Finland's Maintenance Backlog Programme For Signalling Systems

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SUMMARY

The signalling system renewal project 2016-2019 was historically large by Finnish scale. By this kind of investment, the infrastructure manager can assure a high level of RAMS for years to come. Simultaneously, the Finnish Transport Infrastructure Agency is putting a lot of effort in preventing the maintenance backlog having an impact on the usability of the Finnish railway network. At the same time, the signalling systems are seen as a key part in digitising the railways and thus are in constant need of renewal and modification. The 2016-2019 renewal programme was a great success and now planning is to continue the good work.

1 INTRODUCTION

The Finnish transport network (roads, railways and waterways) has been suffering degradation as a result of decreasing funding for routine annual maintenance. It has been calculated that the maintenance backlog for the Finnish transport network is around EUR 2.5 billion. The reduction of this is ongoing with the programme during 2016-2019. The new government has issued an increase of EUR 100 million for the annual maintenance funding. Simultaneously the government has decided to continue improvement projects. The increasing demand for digitisation is also a strong player for investments.

2 PROGRAMME TO REDUCE MAINTENANCE BACKLOG

In order to reduce the maintenance backlog of the transport network in Finland, additional funding of EUR 600 million was granted for the period 2016-2018. Further funding amounting to approximately EUR 100 million was transferred annually from new transport infrastructure projects to basic renovation of transport systems including private roads between 2017 and 2020. Fig. 1 describes the need for additional funding levels to stop the degradation of the transport network.

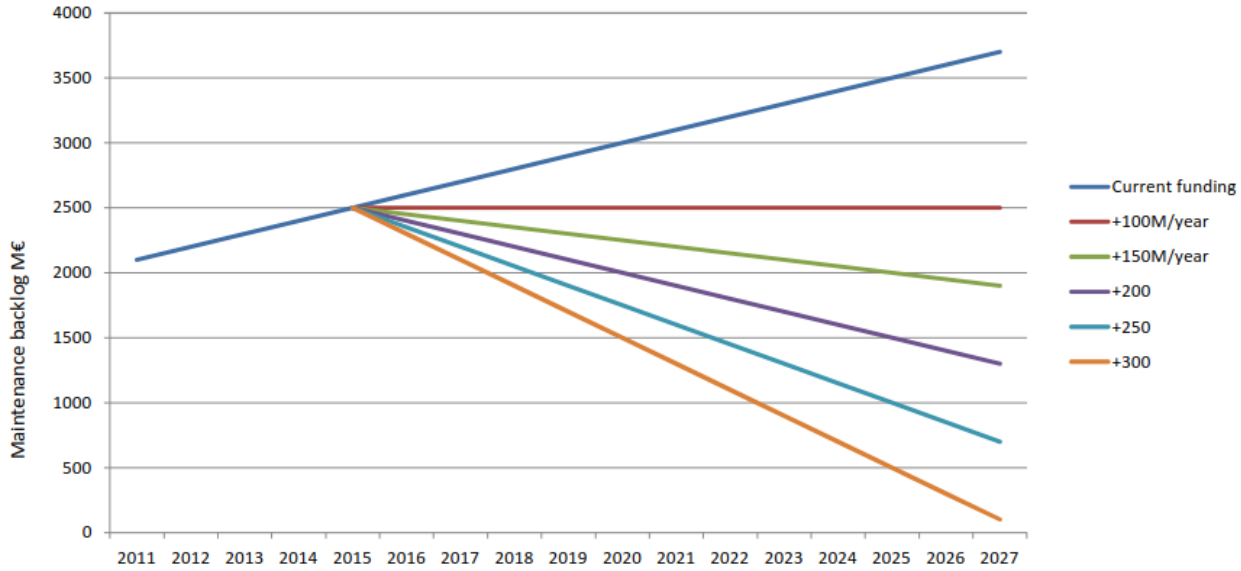

Figure 1: Calculation on how different funding levels reduce the maintenance backlog in Finland (LVM 35/2014)

Around EUR 223 million was granted for railways out of the total of EUR 600 million, in addition to which EUR 101 million from new transport infrastructure projects was designated for the railways.

Great emphasis was on railway signalling systems in the maintenance backlog programme. Altogether, EUR 124.2 million was granted for renewing signalling systems between 2016 and 2020.

3 GENERAL ABOUT FINLAND'S SIGNALLING SYSTEMS

In order to understand the problems of the Finnish signalling system maintenance backlog, here is a short review of Finnish interlocking systems. From Fig. 2 it can be seen that there are many different kinds of interlocking system. In Fig. 2 the different markings show each of the different interlocking models (in total 23 different models, dating from 1960's to 2017). The signalling maintenance is divided into areas in Finland and one area might have several different interlocking models, this makes the asset management and day-to-day maintenance a bit challenging. One of the biggest issues for maintenance is that there are some unique interlocking systems. The knowledge for them is very limited and, because of competition in maintenance, no company wants to invest in training professionals for them, for example for a five-year period of time.

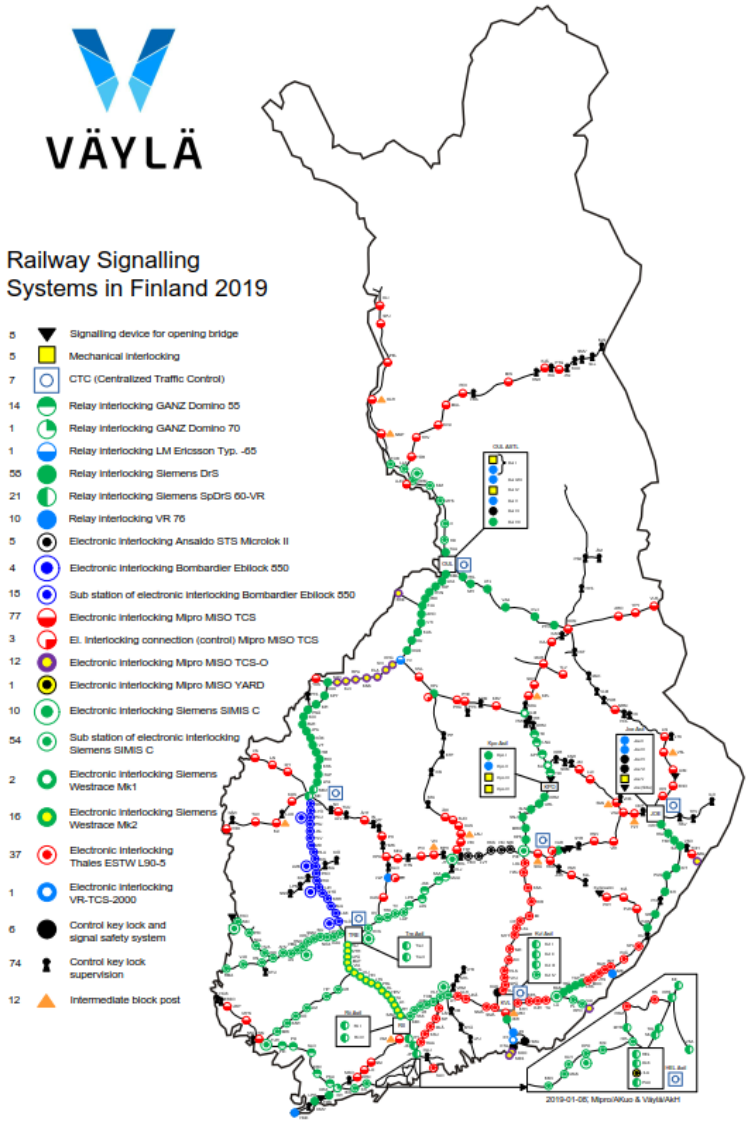

Figure 2: Railway signalling systems in Finland (FTIA material)

Spares and supplier availability are also an issue for maintenance of some of the interlocking systems. If the system life cycle is coming to its end, there may be no production of new equipment to repair the current systems. Also, suppliers are no longer interested in the old systems when it comes to support for maintenance or making changes to functions or track layouts.

The Finnish Transport Infrastructure Agency (FTIA) made a survey regarding the remaining life cycles of Finnish interlocking systems. Fig. 3 describes the situation, where green means that everything is fine for a certain period of time, yellow means that there are going to be some difficulties in getting new spare parts or supplier support and red means that no more spare parts are available and that the supplier does not provide any support for maintenance or modifications. One line stands for one interlocking type.

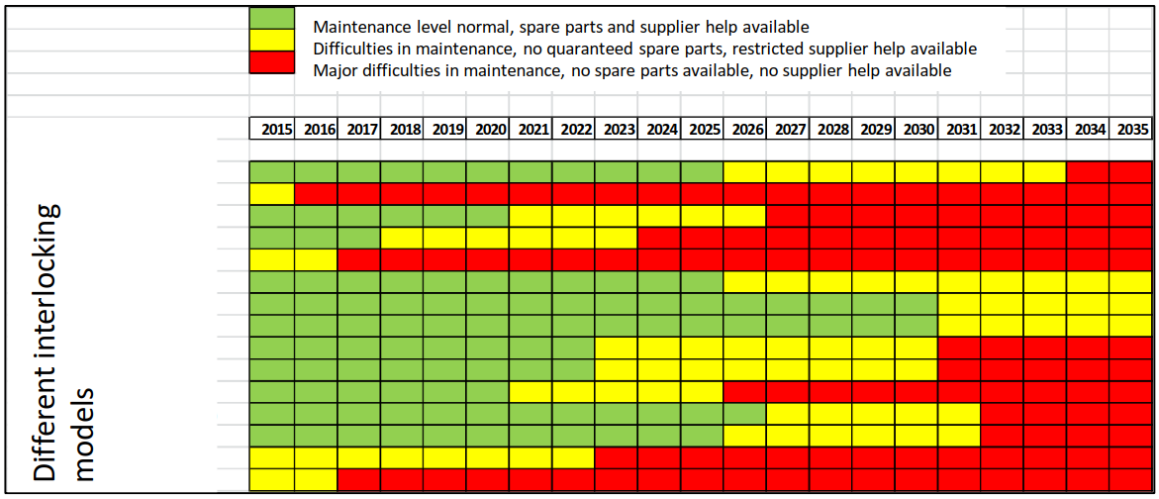

Figure 3: Life cycle estimation of Finnish signalling systems (FTIA material)

Around a third of the interlocking systems are relay-based, and the rest are computer-based from several periods starting from the early 1990s up to 2016. That is not a basis for renewing systems. Some relay interlocking systems are fully functional, have the possibility of being modified and spare parts are available for them, so those still have a long life cycle left. On the other hand, some computer-based interlocking systems are in need of urgent upgrading or renewal.

As Finland's signalling is still based on visual aspects (and will remain so in the near future) we have both bulb and LED–based signal lamps. It is a requirement for newly-built systems to use LEDs, and thus the need for bulbs is decreasing, but still much needed throughout Finland.

4 DIGITISATION

Digitisation is a big thing around the world now. The Finnish railway sector also has a strong desire to digitise for the benefit of railway maintenance. More and more predictive maintenance is required to keep the focus of maintenance personnel on doing the right things at the right time. For that, continuous information is needed from trackside elements to interlocking systems for passage on to higher level ones. Interlockings are a key part of this controlling and monitoring of the outdoor equipment.

In the procurement of the new interlocking systems, the FTIA, as an infrastructure manager, has taken this into account by requiring an easy interface for providing this information to its own systems, where it is forwarded for use by the maintenance contractor.

5 MODERN TRAFFIC MANAGEMENT

Train traffic management is becoming more and more automated. In the past, we used to have dispatchers in every station handling the trains, and later the dispatchers moved to centralised traffic control centres, but were still doing manual work (for example setting the routes), the main difference being that the traffic areas were larger. Nowadays, Finland is moving towards more automated traffic management, where computers control the trains according to train numbers and pre-determined schedules. So, there is no longer any traditional dispatching to be done. As Finland is digitising the higher-level systems at a faster rate all the time, this also sets requirements for the interlocking level. If an interlocking system cannot be modified to make it comply with the requirements set by the digitised new world, it must be renewed at some point.

Another example concerning modern traffic control operations (apart from controlling trains) are track works. In theory, protecting track work could also be automated. Whenever a company wants permission to work trackside, it must submit a reservation request for a certain location. That request is then handled and approved by a coordinator responsible of scheduling track works and train traffic. Once the request has been approved, the system has to generate track blocking or request automatic blocking (within the functional rules of the interlocking system). That will then remove the possibility of human error failing to provide the correct protection of the track work at the right time and in the right location.

Related to ERTMS/ETCS deployment in Finland in the coming years great emphasis is also put to maximise the capacity from the current railway network. The focus is on high level systems related to traffic management but also the potential benefits of ETCS are studied deeply. Bottlenecks are the single track sections in Finland (88% of the network is single track) and on the other hand the capitol area multi track sections and high density of traffic is of the interest on taking the full potential of the network into use.

A fresh study project regarding the ERTMS implementation has been initiated in Finland in the beginning of June 2019. The study looks deeply into capacity needs in different areas. The study project is called Digirail as we look also the TMS level and other digitisation possibilities in addition to ERTMS levels. The main purpose is to define on a need based survey the capacity needs and to define the best possible solution to handle it. During 2019 the project studies the available technologies, different ETCS levels, costs (investment and life cycle) and potential tendering methods. Taking into account the infrastructure and on-board to achieve the Finnish solution as a whole. The proposal shall include an updated Finnish path for implementing ERTMS.

6 RENEWAL PROGRAMME 2016-2019

The locations for the maintenance backlog signalling system renewals 2016-2019 were selected according the survey made by FTIA.

6.1 Locations

The most critical locations were suggested for funding, and out of the original EUR 600 million funding the following were selected:

- Vainikkala yard
- Kotka/Kotolahti and Mussalo yard
- Riihimäki-Tampere main line section

These three with Niirala yard added to them (already decided on before the maintenance backlog funding) have entered service by the end of 2018.

In addition to these, the following received funding from the additional resources for big investments:

- Ylivieska yard
- Kotka/Hovinsaari yard
- CTC Eastern Finland

The two first mentioned are to enter service at latest at the end of 2019. The CTC shall be fully commissioned by the end of 2021.

As the funding was decided in January 2016 for the first three, time became the most important factor for the procurement. The first thing was to arrange market information about the upcoming procurement. It was a great success with participants from more than 15 companies interested in different kinds of tasks related to the projects.

In general, for these projects one procurement was arranged with two parts as follows:

1. Vainikkala, Kotka/Kotolahti and Mussalo and Niirala yards
2. Riihimäki-Tampere main line section

Both procurement parts also included an option. For procurement part one, there was an option for renewing the signalling on the line from Kouvola to Kotka and Hamina, but this option was not ordered. For procurement part two, the option is to renew the signalling on the line from Tampere to Seinäjoki, this option received funding on June 2019 and the project us starting up. The construction works and supplier tests shall be ready by the end of 2021 and commissioning shall take place on summer 2022. One company was only allowed to get one part. The decision was to be made by the winning company and it was required to indicate in its tender which part it would prefer if it were to win in both parts. The locations are shown in the Fig. 4, where the part one locations are

circled in red and part two in blue, solid lines are the areas considering the main contracts and dotted lines are the options..

In addition, the other three projects are ongoing. The new signalling systems in Ylivieska and Kotka/Hovinsaari railway yards are under construction as we speak and shall enter service by the end of 2019. The CTC projct considering the Eastern Finland is under construction also, but shall enter full service by the end of 2021. As these locations are spread all around Finland, FTIA decided to procure this separately.

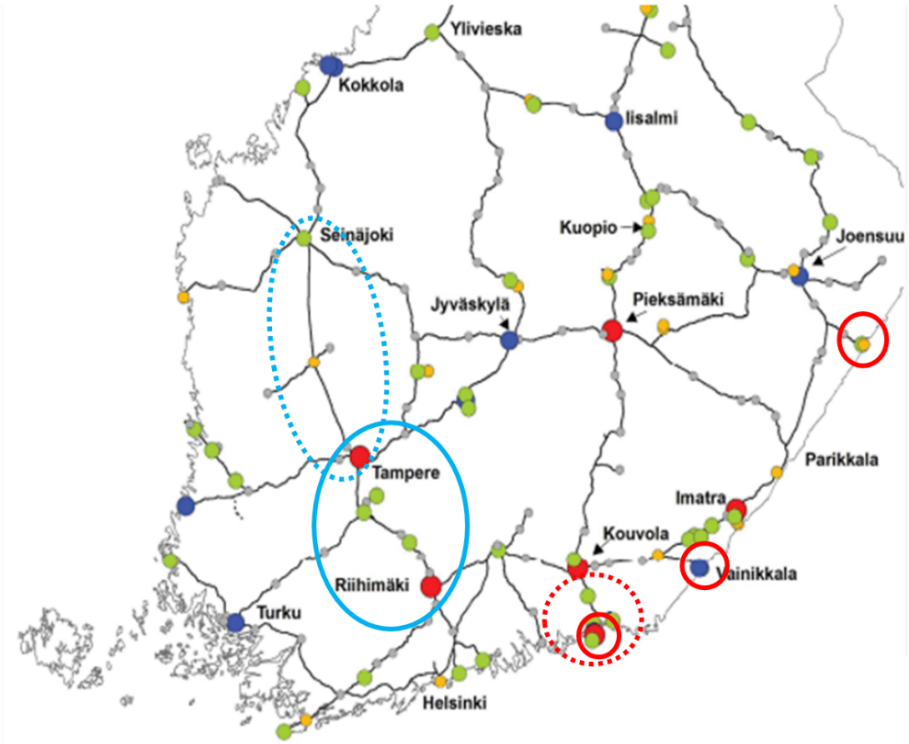

Figure 4: Maintenance backlog decreasing programme signalling locations (FTIA material)

6.2 Very tight schedule

The whole procurement process was carried out during spring 2016. The very busy schedule was as follows:

- 25.2.2016, market info
- 7.3.2016, the public procurement notice was issued
- six applications to tender were received
- 22.4.2016, the invitation to tender was sent to four tenderers.
- 16-19.5.2016, during the tendering period a presentation meeting concerning the invitation to tender was arranged for all tenderers. At that meeting, the FTIA presented the material in the invitation to tender to all tenderers separately. The purpose of that was to make sure that every tenderer understood what the customer wanted.
- 20.6.2016, three offers were received for the procurement part one and four offers for the procurement part two.
- 1.7.2016, the purchase decision was published
- 9.9.2016, contracts signed

This kind of busy schedule sets high demands on both the buyer and the tenderers. In the end, it can be said that there was barely enough time. The quality of all offers was very high, and they were highly comparable. The comparison basis was:

- 40% for quality, divided into:
    - 10% for life cycle control management plan
    - 10% for standard time schedule
    - 20% for a test for key personnel offered
- 60% for price, divided into:
    - Price for basic content
    - Price for option
    - Price for yearly maintenance
    - Price for small and large modification.

6.3 Details about the locations

Procurement part one

Vainikkala:

- Internationally important railway operating location
- One of the most notable railway operating locations on the border between the European Union and Russia
- The only railway operating location on the border between Finland and Russia with regular passenger traffic
- Unique current interlocking system
- More than 30 tracks for mixed main and shunting routes

Kotka, Kotolahti and Mussalo:

- The Kotka railway yard consists of seven parts that form three larger entities in the railway operating location
- The railway operating location of Kotka functions as a stopping point and terminal for passenger traffic and as the harbour's railway yard for freight transport
- Several interlocking systems currently including unique and very old technology
- More than 20 tracks for mixed main and shunting routes

Niirala:

- Railway operating location on the border between Finland and Russia
- Daily freight traffic between Finland and Russia
- 15-track railway yard for mixed main and shunting routes
- Currently very old technology

Option Kouvola-Kotka/Hamina line:

- 35 km double-track line and 36 km single-track line
- Freight and passenger traffic
- Mixed interlocking base currently

Procurement part two

Riihimäki-Tampere line:

- 110 km double-track railway section
- Two larger stations (maximum ten tracks)
- Main railway route in Finland with heavy mixed traffic of freight and passengers
- Interlocking equipment of the railway yards of Riihimäki and Tampere is not included
- Relay interlocking are the technical interface in Riihimäki and Tampere

Tampere-Seinäjoki line:

- 160 km single-track line
- Tampere and Seinäjoki not included
- Important corridor for passenger traffic from south to north
- Old computer interlocking interface in Tampere
- Relay interlocking interface in Seinäjoki

Other three locations

Ylivieska:

- Railway operating location with East/West-North/South crossing traffic
- 15-track railway yard for mixed main and shunting routes
- Currently old and obsolete technology

Kotka/Hovinsaari:

- Busy harbour traffic from Port of Kotka
- more than 20 tracks mainly for shunting routes
- Currently mixed old and obsolete technology or no system at all

CTC Eastern Finland:

- Roughly 1/4 of Finnish railway network operated
- New train number based automation
- Currently no CTC system but centralized dispatching with overlaid automation functions

7 REQUIREMENTS

The FTIA has a collection of requirements called “The Finnish interlocking requirements” (FIR). The FIR includes technical, functional, operational and Reliability, Availability, Maintainability and Safety (RAMS) requirements combining over 4500 items. These are fulfilled with project-related requirements such as design documents, including track layouts, route tables and other functional and operational designs.

A basic high-level requirement in Finland is that if there are main routes included all system functions must fulfil SIL4. The maintainability of the signalling system and availability of spare parts must be assured for at least 25 years.

More detailed requirements include country-specific functions, such as visible signal pattern and aspects and how to generate a route and what the monitoring conditions are. In addition, requirements for shunting work are included in the FIR basically containing operation with buttons outdoor inside a specific local operating area for setting shunting routes.

RAMS requirements are more or less adopted straight forward from the Euro-interlocking documentation with only minor parameter settings done in Finland.

8 BUYERS’ CONTRIBUTION

The FTIA has a strong willingness to contribute to suppliers’ work to achieve all these requirements. For example, the buyer arranged preliminary factory acceptance testing where Finnish interlocking specialists were sent to suppliers’ premises to help interpret the requirements. This has been found out to be a very beneficial way of working. The supplier can show the experts from a demonstration operating panel if their interpretation is correct or not. There is also an opportunity for the experts to point out the usual hard parts by experience before the software is frozen for some release.

In the maintenance backlog projects, the supplier sits at the same table as the final construction designer. The benefit from this is quite major, for example when designing cable routes and final layouts for equipment rooms.

Through these buyers’ activities, the FTIA wants to make sure that no difficult surprises will occur later on during the system build-up phase or, even worse, during commissioning.

In general, in these projects the FTIA wanted to create an atmosphere in which we can work together towards the same goal. The management of the whole project is as open as possible when working under the contract. In this way, decision-making is not too heavy and remains flexible.

9 FUTURE PLANS

The FTIA takes the maintenance backlog problem very seriously and is working on preventive matters. One very important step is to start educating the people working on signalling systems. Brand new educational facilities were opened for all track work and maintenance works in Finland 2017. A strong focus is on signalling systems. Education is planned and controlled by the infrastructure manager (FTIA). That leads also to better understanding of the current systems and by that to wider range of experts working on modification projects. There is a whole hall for various types of interlockings and different kinds of outdoor installation setups. The focus is on installation works but also other kinds of specialist training is available.

Digitisation will be used to steer the maintenance work to be more preventive rather than reactive. The interlocking and CTC systems play key roles in that, as they are the interface between the equipment and maintenance. There are several improvement projects going on which using applications and available data from the signalling systems is to be taken into use to help the process of planning maintenance.

For example, with these the FTIA wants to be in a position in future where at least for signalling systems the maintenance backlog would not be so big. That is also a huge cost-driver with less need for large investments and more focus on sustainable maintenance of current equipment.

FTIA is currently updating the national implementation plan for ERTMS/ETCS. This work considers also deeper studies on capacity improvement as a whole in the network, the focus being in the commuter traffic in capitol area. One very important topic inside the work is interlocking renewals as not all interlockings in Finland are compliant with demands of next generation traffic management and ETCS.

FTIA has also plans for yet another maintenance backlog programme for signalling systems. Obsolescence and lack of expertise is still a problem and without actions will be a big problem when we enter 2030's.

10 CONCLUSION

The signalling system renewal programme was a great success during 2016-2018 and 2019 seems to continue that trend. The programme came just in time as some of the systems were unarguably at the very end of their lifecycle. The important lessons learnt is that even in an extremely tight schedules it is possible to push through quite large signalling projects. The key is making things together in a large scale, taking the suppliers to the same table with the buyer and designer and giving the opportunity to influence. A good spirit, where all parties have the same goal in the project, leads to great success. The buyers' role is to enable the good spirit by looking for the best possible solution all the time rather than strictly complying with the contracts, the end result pay back in money and quality.

Two drivers exists for further renewal, digitisation and obsolescence. The new digital environment specially concerning the traffic management level and the coming of ERTMS/ETCS sets new requirements for the signalling systems. The obsolescence and lack of knowledge demands actions related to education and investments. These are the issues regarding the Finnish signalling system scene when entering the 2030's.

The decision-making atmosphere in Finland has changed a bit during recent years. We are no looking for a long term planning and signalling is playing a key role. At the moment there around EUR 200 million has been granted for more signalling system renewals. With these investments we are already looking for the future tackling the coming maintenance backlog and capacity needs. The next big decision shall be the ERTMS roll-out plan which the survey project is looking at the moment. At the moment we are looking on roughly a 20 year roll-out plan starting in two-three years time. A pilot line has been decided and it shall be built with both ATP and ETCS. Both because we want to gather experience on ETCS for the future roll-out. Most probably the decision shall be that the pilot line contains ETCS level 1 and 2 to get as much experience on technology and implementation as possible.

In general the current government is looking to improve railway infrastructure quite heavily to fulfil ambition for more environmental way of transportation. Strong will is to increase the share of passengers and cargo on railways. This needs actions on increasing the capacity on busiest passenger lines and setting up more dedicated track for cargo trains. Also the share of electrified lines shall be increased to make cargo logistics on railways easier and more competitive in the near future.

11 REFERENCES

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