Ministry of Infrastructure and the Environment

Railway map ERTMS

Version 2.0 – State of play regarding research in the Exploratory Phase

Contents

Management summary

In February 2013, the Railway map ERTMS version 1.0[1] heralded the Start Decision for the ERTMS[2] project. The Exploratory Phase thus began. The Start Decision formulated research questions that have to be answered before an appropriately founded implementation scenario can be drawn up. This Railway map version 2.0 sets out the results of the investigations that have been carried out thus far in order to, ultimately, move towards a phased implementation of ERTMS in the Netherlands from 2016 onwards. The next stage of research and phasing will also be reviewed.

ERTMS has been allocated Major Project[3] status by the House of Representatives. This goes without saying, given the scope, complexity and the ICT components within the project. For each choice in the process, there is a field of tension between opportunities offered by infrastructure, rolling stock and train protection systems. So far, the project has been under the leadership of the Ministry of Infrastructure and the Environment (IenM), in close consultation with ProRail and NS and with cooperation from stakeholders (including unions, passenger organisations, other train operators, decentralised authorities) and market parties. A major project such as ERTMS requires the ongoing involvement of stakeholders and market parties and excellent project organisation and management in order to end up with a sound implementation strategy. This is confirmed by the Major Project Status. The corresponding governance for the subsequent phase is currently being elaborated.

The current train protection system is set to be replaced in the coming years and decades. Alongside safety and interoperability, replacement by the European developed safety and traffic management railway system, ERTMS, also offers potential gains in terms of capacity, speed and reliability.

Research in the Exploratory Phase
In order to be able to make decisions about ERTMS, two lines of research were initiated in the Exploratory Phase. On the one hand, research has been conducted in order to gain more factual information about ERTMS opportunities. On the other, research has been conducted in order to create a 'funnelling' process and end up with a scenario for the implementation of ERTMS in the Netherlands. The expertise that is gained within both lines will used in an interchangeable fashion. Further research is currently being conducted.

Research line 1: Factual research: what we know and what we don't yet know
In order to develop expertise regarding ERTMS, a Knowledge Book version 1.0 has been drawn up by the various Railway map parties; this is a factual description of the current state of play/parties' expertise with respect to ERTMS opportunities. The research has shown that a well-thought-through implementation of ERTMS could contribute towards a transition (system leap) in terms of the objectives that have been set (safety, interoperability, capacity, speed and reliability). This means that safety levels for passengers and railway workers would be increased on and around the railways, that the railways can be used more intensively, that cross-border traffic becomes easier and that reliability increases. All of this does, however, require a number of important points undergoing further investigation and additional experience with ERTMS being accumulated.

[1] Parliamentary documents II, meeting year 2012-2013, 29984 nr. 385

[2] European Rail Traffic Management System

[3] Parliamentary documents II, meeting year 2012-2013, 33652 nr. 1 and Processes TK 2012-2013 nr. 93-13, see also annex D.

The Knowledge Book version 1.0 also highlights issues that are, as yet, insufficiently clear and areas that need developing. Further research will be conducted into the gaps in knowledge. The market for product development will also be reviewed. The need for additional expertise concerns:

- the extent to which ERTMS can lead to capacity gains;
- the required GSM-R communication for national implementation (including sidings) and the development thereof;
- options for using ERTMS on sidings (including migration);
- insight into market developments in costs and technical solutions within the various ERTMS formats;
- the necessary developments (and feasibility and duration) in ERTMS Level 3;
- learning experiences with respect to system integration. What can and/or must this role involve and how can it be fulfilled?

In the recent past, ERTMS has developed extensively and further developments will continue in the coming years given the huge number of projects that are underway in Europe and across the world. These developments and projects were charted within the Maturity Study and must be closely monitored in relation to the issues that remain outstanding.

Expertise about ERTMS is not limited to the Railway map parties and that is also why a great deal of attention will be paid to consultations with stakeholders and market parties. The Knowledge Book will also be shared with these parties in order to ensure it is as comprehensive as possible. The approach to research and the result of studies, as well as any involvement, will also be discussed with stakeholders.

The Knowledge Book is intended to be a dynamic document and will be supplemented over time with insights from other investigations and information from (discussions with) stakeholders and market parties. They have been invited to put forward their suggestions for improvements/additions to the Knowledge Book.

Research line 2: Research in order to draw up implementation scenarios

Alongside the expertise line, in accordance with the MIRT[4] system, work is also taking place on investigating implementation scenarios using an 'outline to detail' method. Two of the three research phases that are necessary in order to come up with a preference scenario have now been completed.

A start has been made on determining the playing field in relation to realistic scenarios. In order to be able to draw up the Memorandum on Scope and Level of Detail (NRD) which traditionally starts the funnelling process in the MIRT system, work sessions have been held with various freight and passenger train operators and ProRail. The problem analysis, the scope, the current situation and the European obligations can then be defined. The latter two form the basis for the 0 scenario. The NRD also encompasses the main points of a scope of considerations which is used to compare the scenarios with one another. The NRD assumes a transition (system leap) with respect to all of the objectives for ERTMS.

The playing field is determined on the basis of extreme final visions. More realistic final visions are then determined as a result of adding certain limitations. A logical combination of final visions for ERTMS in 2030 (what and where) and migration paths that lead to these (when and how) has enabled the NRD to come up with 16 possible scenarios alongside the 0 scenario. The year 2030 was selected because this is the year in which obligations have been set within the context of the European TEN-T directive in terms of equipping a number of cross-border railway corridors with ERTMS. Two corridors also have to be fitted[5] with ERTMS by 2020.

The Hanzelijn is equipped with ERTMS and the current safety system ATB.

The 16 possible scenarios from the NRD form the starting point for more quantitative research in the second step of the funnelling process. This involves the Memorandum on Favourable Scenarios (NKS) and the quick scan Social Cost and Benefit Analysis (qsMKBA). With assistance from ProRail and NS, costs, effects and benefits from 13 focus scenarios have been estimated for the purposes of a comparison. This context encompasses 2 basic scenarios (no ERTMS but some investment in the current system and no ERTMS and extra investment in the current system), 2 0 scenarios (only ERTMS Level 1, or Level 2 as overlay on the current system on the mandatory corridors so that non-cross-border rolling stock does not have to be converted to ERTMS) and 9 scenarios for the broader implementation of ERTMS in the Netherlands. For these 9 scenarios, it was decided that ongoing calculations were only worthwhile for ERTMS Level 2. A transition (system leap) was not achievable with ERTMS Level 1.

An important conclusion from the quantitative analysis is that a logical 0 scenario involves equipping the mandatory corridors with ERTMS Level 1 Overlay. Furthermore, it became clear that the most important cost-drivers for all levels were cabling and, for Levels 2 and 3 (once this is available), new interlockings. Savings on life-cycle costs can be made with Level 3 because fewer elements are required in the track. Benefits and costs are roughly similar in all of the selected scenarios, according to the qsMKBA. Level 2/Level 2+ have the highest costs compared to Level 1, particularly with respect to busy track sections. Level 2 also has the highest investment costs but Level 1 has limited benefits. Finally, Level 1 offers virtually neutral results on the segment of regional lines compared to ATB-NG. Level 2 also seems to offer very limited extra benefits in this regard, considering the additional costs. This will be further investigated in follow-up research.

[4] Multi-Year Programme for Infrastructure, Spatial Planning and Transport

[5] European Deployment Plan(EDP) ERTMS 2009/561/EC, TEN-T directive 2011/0294

Follow-up research
The funnelling approach applied via the NRD, NKS and qsMKBA is currently being checked for plausibility and robustness. The various studies have clarified where additional expertise must be gained. This will take place via additional research. This additional research will partially be conducted during the third step of the funnelling process. In the coming period, the following favourable scenarios, which were selected on the basis of the NKS and the qsMKBA, will therefore be investigated in more depth in terms of costs, benefits and risks in the Memorandum on Alternatives:

- 0 scenario with ERTMS Level 1 Overlay on Trans European Network-Transport-corridors;
- a scenario 1 with ERTMS Level 2 on TEN-T-corridors and PHS lines;
- a scenario 2 with ERTMS Level 2 on the Main Railway Network (HRN);
- a scenario 3 with ERTMS Level 2 nationally;
- a review of the options offered by a Level 2+ scenario and a mixed scenario of Level 1 and Level 2.

It will take at least 10 years to implement ERTMS. The system will undergo further development in the meantime. It is important to pay continuous attention to the field of tension between 'proven technology' on the one hand and new developments on the other. The project must encompass the appropriate degree of focus in this context. Recently, ProRail and other market parties have successfully conducted a 'proof of concept' on Level 3 and established points for development as a result. Level 3 is not yet a stable or proven product, whereas Level 2 is.

The favourable scenarios are currently being further elaborated and investigated in the Memorandum on Alternatives in which further attention is being paid to issues such as possible capacity effects, business cases and the risk profiles for the above scenarios. The Memorandum on Alternatives will also provide further insight into the costs for the scenarios. The Memorandum on Alternatives must offer sufficient and sound decision-making information in order to facilitate a Preference decision being made for an implementation scenario, including a fixed budget.

Preference decision and Plan elaboration phase
After the Railway map version 2.0 there will follow a Railway map ERTMS version 3.0 (in this case, the Memorandum on Alternatives) on the basis of which a Preference decision will be made for the implementation of ERTMS. Many of the dilemmas must be answered.
In the phase after the Preference decision, under the direction of the ministry, an integrated implementation plan will be developed for the implementation of ERTMS in rolling stock and infrastructure on the basis of the selected preference scenario. In addition, this phase will encompass the selection of the tendering strategy, preparation of the tender(s) and the elaboration of plans for including ERTMS in the company processes of the Railway map parties. An important point for attention herein is system integration under the leadership of a system integrator for the purposes of creating a functioning railway system.

1 Introduction

This Railway map ERTMS version 2.0 'State of Affairs with regard to results of research conducted during the Exploratory Phase', which further builds upon the Railway map ERTMS version 1.0 'Start Decision', looks in more detail at the results of research required in order to make a well-founded decision regarding the implementation of the train protection and traffic management system ERTMS (European Rail Traffic Management System). Railway map 2.0 explains the results that have so far been gained as a result of research conducted since Railway map 1.0.

The interim step within Railway map 2.0 – between Railway map 1.0 and the Preference decision – has been incorporated in order to discuss the factual information in Railway map 2.0 with the House of Representatives and the stakeholders and market parties concerned. This will allow any relevant considerations and concerns to be included in the following go/no go moment in the MIRT system and avoid any irreversible steps being taken. This conforms to the desire expressed by the House in the Points of Departure Memorandum ERTMS[6]. It also fits into the chosen approach to the project, whereby interim steps, such as the Railway map 2.0, but also the approach to Railway map 1.0, are discussed with stakeholders and market parties in a manner that is as transparent as possible. The research in the Preference decision primarily focussed on collating facts in order to use them as information in order to make a well-founded Preference decision. This has taken place via layered research that takes an outline-to-detail approach. Alongside the quest for answers, the Preference decision is largely characterised by identifying which questions, uncertainties, 'grey areas' and risks must be answered and/or managed in order to end up with a justified Preference decision and then be able to set up the Plan elaboration phase.

This Railway map 2.0 presents the most recent state of play, from research from the Exploratory Phase to the implementation of ERTMS. These studies fall under the leadership of IenM and have been realised in collaboration with ProRail and NS. Other stakeholders and market parties were involved via individual discussions and general meetings in the period April-November 2013.

This document is structured as follows. After a short review of Railway map 1.0, there is a discussion of the objectives and process approach, followed by an overview of the results of the research and reports in which this has been processed. A distinction will be made between research into facts relating to ERTMS, charting the possible implementation scenarios and the application of a funnelling process on the basis of an evaluation framework and cost/benefit analyses to end up with a number of favourable scenarios that will be further investigated in the coming period. The final chapters examine the risks and process requirements which must be taken into account for the Preference decision or the directional decision in the first quarter of 2014 and will close with a look towards the Plan elaboration phase that is to follow thereafter.

Provocation

The Temporary Maintenance and Innovation for Rail committee (Kuiken committee), the House of Representatives, the Cabinet and the railway sector believe that ERTMS offers opportunities for the future. The Cabinet took the in-principle decision to implement ERTMS[7] on 8 June 2012.

[6] 2013Z15291/2013D33539

[7] 7 Parliamentary documents II, meeting year 2011-2012, 32707 nr 16

Figure 1. Replacement period for train protection installations

The subsequent 'Building bridges'[8] coalition agreement of 29 October included the concept that ERTMS would be implemented in a phased manner from 2016, using existing budgets. With the Railway map version 1.0 of 13 February 2013[9], the Start Decision for the Exploratory Phase was made.

ERTMS is the new European standard for traffic management and train protection with advantages in terms of safety and interoperability. In addition, ERTMS has potential advantages within the spheres of capacity, speed and reliability. ERTMS represents a chance for the railway sector to make a leap forward in terms of quality thanks to additional and more advanced ICT/controls. The research that led to this Railway map 2.0 reviewed which benefits could be realised and which gains corresponded hereto. It would seem that ERTMS can, indeed, make an important contribution to the realisation of objectives from the Long-Term Railway Agenda[10] (LTSA), see chapter 2.

The current train protection system ATB was introduced in the 60's and, as is also the case in many other European countries, is set to be replaced (see figure 1); this offers an opportunity to implement ERTMS.

Major Project Status and Project management

Infrastructure projects in the Netherlands must conform to the MIRT system in terms of elaboration and approach. This contributes towards transparency and effective decision-making. Even though ERTMS is not a traditional infrastructure project, this system of phased decision-making and go/no-go moments is applied in order to facilitate transparent and managed decision-making within this type of complex project with many cohesive elements and relationships.

The House of Representatives ascribed Major Project[11] status to the implementation of ERTMS in the Netherlands in June 2013. It is important to recognise that ERTMS has a significant ICT component. The Major Project Status, the ICT component and the fact that passengers, train operators and freight transporters must not suffer significant interruptions as a result of the implementation, underscore the importance of a detailed process approach and well-thought-through decision moments in order to ensure there is integral management. The MIRT regulation framework and the Major Project Status set specific responsibility requirements that apply to the Exploratory Phase and the subsequent phases. Under the condition of a stable scope, these requirements make the project manageable.

In light of the Major Project Status, the Exploratory Phase has been set up with a specific focus on project management. The management strategy for major projects focuses on ensuring that the project result (including the corresponding quality criteria) can be achieved within the set time and with agreed budget. Scope, time and money are therefore the central issues upon which management is focussed. The ERTMS Basic Report will be drawn up on the basis of the Parliamentary debate, scheduled to take place in January 2014, regarding the response of the House to the Points of Departure Memorandum. The Basic Report is expected to be delivered at the end of the first quarter of 2014. This Basic Report will make a detailed examination of project management and governance for the subsequent project phases.

[8] Parliamentary documents II, meeting year 2012-2013, 33410 nr 1

[9] Parliamentary documents II, meeting year 2012-2013, 29984, nr. 385

[10] Parliamentary document II, meeting year 2012-2013, 29984 nr. 384

[11] Parliamentary document II, meeting year 2012-2013, 33652 nr. 1 and Processes TK 2012-2013, nr. 93-13

Review of Railway map 1.0

Railway map 1.0 sets out the main points that define ERTMS, the relationship it has to other protection components, the various Levels involved and why the process is being conducted within the MIRT framework. In addition, research questions were formulated (which will be answered as extensively as possible in this Railway map 2.0) and an explanation was provided regarding the transition (system leap) required by the railway sector in a number of areas.
This Railway map 2.0 builds upon Railway map 1.0. The objectives, preconditions, points of departure and directional choices, as well as the research questions from Railway map 1.0 are summarised below.

ERTMS objectives

In Railway map 1.0 it became clear that ERTMS could perhaps function as an important resource for realising the Long-Term Railway Agenda (LTSA). If ERTMS is implemented effectively, flexibility, robustness and capacity within the railway system are likely to increase. ERTMS is not an objective in itself. According to current insights, however, it offers important functionality in order to help realise the objectives of the LTSA. For a more technical/factual explanation of ERTMS (e.g. the functioning of the various levels), you are referred to Railway map 1.0 and the Knowledge Book.

In order to take a significant step forwards in the Netherlands in terms of railway performance, ERTMS must be introduced as part of the complete traffic management system. The implementation of ERTMS could then potentially make an important contribution to taking the following objectives to a higher plane:

- Safety
- Interoperability
- Capacity
- Speed
- Reliability

The extent to which ERTMS will offer these advantages in practice varies per situation and from country to country. That is precisely why comprehensive research has been conducted in the Exploratory Phase in order to ascertain how much ERTMS can contribute towards these objectives. The results of these investigations are further examined in chapter 2.

Points of departure, preconditions and directional choices

In Railway map 1.0, several points of departure, preconditions and directional choices were included with respect to the migration to ERTMS. As set out previously, an assumption has been made with regard to the location of ERTMS in the traffic management system chain.

Points of departure and preconditions

The Cabinet opted for the phased implementation of ERTMS in the Netherlands. This was partially based on the report from the Kuiken committee and also as a result of the potential advantages that the implementation of this resource can provide as a 'dot on the horizon' in terms of railway functionality. The ambition goes further than the European mandatory TEN-T-corridors as of 2020, 2030 and 205012, assuming that further research demonstrates that the risks and costs are manageable and the ratio of costs/benefits is acceptable. The Exploratory Phase, within the context of Railway map 1.0, endeavoured to determine the actual scope for implementation and variant choice. This takes place on the basis of considerations regarding need, usefulness, risk, costs and benefits.

[12] See Annex D for more information13 Parliamentary document II, meeting year 2012-2013, 32707 nr. 16

[13] Parliamentary document II, meeting year 2012-2013, 32707 nr. 16

The points of departure and preconditions are applied in the Exploratory Phase. They up-date and firm up preconditions[13] set out previously in the in-principle decision of 8 June 2012.

Points of departure

The migration to ERTMS encompasses the following points of departure:

- The in-principle decision to implement ERTMS has been made. ERTMS will be implemented, in line with the coalition agreement of 29 October 2012, in a phased manner from 2016;
- Implementation will take place with the existing budgets. A condition of this is a cost-effective and efficient choice of variants and use of resources and harmonisation with other programmes and projects;
- Disruption for passengers and freight transporters must be kept to an absolute minimum during ERTMS implementation. The implementation of ERTMS cannot be allowed to lead to the day-to-day quality of rail transport coming under pressure;
- Future robustness of investments: investing with an eye on the future implementation of ERTMS and only investing in updating current safety (components) if this involves a "no regret" situation;
- System effects within the total railway area form an explicit part of the (effects of) the variants to be investigated.

Preconditions

For the migration, the following preconditions are required in order to achieve a transition (system leap) for the objectives:

- There is a transparent and manageable process whereby risks are set out explicitly and managed effectively;
- ERTMS must be sufficiently (technically and operationally) stable;
- Efforts are made to realise a simple and standardised implementation of ERTMS;
- The cost estimate for ERTMS implementation must be sufficiently reliable, costs must fit within the existing railway budget and be in proportion to the social benefits;
- The tendering process must stimulate innovation in the market, keep total Life-Cycle Costs as low as possible and prevent the (negative) effects of vendor lock-in;
- The impact on the profitability/business case for train operators is acceptable or provides added value.

Directional choices

With one eye on the experiences with ERTMS in the Netherlands and elsewhere, the following choices for elaborating the implementation scenarios were made in Railway map 1.0:

- A dual period[14] is required. Many parties depend on the railways. In principle, the 'shop will stay open' during the work;
- Migration to ERTMS will start with rolling stock, given the cost of dual rolling stock is significantly lower than dual infrastructure. Financing agreements with train operators must be made to this end;
- Infrastructure installation is preferably 'ERTMS only'. This is possible if (a substantial element of) rolling stock is first converted to ERTMS;
- Speed increases to 160 km/h on certain, suitable track sections will be investigated. The results of this research are already available[15];
- The opportunities for offering ERTMS on cross-border lines will be further investigated. Encouraging cross-border transport is one of this Cabinet's spearheads. The implementation of ERTMS in Belgium and, for example, the third rail in Germany offer opportunities in this regard;
- The possible benefits of ERTMS for regional, non-electrified lines will be investigated. The pertinent question is the extent to which the intended frequency increases can be

[14] A dual period is a period within which ATB and ERTMS coexist in the train or track.

[15] Parliamentary document II, meeting year 2012-2013, 29893 nr. 151

achieved without expanding infrastructure. As a result, costs and duration times for such plans could reduce;
- The modifications required for the optimisation of adjacent systems, such as the train dispatching system, will be investigated in the context of the Improvement approach from the LTSA; system choices will be included where necessary.

Research questions from Railway map 1.0

At the start of the Exploratory Phase, a number of research questions were formulated. The Exploratory Phase began on the basis of these research questions (and other questions/pledges from Railway map 1.0). During the Exploratory Phase, these questions were supplemented, amended and expanded. This is referred to as an iterative process. Thanks to discussions with stakeholders, market parties, scientific institutes and research agencies, the questions were (and are being) resolved or adjusted.
In the Railway map 1.0, the following questions were formulated for the infrastructure and the rolling stock in the Exploratory Phase:

1. Objectives: to what extent and/or under what conditions can ERTMS provide a contribution to the objectives/benefits set out? Part of this is an investigation into the performance developments and risks associated with ERTMS compared to the situation with current train protection in terms of the objectives: safety, interoperability, capacity, speed and reliability.
2. Implementation strategy: determining scope, where and when ERTMS can be realised in the infrastructure in relation to the objectives and timing of other programmes/projects? What is an appropriate overhaul plan for rolling stock?
3. System choices: what type of 'system' do we need, also in relation to other elements of the entire traffic management chain?
4. What type of tendering and contracting strategy (including management and maintenance) is preferable taking into account costs and risks?
5. Usage and management processes: what is the impact of ERTMS on use and management and how can we deal with this?
6. What are the estimated costs including management and maintenance costs (also in comparison to the current situation); which risks and management measures are there and how will financing be organised?

2 How ERTMS contributes towards its objectives and the objectives from the LTSA

Simultaneously, with the Railway map 1.0, the vision, ambitions and objectives for the LTSA were also presented. The LTSA sets out the main objective to improve the quality of the railways as a transport product so that passengers and freight transporters increasingly regard the train as an appealing transport option and start/continue to use it.

Railway map 1.0 indicated that ERTMS can provide a significant contribution towards realising this main ambition via various, underlying objectives. There is also an overlap between these underlying objectives from the LTSA and the ERTMS objectives:

- safety,
- interoperability,
- capacity,
- speed and
- reliability.

These objectives are elements that are also present in the objectives for the LTSA. The implementation of ERTMS thus also contributes towards the LTSA ambitions: improving the quality of the railways as a transport product so that the passenger and freight transporter increasingly regard it as an appealing transport option and use it.

The five objectives of ERTMS are set out below; i.e. what, whether and how (to what extent) ERTMS can contribute towards these objectives. Where necessary, the conditions required in order to realise the objectives/effects, will also be explained. The ultimate effects always depend on the (technical/factual) cohesion between the opportunities offered by the infrastructure, the train protection system and the rolling stock. This cohesion emphasises the importance of good cooperation between all rail parties on this file.

The descriptions below clearly show that there are still some differences between ERTMS Level 1 and Levels 2 and 3. Level 1 has limited benefits besides interoperability and an increase in safety. The ongoing growth options to ERTMS Level 2 are also limited by differences in technology between Level 1 and 2 and, as a result, investment in the long-term is partially redundant.

This information came to the fore in the study carried out for Knowledge Book 1.0 (see chapter 4).

Safety

Safety is an absolute for users of the railways. The current protection system ATB delivers a high level of safety but is dated and needs replacing. The railways are much busier than they were in the 60's when the current ATB system was installed. Research in the context of the Knowledge Book demonstrates that the (national) implementation of ERTMS will improve safety on and around the railways in the Netherlands compared to the situation with ATB. The most important reasons why ERTMS can provide safer operations are:

- ERTMS allows the speed of trains to be monitored even under 40 km/h (so also in sidings); this is not the case for ATB-EG. ATB-Vv offers a solution for this but is less effective in preventing SPAD's.
- the number of SPAD's is also reduced by ERTMS because brake curve monitoring is applied; this only currently occurs under ATB-NG (on regional lines);
- there is also a clearer overview of where the trains are and how quickly they are going so trains can be prevented from passing red signals at all;

- with ERTMS Level 2 and 3 it is possible to impose continual Temporary Speed Restrictions; with ATB and Level 1 this is more difficult as a result of work that must take place in the track instead of behind a computer screen as is the case for Levels 2 and 3. The use of Temporary Speed Restrictions also leads to safer working conditions for track workers;
- the system with ERTMS is less dependent on verbal communication between the train driver and train dispatcher and is thus less susceptible to errors. Furthermore, this removes concerns from the train driver and the train dispatcher and they can then focus on their core tasks such as paying attention to the track while driving and resolving major problems.

In the event of the complete implementation of ATB-Vv as a supplement to ATB-EG, approximately 100 SPAD's would still occur each year. With ERTMS, there are expected to be 20 to 30 per year.

In addition, the implementation of ERTMS could have a positive impact on safety around level-crossings as waiting times at level-crossings are expected to reduce with Levels 2 and 3. The inconvenience for the road-user will thus also reduce, minimising the chance of risky behaviour by people who find the waiting times to be excessive. Furthermore, the speed of trains around a broken-down level-crossing could automatically be curtailed. The further development of ERTMS is required in order to achieve this latter, positive safety effect.

Interoperability

Encouraging cross-border transport is one of this Cabinet's spearheads. Our neighbouring country Belgium is currently engaged in the tendering process for the national implementation of ERTMS. Once ERTMS has also been implemented in our neighbouring countries, an important barrier for cross-border (passenger) transport by rail will be removed. This could lead to a greater range of (regional) cross-border lines. The option to use rolling stock and personnel (temporarily) in other countries without dual train equipment/expertise and allow these to continue over the border is increased with the implementation of ERTMS. However, there are other barriers such as differences in voltage on the catenary system and the communication language (and possibly the signage for Level 1).

National interoperability is also an area that requires attention. At the moment, the Netherlands has track sections with ATB-EG (possibly supplemented with ATB-Vv), ATB-NG and various Levels of ERTMS. Train operators that wish to use all track sections must therefore have multiple protection systems onboard. A transfer to the national implementation of ERTMS could thus offer advantages for train operators and passengers (more connections).

Increasing interoperability will contribute towards improving the convenience of travelling for people and processing freight via the railways, both of which are objectives from the LTSA.

Capacity

In some cases, ERTMS Level 1 will reduce capacity compared to the current protection system. With the implementation of ERTMS Level 2 and 3, the capacity of the railway system can be expanded and, as a result, track loading can be reduced. Under Level 2, this requires supplementary measures such as signal block compression. This will be applied on the OV-SAALcorridor[16] as of 2023. The increase in capacity, in this case the reduction of loading on the railway network, can be put to good use in a variety of ways: more trains can be used simultaneously, trains can travel at higher speeds, trains can travel with greater speed variations and the additional space can be used to make timetables more reliable. A combination of these methods may also be chosen. A contribution is thus also made towards the

[6] Parliamentary document II, meeting year 2012-2013, 32404, nr. 63

objectives from the LTSA within the context of offering capacity and space for the growth of passenger and freight transport on the railways.

- Capacity gains can be achieved by:
- where necessary, applying shorter (Level 2) or even virtual blocks (Level 3);
- more accurately defining and monitoring the permitted speed of the train (speed traps of 5 km/h under ERTMS instead of 40, 60, 80, 130 and 140 km/u under ATB-EG), independently of block divisions;
- applying specific brake curve monitoring that is adapted to the characteristics of each train;
- limiting inconvenience (fewer train jams/less oil spill processing when there are breakdowns) as a result of signal block compression and quick authorisation updates.

In short, the theoretical maximum train frequency, the reduction of waiting times at stations and level-crossings, optimisation of permitted speed in line with that of the track design and the realisation of more uniform speed will lead to greater capacity and an improved product, assuming that efforts are made to keep punctuality high. All of these details have already been dealt with in a general sense in the quick scan MKBA (see chapter 5).

Finally, it is also possible to increase the capacity of the railway system with ERTMS Level 2 and 3 because less maintenance will be required and the maintenance that is required will not take so long in relation to the protection system in/along the railway[17]. With Levels 2 and 3, fewer outdoor elements (including signals) are required even though Level 2, with signal block compression, does require extra track-based train detection. The fewer outdoor elements there are and the more reliable these elements are, the fewer disruptions there will be. This is appealing for passengers, train operators and freight transporters.

Additionally, the introduction of more ICT (protection) systems means that maintenance can be much 'smarter'. The addition of the ICT component with ERTMS corresponds to the operator having quicker, more and better information available about (the chance of) disruptions and this means that (preventative) action can be taken earlier.

Speed

As set out in the previous paragraph, average speed can increase as a result of the ERTMS introduction. The speed traps used with ERTMS are more refined than with ATB-EG. This means that speed restrictions can be regulated much more accurately and that average track speed can increase. This means shorter journey and travelling times and translates into advantages for passengers (shorter door-to-door journey times), freight transporters (shorter lead times for freight) and train operators (more efficient use of rolling stock). This is positive for all users of the railways and, according to the models, will lead to extra users.

Alongside the fact that the speed of the trains can be increased as a result of the lower track section loading with ERTMS, the current general maximum speed of 140 km/h can also be increased on the railways. The current maximum speed of 140 km/h equates to the highest speed permitted by ATB. Since the 80's, new track sections have been laid for 160 km/h or even 200 km/h. There are currently 7 track sections where speeds of 160 km/h are possible. The majority of NS rolling stock can also attain speeds of 160 km/h.

With the transfer to ERTMS, the 160 km/h speed on these track sections can now be realised, with the proviso that this will not deliver many minutes in terms of reduced journey times in a densely populated country such as the Netherlands, with its short passages and many stations (except for the Hanzelijn). In other words, it must provide some gain but also fit in with the timetables.

[17] This also increases safety for track workers

A move to increase the current maximum speed on other track sections does not seem to be a realistic expectation. There are also other issues that determine whether the maximum permitted speed on a route can be increased, such as the provision of power and the stability of the track body/infrastructure.

The benefits of speed increases for the passenger primarily lie in areas under 140 km/h. For example, as a result of increasing speed restrictions that are set at 80 km/h for ATB to 90 km/h under ERTMS.

Reliability

With the implementation of ERTMS Level 2 and 3, the number of outdoor elements (e.g. signals and detection) will reduce, leading to an increase in the reliability of the system (even though this is counteracted in part by signal block compression). The addition of data communication to the GSM-R network that is now primarily used for verbal communication will increase the consequences of a failure. This may require additional investments to be made in the GSM-R network or other communication technology. This will be investigated.

As indicated previously, the addition of ICT, will lead to the operator having more information about the location and nature of (potential) disruptions; this will lead to reliability increasing. The implementation of ICT via ERTMS will also improve the opportunity for a more direct connection with traffic control and disruption management; this could also improve reliability.

Other objectives

An important precondition/objective is that the railway stays 'open' during the migration to ERTMS. An effective migration strategy is therefore necessary, which takes account of this need but also considers the impact on train drivers and dispatchers. It must be clear when the different systems are in use. The transitions from ATB to ERTMS area must be comprehensible and workable in terms of the employees involved in the operation.

The railway sector is ambitious in terms of sustainability and punctuality. The ERTMS system can provide a significant contribution to both. The impact on punctuality largely depends on the effects on capacity, speed and reliability discussed above. In terms of sustainability, brake curve monitoring means that braking can be more efficient and that it can be more gradual or that trains can travel more slowly in disruption situations. According to Railforum, combating unnecessary braking could also deliver energy savings.

3 MIRT system with a focus on the ICT aspect

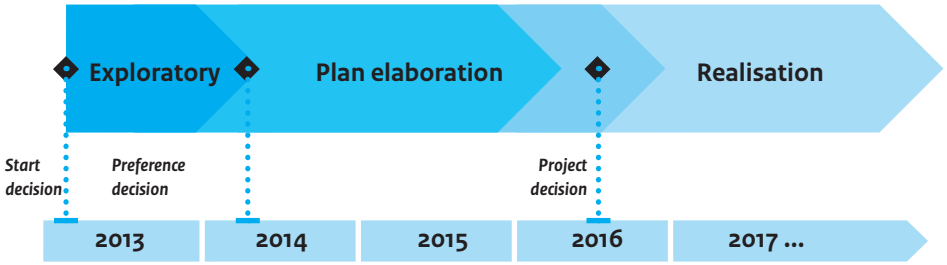
The Multi-Year Programme for Infrastructure, Spatial Planning and Transport (Meerjarenprogramma Infrastructuur, Ruimte en Transport or MIRT) concerns financial investments in integral, collective solutions (programmes and projects) for State and regional/other party tasks. In order to effectively implement ERTMS, it is important to ensure that well-founded decisions can be made. Account must therefore be taken of the substantial ICT component that corresponds to ERTMS. The fact that the implementation of ERTMS requires managed choices to be made at the right moment, means that the MIRT working methods have been largely applied to this project. The development that ICT will undergo during the implementation period must also be paid continual attention. The fact that there are a limited number of providers of (components for) train protection systems must not be forgotten. The tendering strategy(ies) must be protected from this risk.

The MIRT regulation framework

The MIRT regulation framework assumes that projects will move via a funnelled and phased decision-making process, in an accountable, transparent and managed manner, to an end-result. The MIRT approach assures that, at every decision-making moment, there is an assessment of whether there is a sufficiently robust foundation for moving onto the next phase. This will take place via formal go/no-go decisions.

The MIRT phases begin and end with a "go/no-go" moment. Decision-making, elaboration and the implementation of ERTMS take place in a phased manner in the Exploratory Phase, the Plan elaboration phase and the Realisation phase. This means that the In-principle decision, the Start Decision, the Preference decision and the Project decision are moments at which a new decision is made as to whether and under which conditions progress continues in terms of the implementation of ERTMS in the Netherlands. At the end of each phase, the formal go/no-go decision considers which subsequent steps are necessary and justified. Research and decision-making are therefore 'funnelled' and all aspects are processed with an 'outline to detail' approach. At the end of the Exploratory Phase, for example, there will be a decision-making moment at which point a decision can be made regarding the preference scenario for the implementation of ERTMS in the Netherlands. In the context of the Major Project Status, progress reports will also be submitted to the House of Representatives every six months. These reports will then be debated by the House of Representatives. These are the moments during which Parliament can exercise its influence on the progress of developments. Figure 2 provides an overview of the process for the implementation of ERTMS from the Start Decision.
In concrete terms, funnelled decision-making about ERTMS takes place on the basis of the previous (sub) phases of the MIRT system.

Figure 2. Primary phasing of ERTMS implementation



ERTMS is an infrastructure protection and ICT chain project

The Netherlands has acquired a great deal of experience and had many learning opportunities with ERTMS. The MIRT regulation framework was designed for classic infrastructure projects. ERTMS, however, has important ICT elements in addition to the infrastructure aspects. The introduction of a technology which has software at its core requires a separate interpretation and approach to the ICT aspects. That is why the MIRT system is not being followed religiously.

As a result of the iterative nature of ICT developments, there will be ongoing advances in the ERTMS elements during the implementation process. These ongoing technological developments could impact upon the previously preferred scenarios. This then influences the approach to be followed. Space will therefore be provided for developments (which could either correspond to risks or, on the other hand, offer additional perspectives). This also requires a degree of flexibility for the development of the preference scenario and the detail level of the Preference decision. It could, therefore, become clear that space must be provided in the system for further developments and/or that, compared to traditional infrastructure projects that apply the MIRT approach, smaller steps would be more effective in the decision-making process.

The replacement of the current electromechanical protection system ATB by ERTMS also means that ICT will play a comprehensive role in the basis of the railway protection system. There will be computers, both in the train and on the sidelines, (except with Level 1) that exchange GSM-R data with one another.

This process is regarded as a 'chain project' given the fact that the introduction of ERTMS encompasses hard and software being installed within multiple organisations that have no hierarchical relationship with one another. Previous experiences with chain projects, and also HSL-Zuid and the Betuweroute, have shown that the appointment of a 'chain director' is a precondition for success. The chain director will often be referred to as the 'system integrator' within the ICT field. This provides added value for ERTMS because there are multiple parties and a working railway system must be achieved. To this end, a platform of multiple parties or an (independent) party or person is required.

The role of the system integrator for both HSL-Zuid and the Betuweroute was only fulfilled around/after completion of the track. These previous ERTMS implementations have taught us that a failure to appoint a system integrator in advance leads to a situation where it becomes clear that such a role is vital in order to ensure the system works effectively in its entirety. The consequence of only tackling this issue at a later stage corresponds to a risk that the project is not completed within the allocated time and budget.

The availability requirements for the ERTMS system are high. This is comparable to other critical infra/ICT systems such as those for payment traffic, DigiD, air traffic control, tunnel installations and so forth. There must, therefore, be a specific focus on reliability and the redundancy of particular systems and a great deal of attention must be paid to preventing single point failures. This could also have consequences for maintenance strategies in the management and exploitation phase of an ICT system, design, migration strategies for new releases, ongoing development, tests and incident management. Particular attention must be paid to these issues. Experiences in other countries can also be useful in this context. See also annex A.

Vendor lock-in

The number of parties that can provide ERTMS is limited. In order to manage the railways in the Netherlands effectively, ensure there are limited interface problems and achieve (economic) scale advantages via uniformity, contract form and the life-cycle approach, a selection will probably be made from these parties. Large contracts lead to a tendering process that, in terms of scope, is attractive for these parties and delivers scale advantages for the government. In this case, there is a field of tension between economic scale advantages, on the one hand, and dependence on a few parties, on the other. This field of tension could expand further as a result of experiences with large ICT projects in this context. This therefore requires an effective tendering strategy which demands functional specification and standardisation as far as is possible. Compared to the moment at which tendering for HSL-Zuid and the Betuweroute took place, a great deal of worldwide experience has been accumulated with tendering processes for ERTMS.

The risk of vendor lock-in within tenders is limited as a result of including specific measures in the tendering question specifications that eliminate the creation of a vendor lock-in situation. These could, for example, take the following form:

- competing contracts with effective agreements for long-term guarantees and service and agreements with respect to costs for hardware, software, tooling, updates and modifications during the life-cycle;
- opening up and providing expertise, documentation, tooling, training, and so on in order to give ProRail and/or third parties an opportunity to carry out modifications, independent and comprehensive maintenance, and repairs during disruptions;
- developing open interfaces with adjoining (ERTMS) systems from other suppliers.

To a certain extent, there will always be an issue with vendor lock-in but this does not necessarily have to lead to problems. The issue of whether this is the chosen option must be a conscious, deliberate decision. This means that the choices that are to form part of the (long-term) relationships must have been elaborated effectively beforehand. A realistic objective is that the negative effects of vendor lock-in must be avoided.

Tendering strategy

The core of the market strategy is to implement ERTMS, given the characteristics of the market and the ERTMS product, at the best price/quality ratio, via the creation of market tension and scale advantages.

In the Exploratory Phase, the market strategy will primarily focus on providing information to the market. A market scan has therefore been conducted and the Exploratory Phase has incorporated two market information rounds so far. The main points in the reports from the market information rounds were made public in order to ensure all of the concerned parties were able to obtain the same level of expertise (see annex B for the report from the first market information round).

IenM have reviewed the various tendering options. On this basis, the following tendering options have been further elaborated and assessed on the value they could provide:

- the negotiation procedure with announcement;
- a public or non-public tendering procedure with or without the application of an integrated contract form and/or ‘best value procurement’ elements.

This links into an important lesson learnt by Denmark, which opted for a tendering process with a negotiation phase. This approach means that specifications can be clarified and amended during the negotiation phase so that all of the tendering parties can submit a “Best And Final Offer”.

For the time being, other tendering forms will not be considered because they do not incorporate the appropriate market motivators required for this specific situation or offer insufficient room for innovation. There will, however, be further investigations into which options the new European tendering regulations can offer. In terms of contracting, all of the components of 'design, build, finance and maintain' have been charted for consideration.

For all aspects of the market strategy, the expertise and know-how that has been accumulated since the Betuweroute and HSL-Zuid within central government will be put to good use; this will apply, in particular, to IenM and its executive organisation the Department of Waterways and Public Works, and the infrastructure operator ProRail. Experiences from Denmark and Belgium will also be used.

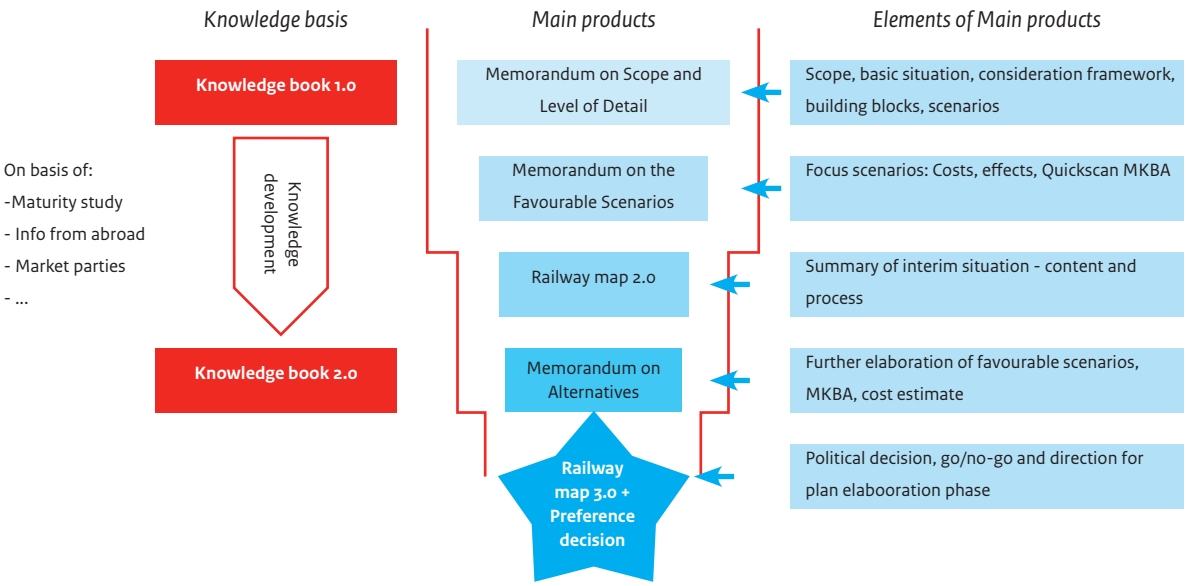
4 State of play November 2013: results of Exploratory Phase research

Since Railway map 1.0, a great deal of research has been conducted in order to expand/deepen the level of expertise regarding ERTMS. The purpose of this was to distinguish opinions based on old experiences from facts about the current ERTMS. This led to the creation of the Knowledge Book 1.0, intended to be used as a growth document.

Additionally, in line with the MIRT system, a funnelling process has been used to inventory the possible scenarios and end up with a limited number of favourable scenarios for implementation of ERTMS in the Netherlands. Chapter 4 sets out the investigations that have been so far carried out and chapter 5 explains the funnelling process and the scenarios themselves. Where possible, the reports from the investigations have been included with this Railway map 2.0 as annexes.

Figure 3 provides an overview of the steps (funnelling) and products from the Exploratory Phase. It must be noted, in relation to this figure, that the Railway map 2.0 represents the state of play for issues up to the Memorandum on Alternatives. In the coming period, the Memorandum on Alternatives will be drawn up on the basis of further, more detailed research into the preference scenarios; see chapter 7. The development of expertise will continue. The Knowledge Book 2.0 will be drawn up on the basis of input from the stakeholders and market parties that have been issued with the Knowledge Book 1.0 since the end of October 2013.

Figure 3. Phasing of the Exploratory Phase



Knowledge book

In order to come to sound decisions regarding the implementation of ERTMS, it is important that decisions are made on the basis of facts. With technology such as ERTMS, which is partially still under development, the facts are often hard to pin down either because developments are still going on and/or because not all parties have been made aware of them.

From opinions to facts

In the railway sector, a great deal of experience from the past, e.g. teething problems with the Betuweroute and HSL, still plays a role. The various backgrounds, tasks, responsibilities and areas of expertise of the three Railway map parties, but also other stakeholders, can lead to differing interpretations of the same information. That is why the facts about ERTMS will be split according to assumptions, interpretations and opinions and then shared with the parties concerned. In so doing, the facts will become clearer and the knowledge base will expand. The Knowledge Book 1.0 (see annex E) has made a useful contribution hereto.

IenM, ProRail and NS collectively drew up Knowledge Book 1.0. The Knowledge Book contains a factual description of these parties' current level of expertise regarding the (im) possibilities that correspond to ERTMS. The Knowledge Book also provides all of the parties with an equal basis with respect to the technical opportunities and limitations of ERTMS and the objectives that are being set with the introduction thereof.

The creation of a collective factual basis enables the various scenarios which have been investigated to be properly substantiated. The Knowledge Book also allows potential differences in insight regarding ERTMS to be clarified or tackled early on in the process. The collective basis of expertise enables each party to hold fact-based discussions about the scenarios from the perspective of their specific role.

The Knowledge Book has provided a clearer and shared overview of topics related to ERTMS. Examples of important questions that were dealt with in the Knowledge Book are:

- What can ERTMS contribute towards the five ERTMS objectives?
- What are the variations between ERTMS Levels 1, 2 and 3?
- What amendments are necessary in terms of infrastructure and rolling stock upon implementation of ERTMS?
- What amendments must be made to GSM-R?
- What is the impact of ERTMS on the optimisation of management?
- What dependencies correspond to the ERTMS Level choice and the role of sidings?

The shared knowledge and results of the follow-up research has clarified the extent to which the intended advantages of ERTMS can also be realised in practice (see chapter 2).

Further research

During the creation of the ERTMS Knowledge Book, it transpired that there is also a need for the further development of expertise. For the purposes of the Preference decision, it is not necessary to fill in all of the gaps in knowledge. In consultation with the Railway map parties, a list of aspects which require further insight in order to be able to make a Preference decision was drawn up. This concerns:

- Limited certainty as to the degree of capacity gains that can be achieved with ERTMS;
- Limited insight into the required GSM-R communication for national implementation (including sidings) and the development thereof;
- ERTMS on sidings (including migration);
- Limited insight into market developments in costs and technical solutions within the various ERTMS formats;
- Limited insight into the necessary developments (and feasibility and duration) in ERTMS Level 3;

- Learning experiences with respect to system integration. What can and/or must this role encompass? And in what way can this role be substantiated?

These gaps in knowledge are currently receiving further attention in the Exploratory Phase. As explained in the previous paragraph about the Maturity Study, a number of (necessary) ERTMS developments will also take time.

Process
The Knowledge Book 1.0 was shared with the stakeholders and market parties that were addressed in the Exploratory Phase in October/November. They were very positive about the method of moving from opinions to facts. They have all been invited to provide their factual observations and supplementary information for the Knowledge Book. The Knowledge Book is a living document which, over the course of time, will be supplemented as and when new knowledge becomes available. During the Exploratory Phase, the aforementioned list of gaps in knowledge will receive further attention and be supplemented by a Knowledge Book 2.0.

Maturity Study

The Knowledge Book focuses on the expertise (and experience) in relation to ERTMS which is available in the Netherlands. It is, however, also useful to look across the borders: are there accessible and/or ongoing studies, developments or projects that could provide answers to questions that are still an issue in the Netherlands?

In 2008, the Danish infrastructure operator BaneDanmark conducted research, via a Joint Venture of engineering bureaus, into the maturity of ERTMS technology on the basis of experiences with ERTMS in various countries. At the time, it was concluded that ERTMS Level 1 and Level 2 could be implemented on free track sections and level-crossings without any problems but that the experiences on medium-sized and large stations were too limited to draw any meaningful conclusions. The researchers at the time expected problems to be encountered with GSM-R at larger stations or sidings.

In 2013, the Dutch IenM asked the initiators of the aforementioned research to provide an update on the state of play with regard to the development of ERTMS technology, see annex F. This update provides an overview of completed and ongoing ERTMS projects. In addition, it contains an overview, drawn up according to the 'system-readiness' method, of developments that have occurred between 2008 and 2013. This shows that since 2008, there have been further developments of the system but that the system requires further development in certain important areas. This may well be underway but, at larger stations, there is insufficient experience with aspects such as ERTMS Level 2, GSM-R and railway level-crossings to be able to speak of a 'mature' system.

It also transpired that ERTMS has already led to increased cross-border freight transport and an increase in reliability, quality and competition within the railway freight transport sector. ERTMS is now being used in 38 countries and has thus become the worldwide standard for train protection. The technology has also matured in the intervening period. According to the research, there is now more extensive experience with ERTMS in stations and sidings but there are still uncertainties in relation to the effectiveness of Level 2 in terms of large sidings, GSM-R and level-crossings. At the moment, there are many projects in the design and testing phase; in the coming 3 to 5 years a great deal of experience will thus be accumulated in relation to this type of more complex application. The update makes a few recommendations that will be included within the Dutch ERTMS project. These recommendations relate, for example, to updates, migration and the involvement of the infrastructure operator and train operator(s).

Overhauling rolling stock

Compared to the current protection system ATB, there is a shift of intelligence within ERTMS from the track to the train. The fact that the majority of the costs and the design issue are connected to the infrastructure means this will receive the most attention.

One of the directional choices from Railway map 1.0 is that a start will be made on overhauling rolling stock to ERTMS. This means that rolling stock will have dual functionality. Given the obligation for the mandatory TEN-T corridors, this overhaul process for rolling stock will run partly in parallel with the overhaul of the infrastructure. The overhaul of rolling stock also takes time because train operators only have a limited reserve capacity. The project follow-up must therefore involve a thorough review of the overhaul plans, including issues such as the purchase of new rolling stock and the logistic processes that must be reconciled with the infrastructure overhaul strategy.

In this context, it is important that the specifications for rolling stock are set in good time so that the train operators can take this into account when purchasing new items. This could concern, for example, the Sprinter New Generation and the IC+ that NS is currently ordering and which will be requested with ERTMS as an option. Decentralised authorities and train operators have already looked into the specifications for rolling stock. New rolling stock with dual functionality is substantially cheaper than incorporating ERTMS into existing rolling stock, a process that also takes time (multiple tasks per train).

Experience with ERTMS has also shown that the integration of train and track systems (system integration) is vital. Furthermore, in the transfer phase from ATB to ERTMS, there is a dual phase during which both ATB and ERTMS will be used in the Netherlands. Trains must therefore be fitted with both systems to be able to work in the Netherlands. This means that the current protection system (ATB) must be linked in the train with an ERTMS system via a coupling (STM). Originally, the idea was to let these STM's be developed by Member States and subsequently made available. In practice, however, suppliers have tended to develop these themselves as and when there has been a need (cf. introduction Betuweroute). There are currently just two suppliers that could provide such an STM for the Netherlands. That is why the market has been asked for its ideas in terms of creating a level-playing-field. This could involve making one of these STM's available to other suppliers, for example. Another option is for the Member States/train operators to develop an STM (or have one developed); this would take two years and it could then be made available to multiple suppliers so that they could make a competitive tender for this part of the ERTMS implementation in the Netherlands. The aim of all this is to obtain the best possible price for overhauling the rolling stock, to expand the market for ERTMS onboard units and to ensure that the current suppliers of ERTMS, with STM-ATB, are not permitted to take up a more favourable position than other market parties.

In the Netherlands, there are two types of ATB system (the ATB-EG (First Generation) and the ATB-NG (New Generation)). The number of trains that will have to be overhauled will depend on the selected preference scenario for the implementation of ERTMS in the Netherlands; one or two types of STM will then have to be developed or released.

The need for train-track-integration will lead to an issue of how the systems in the train and track can be effectively harmonised, also when it comes to regular (software) updates. In this context, the previously addressed question of the role of the system integrator also seems pertinent. A number of countries have chosen to let the infrastructure operator also take responsibility for the systems in the trains. This corresponds to the financing issue and engineering issues that must be further investigated.

If the 0 scenario is chosen, rolling stock overhauls will not apply to passenger train operators; this will however apply to all other scenarios. For more information about the overhaul of rolling stock, see annex G.

Lessons learnt abroad

ERTMS is now the European standard for train protection that is also applied to many new-build projects outside Europe. In terms of the Exploratory Phase, it is vital to examine the state of play and experiences with the implementation of ERTMS in other countries, primarily within Europe. The Netherlands was one of the first countries to accumulate (learning) experiences with ERTMS but it can now learn from other countries that have already opted for the national implementation of ERTMS on their integrated railway networks and are ahead of the Netherlands.

In the short term, ERTMS will initially be applied in order to facilitate uninterrupted train traffic for passengers and freight on international corridors (the motivating factor being interoperability). The harmonisation of technical systems is a vital element of this to ensure that costs are kept as low as possible. The implementation of ERTMS is primarily accommodated within the diverse plans for the European freight corridors. A good example of this is the corridor A (Rotterdam-Genoa).

In addition, a number of countries have applied (variants of) ERTMS on a large-scale in order to increase safety and/or prevent existing train protection systems becoming so antiquated that their effectiveness is jeopardised and safe train travel becomes impossible. In the mid to long-term (2015 and later), ERTMS will be applied as the standard, future-proof system for train management in order to replace the existing system. In terms of the countries that have been reviewed, Belgium, Switzerland and Denmark have opted for a national implementation of ERTMS in or around 2020. Other countries, such as Norway, the United Kingdom and Sweden, have the same ambition but are applying a slower pace (ready in 2035-2040).

Some countries (Germany, France, Spain) have stressed the need for ERTMS in the long term but are starting in a limited fashion by initially focussing the implementation of ERTMS on international and high-speed corridors. These countries (with large networks) are primarily emphasising that 'one-size-fits-all' solutions do not work. Most of these countries have close relationships in this context in order to learn from one another.

Discussions with market parties

A great deal of expertise regarding the latest ERTMS developments is available from market parties. In the Exploratory Phase, IenM, ProRail and NS believed in the value of talking to market parties about the implementation of ERTMS. This was realised via two market information rounds during the Exploratory Phase The aim of the market information round is to facilitate early communication with market parties so that an insight can be gained into the procedure that must be completed in order to make a Preference decision and benefit from this expertise at an early stage.

The market parties are split into three target groups: suppliers, contractors/construction companies and engineering bureaus. A start was made with a general market information meeting for the 15 market parties that are currently already actively working on substantial railway projects in the Netherlands. Eleven market parties then used the opportunity to hold an individual meeting on the basis of a questionnaire. This meeting covered a number of topics, i.e. the content and research questions from Railway map 1.0 and the possible implementation scenarios, contract forms (including the prevention of vendor lock-in), risks during implementation (including costs and technology) and possible management measures, and technical aspects (including transitions, system architecture and experi-

ences abroad). This provided a great deal of information and ideas. The results of the first information round are provided in an anonymous report (annex B).

At the end of October 2013, a second plenary market information meeting was held. During this, the market was provided with information about the result of the relevant research and scenario analyses. They were once again asked a number of questions, this time in relation to the Memorandum on Alternatives. The questions related to rolling stock conversion, sidings and the ongoing development from Level 2 to Level 2+ or Level 3. This latter issue corresponds to the fact that suppliers indicate that they are very confident in the development of Level 3 and recommend applying Level 2 at least. The results of the ongoing market information round will be publicised in Railway map 3.0.

The market information is not adapted in any way and is available for the government as well as market parties. It is important that the tendering principles of non-discrimination and transparency are assured. The information that is obtained during these information rounds may not be allowed to hinder the tendering process. There are checks to ensure that market parties are not excluded at a later stage of the competition as a result of, for example, one market party having too much prior information and thus gaining an advantage in time or expertise. That is why the results of the market information rounds are set out and then made public in an anonymous fashion. As a result, all of the market parties will have the same information at the start of the tendering process.

The most important recommendations from the market parties from the initial discussion round are:

- Implement ERTMS Level 2 during the large roll-out on the free tracks and maybe Level 1 on the large sidings;
- Under Levels 2 and 3, the reliability of GSM-R must be improved; for Level 3, the train integrity issue must be resolved;
- Allow all relevant parties to work together and involve them in the project as early as possible;
- Work with standard contracts in which nothing is overly specified;
- Buy 'off the shelf' as much as you can;
- Choose a system integrator who is responsible for monitoring collaboration and checking to ensure that the specifications are not modified (too much) during the project;
- Make sure there are clear Key Performance Indicators;
- Vendor lock-in is not necessarily negative as long as good, contract-based agreements are made;
- Denmark's tendering strategy is often held up as an example of a system whereby competition ensures low prices and multiple suppliers.

Stakeholder discussions

The aim of stakeholder management is to work towards a well-founded Preference decision via a dialogue with stakeholders (passenger organisations, unions, decentralised authorities, freight and passenger train operators, umbrella organisations, etc). It is thus important to ascertain, at an early stage, where interests and any tricky points lie. This prevents tunnel vision, which can be a risk with any project. All of the relevant parties are provided with information and, where necessary, consulted about the progress of the Exploratory Phase. Interim products, the step-by-step decision-making process and research questions are therefore discussed with stakeholders that have a clear interest in the procedure. The Knowledge Book was shared with these parties in October/November and they were also included in the state of play in terms of research and scenario analyses. In order to prepare for decision-making, potentially ongoing differences of opinion must be examined in good time and, where possible, mitigated. Existing discussions are used and targeted meetings and conversations are organised in line with these efforts.

Prior to the first round of stakeholder meetings, a stakeholder and issue analysis was drawn up. The first round of stakeholder meetings took place in May and June 2013; at these the Railway map 1.0 was explained and research questions were discussed. During these one-to-one meetings, it was also ascertained what degree of involvement was required and desirable for the following discussion rounds. Questions and opinions were inventoried in order to be included in the various studies. In the second round meetings in autumn 2013, alongside the results of the investigations, discussions also centred on the desirable level of involvement by stakeholders after the Preference decision has been made.

The results of the first round of stakeholder meetings were clustered into points requiring attention for the Preference decision or directional decision, points requiring attention for the choices of technology and points requiring attention for the implementation phase.

The most important points from the first stakeholder round are:

- Drivers, in particular, are sure that ERTMS will offer increased safety (large reduction of SPAD incidents) and user-options compared to ATB-Vv and ATB-NG;
- Attention must be paid to the role and task distribution between the various parties after the Exploratory phase;
- One ERTMS concept framework and 'language' is required;
- In terms of ERTMS, it is important that the information about systems and processes is guaranteed independently;
- Every effort must be made to ensure a standard system is implemented;
- The costs form a very important area for attention;
- The benefits for both freight and passenger transport must be charted accurately;
- ERTMS must contribute towards improved information provision on and around the railways.

For a more extensive overview, you are referred to annex C. A second round of discussions is currently being held with stakeholders. During these meetings, the main results of the research that has so far been conducted will be presented and discussed.

In the subsequent process, the stakeholders will again be involved in the results of the Memorandum on Alternatives and the possible content of the Preference decision. This will create an opportunity to consider responses to the preference scenarios in the ultimate Preference decision. In addition, this will enable all of the aspects that form part of the Plan elaboration phase to be prepared and reconciled as effectively as possible with the parties concerned.

Eurobalises in the railway. These function as beacons within ERTMS.

5 Analyses of possible implementation scenarios

Chapter 3 deals with the so-called MIRT regulation framework. The essence of this is that large, complex projects will move via a funnelled and phased decision-making process, in an accountable, transparent and managed manner, to an end-result. It involves a process that works from 'outline to detail'. The MIRT approach ensures that, at every decision-making moment, there is an assessment of whether there is a sufficiently robust foundation for moving onto the next phase. This takes place via formal go/no-go decisions.

This chapter will look at the steps that are involved in the funnelling process, as have been completed so far. The initial step is to determine the realistic scenarios. These are then, in a second step, evaluated via more quantitative analyses; this leads to a selection of a few favourable scenarios. These are currently being investigated in more detail in order to make a Preference decision.

Memorandum on Scope and Level of Detail

This paragraph looks at the first step in the MIRT system funnelling process. The aim of this first step was to set up a framework for the breadth and depth of the research field for the Exploratory phase and provide a base for the development of and further research into the scenarios. The objectives and criteria, points of departure, directional choices and search directions, as set out in the Railway map 1.0, formed the initial frameworks herein.

Method

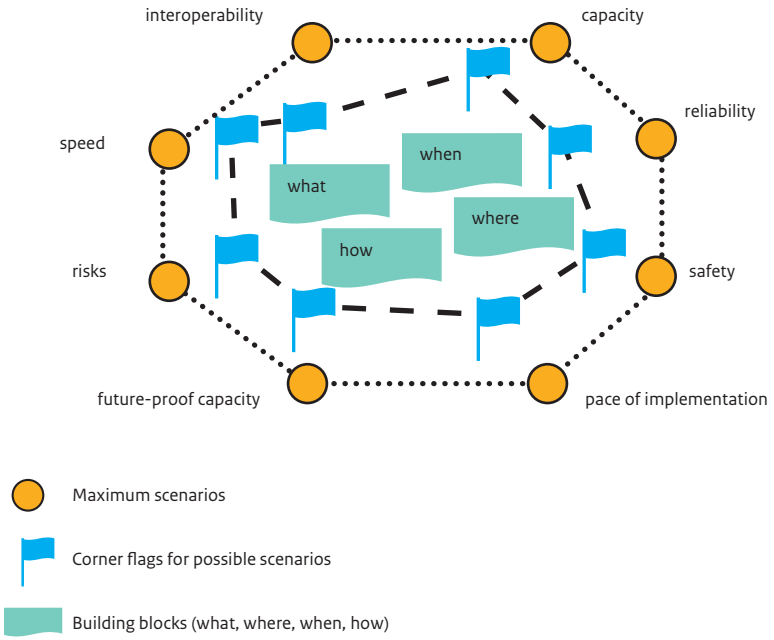
The Memorandum on Scope and Level of Detail (see annex H) first set out the problem analysis and scope of the problem and then defined the current situation (see figure 4) and European obligations surrounding the implementation of ERTMS. These descriptions form the basis of the 0 scenario with which the future scenarios will be compared. More information about the European obligations is included in annex D.

In order to evaluate the scenarios that were developed and researched in the Exploratory Phase, the NRD and objectives and criteria from the Railway map 1.0 were further elaborated in the first version of the scope of considerations. This gives a rough idea of how the objectives and criteria from the NRD will be made operational in order to be able to assess and compare the scenarios.

Creative working sessions with ProRail and NS and also other experts from passenger and freight train operators were used to consider what the possible scenarios could entail, aside from the ultimate method to be chosen for determining the final visions and migration paths. A method was then developed in order to determine the possible scenarios. This method is explained in figure 5.

Figure 4. Current situation regarding train protection in the Netherlands

Figure 5. Process for coming up with possible scenarios



Firstly, in order to end up with these possible scenarios, all possible scenarios (including the extreme ones) were charted on the basis of objectives and relevant criteria from Railway map 1.0. By considering the maximum number of scenarios alongside one another, it was possible limit the playing field to an area within which the possible, realistic scenarios for implementing ERTMS in the Netherlands could be examined.

The building blocks which would be used to construct the scenarios were then determined: the 'what' (technical substantiation), the 'where' (geographical substantiation), the 'when' (temporal substantiation) and the 'how' (the way in which implementation would take place). Combining the individual building blocks for the 'what', 'where' and, to a lesser extent, the 'when' led to the final visions for the implementation of ERTMS in the Netherlands being determined. The target year was set at 2030. In this phase, this is purely intended to function as a calibration/interim step because the European result obligations with respect to TEN-T obligations must be fulfilled in 2030 and because the currently reserved budget in the Infrastructure fund is available over the years up to 2028. Additionally, a place has been allocated to the departure point from the Railway map 1.0 and the LTSA, which involves working towards achieving a transition (system leap) in relation to increasing safety and interoperability and, where possible, capacity, speed and reliability.

Results

All of this led to six possible final visions. The combination of distinctive building blocks for the 'how' and, to a lesser extent, the 'when' provide so-called migration paths (how can the final vision be achieved). The combination between final visions and migration paths led to scenarios. In the context of the coarse analysis in the NRD, it was established that there are three ways to achieve the final visions: via a 'big bang' (migration in one go), on the basis of sub-areas or on the basis of corridors. In the last two cases, two paths can be distinguished: starting on the main railway network or starting in the outlying areas.

The resulting scenarios comprise a combination of one of six possible final visions and one of three possible migration paths. Not all combinations, however, are logical and credible. In this way, in the NRD, 16 possible scenarios were drawn up for the implementation of ERTMS in the Netherlands. These 16 scenarios offer an overview of the field that forms the

basis for ultimately choosing a preference scenario, see table 1. The possible scenarios function as the input for the subsequent research into the Memorandum on the Favourable Scenarios.

Table 1. The 16 possible scenarios

Migration paths (how/when)	Migration in one go	Migration on the basis of sub-areas		Migration on the basis of corridors	
Migration paths (how/when)		First main railway network	First outlying areas	First main railway network	First outlying areas
ERTMS across the Netherlands					
1. Implementation across the Netherlands without transition (system leap)		1		2	
2. Implementation across the Netherlands with transition (system leap)	3	4	5	6	
3. Implementation across the Netherlands with transition (system leap) in part of the Netherlands		8		9	
ERTMS across the Netherlands					
4. Implementation on the main railway network with transition (system leap)	10	11		12	
5. Implementation on the main railway network with transition (system leap) on part of the main railway network		13		14	
ERTMS on PHS corridors					
6. Implementation on PHS corridors with transition (system leap) met systeemsprong	15			16	

Figure 6. The division of the Netherlands into scenario areas for the purposes of research into scenarios (NRD and NKS)

Memorandum on the Favourable Scenarios and quickscanMKBA

The scenarios set out in the NRD were held up to the light once again in the subsequent step in the NKS. The option to further calculate the scenarios played an important role here.

Method and researched scenarios

In the NKS, there was further elaboration of the 16 possible scenarios from the NRD. On the basis of an initial estimate of costs, goal achievement and benefits, 13 focus scenarios were further elaborated; this resulted in the creation of favourable scenarios. The elaboration for the NKS took place on a fairly high level of abstraction. The costs for implementing ERTMS were estimated on the basis of 6 reference projects, the results of which were extrapolated for the whole of the Netherlands. This was therefore a general cost estimate. Assumptions were made using the data that was available at the time, including the transport forecasts for PHS and the corresponding timetable concepts. The quickscanMKBA in this step was not a comprehensive MKBA[18].

In line with the MIRT regulation framework that assumes an elaboration process that moves from outline to detail, the NKS is less general than the NRD. It is for this reason that the final visions and migration paths from the NRD were specified first. A few final visions and migration paths were thus split or nuanced and honed, resulting in:

- 2 distinct 0 scenarios (ERTMS Level 1 or Level 2 in overlay on mandatory EU routes);
- 2 basic scenarios without ERTMS (continuation of ATB) added in order to create a good comparison basis (without ERTMS under similar ongoing circumstances (in this case closed policy with respect to the expansion of ATB-Vv)) and without ERTMS but with optimisations and ATB-Vv across the country);
- 6 more concrete final visions;
- 4 more concrete migration paths.

Table 2. The 13 focus scenarios

	Accelerated first HRN	Accelerated first non - HRN	Natural replacement of rolling stock	Natural replacement of infra	N/A
Basic scenario (without ERTMS)					X
Basic+ (without ERTMS/ATB optimised)					X
L2 TEN-T (overlay) (0 scenario)				X	
L1 TEN-T (overlay) (0+ scenario)				X	
L2 TEN-T+PHS, remaining ATB	X				
L2 TEN-T+PHS, L1 HRN, remaining ATB	X				
L2 HRN, remaining ATB	X				
L2 HRN, remaining ATB, partial L1	X				
L2 national	X	X	X	X	
L2+ national	X				

By combining the 10 final visions and 4 migration paths (for 1 final vision), 13 focus scenarios were created, see table 2. These 13 focus scenarios were further elaborated in the NKS in order to estimate the costs and benefits so that a quickscan social cost/benefit analysis could be drawn up.

[18] (qs)MKBA = (quickscan) Social Cost-Benefit Analysis

Description of results NKS and qsMKBA
In order to estimate costs, calculations of costs for the implementation of various focus scenarios were made for 6 representative railway routes in the Netherlands, with experts from bodies such as ProRail. This context included costs for installation, maintenance and the replacement of parts during the life-cycle, and avoided investments. These costs were then extrapolated for other similar routes in the country insofar as these would be converted to ERTMS in the relevant scenario. The cost estimates were made up of all relevant components from the protection system.

The cost estimate from the NKS is primarily intended to serve a funnelling purpose, i.e. to determine which scenarios are sufficiently interesting to warrant further elaboration in this case. The cost estimates are not suitable to be used to establish a (fixed) budget for the ERTMS project. The creation of such a cost estimate, that fulfils the requirements that are set by the MIRT framework, will take place in the subsequent phase of the Memorandum on Alternatives. The fact that the cost estimate in the context of the NKS and also the qsMKBA have been set up for the purposes of further funnelling, but also contain confidential information, means that the reports will be made available to the House in confidence so as not to impact upon the later tendering process.

These estimates do not yet include scale advantages due to contract forms or risk-surcharges, for example. This could change the overview of the absolute figures and results but is not expected to have any significant impact upon the differences between the variants. The expertise of the NS was used to draw up an estimate of the costs for overhauling rolling stock.

In order to obtain an insight into the impact of ERTMS and to carry out the qsMKBA, further research was also conducted into the benefits of ERTMS. Input from NS and ProRail was used to review the effects on the five set objectives and the criteria from Railway map 1.0 and also the wider social costs and benefits such as economic effects and the impact on the environment. In order to estimate the effects and benefits, literature, accepted rules of thumb and expert opinions were utilised.

Alongside costs and benefits, the Netherlands also focussed on the effects that are more difficult to quantify such as the future-proof capacity of each scenario and the number of different protection systems across the Netherlands in the final vision. The NKS also focussed on the risks in the final visions and migration paths.

Given the confidential nature of the cost figures, table 3 below only provides a qualitative indication of results. The costs and benefits have been compared to the 0 alternative which only fulfils the European obligations to implement ERTMS on TEN-T connections. This involves the lowest investment amount (Level 1). In the scenarios investigated, the implementation of ERTMS on various sections of the network was reviewed. The railway network was thus divided into TEN-T network, the remaining PHS corridors, the remaining HRN and regional lines, see figure 6. Various protection systems are included in these segments in the scenarios. The table below provides a qualitative interpretation of the results.

Table 3. Qualitative interpretation of the results of the NKS and qsMKBA

	L2 TENT+PHS remaining ATB	L2 TEN-T and PHS HRN L1 remaining ATB	L2 HRN remaining ATB	L2 HRN remaining ATB or L1	L2 whole country	L2+ whole country	L1 whole country
Costs	--	--	---	---	---	--	-
Benefits	++	++	+++	+++	+++	+++	0
Ratio costs/benefits	**0**	**0**	**+**	**+**	**0**	**++**	**--**

The costs of Level 1 are significantly lower than those of Level 2. The costs increase in the scenarios as Level 2 is implemented on more network segments. The costs of Level 2+ are lower but, as indicated previously, this technology has not yet been proven.

Benefits increase as more segments are equipped with Level 2. The most important benefit is created as a result of an increase in capacity which then leads to an increase in speed and improved punctuality. Safety also increases and this provides positive benefits.

On balance, the quickscan MKBA demonstrates that the costs and benefits of level 2 counterbalance one another in a high growth scenario. On the regional network, for example, the costs are higher than the benefits. This also applies to a low growth scenario. Given the nature of the quickscan, however, a detailed elaboration has not yet been drawn up and optimisations could well be found. Even though the costs of implementation for Level 1 are lower than those of 2, these are not counterbalanced by the benefits on a national level. This is particularly due to the fact that the effects on capacity are minimal.

Sensitivity analyses have been conducted for the large posts[19] in terms of both costs and benefits. This also clarified the fact that Level 1 overlay is appealing from a cost/technical point of view but delivers little in terms of benefits. Furthermore, it would seem that scenarios in which only the busiest track sections are fitted with ERTMS Level-2 with signal block compression are most favourable when it comes to the benefit/cost ratio. According to the external advisers, given the limited benefits on regional lines, the most reasonable scenarios are those where ERTMS Level 2 with signal block compression delivers most within the Randstad, possibly expanded to include the entire rail network. Given the duration and developments, the recommendation is to include Level 2+, which requires fewer track components, in any subsequent research.

From focus to favourable scenarios

With respect to the final visions, it can be concluded on the basis of the NKS and the qsMKBA that the logical 0 scenario to be elaborated in the future is the 0+ scenario from the NKS, i.e. the implementation of ERTMS Level 1 in overlay on the European mandatory routes (without the non-cross-border passenger rolling stock being overhauled).

[19] The costs and benefits for the RC-growth scenario and the GE-growth scenario have been reviewed.

Furthermore the research also shows that ERTMS Level 2 across the whole main railway network (all segments) has a very high score in terms of a prosperity perspective but is also associated with high investment costs. The most important cost drivers for ERTMS Level 2 are interlockings and cabling (as a result of the new installation of short blocks in order to expand capacity).

ERTMS Level 1 has significantly lower investment costs than Level 2 but, alongside interoperability on mandatory European corridors, only offers limited supplementary benefits and offers no extra benefits on the HRN segment; it does however correspond to lower costs than ATB. It must be noted that Level 1 has not been calculated with block optimisation.

For the segment of regional lines, ERTMS Level 1 leads to practically neutral results and ERTMS Level 2 leads to high costs that cannot be counterbalanced by benefits.

Given the various migration paths to the final visions, it can be concluded on the basis of the coarse analysis that a best migration path cannot be specified on the basis of the NKS. It is clear, however, that natural migration paths are beneficial in terms of costs with respect to accelerated migration; this is the result of higher installation costs (higher design costs as a result of being spread out over time), and lower replacement investments, as well as the point of investment being later. Furthermore, natural migration has the lowest risk profile.

The costs and benefits of the focus scenarios have been charted in a general sense. On the basis hereof, a funnelling process to favourable scenarios has taken place. In the follow-up phase, the costs will be calculated for these favourable scenarios in more detail. Tendering costs and scale advantages will also be taken into account. This will lead to a well-founded cost estimate for the favourable scenarios that can be used to determine the fixed budget for a preference scenario for the purposes of the Preference decision.

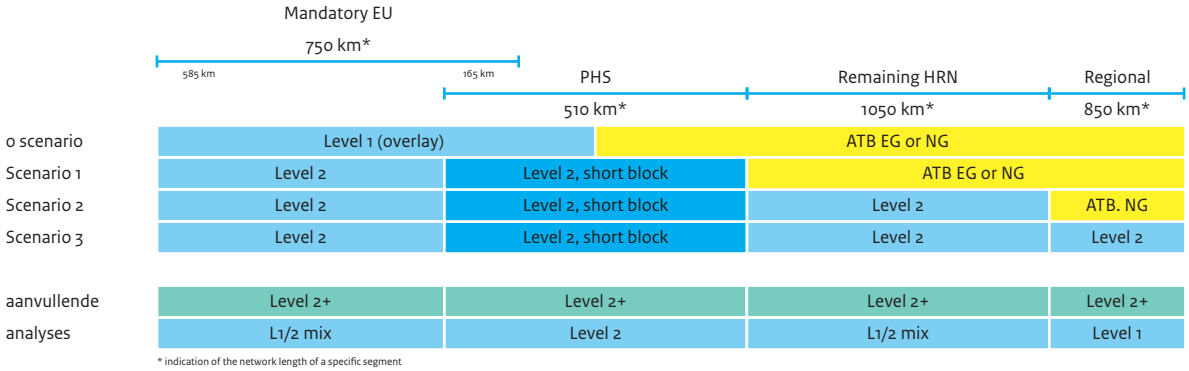
The results of the NKS are sufficiently robust to make a comparison between the different scenarios. This is checked via diverse sensitivity analyses in which a bandwidth for disappointing growth with respect to PHS is also included. In so doing, it is possible to use these research results for the funnelling process, i.e. determine which scenarios are favourable enough to be looked at in detail in the follow-up phase. An independent, external review will be conducted into the plausibility and robustness of the creation of these scenarios via the NKS and the qsMKBA. It is clear that any new railway concepts in the context of the LTSA will also be calculated if possible.

Alongside the 0 scenario on the basis of the findings regarding the final visions, the NKS also provides favourable scenarios that can be further elaborated in the next stage of the funnelling process, i.e. the Memorandum on Alternatives (see figures 7 and 8).

a. A 0 scenario for the Trans European Network corridors that must have ERTMS fitted by 2020 and 2030 (with ERTMS Level 1 on top of the current ATB protection system);
b. A scenario where level 2 is rolled out to the TEN-corridors and PHS-corridors;
c. A scenario where Level 2 is rolled out to the HRN;
d. A scenario where Level 2 is rolled out nationally;
e. A glimpse into the possible alternative scenarios with ongoing development of Level 2 (Level 2+) and a mixture of Levels 1 and 2.

A number of variants with other Levels for the ERTMS routes will also be further examined for all favourable scenarios. Given the expected long period required for the roll-out of ERTMS and the continuing ICT development, Level 2+ will definitely be examined as an alternative.

Figure 7 Scenarios that will be examined in the Memorandum on Alternatives

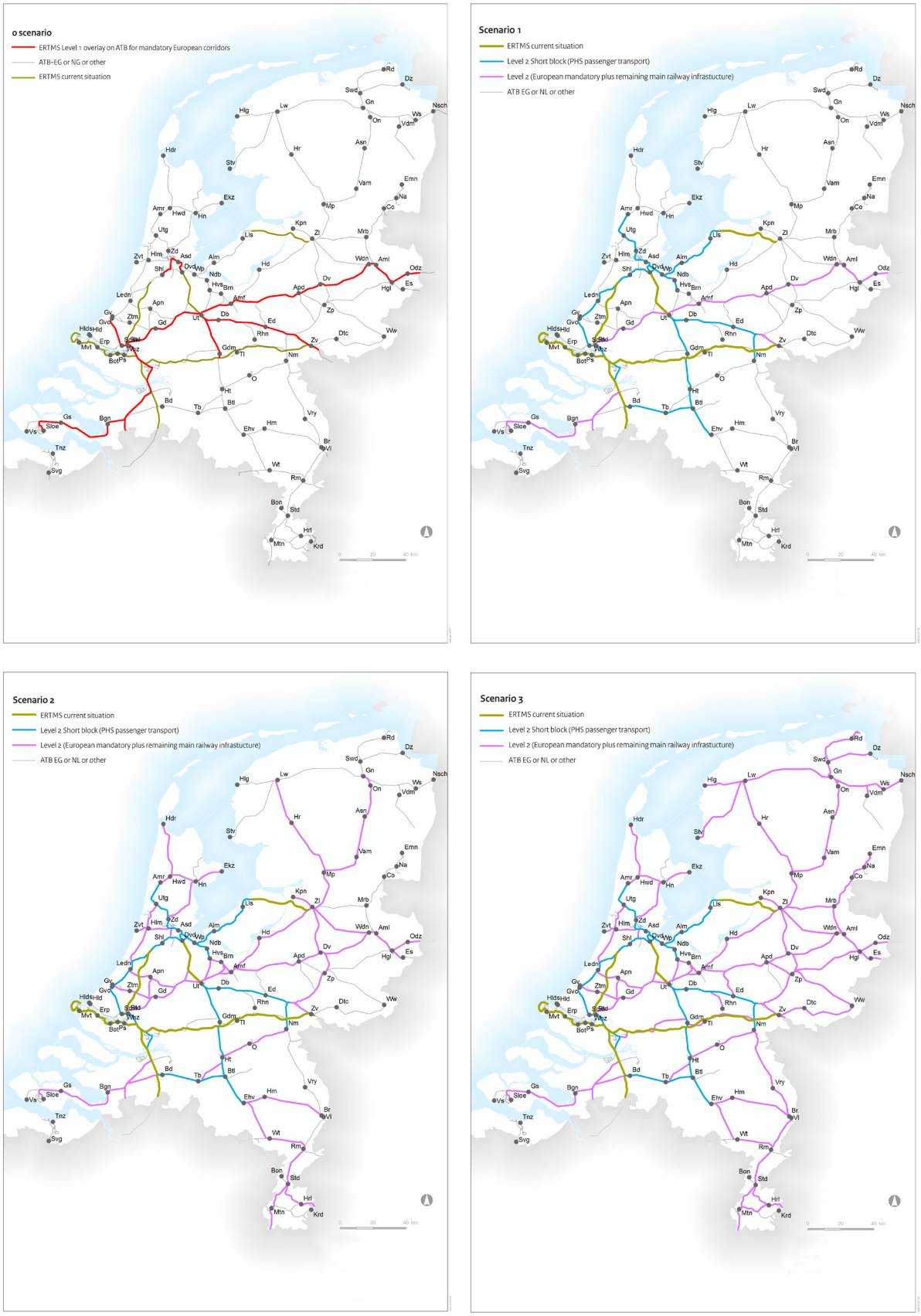


* indication of the network length of a specific segment

The favourable scenarios will be further elaborated and examined in the next step (Memorandum on Alternatives).

Alongside the above, the NKS also provides a number of revelations with respect to the research results that are relevant for follow-up research in the Memorandum on Alternatives. These revelations have been included in the elaboration of the research for the purposes of this Memorandum on Alternatives.

Figure 8. Indicative representation of the routes from the favourable scenarios



The Port Railway Line (Havenspoorlijn) is fitted with ERTMS Level 1

6 Related dossiers

The implementation of ERTMS in the Netherlands corresponds to changes for the entire railway sector. In the long-term it will impact upon various tasks and company processes. There are already many interfaces with other projects and programmes within the railway sector. This chapter provides a brief explanation of the most important related files.

The pilot ERTMS Amsterdam-Utrecht

The implementation of ERTMS is a huge change compared to the existing system. Not only in a technical sense but also in terms of the changes to the necessary expertise and driver methods, timetables and maintenance shifts. One of the conditions linked to the implementation of ERTMS is that passengers and freight transporters will notice virtually no impact from the introduction of ERTMS. In order to gain more experience with ERTMS in practice, and ensure that the implementation runs as smoothly as possible, the IenM tasked ProRail and NS in 2012 with starting an ERTMS-pilot on the Amsterdam-Utrecht route.

This ERTMS-pilot allows the railway sector to examine driving under the ERTMS train protection system on a busy section of track where the current protection system (ATB) is still functioning. This situation is referred to as 'Dual Signalling'. Driving a train in a situation where two systems function simultaneously is new for the Netherlands. The routes that will be fitted with ERTMS from 2016 will ultimately be exclusively equipped with ERTMS however, during the migration period, there will be Dual Signalling situations. That is why it is vital to test and gain experience with dual signalling.

Furthermore the ERTMS-pilot contributes towards gaining further experience with and knowledge about many aspects of ERTMS: putting ERTMS into operation, the impact of ERTMS and dual signalling (ERTMS and ATB) on availability, operational certainty and risks, the way in which drivers deal with dual systems in the cabin, capacity effects, speed increases, overhauling rolling stock to ERTMS, (simplified) access to the national network, training, training materials and experiences of train staff and timetable leaders, new operational rules, maintenance and disruption organisation and the impact on quality of service for the passenger and freight transporter.

This experience and expertise is principally useful for later phases within the project, when more specific reviews will be made of the migration phase, but it already provides many general insights. For example, the pilot demonstrated that it is important, when overhauling trains, to take the time required and not try to rush things as this will often end up taking more time and energy as a result of damage control. Good preparation and then working in a thorough, ongoing manner is often much more productive.

Alongside freight transporters and contractors, NS HiSpeed (with ICE) and NS (with 10 overhauled SLT's) are also cooperating in the pilot. Some journeys on the regular schedule have been carried out using ERTMS since November 2013. This trial must provide additional expertise but may not be have a detrimental impact on customer experience.

The Amsterdam-Utrecht pilot has largely run parallel with the Exploratory Phase; this will also be the case during the Plan elaboration phase. The pilot thus provides input for decision-making, plan development and a thorough implementation phase. The progress of the pilot is monitored by the Regional Group ERTMS. The relevant knowledge that has been gained from the pilot will be used within the national ERTMS project.

Train speed and journey times

In principle, ERTMS facilitates speeds far above 200 km/h. In terms of the approach to and objectives of the LTSA, it is advisable – for the implementation and increase in speed – to look at the average speeds and the impact of these on the passenger. By focussing exclusively on achieving peak speeds, there is a significant chance that investments will be justified in a unilateral manner and from the perspective of a derived goal rather than from an integral point of view (i.e. via weighing up the options of infrastructure, safety and rolling stock). It is therefore all about integrated considerations.

Since the 1980's, the railways have been suitable for speeds of up to 160 km/h. Most NS rolling stock can also travel at this speed. Research has shown that journey time gains are not necessarily to be found as a result of raising the maximum speed of 140 km/h to 160 km/h on the 7 suitable routes, but that increases in the average speed that ERTMS can offer via smaller speed traps can lead to travel and journey time gains that are appealing for passengers and train operators. The fact that limited rolling stock is made available to travel at 200 km/h on HSL-Zuid and the integrated HSL-Zuid and HRN, will therefore have only a slight impact as long as the infrastructure of the HRN remains unsuitable for 200 km/h and other trains cannot travel more quickly. Also, the greater the speed differences, the lower the level of remaining capacity. Increasing the maximum speed therefore remains a question of customisation, even under ERTMS.

In contrast, smaller speed traps can raise average speed locally and therefore also improve average journey times. In addition, ERTMS can facilitate speeds of 160 km/h on the 7 track sections that are suitable for this. The track sections and also the rolling stock are used as effectively as possible in this context. Higher maximum speeds in the densely populated Netherlands, with its many stations on the HRN have little added value and are susceptible in terms of infrastructure modifications.

Long-Term Railway Agenda

As already indicated in chapter 2, ERTMS can provide an important contribution to multiple objectives from the LTSA. It is thus important to keep an eye on the interfaces between these two dossiers. The yet to be chosen operational railway concept from the LTSA could thus impact upon the implementation, costs and benefits of ERTMS, e.g. via the choice of the traffic control and disruption management method. On the other hand, the implementation of ERTMS influences (the choice of) the operational railway concept because ERTMS allows operation to be more flexible and facilitates different traffic control and disruption management methods. A similar, mutual dependency also applies to the recalibration of projects and programmes. These mutual influences will be charted accurately in both dossiers. Where possible, the choices to be made in each dossier will be harmonised with one another.

High Frequency Rail Transport Programme (PHS)

With the realisation of the PHS by 2028 at the latest, it will become possible, on some routes, to harmonise the installation of ERTMS on corridors with the realisation of high frequency timetables, in terms of plan elaboration and execution. The Plan elaboration phase will demonstrate whether this will lead to cost reductions.

Mandatory EU ERTMS corridors and OV-SAAL corridors

The plan studies for mandatory EU ERTMS corridors will not be tackled as separate projects but shall form part of the plan elaboration for Railway map ERTMS.
The medium-term measures for the OV-SAAL corridor encompass a range of measures, including the installation of ERTMS that will be realised by 2023 at the latest. The OV SAAL Medium-term plan study focuses on the ERTMS elements insofar as these specifically relate to the OV SAAL corridor and the Gooilijn. The generic issues will be answered within the plan elaboration for the Railway map ERTMS. This will take place in close consultation.

Mistral, ATB-Vv, Measures for Reducing Follow-up Times, Traffic Control and Disruption Management systems, maintenance and replacement of protection systems

Railway systems must be maintained as a result of ageing. Improvements can then be introduced into these systems.

A Preference decision regarding the implementation of ERTMS can weigh up which replacements must take place in the years prior to the installation of ERTMS, including those in the context of Mistral. Thorough consideration can thus be made of the type of interlocking with regard to the costs and the period up to installation of ERTMS. The replacements that will be carried out in the ERTMS installation period will be integrally harmonised with this.

With respect to the national implementation of ATB-Vv, ProRail was tasked with drawing up a concrete plan of execution, including a cost overview, of the further implementation of ATB-Vv for all manned signals with a seamless connection to the implementation of ERTMS. ProRail has begun working on the necessary preparatory measures. External obligations have not yet been entered into.

Traffic control and disruption management systems will be updated in the context of the Redesign of these traffic systems. The exploitation of the ICT component of ERTMS will be reconciled herewith.

Measures for Reducing Follow-up Times (previously known as Short Follow-up) focus on realising shorter follow-up times between trains. Better exploitation and improved quality of execution can thus be achieved. This concerns a range of measures that relate to all aspects of the railway system: infrastructure, rolling stock, timetables, personnel and management systems that can be used generically or on a location-specific basis. Around 80% of the measures in the toolbox of measures are also useful under ERTMS; around 20% of the measures are useful up to the moment that trains are driven under ERTMS. That is why the elaboration of measures for shortening follow-up times is closely harmonised with ERTMS implementation.

4th Rail package

The House of Representatives will be provided with separate information regarding the European 4th rail package. No significant impact is expected on the implementation of ERTMS. Cohesion, however, must be continuously monitored.

Cross-border railway lines

As also indicated in chapter 2, ERTMS offers opportunities for cross-border freight and passenger transport. A number of border crossings are currently being equipped with ERTMS, e.g. the 3rd rail at Zevenaar which takes the Betuweroute through to the German border. Belgium is also transferring to ERTMS and, in 2022, the entire country will be equipped with this system.

Within the further elaboration of a preference scenario into an implementation strategy in the following phases of the project, discussions with Belgium and Germany must be continued in order to ensure the implementation strategy of the Netherlands connects into the strategies of our neighbours. The Anker/Mastwijk[20] motion must be considered in this context.

[20] Kamerstukken II, vergaderjaar 2009-2010, 32351 nr. 8

Drivers working with DMI (Driver-Machine-Interface).

Other developments, policy wishes and regulations

Developments follow on from one another in rapid succession. In the summer of 2013, ProRail and a number of sector parties carried out a "proof of concept" for ERTMS Level 3. This demonstrated that Level 3 is primarily a further development of Level 2 and that track detection in the track can be useful for restoring the rail service after disruption.

The railway sector is characterised by high ambitions. Now that the path towards ERTMS has been laid out, there are more frequent calls for a new traction facility (25kV or 3kV on the HRN). The ambitions for ERTMS, just like those of PHS, have been calculated and are achievable with the current traction.

In order to ensure effective implementation, modifications to regulations will be necessary. For example, by determining the moment at which only rolling stock that is fitted with ERTMS can run in the Netherlands, but also by figuring out the details of operational rules, etc.

7 Follow-up steps towards directional decision-making

On the basis of the favourable scenarios, work will take place in the coming months on moving towards a directional decision. The following paragraphs briefly outline what research is still required and on what level of detail these studies must be conducted. A closer look will also be taken at the risk analyses that are necessary and the governance for the subsequent phase.

Memorandum on Alternatives

The next step in the MIRT funnelling process is to move to a preference scenario. Traditionally, this takes place using a so-called Memorandum on Alternatives. On the basis of the results of the Memorandum on the Favourable Scenarios and the quickscan MKBA, this work has already begun with the aim of making a Preference decision or a directional decision that accompanies Railway map 3.0, in this case the Memorandum on Alternatives, in the first quarter of 2014.

- The first step in drawing up the Memorandum on Alternatives concerns the further development of the scope of considerations. The general scope of considerations from the NRD will be further substantiated for the favourable scenarios from the NKS. In order to draw up with the Memorandum on Alternatives, the following sub-studies have been started:
- Capacity analyses: this investigation will include analyses of the use of the railways and the changes herein if ERTMS is implemented and will offer an insight into the concrete effect of ERTMS on capacity, journey times and punctuality.
- Financial analyses/Business Cases: these analyses will set out the financial impact of ERTMS implementation for train operators, infra managers and government. Research must also be carried out into the opportunities in terms of tendering and contracting.
- Costs: this research will encompass an accurate cost estimate for the favourable scenarios on the basis of which a fixed budget may also be determined for the preference scenario. The scenarios that will be further researched are:
  a. A 0 scenario for the Trans European Network corridors that must have ERTMS fitted by 2020 and 2030 (with ERTMS Level 1 on top of the current ATB protection system);
  b. A scenario where level 2 is rolled out to the TEN-corridors and PHS-corridors;
  c. A scenario where Level 2 is rolled out to the HRN;
  d. A scenario where Level 2 is rolled out nationally;
  e. A glimpse into the possible alternative scenarios with ongoing development of Level 2 (Level 2+) and a mixture of Levels 1 and 2.
- Other effects: this research will also provide an insight into other effects (not capacity effects).
- Social Cost/Benefit Analysis (MKBA): in this research, the costs and benefits of ERTMS implementation will be elaborated so that an insight can be provided into the extent to which the favourable scenarios can contribute to society.
- Risk analysis: This research will draw up a qualitative and quantitative risk analysis for each favourable scenario in order to determine a risk profile for each scenario.

With the fully substantiated scope of considerations, the favourable scenarios and their scores for the various aspects from the scope of considerations can be compared to one another in order to arrive at one scenario that can be used to implement ERTMS in the Netherlands.

Financing

On the basis of the NKS and the qsMKBA, and in the context of the Memorandum on Alternatives, the costs of the favourable scenarios are currently being calculated. This will lead to the creation of a cost estimate and business cases. On this basis, the first useful discussions can be held about financing the implementation of ERTMS. Meetings will be held with parties in this regard at the beginning of 2014. In this context, the choice of scenario (e.g. national implementation or in part of the Netherlands) and lead times are important.

The Plan elaboration phase

On the basis of the Railway map 3.0, in this case the Memorandum on Alternatives, a preference scenario will be chosen. A decision will then be made regarding the implementation of ERTMS in the Netherlands on this basis.

This decision represents the subsequent go/no-go moment in ERTMS decision-making. The decision will be taken by the Cabinet on the basis of the decision-making information as is available at that moment. This concerns information about the extent to which the objectives can be achieved, which collectively correspond to the transition (system leap) for the railways as a whole and therefore go hand-in-hand with costs and risks.

All of this then forms the starting point for the Plan elaboration phase. While the plan is being elaborated, the sector (under the leadership of the IenM) will draw up a concrete, integrated ERTMS implementation plan for rolling stock and infrastructure on the basis of the preference scenario from the Preference decision.

The fact that ERTMS is still under development, research issues are not all expected to be definitively resolved and there is some cohesion with other projects and stakeholders, means that IenM will continue to lead the project as an independent, in this case responsible, party during the start of the Plan elaboration phase.

The most important issue to be tackled during the Plan elaboration phase will be:

- In order to put a complex system such as ERTMS into operation and maintain it, system integration is vital. System integration forms one of the workflows in the plan elaboration but is determined independently because system integration requires independence from the interests of the parties involved. This particularly concerns the coordination and analysis of aspects that transcend the individual parties.
- The Plan elaboration phase will include preparations for ERTMS tendering. Effective preparation is important because this could lead to substantial savings in terms of time, money and setbacks. This begins with attracting sufficient, qualified capacity.
- A comprehensive market and tendering strategy will also be drawn up for the preference scenario and the tendering documents will be set up in order to engage in the formal tendering procedure.
- Plans will also be drawn up to incorporate ERTMS in the commercial processes of the company.

The aim is to stabilise the scope of the ERTMS project as quickly as possible. On this basis, project decisions/tasks concerning the State Secretary of Infrastructure and the Environment in order to tender for and execute ERTMS will be determined.

Governance

Leadership of the Exploratory Phase for the implementation of ERTMS in the Netherlands is the responsibility of the Ministry of Infrastructure and the Environment (IenM). The ministry is working on this Exploratory Phase with Prorail and NS in the ERTMS Steering Committee on a directorial level, with a collaborative structure under this.
Given the uncertainties and the risks that have been ascertained, even after the Preference decision has been made, further research must be conducted until the time that a transfer

can take place to tender on the basis of a stable scope. The aim is to maintain current governance until that moment via the collaborative working model under the leadership of IenM and with as much involvement as possible of all other stakeholders and market parties. Stable scope is vital for an effective tendering process. How this will be achieved and how the governance will be set up will be further tackled in the Basic Report and/or the Preference decision.

Risks

In the coming period a number of additional investigative issues that need to be examined will come to the fore as a result of the Knowledge Book 1.0 and the Maturity Study. Extra research is also required in the context of the Memorandum on Alternatives which forms the basis of the Preference decision.

Before a Preference decision can be offered to the council of ministers for definitive decision-making, a number of risks will have to be charted and mitigated. Some of these risks will have to be mitigated in the Plan elaboration phase. The risks can be divided into three categories: (a) standard project risks, (b) technical risks, (c) unforeseen risks. Initial risk inventories have now also been carried out; these will be elaborated in Railway map 3.0.

An important point for attention in this context is transition areas between the current system and ERTMS. During the migration phase, but also in some final visions/situations, there will be a case of temporary (or permanent) transition areas between the lines where ERTMS has been implemented and the lines where ATB is still in use. The preconditions that passengers and freight shippers must not be unduly aware of the ERTMS implementation and that personnel can work safely, means that the elaboration of the migration path and the management of the transitions are important points within the project follow-up.

The quantity of transitions during migration and the ultimate final vision thus forms a significant evaluation criterion for the various scenarios.

In conclusion

Over the past few months, a great deal of research has been conducted into the options for ERTMS implementation in the Netherlands. Progress has certainly been made. A number of further studies are, however, required before a Preference decision or directional decision can be made in the first quarter of 2014. The Memorandum on Alternatives that will be drawn up in the coming months will offer a basis for this. Alongside the Preference decision or directional decision, the basic report for the purposes of the Major Project status will be published; this will contain details of project management and substantiation of the project organisation in the follow-up phase in order to create a phased implementation for ERTMS with the existing railway budgets.

Annexes

Annex A: ICT

This annex will take a more in-depth look at a number of important areas for attention in relation to ICT within the ERTMS project that is currently being developed.

System integrator

The first task of the system integrator is to ensure that a working system is provided for the entire scope of the project. A precondition for this is that the system must fulfil the previously set service requirements. The system integrator initiates the creation of implementation choices that transcend the individual parties[21]. Aspects such as consequences for service requirements and total social costs and income will play a role in this type of consideration. The service requirements also play an important role when setting up the ICT architecture. This will determine, among other things, which components must be made with redundancy in order to ensure sufficient guaranteed availability.

Cohesion of ICT systems

In many organisations, an ICT system is not a separate component but the systems actually support the primary processes via the exchange of data. This is no different in the case of the most effective implementation of ERTMS. It must be noted in this regard that many of the systems that support the train loop are managed by Prorail. The successful implementation of ERTMS requires the expertise of all of the systems involved being bundled in order to end up with an implementation process that can fulfil all of the service expansion requirements.

Flexibility

From the perspective of ICT, the ERTMS implementation process involves various generations. This means that it is impossible and undesirable to plan exactly which version of a system will be implemented years in advance. Impossible because the system versions, for example, may not be available after a few years and undesirable because new systems usually offer more for less money. The challenge is therefore to retain flexibility in the tendering process on the one hand and, on the other, to offer sufficient certainty in terms of justification and in relation to ERTMS suppliers regarding the product to be supplied. This concerns content, costs and planning.

In line with the flexibility outlined, consideration must be made of the new versions of the standard (in ERTMS-terms: baselines) to be set by the European Rail Agency (ERA) and new versions of the implementation of a baseline by a supplier. This issue was pertinent right from the start of the project. One the one hand, a great deal of experience has been accumulated, both in the Netherlands and elsewhere, with the implementation of systems based on ERTMS baseline 2 but, on the other, the ERA has stopped updating baseline 2 and baseline 3, on which Denmark has based its implementation strategy, would appear to be more future-proof.

In terms of the implementation of ERTMS, effective configuration management must be set up so that it always remains clear which versions have been implemented and where and whether and how Track-Train-Integration tests have been conducted.

[21] This could include, for example, determining the position of the train. The accent herein can be placed on more train detection systems in the track (under management of ProRail) or more expensive odometry in the train (from the train operator).

Standard products

In many ICT projects, it has been clear that predictions are much easier to make on the basis of standard ICT products rather than customised products. With a customised product, it often takes longer to initially come up with a working concept and it can then also take longer to obtain or provide a stable product. In Denmark, during the tendering process for ERTMS, a choice was therefore made to set as few specifications as possible and establish the architecture on the highest possible level of abstraction. This provides the supplier with the opportunity to fill in the details with a standard solution that is already available. During the Plan elaboration phase, this example and others will be examined carefully

Annex B:
Report of individual meetings with market parties (1st Market information round)

In July 2013, IenM in collaboration with ProRail and NS, held a general information meeting for the 13 market parties that are currently active within the Dutch ERTMS market and which seem to be suitable for involvement in the implementation of ERTMS. In this meeting, the state of play with respect to the ERTMS project was explained and there was a presentation of 11 questions which, if required, can be answered by the market parties in one-to-one meetings. Over a period of 2 weeks, meetings were then held with the 11 market parties which expressed an interest: 4 suppliers, 5 engineering bureaus and 2 railway contractors. These parties provided their visions and approaches to the implementation of ERTMS on the basis of the questions. This document provides a management summary of the meetings. The aim of these meetings was to compare and contrast the various visions in a market information round. This market information will be followed up by a market consultation as preparation for a possible tendering round.

ERTMS added value

The market parties see added value for the Netherlands in ERTMS in a number of areas, particularly given the other ambitions for the railways. The Netherlands is a pioneer compared to other countries in terms of train protection and a greater leap forwards is therefore required in other countries in order to achieve improvements and ensure migration is useful.

ERTMS increases safety as a result of keeping the train driver continuously informed. As a result, the chance of accidents is reduced. Working on the railways also becomes safer as a result of Hand Held Terminals being used by track workers. Under ERTMS, SPAD incidents (Signals Passed At Danger) would be practically impossible (except in the case of issues such as sliding on slippery rails). The Levels of ERTMS do not differ much in this regard. Some parties believe that specific attention must be paid to freight corridors from a safety perspective; ERTMS also contributes to the safety of these corridors.

The higher the Level of ERTMS, the fewer track components are necessary. This increases reliability because there are fewer disruptions involving outdoor elements. With Levels 2 and 3, more GSM-R data traffic is required than for Level 1 and this could have a negative impact on reliability because the GSM-R around sidings is not currently equipped for ERTMS Level 2 or 3. In addition to verbal exchanges, there is also the issue of data communication via GSM-R. Furthermore, it will be more difficult to restore everything in Level 3 in the event of a breakdown.

ERTMS physically and theoretically enables higher train speeds. There are currently large gaps between the ATB speed traps. These can be used more effectively with ERTMS. There are only limited opportunities, however, for increasing the maximum speed to 160 or 200 km/h in the existing infrastructure because the ATB protection system is the limiting factor on just a few lines in the Netherlands.

According to the parties, Level 1 will provide capacity gains compared to ATB EG. In terms of capacity improvements under Levels 2 and 3, it would seem that capacity gains can be expected but also that additional investments in the infrastructure and timetables will be necessary in order to genuinely achieve these gains. The maximum capacity on sidings is partly dependent on the capacity of the Radio Block Centres (RBC's). The difference in capacity between Level 2+ (with short virtual blocks) and Level 3 is just 1.5%, according to the IUC/Aachen study from 2007.

ERTMS offers better interoperability from the perspective of European guidelines. It reduces the number of protection systems and eases the passage between them within Europe. ERTMS can contribute towards sustainability. Improved brake curve monitoring means that braking is more efficient and there is less unnecessary acceleration and deceleration. As and when the share of rail transport is increased within the modal split in the Netherlands, this will also contribute towards sustainability.

The fact that the Netherlands is relatively advanced compared to other countries in terms of train safety, means that a greater step forward is required. ATB is comparable with ERTMS Level 1 so many parties are of the opinion that Level 2 is the more logical choice if the aim is to achieve a transition (system leap) in terms of the 5 objectives from Railway map 1.0.

System choice

The market parties vary in terms of their visions of system choice. Several market parties believe ERTMS Level 1 on the current signalling system to be a step backwards. Most market parties recommend ERTMS Level 2 (which facilitates central monitoring) for the large-scale implementation on free tracks and Level 1 for large sidings. The latter concerns the fact that GSM-R is not (yet) capable of dealing with sufficient capacity. This particularly applies to the four large station sidings. With Levels 2 and 3, this plays a more significant role than with Levels 1. A few market parties see Level 3 as a good ambition but indicate that its development could be a long time coming. Other parties recommend implementing Level 3 as quickly as possible. According to the market parties, the transfer from Level 2 to Level 3 is just a question of a software upgrade. Level 2+ would seem to be a good option to migrate to via Level 2. The step from Level 1 to Level 2 is thus bigger than from Level 2 to Level 3. The market parties note that under Level 3, alongside the reliability of GSM-R, train integrity is also an issue that must be resolved.

The market parties vary in their opinions concerning the moment when Level 3 is expected to be ready. A number of parties recommend starting the implementation where the best capacity gains can be achieved. A step-by-step approach is recommended so that a team of specialists can move from one project to another.

Parties also mention that not every supplier has train management and Automatic Train Operation (ATO) in their standard range.

Dual situation and overhauling rolling stock

The market parties recommend that the new system is overhauled in parallel, creating a temporary dual situation. This is not as pertinent an issue on track sections but it is on a national level. As a result of costs, the parties advise keeping this period as short as possible. The advice is to also avoid transitions as much as possible. Most of the market parties see the intention to start with the overhaul of rolling stock as the most logical process. Furthermore, they advise that the overhaul of rolling stock and the infrastructure run parallel to one another. A number of market parties go even further and recommend that rolling stock is overhauled and then infrastructure.

Corridors

Some of the market parties recommend approaching migration per corridor, as they run through disentangled sidings. Working with corridors limits the number of transitions around sidings, for example, and leads to the network becoming more reliable and robust. This is also better for drivers and train dispatchers as a result of uniformity. The advice is to begin with one corridor and then allow subsequent corridors to connect into this. This will prevent the creation of 'ERTMS islands'.

Collaboration and tendering

A recommendation has been provided to allow all relevant parties to collaborate and to involve them at the earliest possible stage. If contractors or cable installers, for example, are only involved at a later date, this can lead to costs rising in the long-term. If ERTMS is tendered out, standard contracts which are not overly specific are recommended. The telecoms sector is used as an example here; contracts of 150 pages have been reduced to standard contracts of just 12 pages. If there are particular specifications, the market recommends buying 'off the shelf' as far as possible and trying not to stipulate specific requirements for the Netherlands. This will otherwise lead to extra costs.

The market parties indicate that central direction is an important factor for the success of the project. This could be achieved via a system integrator. The system integrator monitors collaboration but also makes sure that specifications are not being overly modified during the particular phase. Clear KPI's also contribute towards successful implementation, given that people must be accountable to the KPI's. Some market parties stress that drivers and dispatchers must also be involved at an early stage. They work within the primary process and can provide valuable input.

ERTMS off the shelf

The technical maturity of ERTMS varies but all suppliers can deliver in the Netherlands. ERTMS is a generic system in terms of technical and elaboration protocols but this is not yet the case in relation to regulations and usage. The hardware is available but still involves supplier-specific systems. Many of the market parties also regard an 'open standard' as a desirable future vision.

Necessary developments

Developments are still necessary in order to make ERTMS suitable for sidings, such as GSM-R. The maximum capacity of RBC's could also be a problem on sidings such as Utrecht Centraal. The connection between RBC and interlocking has not been defined within ERTMS specifications and is becoming more integrated. A number of parties refer to the Netherlands as a 'patchwork quilt' with a variety of different systems. Standardisation (of both ERTMS and other protection components) would be a good solution in this context.

Parties recommend that the Netherlands stays ahead of the game but not necessarily in the advanced guard. By staying a little behind the others, teething problems can be resolved by other parties but the Netherlands can stay sufficiently advanced to remain competitive. This is important both for expertise and the competitive position of Dutch engineering bureaus. The Netherlands has a tendency to try to reinvent the wheel; we must look more to the experience of others.

The fact that ERTMS relies more on ICT means that the market parties need personnel with different qualifications and training than their current personnel. Repairs with ERTMS will be carried out with the computer, not the hammer.
Certifying ETCS per train type is relatively expensive. The recommendation is to streamline the certification procedure in the run-up to the large scale implementation so that these costs can be managed.

Vendor lock-in

At the moment, there is a vendor lock-in with regard to train protection. A number of market parties have indicated that vendor lock-in is not necessarily negative as long as good, contract-based agreements are made; vendor lock-in can also lead to lower prices, jobs and commitment. An open standard helps to avoid vendor lock-in.

The market parties differ in opinion concerning whether or not the blueprint of the ATB EG cabinet in the train is sufficiently transparent for other parties to develop an STM. The

market parties also have differences of opinion when it comes to whether there is a vendor lock-in for the OBU's. Denmark's tendering strategy is often held up as an example of a system whereby competition ensures low prices and multiple suppliers. This applies to both rolling stock and infrastructure. According to the parties, there is no real vendor lock-in with respect to the interlocking even though the exchangeability between interlocking and RBC's is a problem. Collaboration between suppliers is already taking place on HSL-Zuid.

Several market parties have indicated that they are prepared to enable the Netherlands to implement changes/projects within the ERTMS system.

Critical success factors

The market parties refer to a number of critical success factors, some of which have already been indicated. Other success factors are:

- Developing an overall vision for the railways that goes further than just the implementation of ERTMS. An integrated viewpoint is vital;
- Not becoming too focussed on the different Levels but assuming functionalities and talking in terms of developments;
- Preventing the unchecked growth of different systems, resulting in a patchwork quilt;
- Solid version management, issue management, configuration management and safety is vital;
- Guaranteeing a long term commitment of parties;
- Removing complication from the railway system;
- Using simulations for testing.

Annex C: Meetings with stakeholders

Areas for attention for the Preference decision/directional decision

- Drivers believe that ERTMS offers increased safety (no more SPAD incidents) and user options than ATB-VV and NG. The drivers must be kept informed and involved, certainly in order to combat erroneous information and ideas that can 'do the rounds' when there are incidents.
- The use of an ERTMS concept framework and language in use, installation, procedures and training must be unambiguous and clear for all of the concerned parties.
- The biggest threat is costs. Costs for conversion are being scrutinised. If insufficient funding is available, this will result in the Netherlands running trains on at least four different systems for a very long time. How are the benefits of ERTMS shared? If the costs lie in an area where the benefits are not felt, this must be counteracted by IenM. There is some confusion about possible savings in terms of installing infrastructure as a result of ERTMS.
- The ILT must be involved in the appropriate manner.
- Rover is ready and waiting for the vision from IenM on the transfer phase to ERTMS and for clarity about Mistral, ATB-Vv, ATB-147, Robuust Spoor, etc.
- As long as capacity gains from ERTMS are formulated in terms of follow-up times, the paradigm of a fixed plan is assumed. Follow-up time can be compared to the performance of a typewriter. You don't look at the keystrokes per minute, but at the integral performance of the system.
- There are now four lines in the Netherlands with ERTMS. On four lines, five versions of ERTMS are used. This makes it almost impossible to optimise the system.
- An important requirement in this is that legislation on the training of drivers must connect into the actual situation.
- Safety risks must be translated for the market parties. When delivering the infrastructure, everything (ICT in particular) must be well documented.
- On the basis of an RFI (keeping options open instead of binding offers), market parties must promise that capacity will increase so that they can also bear the risks for technology.
- Even though savings must be possible for the implementation of ERTMS, for the moment there are only additional costs. This misplaced effect will not be counterbalanced by the benefits of interoperability. Nevertheless, this bump in the road must be tackled one way or another. Only once Germany has introduced ERTMS will the invested amounts start paying for themselves.
- A higher capacity for the railways can also lead to potential problems. The limits for vibrations and noise are then reached more quickly.
- In terms of ERTMS, it is important that the information about systems and processes is guaranteed independently. This does not mean by industry or a train operator. Nor does it involve any parties with a direct interest.
- Government and train operators would like to receive the ERTMS specifications as quickly as possible. A situation like the case with the OV chip card, where requirements were set (at the time for buses) and corresponding investments were made that then turned out to have been for nothing because the specifications were actually very different, must be avoided.
- Rover and LSvb stress that it is vital that IenM takes the lead in the ERTMS project. Only then will there be a scenario that is best for The Netherlands Plc.

Areas for attention for the choice of technology

- There is vulnerability in terms of a freight driver having to calculate and enter the brake curve with ERTMS.
- GSM-R must function without problems before ERTMS can be implemented.
- Savings must be found for balises, given their important role.
- The sales focus of suppliers means that the anticipation of and preparation for breakdowns receives too little attention during tendering. During a breakdown, a train with ERTMS must be able to move under its own steam in order to pass the next balise and make contact with the system. At the moment an auxiliary locomotive is required. There must also be clarity regarding authorities if ERTMS/ECTS fails. It takes a few seconds before a train begins braking once ECTS has failed because Movement Authority cannot be overruled in ECTS.
- Engineering bureaus often work towards and on sub-optimal solutions. Prorail must take over the standard solutions from the large suppliers and not have any 'bells and whistles' added on by third parties.
- The Netherlands must ensure that ERTMS, in terms of technology, is completely compatible with the systems that are used in Germany. This also applies to detection problems.
- How does IenM perceive the ERTMS 'shunting' mode? This means that at Kijfhoek, for example, a function is switched off within ERTMS, resulting in the train being driven without a protection system. In ATB-EG this is not possible.
- ERTMS must also contribute towards improved information provision on and around the railways.

Areas for attention for the implementation phase

- Transfers from ERTMS contacts between RBL's must take place without a transfer period. There are currently transfers from one to the next supervised area during which there are 10 seconds where there is no management. In principle, in these sections, there are 10 seconds during which trains could drive towards each other without the system intervening. They would not collide but could be heading towards one another without a red signal.
- The period for stabilising ERTMS must be included within the cost/benefit analyses. A long period of instability for railway traffic would not be appreciated by passengers. Safety problems could also occur. On the Betuweroute it took 5 years to stabilise the system.
- As well as drivers, you must also review the changing role of mechanics.
- The Betuweroute plan incorporated a phase of teething problems. The train operators were to obtain agreed savings for these. These savings, however, were not defined accurately enough and this led to a range of problems. This debate can always be predicted and conflict resolution must be agreed properly in advance. The implementation of ERTMS on the Betuweroute went well but a bad taste was left in the mouth nevertheless. The real problem was the difference between the moment of hard installation in the rolling stock and it actually working effectively. Train operators will encounter problems and prepare claims. So it all goes back to what was originally agreed.
- Conversion has a huge impact on the available capacity. Now that Germany has finally agreed to the installation of the third rail, it means that between 2016 and 2022, only one rail will be available between the Betuweroute and the German main railway. This bottleneck will have to be accommodated by the Brabantroute. The ambitious growth will thus be problematic in that period. This means that Basisnet must be amended and that many more trains must pass by Venlo; another AMVB modification is therefore necessary. If IenM start, at the same time, with the installation of testing of ERTMS on these routes, there could be insurmountable problems. The same question marks are now being raised with regard to major maintenance in the period on these track sections. The construction period has already been reduced by 4 years as a result of keeping 2 rails open for three weeks and a single rail open for one week on a rotational basis. This approaches the level of reliability that is required of freight shuttles.

Annex D: European obligations

ERTMS is a system that will eventually be rolled out across Europe and that will deliver significant advantages in the long-term. When the railways in neighbouring countries are also fitted with ERTMS, cross-border transport of freight and passengers is facilitated without a locomotive having to be fitted with multiple protection systems and without the driver or locomotive having to be changed at the border. Rolling stock with dual equipment that has to be changed over by a dual-trained driver will also become a thing of the past. ERTMS is thus an important resource for stimulating (regional) cross-border travel and is important for the passage of freight from the Netherlands to their destinations in Europe.

The European Commission, in the European Deployment Plan ERTMS, has set a number of European railway freight corridors on which ERTMS must be installed. For the Netherlands, the short-term obligations with respect to ERTMS are:

- Directive 2012/88 from the European commission obliges installation of ERTMS on the freight corridors 1 (Rotterdam to Germany via Betuweroute, ready in 2015) and 2 (Rotterdam to Antwerp, ready in 2020) for 2020;
- For 2020, there is also an installation obligation for the line from Amsterdam (port) to Meteren (connection to the Betuweroute).

Additionally, in June/July 2013, a political accord was reached regarding TEN-T legislation. This legislation was passed by a vote in the European Parliament in November 2013. The legislation defines a core network and an extended network of European corridors for both freight and passengers. In terms of the core network, there is a result obligation that involves putting ERTMS into operation on the core network by 31 December 2030; there is an obligation to work on the extended network in order to have equipped the infrastructure with ERTMS by 21 December 2050.

Figure 9 and table 4 provides an overview of which corridors will have ERTMS fitted up to 2030.

Table 4. Overview of European obligations with respect to ERTMS

Railway line	Type	Realisation
Maasvlakte – Kijfhoek – Zevenaar Border (Betuweroute)	Level 2	Ready
Schiphol – R'dam – Hazeldonk border (HSL)	Level 2	Ready
Lelystad – Zwolle (Hanzelijn)	Level 2 (dual)	Ready
Amsterdam Bijlmer – Utrecht Centraal	Level 2 (dual)	Ready
Amsterdam Westhaven – A'dam Bijlmer		2020
Utrecht Centraal – Geldermalsen Betuweroute		2020
Rotterdam – Roosendaal – Antwerp		2020
Rotterdam – The Hague		2030
Rotterdam – Utrecht		2030
Utrecht – Arnhem – Zevenaar border		2030
Amsterdam C – Schiphol – Hoofddorp (for the purposes of HSL)		2030
Rotterdam C – Rotterdam Lombardijen (for the purposes of HSL)		2030
Utrecht – Deventer – Oldenzaal border		2030
Rotterdam – Hannover 1)		Directive 2016
Rotterdam – Amsterdam 2)		Directive 2016
Vlissingen / Sloehaven – Roosendaal – Keulen 3)		Directive 2016

[1] The realisation date is to be decided in 2016. Route is still to be chosen via Emmerich or via Betuweroute – Deventer – Oldenzaal or via (current route) Woerden – Weesp - Amersfoort Oldenzaal

[2] Realisation date to be decided in 2016. Route still to be chosen: via Haarlem or Schiphol or Woerden

[3] Realisation date to be decided in 2016. Route still to be chosen: via Kijfhoek or via Meeteren or via Venlo

Figure 9 .Overview of European obligations with respect to ERTMS and ERTMS as a result of OV-SAAL

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