



# DESTINATION EFFICIENCY

Optimising railway resource deployment

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**Railways form the heart of public transport. They carry vast quantities of people and goods reliably and quickly, keeping cities and industry moving. At the same time, intense competition is forcing railway companies to deliver maximum service at minimal cost. Therefore, it is vital to deploy all resources as efficiently as possible. Optimisation helps to use their full potential.**

Vehicles and staff are probably the most important resources of a railway operator, yet also a major cost factor. The savings potential is huge. Improving the efficiency of vehicle and staff deployment by just a few percent can save a medium-sized railway company several million euros a year. Modern software solutions help companies to achieve this – with optimisation. IVU systems use complex mathematical algorithms that take into account all the requirements of deployment planning and calculate optimum schedules and rosters.

#### Simplifying planning processes

Planning and deployment of vehicles and staff have reached a level of complexity that companies above a certain size can no longer handle without software. “It is now practically inconceivable to draw up schedules and rosters for dozens of trains and employees on a magnet board

and take all conditions into account while ensuring that all resources are deployed optimally and in a cost-saving manner,” said Perry Prust, head of the Public Transport division at IVU.

In vehicle deployment, planners and dispatchers have to deal with numerous issues: train configurations, train separation, capacity, the position and alignment of coaches, maintenance and service intervals, track occupancy, traction and energy demands, daily schedules and schedule chains – the list of requirements is long.

#### OPTIMISATION HELPS TO REDUCE COSTS

The same applies to staff planning: employment regulations, works agreements, qualifications, breaks, travelling time etc. form the parameters for preparing rosters. In addition, duties should be as balanced and fair as possible, and employees should not be overexerted.

Bearing all this in mind presents considerable challenges for planners and dispatchers. That is why software systems perform the task of mapping this process in the best possible way. For instance, with numerous automation functions, IVU.rail helps to maintain an overview and ensure rule-compliant planning, even when there are large numbers of schedules and rosters to devise. When planning schedules, for example, the system calculates the position and alignment of vehicles in the trainset as well as suitable





Martin Müller-Elschner, CEO

### Dear readers and IVU customers,

Mobility and digitisation, two of today's most significant megatrends, will bring lasting change to our lives and work in the years ahead – presenting both a challenge and an opportunity. While railway and transport companies are under growing pressure to meet the rising demand with reliable transport services, digital solutions help to organise the operation and deployment of vehicles and staff efficiently. This is our speciality.

IVU's products offer the ideal combination of mobility and digitisation. German engineering expertise and the findings of scientific research are helping our customers throughout the world to overcome the problems of the future here and now. Our sophisticated optimisation routines ensure that the deployment of resources in railway and bus companies alike is closer to the optimum – thus helping to reduce costs. To see how this works, read our cover story.

On the following pages, you can find out more about IVU and its systems: We examine, how cloud computing contributes to increases in efficiency, learn about the details of complex optimisation algorithms, and take a look at current projects of our offices around the world.

### Best wishes

Martin Müller-Elschner

subsequent journeys. "However, it is not possible to achieve genuine resource efficiency even with software-assisted manual planning," said Perry Prust. "There is always room for manoeuvre. Optimisation is required here."

### Freeing up resources

Optimisation of schedules and rosters is based on mathematical analyses. Yet the associated calculation steps are complicated – and the complexity keeps on growing in tandem with the number of variables. Scientists worldwide are working on methods for optimum deployment of available resources in public transport, and railways in particular. One of the leading research institutes in this field is the Zuse Institute Berlin (ZIB). IVU works closely with the institute's mathematicians and uses the latest research results in its systems.

For instance, these algorithms make it easy for schedule planners to devise schedules that make the best possible use of vehicle capacity as well as to meet all the requirements of the timetable and the service provider. Once all schedules have been completed, the IVU software calculates different variants for a minimum number of empty runs and downtimes as required. To this end, it may suggest moving a journey so that a train can undertake one journey immediately after another instead of waiting idle for several hours until the next deployment is possible. The cost efficiency of each vehicle can be significantly improved in this way.

With IVU.rail, the Swedish railway company Stockholmståg is optimising its rosters in such a way that all jobs that arise are covered while also attaining maximum stability and fairness of duties. This enabled the company to give more employees time off over Christmas than before, without compromising the service. In everyday operation, the algorithms also ensure greater employee satisfaction by making it easier to organise joined-up duties instead of splitting them into several staff assignments spread out across the day.

### Calculating offers

In addition to efficiency gains in everyday operation, IVU.rail ensures that railway companies can respond to changing requirements more quickly and effectively. The rules on which the calculations are based can be flexibly adapted to the respective situation. By changing just a few parameters, planners prepare detailed "what-if" scenarios with the likely costs of different planning variants. These can also be used as the basis for offers in invitations to tender.

The possibilities for optimisation have not yet been fully exhausted. IVU will keep on working to refine the complex algorithms and use them in its software solutions in order to deploy resources in the best possible way – so that railways can continue to deliver efficient services in the future. ■







# EFFICIENCY FROM THE CLOUD

Growing demands on the services of railway and transport operators have been continuously presenting IT departments with new challenges in recent years. Modern IT infrastructures are more complex than ever before. Yet purchasing, operation and maintenance of the necessary systems are time-consuming and expensive. All this ties up resources that are needed elsewhere.

Therefore, with IVU.cloud, IVU now provides a way of using most of the proven IVU solutions in line with the principle “software as a service” (SaaS). Instead of holding the servers for operation of the software themselves, transport companies simply hire the necessary computing capacity from IVU.

“With the SaaS model, everything comes from a single source”, explained Oliver Grzegorski, Development Manager at IVU. “The advantage is that transport operators no longer need to look after the technical infrastructure themselves, enabling them to reduce their costs.”

At the same time, flexibility is increased, as the system grows at the same pace. Transport

companies can simply book any extra capacity as required, for instance when CPU-intensive optimisations are planned. SaaS also simplifies processes. The software is easier to implement, and the system can be used productively more quickly. Updates also reach the customer much earlier if the system is operated by the engineers who know it best.

### No difference from local installation

For the users in the company, nothing changes when server operation is outsourced. Using Remote Desktop via a secure, dedicated VPN connection, they can access the high-availability system, where they work with the familiar interface as usual. And standardised interfaces mean that peripheral systems can also be seamlessly integrated into the IVU environment.

“In terms of performance, availability and data security, our SaaS solution is on a par with the locally installed variants of IVU’s products in every respect”, said Oliver Grzegorski. “What is more,

our customers also benefit from our technical expertise in operating our systems.” This frees up resources, enabling transport companies to focus fully on their main task: moving people. ■

## THE ADVANTAGE OF SAAS: TRANSPORT OPERATORS NO LONGER NEED TO LOOK AFTER THE TECHNICAL INFRASTRUCTURE THEMSELVES

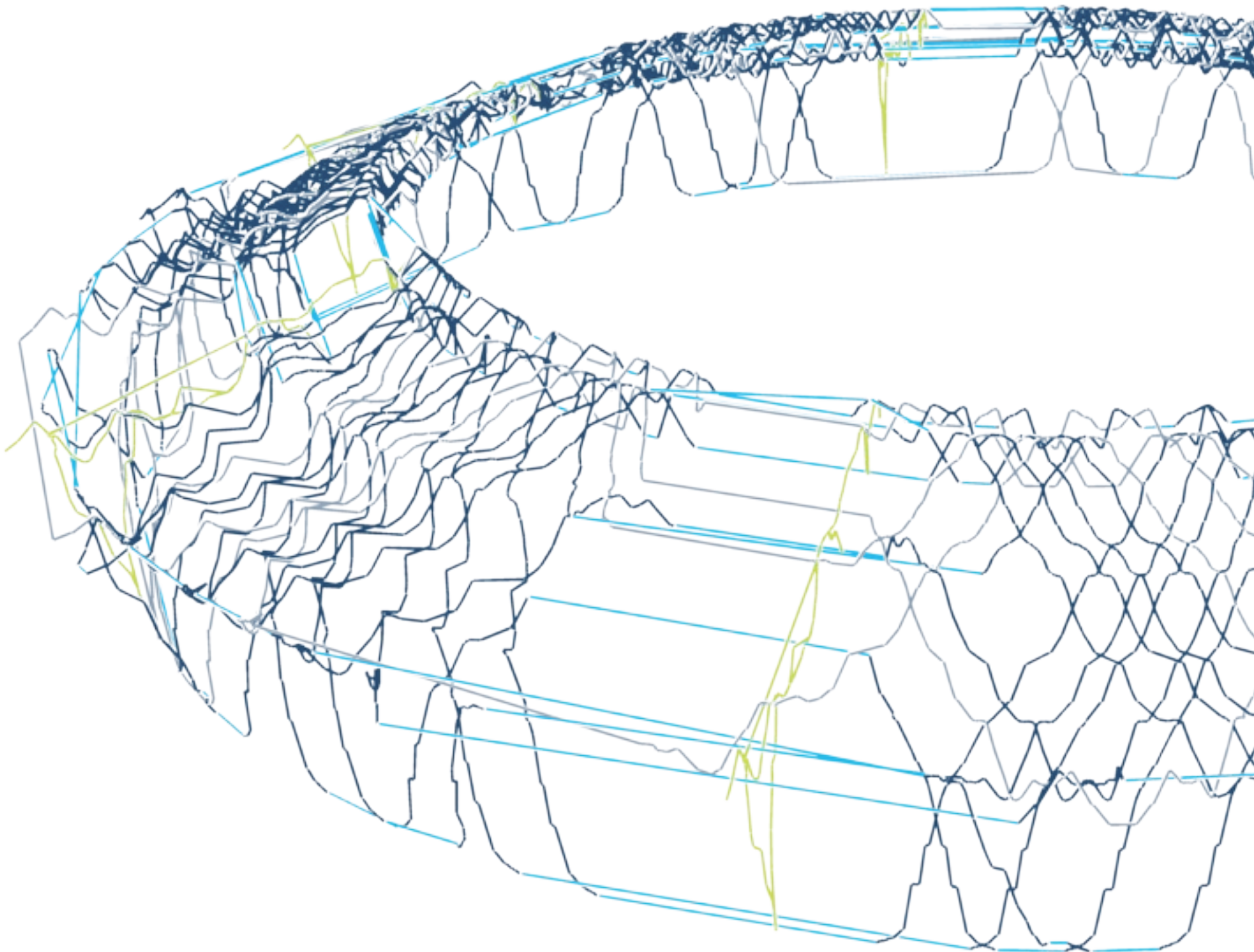
### TRENITALIA OPTS FOR IVU HOSTING

The IVU.rail modules for planning of staff and rolling stock at the Italian market leader have been running on IVU servers since April. With more than 14,000 users and a raft of connected peripheral systems that do not run in the cloud, this highly integrated operating environment is unique in the European transport industry. The optimisation solution is also in a class of its own. No system of this size and completeness has ever been integrated in daily operations anywhere before. IVU is collaborating closely with IBM here. At the IBM data centre in Pero near Milan, the efficient planning of Trenitalia resources is controlled by over 500 processing cores with more than 3 TB of RAM.

# SOFTWARE MADE IN GERMANY

Germany is a railway nation. Around 5,400 stations are linked by more than 37,000 kilometres of track – no country in Europe has more railway lines. 32,000 trains operate daily here in local, long-distance and freight services, carrying around 5.5 million passengers. Researchers, mathematicians and engineers based in Berlin are working to make transport on this network more efficient.

As a public-private partnership, the RailLab brings together scientists from the internationally recognised research centre Zuse Institute Berlin (ZIB) and partners from the industry. Funded by the German federal government, this research initiative produces innovative solutions to the complex problems that arise in railway planning. IVU is one of the parties involved.





# RAILLAB: OPTIMUM TRAIN SCHEDULES

Every complete train costs several million euros to buy – making it all the more important to optimise deployment and maximise capacity utilisation. Even so, many railway companies still schedule their vehicles manually, unlike bus operators and airlines. Compared with buses and aircraft, schedule planning and automatic optimisation are much more complicated for vehicles in railway services.

## From a mathematical hypergraph ...

The underlying technical limitations of the railway system form the biggest obstacle to optimisation of trains. With buses and aircraft, the planning process can be broken down very easily in mathematical terms, as there are only individual vehicles to consider. By contrast, trains consist of multiple units whose sequence and orientation has to be determined. Therefore, classic calculation methods cannot be directly applied.

Instead, to integrate both vehicle schedules and train configurations in the calculation, optimisation programmes must be based on other, far more complex structures. Specifically, in mathematical terms, the multi-week schedules commonly used in planning are based on hypergraphs. Schedules can be represented elegantly and precisely here by circles with mutual dependencies. This modelling makes it possible to optimise schedules by means of efficient algorithms.

The highly motivated mathematicians at the Zuse Institute Berlin (ZIB) handle this. In conjunction with project partners from industry and research, the RailLab based there has developed new methods for solving the problems associated with train schedule planning. First of all work is performed at coarse train or vehicle level, before focusing on the areas important to overall efficiency at the finer level of coach sequence and orientation. In this way, demonstrably efficient vehicle schedules can be prepared with novel algorithms.

## ... to practical deployment

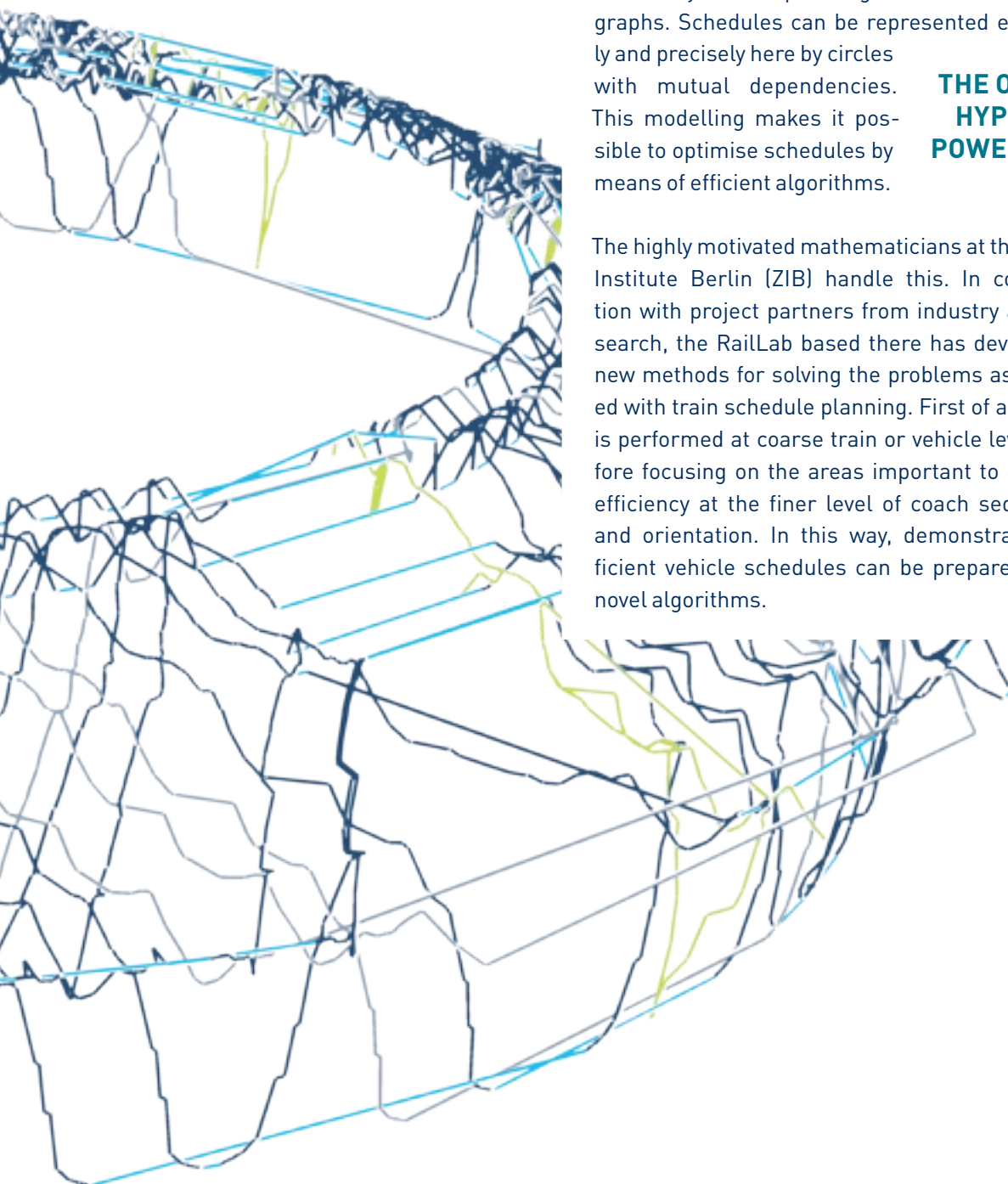
The methods developed in the RailLab form the centrepiece of the optimisation engines of IVU.rail, which is specifically geared towards the requirements of railways. IVU's software engineers and transport experts work closely with the mathematicians from the ZIB. They integrate the continuously improved algorithms into the planning system at regular intervals. By now, numerous national and international customers use the solutions of the Berlin-based mathematicians to plan efficient train schedules on a daily basis.

The next challenge for the RailLab scientists is to refine and accelerate the procedures in order to solve even more detailed problems even more quickly. For instance, compared with the cyclical

standard week, the complexity grows even further if fully dated schedule plans are to be optimised for a specified period. This involves a special non-

## THE OPTIMISATION OF A HYPERGRAPH NEEDS POWERFUL ALGORITHMS

cyclical model extension that places considerable demands on the efficiency of the algorithms. By continuously enhancing their methods, the researchers ensure that the IVU systems also provide optimum results for these scenarios – so that planning and optimisation of train schedules are soon as convenient and intuitive as it is for buses and aircraft. ■



# ON THE RIGHT TRACK

Transport companies worldwide are facing major challenges: a rising population and growing demands on public transport. In Europe and North America as well as Asia and Latin America, government agencies and companies are investing heavily in infrastructure in order to cope with the increase in mobility. With its expertise, IVU is a sought-after partner.

It provides the knowledge and the systems that get transport moving and keep cities vibrant. Developed in Germany, IVU's products help to solve local problems all over the world – with success. More and more customers are opting for IVU. This is also reflected by the share price, which has been constantly rising for several years.

## PERU: ALL-ROUND SOLUTION FOR URBAN TRANSPORT

Lima is a typical big city in Latin America: many bus lines have no timetable or clear departure times. However, the Peruvian capital has been investing heavily in modernising its public transport system for several years. Since the beginning of the year, Grupo Express Perú (GEP Lima) has been running a regularly scheduled service between the metropolis and the neighbouring harbour city of Callao with 150 buses.

On the new concession, the company aims to attract passengers with a reliable transport service, punctual departures and high quality

standards. To this end, the company relies on the IVU.suite for planning and managing vehicles and staff. It also uses the operations control system IVU.fleet, the on-board computer IVU.ticket.box with support for e-ticketing, as well as IVU.realtime, which enables GEP Lima to inform its passengers of current departure times at the respective stops via smartphone apps or its website.

"In Lima, we are proud to be able to help another metropolis to modernise its public transport system", said Dr Claudia Feix, IVU's branch

manager in Latin America. "Many cities in South America face similar problems and have started to build up a modern transport infrastructure. We can provide important impetus here with our expertise from previous projects on the continent."

IVU has extensive experience on the South American market. For instance, the major Colombian cities of Cali and Ibagué already use IVU technology. IVU is also present with two offices in Bogotá (Colombia) and Santiago de Chile. ■







## FROM COAST TO COAST

Part of the route from Toronto to Vancouver passes through the Rocky Mountains. The full journey of around 4,500 kilometres takes the famous VIA Rail Canada train The Canadian around three days and four nights. Several teams of service staff and drivers are always on board – planned and deployed with IVU.rail.

## FIRST-EVER DIVIDEND

IVU paid a dividend to its shareholders this year for the first time since the IPO in July 2000. Martin Müller-Elschner, CEO of IVU, sees this as a clear indication of the company's success: "It shows that we are on the right track with our strategy. We will continue our sustainable and substantial growth of recent years into the future."

IVU's figures confirm this statement: in the 2014 financial year, sales rose to a new record of EUR 47.2 million, while operating earnings also hit a new high of EUR 4.3 million. The shareholders have confidence in the corporate strategy, as demonstrated by the share price growth in recent years alone. Since January 2012, the IVU share has gained over 200 percent.

One of the main factors in the company's enduring success is the high level of standardisation of IVU's systems. This reduces the number of individual adaptations and enables short project lead times. Only recently IVU launched IVU.xpress, a special process that further accelerates project delivery – a key decision-making criterion when awarding contracts. ■

## TRAINING FOR TRANSPORT MANAGERS IN VIETNAM

The first Vietnamese transport managers were recently happy to receive their training certificates. They all successfully completed their courses at the IVU Training Centre in Vietnam in the last few weeks and months. During the two-week course, they were introduced to the key features of modern IT systems for public transport based on the example of IVU products. The participants expanded their knowledge of fundamental aspects such as transport planning, dispatching, fleet management, ticketing and controlling.

IVU supports them here. In conjunction with the Vietnamese University of Transport and Communications (UTC), the company set up the training centre in autumn 2014 with the aim of enhancing the skills of local decision-makers and helping to improve the transport situation. Vietnamese lecturers from the UTC and IVU experts conduct the seminars jointly.

The IVU courses receive broad interest, as Vietnam is currently embarking on a new era: the population is becoming increasingly mobile, and the requirements and expectations of public transport are growing. The country is facing up to the associated challenges, and has started a thorough modernisation of its transport

infrastructure. Specialist staff and managers from Vietnamese transport operators are keen to learn how they can meet the rising demand and deploy buses and trains efficiently.

The contract was officially signed in the presence of Germany's Federal Economic Affairs Minister Sigmar Gabriel and his Vietnamese counterpart Bui Quang Vinh. At the ceremony, Martin Müller-Elschner, CEO of IVU, underlined the importance of the collaboration to the development of the Vietnamese transport system: "With our specialist knowledge and our experience from hundreds of projects worldwide, we can play a key part in preparing Vietnam's transport companies for the challenges of growing mobility."

In addition to the extensive range of events, UTC and IVU also intend to jointly research transport topics in order to increase the transfer of knowledge. The findings obtained will be fed back into IVU's systems, to the benefit of all IVU customers.

Back in 2012, Vietnam Railway (VNR) opted to use IVU's software solution specifically for railway customers, IVU.rail, for planning, dispatching and control of all its operations. IVU has offices in the Vietnamese capital Hanoi as well as Ho Chi Minh City. ■



## SAVE THE DATE

### Trako

22.9. – 25.9.2015, Gdańsk

### Bonding

27.10. – 28.10.2015, Berlin

### CUTA Trans-Expo

24.11.2015, Montreal

### German Equity Forum

24.11.2015, Frankfurt/Main

### IT-Trans

1.3. – 3.3.2016, Karlsruhe

### IVU User Forum

7.3. – 8.3.2016, Berlin

# ON TIME IN THE SWEDISH WINTER

Typical Swedish winters are cold and wet. If once again strong snowfall prevents undisturbed operations, dispatchers in railway companies have to react quickly and rearrange routes or replace vehicles.

Swedish rail operator SJ AB is to use a software solution from IVU for all of its resource planning. IVU will provide its integrated standard system IVU.rail, which is tailored specifically to the needs of train operating companies.

## Replacing multiple individual systems

IVU surpassed all other candidates in an international tendering process. The standard system meets SJ's railway-specific requirements best. Most critical to the decision was its proven range of functions, which was demonstrated live: "The product's high degree of maturity and the numerous automation and optimisation functions were what impressed us about IVU.rail in particular," says Björn Rosell, CIO of SJ AB. "We trust it will provide optimum support for our processes and allow us to make much more efficient use of our resources than before."

SJ will replace multiple individual systems and will carry out the planning and dispatching of all vehicles and employees with IVU.rail in the future. In order to achieve the most homogenous

system environment possible, it was very important to the Swedish rail operator to implement standard software with a broad customer base from a supplier that has proven knowledge and experience in this field: "With IVU.rail, we are getting a future-proof, state-of-the-art solution, with which we can unify our planning processes," explains Ronald Bolijn, responsible IT Architect at SJ AB.

## Around 5,000 employees

Every day, 85,000 people travel with SJ, the largest train operator in Sweden. 5,000 employees work to ensure safe, reliable, comfortable and convenient travel. SJ operates 440 daily departures to 160 stations between Copenhagen and Narvik. All journeys on SJ trains in Sweden are labelled Good Environmental Choice. In 2014, SJ had a turnover of approximately SEK 9 billion.

"We are very proud that SJ, another major rail operator, has put its trust in our standard solution," said Martin Müller-Elschner, CEO of IVU Traffic Technologies AG. "Our more than 500 customers already include state railway companies from Finland, Germany, Switzerland, Italy, Hungary, Portugal, Vietnam and Canada. With our professional expertise and railway-specific knowledge from numerous international projects, SJ is excellently equipped to compete on the market." ■

## IMPRINT

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IVU Traffic Technologies AG  
Bundesallee 88  
12161 Berlin

T +49.30.859 06 - 0

kommunikation@ivu.de  
www.ivu.de

### Editorial

Dr Stefan Steck, Kristin Lawrenz  
Corporate Communications

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