WP5 tool : preliminary demonstration with all modules

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Outline

- Objectives
- General tool architecture
- Demonstration of an example
  - Presentation of input data
  - Explanation of the algorithms over examples
    - Optimization of planning based (Focus on 1 or 2 examples)
- Conclusions & Results
- Future research

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Objectives

- Optimize maintenance possession time. Example based on three activities: 1) measurement before tamping, 2) grinding and 3) tamping.
- Optimize use of maintenance machines in the long term planning.
- Reduce costs

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General tool architecture

- Long-term planning is required:
  - Scheduling of one maintenance operation must be done taking into account the other operations:
    - Machine usage
    - Network usage
    - Precedence constraints
  - Need to have a global view over at least a few months.

- More detailed schedules are also required:
  - Ensure that the operation can be performed at the chosen date (time constrains), with the chosen machine (initial position and characteristics).
  - Deeper insight on the local conditions (considering commercial traffic)

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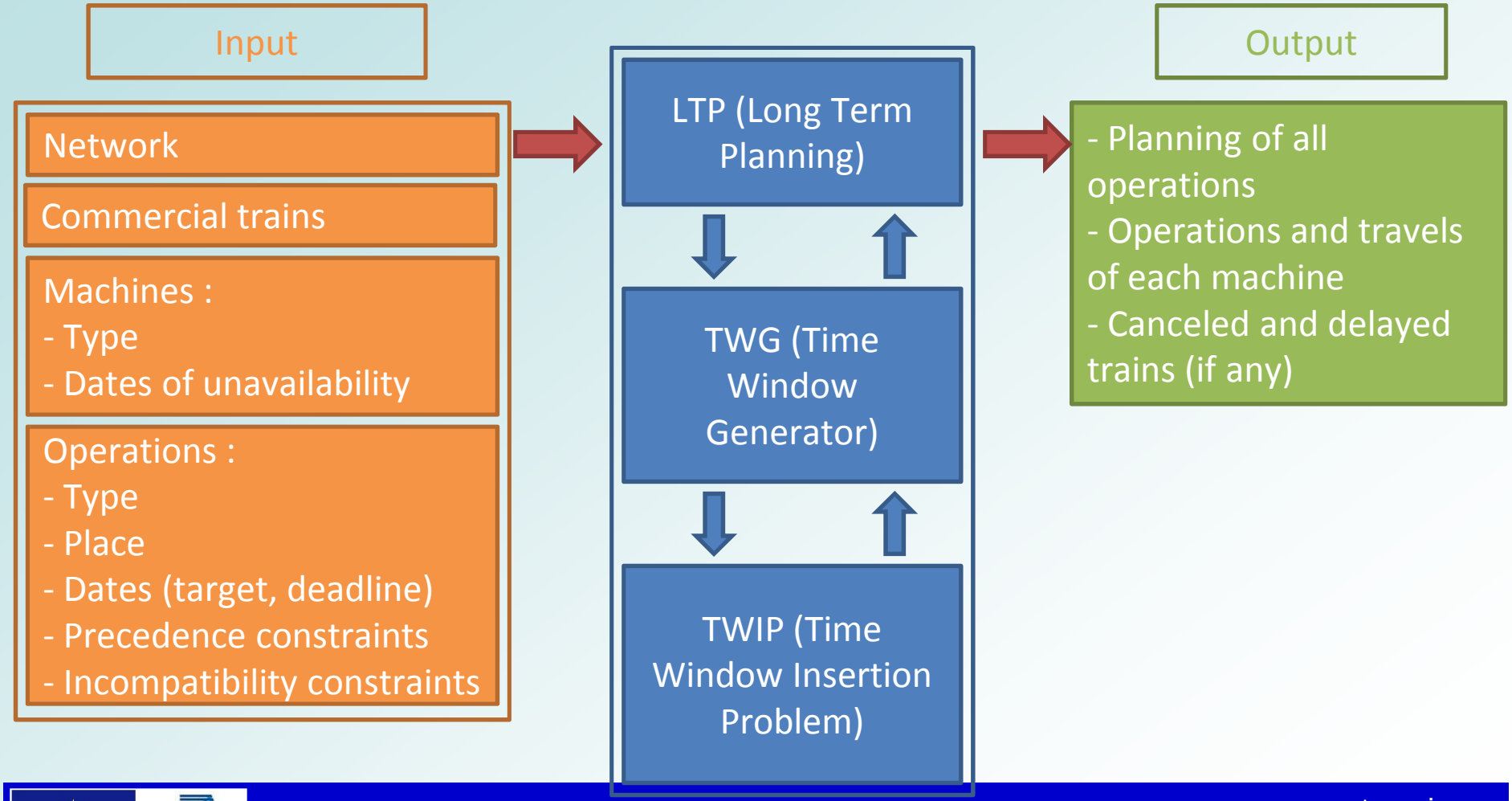
General tool architecture



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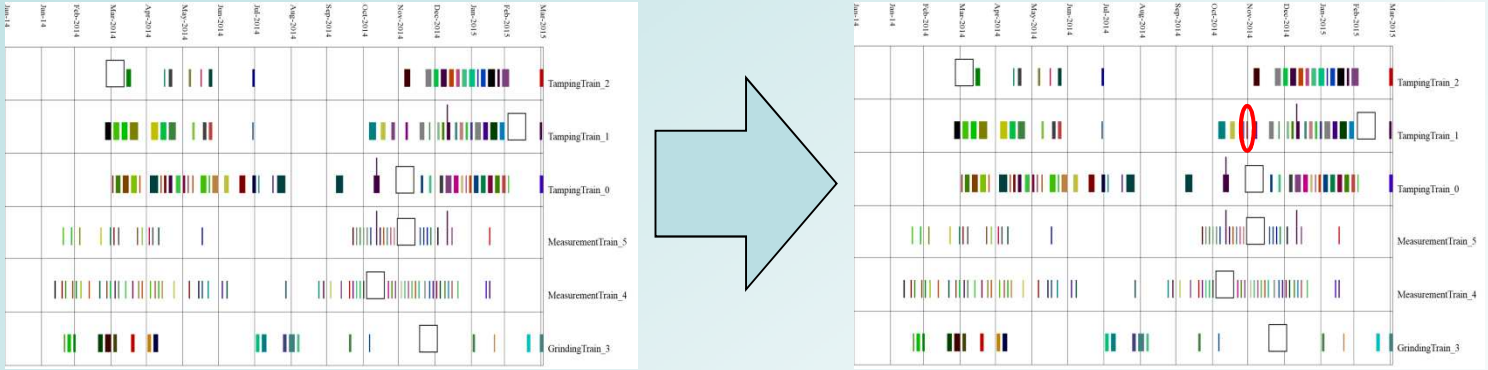
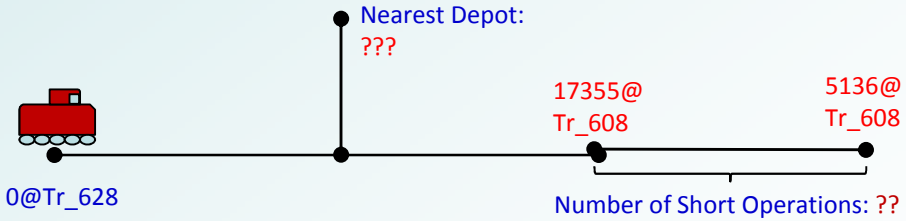
Tool demonstration

For time reasons, only a few features will be presented today:

1. Insertion of an operation into an existing planning.



2. Detailed scheduling of an operation into an existing commercial timetable.



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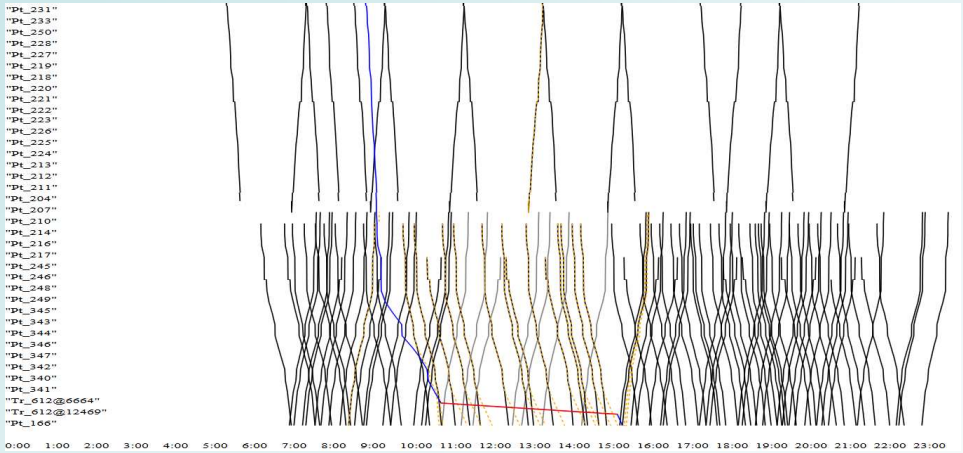
Scenario 1 – input data

- New operation insertion:
  - **4h30** operation to be inserted into heavy traffic.

    - Simple approach : 15 cancelled trains



    - WP5 Prototype approach : 7 cancelled, 27 delayed

    (Minimization of impact on commercial traffic)

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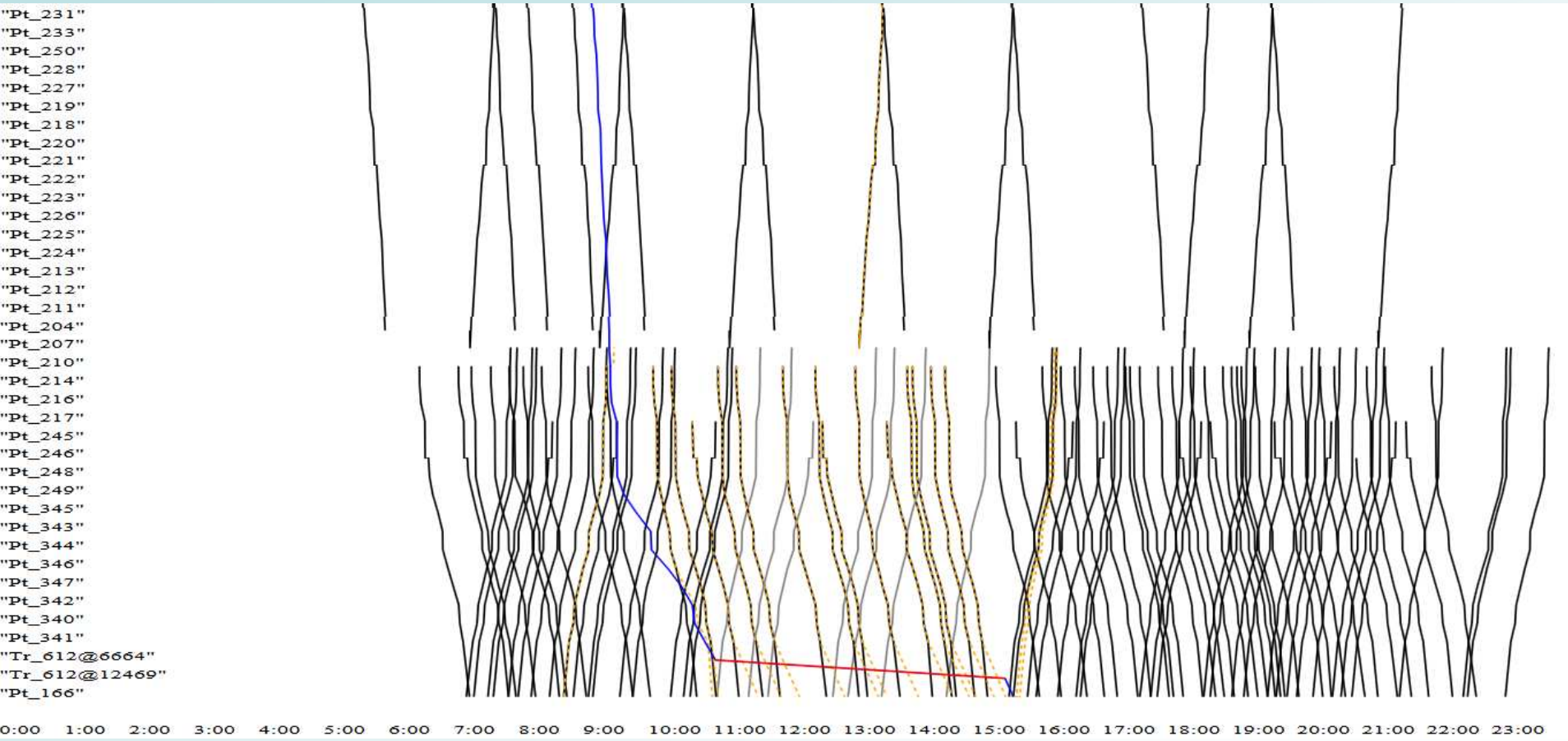
Scenario 1 - result



Scenario 2 – input data

- Operation description (TWG inputs):

- Maintenance Operation data:
  - Name: “Measurement_before_TampingOp_40"
  - Begin: at 17355 m of track "Tr_608"
  - End: at 5136 m of track "Tr_608“
  - Length: 12219 m
- Maintenance Train data:
  - Name: MeasurementTrain_5
  - Work speed: 8 Km/h.
  - Travel speed: 100 Km/h.
  - Initial Location: 0 m from origin of Tr_628
- Time constraints:
  - Machine Available Date: 10/01/2014 00:00:00
  - Latest End Date: 13/01/2014 00:00:00
  - Target End Date: 13/01/2014 00:00:00
- Priority to Traffic: **True (No cancelled train strategy)**


```
Path(1) Name: Path starting at 0@Tr_628,
doing work between 17355@Tr_608 and
5136@Tr_608,
ending at 0@Tr_605.
  -> 0 meters from track Tr_628
  -> 5570 meters from track Tr_628
  -> 6300 meters from track Tr_632
  -> 6100 meters from track Tr_634
       ...
  -> 21754 meters from track Tr_616
  -> 17355 meters from track Tr_608
  -> 5136 meters from track Tr_608
  -> 0 meters from track Tr_605
```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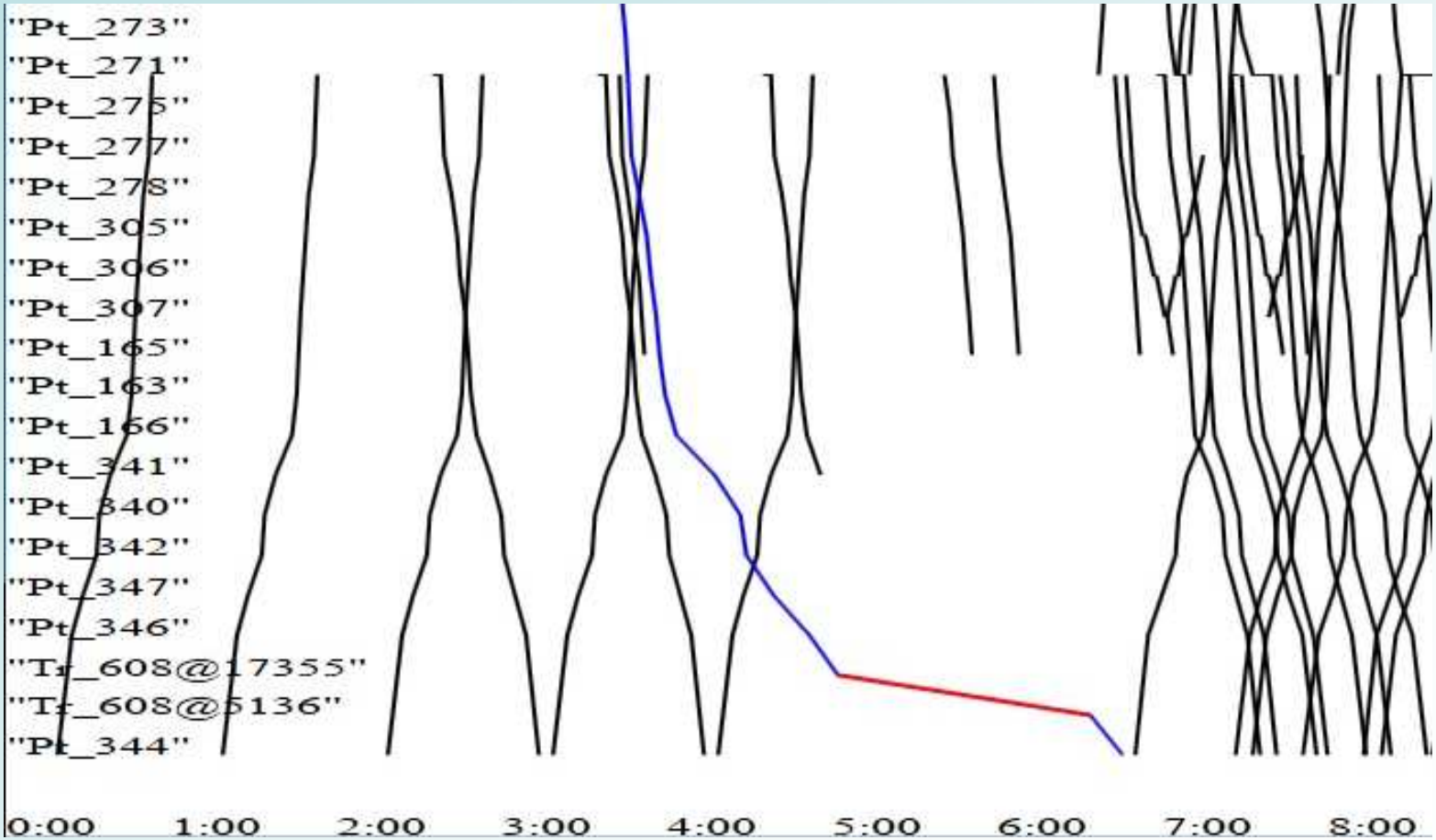
Scenario 2 – Result (1)



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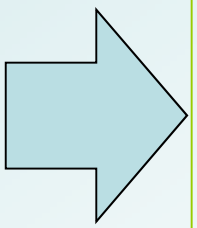
Scenario 2 – Result (2)

- A list of cancelled trains: No cancelled trains
- A list of delayed trains: No delayed trains
- A list of the short operations defined by TWG:
  - One short maintenance operation with the following schedule: (duration 01:31:39)
    - Operation Start: 10/01/2014, at 05:02:19
    - Operation End: 10/01/2014, at 06:33:58
    - Train run makespan duration: 04:24:35
- The full maintenance train path with a defined schedule.

```
Path(1) Name: Path starting at 0@Tr_628,
doing work between 17355@Tr_608 and
5136@Tr_608, ending at 0@Tr_605.
  -> 0 meters from track Tr_628
  -> 5570 meters from track Tr_628
  -> 6300 meters from track Tr_632
  -> 6100 meters from track Tr_634
     ...
  -> 21754 meters from track Tr_616
  -> 17355 meters from track Tr_608
  -> 5136 meters from track Tr_608
  -> 0 meters from track Tr_605
```



```
Path list for MaintenanceTrain (Times by TWIP)
Path(1) Name: Path starting at 0@Tr_628,
doing work between 17355@Tr_608 and 5136@Tr_608,
ending at 0@Tr_605.
  -> 0 meters from track Tr_628, at 2014/01/10 from 02:21:11 to 02:21:11
  -> 5570 meters from track Tr_628, at 2014/01/10 from 02:24:31 to 02:24:31
  -> 6300 meters from track Tr_632, at 2014/01/10 from 02:28:18 to 02:28:18
  -> 6100 meters from track Tr_634, at 2014/01/10 from 02:31:58 to 02:31:58
                ...
  -> 21754 meters from track Tr_616, at 2014/01/10 from 04:51:54 to 04:51:54
  -> 17355 meters from track Tr_608, at 2014/01/10 from 05:02:19 to 05:02:19
  -> 5136 meters from track Tr_608, at 2014/01/10 from 06:33:58 to 06:33:58
  -> 0 meters from track Tr_605, at 2014/01/10 from 06:45:46 to 06:45:46
```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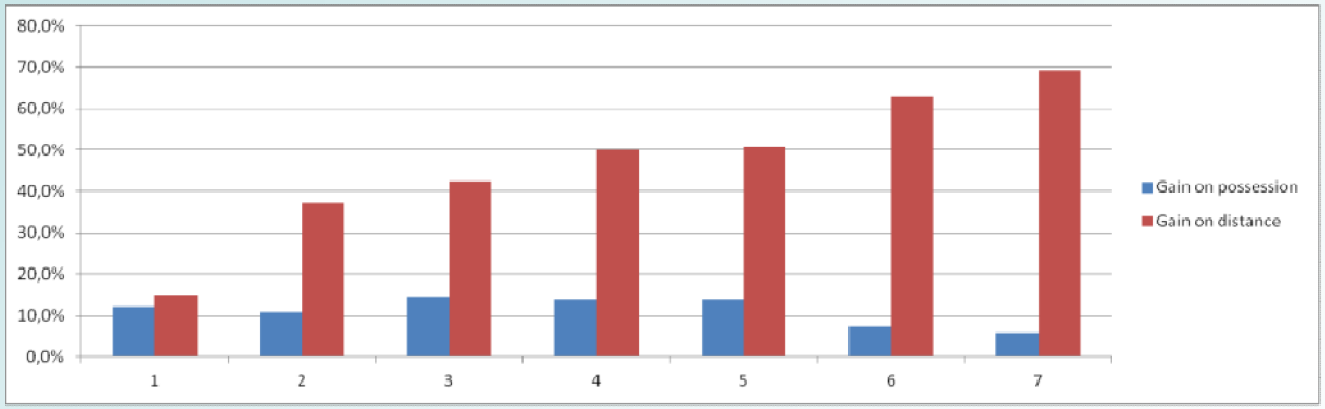
Tool results overview

- Gain on possession time
  - 6% to 15% gained by combining operations
- Gain on machine travel
  - 15% to 69% km gained



- Holistic approach possibility (based on different strategies)

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Results / Conclusions

- Proof of concept: WP5 prototype shows that specific optimization algorithms can bring significant reduction in possession time and minimize impact on commercial traffic**.**
- These more efficient methods achieve an expected decrease of maintenance cost.
- Also there is a potential gain of capacity (due to early combination of maintenance operations).

- Perspectives of customizing this prototype into an industrial tool. Each countries requires specific needs of each infrastructure.

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Future research

- **iQST** is interested in further development:
  - On January 27th in Braunschweig, Germany the first meeting between iQST, AUTOMAIN WP5 and planning and scheduling companies was held, for planning the further development of the tool.

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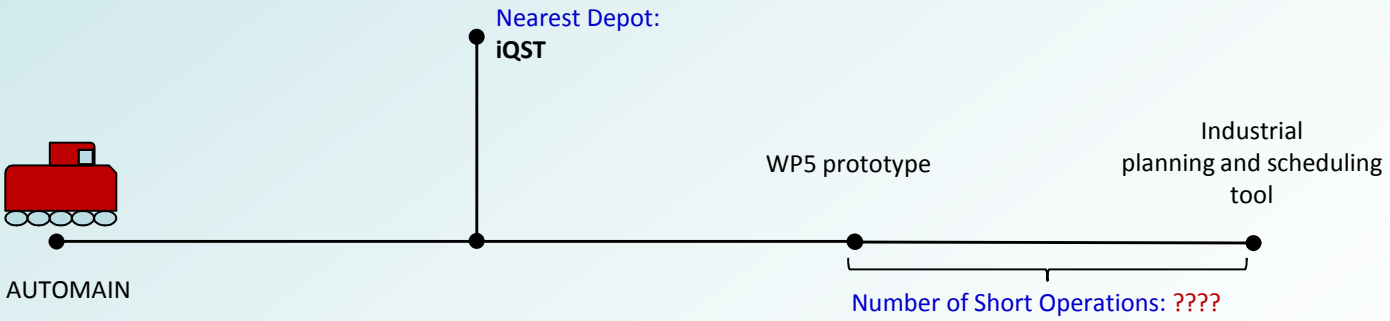
Thank you very much for your attention



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