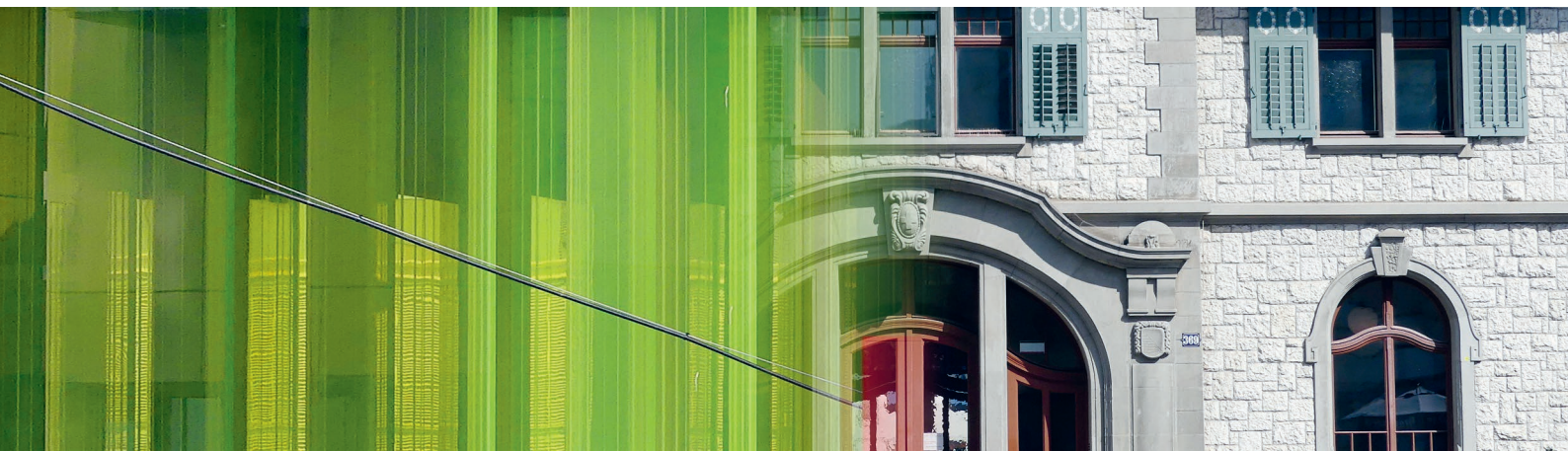


ANNUAL REPORT

**sma**  **optimising railways**



2022

Sustainability is rightly on everyone's lips at the moment. This is the only printed publication from SMA, and it was produced in a climate-neutral way. In our editorial, we also devote special attention to the topic of consistency, another aspect of sustainability. Our series of pictures this year shows both evolution and continuity in our environment.

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# Editorial

Dear readers

**Consistency is also a form of sustainability** – The world is in a disruptive phase, affecting all three pillars of sustainability; Our fragile ecosystem is more threatened than ever, classic macroeconomic models are being challenged or even overturned, and our societal values are increasingly being turned upside down.

How can you ensure consistency in this disruptive environment? As a consulting and software company providing services and products to the railway in an environment that is changing ever faster, it is our task to find solutions to these challenges. In this context, we do not understand consistency in the sense of immutability, but rather as evolution through patience, perseverance, and continuity.

The railway system and, by definition, the stakeholders of the system are subject to long-term investment and institutional cycles, which requires continuity from all market participants. Therefore, in our collaborative models, methods, and products, we favour the long term over the short term, proactivity over reactivity, investment over opportunism.

SMA began digitising processes for planning the railway system very early on. In this context, digitalisation is not an end in itself, but rather a way to reduce the complexity of system planning through intelligent modelling. This basic principle has always shaped our thought model and our long-term strategy.


Complexity management is also central to our software development activities. Consistent and sustainable investments in our software are only possible if the complexity in software development remains manageable over the long term. This is what we want to talk about this year in our introductory article.

Once again, we are pleased to present you with various activities and projects which have been active throughout the past year from our Consulting and Software divisions.

We hope you enjoy reading our 2022 annual report.



Eric Cosandey  
CEO, Head of Consulting



Thomas Bickel  
Head of Software





# Long term software evolution – Taming the complexity beast

“Ideas are easy, execution is everything” – this is a well-known maxim of the influential Intel manager and technology investor John Doerr, with which he emphasises the special importance that the highest implementation competence has in technology innovations. The reason for this assessment is that an existential risk in the development of technology products is the ever-increasing complexity. Demanding functional extensions, the departure of knowledge holders or fundamental changes in production principles are complexity drivers that are often recognised too late or are not addressed resolutely enough. Complexity management is therefore a central task in the implementation of technology products.

In software development, proposals for managing complexity are not new. Different process models were discussed as early as the 1950s, and in the last 20 years agile software development has exerted great influence in many forms, including beyond the software world. However, despite undeniable methodological progress, the number of failed software projects remains high: projects are abandoned, essential requirements remain unfulfilled or fall far short of expectations, or the software can no longer be developed further to meet new requirements.

The process model for software development at SMA is strongly characterised by the product mindset. The software’s life cycle over many years is at the centre of the production process. Exacting requirements in terms of quality, maintainability and delivery reliability are combined with the need to implement innovative and ambitious further developments.

This task has a high inherent complexity and requires the appropriate tools. A central component in this respect is the automation of activities that were originally manual.

One example is the process for creating new versions of Viriato, which today is highly automated: the correct branches are created for all relevant components and versioned in the version control system, jobs are automatically set up on a Continuous Integration server, dependency management is updated and the issue management system is modified to enable the assignment of implemented stories to Viriato versions.

The result of this automation is significant efficiency gains, the elimination of sources of error and improved standardisation.

The production team implements such activities as part of the continuous improvement process, which is an integral part of the Scrum methodology. In this, potential process improvements are identified through a structured procedure, reflected upon and implemented where it makes sense to do so. Viewed over a long period of time, these many incremental improvements lead to impressive results.

Incremental improvements are a fundamental tool for managing complexity because they enable an evolutionary path to be taken in a complex environment that is not available in the same way with a large, riskier replacement. Replacement systems for legacy systems are often developed precisely because incremental adjustments are no longer possible or become too expensive due to unmanageable complexity in the software.



In the articles below, some representatives from sma.software provide an in-depth insight into specific aspects of software production at SMA.

**Product development – Björn Glaus** Björn Glaus is Head of Production at sma.software. For Björn, the unwavering focus on product development for timetable and capacity planning is at the heart of sma.software. In his opinion, this consistency leads to a unique expertise at the interface between high-quality, modern software development, deep domain knowledge and relevant algorithmic applications. Björn sees SMA's core competence in implementing this skill mix in a way that resonates with the user.

One user group of particular importance to sma.software, says Björn, are the Viriato users within SMA. The daily internal use of the software our consulting projects enables a short feedback loop and a constant professional exchange between developers and users. SMA's consultants operate in a highly competitive environment, which requires software that provides optimal support for their projects. This creates an ideal environment for the creation of sophisticated software applications.

According to Björn, improvements that have been achieved in prototyping in recent years are particularly relevant for product development. There are two main points addressed by these improvements:

Firstly, thanks to investments in the technical infrastructure, a functional prototype can now be implemented more quickly and easily and used in suitable consulting projects as a pilot study. Prototype development is decoupled from product development, but is based on precisely defined product and quality levels. The use of the prototype in a consultancy project is lightweight and low-risk for all parties involved because the prototype is strictly used for only in a specific project and it is possible to go back to the product version at any time.

Secondly, the introduction of new roles and processes at the interface between R&D, business analysis and development has meant that results from prototyping can be transferred methodically and efficiently into the product. Thanks to prototype development, uncertainties and risks are clarified early on. This greatly simplifies the transfer into the product, especially the compliance with the high requirements regarding stability, architecture guidelines, automatic test coverage and other quality criteria.

**Software Craftmanship – Benjamin Ernst** As an architect at sma.software, Beni makes a point of continuing to spend a lot of time programming or undertaking code reviews alongside technical coaching and conceptual tasks. He sees Viriato’s modular architecture as a central and effective tool in complexity management: the software is developed in the form of loosely coupled modules, each using a common, powerful domain model as well as a custom-developed application framework that provides shared services and base classes. This modularisation enables a high degree of parallelisation in the implementation, because different modules can be worked on simultaneously without developers getting in each other’s way.

According to Beni, a sustained rapid development speed is only possible if the quality of the code and the way of working is also kept constantly high. For this reason, the architectural integrity and other quality aspects of the software are continuously monitored in an automated way. In addition to this monitoring, constant investment in the architecture, the existing source code and the technical tooling is also necessary. A large code base has a tendency to create structural deficiencies through ongoing developments and to decrease the degree of organisation in the code. Here, Beni emphasises the particular importance of code refactorings and functional re-designs. These are technical practices in which the structure of the code or the user experience is improved without changing the functionality. Such renewal work keeps the software up-to-date, but it is also essential for retaining know-how in the development team. Software that is difficult to develop further because the code is not well understood is an often underestimated risk.

For Beni, development in a product oriented company is characterised by investing more on in-house developments than is typical in the fast-moving project business. To keep project times short, third-party solutions tend to be used. In contrast, because of the long-term perspective in the product business, it is worthwhile to develop the frameworks yourself. These are customised and further development is under our full control. As examples, Beni mentions the build system (for creating the software from the source code), which is specifically geared to the modular architecture, as well as the persistence layer (the database abstraction layer), which is optimised with regard to the high performance requirements of timetable planning.

**Customer-Projekts – Markus Ullius** As Head of Services at sma.software and leading a team of business analysts, project managers and testers, Markus and his team can draw on many years of experience in the implementation of large software projects. Markus proudly mentions that customers have repeatedly emphasised the high quality and adherence to delivery deadlines of sma.software. He sees this as the result of a mature development process that covers the entire functionality life cycle: the precise formulation of the customer's needs as requirements is the first step and is a prerequisite for the development of solution proposals in the form of "stories". The implementation of a solution then takes place in well-planned development "sprints" with a three-week cycle. Delivery takes place only after a quality sprint, in which no more functional development takes place, only testing and bug fixing. After delivery, the newly developed software goes into maintenance and support. Markus emphasises the short communication channels and the organisational proximity of support to development. If necessary, a qualified developer can be called in to deal with a support case in a very short time.

Markus points out that the stories are highly standardised in terms of completeness, comprehensibility and complexity. This standardisation is a prerequisite for multiple projects to be implemented at the same time, because in some respects it becomes irrelevant for the development from which project a user story originates. The story is tailored in such a way that it can be implemented in a few days, acceptance criteria are formulated in advance, and close technical support is ensured during implementation. The business analyst, the developer and the tester form a team within a team during the implementation.

According to Markus, the goal is to protect the development as much as possible from disruptions from day-to-day project business, e.g. last-minute change requests or unexpected re-prioritisations. Such discussions are allowed to take place, but they are upstream of the development. A focused, disciplined and low-stress working environment is the goal for development.

**Conclusion** The domain of sma.software is the railway system. This is characterised by a high inherent complexity and long life and investment cycles. For innovations to be successful, they must be implementable, i.e. feasible, which is a challenging task in such an environment. Here, sma.software has the ability to successfully implement innovations because it has many years of experience in mastering complexity at different levels – code, process, culture, team. The results of this consistent work are a stable, extendable software platform and a powerful, reliable organisation. These serve as the basis for sustainable and delivering fit-for-purpose solutions.

# Software – Facts & Figures

The turnover of sma.software is made up of the three pillars of maintenance, projects and licence sales. In 2022, we sold 17 Viriato.Standard licences and 2 Viriato Enterprise licences. In addition, we sold licences of the add-on modules Vehicle Rostering (8 licences), Works Planning (7), Conflict Detection (5), MicroscopyOnDemand (3), Trip Time Analysis (2), Robustness (1) and Demand Assignment (1). There were also rentals of individual licences or additional modules for shorter periods of time. Geographically, the German and North American markets each account for just under one third of sales. Other individual sales were made to Hungary, Belgium and various other European countries. The ratio of existing customers who purchased additional licences or modules to new customers was about 4:1.

To prepare our customers in the best possible way for working with Viriato, various training courses were held, which were individually aligned to the requirements and working processes of the individual customers. As in 2021, most of the training was conducted online due to the prevailing restrictions.

Number of external training courses	13 training courses
Languages	German, French, English
Number of training days	23.5 days
Number of participants	approx. 100 trainees

As in previous years, our customer projects were strongly dominated by the operators in the German-speaking market. Together with internal projects, 993 software stories, each representing a feature or function, were implemented in 2022 as part of our agile development process. (The comparable values for previous years were 2021: 1038, 2020: 851 and 2019: 619). A total of 61 customer and product releases were delivered for 15 different versions of Viriato, which corresponds to an average of slightly more than one delivery per week.

# Product Management Review 2022

**Keeping the product relevant** Last year we talked in depth about specific examples of long-term activities required to keep a software product such as Viriato alive, and this year we also describe how we tame the complexity of our software design. These are important tasks to keep the internals of the program up to date with modern technologies and good software development practices. Indeed, Viriato is now a veritable Ship of Theseus having been constantly refreshed as a program while remaining true to its founding design principles. However, for the direct user experience of Viriato, we are also faced with the challenge of keeping the product relevant with new and improved features that help the train planning workflow. Product management of a tool such as Viriato requires a long-term view in order to balance the emerging market requirements with supporting the existing functionality and needs of our customers now, while allowing sufficient time to implement the next generation of features.

SMA's goal has always been to invest in the development of Viriato using part of our revenue to stay ahead of the requirements from industry, without waiting for orders from customers for specific feature implementations. Of course, as part of our development process we also implement more customised features to solve specific problems for our customer's railways.

This brings us to the question, how do we decide which features should be on our long-term development roadmap? These are in addition to the ongoing long-term maintenance of the Viriato product through the addition of new features which have been identified as being of general importance as "tactical improvements". As an organisation with a broad range of customers, including train operators, infrastructure managers, regional bodies, consultants and more, and who range in size from a single user to hundreds working collaboratively, there are a wide range of interests and requirements. This is always going to involve trade-offs and we try to balance the mix of features implemented so that all users benefit from some of them.

For the more strategic investments, we try to take a broad overview to capture topics that are already clearly needed, and those which we expect will become of relevance over the next five to ten years. Two obvious strategic examples of how we have answered this question are supporting the maintenance of aging railway infrastructure, and the application of automation techniques.

Many countries are facing a long-term aging of their railway asset base as systems constructed in the second half of the twentieth century reach the end of their lives and require significant renewals or replacement. The ability to keep operating the railway as assets are maintained requires works planning support to create timetables where trains are retimed or rerouted to allow both operations and engineering to occur. We have talked in previous annual reports about the Viriato Works Planning module, which was our contribution to this task, allowing the ability to determine the consequence of these works on trains allowing the efficient replanning of services, and we continue to add features to support this workflow.

At the opposite end of the technological spectrum from infrastructure renewals have been the rapid developments in automation, optimisation and artificial intelligence that are occurring in the fields of maths and computer science. Although many of these have yet to show their full potential in the railway sphere, and for it to become clear what will actually be possible as the hype behind some concepts meets with reality, it is important to study where these ideas may be able to provide support to users of Viriato in making informed decisions. Despite some of the problems that have been experienced in our industry with these techniques, it is important not to underestimate the capabilities of these methods coming out of industry and academia and these will only grow with time.

SMA has created a structure to support this process by splitting our resources into several teams. Amongst these are `sma.software.labs`, which has responsibility for developing prototypical versions, and the development and implementation of productive algorithms. At the same time our production team undertake the professional software engineering tasks concerned with specifying and implementing productive code shipped to customers in Viriato. A key part of this process is the efficiency of the communication between these two groups to ensure that lessons learned by one side is passed to the other, and to ensure that the deliverables meet the required goals for productive use.

## SPECIFIC R&D PROJECTS 2022

**Robustness 2.0** As announced last year in our editorial on the topic of robustness, we have begun the task of developing a completely new robustness module in Viriato. This is based on the high level concept used in the previous Viriato robustness model of delaying trains and propagating these forwards, but with a completely new architecture which will allow much greater flexibility and performance to be achieved. Roughly speaking timetable robustness can be seen as the ability of a timetable to recover from delays caused by unforeseen events, including the potential rescheduling efforts, and gives an indication of whether a timetable will support a punctual railway. In a Viriato robustness analysis we investigate the effects on the planned timetable, and how long it takes to return to normal train operation, after one or more disturbance has occurred on the network. The conflict detection itself, the core component which determines whether trains can proceed or not, has been reimplemented to allow full integration with the robustness model.

The new concepts have been proved using a simplified prototype version which indicated that the ideas that we planned would be successful. In fact, the prototype rapidly displaced the product version of the robustness module amongst our own internal users! The key improvements in the prototype were much greater ability to divert trains onto alternative tracks in the events of conflicts, and to run multiple simulations at sufficient speed to undertake meaningful Monte Carlo analyses. As part of the redevelopment to a full implementation for the product, it will be possible for the train dispatcher to be switched from basic, but often effective, models such as a first-come-first-served rule to priority-based rules, with the potential for much greater flexibility such as replacing a rule-based system with decision making using artificial intelligence.

The software internals of the robustness module have been developed so that it is possible to handle a wide range of input data configurations. It is important to remember that many Viriato databases were originally created for the purposes of strategic planning without the high levels of detail required for accurate conflict detection and resolution, and the effort to add this data can be significant. Supporting this several bulk update functions to set default values have been added.

Although the robustness module is not yet complete, during 2023 we will release a first version, with the existing conflict detection replaced by the new more performant version, and the initial robustness module itself with the default dispatcher implemented.

**Path Search** In 2022 we continued with the productive implementation of a path search feature for Viriato. The traditional use case for Viriato has been a permissive model where the user is encouraged to create trains to meet a high-level service specification, and to then determine if the infrastructure will support this plan and what additional actions are required. When working on long-term studies this is an efficient model, but for shorter term tasks where it is important that additional train paths can be added into an existing plan without disrupting planned operations a more sophisticated process is required where inserted trains are proved to be conflict free at the time of creation.

Path search works by creating a model train, typically based on an existing planned train, where the service specification in terms of the number of stops is defined. The other important parameters to specify are the time window in which this new service must run, and where the times can be flexed or modified to successfully integrate it into the planned service pattern. Other rules such as whether existing trains can be moved to alternative platforms to clear space in the infrastructure without altering existing plans may also be specified. A mathematical model is constructed by the Viriato algorithm platform which assembles the data containing the required train, and the constraints caused by interactions with other trains and the infrastructure. This model is then passed to a high performance mathematical solver developed by Gurobi, which computes the optimal solution for the path given the requirements and constraints, and Viriato then reinserts this resulting train into the timetable as a conflict-free train path. This module will enable users to rapidly find conflict free paths in congested timetables, and to progressively build up the service pattern.

Again, this model was first tested by SMA in a prototypical implementation which allowed us to learn both what was important to the user, in terms of specifying what they want to be inserted and when, and how these concepts can be implanted in a performant manner, before committing ourselves to the full productive implementation based on software engineering principles. The prototype was used internally in a range of studies for our consultancy clients, and the feedback has been incorporated into the productive version.

This path search feature will be made available as an add-on module in 2023.

## VIRIATO HIGHLIGHTS FROM 2022

Typical of the ongoing developments that we make to Viriato as part of our tactical improvement process in 2022 included the following features:

- In the running time calculator, the import of model data for the speed profile, gradient profile and track curvature from csv files was added which reduces the time needed to build detailed models. Also, finer configuration of the calculation parameters between train types was added allowing more detailed simulation of train behaviour in a single timetable.
- Behind the scenes the migration of Viriato to a 64-bit program, and the replacement of MS Access as the basis of file-based databases with SQLite was completed in 2022. This ensures the long-term technical sustainability of the product and allows bigger analyses to be undertaken in cases where computer memory may previously have been a limitation such as trip time analysis or demand assignment.
- In the vehicle rostering, planned empty runs can now be converted into “normal” Viriato trains in the database, which have detailed routing and timing information associated with them, allowing the accurate planning of train resources to support the timetable. In addition, the rosters can be coloured by train type or vehicle.
- To improve the visualisation of validities in Viriato Enterprise, a new segment view groups dates with the same validity allowing the user to quickly identify for each train sets of days with the same operating patterns.
- Additional batch functions allowing the rapid adjustment of multiple trains have been added for updating train attributes, replacing nodes with alternatives in a train run, batch update of separate times in the infrastructure, and the modification of the planned dates for a selected set of possessions.
- Clearer warnings to users whether they are working on an overridden train rather than the entire family, and a symbol on the graphic timetable showing whether the train is derived or overridden. In addition, trains can now be directly overridden from the track occupation view.
- In the works planning conflict detection, additional reserve time required due to a temporary speed restriction can be calculated and added to a train path.
- To assist with line planning studies, the netgraph can now indicate stations at which a train stops without display the times related to the stop. In addition, netgraph background images (such as logos) can now be embedded into the database improving ease of working when sharing databases.
- Multiple trains can be opened from a selection made in the train window, speeding up tasks where a user wants to review and edit trains based on specific criteria.















# Consulting: A selection of projects from 2022

## Our business segments

-  Service offer
-  Production
-  Operations
-  Capacity
-  Demand
-  Franchises & Tenders

## AUSTRIA



### ÖBB-Personenverkehr AG: Workshop dimensioning Salzburg/Linz ÖBB

Personenverkehr GmbH is currently renewing significant parts of the fleet, supplemented by additional vehicles for the further expansion of the service. As part of the procurement of single- and double-decker multiple-units for local transport, an upgrade and expansion of the maintenance facilities (workshops) is also planned.

In order to determine the exact maintenance capacities that were previously estimated by ÖBB Technische Services, ÖBB Personenverkehr commissioned SMA with the determination of the maintenance requirements on the basis of the specific transport services and fleets. For this purpose, a procedure was used that had already proven itself in an earlier project for the services in the eastern region.

By means of an evaluation of vehicle schedules and forecasts for the development of the vehicle fleets and their use in the various sub-networks, it was possible to determine the need for maintenance capacity at the Salzburg and Linz locations for a variety of maintenance scenarios (e.g. modular or non-modular maintenance). This assessment allows a transparent overview of the need for workshop tracks in different planning horizons and scenarios corresponding to the vehicles then in service. It forms the basis for dimensioning the current and new maintenance facilities at the two locations from the perspective of ÖBB Personenverkehr GmbH.

## BELGIUM



### SNCB: 2023-2026 Transport plan

The SNCB transport plan is revised every three years. The next revision is the 12/2023 transport plan, which will set the structure until 2026. Various factors have led to a need to adapt the plan: increased demand following the pandemic, the commissioning of infrastructure linked to the S (suburban) service, particularly in Brussels, and new international links.

SNCB wanted the planning of this to be carried out in parallel, both in-house and by an external consultancy, in order to be able to compare the results with its own work and thus enhance and stimulate the search for optimised solutions.

In this context, SMA planned the timetable of additional trains according to a list provided by SNCB, identified the interdependencies and inconsistencies between them and the existing transport plan, proposed solutions to resolve these issues and defined criteria for comparing the transport plans developed by SMA and internally by SNCB.

Finally, SMA produced summaries of the solutions proposed by SMA and systematically compared the options in the two transport plans in order to identify the advantages and disadvantages of each solution. This analysis was then used by SNCB to develop an optimised transport plan as a basis for developing the services for the next three years.

## SWITZERLAND



**SBB Infrastruktur: Robustness in long-term planning** Long-term planning concepts should also have sufficient robustness in the subsequent stages of planning and implementation without the need for structural revisions, so that the timetable can then be operated reliably. Therefore, a continuous planning process from the long-term through to operation is required. In addition, the requirements for future robust operations must already be adequately taken into account in the long-term conceptual design.

In the planning of long-term concepts, e.g. in expansion steps within the framework of the federal government's strategic railway infrastructure development programme or in SBB master plans, assumptions are made about planning parameters that best reflect the future technical and operational conditions. Although system reserve times are already included in the long-term planning to ensure robust producibility, there are currently no planning rules specifically designed for robustness or appropriately sized supplementary parameters.

The demand for the broadest possible consideration of variants in the long-term horizon goes hand in hand with a correspondingly coarse planning granularity, although this stands in the way of a robust assessment of robustness using the methods currently applied which require a high level of detail. It would therefore be desirable to have a way of taking the robustness requirement into account at the appropriate level of the process.

SMA has supported SBB Infrastruktur with an international comparison of the methods and planning rules used by European infrastructure managers with regard to robustness in timetabling. In addition, SMA evaluated operational data and derived from this step-appropriate approach for methods and the quantification of appropriate system reserves. This includes, for example, approaches such as utilisation parameters and reoccupancy times of system components, potential conflicts or the evaluation of operating concepts.



**Chemins de fer du Jura (Jura Railways): Technical assistance for the study of the ArcExpress project and the CJ2040 long-term vision** SMA carried out a study for the Chemins de fer du Jura (CJ) to assist in the planning of the ArcExpress project. This project concerns the development of the service on the La Chaux-de-Fonds–Glovelier–Delémont corridor, which had not been included in the PRODES 2035 planning stage. It was updated to take into account the changes in the context (in particular the planned timetable and the 2025 reference intermediate stage), and then a more detailed study was carried out for the next planning stage. As part of this further study, a detailed evaluation of the operating costs was carried out by developing a draft daily timetable and associated vehicle rosters. At the same time, a traffic potential analysis was carried out to evaluate in detail the expected ridership. Finally, a socio-economic evaluation was carried out to determine the utilisation rate and the NIBA sustainability indicator.

At the same time as this study, CJ wanted to have a longer term vision in order to define a strategic development perspective beyond the ArcExpress project, which would allow them to enhance the planned service developments and thus ensure the company's sustainability. In a first step, the range of possible solutions was opened up to explore and test new ideas in order to define a target service objective for 2040 from among the concepts selected. The target scenario was then developed and evaluated in terms of all costs, including depots and workshops, as well as ridership and revenue, in order to produce an economic balance. The target scenario was phased in order to establish a financial trajectory for CJ over the next 20 years and to identify the risks and opportunities.



**Canton of Vaud: International links development study** This study carried out for the Canton of Vaud was based on the observation that few international connections currently serve the Canton of Vaud, although several countries are currently planning their development. The aim of the study was to provide a vision of the possibilities of developing international day and night rail links serving the canton, as well as an initial vision of the possible stages of implementation and the potential institutional organisation.

In order to identify the relevant international connections, a simplified international demand model was constructed on the basis of population data and systematic rail services from 21 public GTFS databases. This model was used to produce a demand forecast providing the potential per station and the foreseeable demand on selected corridors. These elements were then used to draw up proposals for international day and night rail services in different time frames and to evaluate the operational and institutional organisation of these services.



**SBB–CTSO: Assistance with the 2025 Romandie timetable project** The current timetable for the French-speaking part of Switzerland is the result of several successive changes designed to introduce a timetable that takes account of engineering works, particularly between Lausanne and Geneva. However, punctuality this part of Switzerland did not reach SBB’s objectives by 2022 and an increase in works is planned for the next few years, which is likely to further reduce punctuality (as the reserves in the timetable are insufficient to carry out the works, which will have a significant impact on the services). Studies have been undertaken internally by SBB to identify the issues and to propose timetable adjustments to rectify the situation, and SBB initially commissioned SMA to analyse these proposals.

In a second phase, given the refusal of the cantons concerned to accept SBB’s proposals, a joint SBB–CTSO (Conférence des Transports de Suisse occidentale) process was launched in 2022 to work towards a common solution. SMA has been mandated by both parties to support this process and to propose consensual solutions. As part of this process, an in-depth analysis of the current situation was carried out in order to objectively evaluate and report on the situation to all stakeholders. Then, possible solutions covering all aspects of the railway system were proposed and combined in the form of a series of approaches. Finally, on the basis of these approaches, timetable concepts were developed and evaluated in order to compare them and select the most interesting ones with the partners for further development and implementation in the near future.



**Analysis of the operation and robustness of Phase 1 and 2 of the Lausanne–Renens tram project** Transports publics de la région lausannoise SA is planning to bring the first new tram line in its network into service in the next few years. Work began in 2021, with the first stage between Lausanne and Renens scheduled to enter service in 2026 and the second stage to Villars-Ste-Croix in 2028. Numerous developments in recent years along the route and on access from the depot have made it necessary to analyse in detail the operating conditions of the line. The study contracted to SMA began with a review of the assumptions which enabled all the elements to be modelled in Viriato. A running time calculation then made it possible to determine future journey times precisely. For the first stage, a systematic peak hour timetable followed by a 24-hour timetable were drawn up in accordance with the service objectives. Various robustness tests were carried out in Viriato using a stochastic approach that allowed a broad range of disruptions to be taken into account, which is a particularly useful approach for a dense urban transport network.

In the second stage of the study, the analysis was updated to take into account the extension to Villars-Ste-Croix. The issues at stake in this second stage were to evaluate, through deterministic and stochastic robustness tests, the impact on the robustness of the timetable, the management of major junctions and various other operational constraints such as common bus/tram platforms. It was also possible to evaluate several operating scenarios based on speed profiles with different speed and rolling stock constraints.









**Canton of Neuchâtel: Assistance with the planning of the direct line in 2035 / SBB Infrastructure: Assistance and robustness study for the direct line project Neuchâtel–La Chaux-de-Fonds**

Within the framework of the 2035 planning stage of PRODES, a major project for the development of the service between Neuchâtel and La Chaux-de-Fonds has been selected with a quarter-hourly service requiring a new single track line, mostly underground.

The Public Transport Service of the Canton of Neuchâtel commissioned SMA to support the planning studies for the project in terms of optimising the railway infrastructure, timetable and rolling stock systems. The aim was to reinforce the project by testing adjustments and optimisations of the project as well as additional variants to those studied so far, then combining these ideas with those studied by SBB and by iterating with SBB Infrastructure in order to arrive at sustainable and feasible solutions. The proposed optimisations included adjustments to the track profile, signalling (within the framework of the cantonal mandate), the design of stations and connections and the impact on journey times, timetables and operations. These have enabled solutions to be proposed for all the difficulties identified in the studies concerning operations and signalling, and several profiles and routes for the line to be selected, as well as a consolidated timetable for the continuation of the studies. In addition, consideration was given to the type of rolling stock to be used on this new infrastructure.

Subsequently, SBB Infrastructure commissioned SMA to evaluate the robustness of the project and to test options for improving it called flexibility modules. Thus, four modules were evaluated on the basis of perturbation simulations in Viriato. More specifically, the work consisted of modelling the infrastructure and the target timetable in Viriato and then simulating operations both with and without delays. Thanks to the detailed analysis of the disrupted timetables in Viriato, the propagation of delays was illustrated on graphic timetables. Finally, these results were compared to the reference project by evaluating the impact of the disruption on connections, the duration of the disruption, the evolution of the total delays and the number of trains affected. This provided indicators of the expected robustness, explaining for each flexibility module in which situations a gain in robustness could be expected and estimating the improvement over the baseline case.

## GERMANY



**Bavarian State Ministry for Housing, Construction and Transport (StMB): “Munich Region Rail Expansion Programme” Feasibility Study**

The “Munich Region Rail Expansion” programme sets out the principles for the future design of local rail passenger transport in the Munich metropolitan region. The programme currently comprises 29 schemes that are already in the planning or implementation stages, including the 2nd trunk line (2nd SBSS) for the Munich S-Bahn as the centrepiece of the programme, supplemented by a number of additional schemes.

With respect to the implementation of the programme, a further 44 individual schemes are to be examined in the Munich Region Railway Expansion Feasibility Study with regard to their feasibility in terms of railway operations and construction, as well as assessed in terms of their impact on traffic. The evaluation was carried out according to a standardised assessment procedure. The change in demand based on service concepts in relation to infrastructure and operating costs identifies which measures should be pursued further. With the actions recommended for further consideration, the target concept for rail expansion in the Munich Region could be systematically progressed.

As a consequence of the postponement of the commissioning date of the 2nd SBSS announced in 2022, the feasibility study was extended to include the investigation of possible service improvements before the commissioning of the 2nd SBSS. Alongside the quality offensive and digitalisation, these service improvements are a key pillar for the programme "Strong Munich S-Bahn – Programme 14plus". The programme assumes the implementation of a series of additional network improvements and is intended to ensure a punctual, reliable, expanded and sustainable service until the commissioning of the 2nd SBSS.



**Baden-Württemberg Ministry of Transport/Nahverkehrsgesellschaft Baden-Württemberg mbH: Stuttgart hub infrastructure dimensioning** The state of Baden-Württemberg has the political goal of significantly increasing the demand for public transport in the next few years and has developed various demand scenarios for the Stuttgart hub. The additional demand is reflected, among other things, in additional trains or lines. For this expanded structure, it must be determined with which infrastructure implementation this will be possible. In the process, it was iteratively determined between service planning (SMA) and traffic assessment (Institute of Transport Sciences (VWI), Stuttgart) which approach and stopping policy the additional services are required to fulfil without congestion of the various routes in the approaches to Stuttgart.

In the coordinated infrastructure reference case, with the complete implementation of the infrastructure currently under construction, with the completion of the digital Stuttgart node and the resulting possible reduction in train times, and with further assumed infrastructure expansion (in particular Deutschlandtakt changes), additional capacity is available for long-distance, regional and S-Bahn traffic compared to the current situation in the core of the major Stuttgart node. For both this reference infrastructure and then for various scenarios with additional infrastructure in the core of the node, an iterative development of service concepts with traffic evaluation was carried out. In addition to regular operations, incident scenarios were also examined in which essential elements of the infrastructure are not available in the node core. These cases with severely restricted infrastructure availability were also examined with regard to impact on the service and the traffic.



**DB Fernverkehr AG: Service planning and timetable concepts for the Berlin–Munich corridor**

Due to the strong growth in demand on selected corridors, DB Fernverkehr AG is striving to steadily expand its services and gain market share. One of the focal points is the design of services on the Berlin-Munich corridor. The main focus of consultancy work in 2022 was to identify options for implementing different service concepts from Berlin to Munich. The planning approach used was to implement the 2029 service concept early in the preceding timetable years in coordination with the public transport authorities and DB Netz AG. The challenge here was that selected infrastructure improvements in the corridor could not yet be assumed to have been implemented for certain years. Based on different hubs of the long-distance lines and alternative approaches to conflict resolution with local traffic, the effects on the service concepts of the federal states were analysed for the entire corridor and conflict resolution guidelines were developed in consultation with the parties involved.

The work will be continued in 2023.



**Saarland Ministry for the Environment, Climate, Mobility, Agriculture and Consumer Protection: Line reactivations in Saarland**

The Saarland drew up in 2021 a new transport development plan for public transport in the Saarland. An essential core element is the further development of regional passenger transport in Saarland and in neighbouring regions. This plan includes reactivating existing railway lines for local passenger transport.

For the routes:

- Saarbrücken–Großrosseln (Rosseltalbahn)
- Saarbrücken/Völklingen–Überherrn (Bisttalbahn)
- Merzig–Losheim
- Dillingen/Saarlouis–Lebach-Jabach/Schmelz–Wadern (Primstalbahn)
- Homburg–Blieskastel (Blisttalbahn)

in-depth investigations were to be carried out within the framework of a feasibility study including a cost-benefit analysis. For this purpose, SMA joined forces with Schüßler-Plan Ingenieurgesellschaft mbH (ZP) and the Zentrum für integrierte Verkehrssysteme GmbH (ZIV) to form a consortium of engineers for the project.

SMA was responsible for investigating the operational feasibility. For each route to be reactivated, Viriato is used to create several variants for the service concept. Different frequencies, through connections, connections to other public transport lines and possible optimisations in the bus network to improve the bus/rail connection are examined. The reactivation routes are first considered individually, and in a later step an overall concept developed in which all reactivation routes in the Saarland are included.

Based on the operational concept, the necessary infrastructure requirements for each line to be reactivated was derived and handed over to SP to investigate the technical feasibility. For the preferred variant, a cost-benefit analysis was then carried out by ZIV for each route according to the standardised evaluation method.



#### **AKN Eisenbahn GmbH: Construction schedule for a suburban railway upgrade**

In the north of Hamburg, AKN Eisenbahn GmbH (AKN) operates, among other things, the lines from Hamburg-Eidelstedt to Neumünster and the connecting lines to Norderstedt Mitte and Elmshorn. In the next few years, the Hamburg S-Bahn will be extended from Hamburg-Eidelstedt to Kaltenkirchen via the AKN routes. Among other things, the extension of the S-Bahn requires the electrification of the line, almost complete double-tracking and the extension of the platforms. In order to carry out the upgrades, section-by-section closures of the line are necessary as a consequence of the construction works.

SMA has developed timetable concepts for the various construction stages. The timetable concepts take into account changed routes so that connections with few interchanges are possible for the majority of passengers despite the works. For the coordinated timetable concepts, 24-hour timetables were developed, which were coordinated with the rail replacement bus planners.

In order to be able to offer a service that is as demand-oriented as possible even during construction, a simplified potential assessment was carried out. This assessment was performed as an iterative process in conjunction with the timetable concept and was the basis for determining the required frequencies and vehicle configurations.

The developed timetable concepts contributed to the decision that, from the second construction phase in summer 2023 onwards, the proposed alteration of the routes should be implemented.



#### **DB Netz AG, Regionalbereich Süd (on behalf of the Free State of Bavaria and the Bayerische Eisenbahngesellschaft BEG): Development of the operational terms of reference for the establishment of a shuttle service on the Munich Nordring**

The north of Munich is characterised by significant population and employment growth. This requires adequate accessibility by local public transport, which brings the use of the Nordring, currently used exclusively for freight transport, into focus for passenger transport. The transport requirements of the local public transport authority for the development of the Nordring from the western side have already been defined in transportation specifications (VAst). In addition, there are the traffic requirements for future freight traffic corresponding to the Deutschland-Takt, including an increase in the proportion of long freight trains. The objective is to establish a shuttle service from Karlsfeld and/or Munich-Moosach to the BMW Research and Innovation Centre (FIZ) in Munich-Milbertshofen with a possible extension to the Euro-Industriepark (EIP) in Munich-Freimann.





The operational and infrastructural requirements for this were defined within the framework of the operational task definition (BAst). Together with DB Netz AG, SMA developed target-oriented and upward-compatible infrastructure variants for the establishment of the shuttle service, taking into account the expected investments within the framework of previous preliminary cost estimates. The infrastructure variants were examined iteratively by means of a railway operation study (EBWU) with regard to the expected operational quality. Finally, the findings were elaborated in written form in the operational task definition (BAst). These will form the basis for the further, detailed design of the infrastructure in the later phases of work as well as for communications with the local public transport authority.



**Verkehrsverbund Berlin-Brandenburg GmbH/Spreepfan Verkehr: INTERREG project RailBLu (Improvement of cross-border local rail passenger transport between Brandenburg and the Lubuskie Voivodeship)** On the regional passenger transport routes between the federal state of Brandenburg in Germany and the Lubuskie Voivodeship in Poland, there is currently only a limited offer with a few train pairs per day.

Within the framework of this project, SMA developed new timetable concepts for cross-border services in consultation with all project participants. Not only the direct cross-border lines were considered, but also domestic services, especially in Poland, were planned in order to achieve the best possible connections with the shortest possible transfer times in the hubs. Previously planned extensions were used as the infrastructure basis and, if necessary, timetable-based infrastructure requirements were derived.

The company Spreepfan Verkehr evaluated the developed timetable concepts from a demand perspective and thus defined the basis for the identification of preferred variants. In the project, it was thus possible to develop a target vision in cooperation with all project participants, which is to be developed further in subsequent steps through the planning of intermediate stages.



**Rhein-Main Verkehrsverbund: Timetable development framework contract** The Rhine-Main region is one of the largest conurbations in Europe and has particularly high levels of demand, especially on the approach to Frankfurt am Main. SMA has been advising the Rhein-Main-Verkehrsverbund (RMV), the responsible public transport authority, for many years on the further development of the integrated interval timetable.

Over the next decade or so several important infrastructure upgrades will be completed in the rail network in the RMV area. These will be associated with a comprehensive change and expansion of the range of services in regional rail transport. These service expansions are possible through new regional traffic lines (e.g. "Regionaltagente West") but also through new express lines (e.g. the new Hanau–Fulda line), as new capacity for services on the existing lines will be freed up. In addition, the service concepts from the



Deutschlandtakt must be taken into account. SMA has examined the required and possible changes to the service concept for the intended step-by-step infrastructure development and summarised them in concept timetables and quantitative frameworks for the interconnected area.

Work for the RMV will continue in 2023.



**Orderer and operator: Support for public transport tender processes** The right support in public transport competition procedures ensures a successful award strategy on the part of the tenderer and the development of the best offers on the part of the bidder. Support relates to various aspects of the competition process and includes, for example, timetable optimisation, vehicle roster planning or the arrangement of workshop locations.

Timetable design and optimisation is an important part of the support for competition procedures in public transport. Here, SMA develops the timetables according to the requirements of the bidder or checks the timetable documents in ongoing procedures for optimisation possibilities.

Another important support service is the vehicle rostering. This involves providing the right vehicle types and the appropriate number of vehicles in order to implement the timetable optimally. The right vehicle types must be selected to ensure both adequate capacity and an economically efficient concept.

Workshop and depot location planning is another aspect of the support services. This involves identifying the ideal locations for workshops to carry out maintenance work quickly and efficiently. It is important to plan workshop locations in such a way that they meet the operational requirements and at the same time are easily accessible.

SMA has been working in this field for over 15 years and has extensive experience in assisting with competitive procedures in public transport. We offer a variety of services to work either on the side of the tenderer or the applicant.

## FRANCE



### **SNCF Réseau: Feasibility study of the Lille Hub Metropolitan Express Service**

As part of the development of a Metropolitan Express Service (SEM) for the Lille hub, SNCF Réseau's Hauts-de-France Territorial Division, as part of a multi-partner approach involving the state, the Hauts-de-France Region and the Lille Metropolis, commissioned SMA to develop a target timetable corresponding to the objectives of the service plans drawn up with the study's institutional partners, as well as identifying the infrastructure needed to achieve these objectives.

Several service scenarios were studied, combined with various infrastructure variants for the route of the new Réseau Express Hauts-de-France (REHF) line. The REHF is intended to free up line capacity on the Lille–Douai/Lens axis and at Lille-Flandres station in order to achieve the objective of a quarter-hourly service for commuter trains and express trains on the majority of the branches of the Lille rail hub. For each scenario and variant, a systematic 2-hour timetable model was created in Viriato, and the necessary associated infrastructure, particularly those linked to the required improvements to the national rail network, were defined.

All the service scenarios and REHF route variants were compared in a multi-criteria analysis including indicators of service clarity, journey times and network saturation. These indicators made it possible to discriminate between the various timetable models and to select one service scenario and two route variants which will be studied in greater detail in a subsequent stage of the study.



**Eurométropole of Strasbourg: Master plan and long-term vision** The Eurométropole of Strasbourg (EMS) and the Région Grand Est established a first stage of the Réseau ferroviaire Express Métropolitain (REME) in December 2022. The partners wanted to have a strategic vision of the development of the next stages of this network. In this context, SMA was commissioned by the EMS regarding two subjects: the development of the master plan and the creation of a benchmark comparing several rail nodes in Europe.

The objective of the master plan was to put the various works carried out by the EMS into perspective in order to propose a multimodal master plan for interurban transport. The aim was to define an optimised inter-city public transport network made up of rail and road lines, guaranteeing compatibility between the two, to propose homogeneous and coherent levels of service for the territory, and to identify the infrastructure developments necessary to achieve this integrated service. The work was mainly focused on the interurban bus master plan. A first assessment was carried out and a plan was iteratively drawn up in collaboration with the partners on the various elements of the network. Finally, a scheme was evaluated, in particular from a demand point of view, using the EMS model and a schedule was established for its implementation in stages.

For the benchmark, five European railway nodes comparable to Strasbourg were selected on the basis of the demographic characteristics of the conurbation and the configuration of their railway networks. The selected nodes were analysed in depth in order to highlight the basic elements of the urban rail systems, to describe their functioning, to list indicators covering the characteristics of the nodes, the structure of the service, the operation and the integration with other public transport systems. The major development projects of these nodes were described in order to identify the structural changes made, the associated functionalities and the common elements. Lessons concerning service, rail operation, infrastructure and multimodal integration were collected and recommendations were formulated for the case of Strasbourg.



**SNCF Voyageurs: Tram-Train Nantes–Châteaubriant Simulation** SNCF Voyageurs asked SMA to verify the robustness of a projected timetable for the Nantes–Châteaubriant tram-train line.

SMA modelled the infrastructure and the reference plan for Nantes–Châteaubriant in Viriato, as well as the target plan, including the proposed rolling stock of TER. The projected plans were first statically checked and recommendations made to ensure the feasibility of line and station operations. These timetables were then subjected to a series of stochastic robustness tests using the Viriato algorithm platform to assess the stability of the two timetables being tested and to compare them. The delay model was calibrated on real data. The result of the tests showed that despite the increase in services on the route, the stability of the timetable remained good.

SMA also produced an educational video to present the tool used and its potential uses in the context of enhancing rail services.



**Corbeil-Essonnes: Study into direct services between the Corbeil hub and Paris**

Since the implementation of the 2019 Annual Timetable and the “metroisation” of the RER D, the Corbeil Essonnes hub has been deprived of fast trains to Paris: the trains currently take more than 40 minutes to reach Paris from Corbeil and passengers coming from the Malesherbes, Littoral and Vallée branches have to change trains to reach Paris.

The municipalities of Ballancourt-sur-Essonne, Étiolles, Le Malesherbois, Ris-Orangis, Soisy-sur-Seine and Corbeil-Essonnes have joined forces to commission SMA to study service strategies that would re-establish seamless connections from Vallée or Malesherbes to Paris and improve service to the Corbeil hub without degrading the quality of service on the other branches of RER D.

The study was carried out in three stages. The first stage consisted of developing a “fixed interval” service that could replace the service currently offered during off-peak periods. SMA then systematically studied the possibilities of running new trains between existing trains during peak hours. On this basis, SMA was able to propose





a timetable for this new line S, structured around strictly timed trains from Gare de Lyon–Juvisy–Malesherbes and Gare de Lyon–Juvisy–Melun during off-peak periods, supplemented by less rigidly timed trains running during peak periods.

It was thus shown that it was possible to create a new line S without modifying the infrastructure and subject to only marginal changes to current traffic. The introduction of this new service would give Corbeil-Essonnes, the second largest town in the department, a fast 30-minute connection to Paris. Based on the study, the communes of southern Essonne have been able to launch discussions with Île-de-France Mobilités to set up these services.



**SNCF Réseau: Audit of the National Railway Network – Capability** As part of the network audit commissioned by SNCF Réseau SMA carried out several analyses for the capacity section of this audit, with the following aims:

- To carry out a benchmark on the allocation of capacity, in particular between train paths and works:
  - To identify the best practices used by European infrastructure managers (IMs)
  - To determine the situation of SNCF Réseau in relation to its European neighbours in terms of capacity management
- To analyse the services/infrastructure approach implemented and identify the benefits and areas for improvement
- To analyse the risks linked to the desire to increase the number of train paths on offer in parallel with the constraint of works (volume and costs)
- To propose solutions to better reconcile traffic and works.

The audit highlighted the benefits of the service/infrastructure approach that is being progressively implemented and showed that it is in line with the best practices of other European IMs, particularly those that have institutionalised the practice to guarantee the legitimacy of the timetables produced. The intensity of the work to be carried out to rejuvenate and develop the infrastructure is nevertheless a strong capacity-reducing factor that could hamper SNCF Réseau’s ability to achieve its service development objectives, particularly on the Metropolitan Express Networks and freight corridors. In line with the practices identified in neighbouring IMs, SMA has proposed several areas for improvement to reconcile the necessary increase in maintenance and development work with train traffic, including

- The organisation of routine maintenance of the infrastructure as a priority for developing regional rail services
- Multi-year planning of works, taking into account the impact on capacity
- Work scheduling constrained by a framework limiting the number of possible variants within an annual service facilitating timetable construction.



**SNCF Réseau: Study for the extension of the Le Boulou freight terminal** The prospects for the development of freight traffic from Le Boulou to France and from Spain on the rolling highway of piggybacked trucks have led the French government to consider extending the capacity of this freight station. The aim of the study, carried out by SNCF Réseau, was to evaluate the consistency and operating conditions of the planned facilities (including a connection to the new Perpignan–Figueras line, LFP) and the associated risks.

After a diagnosis of the current and future uses of the site, SMA modelled in Viriato both the reference and projected traffic at the station boundary and its access points to the National Rail Network (RFN) and the LFP for a basic working day according to various development variants.

All the rail movements in the complex were described in detail and the occupancy graphs of the service tracks of the station's RFN lines and the on-site loading facilities were established. Thus, in this feasibility study the operational analysis calibrated the infrastructure requirements for each variant, as well as the shunting movements. A multi-criteria analysis integrating amongst other things the attainment of the service objective, site saturation, cost and environmental impact, made it possible to rule out certain configurations with a view to moving on to a preliminary study.



**SNCF Réseau: Project Management Assistance for strategic hourly deliverables**

In order to meet the expectations of its current and future customers, and to maintain, modernise and develop the network and operations, SNCF Réseau is setting up a timetable-infrastructure plan for 2030, with operating plans as intermediate steps. These plans include elements related to commercial passenger and freight paths, maintenance or works slots, as well as elements related to robustness, both on the lines and in the nodes. They are drawn up for two horizons, five years (Reference Operating Plan PER) and ten years (Emerging Operating Plan PER) in the future for the whole of France and are debated within the framework of the services and infrastructure managed by the State. In this context, SNCF Réseau has appointed SMA to assist it in drawing up the 2-hour and 24-hour timetables on the Grand-Est and Hauts-de-France networks, with the following objectives in particular:

- To integrate the latest scenarios in the 2-hour systematic timetable linked to the Eole extension project to the west (extension of RER E via a new underground infrastructure) and to check their compatibility with the rest of the Grand-Est network on the different horizons considered
- Construct a 24-hour passenger timetable on the Grand-Est network for the different time horizons under consideration by configuring the tasks in Viriato to correspond to the objectives of the stakeholders while ensuring that there are no conflicts on the lines or in the stations

- Construct a 24-hour timetable of freight paths for the different horizons, integrating works constraints to evaluate the maximum capacity available for freight, comparing it with the volume assumptions for the same horizons and reviewing the impact of the adjustments made
- Supporting SNCF Réseau's Operations Department (DGEX), which is an internal SNCF Réseau body that aims to prepare the elements for the services and infrastructure platforms in the context of Grand Est operation
- Supporting DGEX in the study and coordination of interactions with the German infrastructure manager DB Netz concerning cross-border high-speed train paths.
- Supporting DGEX and the Bourgogne-Franche-Comté territorial management in updating the socio-economic studies for the second stage of the Rhine-Rhone high-speed line project by integrating it into the PER and PEE and by studying service variants on the Lyon–Strasbourg and Paris–Zurich routes.



#### **Nouvelle-Aquitaine Region: Transport plan and rolling stock requirement studies**

The Nouvelle-Aquitaine Region wishes to develop the rail transport service throughout its territory, particularly in the context of the development of a metropolitan network around Bordeaux in collaboration with the Bordeaux Metropole. These developments should make it possible to respond to the strong growth in demand as well as to new mobility needs, particularly in the wake of the pandemic. These developments form part of the context for future contracts for rail services.

In this context, SMA has been contracted to develop year-by-year service scenarios up to 2030 in order to determine the evolution needs of the regional rolling stock fleet, with the multiple perspectives of renewal, modernisation and greening of the fleet as well as allocation to the different geographical sectors that could potentially be formed. Several sets of parameters were tested through contrasting scenarios. Particular attention was paid to the needs of the Bordeaux metropolitan network and to different scenarios of coordinated development between rolling stock and infrastructure.

Finally, a specific look was taken at the strategies for the acquisition and deployment of rolling stock in view of the end of life of the oldest units in the fleet. An analysis of the current regional rail equipment market was carried out in order to determine the essential characteristics of the equipment to be acquired and to size the corresponding fleet.



## NETHERLANDS



**Province of Drenthe: Development of Emmen–Rhine services** The southern section of the Bentheim line between Bad Bentheim and Neuenhaus was reactivated for passenger traffic in 2019. The extension of the line to Coevorden is planned and has already been investigated in several studies. The through connection to the Netherlands and the connection to the ProRail network in Coevorden have not yet been considered in detail.

The aim of the project was to create a collectively agreed, integrated timetable as a starting point for further planning. For this purpose, the national developments in the Netherlands and Germany regarding the proposed service changes between Coevorden and Bad Bentheim have been presented and possible conflicts and interdependencies have been identified.

Based on a pre-defined initial situation (rolling stock, speeds and the regional offer in the Netherlands), the feasibility of the timetable was assessed with running time calculations and conflict identification for different time horizons. In addition, a crucial question to answer was whether an additional Euregioweg stop could be integrated and under which conditions this would be possible.

Due to the dense service on the Dutch side, only a small time window is available for the arrival and departure of the train at Coevorden station. Various solutions were identified, such as speed increases, alternative track occupancy or changes in the stopping policy. The interchange possibilities in Coevorden were evaluated and the new running times between different stations were calculated.

Finally, a possible phasing was outlined at the level of a netgraph for each project time horizon. Compatibility with the developments of the regional offer on the Zwolle–Emmen line was also taken into account in the analyses.



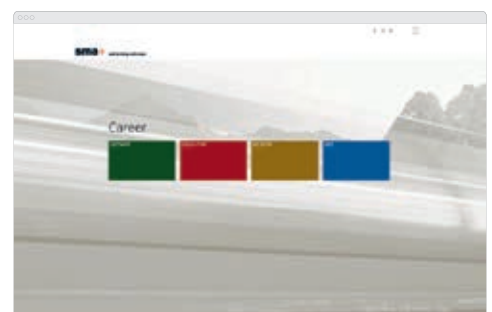
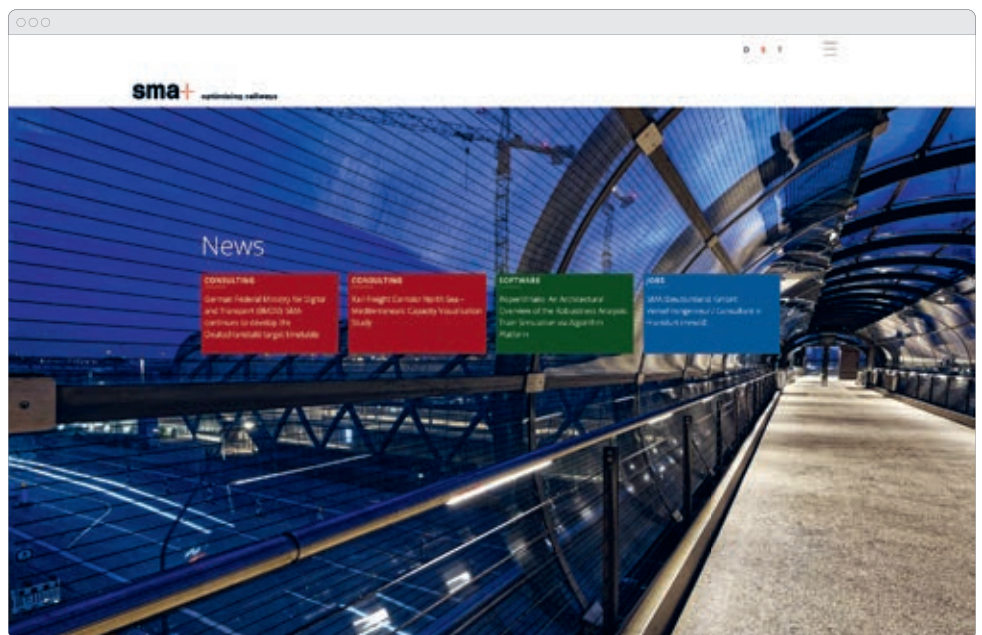


# Communications

**New Website** In 2022, our new website also “picked up some speed”. Under the motto “evolution instead of revolution”, we have repackaged our content and switched to a new background technology.

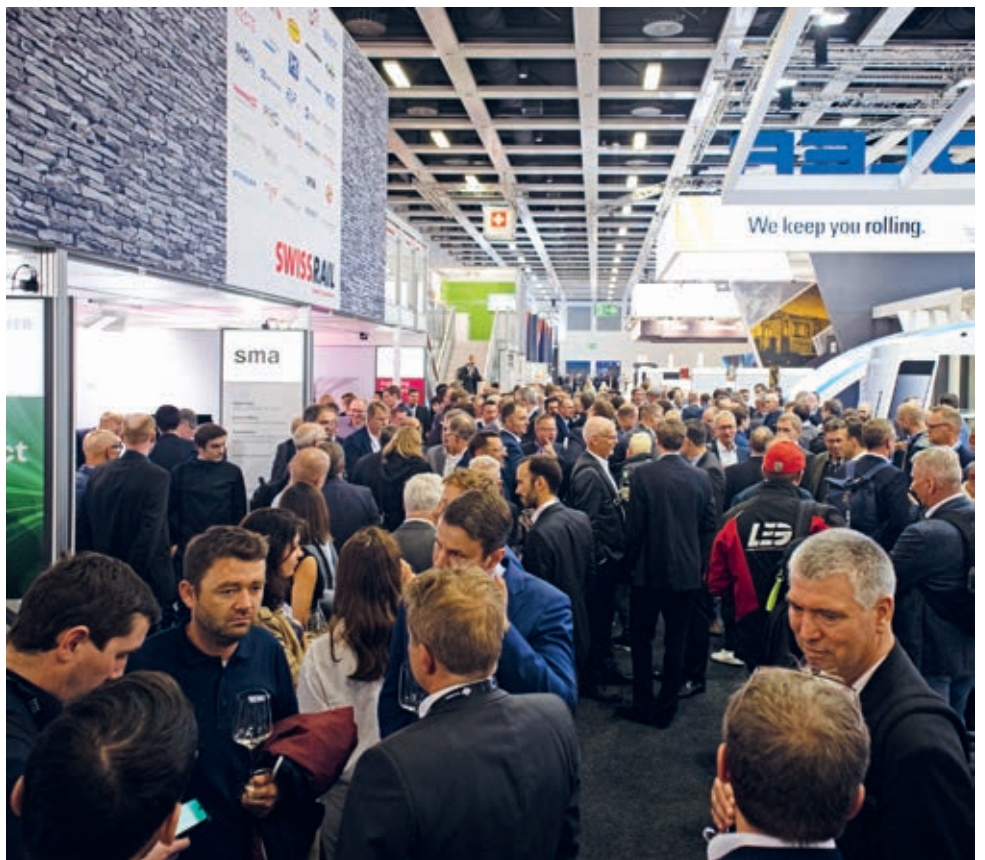
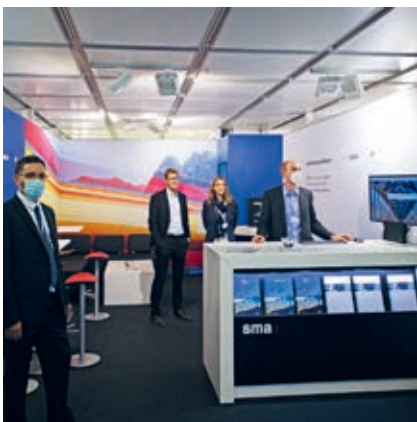
Besides a clear structure within the two segments of consulting and software featuring many references and reports, we also focus on our employer branding.

Take a look here



**InnoTrans 2022** After a four-year break, InnoTrans opened its doors again in Berlin. Over 135,000 visitors from more than 130 countries travelled to Berlin in September to discuss the latest topics from the world of railways.

Of course, we were there too, and once again we had the pleasure of welcoming many guests to our stand.



## Publications and lectures

Eisenbahntechnische Rundschau April 2022	<b>Taktverdichtung im Bahnverkehr der Schweiz unter Berücksichtigung des Knotenprinzips</b> Michael Frei, Raphael Karrer
Eisenbahntechnische Rundschau July/August 2022	<b>Programm «Bahnausbau Region München» nimmt Formen an</b> Bernd Kollberg (Intrapolan Consult GmbH), Michael Frei (SMA), Ralph-Dieter Streble (Schüßler-Plan Ingenieurgesellschaft)
Schweizer Eisenbahn-Revue August/September 2022	<b>Zuerst den Bahnknoten Basel ertüchtigen, dann in variablen Schritten zum Herzstück</b> Christoph Fessler (SBB), Rolf Steinegger (mrs partner AG), Andreas Berchtold (SMA), Vincent Rieder (SBB)
DER NAHVERKEHR October 2022	<b>Weichenerneuerung bei der Münchner U-Bahn</b> Cyrill Baertsch
Technische Universität Darmstadt Germany January and February 2022	<b>Der Deutschlandtakt</b> Marten Maier
École des Ponts ParisTech Paris, France January and June 2022	<b>Exploitation des transports ferroviaires et guidés</b> Henri Saïssset, Pascal Joris
École Polytechnique Fédérale de Lausanne Switzerland April 2022	<b>Timetable Saturation in Practice with Methods from Operations Research</b> <b>Lecture in Decision-aid methodologies in transportation</b> Matthias Hellwig
RAILcph Kopenhagen, Denmark June 2022	<b>Operational simulation models for rail systems</b> Frederik Ropelius
Fachtagung Forschung 2022 SVI Basel, Switzerland September 2022	<b>Taktverdichtung in der Schweiz unter Berücksichtigung des Knotenprinzips</b> Raphael Karrer
École des Ponts ParisTech Paris, France September and October 2022	<b>Analyse et conception des systèmes de transport</b> Henri Saïssset
Persontrafik Stockholm, Sweden October 2022	<b>Kann tågen planeras smartare än idag?</b> <b>En europeisk utblick</b> Frederik Ropelius
Table ronde Cadencement 2012–2022 Alumni du mastère ferroviaire SNCF Campus Étoiles, France October 2022	<b>Cadencement 2012–2022, 10 ans après: Définitions et concepts</b> Luigi Stähli
Cours Transports publics intégrés Chemins de fer fédéraux suisses Löwenberg, Switzerland November 2022	<b>Principes de conception de l'offre de transports voyageurs</b> Luigi Stähli
Mobilitätstag NRW Düsseldorf, Germany December 2022	<b>Das Netz ist das Ziel – der Game-Changer für die Schiene</b> Philipp Schröder (SMA) and Kai Schulte (Kompetenzcenter Integraler Taktfahrplan NRW)

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# Key figures

While 2021 was an exceptional year in terms of licence sales and the use of more sub-contractors, 2022 was more consistent with our trend over the last decade, allowing us to achieve stable and robust growth in our services, despite an increasingly strong CHF (see chart: gross sales in CHF). The 2022 result vindicates our strategic and market decisions, both in consulting and software.

Key Figures*	2022	2021
Gross turnover (million CHF)	<b>14.2</b>	16.1
Full-time employees	<b>75</b>	70

\*incl. subsidiaries

## Turnover by country

- Germany
- Switzerland
- France
- Belgium
- Various



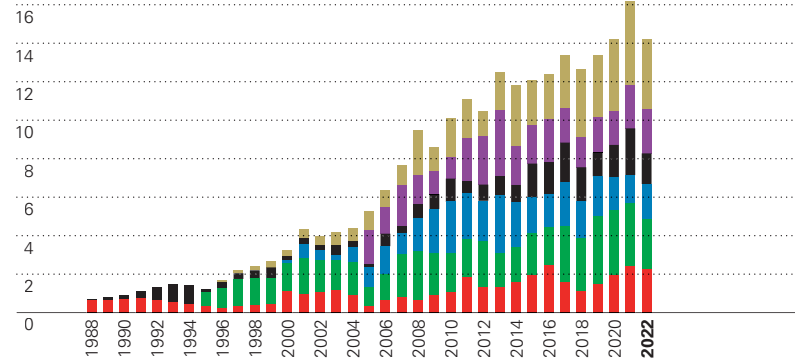
## Turnover by client category

- Transport operators
- Rail infrastructure managers
- Public agencies
- Integrated railways
- Various



## Development of turnover 1988 – 2022 (million CHF)

- Software**
  - Viriato and ZLR
  - Software services
- Consulting**
  - Various
  - France
  - Germany
  - Switzerland



**Editorial services**

SMA and Partners Ltd., Zurich

**Visual concept**

Eggmann-Design, Grüningen

**Printing**

Linkgroup, Zurich

**Photo credits****Cover**

Anne Eggmann

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