smartrail 4.0:
Interim report 2018
for the attention of
the Federal Office of
Transport (FOT)

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**Background**

Existing railway production is inadequately equipped for the challenges of the future. This is due to increasing system complexity, steady growth in demand, the sharply diminishing marginal benefits of conventional railway expansion, the energy savings needed to support the federal government's energy strategy, and the limitations to the railway system's competitiveness compared to road traffic.

The Swiss rail industry is working to improve the performance of the railway system by 2040 through the smartrail 4.0 programme (formerly Rail 4.0). Its aim is to provide a long-term boost to the railway system's attractiveness and competitive ability. Time is very much of the essence here, as key railway production systems will be reaching the end of their useful life within the next few years. Most notably, these systems include signal boxes, control technology, external installations, data communication systems and the Rail Control System (RCS). Technological developments have brought with them radically new functionalities, such as reliable and precise location services and automatic train operation (ATO), which open up new opportunities for wide-reaching automation and optimisation in railway production. Targeted investments are being made in an upwardly compatible system which will also improve the security of these investments.

A reduction in the basic costs of the railway system, coupled with increased capacity and improved punctuality thanks to greater availability of safety installations, will deliver directly tangible benefits for end customers.

On this basis, the FOT decided in August 2017 to task SBB with commencing the smartrail 4.0 (SR40) project – in cooperation with the railway industry at large – in order to devise a complete architecture that will enable integrated development of all aspects relating to optimisation and automation. The project planning phase, which began in 2017 and is scheduled to run until the end of 2019, involves investigating technologies and systems that are available to the railway sector but have not yet been used in order to determine their operational capability and suitability for approval. Once the ongoing concept phase has been completed in late 2019, FOT and the railway industry will make a decision on the ETCS strategy for the future as well as on the plans for migration, in other words implementation of the overarching architecture designed for SR40, which has been coordinated and divided up into stages. Upon completion of the design phase, which is currently under way, the next steps will be trial operation (2020–2027) followed by the industrialised roll-out of the new components to all areas (from 2027).

This summary of the interim report reflects the results achieved and insights gained so far with the smartrail 4.0 programme. In addition to this brief report, the specialists at the FOT will also provided an expert report that goes into more detail. The insights gained and the issues that still require clarification are to be discussed and validated in a constructive, critical dialogue between the FOT and the Swiss railway industry, using these reports as a basis. In the meantime, work will continue on the design and planning phase.
Target vision

A functional target vision has been defined which describes how railway operations will look once the programme is complete. It also forms the basis for the general framework of the smartrail 4.0 system, which is to be implemented for future railway operations, and the requirements placed on it. The corresponding end-to-end processes are mapped in varying levels of detail. The figure below shows the top level of detail, which covers the main process steps after the implementation of smartrail 4.0.

Figure 1: Smartrail 4.0 end-to-end processes (main process steps)

The technical target vision for smartrail 4.0 takes into account all the potential offered by new technical capabilities and is based on existing ETCS protocols, but will reduce the current associated system complexity whilst also deploying new technologies.

Achieving what we set out to do.

Figure 2: Technical target vision for smartrail 4.0
This will result in an overall architecture with homogeneously coordinated components that simultaneously define the scope of the services covered by the programme:

- **Physical rail infrastructure**: Smartrail 4.0 relies on the existing infrastructure and does not require any compulsory adjustments to the track topology. By contrast, there is no need to implement it on all signals, signboards and most track-release signalling equipment (GFM). This results in a 70% reduction in external safety installations and corresponding cost savings in construction and maintenance.

- **Traffic Management System (TMS)**: Ensures consistent planning and control of train traffic. Timetable creation and control of train traffic is largely automated. In the event of deviations, a new, optimised timetable is automatically created. This ensures that the existing railway system is used optimally in all cases.

- **ETCS signal box (ES)**: It is the task of the central ETCS signal box to check whether movement authorities and hazard areas on the track are created, modified or resolved. This central component integrates and simplifies existing signal boxes and RBC. The ETCS signal box is based on a geometric safety logic, which creates more capacity and simplifies complex project planning. The ETCS signal box functions solely as a gatekeeper.

- **Precise location**: All trains can be located precisely, continuously (i.e. without fixed block intervals) and safely (including train integrity). This allows a more precise control of train movements (capacity) and the dismantling of the track-release signalling equipment (costs).

- **Connectivity**: A prerequisite for optimised control is secure, high-performance data transmission. For this, the programme relies on the upcoming FRMCS standard to replace GSM-R.

- **Automatic Train Operation (ATO)**: Smartrail 4.0 will introduce automatic train operation (ATO) as part of a step-by-step development of the current driving recommendations. The current goal is automation level GoA2 (i.e. autopilot, engine driver is still present and retains responsibility). Thanks to the more precise speed control, ATO results in more capacity, punctuality and the potential for energy savings.

- **COAT onboard equipment (CCS onboard application platform for trackside related functions)**: Smartrail 4.0 shifts functionalities from the infrastructure to the vehicle (for example localisation: from the electronic signpost to vehicle location accurate to the metre). With a fundamentally different approach similar to examples from the aviation and car manufacturing sectors, a standardised architectural concept is envisaged, with separation of hardware and software procurement.

The full impact (i.e. the greatest benefit) is achieved by implementing all components. In order to reduce complexity, detailed phasing options have already been developed for the industrialised roll-out. This has resulted in four key phasing steps that can be used firstly to get to grips with the complexity of the overall system and secondly to enable the benefits of smartrail 4.0 to be generated as quickly as possible.
The functional and technical target visions have been agreed internally at the infrastructure level and coordinated with the route, the RUs and the ongoing optimisation programmes run by SBB (such as SBBagile2020 and Infrastructure 2.0).

Customer benefits
Smartrail 4.0 plays a significant role in reducing overall system costs, enabling all those who use the railway to benefit from improved safety, capacity and availability.

Objectives for smartrail 4.0

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<th>Company perspective</th>
<th>Customer perspective</th>
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<tr>
<td><strong>Costs</strong></td>
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<tr>
<td>Sustainable savings of CHF 450 million per year.</td>
<td>Good price/performance ratio for all transport types.</td>
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<tr>
<td><strong>Capacity</strong></td>
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<tr>
<td>Improvements in train path capacity on the network of up to 30%.</td>
<td>More trains running on the network. Denser timetable.</td>
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<tr>
<td><strong>Availability</strong></td>
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<tr>
<td>Availability of safety installations improved by 50%.</td>
<td>Fewer disruptions. Trains are more punctual.</td>
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<tr>
<td><strong>Safety</strong></td>
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<tr>
<td>Probability of collision reduced by 90% (manoeuvres and worksites).</td>
<td>Reduced probability of harm to persons or property.</td>
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<tr>
<td><strong>Service</strong></td>
<td></td>
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<tr>
<td>Improved customer information in the event of a disruption and data rate &gt;20 MB/s.</td>
<td>Customers can make phone calls without interruption, surf the net at higher speeds and obtain information in real time.</td>
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Figure 3: The benefits of smartrail 4.0 for companies and customers

A reduction in the basic costs of the railway system, coupled with increased capacity and improved punctuality, will deliver directly tangible benefits for end customers.

Digitalisation across the board opens up new opportunities such as qualitative, personalised customer information in the event of a disruption. A high data communications capacity of 20 MBit/s ensures a better quality of communication services for passengers.

The automated driving mode for trains also brings the benefit of further optimising energy consumption while on the move.

Phasing and migration
The smartrail 4.0 programme is based on an overall architecture. In order to see a benefit early on and to master the complexity of the overall system, a number of phases are envisaged:

- Phasing step 1 – to take place promptly on the basis of the present production situation, installations and vehicle structure. The projects required for this have been defined and are in progress. By making full use of the early potential for optimisation, annual gross gains of CHF 41 million are anticipated from 2025 onwards in comparison with current figures.
• Phasing step 2 – also based on the present production situation, installations and vehicle structure. The projects required for this are currently being prepared. By making full use of the early potential for optimisation, additional annual gross gains of CHF 26 million can be achieved from 2028 onwards.

• Phasing step 3 – entails the complete roll-out of smartrail 4.0 with annual gross cash flow savings of up to CHF 450 million (only for SBB) from 2040. This roll-out will take place in three phases:
  - Phase 1 – testing: Individual functions will be trialled gradually from 2020. Testing of the full functionality of smartrail 4.0 will commence in 2025 on one to three route sections which can be isolated for this purpose, such as (Wil)–(Wattwil), and on which the interactions between the ETCS signal box and the object controllers can be tested extensively, as well as the interactions with the handful of vehicles that will have been equipped with the new technology by this point. The trial routes will be determined by late March 2019.
  - Phase 2 – isolated individual routes: Once the findings from the trial phase have been evaluated and the systems optimised, roll-outs can start to take place between 2027 and 2030 on individual isolated routes with restricted vehicle circulation, so that only minimum adjustments to the existing vehicle fleet are required for the rolling stock. The four to five individual routes will be determined by late March 2019 on the basis of the suitability of their installations, the existing and planned connectivity equipment, and vehicle circulation.
  - Phase 3 – core network: The roll-out to the core network throughout Switzerland will begin in 2030 in ten large network segments based on TSI CCS 2022. The segments with optimum interfaces will first be defined on a provisional basis by September 2019, depending on the vehicle circulation and the LCC of the existing vehicle fleet. Wherever possible, vehicles set to reach the end of their useful life by 2040 will be excluded from the migration. It will also be ensured that the LCC of the signal boxes and the major changes to installations planned as part of the 2030/35 expansion step are taken into account. The soft object controller concept enables a significant proportion of the modern signal boxes to be migrated into the smartrail 4.0 environment. When planning the phasing for the roll-out of the functionalities, this means that fall-back levels (e.g. the need for clear track signalling systems due to the lack of a localisation function) are also provided that can be transferred over on a 1:1 basis without the need for significant additional investment. Migration of the S-Bahn regions Zurich and Bern, along with the TEN corridors and border crossings, is not scheduled to begin until 2035.

• Phasing step 4 – builds on phase 3 of SR40 and includes the potential use cases for GoA3/4. The first business case for this will be devised by late 2019.

**Feasibility testing**

Feasibility tests or "proof of concepts" (PoC) will be used to confirm the issues and results arising from the design and planning phase, for instance in order to identify risks at an early stage and make any necessary adjustments to the agenda. Depending on the item being tested, the feasibility tests for the
smartrail 4.0 programme may involve concept-based/analytical approaches, simulations, or creating prototypes or conducting practical tests. To date, around 50 feasibility tests have been started or completed across all the applicable areas and issues.

No obstacles or problems have yet been identified that fundamentally undermine the concept of SR40. However, there are still some pending issues, in particular the feasibility evaluations for determining the safe length of freight trains, as well as passenger trains in the case of special compositions.

The ETCS signal box (ES) programme has been able to confirm the fundamental suitability of the concepts for approval, among other things, on the basis of the previous PoCs. This involved collecting evaluations from independent experts and conducting a preliminary safety analysis. Another PoC confirmed the feasibility of the “Y switch” in the object controller. This is an essential element of the migration and enables automatic switching between the “old” installation and the ETCS signal box for test and inspection purposes and for placing in service. Overall, the planned PoCs and those that have already been conducted cover all critical aspects and issues of the ETCS signal box, meaning that once the PoCs have been concluded with positive results, it can be assumed that the technical feasibility of the concepts has been proved.

With regard to localisation, measurement runs and a study conducted between summer 2017 and early 2018 have been able to demonstrate the fundamental technical feasibility of the use of mobile sensors to locate the front of the train. However, the technologies tested and the data collected are not yet sufficient to define and quantify the mix of sensors on the vehicles and the necessary track-side infrastructure. Therefore, measurement runs with an expanded measurement setup for locating the front of the train have been taking place since August 2018 in order to obtain further insights into the combination of sensors required. Measurement runs with a simple train end tag have been ongoing since November 2018. It has not yet been possible to confirm the feasibility of locating the rear of a train (single wagon, additional modules) or tagging other hazardous objects. At present, it must be assumed that full readiness for safe and accurate location of the front of the train and the train integrity for train compositions will be in place from 2027 (moving block operation), while location of the rear of the train for trains with a single wagon and additional modules will only be available from 2030 (elimination of clear track signalling systems). It is anticipated that significant progress will be made in this area in the coming years.

A wide scope for connectivity solutions was first opened up in order to enable evaluation of the variants in the next step and to test them where necessary via theoretical means and/or field tests. This procedure has been used because the overarching regulatory and technical conditions will not be known in full by the end of 2019, meaning that some of the potential solutions will no longer be applicable. The present assumption is that it will be possible to fulfil the mobile communications requirements of SR40 using 5G technology. However, unresolved frequency issues and the restrictive Swiss ordinance on protection from non-ionising radiation (Verordnung über den Schutz vor nichtionisierender Strahlung, NISV) will limit the scope of the solutions. A further challenge lies in influencing the “Technical specifications for the interoperability of control command and signalling”
Such that the scope of solutions is not narrowed even further due to vehicle-related restrictions.

With regard to the Traffic Management System (TMS), the milestones planned for 2018 in order to validate the smartrail 4.0 concepts have been achieved. In particular, important milestones have been achieved thanks to the success of the automatic timetable calculation and the good results from the TMS ATO trackside tests (conducted with other players in the rail industry), as well as the validation provided by the TMS steering project for the proposed overall architecture for TMS. In order to ensure that the full functionality of TMS was validated by 2018, a complete system test (TMS pilot) was conducted which involved technical integration of all the components of TMS. The TMS pilot involved testing, validating and improving the architecture and the standard interfaces between the individual components of TMS. The results of the pilot confirmed the previous architecture. In general, the TMS programme is working its way through the contents prioritised by risk potential as planned.

Five pilots were started in 2018 for the Automatic Train Operation (ATO) programme in order to examine a range of technical and operational issues. BLS is testing driver assistance systems (GoA1), SBB is trialling the use of TMS for control purposes (ATO-TS) and vehicle equipment according to the standards emerging at international level, while SOB is trialling applications with L1LS and conducting initial commercial testing and the Union of Public Transport (UPT) has defined pilot programmes for MS ATO and is examining the standard for metre-gauge railway lines.

- SBB ATO pilot phase 1 (ATO under ETCS full supervision, L2): Upon completion of the initial test runs, it has been possible to confirm achievement of the two key objectives of (a) transferring the segment and journey profile from ATO-TS to ATO-OBU and (b) adapting the OBU controls to the vehicle controls in order to achieve a suitable control procedure for the desired driving behaviour. The next step will involve examining the assumptions made in relation to the potential for capacity and energy savings with GoA2 under ETCS L2.
- BLS ATO pilot: It has been demonstrated that energy consumption can be reduced by 10–15% with the aid of optimised driving profiles. Driving recommendations help to ensure a high level of punctuality and reduce the variation in driving styles.
- SOB ATO pilot (ATO under L1LS): In December 2018, a competition was used to rank three suppliers, two of whom are able to take part in the pilot scheme.
- UPT MS ATO pilots: The standard for metre-gauge railway lines is to be defined and tested. Technical workshops were held with potential suppliers in November 2018. The insights from these workshops are being used to refine the list of requirements and review the findings that the pilots aim to deliver. Suppliers prepare their tenders on the basis of this information.

Smartrail 4.0 includes features that must be implemented on board the vehicles. These are ETCS L3, FRMCS (data communication), ATO, virtual electronic signposts or GLAT (mobile localisation), TIMS (train integrity), MTC (Mobile Traffic Control, full monitoring of trains during shunting, disruptions and running at sight). On 28 August 2018, the steering committee made the strategic decision to launch the COAT programme (CCS onboard application platform for trackside related functions), on the condition of funding from the FOT and the involvement of the RUs. This programme serves to tie
together all the issues relating to the features listed above. COAT includes the use of synergies between the railway fleet and the railway infrastructure. The common, generic vehicle equipment and the vehicle interfaces are to be specified in a standardised format and made freely available as sample and test systems. Meanwhile, the functionalities of smartrail 4.0 are to be implemented in the form of applications that are freely available on the market. The proof of concept for the open CCS vehicle architecture and the results from the initial trials should be available by late 2020, following which the openETCS software is to be ported to a generic hardware platform (which is yet to be defined), which in turn will be installed in a carrier vehicle and tested. The definitive format of the architecture can only be confirmed once these tests have been successfully completed. This will also require a new approval concept and first-time application of this concept for the prototype.

**Safety installations "Plan B":** The strategy for connecting safety installations to smartrail 4.0 is currently under discussion. It is being designed such that the assets for the target architecture of smartrail 4.0 are upwardly compatible and the installations can be migrated without extraordinary depreciation. Meanwhile, independence from smartrail 4.0 must remain guaranteed so that production is ensured at all times in the event that the technical developments of smartrail 4.0 modules are delayed or can only be realised in part ("Plan B").

**Objectives and challenges**

The strategic objectives of smartrail 4.0, formulated initially as part of the preliminary study (in the programme's fully realised state from 2040)

1. Reducing the annual system costs in railway production by 450 MCHF (SBB only; infrastructure and vehicles)
2. Increasing technical capacity by 15% to 30%
3. Increasing safety, especially when shunting and on construction sites
4. Increasing the availability of safety installations
5. High data communications capacity for customers

can be confirmed and/or safeguarded on the basis of the insights gained since the preliminary study and the results from the feasibility tests performed previously. It will be possible to increase network capacity on the routes thanks to a reduction of up to 30% in headway times and an improvement in the departure and driving precision. The limiting effect of the nodal points is still under investigation.

According to the 2016 migration report, with regard to the ETCS strategy, "it has not been possible to confirm the benefits of ETCS Level 2 anticipated in 2011 in terms of capacity, safety and costs [...]" with ETCS L2 in the "current design". With this background situation in mind, the springboard in relation to the preliminary study was changed. Optical signalling with ETCS L1LS including closure of a gap in Valais and Ticino ("V zero") is now being used as the springboard.

Thanks to additional potential benefits and the anticipated effects of the COAT programme, sights are still set on the goal of reducing system costs by CHF 450 million from 2040 (only for SBB's share) despite the lower ETCS L1LS being used as the springboard.
The benefits contributed by the individual new technical capabilities to the three strategic goals of cost reduction, capacity increase and safety, including their current grading, are shown in the figure below.

**Figure 4: Assignment of benefits to technical capabilities**

From today’s perspective, safe and precise location of the end of the train (number 1 in the figure above), a standardised vehicle architecture (number 2) and the risk of a delayed or incomplete TSI 2022 (number 3) are the main risks to achieving the desired benefits of smartrail 4.0.

The economic efficiency calculation (WIRE) for smartrail 4.0 is being updated on an ongoing basis and adapted in line with new findings and altered framework conditions. The full functionality of smartrail 4.0 with annual gross cash flow savings of CHF 450 million (only for SBB) is anticipated from 2040 (cash flow with new operating costs without reinvestments into SR40 after useful life). In order to achieve this effect, initial investments of CHF 3,000 million are required according to the current status of the updated business case in relation to the springboard.

The business case has now been mapped in a cross-industry process for the first time. Owing to the differing starting positions and complexity of the railway system (proportion of single-track and double-track lines, barriers), there is currently some variation in the production costs (unit prices) and benefits.

The next phase will involve comparison and challenging of the assumptions made and justification of the differences.

In the first half of 2019, a second opinion will be obtained from an independent body with certified expertise in order to validate and safeguard the assumptions made in connection with the business case.

Further challenges arising up until the end of the project planning phase are a) creating a new agreement on cooperation with the industry for the development/trial phase, b) specifying the details of the cooperation with the industry, and c) ensuring that the human and financial resources for the COAT programme are available on time.

a) The focus of the industry cooperation will be on drawing up a new cooperation agreement. The basis for this will be the overview of system management in the infrastructure sector that was
ordered by the Commission for Infrastructure of the UPT (KIS) on 20 November 2018. This will be done through a separate project organisation of the industry and therefore outside of the smartrail 4.0 committees. Drawing up the cooperation agreement will also present an opportunity to check whether the circle of cooperating partners should be expanded.

b) The cooperation with the industry will primarily centre on using clear signals to ensure that the industry understands what the plans are for SR40, so that it can begin to make preparations for the impact on its product strategy and business model from an early stage. It is important for the industry to perceive smartrail 4.0 and the associated international initiatives as an opportunity and, ultimately, to be able to offer the necessary components at the required price/performance ratio.

c) On 28 August 2018, the smartrail 4.0 steering committee made the strategic decision to procure the COAT programme, conditional on clarification of funding with the FOT and involvement of the RUs. The financing discussions with the FOT are under way (see letter from SBB dated 13 November 2018 on the second supplement to the 2017–2020 performance agreement and the letter from the FOT dated 15 November 2018 on the delimitation between the financing of traffic and infrastructure). Meanwhile, the COAT programme organisation must be put in place promptly. In order to achieve the objectives by the end of 2020, the staff working on the project must firstly bring with them the necessary expertise and secondly be immediately relieved of their duties, which can only take place once the "run the business" plan has been secured.

Transformation

A high level of automation always results in a greater demand for the expertise needed to restore normal operation of the automated process system in the event of a fault. Consequently, the demands placed on operational continuity management are growing steadily. The “pure user” exists less and less frequently, or is evolving into the "system configurator". This job enrichment makes the job descriptions more attractive, but it also increases training requirements.

The focus points and particular challenges of long-term change management with smartrail 4.0 are:

- **Planning and operations**: The high level of automation of planning and control which is possible in the long term leads to major changes to job descriptions and greater demands. Instead of “manual planners, rail dispatchers, conflict resolvers and operators”, it is increasingly “managers of a largely automated process” who will dominate job descriptions. This represents a fundamental change for timetable planning and operations, as its effects will begin to take shape from as early as 2020.

- **Changes to systems**: For the technology-heavy areas, smartrail 4.0 results in a change to processes, know-how requirements and methods due to the changed technologies and the greatly reduced system portfolios. Major reductions in expenditure, changes in job descriptions and the merging of roles must be prepared and implemented. A particular challenge is posed here by the parallel existence of old and new technologies over long periods.

- **Train management**: More intensive use of the network capacity requires trains to be driven more precisely. In GoA1, it is essential to achieve acceptance of the driving recommendations by the
locomotive drivers. By contrast, GoA2 will face challenges in the areas of maintaining alertness and work quality, as well as in the attractiveness of the profession (depending on the scope of implementation). In addition, some safety-related skills and responsibilities will need to be defined and clearly delineated. These issues will be discussed and tackled in cooperation with the relevant industries of the industry partners.

**Cooperation**

Cooperation within the Swiss railway industry is already established. The steering committee and the project organisation of smartrail 4.0 are a collaboration of representatives of the UPT, SBB, BLS, SOB and RhB. The other railway companies are integrated into the work via the UPT committees. Representatives of the above-mentioned railways also sit on the four steering committees of planning and operation, system modification, train control and vehicle equipment, both on the infrastructure and transport side.

At the European level, momentum has also been increasing in recent months in the fields of automation and digitalisation. The major partner railways DB, SNCF and ÖBB have started comparable programmes. SBB has concluded a formal cooperation agreement with ÖBB. Particularly noteworthy here is the support given to the smartrail 4.0 programme by Josef Doppelbauer, Executive Director of the ERA, who made an impassioned plea for a new safety architecture in the July/August 2018 edition of IRSE-News (Institution of Railway Signal Engineers), giving particular praise to Switzerland for smartrail 4.0.

A key aspect in the cooperation with the industry is establishing suitable procurement strategies and fair methods of handling immaterial assets. The ultimate goal is to procure the right services at the right time, from the right partner and using the right procurement model. The desired outcomes are long-term sustainability, availability, independence and cost-effectiveness. In addition to using established providers, dedicated efforts are to be made to find new suppliers in order to increase competition and innovative strength. Services should therefore be procured from a broad market with robust competition. A procurement strategy and a procurement handbook for concrete implementation of these plans were drawn up in 2018 in cooperation with the installation management team in order to provide a precise picture of these requirements.
Risk management
The goal of the opportunity and risk management is to use an early warning system to predict potential deviations from a planned target state, to evaluate the impacts on the success of the programme, and to react appropriately. A systematic opportunity and risk management framework has been created for all projects of the smartrail 4.0 programme. The top two programme and project levels are included in the periodic risk reporting and updated at least twice a year. Reports are given on five risk categories in each case (policy & regulation, organisation & management, migration & transformation, cyber security, technology). The sum of the expected opportunity and risk values results in an expected risk value of CHF 337 million for the overall programme (effective date: half-year report of 30 June 2018).

Overview of the funding used in the performance agreement
The FOT has granted a total of CHF 200 million for the smartrail 4.0 programme as part of SBB's 2017–2020 performance agreement. In addition, but outside of this total amount, the two portfolios "automated warning processes" (AWAP) and the automated "planning and production system" (PPS) are also managed under the umbrella of the smartrail 4.0 programme organisation. The latest estimate (LE), which was last updated on 30 November 2018, indicates compliance with the overall financial framework up until the end of the ongoing period of the performance agreement. For the 2017–2020 period of the performance agreement, CHF 3.2 million was granted to BLS and CHF 12 million to SOB. Here, too, the LE for 2018 indicates that the overall financial framework is being complied with.

Outlook
This interim report reflects the current status of the work in the smartrail 4.0 programme and the insights obtained before the end of 2018. It is a key stepping stone on the way towards the implementation report, which is due in a year's time and will form the basis for decision-making at the start of the trial phase from 2020.

In particular in the areas of funding and technical regulation, this report serves as preparation for the decisions required from the FOT in these areas. With regard to funding, this concerns the consideration of smartrail 4.0 in the overall funding requirements for the 2021–2024 performance agreement of the individual railway companies on the one hand and as an FOT industry reserve on the other. Decisions will also need to be made on matters relating to technical regulation and planning premises. As the following figure shows, there are still extensive milestones that require clarification in the areas of cost-effectiveness calculation, the roadmap, coordination at the European level, application and migration. The core smartrail 4.0 team will hold a specific planning week in January 2019 for this purpose.
Bern, 12 December 2018

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