SEVENTH FRAMEWORK PROGRAMME

UPPSALA UNIVERSITET

TYRÉNS

[Optimal Networks for Train Integration Management across Europe]

Collaborative Project

7th Framework Programme

WP 3, task 3.3: Problems in the integration of timetabling and traffic control.

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KAJT, Stockholm, 5 December 2013

ON-Time WP3, task 3.3

- WP3 ("Development of robust and resilient timetables")
- The aims of WP3 is to develop common railway timetabling and capacity estimation methods for EU member states
  - that reflect customers' satisfaction and enable interoperability, more efficient use of capacity, higher punctuality and less energy consumption.
- Uppsala University has a minor part of WP3, task 3.3 which has the following objectives:
  - To get a clear understanding about the problems in the integration of timetabling and operational control.
  - To describe existing approaches of how to solve the integration problems and improve the railway system.
  - To describe innovations and development in these areas.

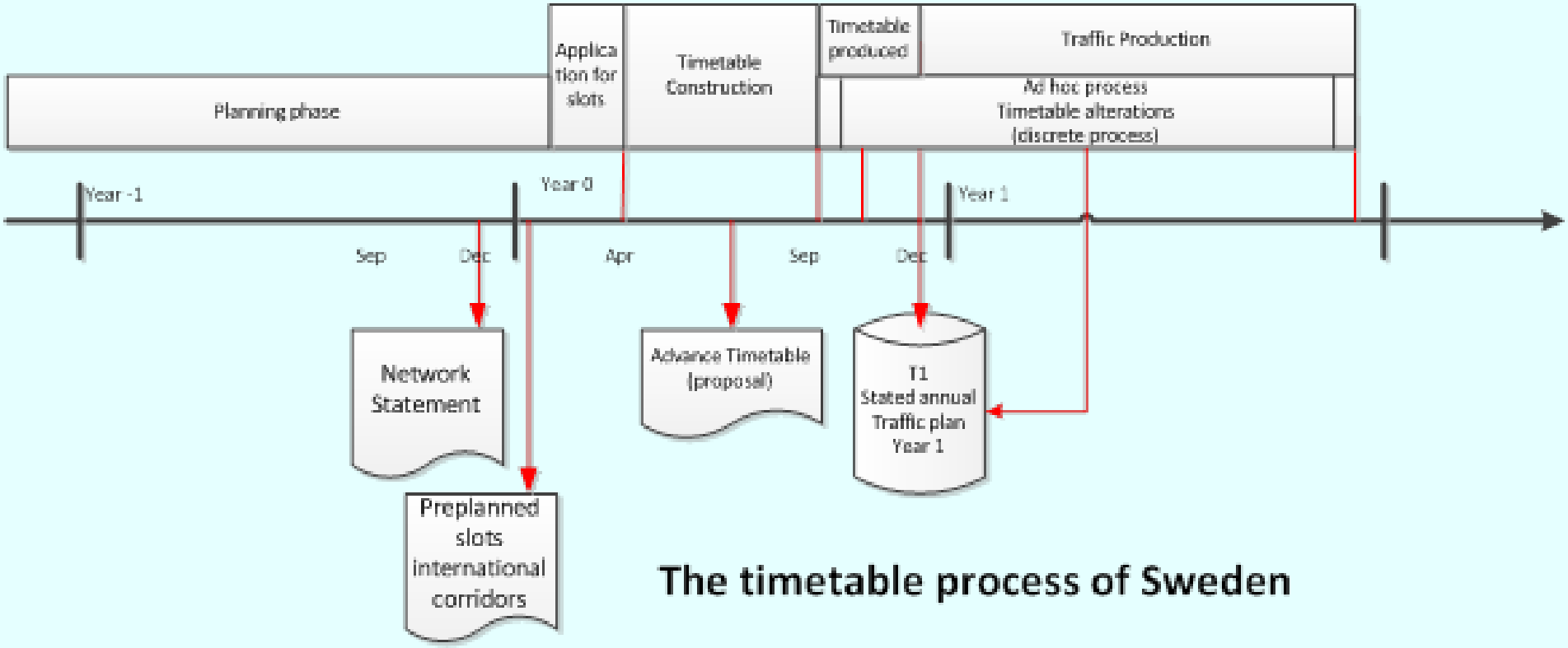
ON-Time WP3, task 3.3

- We have focused on the following main issues
  - more or less excluding the issues dealing with problems that have its roots in how the work is organised
  - The time spans of in first-hand the timetabling process.
  - The rules and regulations.
    - The rules and regulations that have to be obeyed by the IM when scheduling trains of several train operators.
  - The tools used in the creation of the timetable.
  - The quality of the timetable.
    - How is the quality of the production plan, validated?
    - The usability of the timetable in the traffic control process?
  - The feedback process.
    - The feedback, short or long term, from the traffic control process – back to the planning process

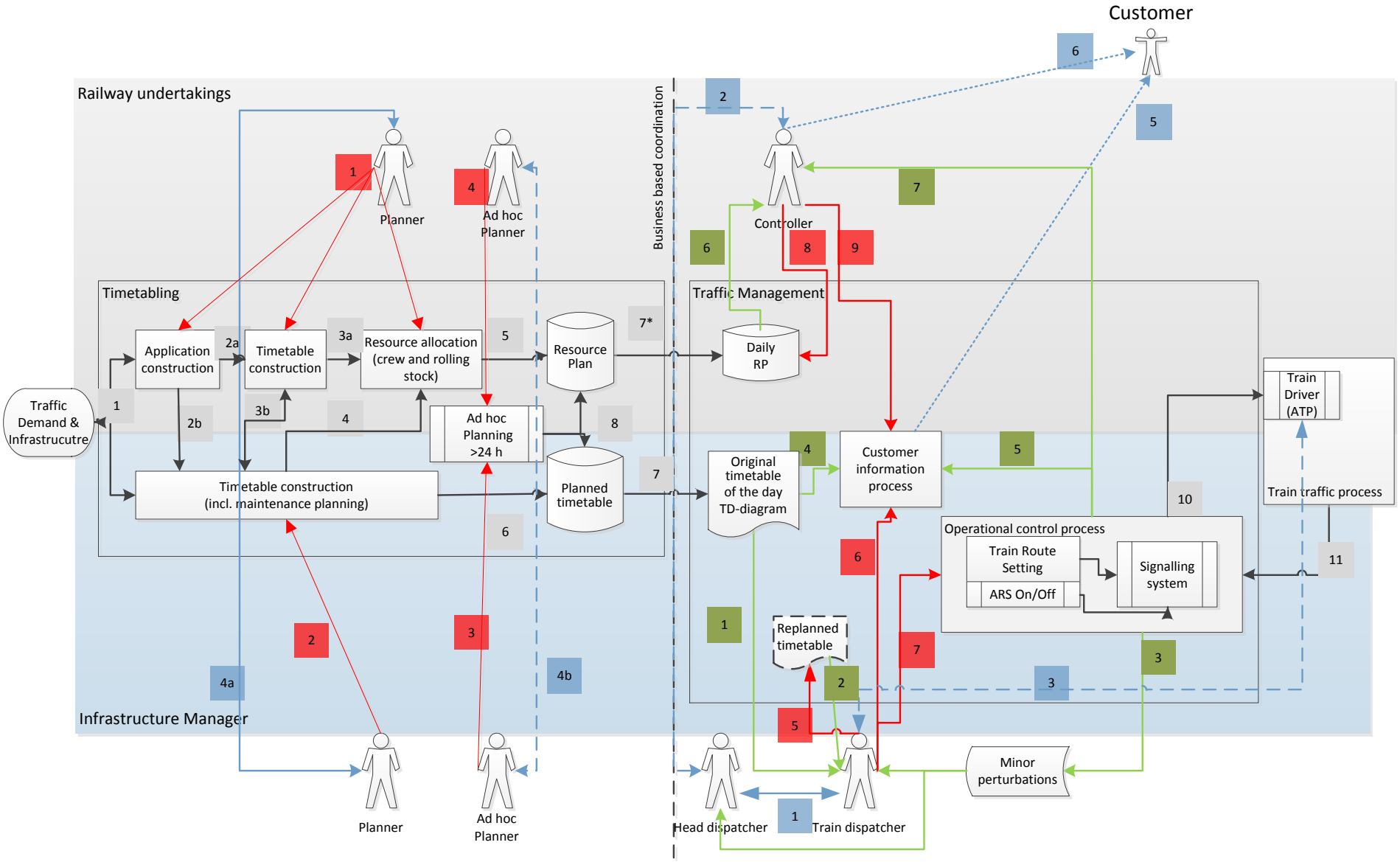
ON-Time WP3, task 3.3

- Our work reported here focuses primarily on the prevailing conditions in Sweden.
- The work done is divided into four parts:
  - an overview of the timetabling and operational control processes in Sweden.
  - **interviews with people working in the timetabling and operational processes**
    - **to get a brief overview of the most important, noted problems**
  - an overview of what is reported in the scientific community in Sweden within the described scope.
  - a final part describing promising innovations and developments in these areas in Sweden.

Timetabling process



The timetable process of Sweden


Customer
Railway undertakings
Business based coordination
Planner
Ad hoc Planner
Controller
Timetabling
Traffic Management
Application construction
Timetable construction
Resource allocation (crew and rolling stock)
Resource Plan
Daily RP
Traffic Demand & Infrastrucutre
Ad hoc Planning >24 h
Timetable construction (incl. maintenance planning)
Planned timetable
Original timetable of the day TD-diagram
Customer information process
Train Driver (ATP)
Train traffic process
Operational control process
Train Route Setting
ARS On/Off
Signalling system
Replanned timetable
Minor perturbations
Infrastructure Manager
Planner
Ad hoc Planner
Head dispatcher
Train dispatcher

Conclusion

- This part is based on short interviews
  - in person or by phone
  - with people working in Sweden
    - in the timetabling and operational processes,
    - or in close connection to them.
  - Representatives of both freight and passenger operators (RUs) as well as representatives of the IM have been interviewed.
  - The purpose of these interviews was to get a brief overview of the most important, noted problems in the mentioned processes.
    - with focus on the main issues mentioned above.
- Based on the interviews the main underlying problems
  - broken down in the same way as in the chapter "Noted problems based on interviews"
- are the following:

Conclusion, cont.

- **Quality of the timetable**
  - The construction of the timetable is based on old principles when it comes to so-called buffer times, running time supplements, and other allowances etc.
  - The precision in the planned timetable for individual trains varies a lot.
    - Especially the running times for the freight trains deviates quite often from what is planned in the timetable.
  - The planning of track usage on larger stations and yards is not good enough today.
    - The precision in the data and models used as a basis for the calculations of running times and margins is too simplified.
  - The time supplements that are added to trains in the yearly timetable due to planned maintenance work are often based on rough estimations.

Conclusion, cont.

- **Quality of the timetable, cont.**
  - The running time calculations that are done as a basis for the construction of the timetable have several drawbacks.
    - calculated in advance for a specific, limited number of different types of trains.
    - (including start and stop time supplements) are made from station centre to station centre on the main track.
      - Without considering effects of points and the signalling system.
    - running times for long and heavy freight trains are many times wrong.
      - The long and heavy freight trains are modelled in the shape of a "point". This fact in combination with that their length and weight affects both where in a station they will stop and the time to get to the stopping point, makes it difficult to create good, detailed timetables for these trains.
    - The models and the train data used in the calculations are not always the best possible.
    - The calculated values are today not validated on a more regular basis.
      - In fact it is seldom done.

Conclusion, cont.

- **Quality of the timetable, cont.**
  - The following "deficiencies" in the used timetables are noted:
    - Quite often hidden conflicts between trains in the timetable
    - Planned train meetings (on single track) are sometimes impossible to carry through according to plan, even if both trains are on time.
      - The time delays in the interlocking system is not considered in the timetable. It is especially noted on the iron ore line.
      - Also note that the mentioned time delays to some extent varies between different interlocking systems (and usually is not documented).

Conclusion, cont.

- **Quality of the timetable, cont.**
  - The traffic system of today isn´t capable of delivering trains with a "minute precision".
  - Planning the trains with a low precision as in Sweden, creates large punctuality problems, especially in areas with high capacity consumption.
  - "Too often the timetable is not used as a timetable but mere as a broad outline for running trains on the tracks".
  - Another problem with the Swedish timetables is that the planning is done with almost no consideration to the variations of the seasons (adhesion).
    - Sweden is a quite large country with very large seasonal variations in temperature, precipitation (snow) etc. and there are also very large variations between different parts of the country.

Conclusion, cont.

- **Timetabling and its tools**
  - One major problem is that the timetable is not planned for every specific day.
    - Trafikverket does not have enough resources
      - (and not the appropriate tools etc.).
  - The timetables are planned with a low degree of precision and therefore creating many problems.
    - In practice not even working on a "one minute" level!!
  - enhancing the so called "time in the forest", introducing delays, spreading knock on delays etc.
  - and in the end increasing transport and travel times, and energy consumption and decreasing punctuality.

Conclusion, cont.

- **Timetabling and its tools, cont.**
  - The timetable constructors don't specify time supplements in the timetable in a structured and validated way.
    - It is, apart from existing rules and regulations concerning allowances,
      - based on pre specified headway limits and personal experiences.
  - The main timetable tool (Trainplan) used today
    - has no functions for an appropriate handling of the planning of tracks on larger stations and yards.
    - has no developed functions for dealing with different versions of infrastructure or different versions of the same timetable in an effective way.
    - It is also very time consuming to alter the timetables for trains running long distances.

Conclusion, cont.

- **Timetabling and its tools, cont.**
  - The construction of the timetable is done with Trainplan based on pre calculated running times and a (very) simplified infrastructure model.
  - During construction
    - the timetable is represented as a "Train graph".
    - This tool has no "built-in intelligence"
    - is just a mere "drawing board".
    - in the used infrastructure model there is no representation of the signalling system whatsoever
    - which have several effects on the quality of the timetable.
  - The impression is that one main cause to the problems are inadequate and old fashioned support systems making an efficient planning process impossible.

Conclusion, cont.

- **Operational control and the usability of the timetable**
  - One effect of the prioritisation rules of today (i.e. trains on-time are prioritised) is that trains running long distances are treated unfairly.
    - The probability that a train is on time is much higher if it is running only a short distance.
  - Temporary speed restrictions are quite frequent and are a source for delays spreading through the traffic system.
    - The timetable is normally not adapted to them
    - it is left to the dispatchers to handle them in their re-planning procedures.

Conclusion, cont.

- **Operational control and the usability of the timetable, cont.**
  - Sometimes there are intentions in the originally planned timetable not known by train drivers and dispatchers.
    - I.e. information that is necessary in order to take correct replanning actions is lacking in the planned timetable.
  - Train drivers are normally not informed about changes of the actual timetable
    - i.e. changes made by dispatchers due to different perturbations or disturbances.
    - Therefore they cannot adapt their driving to the actual timetable.
  - The train drivers involved in upcoming train meetings seldom have detailed information enough about how to perform them in the best way possible.
    - Train meetings on single track stations are an extremely frequent event in Sweden, whose railway net has only around 20 % double track (or more).

Conclusion, cont.

- **Operational control and the usability of the timetable, cont.**
  - Train drivers in Sweden seem to always drive the trains as fast as possible according to the actual speed limit.
    - This makes trains sometimes running out of its schedule.
    - Concerns above all freight trains.
  - A severe fault is that the trains do not follow their timetable (especially the freight trains). The numbers of freight trains that are carried forward in their timetable channel (plus/minus 5 minutes) are only around 20-30 % of the total number of freight trains.
    - The freight RU's doesn't prioritise running their trains according to the timetable?!

Conclusion, cont.

- **Operational control and the usability of the timetable, cont.**
  - The signalling system (i.e. the control system and the interlocking) in itself is said to often be equipped with "small" faults or "peculiar" behaviours, making them impolite
    - thereby making the operational control even more difficult for the dispatchers.
  - The times in the time-distance diagram ("train graph") used in operational control are truncated (not rounded).
    - Thereby further decreasing the precision in the operational control of the trains.
  - The professional skill varies a lot among the dispatchers and so much that the overall quality of the control process is affected as is the punctuality.
    - Educational problem?!

Conclusion, cont.

- **Operational control and the usability of the timetable, cont.**
  - A general and major problem in the operational process of today is that the actual timetable (RTTT) used exists only in the head of the dispatcher or at best also on the "train graph" in front of her.
    - The RTTT isn´t communicated and almost not possible to communicate to the persons directly involved in the process.
  - A general and major problem in both the timetabling and operational processes is the quality of the information structures and also the quality of the data stored in them.
  - Where Trafikverket has started using modern tools (STEG and CATO) in the operational control process many weaknesses and faults in the timetable have been revealed.
  - The tools and planning procedures used today in the timetabling process are not detailed and accurate enough for a modern, high quality operational control.

Conclusion, cont.

- **Rules and regulations**
  - The planning phase of the timetabling process of today
    - is by far too long and too rigid
    - has some strange rules for prioritisation between different trains
  - thereby creating problems with:
    - overbookings, cancellations, badly adapted train timetables, bookings with the "wrong" type of train etc.
  - The actual timetable of today
    - based on the yearly timetable
  - is in a constant state of deterioration due to
    - the rigidity and sluggishness of the current process
    - the lack of appropriate tools

Conclusion, cont.

- **Rules and regulations cont.**
  - The yearly process and the ad hoc-process are by no means coordinated in an optimal way.
    - Trafikverket receives more requests for slots than they have capacity to inspect.
      - Again a tool-problem.
  - The RU´s only pay for utilised slots and not for every requested slot.

Conclusion, cont.

- **Rules and regulations cont.**
  - The ad hoc-process is not allowing the creation of an – for the actual day – optimal plan
    - new trains have to be adapted to the timetable without any alterations of the trains already in the planned timetable.
  - "Capacity congestion plans" used are too rigid and are "stealing" useful capacity.
  - The cyclic timetables introduced locally creates conflicts
    - between the local trains on one hand and the freight and long distance trains on the other
      - more capacity consuming than non-cyclic ones!
    - This is a complex problem that has to be solved.

Conclusion, cont.

- **Feedback**
  - The accumulated proficiency of train dispatchers and train drivers is not fed back to the timetable construction process to any larger extent.
  - The punctuality data that is stored in the databases may have some small errors due to a couple of sources of error.
  - It is today difficult to analyse the punctuality with the actually used timetables and the actual performance of the trains.

Conclusion, cont.

- **Feedback, cont.**
  - There are some general problems concerning the feedback reported:
  - If there are badly planned trains in the original timetable
    - and an urgent need to make appropriate changes
  - there is often a lack of energy in the organisation and the whole process is experienced as quite sluggish.
  - If a specific problem every day on a particular line or station
    - it often takes months before the corrections of the timetable are finalised
  - There are even trains that, in the same way, year after year are badly planned
    - without any corrections are being made.

Future work

- *Quality of the Timetable*
  - **Enhance the quality of the models and data used in the timetabling process.**
  - **Instate the validation of used data, models, timetables etc. as a standard.**
  - **Introduce structured ways of working with so-called buffer times, running time supplements, and other allowances etc. in the timetabling process.**
  - Start considering the very large seasonal variations in temperature, precipitation (snow) etc. in the timetabling process.
  - The plan as a whole should have specified values for quality measures:
    - capacity utilisation, robustness and resilience, comfort, cost of wear and tear, i.e. maintenance, energy consumption

Future work, cont.

- *Timetabling and its tools*
  - **Introduce modern and appropriate tools**
    - **for running time calculations, simulations and "optimisation" of the timetables.**
  - **Work consistently with the introduction of uniform and appropriate information structures**
    - **in all involved IT systems.**

Future work, cont.

- *Rules and regulations*
  - Create operational rules concerning the dynamic prioritisation between trains that supports an overall effective operational control process.
  - Adapt as far as possible rules and regulations to an overall effective planning and operational control process.
    - And of course also the organisation.

Future work, cont.

- *Operational control and the usability of the timetable*
  - **Make sure that the timetables do contain all information needed by dispatchers and train drivers in the operational process.**
  - **Force the train operating companies to run the trains according to the plan.**
    - **And to make necessary updates of the train characteristics relevant for the re-planning process.**
  - Develop standardised semi-automatic functions for evaluation of accomplishments.

Future work, cont.

- *Feedback*
  - **Involve the accumulated proficiency of train dispatchers and train drivers in the timetable construction process.**
  - **Eliminate the existing imprecisions in the measuring of punctuality.**
  - **Make sure that it is possible to analyse the punctuality with the actually used timetables and the actual performance of the trains.**

Future work, cont.

- *General*
  - Make sure that all information systems are accessible and usable from a train traffic point of view.
  - Avoid "elephantiasis" when developing and introducing new methods and systems.

Den svagaste länken bestämmer kvaliteten i Järnvägssystemet!

Ett modernt, effektivt Järnvägssystem kräver användarvänliga stödverktyg baserade på bra modeller och algoritmer och korrekta indata!