Government Offices of Sweden

Memorandum

28 June 2017
N2017/02421/TIF

Ministry of Enterprise and Innovation

Swedish National Implementation Plan - Regarding obligations concerning fulfilment of TSI-CCS (2016/919/EU)

General context description Swedish railway

Sweden has around 14 100 km trafficked railway, whereof the majority is single track (around 9 100 km) and electrified (around 12 300 km). Around 9 800 km are equipped with ATC, Sweden´s current class B system. Currently Sweden has around 780 interlocks, 35 000 ATC balis groups, 15 000 switches and train detection is done with track circuits. The governance of the Swedish rail network is mainly done by the Swedish Transport Administration. The railway undertaking is highly privatized for both passenger and freight traffic with around 40 operators.

Technical transition strategy

Sweden has chosen dual on board strategy since it is more cost efficient from a socio economic perspective.

Open market conditions

Sweden has ensured open market conditions for its legacy Class B train protection system by taking an active part in developing a STM. The STM is now available at the open market.

Cost Benefit Analysis of ETCS implementation

The CBA can be found in **annex 1**.

Planning

The Swedish planning horizon for infrastructure investments is 12 years. The plan is updated every 4 years. Consequently, the plan for ERTMS implementation is divided into different sections.

- The current national infrastructure plan cover 2014–2025.
- The upcoming national infrastructure plan cover 2018–29 is currently under political discussion to be firmly decided early 2018.
- For the period after 2029: Under political discussion to be firmly decided during next planning process.

The full planning including dates for ETCS deployment, decommission of Class B system and ETCS-only operation, can be found in **annex 2**.

Annex 1: CBA Swedish ETCS implementation

Background

The current signaling equipment in Sweden is old, heterogenic and based on outdated relay technology. The majority of the equipment will have reached its economic life time within the upcoming 15 years. Consequently, Sweden has decided to reinvest the current equipment during the upcoming 17 years. More specifically, the current signaling equipment architecture of around 780 interlocks will be reinvested into an architecture of around 160 standardized, modern, computerized interlocks placed in clusters. This reinvestment will be an important step in taking Swedish railway into the digital era and lead to great benefits. Standardized, computerized interlocks enables features such as increased surveillance and predictive maintenance. Standardization streamlines the demands for spare parts as well as competence for maintenance personal. Furthermore, the minimization and cluster position of interlocks will, as well, improve the maintainability.

The reinvestment and changes in architecture described above is a necessity for the future competitiveness and cost efficiency of the Swedish railway industry. Hence, these changes will take place regardless of train protection system and is therefore a fixed condition for all scenarios in this analysis.

Scope of CBA

The scope of this CBA analysis is to compare class A (ERTMS) with current class B system (ATC) on the entire Swedish network. It shall be noted that this CBA only intend to compare evaluate choice of train protection system. Not choice of hardware. Furthermore, the scope is limited to the current network, future lines are excluded.

Scenarios

Two scenarios will be compared. Scenario 1, ETCS implementation according to plan and scenario 2, maintain current class B system for the rest of its remaining lifetime. Due to current market conditions, ATC is estimated to reach end of life in the year of 2035. The scenarios are described below.

Scenario 1: ETCS implementation according to plan

- In between 2021 and 2035 around 780 interlocks will be re-invested into around 160 modern computerized interlocks equipped with ERTMS technology
- Deployment according to the dates handed in the National Implementation Plan (core network equipped by 2030).
- Current class B system will be completely phased out in 2035
- All vehicles will be equipped with ETCS by 2027,

Scenario 2: Maintain current class B system for the rest of its remaining lifetime

- In between 2021 and 2035 around 780 interlocks will be re-invested into around 160 modern computerized interlocks equipped with ATC technology (current class B system)
- Core network will not be ERTMS-equipped by 2030
- End of life for current class B system is estimated to 2035, thereafter the network will be converted to ERTMS. Current class B system will be phased out in 2041,
- Only cross boarder traffic and new vehicles will be equipped with ETCS before 2027.

Time frame

Costs and benefits are quantified up until the year of 2041. After 2041 costs and benefits will be equal for both scenarios.

Cost

Cost signaling equipment

In both scenarios a re-investment in around 162 interlocks will occur in between 2021 and 2035. This cost is estimated by an average cost per signaling object and is the same whether the equipment is installed with ERTMS technology or ATC technology.

Since the reinvestment in equipment is the same in both scenarios, the rest economic value is the same in both scenarios.

Reinvestment cost	
Scenario 1	26.2 bn SEK
Scenario 2	26.2 bn SEK

Market conditions

In scenario 2 Sweden will be the only customer of its current class B system. This system will be sold on a monopoly like market. This is not the case for scenario 1 since ERTMS is sold on a larger market with a higher level of competition. Consequently a 10 % cost increased is assumed for the scenario 2 starting from 2024.

Additional cost due to market conditions	
Scenario 1	0 bn SEK
Scenario 2	1.8 bn SEK

Conversion costs

When end of life for current class B system occurs at 2035 the Swedish network will be converted to ERTMS. The conversion cost is estimated to 40 % of the cost for the re-investment in signaling equipment described in chapter "Cost signaling equipment" and takes place in 2036-2041.

Conversion cost	
Scenario 1	0 bn SEK
Scenario 2	10,5 bn SEK

Onboard cost.

In Scenario 1 all vehicles will be equipped by the year of 2027. This is based on the assumption that all vehicles need to be equipped before the core network is converted. Adjustment have been made for already equipped vehicles, natural renewing of vehicle and the assumption that all new vehicles will be ETCS equipped in accordance to EU-legislation. Consequently 57 % out of the current fleet will be retrofitted.

In scenario 2 cross boarder traffic will be equipped in between 2020 and 2022 (12 % of total fleet). In between 2027 and 2035 remaining vehicles without ETCS will be converted. In total, 25 % out of the current fleet will be retrofitted.

On board cost	Year 2018-2035
Scenario 1	3.5 bn SEK
Scenario 2	2.3 bn SEK

Operating and maintenance cost

The operating and maintenance cost is likely to decrease in scenario 1. This is based on the total number of errors per system and number of objects per system. However, this cost has not been quantified.

Total cost

The total cost is summarized and discounted to net present value for the year of 2020 and calculated with a 1.3 tax factor according to the Swedish Transport Administration´s standard methods.

	Total cost	Net present value
Total cost scenario 1	29.7 bn SEK	30.3 bn SEK
Total cost scenario 2	40.8 bn SEK	37.8 bn SEK

Benefits

Capacity

Capacity simulations show that there will be no significant differences in between ERTMS and current ATC once the signaling equipment has been renovated for both scenarios. Since the same reinvestment in signaling equipment takes place in both scenarios, the same turning measures for increased capacity can be made in both cases to an equivalent cost. Consequently, the difference in between the two scenarios is zero.

Safety

Both scenarios have a high level of safety. Additional safety benefits may be possible in scenario 1 since ERTMS, unlike ATC, is a continuous system and correspond to CENELEC standards. However, these benefits are deemed to be small and has not been quantified. Consequently, the difference in between the scenarios is zero.

Reliability performance

The reliability performance has been valued by measuring delayed minutes for each system. The method used is big data analysis on statistic from current ATC equipped lines and current ERTMS pilot lines. Statistical delayed minutes for each system has been divided with the total amount of train kilometres for each system in order to adjust for different amount of traffic on different lanes. Thereafter, the number of delayed minutes per train kilometre for each system has been scaled up for the entire network and valued according to Swedish CBA standard methods and discounted to net present value for the year of 2020.

	Reliability performance, net present value
Scenario 1	3.9 bn SEK
Scenario 2	1.0 bn SEK

Other benefits

A number of other benefits are assumed result from ERTMS implementation. Due to inadequate models for measuring and valuing these effects they have not been quantified. The most important of these benefits are:

- Standardization: standardization of components, regulation and technology leading to innovation and lower cost is assumed to occur within ERTMS but not with ATC
- Interoperability benefits: With ERTMS leasing of vehicles over borders will be possible, which would generate a better opportunity for fleet optimization.

Socio-economic result

It shall be noted that this is not a traditional CBA. Resulting from the current state and large reinvestment need of the signaling equipment in Sweden there is no "do nothing option" regardless of signaling system in place. Consequently, there is no NPV ratio and scenario 1 can only be view in comparison with scenario 2.

When comparing the two scenarios it is evident that scenario 1 is the better option from both a cost perspective, a benefit perspective and a total social economical perspective. In comparison to the alternative, ETCS implementation is 10.5 billion SEK less expensive.

	Total cost	Total benefits	Result
Scenario 1	-30.3 bn SEK	3.9 bn SEK	-26.3 bn SEK
Scenario 2	-37.8 bn SEK	1.0 bn SEK	-36.8 bn SEK

Annex 2 – Implementation of TENtec lines – according to map structure

(http://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/map/maps.html?layer=input_1,20,21&country=SE)

Different lines of the network	Start		End		Possible to operate with ETCS&STM	First ETCS implementation	Last ETCS implementation
Boden-Riksgränsen	Boden	(Bdn)	Riksgränsen	Rgn	2017	2021	2023
Boden-Luleå	Boden	Bud-Bdn/Bds	Luleå	Le	2017	2023	2023
Boden-Kalix	Buddbyn	(Bud)	Kalix	Klx	2017	2013	2013
Kalix-Haparanda (TornioRaja)	Kalix	(Klx)	Haparanda (TornioRaja)	Hp	2017	2013	2013
Umeå-Luleå	Umeå	(Uå)	Luleå	(Le)	TBD	TBD	TBD
Sundsvall-Umeå	Sundsvall	(Suc)	Umeå	Uå	2017	2010	2026
Soderhamn-Sundsvall	Söderhamn	(Shv)	Sundsvall	Suc	2017	2028	2028
Gavle-Soderhamn	Gävle	Gä	Söderhamn	Shv	2017	2028	2028
Kilafors-Soderhamn	Kilafors	Kls	Söderhamn	(Shv)	2017	2030	2030
Ockelbo-Kilafors	Ockelbo	Ob	Kilafors	(Kls)	2017	2030	2030
Hallsberg-Ockelbo	Hallsberg passagerarbangård	(Hpbg)	Ockelbo	(Ob)	2017	2028	2030
Gävle-Stockholm	Gävle	(Gä)	Stockholm-Ulriksdal	(Udl)	2017	2028	2029
Stockholm-Stockholm *	Stockholm-Ulriksdal	Udl	Stockholm-Älvsjö	Äs	2017	2029	2030
Stockholm-Järna (Part 1)	Stockholm-Älvsjö	(Äs)	Järna	Jn	2017	2025	2025
Järna-Åby	Järna	(Jn)	Åby	Åby	2017	2025	2025
Åby-Linköping	Åby	(Åby)	Linköping	Lp	2017	2024	2024
Linköping-Mjölby	Linköping	(Lp)	Mjölby	My	2017	2024	2024
Järna-Katrineholm	Järna	Jn	Katrineholm	K	2017	2024	2025
Katrineholm-Hallsberg	Katrineholm	(K)	Hallsberg passagerarbangård	(Hpbg)	2017	2024	2024
Hallsberg-Mjölby (Part 2)	Hallsberg passagerarbangård	Hpbg-Skms/Öj	Mjölby	(My)	2017	2025	2025
Hallsberg-Laxå	Hallsberg-Östansjö	(Öj)	Laxå	Lå	2017	2029	2029
Laxå-Karlstad	Laxå	(Lå)	Karlstad	Ks	2017	2030	2030
Charlottenberg-Karlstad	Charlottenberg	Cggr	Karlstad	(Ks)	2017	2030	2030
Laxå-Göteborg	Laxå	(Lå)	Göteborg Olskroken	(Or)	2017	2027	2029
Mjölby-Malmö	Mjölby	(My)	Lund	Lu	2017	2023	2025
Ed-Kornsjö	Ed	Ed	Kornsjö-gränsen	Ko	2017	2026	2026
Göteborg-Ed	Göteborg Marieholm	(Gbm)	Ed	(Ed)	2017	2026	2027
Göteborg-Göteborg (Västlänken part 2)	Göteborg olskroken	G-Or/Gbm/(Am)	Göteborg Almedal	(Am)	2017	2027	2027
Göteborg-Göteborg (Västlänken part 1)	Göteborg	(G)	Göteborg Almedal	(Am)	2017	2027	2027
Göteborg-Göteborg (Örgryte)	Göteborg Gubbero	Gro	Göteborg Almedal	Am	2017	2027	2027
Göteborg-Ängelholm	Göteborg Almedal	(Am)	Ängelholm	Ä	2017	2026	2027
Ängelholm-Arlöv (Part 1)	Ängelholm	Ä	Kävlinge	(Kg)	2017	2026	2027
Ängelholm-Arlöv (Part 2)	Kävlinge	(Kg)	Arlöv	(Al)	2017	2026	2026
Ängelholm-Helsingborg	Ängelholm	(Ä)	Helsningborg	Hb	2017	2027	2027
Helsingborg-Lund (Part 1)	Helsingborg	(Hb)	Kävlinge	(Kg)	2017	2026	2027
Helsingborg-Lund (Part 2)	Kävlinge	Kg	Kävlinge	Kg	2017	2026	2026
Helsingborg-Lund (Part 3)	Kävlinge	(Kg)	Lund	(Lu)	2017	2024	2024
Lund-Malmö (Part 1)	Lund	(Lu)	Arlöv	(Al)	2017	2024	2024
Lund-Malmö (Part 2)	Arlöv	Al	Arlöv	Al	2017	2023	2023
Malmö-Border DK_S	Malmö	M	Lernacken	Lnk	2017	2023	2023
Border DK_S-Fosieby	Lernacken	(Lnk)	Svågertorp	Stp	2017	2023	2023
Malmö-Fosieby	Malmö-Östervärn	Övn	Fosieby	Fsb/Lrp-(Stp)	2017	2023	2023
Fosieby-Lockarp	Fosieby	(Fsb)	Lockarp	(Lrp)	2017	2023	2023
Trelleborg-Lockarp	Trelleborg	Trg	Lockarp	(Lrp)	2017	2027	2027
Stockholm-Jönköping (part 2)	Stockholm-Karlberg	Ke	Järna	Jn	TBD	TBD	TBD
Stockholm-Jönköping (part 1)	Järna	Jn	Åby	Åby	2028	2028	2028
Åby-Linköping (high speed)	Åby	Åby	Linköping	Lp	2028	2028	2028
Rest on the network in SE					2017	2031	2035

** This line is not part of the TENtec map structure.*

TBD, These lines are currently not part of the National Infrastructure Plan in Sweden