays caused by infrastructure) • Reactivity of the maintenance → (Mean?) duration to repair infrastructure failures Maintenance is now mainly scheduled for each of the main axis (the rest of the network is divided into subset of lines). The decisions about what maintenance should be done are based on indicators based on models or inspections. For example, the time periods between some periodic operations change in function of the UIC group of the line.



Trends, developments or opportunities for train free periods

What trends, developments or opportunities do you see in the length or the effectiveness of the train free periods?

- What innovations are used at this moment?
- What are the results on performance and costs?

Additional questions

- Could all IMs please check that they have answered the question about trends?
- Most IMs foresee an increase of the maintenance costs. Please explain.
- How do IMs balance the demands from train operators for more track access, with the increased maintenance cost that will result?
- What cost increase is acceptable to decrease possession time by 1% / 10% / 50%?

IM	Answer
TV	• What innovations are used at this moment? With the current procurement strategy using functional contracts with little or less impact from IM, regarding the decision making process of choosing activities, the trend must be to develop train free periods. This is to get at better logistic forecast to allocate time and resources to perform preventive maintenance actions. It is too complex to work with a dynamic planning self updating process with all involved parties as we do today. • What are the results on performance and costs? Performance might go up and maintenance cost might also go up. This is all linked to how much profit the contractor is willing to get and how good the IM is to manage and control the situation. If successful, the LCC per train kilometer might go down.
PR	• Within ProRail we see a trend called “more for less” (also known as “simple track”). This means we want to create more capacity and functionality using less infra. This means we have to maintain less infra. A disadvantage can be the accessibility of the infra to be maintained. • We use a method (TRS) to optimize the effectiveness and costs of the trainfree period. We optimize between the Life Cycle Costs and the social benefits for the passengers and freight trains. We use a self developed calculation tool to do the calculations (LCM tool). In this tool we calculate the prize of planned unavailability (a train free period) and unplanned unavailability (errors). The prize depends on the number of trains, number of passengers, time of day etc.. • We want less people on the track during opening hours. We achieve this by using an other maintenance regime and making more use of dedicated measuring trains: - ProRail is developing a new maintenance planning (Maintenance Planning 2020) in order to facilitate future developments concerning maintenance



	and traffic. The most important developments are: ▪ Increasing traffic demand (High Frequency Programm to be implemented in 2020) ▪ Increasing maintenance activities ▪ Increasing complexity of safety measures resulting in more out of service hours The new planning will be based upon another frequency of service hours with an adjusted time slot. At the same time it will optimize the service hours needed for projects and systematic maintenance. Major benefits will be an increase of capacity needed for traffic and a decrease in cost. - We changed from inspecting the switches and crossings by men force to inspection with a dedicated inspection train. - The use of specific measuring and inspecting trains increases. This has a big advantage for the safety and the required train free periods. Cost benefits depend on the type of measurement. - We want to make a switch from using specific measuring and inspection trains to normal passenger trains equipped with measuring devices. • With equipment build in in the infra we monitor the condition of the trains (e.g. Quo Vadis, hotbox detection). Most IMs foresee an increase of the maintenance costs. Please explain. We expect that flexible planning of the possessions leads to an increase of the cost. The longer the planning horizon the lower the prize. So there must be relevant cost benefits for the Asset User to compensate for the increase of cost for the Asset manager (maintenance) due to flexible planning of the possessions. The increase of cost is caused by: • Fragmentation of the work and the late fixation of the date and time of the possession leads to inefficient use of man and machine force resulting in higher absolute price and probably a higher price per trainkilometre (increase in cost is more than increase in tonkilometre!) • Flexible maintenance leads to more space for passenger and freight trains. So the track is used more intensive resulting in a high demand for maintenance. This will lead to a higher absolute price and a lower price per trainkilometre (increase in tonkilometre is more than increase of cost!). How do IMs balance the demands from train operators for more track access, with the increased maintenance cost that will result? Up to know the (increased) cost of maintenance is not an issue during the negotiations between the infra manager and the asset users (train operators). We negotiate only about the time available for riding trains and time for maintenance
NR	Current work streams now used or in planning: In-service train and measurement train monitoring and inspection Line side intelligent infrastructure monitoring including S&C remote condition monitoring Modular S&C for quick renewal



High volume track renewal trains
New road-rail vegetation clearance machines

The results of all of these initiatives will result in reduced possession time and reduce numbers of people out on track.

Could all IMs please check that they have answered the question about trends?

It is expected that there will be a growing trend for the maintenance to be fitted into shorter slots, the current use of longer maintenance slots at weekends is likely to be pushed as much as possible into mid-week night time slots in order to provide a full timetable service at weekends and on public holidays. This will be especially true on the main routes.

Most IMs foresee an increase of the maintenance costs. Please explain.

Maintenance costs are expected to rise due to increasing numbers of staff working unsociable hours, but there is also a reduction in the utilisation of machinery if it is only used in the night time.

How do IMs balance the demands from train operators for more track access, with the increased maintenance cost that will result?

Maintenance will need to be fitted into the shorter slots, but improvements in efficiency and carrying out more work and inspection away from the track is expected to drive through cost reductions as well as meeting the train operators demands. Also efficiency improvements in the opening and closing of possessions such as ensuring that the possession is clear of plant will have an impact.

What cost increase is acceptable to decrease possession time by 1% / 10% / 50%?

The acceptable increase in costs to decrease possession times will depend upon the track and the current capacity constraints on that track. For many rural lines there is probably no incentive to increase costs to reduce possession times. However, for a major route that is capacity constrained such as the West Coast Mainline in the UK the business case will be in favour of spending more money on maintenance in order to free up capacity. For example in Network Rail's 2007 Strategic Business Plan for a Seven Day Railway, [http://www.networkrail.co.uk/browse%20documents/strategicbusinessplan/other%20supporting%20documents/seven%20day%20railway%20\(final\).pdf](http://www.networkrail.co.uk/browse%20documents/strategicbusinessplan/other%20supporting%20documents/seven%20day%20railway%20(final).pdf), identifies that estimates from EWS and Freightliner predict that a seven day railway would add £105m pa of freight revenue to the UK railway and by 2030 the additional freight earnings would be as high as £210m pa,

The same report estimates that to achieve this maintenance costs would need to increase £90m pa and significant enhancements would be required including remodeling and adding additional cross-overs, bi-directional signaling, modified



	isolation and earthing arrangements on electrified routes.
DB	DB changes the percentage between corrective (condition based) maintenance with short-term planning (handling time) and preventive maintenance with mid- and long-term planning to preventive maintenance. These increase the efficiency of maintenance activities due to longer possession times, grouping of maintenance activities and better pre preparation. Most IMs foresee an increase of the maintenance costs. Please explain <i>The increase of maintenance costs is related to more or new traffic. For example the increase of head checks (all over Europe) results actual in higher maintenance costs for the rail. But the 3-i-strategy at DB has the goal to reduce the maintenance and investment costs in long-term at higher track quality.</i> How do IMs balance the demands from train operators for more track access, with the increased maintenance cost that will result? The train operators have to pay a track access charge that is based on the infrastructure costs. What cost increase is acceptable to decrease possession time by 1% / 10% / 50%? Only in the case the IM can sell more slots (more trains on a line) an increase of maintenance cost is acceptable. But in case of highly loaded tracks you have to take into account the reduced life time of the assets and the related interruption time for renewal.
SNCF	Maintenance by night with single-line working may increase maintenance cost by a factor of 2. Innovations • Gates between track to increase the safety of the workers • Train announcement by radio. Trends: The infrastructure management agreement is to be renewed in 2012 and will fix the trends for the coming years. Since, much maintenance and works are planned in the next years, the trend is to combine as much work as possible in somehow large possession times. This process is called massification. Most IMs foresee an increase of the maintenance costs. Please explain. -



	How do IMs balance the demands from train operators for more track access, with the increased maintenance cost that will result? The maintenance cost per train-km was 3.55€/train-km in 2008, 3.66€/train-km in 2009 and 3.84€/train-km in 2010. What cost increase is acceptable to decrease possession time by 1% / 10% / 50%? -
Strukton	Through the use of measurement and video trains and measurement systems like POSS, the need for staff presence on the tracks will be significantly reduced.



Good practices and benchmarks

What good practices / benchmarks do you know about how individual infrastructure managers in Europe translate their company goals (such as punctuality) to asset management strategies?

- Mention the relevant situation and explain briefly why this is a good practice.

Additional questions

- Could each IM say what technique or process they have seen used by other IMs, which has impressed them sufficiently to want to try it on their own network?

IM	Answer
TV	In 2007 Banedanmark, the Danish rail infrastructure operator, commissioned BSL to conduct an international study on asset management practices in railways. For that project eight European railways in total contributed to the study and met in several workshops to discuss their good practices in areas such as organizational structures, core processes and information management. As a result the complete peer group agreed to continue working together in a so called "club project" to explore several issues more in depth and to take advantage of the project as a platform for networking and further exchange. In the course of this club project the railways openly provided dedicated experts and comprehensive information on the defined work packages, held presentations during the workshops in London and Bern and vitally exchanged ideas. Mention the relevant situation and explain briefly how to find good practice.
PR	The punctuality is now used as a KPI for the asset user. The IM (asset manager) can only affect a portion of the punctuality. We mention some developments that can be relevant for other IM's: • more capacity and functionality using less infra • we use more and more partial lifetime extension instead of complete renewal • new maintenance contracts are performance based, this means that the contractor decides what maintenance is needed to meet the specifications (kind of maintenance and the frequency is not prescribed by ProRail) • many initiatives to reduce the LCC with 20 % in projects for renewal, small maintenance (e.g. performance based contracts), new functionality • due to recent accidents the focus of the asset owner, asset manager and asset user is more and more on the customer (= passenger) • many project are started to reduce the number of incidents with casualties • ProRail has a new management which focuses more on the translation of the company goals to activities for each department and individual • ProRail succeeded to make the connection between RAMSHE performance and the economic value.



	• We are starting projects to change the position of the signals. One of the consequences is that the distance between the signals will decrease. This must result in a quicker reduction of the train delay minutes following to a disruption. In Japan this is proven method to optimize the punctuality. • ProRail is impressed by the way NR translates company goals (business objectives) to AM Strategy • ProRail is impressed by the performance dashboard of NR • ProRail is impressed by the Infrastructure deterioration models for maintenance planning used by SNCF. We learned about these models during the UIC study "Line Comparison Study" • Recently ProRail was impressed by the usage of SAP for asset management by RFF. After 10 years work they have achieved a level of automation that is the benchmark for ProRail. The situation of both infra managers is different (RFF is their own service provider and ProRail outsources everything) but many subjects are eye openers for ProRail.
NR	All of Network Rail company goals are translated into asset management policies and are monitored by Office of Rail Regulation through the KPIs and define the asset management strategies. In terms of benchmarking studies there is the Asset management Club Project, which Network Rail participated in. Could each IM say what technique or process they have seen used by other IMs, which has impressed them sufficiently to want to try it on their own network? Network Rail has been very impressed with the KPIs developed by ProRail and Trafikverket and the cost savings derived from negotiation of maintenance supply contracts. The use of KPIs is of interest to compare and monitor the performance of the different routes although Network Rail carried out the maintenance activities in-house.
DB	DB AG: • Use of high performance maintenance machines like



	- Four sleeper tamping machine 094X inclusive high speed ballast plough (?) (Pflug in German) - High performance grinding and milling machines with up to 64 grinding stones - High speed grinding - Two-Pass-Grinding • Preventive maintenance (grinding, tamping) • Use of optimised track components and track construction (rail, rail fastening, under sleeper pads, under ballast mats, slab track, ...) • Maintenance groups for switch maintenance High performance maintenance machines ensures longer maintenance sections during a given possession time. Preventive maintenance enables longer possession times, grouping of activities and reduction of machine movements. An optimised track reduces the need of maintenance due to an decrease of deterioration and harmonises the maintenance cycles.
SNCF	Macroscopic degradation laws are useful to evaluate the required volume of maintenance. Systematic renewals of long line sections at fixed time-intervals makes the network more efficient.



Available data on performancekillers and overruntime

Do you have data available concerning:

- Performance killers:
- The planned activities that have the most effect on the unavailability KPI.
- Data about the overruntime of planned activities
- The time for each sub-activities of the performance killers?

Additional questions

- Please could the IMs say what are their top three performance killers and why? The answer should be on the basis of 'gut feeling / experience'; there is no need to do a data analysis to find the answer. We can then compare the IM answers with our own analysis of the data

IM	Answer
TV	• Performance killers: Yes and No First of all one need do define a performance killer. These are current developed during 2011. • The planned activities that have the most effect on the unavailability KPI. First of all one need do define an unavailability KPI. These are current developed during 2011. • Data about the over runtime of planned activities These are current developed during 2011. • The time for each sub-activities of the performance killers First of all one need do define a performance killer. These are current developed during 2011.
PR	• The planned activities that have the most effect on the unavailability KPI: we do not know what activity the small maintenance contractor executes in a planned possession. For renewal and new infra we have more knowledge about the activities in a possession. • Data about the overruntime of <u>planned</u> activities: we have data of the overruntime of a possession. We have no data to relate specific activities to overruntime. • The time for each sub-activities of the performance killers: The contractor has this information but he only askes us permission for the total time. Prorail has no detailed information.
NR	• The planned activities that have the most effect on the unavailability KPI: Yes we can obtain this data from our possession plans • Data about the overruntime of <u>planned</u> activities: Yes, we can obtain this data from the possession data and our penalty payments • The time for each sub-activities of the performance killers: Data is not recorded in this much detail, but we have standard task times for planning purposes Please could the IMs say what are their top three performance killers and why? The answer should be on the basis of 'gut feeling / experience'; there is no need to do a data



	analysis to find the answer. We can then compare the IM answers with our own analysis of the data Experienced gut feeling of the top 3 performance killers are: Tamping Wet bed removal OHL maintenance As these are felt to be the top 3 activities which impact on the availability of the track to train operators.
DB	Performance killers: • The planned activities that have the most effect on the unavailability KPI. YES. This question is difficult to answer (please explain in more detail). Do you mean the activity itself or do you mean the influence of the activity on failure that causes unavailability. • Data about the overrun time of planned activities No - we have to check • The time for each sub-activities of the performance killers Yes – hopefully we can take this at least from time and motion studies Top performance killers, based on possession time: 1. Renewal of track and components 2. Grinding Tamping
Strukton	Currently, it is not possible to work according to safety regulations outside possession times. Fail-safe detection equipment might enable maintenance outside possession times.



Maintenance and inspection processes

Processes to plan a possession

Explain the processes, involved parties, decision moments and criteria that are relevant to decide whether or not a possession will be planned.

- What determines when a possession is carried out?
 - MGT – scheduled into campaigns (e.g. tamping campaign for a whole route) or individual sites.
 - Inspection data
 - Availability of plant
 - Timetable availability
 - Public holidays/low traffic
 - Availability of budget
 - Pre defined maintenance intervals preventive/prognostic) maintenance
 - Other things
- Who is in charge of the decision?
- Who is the owner of the processes?

Additional questions

- How do IMs decide what work should be done?
- How do IMs 'bundle', group, or package together the tasks?
- How do IMs decide what length of possession would be best?
- Who measures the status of the infrastructure?
- Can NR system provide more information about "Modelled prediction of wear and crack growth"?

IM	Answer
TV	All inspections are performed by the maintenance contractor according to the stipulated safety regulations. The contractors also decide on witch action that is needed to take after the inspection, depending on the results of the inspection. Regular track patrolling frequencies take place every second month. Regular frequencies for measurement trains take place every 6 months. Regular frequencies for ultrasonic measurement trains are based on line categories. Usually it inspects all rails one to two times per year. All inspected data are reported in IM own data bases BESSY and in OPTRAM. Trafikverket have detailed regulations for condition assessments and it differs according to line categories. Inspection frequencies for measurement trains also vary according to line categories. Trafikverket's contractors can use several modern and multi-functional measurement trains that are utilized for condition assessment. In order to control the development of KPIs, frequent and systematic condition assessments are regulated by Trafikverkets different inspection regimes. In recent years Trafikverket invested a lot in technologies to improve the accuracy of measurement results and to optimize the need of human resources for condition assessment. Appropriate evaluation

processes and new developed computer software are necessary to sort the benefit from the terabytes as input for condition based activity planning and handling raw data from the inspections.

Trafikverket's Infrastructure system for assets is called BIS, corrective (emergency) maintenance report failure data system is called Ofelia, the preventive and safety Inspection System is called BESSY. Track quality measured data are analyzed in OPTRAM and data can also be found from safety way side monitoring systems for wheel flats and hot bearings.

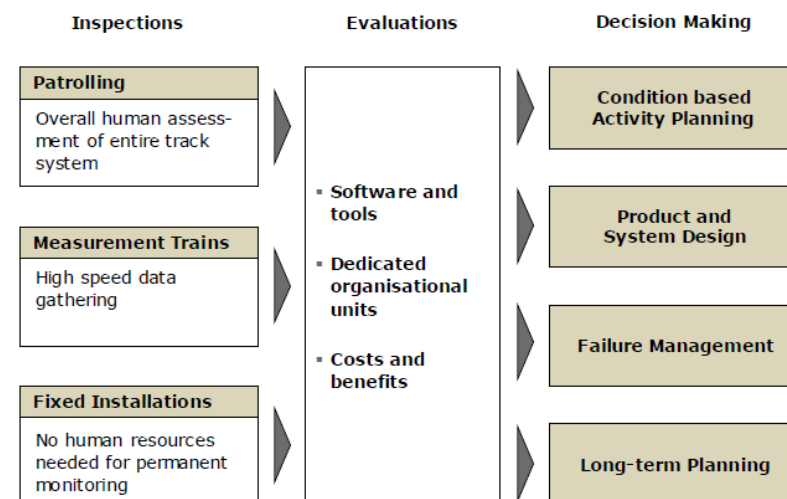


Figure 5. Inspection process chain from inspection via evaluation to decision making.

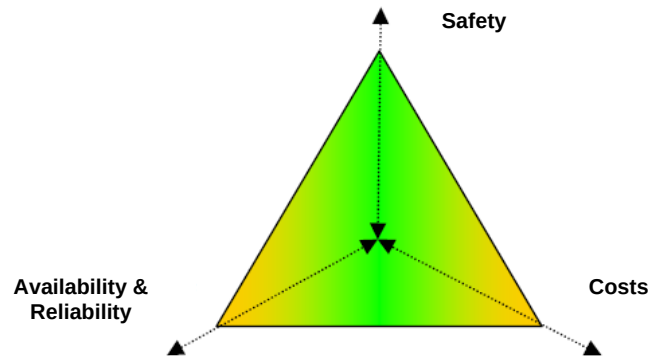
Trafikverket use both mind-based knowledge inspections to IT-based condition assessments such as HI tech video recording systems and laser measurements from measurement trains. Information on historical and current asset condition is also stored in order to support decision making and to improve knowledge on asset degradation and its behavior. Inspection regimes – especially for visual inspections – are sometimes not so updated. Potential and possibilities of modern information technology that results in high expenditures for human resources might be used in future. Video inspections play more and more an important role in condition assessment, in parallel reducing safety risks for track patrolmen. Still, the general opinion is that automated inspections will not fully substitute human assessments fully.

What determines when a possession is carried out? Due to seasonal changes in frost and winter conditions, the Swedish philosophy on tamping is “if it lies still inside its limits, do not fix it”, meaning that if the track is stable, do not tamp and adjust. Also, due to the frost problems, most of the tamping must take place during the summer months. In spring the measurement train gives data on places that needs tamping. Tamping is then performed during summer and in the autumn the contractor validates the track position using the measurement train. The grinding campaigns are planned according to data on corrugation, NDT train measurements and visual inspections.

- MGT – scheduled into campaigns (e.g. tamping campaign for a whole route) or individual sites. See above explanation.
- Inspection data. See above explanation.
- Availability of plant. It is up to the contractor. See above explanation.



	• Timetable availability. It is up to the contractor. See above explanation. • Public holidays/low traffic. It is up to the contractor. See above explanation. • Availability of budget. It is up to the contractor. See above explanation. • Pre defined maintenance intervals preventive/prognostic) maintenance. It is up to the contractor. See above explanation. • Other things Who is in charge of the decision? All decisions are taken by the contractor, except for grinding. Who is the owner of the processes? IM in close corporation with the contractor.
PR	Involved parties in possession planning: Asset manager (maintenance and traffic) and (sub)contractor (responsible for small maintenance). The asset manager plans the possessions. The planning horizon (normal process): Year N+2 and further: long-term series (planning on year-level) Year N+1: finalize maintenance planning (planning on day-level). The N+1 planning is adjusted to the needs of train operators in order to come to an agreement on maintenance vs train operations (In Dutch: Net declaration). Year N: keep planning actual. In year N we make a distinction between small and large maintenance. Slots for small maintenance (at most several hours possession time) need to be requested 11 weeks in advance to the possession. Slots for large maintenance activities (renewal, grinding, tamping) need to be requested by contractors 21 weeks prior to the moment the possession is needed. Planning horizon in case safety of the track is at stake: Repairs need to be carried out within 6 weeks (small issues that cannot wait 6 weeks to be repaired, not safety related) Repairs need to be carried out immediately or within 48 hours (small issues, safety related) Relevant milestones in the planning process: Long term planning (year planning / timetable): • 2nd Monday in April: Closing date maintenance slots (year N+1) • 3rd Monday in August: Timetable approved (trainpaths as well as maintenance slots) • 2nd Sunday in December: Start new time table Decision for maintenance is based on: • Costs (minimal costs) • Safety (sense of urgency) • Manufacturability • Necessity (what kind of work should be done) • Duration / (un)availability of infra ProRail uses the following model for maintenance:



How do IMs decide what work should be done?

- At the beginning of a contractperiod the contractor asks the possessions to do the “small scale” maintenance in his contract area. Bases on the status of the infra the contractor decides to do the work or to postpone.
- For the condition based maintenance, predetermined maintenance and complete renewals we make every year a production plan. When the money is available and the priority of the activity is high enough the activity is included in the plan.
- Based on questions from national or local governments ProRail changes the existing infrastructure of build complete new infrastructure.

Based on the capacity of ProRail and the contractors the activities 2 and 3 are planned in time.

How do IMs ‘bundle’, group, or package together the tasks?

We use a method (TRS) to optimize the effectiveness and costs of the trainfree period. We optimize between the Life Cycle Costs and the social benefits for the passengers and freight trains. We use a self developed calculation tool to do the calculations (LCM tool). In this tool we calculate the prize of planned unavailability (a train free period) and unplanned unavailability (errors). The prize depends on the number of trains, number of passengers, time of day etc..

When we combine tasks the tool also calculates the volume purchase discount and the discount due to the use of longer possessions instead multiple short possessions.

How do IMs decide what length of possession would be best?

When combining possessions we use the ProRail LCM tool to calculate the optimum length.

Who measures the status of the infrastructure?

Prorail is responsible for measuring the status of the infrastructure. We contract specialized companies for doing the measurements. The output data is available for both Prorail and the contractors. The data is analyzed mainly by the contractors and sometimes for specific reasons by ProRail.

NR

Answer to 2.1 and 2.2 - Infrastructure Maintenance Delivery Managers submit their requirements for maintenance possessions based on their planned campaigns, past data, track data and modelled predictions of wear and crack growth. The National Delivery Service (NDS) will then co-ordinate and optimise these requirements and schedule with the



availability on-track machines and haulage as required.

Timescales:

Time Table/Time	Description
TT-95 – TT-80	Maintenance informs NDS of requirements for T3 access, on-track machines and engineering trains. NDS commences integration of access requirements and initiates negotiations with NAU (National Access Unit).
TT-80 – TT-65 (80-65 weeks before the timetable is set)	NDS co-ordinates and optimises maintenance requirements. This includes allocating follow-up possessions to track recording trains. The outputs of this are the draft versions of Rules of the Route (RotR), which is base annual access plan and establishes the frequency, amount and type of access required over the year. The WTT (Working Time Table) is also produced at this stage.
TT-65 (65 weeks before the timetable is set)	“PPS freeze date”. Further requests for changes to Rules of the Route are no longer accepted.
TT-60 – TT-45 (60-45 weeks before the timetable is set)	NAU negotiates RotR and WTT with TOCs (Train Operating Companies) & FOCs (Freight Operating Companies). NDS publishes RotR at TT-44.
T-38 (38 weeks prior to possession)	Last opportunity to request low cost track access (input to the DPPP[Draft period possessions plan]). The DPPP firms up the T3 possessions and confirms specific locations, dates and durations. NB- A period is a 4 week long period of time, Network Rail splits a year into 13 four week periods.
T-38 – T-26 (38-26 weeks prior to possession)	NAU negotiates and confirms Period Possession Plan with TOCs & FOCs.
T-26 (26 weeks prior to possession)	NDS publishes CPPP.(Confirmed Period Possession Plan) which is the final agreed track access plan agreed by all stakeholders including the TOCs and FOCs
T-12 (12 weeks prior to possession)	NDS confirms provision of additional (high cost) track access requested after publication of CPPP
T-7 (7 weeks prior to possession)	“PPS (Possession Planning System) lock-down” – further changes to work site information are no longer accepted.
T-5 (5 weeks prior to possession)	NDS / Maintenance “T-5 review meeting” held.
T-8 days (8 days prior to possession)	Draft WON (Weekly Operating Notice) is published, which is a weekly notification of all possessions and speed restrictions

Possession types:

1. *Absolute Possession* (“T3”). These are green zone possessions where lengths between signals or junctions are totally blocked to the passage of trains and controlled by a PICOP who has ownership of the line until it is handed back. They are commonly divided into a number of worksites, or can be used to allow bigger items of work to be carried out.
2. *Protected Possessions* (“T2”). These are usually short-duration possessions that are ideally taken between trains in quieter times of the day. T2 possession arrangements prevent train movements to protect a worksite using a number of protection arrangements.



	How do IMs decide what work should be done? The maintenance work that should be carried out is decided by the track engineers based on anticipated work based on previous years, known problem spots and need for renewals or enhancements. Work is prioritised based safety, then based on cost and whole life cycle asset management and ability to gain access to the track. How do IMs 'bundle', group, or package together the tasks? Work is bundled and planned, based on a primary task for the possession around which everything else is planned. Typically the principle task is planned from 95-80 weeks before the timetable is set, whilst other activities a planned around this, additional activities can be added into the possession up to 8 days before the possession as long as they don't impact on the possession length. How do IMs decide what length of possession would be best? The possession length depends upon the location. The physical length of the possession can depend upon the rate at which work can be carried out at eg tamping or grinding processes. The physical length of a possession typically is between switches or based on signalling block lengths. The time length of a possession is typically based on the white space in the timetable, unless the activity needs requires a longer possession. Who measures the status of the infrastructure? Network Rail measures the status of the infrastructure and this is reported to the Office of Rail Regulation through the infrastructure condition metrics. Please see question 1.4 for details of the infrastructure condition metrics used. Can NR system provide more information about "Modelled prediction of wear and crack growth"? Network Rail has developed a tool called TrackEx which is designed to be simple to use and is written in visual basic in Excel so it can easily be used by track engineers for planning grinding and renewal work. TrackEx can model the impact different types of rolling stock on individual routes.
DB	What determines when a possession is carried out? • MGT – scheduled into campaigns (e.g. tamping campaign for a whole route) or individual sites. Partly in conjunction with preventive maintenance but not only the MGT is considered but maximum speed of track, radius, ... • Inspection data YES – basis for corrective/condition based maintenance • Availability of plant YES, especially in case of preventive maintenance, grouping of activities to ensure availability and short transportation distance of plant • Timetable availability Partly, weekend, night, Monday (less freight trains), ... • Public holidays/low traffic • Partly, low traffic, the timetable does not consider public holidays



	• Availability of budget Yes, the responsible asset manager has to look for the budget and makes a prioritisation of the maintenance activities (shift of activities (next year), grouping of activities, ...) • Pre defined maintenance intervals (preventive/prognostic maintenance) Yes, DB uses more and more a mid-term planning of maintenance (preventive tamping and grinding) based on load, speed radius, ... • Other things Who is in charge of the decision? In detail a lot of different peoples are involved. In either case the local asset manager, local head of maintenance and the local scheduler of construction phases are in charge. Also the internal or external service provider is in charged in the process to guaranty the availability of the plant and experts. In case of preventive maintenance activities experts from general office of DB Netz are involved. These experts elaborate the proposals for the maintenance activities. In case of activities, which have a big impact on the train operation a central scheduler of construction phases and people making the time table are involved in the process. In some cases the EBA (Eisenbahn Bundesamt) has to be involved. This may be necessary if DB gets a funding from the government or a new method apart from the regulation is used. Who is the owner of the processes? Local asset manager.
SNCF	SNCF and RFF are currently experiencing a major change in the process of track possession demands, allowances and planning. According to the maintenance needs expressed between 18 months and 2 years in advance by SNCF, RFF defines on each track segment a possession window typology (number of hours per day or night, number of weeks per year, single or double track possession, ...) and allows an maximum amount of possessions corresponding to the amount of planned maintenance. “Established track possessions” Established possessions allow the completion of preventive and corrective maintenance as well as works suitable with their dimensions. The periodicity and schedule of these possessions are defined considering the particular situation of each track : • daily possessions - 1 hour during day time every day (for inspection and patrolling) + 4 to 6 hours at night for a limited number of weeks during the year + 3 hours minimum during low traffic time (week-end nights). - 1h50 at day time or 4 hours minimum at night from Mondays to Fridays. • variable possessions - maintenance is then performed during at a regular time, but on a varying locations, resulting in a limited flow and a fixed transit delay during the considered time. “Special track possessions” Selective possessions can be allocated to specific works such as investment works, renewals or major maintenance operations, for which RFF is looking the best technico-economic solution: i.e. possession for 8 hours a day on one or two tracks, line closure, etc. Such special possessions are scheduled within a five-year sliding scheme, for the major routes. The scheduling of these possessions is planned in several steps : • Identification of main capacity options, 3 years before, on structuring axis and for major works. • Planning of required possessions start from 2 years earlier. Close collaboration



	between RFF and SNCF. Planning sent to TOCs at the end of this step. Derogatory and late possession applications The schedule of these possessions is negotiated between SNCF, RFF, train operators, and regional transport authorities, according to the needs of each, high and low traffic periods, planned renewal works, availability of plants, etc. Dispensatory possessions can be allowed up to 35 days in advance, after negotiation within “capacity committees” where RFF, train operators, SNCF Infrastructure and scheduling office are represented. This new process is still generating a large number of dispensatory and late applications. Under the pressure of the French Ministry of Transports, RFF and SNCF have created common coordination structures to optimize their cooperation. Main axis and regional routes are to be considered differently according to the needs for anticipation and the capacity of negotiate dispensatory possession. How do IMs decide what work should be done? Renewal and investment works are decided by the IM (RFF) at the delegate IM’s (SNCF) instigation, based on the assessment of the infrastructure condition and on the expected life time of the components. The IM decides to undertake the works according to its investment capacity and its strategic choices regarding impacted the line. Planned maintenance operations are decided according to the maintenance needs expressed by the DIM, following the infrastructure monitoring and assessment and in accordance with maintenance rules. Corrective unplanned maintenance works might be justified by the knowledge of the track condition and the compliance with safety standards How do IMs ‘bundle’, group, or package together the tasks? Possessions are decided and dimensioned for main structuring tasks (renewal works, sleeper replacement campaigns...). Secondary tasks are combined and integrated with the main ones by the Maintenance Production Territories, on the request of Maintenance business units (Infrapôles) and according to the availability of human and technical resources and operational compatibilities. How do IMs decide what length of possession would be best? RFF looks for an technico-economic optimum between the preservation of a maximal traffic capacity and the possession length needed by SNCF to perform the work. Who measures the status of the infrastructure? The condition of the infrastructure is measured and analysed by SNCF, as delegate infrastructure manager, who maintains the control over the measurement tools and process and who regularly reports to the infra owner on agreed indicators.
Strukton	For the dutch practice possessions can be characterized as planned in a repeating roster (available for multiple contractors to carry out maintenance tasks),

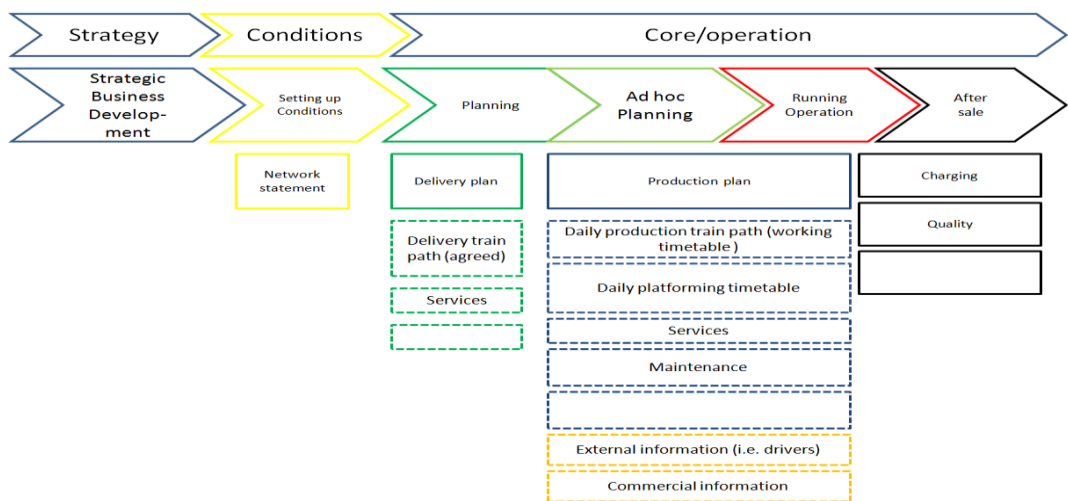


- | | |
|--|---|
| | <ul style="list-style-type: none">• as dedicated planned for multi-possession tasks (possibly combined with compatible other tasks),• as dedicated planned for specific tasks and as unplanned (break down service). |
|--|---|

What are the relevant time-scales for booking a possession?

Additional questions

- Please describe in more detail the process for setting up a possession?

IM	Answer
TV	It is up to the contractor. See above explanation. The contractor is a part of the overall process, see figure 6.  Figure 6. Time table process planning.
PR	In general for maintenance slots: - Long possessions: 21 weeks in advance - Short possessions: 11 weeks in advance - Safety/reliability issues on the track: issues need to be solved within 48 hours See also 2.1
NR	See answer 2.1
DB	Depending on the scale of activity • maintenance, • heavy maintenance (noticeable impact on train operation), • renewal or • rebuilding a time scale between 14 weeks and 2 years is necessary.
SNCF	2 years before: • Expression of maintenance needs on each line segment • Definition of possession window typology • Negotiation and allocation of possession times from 2 years to 6 month before:



	• Continuous adjustment process • Bundling of tasks from 6 months to 35 days before : • Derogatory requests, submitted to a Capacity Committee From 34 days to 1 day before : • Late requests within the residual capacity
Strukton	It is possible to use mainly the available possession schedule, except for incidents which need to be solved within two weeks.



Incentives, bonuses or penalties for possessiontime

Do you use any incentives, bonuses or penalties regarding to the use, overrunning or under running possession time?

- Describe the incentives that are in use.
- In what way are they part of the contract?
- Do they stimulate the right culture and results or do they occasionally turn out to be counter-productive?

Additional questions

- Please could the IMs give examples of the size of the financial penalties?
- Please could the IMs say whether they have bonus systems in place, as well as penalty systems; and if they do, what size is the bonus?

IM	Answer
TV	No, but Trafikverket is planning for this in future. Describe the incentives that are in use. In what way are they part of the contract? Do they stimulate the right culture and results or do they occasionally turn out to be counter-productive?
PR	Yes, there is a bonus/malus system for contractors. There is also stimulation for contractors who minimize the number of possessions and for innovations (like mobile worksphere) to decrease total downtime of the infra due to maintenance. For the new performance based contracts we use incentives for the different KPI's. When train passengers have more than 30 minutes delay they get a refund. This is paid by the largest passenger train carrier (NS) and ProRail. Please could the IMs give examples of the size of the financial penalties? For the new condition based contracts one of the criteria to get the contract is the number and length of the possessions. Depending of these numbers the value of the contract is adjusted. So a contractor with an offer of € 5.000.000 with 500 hours cumulative possession has a better offer than a contractor with an offer of € 5.000.000 with 750 hours cumulative possession. We have an algoritme to compare both offers. Please could the IMs say whether they have bonus systems in place, as well as penalty systems; and if they do, what size is the bonus? ProRail has a bonus/penalty system for small maintenance work following Output Controlled Contracts (± 15 % of all activities are output controlled now). The goal of ProRail is to change old maintenance contracts into new OPC-contracts within the next years.



	Subcontractors get a bonus of 0 – 5 % for minimizing the total TVP-time / number of TVP's. In case a subcontractor exceeds the given TVP-time the penalty will be of 0 – 5 %. Tamping / grinding / large maintenance works (i.e. renewal): There is no bonus/penalty system. The planning for these works is optimized by ProRail. The number of TVP's that was planned, but not used is very little. TVP's will be rescheduled and this will be communicated with train operators in an early phase. This makes it still possible for train operators to run their services. However, rescheduling TVP's should be minimized in order to unburden the planning department.
NR	Delay minutes and cancellations from overrunning possessions are both monitored KPIs. Network Rail must also compensate the train operating companies for any overrun of possession resulting in service delays and cancellations. Network Rail must also pay for access for the possession length, however, if the possession is booked more than 38 weeks before the work there is a lower cost for access to the track, so over booking possessions still costs Network Rail, but the incentive overall can be book longer possessions than required to avoid the expensive delay minute and cancellation compensation. Please could the IMs give examples of the size of the financial penalties? The financial penalties for interrupting traffic due to unplanned maintenance, infrastructure failures and possession overruns, these come under Network Rail's schedule 8 payments, the scale of these payments depends upon the route and train operating company. Traffic interruption due to planned maintenance comes under Network Rail's schedule 4 payments and again is based upon the route and train operating company. During 2009-2010 Network Rail paid a total of £149m in schedule 4 and schedule 8 payments. Please could the IMs say whether they have bonus systems in place, as well as penalty systems; and if they do, what size is the bonus? There is no bonus system in place for completing possessions early.
DB	Service providers have to pay a penalty if they don't meet the possession time. Normally the SP breaks the maintenance to allow train operation. In case the SP can't break the activity (e.g. heavy maintenance at a bridge or renewal of track) the SP has to pay for the delay minutes. The penalty depends on the train type and delay. Contractual details are not public. Yes they stimulate the provider to finish their work in time.
SNCF	There is currently no incentives, bonuses or penalties regarding to the use, overrunning or under running possession time, by the delegate IM. However, a global bonus/penalty arrangement between RFF and SNCF exists over track



	availability and train delays, which is partly impacted by possession time overrunning. Statistics on the use of possession are however recorded by both parts. Contracts between delegate IM and work contractors may include clauses on the respect of possession times.
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Does the involved equipment affect the decision making?

- Types of worker protection applied – e.g. signal protection, detonators etc
- Type of maintenance machine used
- Shift length

Additional questions

- How do you decide what method of working to use?
- Can the IM influence the optimization of pre and post-possession activities?

IM	Answer
TV	Yes, especially on single tracks and if we are running near capacity limits on the track section. It is up to the contractor. See above explanation. • Types of worker protection applied – e.g. signal protection, detonators etc Yes, always due to safety. It is done by a certified personal that always travels with the machine. • Type of maintenance machine used It is up to the contractor. See above explanation. • Shift length It is up to the contractor. See above explanation.
PR	• Types of worker protection applied – e.g. signal protection, detonators etc Yes. Mobile worksphere creates possibility to make use of very small time slots for maintenance Videotrain / inspection train: helps to inspect the infra in a safer way compared to personal, visual inspections. Use of remote controlled detonators • Type of maintenance machine used Mostly that's up to the contractor, but innovations are stimulated: Grinding machine: Using higher grinding speed 7 km/h instead of 5 km/h (reduces track possession or less possessions that • <u>Shift length</u> Shift length is important. For grinding / tamping longer shifts than usual (5.5 hours) are needed, because the used machinery is very expensive. For controlling switches small(er) slots of at most 5,5 hours can be used. How do you decide what method of working to use? This is up to the contractor, but during planning (1 year in advance) a rough estimation is made on what kind of working method will be used. For example when special work trains are needed the planning department should take into account that these trains are able to reach the spot where the work has to be carried out. Can the IM influence the optimization of pre and post-possession activities? ProRail does not do that at the moment. This is up to the contractor.



NR	Yes – requirements for engineering trains and labour are made to NDS (National Delivery Service) with the initial possession request. NDS will then optimise possessions based on the availability of equipment. How do you decide what method of working to use? The methods of protection used in possessions are defined in the Rule Book which can be found on the RSSB website: www.rssb.co.uk There are two types of possessions – Absolute possessions – which are green zone possessions where the work site is protected, either by closing all lines to traffic; workers are protected from traffic by a fence; or the use of warning systems and look outs. These are typically larger possessions with multiple work sites. - Protected possessions – are protected by signals and are typically used for short work tasks. Additional protection devices such as detonators should also be used if: • you are working on a single or bi-directional line • single line working is in operation on the line concerned. Emergency protection can be applied by use of track circuit operating clips and detonators Lines need to be blocked if: • The work group are at risk from trains • Work affecting the safety of the line - Carrying heavy or awkward equipment or materials across or along the line. - Work that will affect the condition of the track. - Digging a hole or stacking material or equipment close to the line or near the edge of a platform. - Placing a hand trolley on the line. - Using plant within 2 metres of the line. - Using a road vehicle within 2 metres of the line. - Using on-track plant (OTP) that will foul the line. - Using a crane or other lifting equipment that will foul the line. - Attaching anything to a railway structure, such as a bridge, a station roof or building, a signal post or gantry, or electrical equipment. - Using a ladder, unless secured so that it cannot fall towards the line. - Using scaffolding or a climbing tower, unless secured so that it cannot fall or move towards the line. - Felling or trimming trees. Can the IM influence the optimization of pre and post-possession activities? Network Rail aims to optimize the pre and post-possession activities, however, the RSSB Safety Board are the custodians of the safety case and therefore own the process for the safety related activities and the Rule Book.
DB	• Types of worker protection applied – e.g. signal protection, detonators etc No information, only a small influence expected



	- Type of maintenance machine used Yes. In case of preventive maintenance and the grouping of activities the type of machine is very important. Also for longer maintenance sections the type of machine influences the number or duration of possession - Shift length Yes, very important
SNCF	Involved equipments might affect the need of derogatory possessions, such as double track possession, when only a single track possession is planned. High output equipments allow more work to be done within the allocated possession. Innovation is highly encouraged towards higher output and alternative techniques allowing a reduction of possession needs.
Strukton	The choice of equipment and work method will of course influence the required length of possession time. It is therefore necessary to include start-up and clear-up time (e.g. equipment readiness time eating into the possession time).



Involvement of IM in efficiency of use of possession time

- Possession pre-possession and post-possession tasks and timings
- Regulations and standards
- Experiences of IM
- Is there a central database for experience/knowledge about maintenance? This could help a new one to start working faster.

Additional questions

- Do you have a well defined process (LEAN, for example) for driving up the efficient use of possession times?
- If so, what is it, and what problems does it have?

IM	Answer
TV	The software Trainplan presented on a graphical time/distance graph and the graphs are re-planning manually by drawing in graph. Steering order is manually typed in to the central control system. The result manually recorded in the paper graph. In Sweden we are now testing STEG – Controlling train traffic through a computerized time-distance graph. It's the Swedish National Railway Administration's project for development and implementation of an interactive prototype system based on traffic management rules and user interface researched. • Possession pre-possession and post-possession tasks and timings Yes during the BAP process see above. • Regulations and standards Yes during the BAP process see above. • Experiences of IM Yes during the BAP process see above. • Is there a central database for experience/knowledge about maintenance? This could help a new one to start working faster. No we do not have such database in Sweden.
PR	IM is involved. There are dashboards for reporting about efficient use of possessions. IM is involved by joining programs like mobile worksphere and for the planning of grinding machines. (see also 2.4) There is no central database for experience/knowledge about maintenance. Probably contractors have. Do you have a well defined process (LEAN, for example) for driving up the efficient use of possession times? If so, what is it, and what problems does it have? See also 2.3 answer first additional question See also answer 1.5 second bullet
NR	Network Rail is directly involved in improving the efficiency of possession times and is heavily incentivised to do this to increase the availability of the track, this optimisation is part of the possession planning process. Network Rail maintenance improvement teams have also been working on optimisation of the pre-possession and post-possession tasks subject to RSSB



	Safety Board approval. Network Rail has several databases which hold details of the task and sub-tasks carried out within each possession within the Ellipse database and the details of the possession and timings within the PPS database. Do you have a well defined process (LEAN, for example) for driving up the efficient use of possession times? If so, what is it, and what problems does it have? Network Rail have previously employed six sigma personnel to optimising and carrying out process improvement. However, there is currently no well defined process for driving up efficiency.
DB	• Possession pre-possession and post-possession tasks and timings Yes • Regulations and standards Please explain this question. Do you mean that IM give an input for regulation and standards? • Experiences of IM Yes • Is there a central database for experience/knowledge about maintenance? This could help a new one to start working faster No
SNCF	RFF is engaged with the French State through a Performance Contract, and is bound to improve the global efficiency of maintenance and the availability of good quality train paths. RFF is then working in close cooperation with SNCF to control and measures the efficiency of possessions, to assess the results of maintenance, to improve and adapt the maintenance and inspection policies and techniques and to keep an optimised balance between renewal, modernization and maintenance in order to minimize the maintenance needs and maximize the availability for traffic. Do you have a well defined process (LEAN, for example) for driving up the efficient use of possession times? If so, what is it, and what problems does it have? No permanently/globally defined process. Some optimized processes are being tested for particular conditions (heavy duty and suburban lines).

External regulations

To what extent does external regulation (safety rules, law) affect the organisation of possessions?

- Regulations and standards
- Access to track and use of bi-directional running, single line closed, etc – does this depend upon line speed and track category?

IM	Answer
TV	It effects, but it is needed to fulfill its purpose, a safe working place for the personnel. If we had a “smarter” planning tool it might be helpful. Today we are using TrainPlan software for the planning and simulation. The contractor use an in data planner called “Trans” to plan their work and then this data is uploaded to TrainPlan for the IM to use as a maintenance tool. • Regulations and standards No impact – it is the safety frame that we need to work within. • Access to track and use of bi-directional running, single line closed, etc – does this depend upon line speed and track category? Yes, speed and safety regulations. Some contractors also have an open wagon that they can work in, see figure 7.   Figure 7. Maintenance vehicle providing protection from traffic and harsh weather conditions.
PR	Safety is the most important factor. The short process in 2.1 is partly enforced by law: Net-declaration. There a standards on safety (enforced by law). For every possession the contractor develops a safe work spot. The safety measures are checked by ProRail. Single track possessions are rare, more and more double track possessions are used. Innovations like mobile worksphere make single line possessions possible.
NR	Standards / ‘The Rule Book’ (an industry wide set of rules for accessing and using the track, http://www.rssb.co.uk/RGS/Pages/RULEBOOKANDOTHERPUBLICATIONS.aspx) dictate the



	types of protection required for different work activities and the use of barriers, detonators and other worksite protection. Network Rail's commitment to safety is also driving more work into green zone worksites, where the task is carried out within a protected possession.
DB	- Regulations and standards Noticeable extent for high speed lines, inspections and maintenance only possible at night when train operation ends or if the track is the blocked also the neighbour track Small extent for other line, speed reduction on neighbour track - Access to track and use of bi-directional running, single line closed, etc – does this depend upon line speed and track category? Yes, see above
SNCF	Performance Contract between the French State and RFF?
Strukton	Increasing safety levels makes it more difficult to create a workable day/night/weekend balance for staff. Safety is actually the most important factor in work planning and execution. However, the balance between safety and delivery must be continuously maintained. Sometimes during single track possessions, the other track is not used. In this case the contractor should be informed and a double track possession ensured.



What good practices / benchmarks do you know for maintenance and inspection processes?

Mention the relevant situation and explain briefly why this is a good practice.

<i>IM</i>	<i>Answer</i>
PR	Internal projects to improve processes / save costs: • OHR 2020 (developing the maintenance regime for 2020) • Mobile Worksphere • Contactors contracts: from predetermined maintenance to condition based maintenance • Planning inspection trains/services in-house with dedicated software
NR	Network Rail has a number of projects to optimize maintenance and inspection as part of the 7 day railway strategy. Developments have included the development of modular S&C for rapid renewals, improved inspection techniques such as plain line pattern recognition systems and image based S&C inspection and increasing the speed of ultrasonic inspections. Where appropriate technologies have presented themselves from other railways Network Rail has looked at implementing them, for example Network Rail has implemented the Dutch wheel impact measurement system.
Strukton	Manual inspection using hand-held computers with direct on-the-spot analysis will enable direct response (maintenance actions).



Available data for possessions

Do you have data available concerning:

- The distribution of the overall length of possessions.
- The distribution of possession lengths based on weekday/weekend/public holiday.
- Information about the time of the day in which possession carried out – overall
- Time of day in which possession enforced – split by weekday/weekend/public holiday

Additional questions

- Please ask for the data
- Please ask how long it will take to get the data

<i>IM</i>	<i>Answer</i>
TV	Yes to all questions. It is possible to extract from TrainPlan.
PR	All answers are: Yes. We already send data from Jan Swier to Jon Paragreen
NR	Yes to all questions. Network Rail collects data against each possession of the start and end time of each possession from which it is possible to plot these distributions.
DB	All answers are: Yes
SNCF	Existing data make it possible to provide the required information, but a few weeks needed to proceed.
Strukton	ProRail has all data, Strukton as a contractor has only limited information available.



Integration of maintenance in the timetable

Do you use planning/scheduling software for maintenance activities?

Describe the systems / databases that you use for:

- Maintenance activities to be planned
- Resources availability
- Process standards

Additional questions

- What problems, if any, do you have with maintenance planning/scheduling software?
- How could it be better?
- Is the planning/scheduling software developed in-house, or commercially available?

<i>IM</i>	<i>Answer</i>
TV	It is up to each contractor to plan their own work. Time plan for 2011 is presented below. • January – International train traffic corridors are planned into the Swedish time table. • April – Supplemental application for maintenance activities are to be delivered by the contractor for maintenance activities not included in PSB application (Planned Substantial maintenance work) • July – First version of train plan (trains and maintenance work) for 2012 are public published. • July – Committee reports are collected from involved parties. • August – Last date for acceptance, train plan committee reports. • August – Co-ordination period starts with all involved parties. Parties can send a contention regarding the suggested train plan • September – Contention period is over and solutions must be agreed on. One solution might be that the track is “over charge” with too much maintenance work and train traffic. If so, we have capacity (maintenance and traffic) priority principals to be used, for solving the “over charge”. 16th of September – The official train plan for 2012 is published. Describe the systems / databases that you use for: • Maintenance activities to be planned – TrainPlan database • Resources availability – It is up to the contractor how to solve this • Process standards – See above explanations.
PR	Yes. Maintenance activities are planned with help of software packages: there are different software packages for long term, mid-term en short term planning Most packages are based on MS Access / SQL server. Resource availability: IM is responsible for infra availability planning, contactor is responsible for material and human resource planning. What problems, if any, do you have with maintenance planning/scheduling software? How could it be better? Problems in planning: ProRail lacks the overview of the relationship between all planned maintenance activities. The planning/scheduling software is mainly based on MS Access. Recently ProRail started a project to build a software package where the main functionality is



to visualize the relationship between all possessions at a certain location / time period. This makes it possible to see the impact of a possession.

Is the planning/scheduling software developed in-house, or commercially available?

The planning / scheduling software is commercially developed.

NR

Data system	Description
Ellipse	The data system used to store record and progress all maintenance work. Used mainly by the Section Planners who enter all work arising and reactive works into Ellipse and then utilise it to plan the delivery of all the work items stored in it.
Geogis	The system that stores all information regarding the topography of the Track infrastructure. Maps on the layout, buildings and equipment
PPS	Possession Planning System. The system used by NDS to review Possession and Worksite requests. The IMSM Team enter requests into PPS and receive conformation from it.
Visible plan (PossMan/WAR/ARP)	This is the local section visible plan that identifies the RotR T3 access footprint. It shows cyclical and inspection requirements, large maintenance blocks and projects. Available for Sections to identify worksite opportunities within the existing T3 plan
P3	Project planning tool used by Infrastructure Projects to plan the delivery of their projects. Does not interface directly with the work planning process
NROL	Network Rail On-Line. The system used to order plant, materials and resources. Usually operated by the Resource Planner
NEONs	Data system used to review the progress and delivery of S&C, etc. Used by Resource Planner to identify progress and plan delivery to site.
RDMS	Rail Defect Management System. The system that stores information on defects that have been discovered and reported.
SSoWP	Safe System of Work Programme used to put together all relevant information for establishing a safe working environment for operatives working in a site of work



	TrackEx Track Engineers tool to predict rail wear and crack growth rates for the planning of grinding and rail renewal	What problems, if any, do you have with maintenance planning/scheduling software? How could it be better? The current databases are not fully compatible and often data has to be manually transferred between databases. Also most of the systems are purely databases with any optimisation still being carried out manually. A better system would integrate all of the data automatically and provide some intelligent optimisation and planning systems. Is the planning/scheduling software developed in-house, or commercially available? Most of the systems have been developed or customised for Network Rail.
DB	DB uses software for planning and scheduling of maintenance activities. There are three different systems/databases in use: 1. SAP R3: financial/technical database with failure indications and required maintenance activities (kind, time and place) 2. BBP: planning tool for building/maintenance activities upon traffic (regional planning and scheduling) 3. Granit: financial planning of maintenance activities These three systems are not compatible and can not change the data automatically. For planning of availability of maintenance machines DB uses just simple Excel-tables. DB has extensive process standards for planning of maintenance activities under traffic: "Planquadrat" is a main standard and there are recently new created standards from the innovative cost saving maintenance strategy "3i".	
SNCF	SNCF (in its role of delegated IM) uses software to plan between Y-3 and June Y-2. This includes not only maintenance activities (including renewal), but also those related to development and investment, and those related to other activities. SNCF wants to develop software to plan precisely at later stages (from 6 months to 8 days prior to activities) all types of activities (maintenance, investments, and other works). This software should enable a better use of both human and mechanized resources. Availability of these resources is considered in the previous stage (Y-3 to June Y-2). For the most relevant maintenance operations, SNCF built up a "work catalog", both at national and local levels (meaning adapted to local work conditions on each line segment) : preparation, realization and finalization, including work speeds and required resources. RFF (the Infrastructure Manager) also uses an IT system to plan the use of the network capacity (track possession used to perform maintenance and other types of works on the network).	



**What problems, if any, do you have with maintenance planning/scheduling software?
How could it be better?**

The planning system could be improved by integrating many sources of data and automatic decision support. Several schedules are still manually generated which could be improved by new software tools.

Is the planning/scheduling software developed in-house, or commercially available?

The software is developed in-house but most of the tools are derived from commercial software.



Do you think automated planning and scheduling tooling would be useful?

- How is your current process of planning and scheduling automated?
- Describe the main benefits of an automated planning and scheduling tool compared to your current situation?

Additional questions

- Do you think that better management/scheduling of logistics trains could shorten possession times?

IM	Answer
TV	We already have a planning tool that the IM uses – what we need is also a simulation tool that simulate the actual situation and is able to do prognostics. How is your current process of planning and scheduling automated? – No atomization Describe the main benefits of an automated planning and scheduling tool compared to your current situation? It could help the planner with some good judgments in the beginning of the process. Today it is up to the individual personnel skills to do these judgments and hence, years of experience is vital for this work.
PR	Yes. An automated planning tool could help to calculate different scenarios. Tooling could help to calculate different scenarios for now and in the future. A tool could give an overview of all activities. Do you think that better management/scheduling of logistics trains could shorten possession times? Tooling could also be helpful to propose combinations of possessions and to increase the occupancy of machinery. This could minimize the total downtime of the tracks and the degree of occupancy of expensive machinery.
NR	Yes an automated planning and scheduling tool which optimises work within a possession, the track maintenance machinery as well as optimising possessions for the least impact on the timetable has the potential for optimisation beyond what is currently possible. Do you think that better management/scheduling of logistics trains could shorten possession times? Better management of the logistics of maintenance trains would help to improve possession times, however, there are also a number of other issues regarding logistics including available stabling locations and the safe management of the trains within the possession.
DB	The current process of maintenance planning and scheduling at DB is not automated. Interconnection of our existing systems and a possibility of automated planning of maintenance activities would open new options for saving time and money.
SNCF	Yes. Some optimization should be performed to take into account simultaneous multiple



resource usage: any activity uses several types of resources, and its shifting in time to optimize a given resource might degrade the use of other resource types. This cannot be managed by a simple, off the shelf, planning tool, as the following aspects must be considered :

- A real-time view of the workload of all the resources must be available
- Some decision support must be proposed through the use of a powerful dedicated optimization engine.

The expected benefits are a better reactivity in decision taking (with a faster convergence to an acceptable solution) and an optimization of the required resources through a better balance of the workloads over time.

Do you think that better management/scheduling of logistics trains could shorten possession times?

Scheduling of logistics trains could be improved for complex track possessions where several tasks are combined. By the way, robust scheduling of logistics trains between commercial trains is necessary so that works can start with no delay.

The quality of logistics train paths is also important for SNCF Infra even if it has no direct impact on possession times.



Estimation of track possession for each maintenance strategy

Make a rough estimation of the percentage of track possessions used for:

- Condition based maintenance
- Predetermined maintenance
- Corrective maintenance
- Inspections
- Complete renewal (done at the end of the lifetime of object)
- Focus on heavy maintenance activities addressed in Automain (grinding, tamping and renewal)
 - Condition based maintenance
 - Predetermined maintenance
 - Corrective maintenance
 - Inspections
 - Complete renewal (Total of the 5 factors is 100%)
- How will the future situation differ from the current situation?
- Is there a differentiation of planning horizon for those maintenance activities?

Additional questions

- Explore the differences between the numbers quoted: for example, ProRail has 70% predetermined maintenance, while Network Rail only has 10% - why?
- Some of the IMs failed to provide numbers. Please ask them to complete their answers to the original question
- There is considerable variation in the estimates. Could this be because the IMs are using different metrics; for example, percentages of: possessions, the cumulative length of possessions, or something else?
- Can the result also be affected by the method of contracting?

IM	Answer
TV	• Condition based maintenance – No • Predetermined maintenance – No • Corrective maintenance – No • Inspections – No • Complete renewal (done at the end of the lifetime of object) - No Focus on heavy maintenance activities addressed in Automain (grinding, tamping and renewal) • Condition based maintenance – It is up to the contractor how to solve this • Predetermined maintenance – It is up to the contractor how to solve this • Corrective maintenance – It is up to the contractor how to solve this • Inspections – It is up to the contractor how to solve this • Complete renewal – It is up to the contractor how to solve this • How will the future situation differ from the current situation? It is up to the contractor how to solve this



	Is there a differentiation of planning horizon for those maintenance activities? It is up to the contractor how to solve this
PR	Based on <u>total number</u> of possession: - Condition based 70 % (yearly maintenance scheme: planned 11 weeks in advance) (after infra inspections by train or hand) - Predetermined 20 % (yearly maintenance scheme: planned 11 weeks in advance) (especially tamping and grinding is planned one year in advance, based on use figures of the infra (i.e number of trains that run on a specific track)). - Corrective 5 % (ad-hoc, as fast as possible) - Inspections 4% (planned one year in advance) - Complete renewal less than 1 % (planned 1 year in advance, but combinations of renewal activities are already made 2-10 years in advance) <u>Planning horizon</u>: In brackets above, planning need to be updated at all time. In the future more and more possessions are condition based instead of predetermined. Another change could be innovations like mobile workspheres, more use of inspection trains instead of human inspections, more use of switches with remote sensors signaling the status of the switch. Note: When possessions are ranked based on total duration, the figures will be different, but not easy to collect on a short term. Can the result also be affected by the method of contracting? More and more possessions are planned for condition based maintenance, at the expense of predetermined maintenance. ProRail sees a shift from a fixed determined maintenance planning to a more flexible (condition based) maintenance planning. In the new contracts contractors are stimulated to use as little possessions as possible and do more work in a single possession.
NR	- Condition based maintenance 17% - Predetermined maintenance 10% - Corrective maintenance 20% - Inspections 25% - Complete renewal 28% How will the future situation differ from the current situation? - It is expected that in the future more of the inspections will be carried out from in-service, inspections vehicles and remote condition monitoring sensors. Corrective maintenance should be reduced and condition based and predetermined maintenance increases with improved remote condition monitoring and asset condition models. - A tool that would allow us to model the different options, give us a first cut optimization and allow us to alter the variables to generate alternatives that we could then decide on would be very useful indeed.



DB	How will the future situation differ from the current situation? Is there a differentiation of planning horizon for those maintenance activities? <i>Answer</i> Answer is still open yet. We will deliver more verified data if available. My (Burchard Ripke) rough estimation: • Condition based (short-term planning) 2,5% • Predetermined (mid-term planning) 1,5% • Corrective maintenance (immediately) 5,0% • Inspections ~ 0% (in relation to all five activities) • Complete renewal (long-term planning) (renewal of switches, rail and track) 91% Most possession time is required for renewal or reconstruction of bridges, switches, rails and tracks. But these activities are planned for longer times and in general included in the time table. Most inspection activities are done in the train free period or with high train speed e.g. track recording car runs with up to 200 km/h.
SNCF	This point should be more carefully investigated. There are two ways a organising possession times : In the “weekly model” model (over old lines, including condition-based maintenance, predetermined maintenance and corrective maintenance, excluding renewals) : 4 day * 1.9h/day * 200 days = 1600 hours per year Massified maintenance model: 300 to 400 hours per track Predetermined maintenance : 5 to 6 weeks a year * 5 hours a day = 125 hours per year Condition based maintenance + corrective maintenance + inspections : 1 hour a day = 200 hours per year Renewal : 15 hour per km of track every 30 to 40 years In euros: 60% for maintenance and 40% for renewals.



Are tasks combined in order to reduce possession time?

- Describe whether activities are combined in one possession in order to reduce possession time
- Are there different approaches for:
 - short / long possessions
 - main track on lines/station yards/side tracks

<i>IM</i>	<i>Answer</i>
TV	• Are activities combined? Yes; we do try to find combined possessions when the contractor is applying. That is taken care of when the IM is doing its total planning from the different contractors; however, we need to develop some penalties and rewards to find these combinations with the contractors. • Are there different approaches for: - short / long possessions – No - main track on lines/station yards/side tracks – No
PR	Yes, tasks are combined in order to reduce possession time. For larger possessions we see more tasks combined. There is more time and flexibility to combine tasks for long possessions compared to short ones. There is not a different approach for main line or side track (goal is to minimize the unavailability)
NR	Tasks are combined for maximum utilisation of the possession to reduce the costs of track access especially on the major routes. If timetable slots are required to carry out the maintenance on our heavily utilised routes a greater emphasis is put on maximising the effectiveness of the possession, whereas work in yards and low volume traffic lines is not subjected to so much pressure as there is less impact on the timetable for passenger and freight traffic and possessions can be fitted into the timetable.
DB	Yes, DB combines maintenance activities to reduce possession time. The new strategy “Integrative Bundling” postulates that generally all maintenance activities should be combined according to place and time as far as possible. In the case of renewal and preventive maintenance it is always possible to combine more activities in the same possession (vegetation control, catenary maintenance, drainage maintenance etc.). In the case of corrective maintenance and maintenance activities with short planning periods, it is unusual to combine more different maintenance activities at the same time. Generally, it is more difficult to bundle tasks on free lines of main tracks than in stations and on side tracks (because of difficulties of alternative routing).
SNCF	Massified maintenance: works on track, signalization, and catenaries performed simultaneously over a period of 2 to 4 weeks within intervals of about 5 hours over 50 to 100 km. In general, the limits of this approach lie in the use of maintenance-specific trains that must go through the different work sites.



	This model is used for main lines and on-line stations. For railway nodes, specific studies are carried out to build itineraries enabling the maintenance operations (some traffic can for example be switched from a line to another). SNCF would like to develop software to check the coherence between capacity usage by works on the network (maintenance and other types of possessions) and the traffic to go through a station, by modelling itineraries. This would also be useful for train operators willing to design new cyclic schedules, for example.
Strukton	Combining will definitely have an advantage, however requires a lot of discussion, negotiation and agreement. This might lead to delay of some activities during possessions with possible resultant overruns.

Are combined tasks successful in any case or most cases?

Describe whether combined activities are successful or new problems raises due to:

- availability of maintenance machines
- reliability of maintenance machines
- performance of maintenance machines
- higher complexity of planning and maintenance processes
- ...

Additional questions

- What are the problems combining tasks? How could things be improved?
 - What is the role of the service provider / contractor in combining tasks?
 - Some IM give the contractors much freedom in finding solutions (eg TV question 3.5). Please explain why and what are the benefits?
- Are there formal rules to explain to the maintenance provider how possessions can be planned (alternative routes, combination of tasks, night/day...)?

IM	Answer
TV	Describe whether combined activities are successful or new problems raises due to: • availability of maintenance machines – It is up to the contractor to find solutions • reliability of maintenance machines – It is up to the contractor to find solutions • performance of maintenance machines – It is up to the contractor to find solutions • higher complexity of planning and maintenance processes – It is up to the contractor
PR	Combined tasks are successful in most cases, but combinations of tasks makes possessions more complex. It's more the responsibility of the contractor to combine activities. Certain activities exclude each other, or certain activities have an overlap in time and location. ProRail has limited overview over the activities and little incentives to stimulate contractors. But this is starting to change by introducing a new application to help creating the overview of possessions shown on the infra network. Certain activities exclude each other (i.e. switch renewal and grinding). Example of combining tasks: Project Arnhem where the complete station/infra within 6 weeks was rebuilt during summer without running trains. How could things be improved?

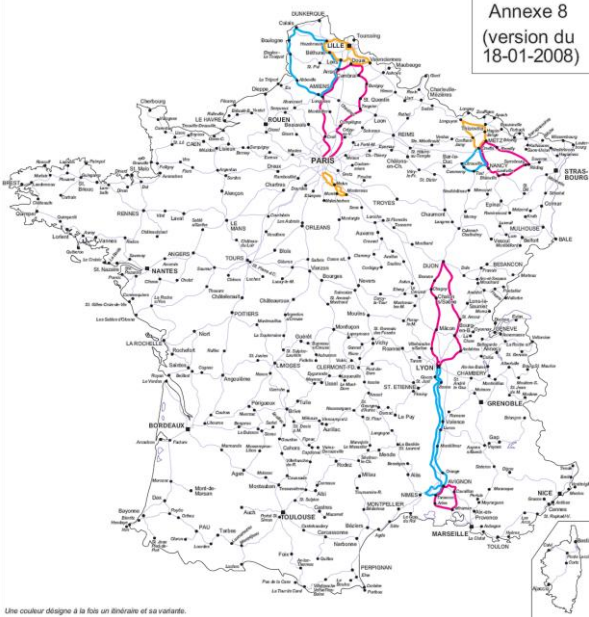


	Overview in combination of tasks could be improved by using software packages that help to generate an overview of all planned possessions, plotted on the network. ProRail lacks this overview. What is the role of the service provider / contractor in combining tasks? For small maintenance: contractor is fully in control of planning and combining tasks. Incentive: Required level of quality needs to be assured with minimal possessions. Large maintenance (Grinding, tamping, renewal): Planning is made by ProRail and contractor has no influence on the planning which is made one year in advance. For the detailed planning (11 weeks in advance of performing the activities) there is some space to change the planning and combine activities. Are there formal rules to explain to the maintenance provider how possessions can be planned (alternative routes, combination of tasks, night/day...)? There are rules. The Dutch railway network is divided in so called corridors. At the moment a possession is planned on corridor A, it's not possible to plan another possession on corridor B (when corridor B is a bypass route for corridor A. Besides it's not allowed to plan several possessions on one corridor. Example (A2 corridor): Amsterdam – Utrecht – 's-Hertogenbosch – Eindhoven It's not allowed to plan at the same time a possession between Amsterdam-Utrecht and 's-Hertogenbosch-Eindhoven. As stated earlier for large maintenance activities ProRail is responsible for the planning of possessions.
NR	Generally the combining of tasks is planned as part of the possession plan, with maintenance machine availability part of the very early stages of possession planning and the actual possession is planned to ensure that the individual tasks do not interfere with each other. What are the problems combining tasks? How could things be improved? Problems with combining tasks are generally that it makes the possession more complicated and more difficult to manage, there can also be safety issues with more movements of plant on site and potentially incompatible tasks. Better planning and communication systems could improve this. What is the role of the service provider / contractor in combining tasks? Network Rail is the service provider as well as the Infrastructure Manager, so is wholly responsible for combining tasks. However, UK experience from when maintenance was sub-contracted out found that there was no incentive for a principle contractor in charge of the possession to incorporate other tasks by other contractors as any overrun would result in penalties. Are there formal rules to explain to the maintenance provider how possessions can be planned (alternative routes, combination of tasks, night/day...)? No formal rules other than the guidelines of the Rules of the Route which say how many



	possessions can be planned as service interrupting possessions and the maximum length of diversionary routes and compensation to be paid.
DB	Combined tasks are successful in many (most) cases. There are some differences upon different regional districts because of diverse infrastructure complexity and sometimes also because of diverse experiences / principles of infrastructure managers. The problems we don't see in availability, reliability and performance of maintenance machines or in complexity of planning, but more in unexpected situations that can occur, for example: bad weather, other soil conditions, accidents, machines out of order, human errors etc.
SNCF	Combined tasks work better when the following conditions are met : • Possession time is at least 5 hour long • Work train circulation constraints were considered well in advance • An assigned work manager designs the possession (long enough before the actual date) and manages all operations in space and time • A complete, detailed, space – time representation is made (that includes the paths of the commercial trains). However, the space-time graph is only partially available between Y-3 and Y-1. What are the problems combining tasks? How could things be improved? Combining tasks makes the scheduling of the maintenance tasks during a track possession more constrained, more complex, also less robust. Things could be improved with the help of dedicated scheduling software that are precisely informed of what is possible to combine and what is not. Maintenance process could be improved to make each maintenance operation less intrusive with respect to other maintenance operations. What is the role of the service provider / contractor in combining tasks? RFF lets SNCF combine and schedule the maintenance in order to minimize the total cost. Are there formal rules to explain to the maintenance provider how possessions can be planned (alternative routes, combination of tasks, night/day...)? • RFF gives a list of alternative routes (RFN-REF-Capa-REPART-V10 – Annexe 8). Two track possessions cannot be simultaneously scheduled on alternative routes.



	Annexe 8 (version du 18-01-2008)  • The minutes that can be lost due to speed limits is bounded between some pairs of stations (otherwise, timetable of affected trains must be changed).
Strukton	A large proportion of activities can be combined depending on location and the methods chosen.



Influence on task duration and effectiveness

How do each of these factors influence task durations and effectiveness?

- Seasons
- Night/day
- Track topology
- Region
- Dedicated freight / passenger / mixed lines
- Single track / double track
- UIC class of track
- TEN / TSI
- Safety

Describe the influence of the characteristics on task duration (i.e. will a season influence task duration and to what extend?)

IM	Answer
TV	Seasons – In the north we only do maintenance work in the summer • Night/day – In the north we have daylight 24/7 in the summer • Track topology – No influence • Region – No general influence, but for single line traffic – yes • Dedicated freight / passenger / mixed lines – Mixed lines with limited places to wait for its possession is not so good. • Single track / double track – Lines with limited places to wait for its possession is not so good. • UIC class of track. ?? • TEN / TSI. ?? • Safety. ??
PR	The three most important factors are: • Safety: For every possession the right safety measures should be taken. This takes time which puts limitations on the net Train Free Period. • Seasons: Some activities are season-based and some activities cannot take place in a particular season • Day/night: There should be a right shift in work during day/night hours • Track topology: There are certain tracks and yards where's little capacity for maintenance. Smart planning is needed in order to carry out the maintenance activities. A mobile work sphere is a piece of equipment that helps to safely carry out activities in smaller slots.
NR	• Seasons



	weather conditions can have a large impact on the effectiveness of maintenance tasks potentially leading to requiring greater preparation times, especially in snow. Workforce • Night time Labour costs can be greater for weekend and night time work and tasks such as inspection are especially more difficult at night • Track topology and location will impact access to site and again have a large impact on pre and post maintenance tasks and logistics of getting materials and staff to the worksite • Mixed traffic lines present some of the largest problems in terms of access, especially for example our West Coast Mainline which has very little spare capacity.
DB	• Seasons characteristics like temperature, rain, frost can extend or even be a reason for failure or displacement of possession time. • Night/day: On the most lines there is more traffic during a day. Longer possessions are possible at night, on weekends and holidays. • Track topology: High gradients or small radius in curves can be reason for decreasing of performance and hence for longer required possessions times. • Region itself doesn't influence task duration, only through different regional seasons characteristics; different topology, soil conditions or different train mix. • Dedicated freight / passenger / mixed lines: - Pure passenger lines have normally very good possibilities for long possessions at night. - Task duration possibilities on pure freight lines depend on distribution of traffic. Most of them have also quite good possibilities for longer possessions either during a day or during a night. - Mixed lines have a lot of traffic on daytime as well on night time, there are possibilities only for short possession times during a day and maybe a little bit longer possession at night time. • Single track / double track: - Logistic of material transport as well alternative routing for traffic is more difficult on single track lines. - Double tracks with traffic on the neighbouring track during maintenance need more time and effort for safety. • UIC class of track: there is no influence • TEN / TSI tracks require special regulations and maintenance, e.g. regarding noise, equivalent conicity or track equipment, TEN tracks are important lines for international traffic • Safety has especially for high speed lines an impact on task duration and effectiveness. On German high speed line from Frankfurt-Cologne the inspection and all maintenance (including very small maintenance) are only possible if the trains are stopped on both tracks. The visual inspection is carried out at night with an SKL and artificial light.
SNCF	• Season: cold and heat prevent specific operations (such as long welded rail maintenance). Rain can disturb some operations. • Night: decreases efficiency (by around 20%), it becomes difficult or even impossible to set up human announcement chains • Track topology: problem of visibility for human announcements, problems of access to track for human and mechanized resources, and for maintenance trains (including rail / road with specific devices to access the track) • Region: some mobility constraints for human resources • Freight / passenger lines :



	Freight is mainly operated at night, passengers during day : some constraints on planning day / night / both No impact on operation durations, but impact on frequency • Single / double track : potential problem on single track for some operations which need simultaneous possessions on the track and its contiguous track (size of devices, crosses of material and mechanized resources...) • UIC Class : impact on frequency of maintenance • Safety : the duration of safety procedures (no circulation periods, work train circulations, etc.) degrades efficiency in limited time possessions
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Effect of automatic planning

Where do you think that automatic planning can contribute most:

- Scheduling over one day in the future of the elementary maintenance tasks during a track possession
- Planning 1-3 months in the future of the operations assigned to track possession
- Planning over 1-3 years in the future of the operations in order to balance track possession and resource usage

Describe in what time window/interval you will expect most value of automatic planning tooling.

Additional questions

- For what planning horizon do you see the biggest potential when implementing an automated planning tool?

IM	Answer
PR	Automated planning will contribute in every phase of the planning, but will be most useful in planning and scheduling for the current year (bullet 1 and 2), while in the current year the changes in the planning are the biggest and have the largest impact on train service/other possessions. It would be very helpful to see the impact of the plan changes directly in the software tool. Planning for over 1-3 year in the future is very uncertain: there are a lot of plan changes. But maybe the tool could help to calculate different scenarios for future situations (taken into account the uncertainty of planning).
NR	For what planning horizon do you see the biggest potential when implementing an automated planning tool? The most useful stage to have the automated planning is in the 1-3 years to balance track possessions and resource usage, but potentially an automated planning tool could have it's greatest advantages for scheduling and optimising possessions on a very short term basis optimising possessions for corrective and condition based maintenance, which cannot be as well planned as the predetermined maintenance tasks. Major changes occur at the shorter timescales 1week – 3months can be particularly problematic. This is potentially where the modeling and selection of the best option will derive most benefit where many different scenarios and the necessary resources can be analysed quickly.
DB	Planning 1-3 months in the future of the operations assigned to track possession (Maybe also for long-term planning over 1-3 years)



What good practices / benchmarks do you know for the integration of maintenance in the timetable?

Mention the relevant situation and explain briefly why this is a good practice.

Additional questions

- Please could the IMs explain what they think of as good practice for short term rescheduling (especially for corrective maintenance or to adapt the planning to any area).

IM	Answer
PR	• Mobile workspace • Software package for videotrain planning to optimize the planning • Inspection equipment on commercial trains (passenger or freight)
NR	Please could IMs provide more detail in their answers to the original question? Please could the IMs explain what they think of as good practice for short term rescheduling (especially for corrective maintenance or to adapt the planning to any area). Good practice for short term corrective maintenance in the UK is to as much as possible schedule this maintenance into possessions that have already been planned and if necessary delay some of the less critical activities that were planned during that blockade. If this is not possible the next best scenario is to plan the corrective maintenance between trains or within the white space within the timetable, with traffic only being interrupted in the cases where immediate action is required either due to safety or to preserve the running of services. A move away from corrective maintenance with improved preventative and prognostic maintenance is being adopted where possible, utilizing data from measurement trains, line side monitoring and other remote condition monitoring systems as well as models and algorithms to understand the rates of degradation, so that maintenance can be carried out in a well planned manner.
DB	DB: Preventive or prognostic maintenance increases the shift performance and reduces the cost per meter maintenance. The use of high performance maintenance plants to increase the maintenance length per possession. A Continuous track monitoring using a conventional train for evaluation of track degradation and the development of deterioration laws. These laws are used for prognostic maintenance procedure. SNCF: Stop of the train operation on the affected line and maintain the track in one possession; often over more than one day. Higher efficiency of maintenance and higher quality. Heavy Haul: Preventive grinding and tamping of track with plants exclusive available for the line. High quality of track, short transportation distances of plants, high availability of plants and therefore maintenance is easier to schedule.
SNCF	Good practices: integrate maintenance within circulations?



	Tracks in station: • adapt timetables in collaboration with operators, taking into account itineraries and possible postponement/rerouting of trains or passengers. Tracks out of station: • Permanent devices on the track to switch traffic from one track to another (single-line working) • Alternative itineraries enabling to free tracks for maintenance, switching traffic, and possibility of working on both itineraries when no traffic is planned • French "IRIS 320" train : high speed inspection between commercial paths • Mechanized resources able to drive both on tracks and on road to reduce transportation durations (hence increasing work speed), if specific devices are usable (parking locations, rail / road platforms...)
Strukton	Exploiting short gaps between trains (as possible before current safety regulations). With the use of modern techniques this might be possible again whilst still complying with current safety levels.