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Digital technologies are going to shape transport by rail decisively in future

Germany must take the lead in the digitisation of rail traffic if it is to safeguard the extraordinary competitiveness of the railway manufacturing industry. With sales of around EUR 12 billion and more than 50 000 people employed directly by it and a further 165 000 employed indirectly, it is one of the most important industrial sectors in Germany. Its long tradition gives it particularly close ties with our country.

Amongst the 200 German businesses manufacturing railway vehicles and infrastructure there are numerous "hidden champions". They are making their contribution to Germany's economic growth and prosperity and also to the creation of good jobs. It is only if such companies are able to work in a propitious, reliable general business environment that it will be possible to safeguard the competiveness and innovativeness of this sector. That is why the German Federal Ministry of Economic Affairs and Energy is pursuing a dialogue with the companies and workers in this industry.

Germany must take the lead in the digitisation of rail traffic if it is to safeguard the extraordinary competitiveness of the railway manufacturing industry.

The railway manufacturing industry in Germany has a strong export focus. It achieves approximately half its sales outside of its home market. That is a clear indication of the technological leadership of German products and their strong competiveness. International competition, however, is increasing all the time. That is why it is important for the German manufacturers of railway technology and their suppliers to be leaders as the next fundamental wave of innovation takes hold: the digitisation of rail transport. That includes digital command, control and safety systems, digital electronic interlocking systems, autonomous train control, intermodal service platforms, networked logistics, the precise diagnosis of conditions for preventive maintenance and a high level of data security. Transport by rail tomorrow is going to be decisively moulded by these developments, and they are what will bring about its progress.

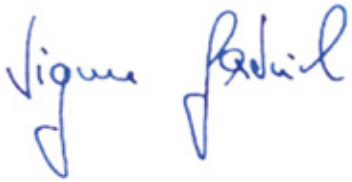
These innovations are going to be on display at the 2016 edition of the world's leading trade fair for the railway manufacturing industry, InnoTrans in Berlin. Visitors are able to walk around a dedicated set of railway tracks beneath the Berlin Funkturm and directly assimilate the innovations from the railway manufacturers. The trade fair presents everything from high-speed trains and systems of local public transport through to detailed solutions for equipping the infrastructure. There is tremendous variety, ranging from the classical construction of tunnels and bridges by large civil-engineering companies through to digital timetable information delivered by a smartphone app developed by a start-up.

As a high-technology country, Germany must in future remain a leading supplier of sustainable mobility and a leading market for it. That being so, the Federal Government will continue to support research and development and to take action in the political field to accompany the worldwide marketing of innovative products and services.

It is also a contribution to attaining Germany's tough climate objectives. Transport by rail offers enormous potential for saving CO_2 as the backbone of sustainable mobility.

I trust that InnoTrans 2016 will prove a big success for the companies and visitors alike, and may the trade fair achieve everything it is setting out to do.

Sincerely yours,



Sigmar Gabriel
Federal Minister of Economic Affairs and Energy

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Digital mobility by rail

Digitisation is creating the best rail mobility ever – even safer, even more attractively priced, even quieter, even more comfortable and causing even less harm to the climate. That is a claim made into a living reality by the companies manufacturing for the railways in Germany and the technologies that are theirs. These developments are always clearly centred on people, and it is they who benefit from the technological progress of "Rail 4.0" through social participation and sustainable mobility. Quite apart from that, transport by rail is indispensable for a modern society the basis of which is division of labour.

The digitisation of transport by rail is the next wave of fundamental innovation. The industry supplying the railways in Germany occupies a starting position from which it is capable of taking the lead and staying there. The expression "Rail 4.0" is synonymous with rail crossing the threshold into a new age, the digital one.

"Rail 4.0" stands for innovative technologies, such as digital command, control and safety systems, digital electronic interlocking systems, networked stations, trains able to drive autonomously, intermodal service platforms, more intelligent logistics, precise diagnosis of conditions, predictive maintenance and a high level of data security.

"Rail 4.0" thus stands for the future of transport by rail, for even more climate friendliness, energy efficiency and environmental compatibility as well as less noise. It stands for transport by rail achieving an even higher performance and contributing to greater prosperity. It also means that passengers travelling by rail find the experience more agreeable and entertaining than ever before and with the promise of a safe journey – wherever they happen to be in the world.

"Rail 4.0" stands for industry in Germany creating wealth with the support of digital resources.

All of these developments are going to be the predominant characteristics of transport by rail in future. Demand for them is going to grow rapidly, particularly in the major urban centres. The fact is, however, that other regions have also recognised these opportunities a long time ago and are investing enormous sums of money. Germany and Europe have the ability to fare well in this competition. The prerequisite for that, nonetheless, is that manufacturers, operators and government must toe the same line. Germany must be both a leading supplier and a leading market. It is of decisive importance to have both more proactive support for research and development and political actions accompanying the endeavours to make marketplace realities out of innovations. What we need is an ambitious agenda on which the two fit together like hand in glove.

What we now need is for manufacturers, operators and government to do more to toe the same line. Germany must be both a leading supplier and a leading market.

This year, the world's leading trade fair for the industry supplying the railways, InnoTrans in Berlin, is very much given over to the theme of "Mobility 4.0". There could be no better occasion for the German Railway Industry Association (VDB) and the DVV Media Group to publish a special international edition of Eisenbahntechnische Rundschau with the title of "Advanced Digital Mobility on Rails". With its collection of specialist articles, company portraits and technological descriptions, the magazine gives its readers an insight into how the digital railway "made in Germany" is playing a decisive role in shaping the future.

Volker Schenk
President,
German Railway Industry Association (VDB), Berlin

Interview

Germany has got to invest now

Volker Schenk, President, German Railway Industry Association (VDB), Berlin

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Companies of the Schaltbau-Group

Germany has got to invest now

The companies manufacturing for the railways in Germany are innovative and are setting standards for the entire world, with an export share of more than 50 %. However, it is the view of Volker Schenk, President of the VDB, that the challenges of digitisation and "Rail 4.0" are such that an even greater commitment is called for from government.

On which points do you want to focus most as President of the VDB?
The entire railway sector must intensify its co-operation in order to make a bigger impact and to be heard in political circles. We ought to focus on just a few issues and work at them together. At the same time, it is my aim to have government better involved. We want to do more than just demand; we want to be proactive in showing what solutions rail offers for today's and tomorrow's transport problems. It is not a matter of fighting against road. No one mode of transport is in a position to offer all the solutions entirely by itself. We must set out to move forwards, all taking the same route. In doing that, it's not enough just to talk; we have got to act too. We need specific targets, not just a pretty-looking parcel of wishes that it won't be possible to put into practice later.

It is unlikely to be easy to find a uniform approach if one partner, Deutsche Bahn namely, is facing very considerable shock-waves and upheavals.
At the end of the changes currently going on, things will calm down once again. In our talks with Deutsche Bahn it has become very clear that the need for change has been recognised, the need to cross the threshold into the new digital age. The will to work with others has definitely come to stay.

How is the railway sector as a whole positioned as far as digitisation is concerned?
My view is that the issue of digitisation has not yet really seriously taken hold of the railway sector. Other industries have progressed further in that respect. There are good reasons for that. We are a very conservative sector with demanding safety requirements and approvals processes that take a very long time. Life cycles in the railway sector span up to 40 years, whereas in telecommunications they are down to just one year in some instances. Nonetheless, we do observe that subjects like data, data processing and sensors have taken on major importance.
The spectrum of products and services of our member companies has been changing and will change even more in future. There is going to be more preventive work, and the significance of service and life-cycle measures will increase. It is also a question of economics. When investments are made in the railway sector, huge sums are involved, and it is worth ensuring that the money spent maintains its value. It is a point on which we are going to have to act quickly, because otherwise we are going to be overtaken not only by other industries but also by competitors from abroad. We are therefore going to make progress on these subjects one after the other and create the general environmental conditions that we need to be able to integrate new developments in existing systems.

What has got to be done?
The integration of the new technologies is going to be the biggest challenge. We need changes in the approvals processes and we need model railway lines where innovations can also be tested in practice. There are masses of things coming our way that are going to revolutionise our industry. It is not just a matter of new technologies, but of new processes too. We must take a keen interest in how the world of work is changing and we must ask ourselves what is socially compatible and find a uniform solution for how we want to resolve such questions in future. There are still many unanswered questions, but one thing is clear: we must act now, otherwise others will overtake us.

Has enough technology been developed already and have we already agreed on standards to an adequate extent?
The technology is already there. The central problem is going to be to create an appropriate infrastructure for putting this technology to good use. The railway infrastructure throughout the world is rather old – not only in Germany. We know that only 12% of all the interlocking units in Germany work digitally. Conversion is a huge challenge, costing vast sums of money. It is, nonetheless, necessary for ensuring that the infrastructure can be used more economically; driverless trains can operate with appreciably shorter headways than the ones running today. That makes it possible to make fuller use of the infrastructure capacities. Germany must invest – and now. Other regions of the world have also recognised the opportunities opened up through digitising the railway sector and are investing tremendous sums in their own railway manufacturing industry. For that reason, both industry and government must remain on their toes. Germany – and Europe – must be pushing innovations more proactively.

Why do you need government grants? Other sectors are developing under their own steam.
Objection. Other sectors are receiving very considerable sums in grants, for example for electrically driven mobility. It is also correct

▶ VITA

Volker Schenk

President of the VDB (Verband der Bahnindustrie in Deutschland/German Railway Industry Association)

Volker Schenk was born in 1964 in Kösching in Upper Bavaria. He has been President of the VDB since January 2016. In 2014, he joined Vossloh, the manufacturer of infrastructure equipment for the railway with activities around the world, in North Rhine-Westphalia, as a member of its executive board with responsibility for technical matters.
Before that, since 2011, he had been executive director of Thales Transportation Systems in Stuttgart, dealing in particular with control, command and safety systems for both long-distance and local railways.
Between 2008 and 2010, Schenk was general manager of Vossloh Kiepe and specialised, amongst other matters, in electrical equipment for railway vehicles operating local public-transport services. From 1992 to 2007, Schenk worked as an engineer and senior manager with Siemens in both Germany and abroad. He studied electrical engineering at the university of Erlangen.

for the state to provide grants for research and development in ways that do not affect competition. Another factor is that the margins in the railway sector are often very low, for which there are various explanations. If something does not happen soon, too many of today's jobs in Germany are going to cease to exist. We are running the risk of losing the industry's sectoral know-how in our country. It is precisely in control, command and safety systems that fatal tendencies have already advanced the furthest. Too little has been invested there in recent years. That, by the way, is a further advantage of digitisation; it is making our industry more appealing once again, especially for young people.

The German federal government is making more money available for infrastructure. The market does not appear to have reacted to that. Why not? What would need to be done to bring about a change?
That is indeed a situation that is causing us huge concern, because it has a direct impact on the business of equipping the infrastructure. Despite a very clear increase in the finances available for replacement investments, we have not detected any form of direct impact on the business of our member companies. The increased money made available as a result of the agreement between Deutsche Bahn and the government on performance and finance ("LuFV" for short) is not making its way into the companies manufacturing for the railway. That is fatal. For around a decade already, the necessary investments in the upkeep of the railway network in Germany have not been forthcoming. So the true need for investment today is correspondingly greater.

How high do you estimate the need for investment to be?
Our assumption is that an annual sum of at least EUR 4 billion is necessary just to keep the status quo. The shortfall on replacement investments has been growing and has reached drastic proportions. The investment backlog is weighing heavily on those of our member companies that produce infrastructure equipment – not only in terms of sales figures but also as regards human resources. The companies are still managing to hang on to the specialists. If investments continue to be shelved, we'll lose those employees – and then they'll be gone for good. We have simply got to stop that from happening.

What reasons do you see for this investment backlog?
Germany needs a policy for investing in the German railway network, and it is high time to get things moving in that respect too. To achieve that, we are going to have to speed up the planning resources in our country and make better use of them. You might have heard the saying of "too much planning, not enough building". That must not be allowed to become a dogma hewn in stone. It is a fact that companies are facing either/or decisions and that they are losing planning intelligence. If everything is focused on competition and processes are transparent, then it is indeed possible for planning and building to dovetail with one another.

Manufacturers, operators and government ought to accept the challenges of "Rail 4.0" together – that is the aim of VDB President Volker Schenk (photos: Rolf Schulten)

Precisely when it comes to control, command and safety systems too, we have been creating stumbling blocks for ourselves with the large number of ETCS versions.
It is wrong for the railway sector to develop too many variants of ETCS. Rather than that, it ought to be concentrating on one system, that, furthermore, is backward compatible. We urgently need a system that works across national borders – one that is uniform. Government, operators and manufacturers together are called on to act.

It would, of course, be thinkable for all development from now on to be based on a future 5G standard.
The question is, however, when is 5G really going to be available. There are still many open questions, especially as regards safety and security. So we cannot simply just keep waiting. That would be a mistake with ETCS as well.
The other side to that is that a paradigm shift really does seem to be on the way. If 5G is used as a synonym for machine-to-machine communication, then in future there is going to be no need for control, command and safety systems apart from those onboard the trains. Would it not be better to wait another couple of years until machine-to-machine communication has matured sufficiently for it to be usable on the railway too?
Nobody knows when 5G is really going to be reliably available. Sometimes there is talk of 2020, today the tendency is more to speak in terms of 2025. A start has got to be made sometime. ETCS is a proven technology. Many countries all around the world have already been placing their faith in ETCS for many years. If we were now to declare our existing control, command and safety systems to be dead, then nothing more would be invested in them from now on. In the final analysis, that would also lead to safety problems. It is not a simple black-and-white issue. We must draw up a long-term concept that is open-ended for further development. »

What are Germany's strengths when it comes to digitisation?
Those of us in the industry manufacturing for the railways in Germany channel 9% of our revenue into research and development, which is a very appreciable percentage. At present, our industry here in Germany is probably the most innovative in the entire world. We have got the know-how and clusters of big companies and SMEs. Even today, our export share is already higher than 50%. What German companies supplying the railways do is of importance worldwide. If, however, we are to make real inroads with digitisation, we need even more resources and greater political backing. China is setting a good example; the industry supplying the railways there is regarded as one of the key technologies and is receiving the commensurate massive support.

What form ought more intensive promotion of innovation to take?
In Germany we need various measures for the implementation of "Rail 4.0". First of all, more proactive support for research through a consistent railway research programme with a big budget. Next, we want to be top suppliers. There is a need, on the other hand, to put highly innovative digital technology into practice in pilot projects in Germany. We want, after all, to be the leading market too – with an eye on exports as well. Finally, we need more efficient interaction amongst government, railway operators, manufacturers and research. We have got to act together after all. The digital leap forward in innovation on the railway has the making of being a German success story. It will, however, only become reality if government, manufacturers, operators and researchers write it jointly. Now.

What is the explanation for the lack of a decisive advance in promotion to date?
Our view is that the German federal government is neglecting railway topics in its current research projects. While electrically driven mobility on the roads is enjoying wide-ranging support, virtually no attention is being paid to the same thing on the railways. That contrasts with the fact that electrically powered mobility on the railways has already existed for decades – efficient, effective and climate-friendly. Railway technology is not a trivial matter – quite the opposite: it requires intensive research. The one-sided perception of electrical mobility on the roads is a blatant shortcoming. An urgent change needs to happen there. That is something for which we are campaigning. What Germany needs today is a targeted and coordinated railway research programme. It has got to be interdepartmental, so as to focus the energy and finances available in this country. In that way, it would be possible to strengthen the export drive of a strategically important sector of Germany industry – looking to the future as well.

The approval of new products ought to be accelerated. How do you appraise the technical pillar of the fourth railway package now that it has been adopted?
Strengthening Europe is a success, and the VDB has played a vigorous part in it. It is, nonetheless, far from being the last word on the central issue of "approval of technical railway systems". The real work is now only just beginning. The new framework conditions must give rise to real value for the industry manufacturing for the railways and indeed the entire sector of transport by rail.

What still has to be put into practice?
There is still a great deal to be done. The practical procedure for cooperation between the European Union Agency for Railways (EUAR) and the national safety authorities must still be worked out and tested in practice. Structures that would spawn more red tape must at all events be avoided.
In future, the EUAR is going to issue so-called "authorisations to place in the market" (APIMs) for technical railway systems, authorising their holders to place their products on the European market. The intention is that in future "authorisations to place in service" (APISs) will play a very much more important role and be issued to operators and infrastructure managers; they could be compared with the "Inbetriebnahmegenehmigungen" that we are familiar with today. That is going to have implications for the way companies manufacturing for the railways conduct their business. It is going to be necessary to keep an eye on those influences to ensure that they turn out to be in the interests of the companies.
The interoperability directive is following the European Union's "new approach", a principle scarcely applied to railway technology to date.

» Other regions of the world have also recognised the opportunities of digitisation and are investing tremendous sums of money. «

What it means is that there are to be harmonised rules for all products on the railway market, and that compliance with them is to be scrutinised by an independent outside body. The situation is similar to the highly complex construction of aircraft, in that the know-how of the manufacturing companies can also be put to use. For that to be able to happen, however, there has got to be a reorganisation of the role played by the manufacturing industry's know-how in approvals processes.

Competition from foreign countries outside of Europe is on the increase. Deutsche Bahn has a procurement office in China, and China is beginning to make purchases in Germany. What can the railway manufacturers in Germany do to counter that?

Yes, international competition is very clearly becoming tougher. We observe that to be particularly the case with China. With its latest five-year plan and its newly created market giant, CRRC, China is elbowing its way massively onto the world market. China has already been successful in the past in developing and emerging countries – often with very attractive financial arrangements. In the meantime, China has also managed to win the second big project in the USA. After Boston in 2014, China also won the contract for Chicago in March 2016. China is becoming increasingly successful on the world market.

The industry supplying the railway in Germany is facing up to this challenge. Considering our technological excellence, we are not worried about our position in the world market. Incidentally, I would add, it is another issue that cannot simply be reduced to black-and-white. It goes without saying that we are cooperating very closely with our partners in China, and it is not least the small and medium-sized suppliers from Germany that are benefitting from numerous projects.

But: it does cause us concern to see some of the means that are being deployed in wrestling for contracts. It often appears to be the case today that it is no longer either the technology or the price of the product that is the decisive criterion on which decisions are taken, but that the job goes to whoever can throw the financing in as well. It is quite clear that Chinese bidders have a definite advantage here, given that they are covered by literally inexhaustible public finances. What is government doing about it in Germany and Europe? Not enough as yet – that is the view of the railway manufacturers in Germany.

What do the German and European railway manufacturers need from government?

We need fair competition. We need the same rules of the game to apply for everyone. We go on record as emphasising that we do not want any form of protectionism. We want open competition, open markets and tendering procedures, transparent financing and stringent requirements for businesses to act in accordance with the rules. The German federal government and the European Union simply must play their part in the bodies that matter to insist on compliance with such entrepreneurial principles.

Government must display its unequivocal backing for transport by rail. China is pouring massive support into its railway sector, because it has rightly recognised it as a key industry. A protectionist policy would clearly be wrong, whereas prioritising sustainable mobility would be equally clearly correct.

Such changes in the general business environment have not yet started to affect financing.

Part of the measures must also involve reforming the Hermes guarantees. It is our opinion that it must be possible, if necessary, to use Hermes guarantees for big contracts too, for instance for financing infrastructure. Other countries, such as Switzerland, are very clearly ahead of us when it comes to guaranteeing loans for international industrial projects. They are, in particular, more flexible and more generous. Germany too must have an instrument that is similarly effective.

Germany must be a global leader in "Rail 4.0". Government can strengthen the position of the railway manufacturers by providing interdepartmental support for research. It can also make the unified European railway area into a reality, including a modern system of train control and protection.

To finish on a personal note, what do you do for relaxation?

What I like best is going out on the golf course with my wife. The peace and quiet, the fresh air and the beautiful countryside are a source of new ideas for me. ◀

(Interview conducted by Dagmar Rees)

» Government must display unequivocal backing for transport by rail. «

Automation and digitisation as an opportunity

Germany has set its sights on becoming an international technological leader in the future digitisation and automation of transport by rail. Its strategy has been laid down in a five-point programme. At the same time, practical solutions are being developed on the marketplace.

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▶ Within the framework of the Digitisation Forum, the German Federal Minister of Transport, Alexander Dobrindt, the Chairman of the Deutsche Bahn Board of Directors, Rüdiger Grube, and the President of the German Railway Industry Association (VDB), Volker Schenk, have signed a five-point strategy paper, the aim of which is to make Germany the market leader in digitisation and automation. The railways are to be put in the position of being able to cope effectively with the tasks facing them in future. The forecasts for 2030 compared with 2015 see the volume of freight traffic increasing by 43% and the growth in passenger transport by rail being double that of passenger transport by motor car.

Rüdiger Grube referred to it as the most radical change affecting rail in Germany since that country's railway reform. He said that the change was to be seen as a turning point, as an opportunity to be leveraged and managed proactively. It is Deutsche Bahn's intention to go further than being a mere provider of data services for third parties and it is to keep its data potential, and thus digitisation, in its own hands – to be the driver, in other words, not driven by others.

The five points contained in the strategy describe a comprehensive programme for the immediate future.

1. INVESTMENTS IN THE MODERNISATION AND DIGITISATION OF RAIL

The Federal Republic of Germany is making a total of EUR 28 billion available for this task up until 2020. The principal emphasis is on making more widespread use of ETCS and on installing new electronic interlocking systems.

2. FREE INTERNET ACCESS USING WLAN IN TRAINS AND STATIONS

The frequency auction for telecommunication companies in 2015 included the condition that they were to provide comprehensive coverage along all railway lines with ICE services. By the end of 2016, there is to be free internet access on all ICE trains. Further expansion to cover local railway networks too is then to follow by 2018. There are, however, going to continue to be restrictions on the permitted data volumes for users, since there would otherwise be additional annual costs of EUR 150 million for the railway, which it would not be able to offset.

Free internet access using WLAN in trains and stations

(Source: DB AG/Thomas Herter)

3. RESEARCH AND DEVELOPMENT OF DATA-BASED INNOVATIONS AND DIGITAL NETWORKING

National research programmes are to support rail's digital innovations. A sum of EUR 75 million is available under this heading. Deutsche Bahn is encouraging developments here with its own projects and resources. The target is a "mobility platform 4.0". All transport services from a single source are to be interlinked to form effective and ecological "customised public transport".

At Deutsche Bahn there are various project groups and start-ups working in this field. Examples are d.lab, mindbox, Skydeck and Enterprise lab. It is their remit to develop new services to offer clients, to automate processes and to create data-based business models.

Initial results have already been presented. One example is that all escalators are to be equipped with sensors, so that the performance of maintenance jobs can be determined by their condition and breakdowns can be rectified quickly. A station app associated with that provides travellers with information about which lifts and

escalators are in working order and which ones are not.

Sensors are also to be fitted to 33 000 of the more than 70 000 switches and crossings to be found throughout the railway network with a view to preventing disruptions. That is one way of improving the punctuality of railway services. That is also the goal being pursued with digital monitoring of the condition of locomotives and other traction vehicles. Driver assistance systems from various companies are to encourage a more economical driving style, resulting in energy savings of up to 30 %.

The autonomous, driverless operation of trains in closed systems, such as the Nuremberg metro, has now progressed beyond the realm of science fiction. Deutsche Bahn is also running initial tests on local services. One manufacturer has successfully completed a pilot operation on a dedicated freight line in Australia. Another manufacturer is working consistently on the further development of electronic interlocking systems. Work is also advancing on providing travellers with more comfort and convenience. Examples of this are the provision of advanced information on where free seats and boarding aids for passengers with limited mobility are to be likely found on trains, the automatic detection of emergency situations in trains and the triggering of corresponding announcements (for instance for occurrences such as vandalism, attacks on people or accidents inside the passenger accommodation) as well as other forms of information in real time delivered to smartphones or similar devices.

The activities to be performed by train drivers are going to change fundamentally in future. According to Grube, drivers are at the same time also going to be traffic managers, and it is now up to the government to create the legal framework for that to become possible.

It ought to become increasingly feasible for freight trains to move about as required and not to be constrained by rigid timetables. That is a goal that is facilitated by digitised timetabling. This is based on a system containing all the possible train paths for the various speed ranges. A client can pick a train path at short notice and pay for it. A scheme of that nature permits a very much better utilisation of network capacities.

4. ENHANCING THE PERFORMANCE AND RELIABILITY OF THE RAILWAY NETWORK THROUGH AUTOMATION AND NETWORKING

The German federal government is creating the legal framework conditions for automated, networked driving of trains. As transport by rail becomes more and more automated a stage at a time, the preconditions are coming into being for a new level of performance. Optimised transport chains ought to make combined transport more attractive. Digitisation offers many ways of doing that. One is for sensors on freight wagons to make it easier to track consignments and monitor their condition. One example of the most modern technology being put to use is the automation of train formation in the marshalling yard of München Nord.

5. DIGITAL PLANNING AND BUILDING – TO BECOME STANDARD FOR RAILWAY INFRASTRUCTURE PROJECTS BY 2020

Large-scale railway projects are also frequently affected by delays and higher costs than budgeted. It is hoped that digital planning and construction-site supervision will lead to a better involvement of the population. Mistakes and omissions in the planning can thus be detected in advance, which makes it easier to rectify them. Another advantage is that amendments to tendering documents and engineering contracts can be minimised. A number of initial pilot projects, such as Rastatt Tunnel, are running successfully with the help of 5-D planning. The biggest advantage is the integration of everyone involved in the construction work.

Rüdiger Grube commented that digitisation constitutes a true challenge for both management and the workforce. He sees a need for fresh thinking across the board and for new concepts to be drawn up. He believes that many of the professions involved in the transport process are going to change in future and that the rate of change will keep on accelerating. Employees are going to have to face up to new demands; they are going to need to shift their outlook and to undergo further training.

The participants in the Digitisation Forum are unanimous about one point: putting the strategy into practice is going to call for coordinated action throughout the entire railway sector.

MAKING IT INTO REALITY ON THE MARKETPLACE

The time for action has come. In Germany, digitisation and automation are the dominant themes of 2016. Trade fairs and congresses throughout the country are making "Rail 4.0" into an issue. They are showing where the railway sector stands in practice at present. One initial conclusion can certainly be drawn: "Industry 4.0" has made its way into transport. The fact is that the massive increase in the data available to public-transport operators is bringing about changes in operational procedures throughout the industry. At a press conference held just before IT-Trans, the specialist exhibition for IT solutions in public transport in Karlsruhe, Jarl Eliassen, a UITP expert in information and ticketing, expressed the view that such data is creating the potential for a revolution in client service in public transport. He went on to say that passengers were becoming more demanding and that the effect of the numerous apps now available was that clients were becoming increasingly fastidious in what they were expecting of public transport.

It emerged clearly at IT-Trans in spring 2016 that the use of smartphones and smartwatches is playing a big role in the improvement of client service. These so-called "wearables" are coming to be regarded more and more as instruments that not only provide travellers with information about itineraries but also advise them on which mode of transport to take, buy the necessary tickets for them and guide them on their travels as navigation devices. Various manufacturers have developed apps offering this new comfort and convenience. The functions on offer today include the following:

- → Not only are itineraries displayed, travellers are also able to choose their preferred options (fast, cheap or particularly ecological);
- → Tickets can be purchased directly from within the app and downloaded onto a mobile phone or an NFC card;
- → For passengers unable to negotiate steps, there are applications for showing them step-free routes into vehicles and buildings;
- → It is also possible to purchase a ticket using a smartphone and a voice input;
- → Voice output provides passengers with direct door-to-door navigation;
- → Ticket sales are becoming even more automated, with beacons registering passengers entirely automatically as they board and alight. The only action that a passenger still has to take is to ensure that Bluetooth is active on his or her smartphone or smartwatch; and
- → Passengers are presented with active proposals as to how best to get back home from wherever they happen to be at any point in time.

Apart from smartphones and smartwatches, smartcards remain topical in ticketing, both as cards on which the tickets are actually »

booked and also as cards now reduced to the function of identifying the client, while the process of checking in and out triggers the corresponding debit from a client account. Solutions are also on offer for use by tourists and businesspeople who are only present within a particular fare scheme for a limited period of time. Another important point is that such a system must also function offline for the eventuality of disruptions occurring in wireless links.

Passengers also want to remain digitally connected when travelling by public transport. One problem as far as that is concerned is to keep mobile wireless connections up and running in fast trains. Solutions are on offer for this too. One example is the multi-operator router, which keeps mobile wireless connections active for travellers' laptops, tablets or smartphones. In some applications, the provision of WiFi for passengers is combined with an onboard infotainment system. A system like that provides information about the journey and the destination, offers entertainment in the form of films, music, games or serviceable e-books and provides the opportunity of inserting advertising or operating onboard e-shops.

More and more transport operating companies are having recourse to big-data analyses in support of their own business. With these, it is possible to detect trends in client behaviour early, and they allow businesses to evaluate their own performance with precision relative to their clients' expectations. Various solutions were presented at IT-Trans. The following are some of the functions making a new appearance on the marketplace:

- A system with which it is possible to monitor the flows of visitors in a town in real time and to be able to react at short notice.
- Data on traffic movements as well as settlements with transport operators and data from traffic monitoring centres and depot management systems is all fed into a timetabling program. In the process, optimisation modules ensure better use of the capacity of the available vehicles.
- Web-based approach: Increasing numbers of planning and operating modules are now becoming web-based. Their contents can thus also be called using mobile systems and with low-cost hardware such as smartphones or tablets.

It is estimated that the overall market for intelligent transport systems in Europe will be worth EUR 1.43 billion in 2019 (2014: EUR 1.03 billion).

Whereas those digitisation and automation steps that are based at heart on the use of the new, mobile communication devices or that only require software modifications can be implemented quickly, there are very considerably greater challenges when it comes to combinations with typical railway hardware with life cycles running into several decades. The Railway Forum in Berlin pinpointed where the problems lie, but also showed where to look for possible solutions.

INTELLIGENT EVALUATION OF DATA

Digitisation offers the opportunity of developing more efficient operational procedures by making use of the potential of large quantities of data and sensor systems for better maintenance, administration and improved operation of the means of transport, i.e. the infrastructure and the vehicles.

In order to be able to take good decisions in the digitisation age, there are five essential givens in the view of Prof. Dr. Michael Feindt of the Karlsruhe Institute of Technology:

- objective data
- good/correct forecasts including uncertainty
- good/correct cost/benefit functions for one's own business
- good/correct optimisation, and
- automation

Feindt is convinced that 99 % of all processes in a business can be automated. With a net margin of 2% in the railway sector, he sees automation as constituting an opportunity.

It is not necessarily the case that the call for objective data has to mean capturing more data. At the digitisation workshop of the Railway Forum, Dr. Mervyn Gerarde Maistry, a partner in Digital Business Models with Ernst & Young, made the point that, today, companies and entire sectors are investing billions of euros in capturing new data without bothering first of all to consider which items of data they are then really going to need. He expressed the view that this was a task to be tackled on a sectoral basis, that each sector would have to arrive at an understanding of which items of data were needed. The individual companies would then be able to use this data foundation to build good business models on it. That was one of the conclusions to emerge from the event.

Uwe Hartenfeller and Dr. Oliver Skiba von Ernst & Young presented a breakdown of the various goals that the business models might pursue:

- cost optimisation
- liquidity optimisation
- business development, and
- client retention

They warned against combining several of these goals in a single business model, since contradictory project goals might cause the entire project to fail. Moreover, although a profitable business model must be up and running at the end of the development, micro-economic considerations must not be allowed to stifle the creative spirit. They urged companies to use not only their own data, but also other sources of data, which are often available for free. It would be possible, for instance, to take the client data acquired by transport companies through BahnCards, online tickets and passes and to add to it data from the social networks and thus to be able to recognise client preferences and to put together customised offers. ◀

Enhancing the performance and reliability of the Railway network through automation and networking

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"Always-on" – modern vehicle IT as a basis for future-oriented passenger rail operations

Train operating companies involved in passenger services find themselves in a market where competition is intense. At the same time, the use of the internet by passengers on the move is increasing at a very rapid rate. If such companies are to keep pace with the growing competition from long-distance coach services, one way to improve customer experience in rail traffic is to provide reliable wireless access to the internet. This article presents an up-to-date vehicle IT system based on an all-IP vehicle communication infrastructure. One possible basis for this, which is becoming more and more attractively priced, is to equip the trains with a broadband data connection to the public mobile networks. This would address not only the possible transmission of data for optimised operations, for example in the sense of being able to transmit diagnostic data in real time for condition-based maintenance, but also the more demanding expectations passengers now have of high-performance onboard WiFi.

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1. BACKGROUND

It would appear that nothing is going to stop the growing trend of the mobile internet. We have already arrived at a situation in which the majority of passengers travelling today have a smartphone in their pocket and would thus be able to access the internet round the clock wherever they happen to be. The latest figures according to [1] show that more than 75 % of all mobile telephones in Germany are smartphones. The proportion even rises as high as 96 % if we consider only new acquisitions of mobile telephones. The results of an online study carried out by Germany's public-service television broadcasters (ARD and ZDF) in 2014 paint a very clear picture of how people in that country are using the media [2]. That was the first year when it was recorded that the majority of them were using the web for mobile communications. Smartphones and apps have now overtaken the stationary internet as the principal channel for information and marketing. The motivation that originally dominated the acquisition of mobile terminals, namely of being able to move about freely in one's own home and enjoying convenience of operation, has given way to the wish to be "always on" and thus also to be online when travelling. The proportion of German users accessing the internet while travelling too reached the 50 % mark in 2014 [2]. The most important activities of mobile online users are looking for information, using search engines and consulting e-mails. Compared with the applications used generally in the home or at work, weather forecasts and travel information are consulted more frequently by users on the move. That also applies to contacts with one's own community through social networks [2].

Specific technologies are required for providing adequate IP connectivity in railway vehicles operating short-distance passenger services too and these technologies are the subject of this article. It also looks into aspects of system design and the approval of the system concept presented.

2. IT SYSTEM INSTEAD OF MOBILE REPEATERS

In choosing infotainment equipment for trains the question often asked is: which technical solution best satisfies the specific requirements in passenger transport by rail? One option is to equip the trains with mobile repeaters. Another is to equip them with a complete IT system. That normally includes the provision of a wireless local area network (or WiFi) throughout the passenger accommodation.

Mobile repeaters function as relay stations for the public networks that can be received outside of the train. Which data is transmitted through a repeater is determined solely by the passengers' terminal devices and it cannot be used by the transport companies unless they install additional IT systems with their own mobile functions. When equipping a train with mobile repeaters, it is a frequent practice to install a separate one in each of its coaches. As a general rule, repeater systems cost significantly more to acquire than IT systems, especially for long intercity trains.

By contrast with the installation of mobile repeaters, an IT system needs only one central router for the entire train. That makes the acquisition costs of an IT system very much lower. Moreover, operators of IT systems are able to insert so-called "landing pages". These are webpages on which it is possible to place operator-specific information, such as details of connecting services or advertising. An IT system can thus be used for more than just giving straightforward internet access and can also create a further-reaching information platform for passengers. A general-purpose IT system thus also contrasts with mobile radio repeaters in that other applications can be added to it as well.

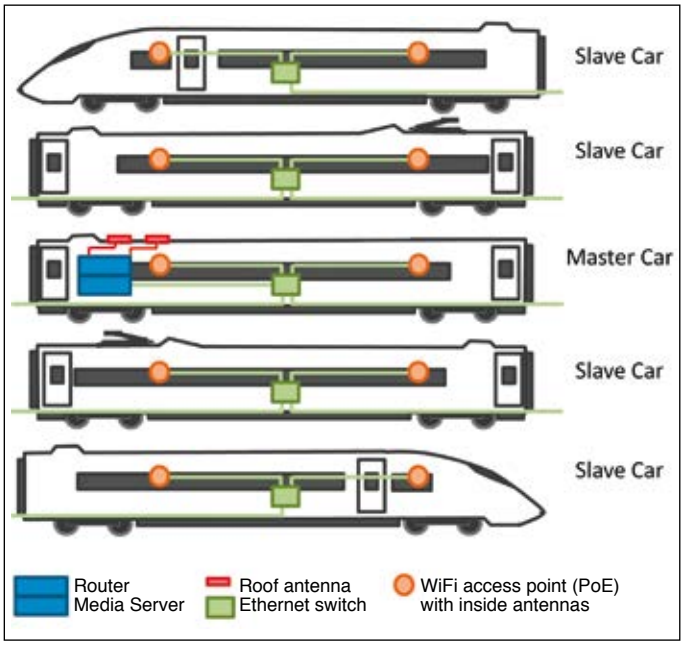


FIG. 1:
IT system in a high-speed train (simplified)

3. THE IT SYSTEM'S ARCHITECTURE

The idea of offering railway passengers high-performance WiFi presupposes that a central onboard computer providing IP connectivity for all applications throughout the train is integrated in the public networks through mobile wireless. This router must be equipped with at least one roof antenna, which establishes the link with the trackside infrastructure. The routers have several SIM cards and aggregate the available bandwidth of the individual mobile networks. In this way, it is possible to achieve a multiple of the bandwidth of a simple SIM card and also a high data transmission rate (using subscriber identity management, SIM). The big advantage, however, is that it achieves a very significant reduction in the lengths of track over which there is no connectivity or only poor connectivity. Starting at the central router, an Ethernet network stretches through the train, and additional applications can be connected up to it. As far as the passenger WiFi is concerned, a typical onboard infrastructure is comprised of a central switch along with WiFi access points in each coach. It is these that the passengers' terminal devices connect up to.

Figure 1 shows one possible system configuration for a high-speed train operating cross-border services. It is to be reckoned that, as a mean, passengers will spend very considerably more than 20 minutes onboard such a train. It therefore makes sense for the train to have its own infotainment server offering them travel information, videos, music and games, without needing to exchange data continuously over the train-trackside connection for each individual user. In order to ensure that as high a bandwidth as possible is provided for all passengers, each coach has two access points in it, transmitting in various frequency bands. It takes up to eight mobile wireless connections to ensure adequate bandwidth for the train-trackside connection. Given that the train is operating across national borders, it has various nationally specific SIM card packages. It switches between these every time it crosses a border in order to minimise roaming charges.

4. MEASUREMENT OF MOBILE WIRELESS AVAILABILITY FOR DIMENSIONING THE TRAIN-TRACKSIDE CONNECTION

A precondition for transmission of data between a train and stationary installations is the use of public mobile networks. The availability of such networks along railway lines is, however, often limited, given that only sparse populations live there. This calls for detailed prior planning to ensure the choice of suitable onboard equipment, to assess user behaviour and the consequential broadband requirement and above all the use of the mobile wireless networks. The availability of mobile networks along the line is measured either (a) with mobile apparatus and no fixed installation in the trains or (b) by travelling along the line with a vehicle already equipped with roof antennas or even a vehicle with a complete IT system already installed. The first of these approaches has the advantage that the measurement can be made at short notice. Mobile measuring devices, however use only antennas in the vehicle's interior. That makes them an inappropriate method for railway vehicles some of whose window panes have strong metallic coatings. The shells of such vehicles act like a Faraday cage for mobile wireless signals and insulate a large proportion of their field strength (> 99 %). With the second method, the roof antennas are outside of the insulated passenger accommodation and also several metres higher up. That greatly improves reception quality. In addition to that, the result measured with this scenario corresponds to the system that will be used later on, which will usually be based on roof antennas.

Figures 2 to 5 show the results of a measurement run in March 2015 between Braunschweig and Leipzig. Four SIM cards from three different mobile network providers were used. Figure 2 shows the computed data throughput to the train for each of the SIM cards, which were used in parallel. Figure 3 shows the mean data throughput for each of the SIM cards and also the possible total throughput resulting from aggregating all four of them, which, with a mean of nearly 40 Mbit/s, is relatively good. Figure 4 presents a breakdown of the mobile transmission technologies selected by each of the SIM cards. The result that is generally of interest for real projects is presented in Fig. 5; whereas even the best individual SIM card manages to achieve a throughput of less than 2 Mbit/s during 37 % of the travel time, this proportion is reduced to 17 % when all four of the SIM cards tested are aggregated. Another way of interpreting this result is that, assuming the target data throughput is greater than 10 Mbit/s, the best individual SIM card achieves this value only 39 % of the time, whereas it is attained 78 % of the time when all four cards are aggregated. »

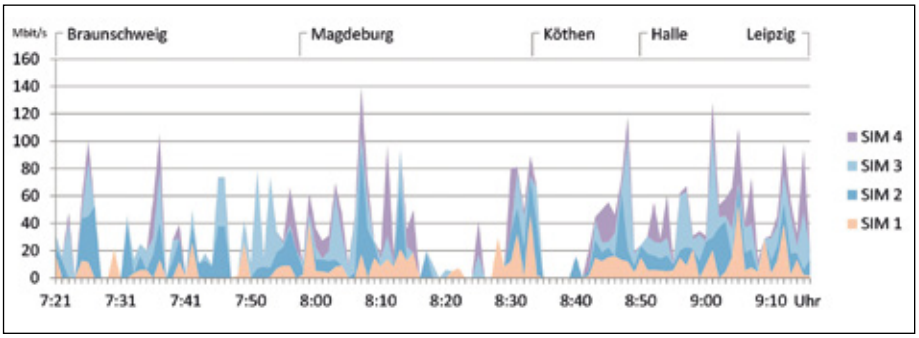


FIG. 2: Data throughput (measurement run from Braunschweig to Leipzig, March 2015)

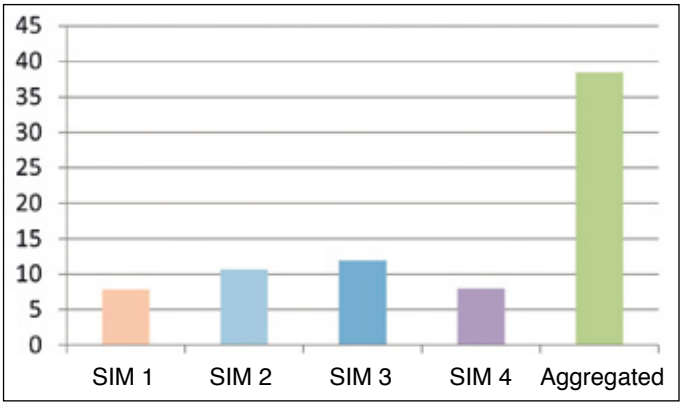


FIG. 3: Mean data throughput per SIM (measurement run from Braunschweig to Leipzig, March 2015)

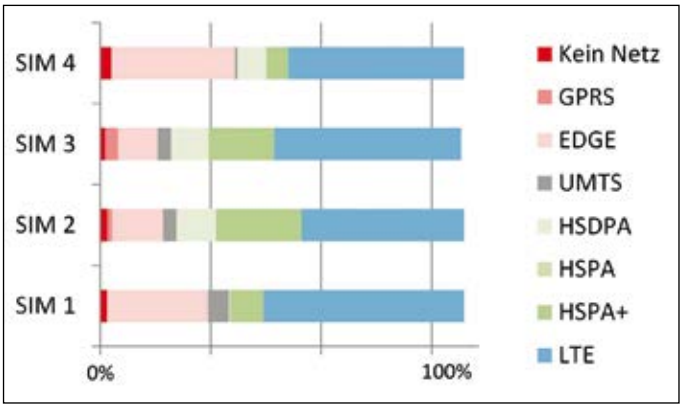
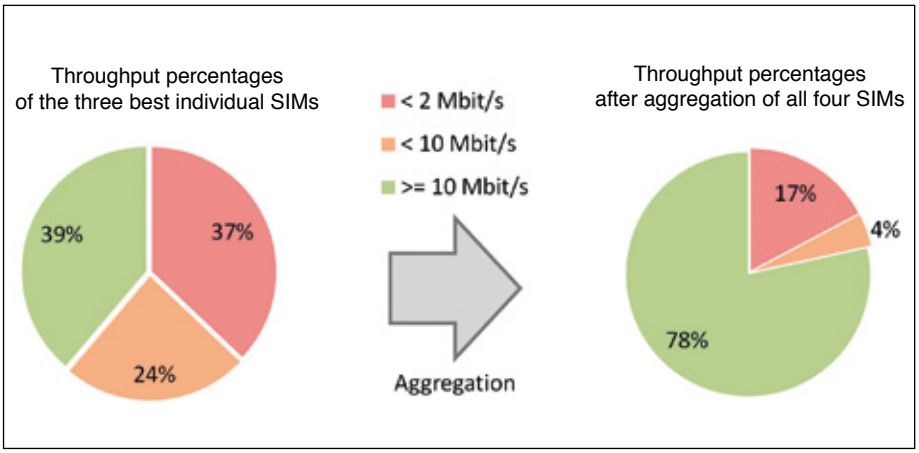


FIG. 4: Mobile radio technology used by each SIM (measurement run from Braunschweig to Leipzig, March 2015)

FIG. 5: Usability with aggregation (measurement run from Braunschweig to Leipzig, March 2015)



Every measurement of the mobile wireless bandwidth is a momentary one, depending, amongst other factors, on other users in the same mobile cell. The results nonetheless provide very good guidance as to mobile network availability. That is indispensable for dimensioning the onboard router, choosing the number and type of antennas, selecting mobile wireless providers and deciding on the number of SIM cards.

5. APPROVAL OF THE ONBOARD EQUIPMENT

In Germany, it is permissible to integrate infotainment solutions in new vehicles or in vehicles undergoing renewals or conversions that already have an approval in accordance with § 32 (1) of the Ordinance on the construction and operation of railways ("EBO"), an authorisation for placing in service in accordance with § 6 ff. of the Trans-European railway interoperability ordinance ("TEIV") or any other railway approval for which there is statutory provision. Whatever the case, it must be documented that the IT system does not impose any retroactive effects on other (vital) onboard systems. For this purpose, it must be shown that the vehicle IT has no functional and no technical software or hardware connections to safety-relevant items of equipment or that it does not influence or corrupt any of the data held in these [3].

In addition to that, the components of the IT system must satisfy the crucial requirements for use in a railway operation. What that means is that the parts are required to have not only a long service life but also a high availability in operation in all imaginable environmental conditions. That includes shocks and vibrations, aerosols, salt and fluctuations and transients in the voltage supply (cf. DIN EN 50155).

Items of technical equipment must function impeccably (i. e. not be affected by interference) and/or be capable of integration with the existing onboard electronics without creating feedback (i. e. without causing interference). DIN EN 50121 describes what consideration must be given to the discharge of static electricity or the interferences caused by radiating high-frequency electromagnetic fields (such as mobile telephones).

To have the vehicles approved, it is necessary to submit documentation detailing the technical measures of fire protection in consideration of the crucial binding standards (DIN EN 45545). The effectiveness of existing approvals may not be forfeited through the integration of new components.

6. FURTHER SERVICES AS SYSTEM USER – TECHNICAL AND COMMERCIAL BENEFITS

In this article a system architecture has been presented that is able to satisfy demanding requirements for applications even when there are severe variations in the quality of service (QoS) of the mobile communication between trains and wayside communications infrastructure. The IT system described supports the simultaneous operation of several applications, for example:

→ Dynamic passenger information: Passengers are kept informed about the current status of the transportation system (Real Time Passenger Information, RTPI). Time table information is continuously updated with real time information about arrivals and departures of connecting trains. The existing IP-based onboard network permits the integration of various output channels. The possibilities here range from electronic displays and acoustic announcements in trains through to dynamically generated webpages in the internet.

→ Vehicle diagnosis: Thanks to the availability of a broadband data communication channel, the maintenance of the entire fleet of trains is very considerably improved. If comprehensive data is available for each vehicle, intelligent algorithms can produce a forecast of possible future failures. That enhances the availability of the fleet by avoiding unplanned downtimes, improves the plannability of maintenance activities and avoids unnecessary (preventive) maintenance measures.

→ CCTV (closed-circuit television) can be used to watch what is going on inside public-transport vehicles using optical-electronic devices. It has now become usual to deploy digital cameras, which can be connected up to the vehicle's IT system through a TCP/IP network (IP cameras). It is also possible to add special software for additional functions, such as movement detection, facial recognition or data storage.

The potential of the architecture concept described emerges particularly in the use of a shared platform, which creates synergies between the applications running on it. Aggregation of the connectivity of several underlying public mobile networks ensures that the tough demands the applications make of the qualities of the communication service can be satisfied at all times.

The architecture concept described satisfies the passengers' demanding expectations for being able to use the internet while on the move. Moreover, it achieves synergistic effects by opening the way for other applications to be integrated in using it too. ◀

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Rail Communication Systems

Progress is being encountered throughout the railway world. The railway system gets faster, more reliable and provides better connections. On top of that passengers are better informed and increasingly provided with access to the internet. So where does this progress come from? The major driving force behind these improvements is digitalization or, in other words, developments in the area of rail communication systems.

▶ The main aspects of digitalization are:

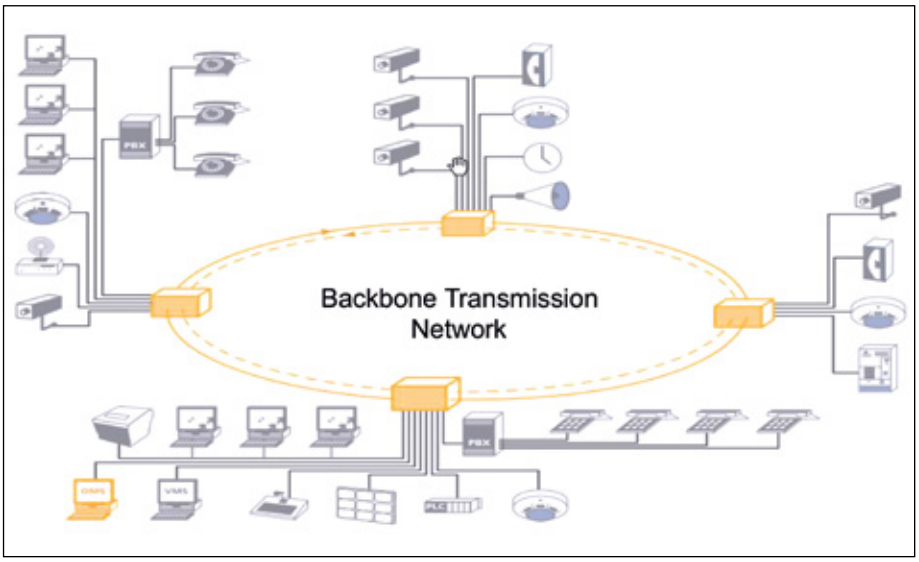
→ increased data transmission capacity
→ fast evolution of data-based functionality
→ higher expectations of passengers for information, convenience and entertainment

This article aims to describe the demands digitalization puts on the individual elements of rail communication systems and the trends that emerge in response to these demands.

1. WHAT ARE THE ELEMENTS MAKING UP RAIL COMMUNICATION SYSTEMS?

→ Data backbone network (fixed data network)
→ Mobile data networks
  – data radio networks
  – broadband communication systems
→ Voice communication systems
  – telephony
  – voice radio
  – emergency help points (at stations and on trains)
→ Operator monitoring and control systems
  – SCADA station and tunnel supervision and control systems
  – CCTV supervision (at stations and on trains)
  – passenger counting and passenger flow monitoring systems (at stations and on trains)
  – access control systems
  – intrusion alarm systems
→ Passenger guidance and entertainment systems
  – passenger information systems (at stations and on trains)
  – passenger announcement systems (at stations and on trains)
  – passenger entertainment, advertising, content stored on trains, internet access

FIG. 1: Backbone Transmission Network



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2. DEMANDS AND TRENDS FOR RAIL COMMUNICATION ELEMENTS

→ Data backbone network (fixed network, BTN – Backbone Transmission Network)):
The data backbone network faces a large variety of demands, most notably:
  – sufficient capacity for today's and future demands
  – upgradability, i.e. long service and investment life in an IT world where innovation cycles are spinning faster and faster
  – provision of a vast range of interfaces from analog to digital
  – interoperability between a multitude of networks
  – absolute reliability
  – IT security, i.e. protection against intrusion
  – data management in line with the requirements of interfaced applications

Trends: networks are moving towards IP whilst providing solutions for the interfacing of legacy interfaces. Network architecture supports robustness and high availability. Nodes are upgradable to evolve with increased capacity demands.

→ Mobile data networks and communication systems
In the transportation world, the demand for mobile data communications is vastly increasing.
This is driven by three aspects:
  – By its very nature, the transportation world is mobile, which means that data transmission has to take place between stationary and mobile ob-

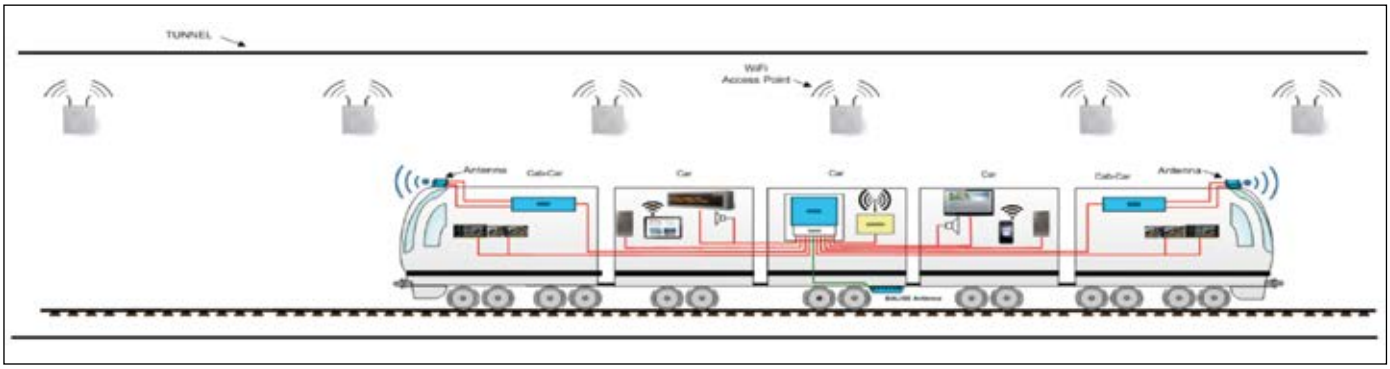

FIG. 2: Illustration of an example of communication and information systems on trains

jects (e.g. trains, buses, trams and the associated wayside control and supervisory systems).

- Digitization is driving demands for data exchange, e.g. for diagnostics, predictive maintenance, CCTV monitoring and passenger information.
- Passenger expectations require access to infotainment and ideally the internet. Especially in long-distance travel, the railway operator faces the task to provide adequate communication infrastructure to passengers to be competitive with road transport where data coverage is typically provided by mobile operators.

3. TRENDS: THERE IS A DIFFERENCE BETWEEN TRENDS IN URBAN AREAS AND TRENDS ON LONG-DISTANCE RAILWAY LINES.

In urban areas, railway networks are becoming equipped with broadband networks operating in WLAN bands where licensing is typically not required. The disadvantage is the severe limitation of data throughput in standard WLAN systems when transmitting objects are on the move. To overcome those limitations some companies have developed proprietary and closed network solutions in the WLAN band that achieve higher data transmission rates in a moving environment. LTE (Long Term Evolution) is emerging as an alternative; however, licensing aspects prevent its widespread use at the moment. This may change if transport operators and licensing authorities agree on the terms of use in the transportation domain (example: GSM-R).

In the mid- to long-term future, convergence with the evolution of general communication systems seems feasible. Systems such as the upcoming 5G mobile networks may be able to serve private and public mobile radio needs simultaneously.

On long-distance railway lines, the provision of high-capacity data radio is generally challenging as the large-scale roll-out of dedicated data transmission systems is costly.

Various solutions are offered but two dominant scenarios have emerged:

→ Intermittent high-capacity data transmission provided in certain areas along the railway line (hot-spot scenario). This supports the downloading of diagnostic and on-board CCTV data and the uploading of up-to-date infotainment content (news feeds, updated passenger information). This does not support passenger access to the internet however.

→ Continuous data transmission of varying capacity by bundling access to all available public mobile networks in the area of train travel. For this purpose, trains need to be equipped with an array of antennas and mobile radios enabling log-in to any network available along the railway line, potentially including satellite communications in very remote areas.

Generally, the railway operator has to negotiate contracts with mobile operators along the line and sell capacity to users of services (railway-internal for diagnostics, advertising, etc., and railway-external to the public for access to the internet). »

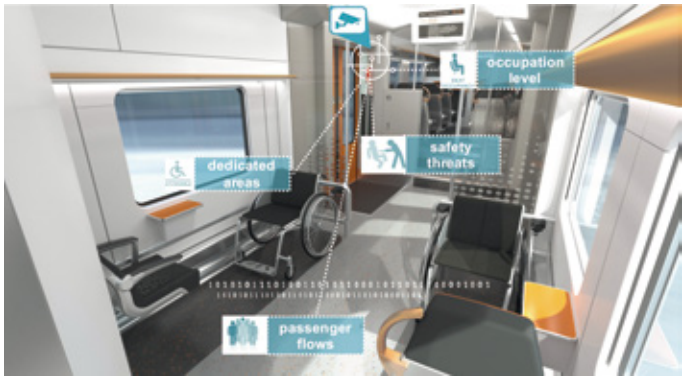

FIG. 3: Illustration of an example of the innovative use of railway communication systems

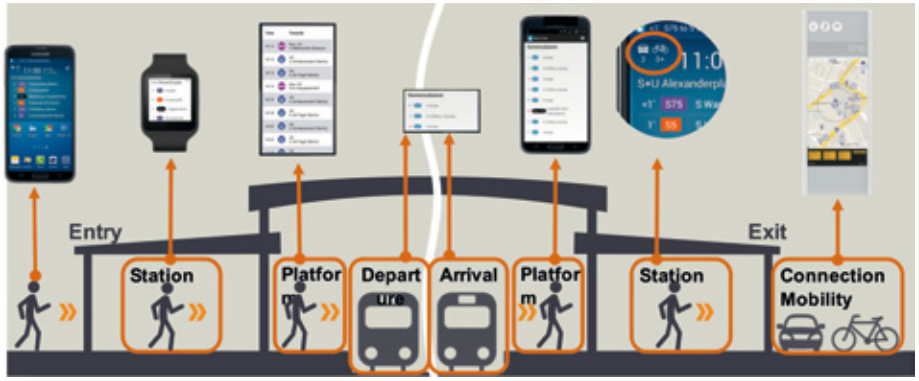

FIG. 4: Illustration of an example of door-to-door guidance for passengers

→ CCTV systems
CCTV systems are among the most versatile systems in the rail com world with a vast potential for innovation.
They are driven by three aspects:
- advances on the camera side (resolution, lens speed, handling of adverse conditions)
- increased data transmission capabilities (data networks) and computing power (video processing)
- advances in the area of picture analysis (intelligent video)

Trends: the video streams and pictures gained through CCTV will be utilized for an increasing range of uses. The intelligent utilization of video content will increase security and will allow passengers to be guided efficiently throughout the transportation world. For example, video monitoring will show the movement of passengers in station areas, on platforms and on trains, feeding algorithms that trigger appropriate passenger guidance information.

→ Passenger information and guidance systems
Passenger information systems are evolving from 'fragmented' to 'integrated', with information being provided as a service and regarded as an opportunity for business.
The driving aspects are:
- passenger expectations; car navigation sets the precedence for what is to be expected (door to door)
- convergence of information about individual movements and network-wide transportation system capacity (planned capacity and up-to-date situation)
- advances in algorithms and computing power enabling large-scale optimization in complex networks, taking into account individual preferences, environmental aspects, network capacity, overall demand prediction, system disruptions, etc.

Trends: traditional passenger information systems will be complemented by individualized information provided to the passenger by individual means, e.g. PC, smartphone, smart watch. The individual movement within a complex network and the knowledge of the ideal sequences both offer vast potential for system-wide optimization and, to a certain degree, commercialization.

→ Station management and supervisory and control systems
Historically, station management systems inform station operators about the status of station equipment and allow an efficient response to be made to a certain range of incidents (e.g. equipment failure, security incidents and emergencies such as fire). However, with advances in video monitoring, passenger communications and train-to-track data communications, it becomes possible under the name of advanced station and infrastructure management to optimize utilization of the station and train infrastructure with the aim to increase throughput, passenger safety and convenience.

Trends: especially in high-capacity railway operations, it is desirable to understand and exploit the available margins in network capacity before investing in rather cost-intensive network expansion. Monitoring the flow of passengers throughout the transportation network makes it possible to develop an understanding of movement patterns as well as to react to demand changes and incidents. By combining the understanding of the movement pattern with proper planning and management as well as the utilization of innovative passenger information systems, optimized use of the available infrastructure will be supported.

Figure 5 shows an example of a system structure that allows integrated supervision and control of the complete railway infrastructure. The signaling (ATS) and the rail communication supervision systems are essentially separate systems however they are integrated at the management level. ◀

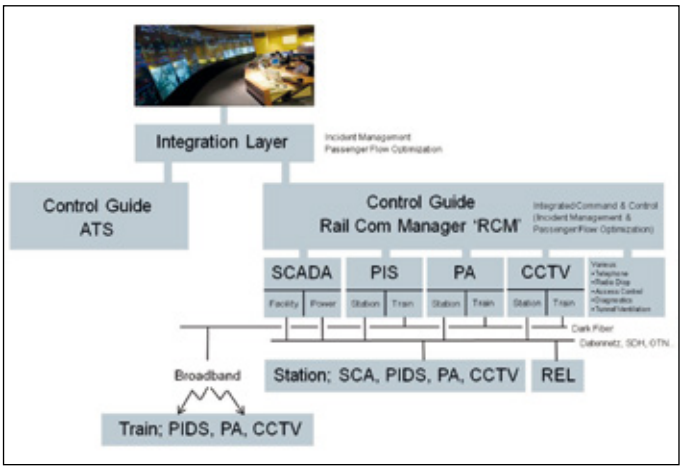

FIG. 5: Illustration of an example of a system structure

WBN Waggonbau Niesky GmbH digitizes freight wagons

WBN

Tradition since 1835

Innovations from Niesky applied to digitization of wagon fleet incorporating tracking and tracing diagnosis systems

Europe alone boasts some 273,000 kilometres of track used for transporting almost 438 billion tonnes of heavy domestic freight, mile after mile.

To facilitate this formidable task, the Niesky-based wagon manufacturers have now focused their activities on streamlining their freight wagons – both existing and new models – and equipping them with state-of-the-art telematics systems intended to secure and enhance monitoring and availability aspects of the wagons. This is an exciting mission embarked upon in active cooperation with various system suppliers designed to cover a whole diversity of rail applications. One example is the use of sensors to implement and analyse technical features such as distance performance, load status, vehicle location, wheel-flat detection, impact, humidity and temperature and other features in alignment with cargo monitoring security.

Proceeding hand-in-hand with our customers and system suppliers, we are currently working on new functions along with further integration of the systems into the Niesky fleet of freight wagons.

Advantages and solutions

- *Location monitoring features serve to simplify wagon scheduling operations while also speeding up flow.*
- *Distance-performance recording facilities for precise monitoring of wagon distances. In addition, it is possible to determine maintenance intervals and maintenance scheduling with precision.*
- *Shunting impact can be monitored and the causers of potential damage to wagons and cargoes accurately determined.*
- *Cargo monitoring, e.g. with respect to temperature & humidity can proceed on transparent lines in addition to supervised compliance with transport conditions.*

Technical system features

- *Battery operation or axle bearing generator.*
- *System life for battery operation approx. 6 years; afterwards simple replacement of components.*
- *Wired or wireless data transmission (within freight wagons).*
- *Wireless data transmission to host computer by embedded GSM/SIM chip.*
- *Range of application:*
  - 40° C – +75° C
- *Protection class up to IP69 (depending on system).*

reference: [1] *http://ec.europa.eu/eurostat (Tabellen) https://www.destatis.de/DE/ZahlenFakten*

[2] *Freight wagons – Global market trends, forecast, installed bases, suppliers, procurement projects, Berlin, July 2015, SCI/Verkehr Berlin 2015, Seite 58*

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MADE IN GERMANY

Reducing noise – a challenge for railway traffic

Halving noise exposure by 2020 – a core element of a sustainable corporate policy to maintain the acceptance of the most environmental mode of transport.

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1. NEIGHBOURHOOD EXPECTATIONS AND THE NEED FOR NOISE REDUCTIONS

"The acceptance of mobility and the further modernisation of the infrastructure depends decisively on reducing noise annoyance. We shall therefore make considerable improvements in controlling traffic noise..."[1].

This quotation is taken from the agreement between the CDU, CSU and SPD political parties when they set up Germany's current coalition government. It brings out the challenges facing the federal authorities and the rail-transport sector in adapting the infrastructure to meet future demands, in reinforcing transport by rail and, at the same time, in very significantly reducing traffic noise.

In the course of recent years, the population at large has clearly become less and less tolerant of emissions from traffic routes affecting locations where people live. Citizens' action groups have been created throughout Germany with the aim of standing up for their members' interests. Some of them are displaying a high level of competence in pursuing their goals, and many have also achieved them by acting through political channels. Expanding the infrastructure is only possible today by adopting a very long-term approach. In the past, it used to be financial questions that determined how long it took to complete projects, whereas the decisive factor nowadays is especially the time taken by the procedures until permission is granted for construction to go ahead. It is by no means a rarity for planning assessment procedures to take very considerably longer than ten years. Most of the objections from those affected concern the noise and vibrations resulting from the operation of the route it is proposed to build. In the perception of those affected, "severe and intolerable effects" are no longer to be measured in terms of the limit values laid down in law. Such demands are now also being voiced for sections of routes where the effective exposures are equal to or below the values laid down in the Ordinance implementing the Federal Immission Control Act ("16th BImSchV") [1] thanks to active measures, such as the erection of noise barriers and the conversion of freight wagons to lower-noise composite brake blocks. The costs for planning noise abatement involving a multitude of variants have risen over time and now account for a considerable proportion of a project's overall planning costs.

When new infrastructure is being built or existing infrastructure expanded, the claims those affected are entitled to make are laid down in law. By contrast, there is no legal basis for claims to have noise reduced if it is caused by existing railway lines not undergoing structural changes. According to the results of the noise maps produced by the German Federal Railway authority (EBA)[2], some seven million people are exposed to noise at a level greater than 55 dB LDEN[3] along principal railway lines and in conurbations.

The German federal government set up a voluntary noise remediation programme in 1999, which is currently funded with an annual appropriation of EUR 150 million out of the federal budget. These resources are used primarily to finance investments in noise abatement along existing lines of railways belonging to the federation. Money from the same budgetary heading is also used for grants for converting freight wagons and for other additional measures. From 1999 up until the end of 2015, this programme supported remedial measures along some 1500 km of the railway lines determined to be in need of remediation. It has included the erection of some 610 km of noise barriers. There are still approximately 2200 km of railway lines in need of remediation applying the framework conditions that were valid up until 2014.

In accordance with the objectives set in the coalition agreement, the so-called "rail bonus" was removed from the exposure computations on 1 January 2015. It used to take the form of an adjustment of -5 dB(A), since railway noise was deemed to be less of an annoyance than other sources. Furthermore, the exposure limit value in the noise remediation programme (Lärmsanierungsprogramm; LSP) was brought down by 3 dB from 1 January 2016 onwards. In addition to that, the computation rules known as "Schall 03" were completely revised, and the amended version also took effect on 1 January 2015. There has been a very considerable increase in the scope and intensity of noise remediation given the improvement of 8 dB in the level of noise protection associated with existing railway lines brought about by the modified framework conditions. The German Federal Ministry of Transport and Digital Infrastructure ("BMVI") has initiated a review of the overall concept, giving priority

1) The agreement bears the title of "Shaping Germany's future" ("Deutschlands Zukunft gestalten") and was concluded by the three coalition parties on 14 December 2013.

2 http://laermkartierung1.eisenbahn-bundesamt.de

3 Noise Level Day Evening Night. Established by applying the noise index in accordance with the EU's environmental noise directive

to those sections of railway lines classified as in need of remediation. As far as noise-prevention measures for new and upgraded railway infrastructure are concerned, the better level of protection of roughly 10 dB that was already provided for them compared with noise remediation has been increased by 5 dB through abandonment of the rail bonus. The review of the "Schall 03" computation rules has created an important prerequisite for more or less attaining the ambitious noise-abatement targets through technical means as well, with active noise-abatement measures at source and along propagation paths [2].

2. THE "SCHALL 03" COMPUTATION METHOD

The legal bases are laid down in the Federal Immission Control Act (Bundes-Immissionsschutzgesetz; "BImSchG") [1]. It is stated there that, when railway lines are constructed or significantly modified, all that is possible must be done to make sure that no deleterious environmental effects are caused by traffic noise if it would be possible to avoid them within the state of the art. The limit values and the bases for the computations are to be found in the 16th ordinance implementing the above-mentioned federal act ("16th BImSchV") [1] and its annex 2 ("Schall 03") [2].

"Schall 03" (or "Noise 03") lays down a method for calculating a "rating level", Lr, separately for the day and night time, which is then compared with the limit values to be found in the 16th ordinance. In its 1990 version, this method was based on the recognition that the principal parameters influencing the noise caused by a passing train are its length, speed and type of brakes (disc brakes or block brakes). If these effects are mathematically eliminated from the measurements of the noise level of passing trains through suitable correcting factors, what remains is a narrow scatter of the measured values in a band either side of a mean. This scatter results to a very considerable extent from the different conditions of the rails' contact surfaces, which also have a crucial influence on rolling noise. This recognition led to the definition of a "baseline value" of LG = 51 dB. This value indicates the mean level of sound over time for a point of exposure at a distance of 25 m from the centreline of a track (with wooden sleepers on ballast) which has one train with a length of 100 m passing over it every hour at a speed of 100 km/h, assuming that the entire train is equipped with disc brakes. Acoustically relevant deviations from this reference scenario are taken into consideration by adding or subtracting the appropriate values. There are, for example, corrections for other train lengths and other speeds, additions for vehicles with block brakes, deductions for vehicles with wheel-mounted noise absorbers and corrections for particular features of the line, such as curves, ballast-less track, bridges and level crossings.

The "Schall 03" computation basis in the 1990 version reflected the state of knowledge of the late 1980s. No provision was included for the systematic consideration of the further development of the state of the art. The only exception was that it was possible to make allowance for noise-reducing measures on the track through appropriate correction factors. This measure was actually used in practice by the Federal Railway Authority in 1998 when it issued an order recognising a deduction of 3 dB for "track subject to special monitoring" ("besonders überwachte Gleis"; BüG) [3].

An extensive revision of the "Schall 03" method came into force on 1 January 2015. The concept of a baseline value was abandoned in favour of a differentiated description of the acoustic properties of different classes of vehicle. Aggregate noises and aerodynamic sources of sound were added to the method. In that context, the opportunity was also taken to include innovations in the field of noise abatement in the set of rules laid down in law, making it possible to »

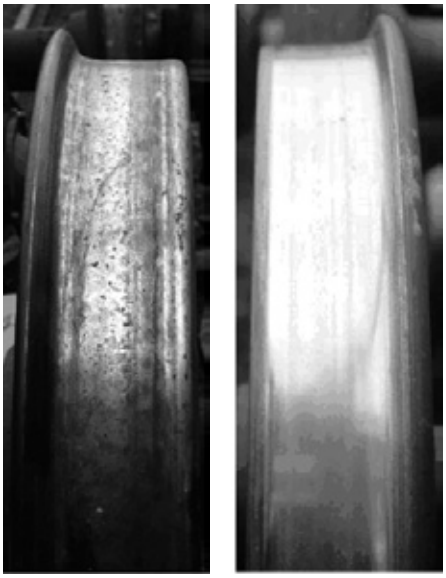

FIG. 1: Contact surface of a freight-wagon wheel with grey cast-iron brake shoes (left) and a freight-wagon wheel with composite brake shoes (right)

include them in acoustic computations in future in connection with projects to build new railway lines and upgrade existing ones as well as projects of noise remediation along existing railway lines. These innovations include composite brake shoes, dampers and shielding on rail webs as well as sound absorbers on ballast-less tracks, low noise barriers and noise-reducing measures on bridges. Some of these measures had previously undergone field testing in the framework of the German federal government's "KP II" programme (otherwise known as the second package of measures to stimulate the economy) [5]. Since they had been shown to bring about effective reductions, it was possible to include them in the legislation at short notice.

As it happened, the 1990 version of "Schall 03" turned out to constitute an impediment to innovation. So it was only logical, when a new version was under consideration, to make explicit provision for consideration of acoustic engineering innovations. There is now a separate chapter dealing with requirements for documentary evidence for vehicles, railway tracks, marshalling yards, transhipment terminals and bridges and also for propagation paths. These deal, amongst other matters, with which standards and norms are to be applied, how measurements are to be performed, which parameters are to be established and, if appropriate, which corrections are to be made. Measurements for documentation purposes are to be performed by a recognised laboratory. The decisive acoustic characteristics are determined by the Federal Railway Authority as the competent office.

Another crucial difference between the current version of "Schall 03" and the preceding one is the disappearance of the bonus for railway traffic noise considered as constituting less of an annoyance. It used to be the practice to deduct this correction of 5 dB when calculating the baseline level. Now that that adjustment has gone, the requirements under planning law for new and upgraded lines have been tightened up very considerably. In parallel with that, the exposure limit values for railway noise in the framework of the federal noise-remediation programme were lowered by 3 dB. Since then, it has been possible to pay grants to finance the construction costs for noise remediation along railway lines belonging to the federation if the baseline value exceeds 67 dB(A) during the day and/or 57 dB(A) at night in residential districts in general (other limit values apply for districts with other land uses). The need for innovative techniques for reducing noise has therefore increased. The amended wording of "Schall 03" has succeeded, firstly, in making innovations ready for practical use available to specialist planners and, secondly, in creating the legal framework to be able to add future developments speedily to the applicable rules.

3. NEW TECHNOLOGIES FOR REDUCING NOISE

The classical instrument for reducing the noise occasioned by railway traffic is the noise barrier positioned around 3 m from the track and with a height in most cases within the range of 2-5 m. It has to be said that such barriers are very effective, but they have been coming in for increasing criticism from people living nearby because they detract from the appearance of the landscape. It has to be added that the tightened-up requirements can often no longer be met with noise barriers on their own. That is especially so if there are high buildings near the track or if the railway installations are particularly extensive. A crucial contribution to coping with the tougher noise-abatement demands comes from converting freight wagons to brakes with composite shoes. Their effect is that the wagons' wheels are no longer roughened with every brake application as used to be the case with conventional grey cast-iron shoes. The wheels' permanently smooth contact surface (Fig. 1) reduces the rolling noise of passing freight wagons by approximately 10 decibels, which corresponds to the subjective perception of the noise being halved. The effect of composite brake shoes is further enhanced by the fact that the condition of the contact surface of the rails in the Deutsche Bahn network has been continuously improved thanks to optimised grinding technologies ("smooth wheel on smooth rail") [4].

The conversion of freight wagons is an example of efficient noise reduction directly at source. However, its contribution in combination with the construction of conventional noise barriers with a height of more than 2 m relative to the top of the rails is not enough everywhere to attain the demanded reduction in exposure. Techniques applied on the infrastructure side are necessary too in order to reduce noise close to source.

In the course of time, individual innovative technologies, like rail-mounted dampers, have been developed in isolated research and development projects at a national or European level. It has often happened, however, that the innovation process did not manage to advance any further than the development of a prototype. Field tests, operational trials and approvals were not included.

A new approach was therefore adopted between 2009 and 2011 in the framework of the "KP II" programme. It involved the simultaneous testing of several innovative technical measures at noise hotspots and documenting their effect through on-the spot measurements [5]. Those innovations that emerged as successful were included in

FIG. 2: Principle of a rail-mounted damper. With vibration absorbers tuned over a broad band, the rail's contribution to running noise can be very considerably reduced (source: Fa. Schrey und Veit)

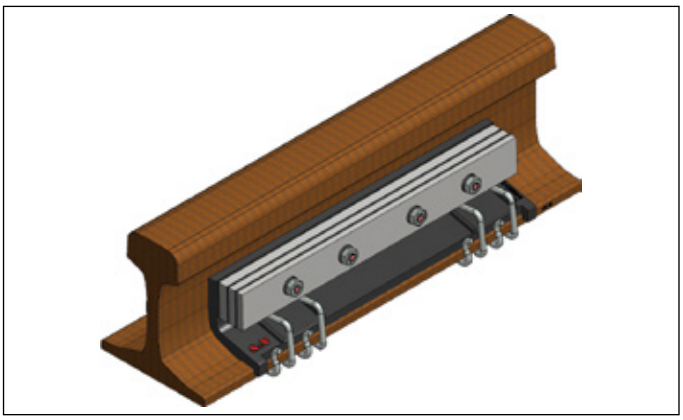

FIG. 3: Screening applied to a rail web and foot (source: Fa. Sekisui)

the new "Schall 03" annex, which means that they were thereby also formally recognised as noise-abatement methods. That was followed by another programme known as "IBP II" (the second infrastructure acceleration programme or Infrastrukturbeschleunigungsprogramm). In 2013 and 2014, that programme offered the possibility of trying out further innovative measures and having them used in practice [6].

Fundamentally, the technologies tested in the two special programmes can be fitted into three categories.

3.1. MEASURES APPLIED TO THE RAIL

At speeds of less than 100 km/h the dominant component in rolling noise is the sound emitted by the rail. Rail-mounted dampers cause the track to vibrate less and thereby reduce the train's rolling noise. Screening on rail webs prevents the sound emitted from the web and foot of the rail from propagating further. In that way, it is possible to reduce noise levels by up to 3 dB.

Another aspect investigated as part of the "KP II" programme was the acoustic implications of "high-speed grinding", a technique that removes only small quantities of material at a working speed of 80 km/h and which, if applied regularly, is able to keep the contact surface of a track in a condition corresponding to the quality of a "track subject to special monitoring" for a long time [6]. In the amended version of "Schall 03", high speed grinding is recognised as an alternative to conventional acoustic rail grinding.

3.2. MEASURES APPLIED TO THE PROPAGATION PATH

Starting from the fact that the overwhelming part of the noise emitted by moving railway vehicles originates in the wheels, rails and sleepers, nothing could be more logical than to position the noise barrier as close to the track as possible and at the same time to reduce its height drastically. Tests were carried out on low noise barriers of various heights and designs but making full use of the free space outside of the normal clearance gauge. Figure 4 depicts one of these designs, namely that of a gabion wall. One of its advantages is that it can be made to fit in with the landscape better and that it reduces the impression of an optical dividing line caused by conventional noise barriers.

Low noise barriers achieve a reduction in noise levels of around 5 dB, but that depends very much on the situation of the exposure locations relative to the railway line.

3.3. MEASURES APPLIED TO PARTICULAR ELEMENTS

Other measures tested in the special programmes deal with particular elements, which are often also noise hotspots (bridges, tight curves and train-formation facilities):

- → Vibration absorbers on superstructures of steel bridges, highly elastic sleeper supports and under-ballast mats reduce the booming noise caused by steel bridges;
- → Conditioning agents on the hump retarders of marshalling yards reduce the high-frequency screeching of brakes;
- → The application of ecological friction agents on the contact surfaces of rails in tight curves may be able to prevent screeching in curves entirely; and
- → Of all the innovative noise-abatement techniques deployed for the first time within the framework of the "IBP-II" programme, infill panels on bridges would appear to be the most promising for widespread use and for inclusion in "Schall 03". The technique involves fastening sound-absorbing materials »

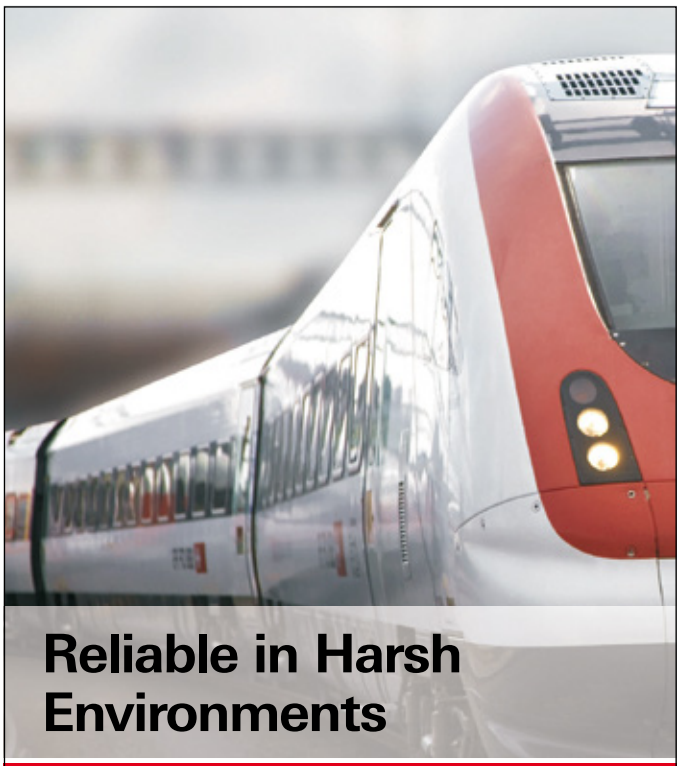

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FIG. 4: Low noise barrier made of timber/concrete composites in Burghausen

(source: Südostbayernbahn, Kollai)

FIG. 5: Infill panels on a railway bridge over a road in Oberwesel

(source: DB Netz AG, Karaca)

in the spaces on bridge railings. It is simple to apply in practice and offers economic benefits. Before a definitive verdict can be issued for this technique, it is still necessary to wait for an outstanding acoustic evaluation of a test section in Niederheimbach.

4. THE "I-LENA" INITIATIVE

"I-LENA" was launched in April 2016 as an autonomous part-project within the federal "ZIP" programme ("Programme of Investment in the Future" or Zukunftsinvestitionsprogramm). I-LENA is an acronym of the German for "Initiative for new and application-oriented noise-abatement testing". The initiative is to run until 2020 and gives developers of noise-abatement measures affecting the infrastructure the possibility of testing their innovations in practical use with Deutsche Bahn. I-LENA is going to bring about a radical acceleration and simplification in the innovation process for noise-abatement technologies. The development of innovations within I-LENA is intended to:

- → identify technologies with additional or improved contributions to noise reduction
- → bring down the costs of noise-abatement technologies
- → reduce the follow-up costs for maintenance, and
- → develop construction methods with less of an impact on operations and requiring shorter track closures for installation.

Deutsche Bahn is going to make test tracks available for this programme on the lines between Munich and Regensburg as well as Berlin and Frankfurt an der Oder. What is new compared with the earlier special programmes of "KP II" and "IBP II" is that the test sections are not going to be at noise hotspots but on "greenfield sites" in order to ensure optimum overall conditions for acoustic measurements. That includes unimpeded sound propagation away from the track without interference due to background noises. The exclusion criteria include buildings and high vegetation along the railway line as well as cuttings and embankments. The appraisal of effectiveness is to follow uniform principles and is to take place in comparable measuring conditions.

I-LENA is kicking off with a competition for ideas. Industrial companies, universities, research institutes and even private individuals with good ideas are urged to submit concepts for innovative noise-abatement technologies. For those proposals that are accepted, the German Federal Ministry of Transport and Digital Infrastructure will assume the costs for obtaining the necessary approval from the Federal Railway Authority to carry out the civil-engineering tests, the costs of installing the technical systems to be tested and also the costs of the measurements during the test phase, plus the costs of dismantling the technical system after completion of the test phase. It is planned to install the first items to be tested before the end of 2016.

Further innovations are indispensable for ensuring the efficient shaping of future noise control in rail traffic and for maintaining the long-term acceptance of rail as a mode of transport. The I-LENA programme is giving the correct impetus for this.

5. PROSPECTS

The target set by the German Federal Ministry of Transport and Digital Infrastructure and the Deutsche Bahn group of halving noise by 2020, i.e. of achieving a reduction of 10 dB in noise exposure, which is subjectively perceived as a halving, is certainly going to be achieved thanks to the two pillars of converting freight wagons and implementing the noise-remediation programme. That is, however, not enough, and further measures are necessary to cater for the noise-protection demands of a changing social environment and the growing need for mobility. Innovative solutions are to be sought preferentially on the technical side, namely applied to the track and the vehicles. Where appropriate, these are to be accompanied by public-policy measures, such as the prohibition of grey cast-iron brake shoes announced by the federal authorities. One measure that would not be suitable, on the other hand, would be to impose speed restrictions on freight trains at night, since that would cause capacity losses, leading to a shift in freight traffic onto the roads, taking the noise with it. ◀

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[7] K. von Diest, M. Beier; HighSpeed Grinding dient auch dem Lärmschutz, Eisenbahntechnische Rundschau; Nr 7+8, 2012

Sustainable track greening by locally adapted planning, implementation and maintenance

The always visible tracks of trams and light rail have a visual impact on the city landscape, and are therefore an important element in urban design. One of the main advantages of greened tracks is the aesthetic effect compared to ballasted tracks or tracks covered by concrete or asphalt.

▶ This is especially important for urban spaces with less green such as inner cities. There, track greening can create new vegetation area, which hardly ever gets such a potential for green space. This way, four kilometre of single track create one hectare already. So far, 565 km single track are greened in Germany, which add up to 141 ha, or 1.4 million m^2, respectively, plus additional green spaces adjacent to the tracks.

Apart from the urban design aspect, their ecological effect in highly sealed city sites comprises for example rain water retention, binding of fine dust and pollutants, reduced track temperature during strong solar radiation, increased biodiversity of flora and fauna.

An important reduction of the inevitable noise emissions of trams can be achieved with track greening. It absorbs noise in the pores of its substrate and plants and prevents emissions from the rail if the vegetation system is installed up to the top of the rail.

Other influencing factors on sound mitigation are determined by the condition of the vegetation system (plant cover and height, porosity and water content of the substrate).

PROBLEMS IN TRACK GREENING

The conditions of the greening of older grass tracks are often not as satisfying as straight after installation. That means that the above mentioned effects are mitigated as well.

After long periods of drought, dry grass appears very often. During the following recovering period especially tuft-forming grass varieties develop, which show bunch type growth and leave gaps in the plant cover. These gaps are populated by weeds, mostly herbaceous. A transformation of the original plant population starts, which might not offer the same design and ecological aspects as originally intended.

Incursions of street cars in Green Tracks damage the vegetation systems and extensive foot traffic leaves its marks.

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These optical appearances result from different, frequently related causes with multiple effects. Identifying theses causes and their complexity is basis for mitigation and prevention of the loss of function from track greening, respectively. »

FIG. 1: Appearance of the tracks before and after the greening process in Berlin (Photo: [2])

FIG. 2: Dry plant cover (Photo: [5])

FIG. 3: Spontaneous vegetation after drop out of the grasses (Photo: [1])

FIG. 4: Vegetation drop out and transformation of plant population (Photo: [3])

FIG. 5: Pedestrian path with compaction of the substrate and vegetation drop out (Photo: [3])

FIG. 6: High amount of foliage in Sedum track followed by vegetation drop out (Photo: [4])

Central aim for transport companies is the track as part of the transport system, which is safe to operate with minimised costs. Thus, the integration of horticultural knowhow when covering tracks with vegetation systems often was secondary.

Most problems in Green Tracks can be ascribed to the neglect of the fact that tracks offer extreme growing conditions for plants, such as limited space for roots, often reduced water supply, wind suction due to passing trams, heat emission of trams or excessive foot traffic. Depending on the intensity of the stress, plants will react to it.

If these adverse effects will not be antagonised or if basic growing conditions cannot be provided, the intended plant condition cannot be preserved.

During planning phase, an assessment of the expected growing conditions might lead to more suitable systems for a location. As a result, those systems can function more sustainable at reduced maintenance and costs. With increasing awareness on the multiple use of urban greening on buildings and the accompanied imposed conditions by the Authorities Having Jurisdiction for new constructions and reconstructions of tram tracks the demand for sustainable greenings with stable performance (optic and ecology) rises.

GREEN TRACK NETWORK

GRÜNGLEIS NETZWERK

In 2011 the Green Track Network was founded to solve these problems. It deals with the optimisation of intensive and extensive tram

FIG. 7: Substrate compaction results in impeded drainage and vegetation drop out (Photo: [3])

track greening systems and its development. It involves experts from construction to maintenance. It incorporates planning, supply and construction of track systems, pre-cultivation and installation of vegetation systems as well as maintenance.

The Green Track Network (www.gruengleisnetzwerk.de) is a consortium of 14 members from small and medium sized enterprises, big enterprises, transport operators and research institutes.

It inter-relates research and development capacities with practical knowhow.

Greening guidelines and standards exist for sports turf areas, golf courses and roof greening. But they do not cover the issues of tram track greening. Many unknown aspects and relations have to be considered, which had been unpublished. For that reason the network members compiled the Handbook Track Greening during the last 5 years.

The holistic approach from vegetation and track, from planning to maintenance was worked out by means of intensive exchange of experience in 15 meetings and the visit of 10 transport operators and their green tracks (Berlin, Munich, Mannheim, Düsseldorf, Kassel, Bremen, Dresden, Ulm, Potsdam, Braunschweig) paying special attention to local conditions, requirements, systems, visions and solutions. Furthermore working groups, own research in Green Tracks, regular surveys of Green Tracks in different transport companies and intensive public relations (workshops, presentations, exhibitions) helped to work out key issues of that topic.

The knowledge of the relations is essential for the adaption of the track structure to the requirements of the vegetation on the one hand (e.g. higher substrate thicknesses), and the adaption of the vegetation system (choice of plants, substrate and maintenance measures) to the growing conditions given on the other hand.

REQUIREMENTS FOR SUSTAINABLE TRACK GREENING

Sustainable track greening requires the knowledge of the demands of the vegetation and its application during planning, implementation and maintenance.

An analysis of the local growing conditions as well as the conditions given by the track and the type of use will decide whether greening is possible and which requirements have to be imposed on the vegetation system. Furthermore it will facilitates the choice which greening system might function reliably, which maintenance measures are needed and which additional measures need to be »

At this year's Innotrans, GHH-BONATRANS will go one step further presenting their latest innovation for LRV's and trams:

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FIG. 8: Grass Track in Braunschweig, sustainable for 30 years

(Photo: [3])

taken at the specific location in order to protect the vegetation.

The choice of vegetation system and its components, in in particular the mixture of plant and substrate but also the types of Green Track depend on the local growing conditions (precipitation, sun and wind), on the track structure and thus, influences the possible substrate thickness.

Implementing knowledge about the influence of track and vegetation issues is required for a sustainable and aesthetic greening.

The following references show selected examples for locally adapted green tracks.

HANDBOOK TRACK GREENING – DESIGN – IMPLEMENTATION – MAINTENANCE

The Green Track Network compiled the Handbook Track Greening – design – implementation – maintenance, which was first published in German language in 2014 by Eurailpress, DVV Media Group GmbH. This book contains information e.g. about track types and different track structures for green tracks, basic requirements for the implementation of vegetation systems in tracks, types of greening and vegetation, structure of vegetation systems and their planning, implementation, maintenance and basics for the planning of green tracks as well as problematic issues and possible solutions.

In a requirement matrix for different local conditions recommendations are given for locally adapted vegetation systems depending on climate (sun/shade, precipitation), the track structure (possible substrate thicknesses) and the maintenance for an accepted or desired visual appearance.

The English version of the handbook has just been released in August 2016. Our network partner can be contacted directly regarding track greening, and you'll also find edilon)(sedra Gmbh, Kraiburg Strail GmbH and Rail.One GmbH at the InnoTrans in September 2016. ◀

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[2] Grätz, SchmidIngenieure GmbH
[3] Kappis, IASP
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[5] Schreiter, IASP

FIG. 9: Sedum Track in Berlin, sustainable for 16 years (Photo: [5])

FIG. 10: Grass Track in Berlin (Photo: [3])

Semi-automated software documentation for modernised railway vehicles – a first-hand report

Producing software-development documentation in accordance with DIN EN 50128 when modernising a railway vehicle constitutes a tough challenge for small and medium-sized enterprises. A company called Westfälische Lokomotiv-Fabrik Reuschling GmbH & Co. KG has now partially automated this documentation process through the use of a software tool in a methodologically supported continuous improvement process (CIP). By doing that, it has managed to bring the documentation process under control.

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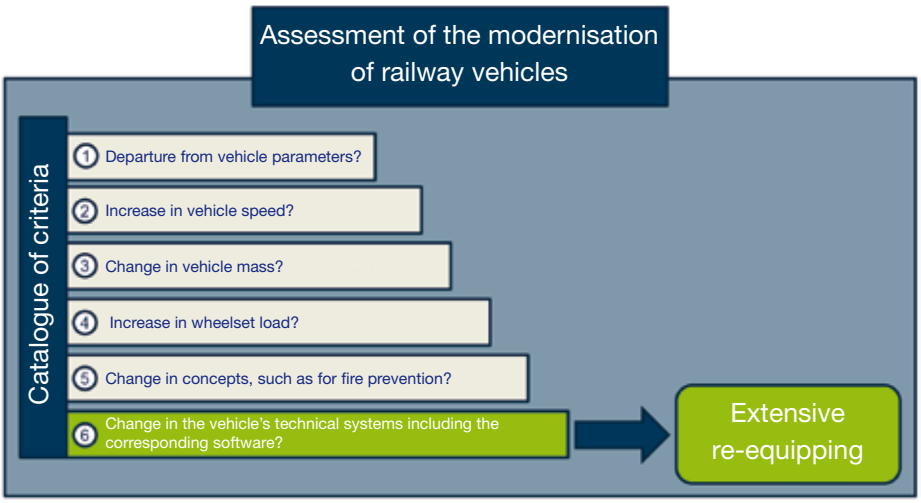
▶ Obtaining a vehicle approval in accordance with the provisions of the memorandum of understanding [1] issued by the Germany Federal Railway Authority (EBA) or the Trans-European Railway Interoperability Ordinance (TEIV) [2] constitutes an enormous organisational challenge for small and medium-sized companies. In the case of modernised railway vehicles, most of the effort involved goes on software documentation as detailed in DIN EN 50128. This contribution takes the example of Westfälische Lokomotiv-Fabrik Reuschling GmbH & Co. KG (or "Reuschling" for short) of Hattingen to show how this challenge can be successfully met.

1. RE-EQUIPPING SHUNTING LOCOMOTIVES

Shunting locomotives are a central element in the movement of freight by rail everywhere in the world. On the one hand, they are indispensable, but, on the other hand, they require very heavy investment, especially when they are first acquired. For that reason, many operators keep their shunting locomotives in service for a mean of 30 – 40 years, until such time as they have fallen into a state in which no further use can be squeezed out of them.

Reuschling offers to modernise existing locomotives as an alternative to purchasing new ones. The locomotive is completely stripped down, and each individual part is subjected to a thorough examination. Decisions are then taken as to which components to keep and which ones need to be replaced as part of the modernisation process on grounds of wear or performance, or because of the client's wishes.

FIG. 1: Catalogue of criteria for assessing the modernisation of a railway vehicle



1.1. THE LEGAL SITUATION

When a locomotive is rebuilt, its original characteristics may undergo a definite change. To deal with that, catalogues of cri- »

teria exist for national approvals [2, 3] and they lay down limit values and conditions for locomotives' characteristics (Fig. 1). If one of these criteria is exceeded, the modernisation is given the status of "extensive re-equipping", and a renewed approval procedure must be launched and performed for the criterion affected. In the course of that, it must be demonstrated to the competent authority that the safety of the railway vehicle concerned as defined in [3] continues to be guaranteed with the modernisation. It is also necessary to look to the future and consider the safety relevance and significance of the conversion work.

1.2. CORE ASPECT OF SOFTWARE DOCUMENTATION

Taking the example of Reuschling, after a locomotive has been operating for several decades, it is more or less inevitable that its central controls will have to be replaced when it undergoes modernisation. As can be seen from Fig. 1, however, catalogue criterion 6 is affected by this, meaning that the locomotive has been extensively modified. The consequence of that is that when the application for a renewed approval for the locomotive is being examined, the safety of its controls must be documented and that process, in turn, is divided into software and hardware components.

By contrast to typical quantitative mechanical-engineering evidence, this is done here by means of software documentation conforming to the standard. When the scope is so extensive, software documentation becomes the core aspect of the approval work for modernised railway vehicles.

1.3. DOCUMENTATION IN ACCORDANCE WITH DIN EN 50128

The applicable regulations lay down that the crucial standard provision for the development and documentation of software applications for technical railway systems is DIN EN 50128 [4] which forms part of the CENELEC package of railway standards.

With the aim of guaranteeing safe software, this standard not only demands continuous verifications and software tests but also lays down certain principles, such as procedural models (the German Federal Railway Authority stipulates the V model [3]) and an allocation of roles appropriate for the safety requirements and method. The numerous demands, some of them strict, contrast with a rather general formulation of these objectives, the reason being that it is felt desirable to keep the standard as generally applicable as possible and to make it possible for it to be used in many different types of software project.

1.4. PROBLEMS WITH DOCUMENTATION COMPLYING WITH THE STANDARD

Software development conforming to the standard constitutes an enormous challenge for many companies. The problem often lies not in the development of safe software itself but in complying with the standard's strict provisions as regards documentation. It can thus generally be said that amongst the developers who use it the level of acceptance of it is low. The deliberate policy of the standards committee of keeping the wording of the content general with the purpose of ensuring the standard's widespread applicability has precisely the opposite impact to the one desired, often causing disorientation or even a feeling of helplessness in the documentation process. This is made worse by the rumour that documentation in conformity with the standard increases the bureaucratic burden. One explanation for that is that many elements of documentation are created in the course of development work anyway, but then need to be recast in a form complying with the standard for the purpose of assessment ("duplication of documentation"). The problems referred to above have already been discussed in the literature in the context of bigger companies [5, 6]. Substantial ideas on how to cope with this challenge have not, however, been presented, especially not ones that would assist small and medium-sized businesses whose human resources are very much more limited.

2. PLANNING AND CHARACTERISING THE DOCUMENTATION IMPROVEMENT

The challenge described above was one which the Reuschling company also had to face up to. It began early on by arranging its software documentation to ensure procedural efficiency. It set a priority target of having control over the development process complying with the standard, so it put suitable processes and structures in place to offer its clients a high-quality product that would be bound to obtain an approval.

Development documentation is fundamentally a company's internal process in which there is a discrepancy between the actual state of affairs and the target one. Having recognised this, it follows that there is a need for an improvement measure. Its outcome ought to be more than just a short-term, one-off increase in the degree of compliance with the standard but achieving sustainable mastery of the process. It is the PDCA cycle that is applied for performance of the continuous improvement process (CIP). That cycle is inspired by Deming's problem-solving process, given its proven suitability for all types of quality-related problem [7]. The individual phases of the model (Plan, Do, Check, Act) are fleshed out with scientific methods appropriate for the requirement, for example obtaining and analysing information. Figure 2 illustrates the methodology of the dynamic PDCA cycle, including activities typical for each phase.

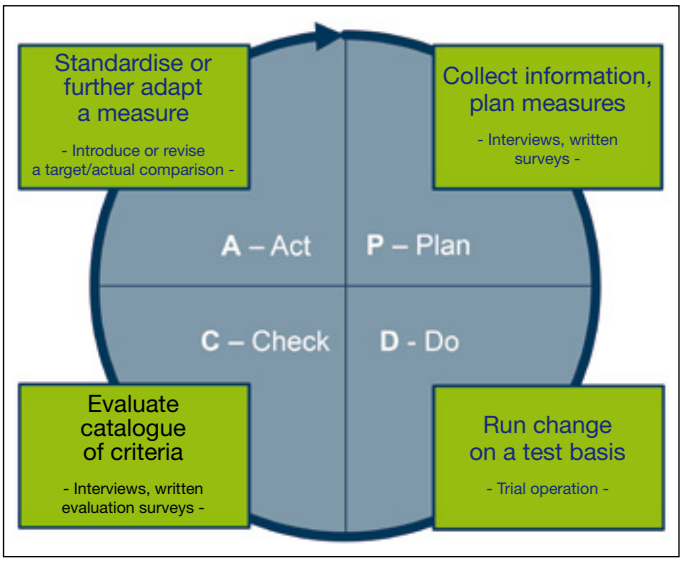


FIG. 2: The PDCA cycle [7], including activities typical for each phase

3. IMPLEMENTATION

Success in the form of sustainable improvement can only be produced by applying the

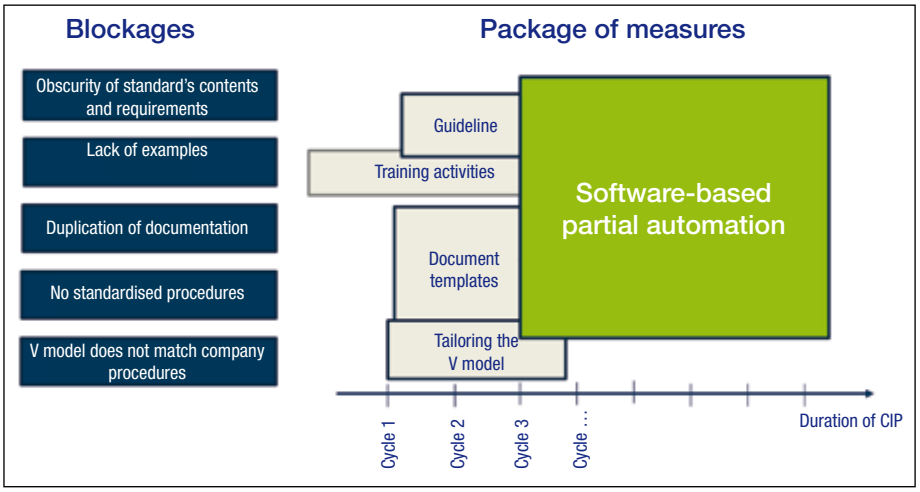


FIG. 3: Documentation-specific blockages and measures to eliminate them

model consistently over time. Once the CIP wheel has been set in motion, it must (to stick to that image) be kept moving, since the most that can be achieved through a single, static use of it is a short-term improvement in the target process.

The following section describes how Reuschling uses the cycle in practice. It is not an account of a single round of working through the cycle but the essence resulting from continuous improvement, in other words several rounds of working through the measure.

3.1. IDENTIFICATION OF COMPANY-SPECIFIC BLOCKAGES

Before a process of whatever sort can be improved, the first step is to identify the real problem that is the root cause of an unsatisfactory situation. Whereas a broad range of sources are generally available for acquiring the information needed to construct the foundation for the CIP measure, there is an absence of secondary data on problem identification when it comes to software documentation for railway applications. That makes it indispensable to gather information at first-hand about the specific problem.

For the capture of data that is typically waiting to be done in the first phase of the PDCA cycle, all methods for generating data are fundamentally suitable, including surveys and interviews, through which it is possible to obtain the employees' personal perceptions of the problem.

Performing problem identification initially confirms the obscureness of the standard, as has already been mentioned in the literature [5, 6], and also the duplication of work involved in getting the documentation ready. Further interesting aspects to the problem also become evident at this stage. Many of the employees will remark that the V model as envisaged in the standard does not appear to tally with the company's internal procedures. In addition to that, the documentation lacks standardised »

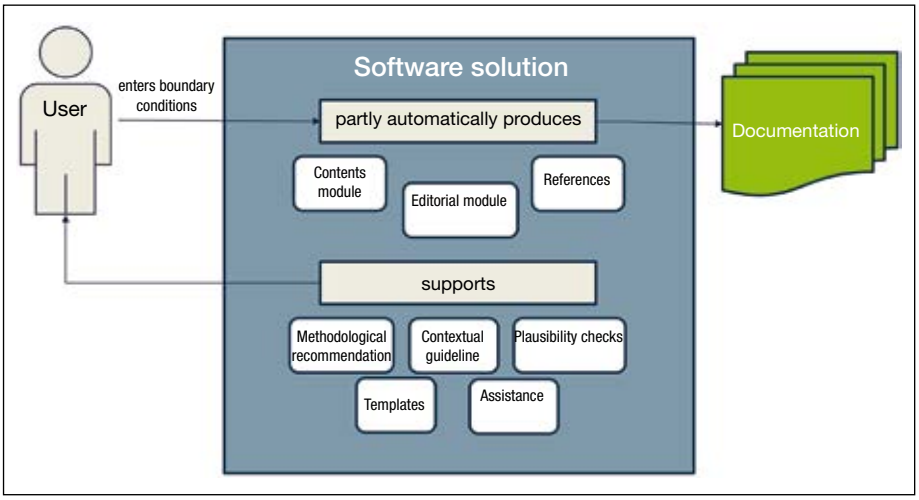


FIG. 4: How the documentation tool works

structures and procedures. All in all, they express the wish to be better supported in the documentation process. The key problems identified have been grouped together as crucial blockages and highlighted in the blue boxes in Fig. 3.

Repeated employee surveys carried out at the beginning of the cycle pinpointed a need for improvement measures. In the first few rounds of CIP, the main focus was on individual measures, as shown in Fig. 3, such as the production of a company-specific documentation guideline and documentation templates as well as tailoring the V model, in other words customising it to meet the company's own needs. It ought, however, not to take long for it to emerge that these individual measures, especially the guideline, will have triggered a learning effect in the developers, leading them too to feel the growing desire for a partial automation of the documentation process.

As a reaction to that, Reuschling, in close liaison with the future users, developed an innovative software tool, which aims, on the one hand, at the partial automation of the production process and, on the other hand, at user support in the sense of an assistance system. The elements the software uses for this purpose are illustrated in Fig. 4. In a certain way, the tool can be seen as an extended collation of the individual measures established beforehand and as a help in configuring transparent, structured and resilient information on documentation conforming to the standard.

4. EVALUATION

The success of the catalogue of measures is repeatedly confirmed through written evaluation surveys that are comparable with one another every time the cycle is run. From the point of view of both the developers and assessors, it can be concluded in this way that there has been a clear-cut improvement in both the perceived and factual quality of the documentation. That fact is reflected particularly in the faster and smoother process cycles, despite the high process complexity, which finally leads to satisfactory assessments.

Acceptance of the use of the standard has grown in the same way, which, in turn, is to be ascribed to the intended learning process on the basis of the company-specific guideline. The developers affected, who at the outset felt a lack or orientation and helplessness, have assimilated an understanding of the process, which permits them to master it and develop it further. The catalogue of measures can therefore be described as a complete success on the way to mastering the process.

The fact that the target has been reached through the catalogue of measures permits the conclusion that the chosen methodological framework in the form of the PDCA cycle as an overarching accompaniment of the CIP measure is appropriate for the problem posed.

5. CONCLUSION AND PROSPECTS

This contribution has shown how, by applying suitable methods, it is possible to find a company-specific way of mastering the railway-related documentation process ensuring procedural efficiency with a cost-efficient process. Reuschling's experience shows that if a company has a certain willingness, then scientific measures can also be applied successfully in a medium-sized company to bring about a change and become established, producing a very considerable benefit.

What is of eminent importance in carrying out the CIP measure is to keep the CIP wheel in motion, not losing its initial momentum, so as to ensure that the improvement is really achieved and that, in the end, things keep on moving in the direction of excellence. It is the employees who are the crucial asset in consideration of this purpose, since, once they have accepted the improvement process and made it into a living reality, they develop a dynamism all of their own and drive the improvement process forward in a decisive way, as has been borne out by the example of Reuschling.

Following the example set by software documentation, Reuschling has gone on to revolutionise what it does inside the company in other facets of locomotive approvals, so that at all approval levels it is possible to guarantee the dependability of its process and the certainty of obtaining approvals. ◀

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Creating a secure state-of-the-art remote access

Control technology within the rail energy supply is an important component. Frequently maintenance and service work are only possible within a time-consuming on-site deployment. A remote access for the operator and its service partners enables a flexible and less time-consuming way to check the condition of the plant and to carry out work. This remote access requires a technical protection against unauthorized access.

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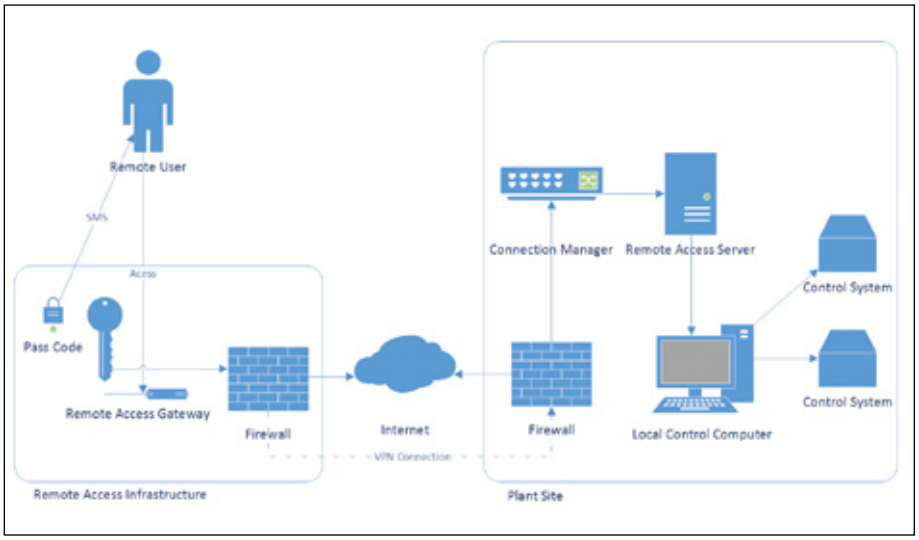

Schematic diagram of the remote access

In critical operating situations a remote access enables the elimination of an operation impending defect within a short time. The challenge for the design of a remote access is to create a prior art secured access against a malicious third party access. A convenient access should be allowed for authorized parties. During the construction of substations and switching stations for train operators it is now necessary to establish a remote maintenance access which complies with the relevant IT security requirements. Besides pure control technology the necessary secure IT infrastructure is also to be set up.

The remote maintenance access allows maintenance and service technicians to take insight from afar into parts of the control system. If due to a fault an on-site deployment is required it can be selectively prepared by a remote fault analysis or even fixed remotely. Due to classification as a sensitive infrastructure the design and implementation had to consider the requirements of the BDEW whitepaper "Requirements for secure control and telecommunication systems", which was developed for the general power supply and is updated according to technical progress.

The created infrastructure consists of the technical solution including hardware and software as well as the organizational solution. These include the definition of responsibilities and processes. The remote maintenance access is independent of the operational management and does not interfere with it. As an entry point, a separate Citrix-based infrastructure was created. It can be accessed via a browser-based client and is authenticated by a domain registration and a SMS-session pass code. The actual access to the control system's location is established via a VPN connection which is permitted by the operator using a person-related authentication. The personalized access of the site is passed to an infrastructure consisting of a connection manager and a virtualized server infrastructure.

From this application the local control computers of the control system can be reached. The remote access infrastructure is secure using restrictive access rules, a domain and a separate malware protection solution against unauthorized access. Different service partners and the plant operator can perform logically separated activities.

The established solution has a modular design and can serve as a basis for other facilities. Its advantage is the flexible, role-based access authorization and the secure three-factor authentication when logging on to remote maintenance portal. Using this various process control facilities can be accessed centrally after activation.

Within the project Lohsa/West an equivalent remote solution access has already been designed and implemented.

Bode digital railways: virtual interfaces for doors

In order to face the challenges of the increasing speed of technological developments in the 21st century Bode now introduces an innovative digital strategy to improve both safety and passenger comfort with their own Boarding Management Unit (BMU) for doors.

SCHALTBAU BODE

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The Gebr. Bode GmbH & Co. KG in Kassel, Germany, delivers complete automatic door systems as well as sub components for the rail, bus and automotive industry since 1968.

▶ A Bode entrance system will no longer rely on the classic order-action principles only, but rather monitoring the whole entrance area and e.g. replacing the pushbutton logic with an innovative gesture controlled interface. Complex sensor systems already successfully established and well accepted in the automotive and industrial sector will now be an integral part of a door system allowing operation by virtual interfaces and offering even more safety and comfort. Even passenger counting and ticketing are side features especially interesting for any public transport operators.

SENSORS

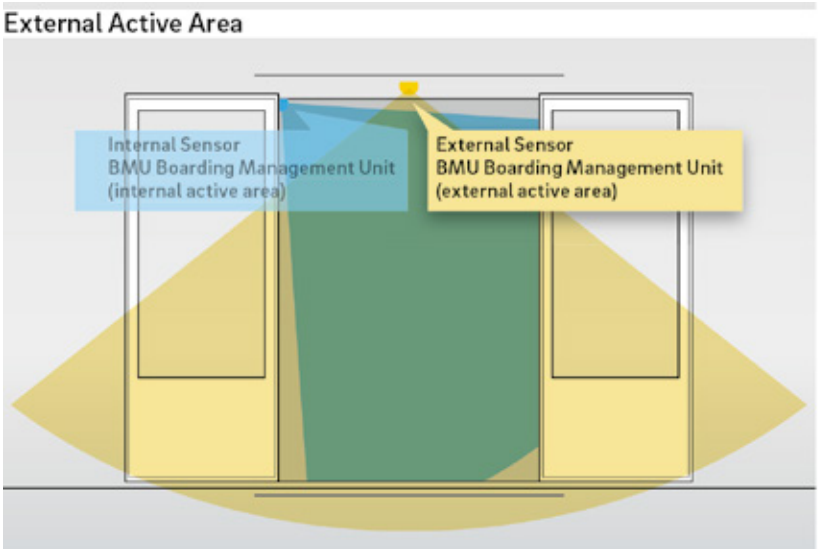
The implemented sensor arrangement of the entrance system relies on highly sophisticated linear laser scanning devices. The laser distance sensor, currently one of the most powerful measurement tools on the market, is used in a variety of industrial applications such as driving assistance systems, medicine technology, robotics etc. Due to its reliable characteristics, e.g. accuracy, definiteness, interference immunity, and target independence it is more than state of the art technology used within the heart of the BMU.

The grouping of numerous laser beams into one central sensor unit allows comprehensive monitoring with a great many functional features. Moreover, this kind of sensor is not subject to any data protection limitations, which is a clear advantage in comparison with CCTV (closed-circuit television) based systems. Thus, the Bode BMU is solely based on sensors using the laser technology.

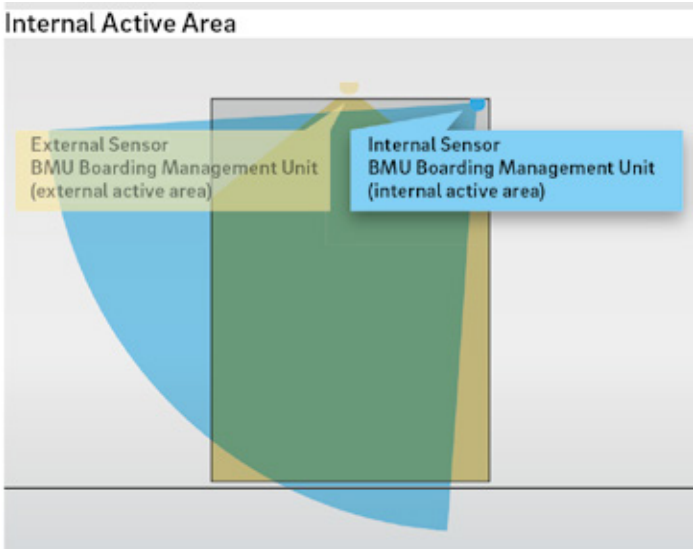
The BMU arrangement usually is built around two laser sensors, i.e. an internal sensor and an external sensor. Each sensor is installed in such a position, that the sensitive areas for interaction with the Bode entrance system can be monitored. The external sensor is located outside, preferably above the door. The monitored area is visualized as the top perspective view over the scenery as illustrated in Fig.1. The internal sensor is located either on the top right or left side of the entrance in order to cause no interfer-

FIG. 1: Sensor positions and Bode Boarding Management Unit

(a) External active area



(b) Internal active area



ence with the mechanics of the door but still maintain a comprehensive overview of the vestibule entrance area. The covered areas of both sensors are called the internal active area and the external active area. The information of both active areas can be directly provided by the laser sensors and evaluated by the door control unit, respectively.

REPLACING AND ENHANCING EXISTING FUNCTIONALITIES

A large variety of different sensor types is currently used in entrance systems. The most popular and widely known sensors and switches are

- Push buttons
- Light curtains and light barriers to monitor the passenger flow
- Switches and sensitive pressure mats integrated in step systems to prevent any step movement while people are boarding
- Sensitive edges to detect obstacles and prevent passengers from being trapped in closing doors
- Ultrasonic sensors to measure the extension distance of steps to the platform

In order to connect these various sensors to the door control system, it is necessary to implement an elaborate system of electrical interfaces. This does not only require significant engineering effort and thus cost, it does also have a considerable impact on reliability and durability due to the number of different electrical interfaces.

The new Bode BMU sensor system based on laser range measuring technology is able to replace all of above mentioned switches and sensors and thus to reduce the number of components. The overall reliability of the system is increased while lifecycle cost (e.g. planning, maintenance, etc.) are minimized. Even though the overall sensor system is simplified, an enhanced perception of the entrance's environment is achieved. This originates from the higher information flow and output of the newly employed technology. The capabilities to react to its different surrounding conditions are augmented.

The door system will now be able to detect and react to obstacles without any contact, reducing or even avoiding possible incidents that may result from the door's kinetic energy while opening and closing. The new capability to accept e.g. door open commands also increases passengers' convenience. The 'touchless' user interface can be enhanced to a gesture controlled interface enabling the passenger to request special functions provided by the door or the vehicle such as control a built in infotainment system.

Further, the new Bode sensors are capable to identify potential sources of hazard and thus trigger a warning to passengers even before an actual danger occurs. This functionality may decrease the operating cost for operators as the passengers can be directly guided to leave for example danger zones or to leave highly frequented areas and hence increase the efficiency and comfort of the over-all service.

Just recently, the close-to-production prototypes are going through an extensive validation with the support and cooperation of two well-known urban transport operators located in Kassel and Berlin, Germany.

With this approach of prototype validation in an operating environment, it is expected to gain further experience regarding the functional stability and algorithmic setup of the sensor system. Further these installations are being used to investigate the general acceptance of passengers of the new interface and finally explore the multitude of further potential applications in the future.

GOING BEYOND

The introduction of the Bode Boarding Management Unit does not only reduce the number of electrical interfaces within a door system by replacing the classic actuators such as pushbuttons, sensitive edges or infrared sensors but opens the door to a whole variety of new functionalities. These functionalities are apt to improve the traveling experience of passengers as well as to provide a supplier of transportation more detailed information about their services and increasing efficiency and convenience.

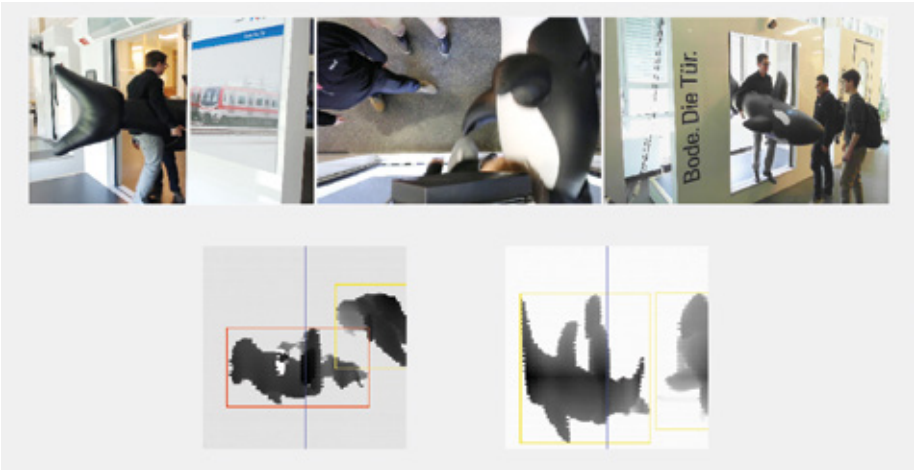
The two sensors that are mounted as part of the door system itself are able to monitor events that are occurring in the vicinity of the inside and outside entrance area capturing movements and passenger flow. The basis for all such considerations is a suitable object recognition that assigns categories to the patterns that appear at a time in the laser scanner. Aforesaid categories are humans, objects, humans with objects, etc. The sensor system also retains the timings of the events that are detected in the course of an episode.

These data and the two perspectives (see Fig. 2), that are delivered with the system, allow to establish a number of assumptions about the events that are occurring around a BODE door. By matching patterns of persons in the internal and the external sensors and taking into account the respective timings, it can be deducted whether a person is entering or exiting the vehicle through the BODE door.

Thus, a passenger counting system can be deployed with minimized costs, simply by using the technical features of the BMU. Furthermore, it is possible to detect passengers with reduced mobility (PRM) (e.g. wheelchair users) and appropriate measures can be executed accordingly (for example an extended wheelchair ramp).

These are only a few examples of the technical abilities such a Boarding Management Unit may bring into the Passenger Transport. ◀

FIG. 2 : Object and Person recognition using the Bode sensor framework



Optimization of life cycle cost of cooling systems

The consideration of the total life cycle cost for components of trains and locomotives becomes more and more important. An intelligent layout of cooling systems offers significant potential to reduce the production cost for the cooling system, its maintenance cost, its energy consumption, its weight, its space envelop and its aerodynamic resistance, respectively.

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Together with the customers, the Industrial Thermal Management profit center develops complex cooling and air conditioning systems for railroad and specialized vehicles, agricultural and construction machinery, as well as for large engines, power generation, and power electronics. In addition, it provides worldwide, easy access to spare parts and professional repairs for the products delivered and the entire service life of our customers' products.

▶ The following chart (figure 1) shows how significant the maintenance and energy cost over lifetime are, when compared to the purchasing price of a cooling system.

The following two approaches lead to a significant improvement of the life cycle cost which will be described in more detail:

1) integration of different cooling applications into a combined cooling system
2) consideration of the operational cycle for the dimensioning of the required cooling performance

The resulting saving potential is larger than one third of the total life cycle cost of a cooling system. Here, the expertise of the cooling system supplier is key to tap the full saving potential.

INTEGRATION OF DIFFERENT COOLING APPLICATIONS INTO A COMBINED COOLING SYSTEM

In many trains, different cooling applications are required, such as transformer cooling, inverter cooling, traction motor cooling, diesel engine cooling, etc.. The Mahle Monobloc® design allows to combine different cooling circuits into one heat exchanger and hence into one cooling system, with advantages in packaging, costs and complexity. As an example: the combination of transformer and converter cooling into one cooling system for a regional EMU leads to a reduction of the total LCC cost by 20 Percent, to a reduction of the number of fans from 5 to 4 units, to a reduction of the total required length from 3.0 meters to 2.2 meters and last but not least, to a weight reduction of 100 kg (from 800 kg to 700 kg).

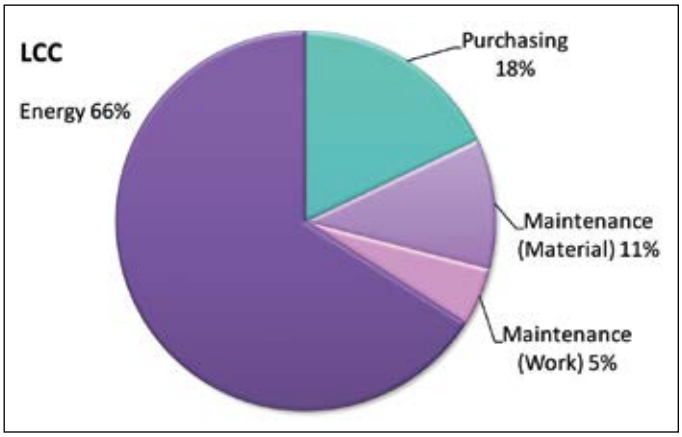

FIG. 1: Maintenance and energy cost over lifetime in comparison with the purchasing price of a cooling system for a regional EMU

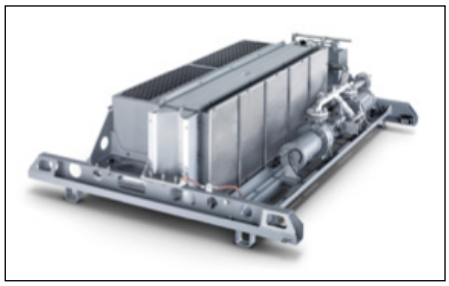

FIG. 2: Combined transformer and converter cooling unit for Regional EMU with Mahle Monobloc® technology

The Mahle Monobloc® design offers the following advantages compared to separate coolers:

→ safe integration of different circuits in one single heat exchanger (safety channels prevent mixture of different cooling liquids in case of a leakage)
→ only one cooling surface to be cleaned
→ continuous air fin over the whole depth of the heat exchanger and hence high resistance against pollution and easy cleaning procedure
→ maximum utilization of the cooling potential of the cooling air and hence reduced cooling air flow, reduced fan noise, reduced energy consumption of fans
→ reduced weight and reduced space envelop

CONSIDERATION OF THE OPERATIONAL CYCLE FOR THE DIMENSIONING OF THE REQUIRED COOLING PERFORMANCE

In order to define the required cooling performance, the standard approach to design a cooling circuit takes the worst case operating conditions (max. heat rejection, max. ambient temperature, max. altitude for op-

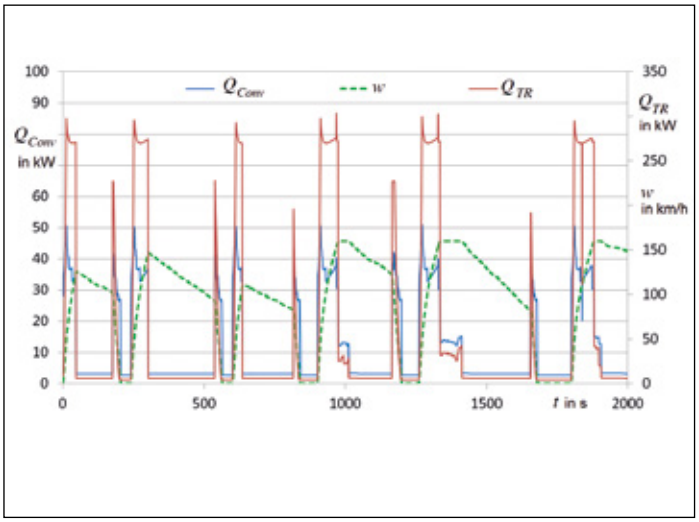

FIG. 3: Operational cycle showing the heat rejection of a transformer (QTR) and a converter (QConv) over the vehicle speed (w)

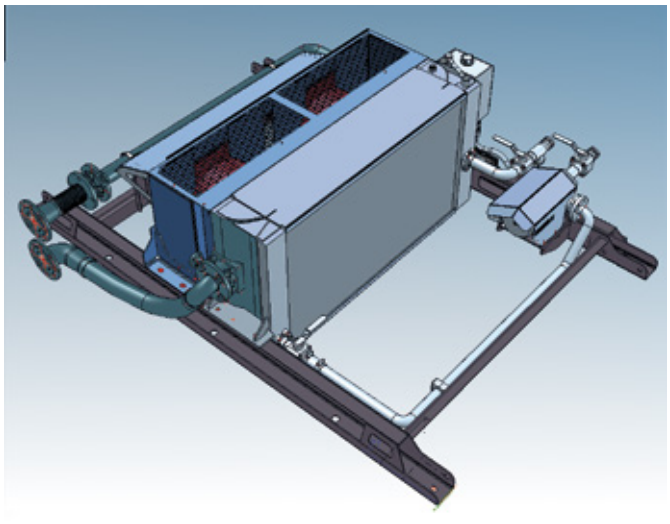

FIG. 4: Combined transformer and converter cooling unit for Regional EMU designed based on the operational cycle of the EMU

eration) and the highest acceptable temperature within the cooling circuit into account. Consideration of the operational cycle of the vehicle and a corresponding dynamic calculation allows to reduce the required cooling performance by using the actual load conditions and by considering the heat capacity of the complete cooling circuit. The following detail of an operational cycle shows that the full heat rejection applies only for the short phases of acceleration and braking.

The Mahle design software allows a dynamic calculation of the temperature levels within the cooling circuits based on the heat rejection data of the operational cycle. The cooling performance of the cooling circuits can be reduced as long as the maximum temperature levels for the cooling circuits are not exceeded. As an example: the length of the cooling unit shown in figure 2 could be reduced from 2.2 m to 1.2 m, the number of fans from 4 to 2, the weight from 700 kg to 400 kg. Total life cycle cost could be reduced by 17 %.

EVALUATION OF THE SAVING POTENTIAL

Mahle has developed a software to determine the total yearly energy consumption of the system (see figure 5). This program calculates the annual power consumption of the cooling systems and hence the annual energy cost based on the ambient temperature, the altitude of operation, the required cooling performance (dependent on the operational cycle) and the air inlet pressure drop (dependent on vehicle speed). The software considers the typical variations of this input data over a whole year's cycle.

SUMMARY

Expertise in thermal management helps saving a significant amount of the total life cycle cost of cooling systems through the integration of different cooling applications into a combined cooling system and by considering the operational cycle of the train/locomotive. Mahle has developed a software which allows to reduce the size of the cooling unit by considering the operational cycle of the vehicle and a second software to determine the total annual energy cost which allows to demonstrate the savings of an optimized cooling system. The overall saving potential is shown in figure 6. ◀

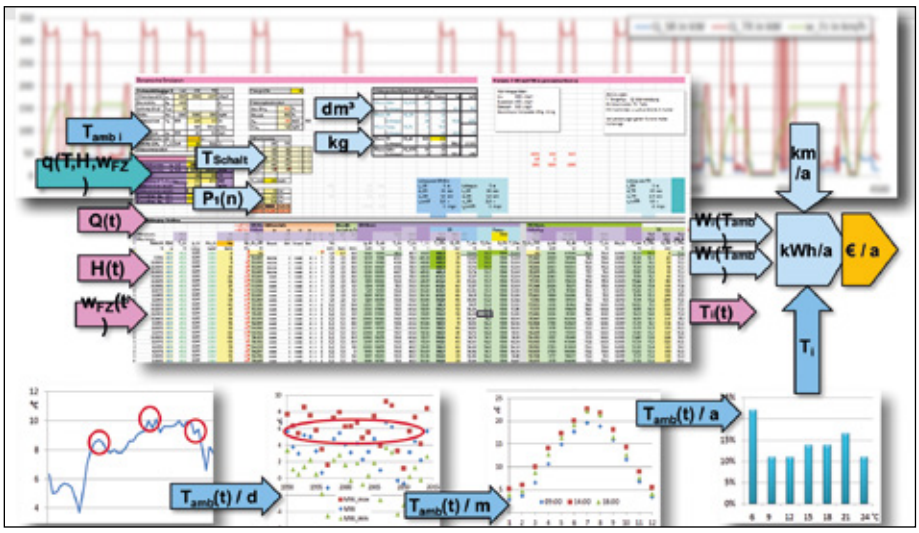

FIG. 5: Prinicple of the Mahle software for the calculation of the total life cycle cost

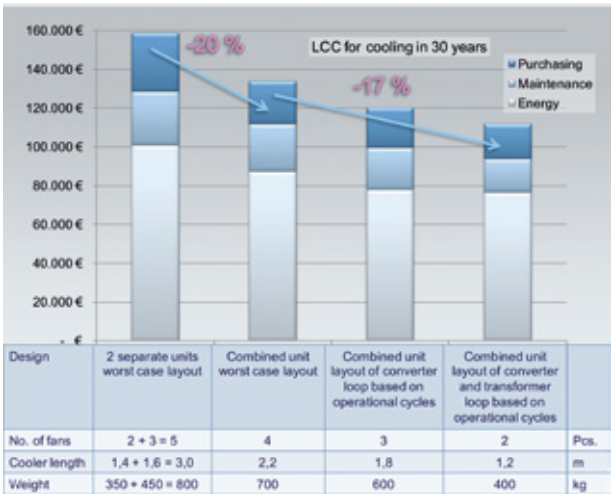

FIG. 6: Saving potential of an optimized cooling system

Innovative RFID sensor concept for railway applications

How to generate high-value solutions for customers by combining diverse areas of expertise, Ephy-Mess and Harting will demonstrate at this year's InnoTrans 2016 in Berlin.

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Ephy-Mess GmbH is a leading manufacturer and distributor of tailored made industrial measurement and sensor technology. For over 60 years Ephy-Mess sensors add efficiency and safety to industrial applications, wind power plants and rail vehicles.

▶ Against the backdrop of the current debate on the implementation of industry 4.0 solutions Ephy-Mess GmbH together with its long-term business partner Harting Technology Group developed a new and innovative RFID sensor concept for the railway industry.

The trend of continuous condition monitoring is also impacting the demand in the RFID sector. For one thing, RFID sensors are used in mobile applications to identify objects and their condition, e.g. in the logistics sector. For another, they are used in fixed installations to monitor machine or product condition. Based on the analysis of the sensor data, a reliable and responsive security system can be realized.

The extremely robust RFID system by Harting in combination with the advanced sensor technology of Ephy-Mess, unites these two features. The industrial and railway-compliant RFID reader and its components (transponders etc.) are designed for a very long lifetime in harsh industrial environments and are tested according to EN 50155.

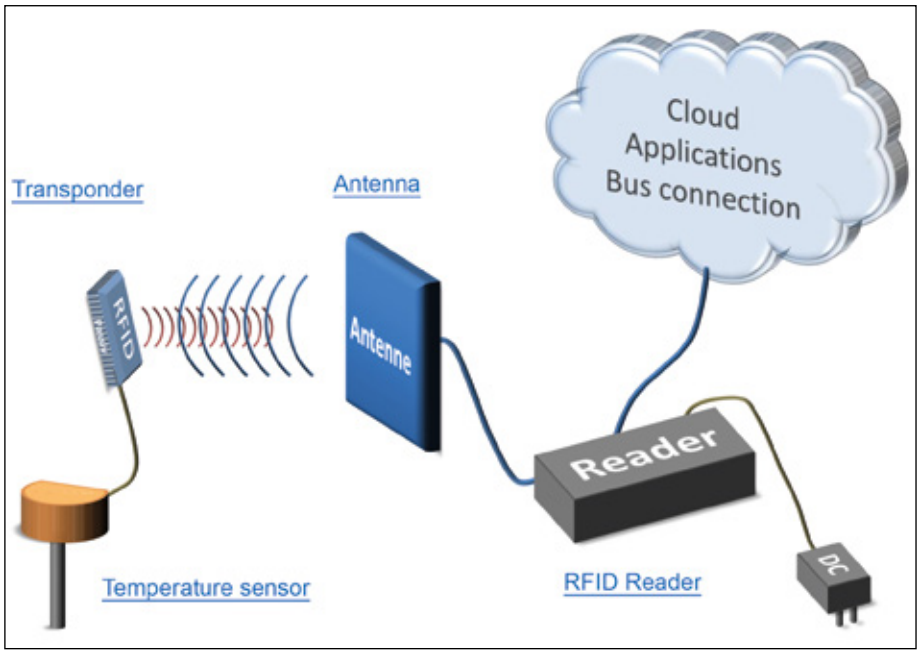
The sensor complies with the applicable railway standards EN 61373 Category 3, DIN 5510, NF F16-101, EN 45545-2, EN 50305, UIC 564-2, DIN EN 60332-1-2: 2005-06, DIN EN 61034-2: 2014-11 and is initially based on platinum measuring resistors. The implementation of other measuring elements for different monitoring tasks and additive applications is planned for the future. Today, the supervision only of binary switching states is already possible. Using the Ha-VIS RFID Control Series enables sensors and actuators to be operated in passive mode.

The modular software concept of the newest reader family Ha-VIS RF-R3x0 by Harting supports different communication protocols and enables the complete sensor data preprocessing and individual evaluation. All information can be extracted wireless at a distance of up to 1.5 meters depending on ambient conditions.

The advantages of this RFID-based data transmission are obvious. The digital radio technology eliminates the use of expensive cable connections and their costly installation and maintenance. In operations the system replaces time intensive manual and visual inspections, further it reduces downtimes and increases availability. Additionally, it facilitates a predictive maintenance and helps to prevent damage to bogie components such as wheel set bearings, gears or traction.

The prototype of this system will be presented to interested visitors at this year's InnoTrans from 20th – 23rd September 2016. The stands of the companies are located in Hall 6.2, booth 402 (Ephy-Mess GmbH) and in Hall 4.1, booth 426 (Harting Technology Group). ◀

RFID sensor system



Powerlines Group: The full service supplier in rail electrification

The Powerlines Group is an international group of companies operating in the business segments Rail, Energy and Products. Its scope of services encompasses project planning, engineering and consulting, right through to the installation and maintenance of systems. The Group employs 900 qualified and experienced specialists, and is one of the market leaders in Northern and Central Europe.

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The Powerlines Group is an international company active in the business segments RAIL, ENERGY and PRODUCTS. Powerlines is the European specialist for the electrification of railway infrastructure.

A FULL RANGE OF SERVICES FROM A SINGLE RELIABLE SOURCE

The Powerlines Group is a full spectrum supplier in the rail sector. Powerlines is active in both local mass transit and mainline transport. The range of services includes the electrification of tram systems, trolleybus infrastructures, underground trains and urban rail transit, and also involves the electrification of normal speed and high speed routes in several countries in Europe. Powerlines is a reliable single-source provider of all necessary products and services. Powerlines' customers benefit from a complete service package of consulting, planning, engineering, project planning, the provision of components, construction and installation, plus the servicing and maintenance of entire systems. Powerlines also implements custom-built solutions and can meet special requirements for various projects. Many years of experience, sector-specific expertise and a modern vehicle pool enable the Group to meet the wide variety of demands made by each of these markets. Gerhard Ehringer, CEO of the Powerlines Group GmbH: "We pursue the goal of being 'Best-in-Class' in terms of safety, quality, reliability and project management for every single one of our projects. I am particularly proud of our highly-experienced assembly and installation teams. In comparison with the rest of Europe, we have a unique team of over 500 assembly and installation engineers for the construction of overhead lines and an unsurpassed resource pool."

Erected catenary system at „Hauptbahnhof Wien" (Vienna Main Station)

DEVELOPMENT AND PROVISION OF COMPONENTS

As well as being firmly established in the operative project sector, the Powerlines Group is also active in the development and design of overhead powerline components and systems via the Powerlines Products GmbH subsidiary. Emphasis is placed on holistic system development using the very latest production methods in compliance with the strictest quality standards. Moreover, operational reliability and the reduction of maintenance requirements in terms of components and systems have been given top priority. Close proximity to our customers, on the one hand, and our installation teams on the other, enable us to integrate the benefits of experience gained during installation, and knowledge of requirements placed on products, into the development of components. We distribute our overhead powerline components and systems right around the world.

INTERNATIONAL – AND YET ALWAYS CLOSE TO THE CUSTOMER

Powerlines operates in Northern and Central Europe via a network of subsidiaries. The business group is one of the market leaders in the German-speaking countries, Scandinavia and the UK. Being present in each of the individual countries facilitates close and direct customer contact. This international network enables experiences to be shared across national borders to provide growth in know-how throughout the entire group of Powerlines subsidiaries. ◀

Schaeffler's system expertise for drive components and big data

Gearbox bearings specially developed for high-speed traffic, robust bearing units for the axleboxes in freight trains, and rail-specific condition monitoring systems connected to the Cloud – at the 2016 InnoTrans, in hall 21, booth 402, Schaeffler will be demonstrating new technological solutions for the mobility of tomorrow that increase efficiency and safety in rail transport.

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Schaeffler is a leading global integrated automotive and industrial supplier. Bearings and system solutions from Schaeffler help railways prepare for the challenges of the future. Solutions are developed in close partnership with manufacturers and operators for any bearing application in rail vehicles.

PREDICTIVE MAINTENANCE

For the digitalized monitoring of bogies in passenger trains, Schaeffler will present condition monitoring systems (CMS) with added value. Data analyses permit higher average speeds, improved operational performance and longer maintenance intervals for future train generations while also improving operating safety. Sensor units specially designed for railway applications are used to measure structure-borne sound, temperature and speeds on the axlebox bearings. In addition, the traction motor and gearbox can be monitored on a motorized bogie by means of vibration measurement.

CMS data are analyzed either in the Schaeffler Cloud or in a local entity and displayed as plain text. Unlike a conventional CMS, the customer is not required to have vibration-specific expertise or to perform manual evaluations. The operator or maintenance technician is connected to the Cloud and can monitor the condition of individual axlebox bearings and even entire axleboxes and bogies.

EXPERTISE FOR THE OVERALL SYSTEM

The exhibit of a complete axlebox shows conventional, mechanical rail technology that has been developed further in many aspects, making the overall system more efficient and safer. The design of FAG tapered and cylindrical roller bearings for gearboxes has been optimized for high-speed traffic. Both are now able to withstand much higher speeds as well as vibration and shock loads. The one-piece machined brass cage allows the cylindrical roller bearing to withstand high radial and tangential loads. Even under high dynamic loads, the gearbox bearing can be used considerably longer. In the traction motor, coated FAG deep groove ball bearings and cylindrical roller bearings provide insulation against electric current. At the InnoTrans, Schaeffler will be introducing a new Insutect A coating that offers a disruptive strength of up to 5000 V DC with a layer thickness of 700 µm. The tried-and-tested TAROL axlebox bearing units, consisting of a tapered roller bearing and adjacent components, have also been developed further especially for applications in interurban high-speed trains.

MORE ROBUST AND DURABLE

The "High Capacity TAROL Class K", an axlebox bearing for heavy freight traffic, combines a 30 percent higher axle load with at least double the service life. This performance increase is achieved by a range of measures, such as the Mancrodur case hardening steel developed by Schaeffler. Customers do not have to adjust their adjacent construction and can easily retrofit this easy-to-install unit.

Another exhibit proves how robust and durable FAG's TAROL tapered roller bearing units really are: They have been in use in the Metro vehicles in Instanbul, Turkey, since 1987 and have completed a total of 2.7 million kilometers. ◀

Schaeffler – Your Partner in Rail. Visit us at the 2016 InnoTrans, in hall 21, booth 402

Integrated railway infrastructure solutions

Rail and network operators face major tasks by managing the growing mobility requirements due to the increased globalization and conurbations. In addition, the necessary expansion of passenger and freight transport goes hand in hand with more rigorous environmental regulations and an increased environmental awareness. Thus, Vossloh answers to three key challenges affecting the rail technology sector.

vossloh
connecting expertise
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Vossloh is a leading global rail technology company and makes an important contribution to the mobility of people and the transport of commodities – safe, sustainable and environmentally friendly. Vossloh AG is a listed company and in 2015 achieved sales of around €1.2 billion with around 4,900 employees.

EFFECTIVE REDUCTION OF NOISE AND VIBRATION

Vossloh offers specific solutions like highly elastic rail fastening systems with vibration damping components made from *cellentic* as well as special turnout designs which makes transit considerably quieter. The High Speed Grinding (HSG) technology for preventative rail maintenance eliminates corrugation and fatigue damage on the surface of the rail responsible for the noise. The measurement data from numerous global projects set a clear statement: With regular grinding intervals using HSG, and depending on the condition of the rail, noise reductions of up to 10 dB(A) can be attained. Responsible for this is the characteristic diagonal grinding pattern which generates neither martensite nor transverse grooves.

AN EFFICIENT AVAILABILITY OF TRACKS

To this complex topic, Vossloh looks into the manifold options for raising efficiency of maintenance measurements with integrated product solutions that directly and demonstrably lead to a prolonged track availability. Here, four significant influential factors are defined, on which a network operator can actively control their track availability:

1. Durable products and as maintenance-free as possible,
2. product solutions and procedures that facilitate quick and easy installation,
3. technologies that ensure the most possible trouble-free maintenance process, and
4. proactive and holistic asset management based on use of statistics and depending on the documented and regularly measured condition of the infrastructure.

This applies to both planned measures and unpredictable events.

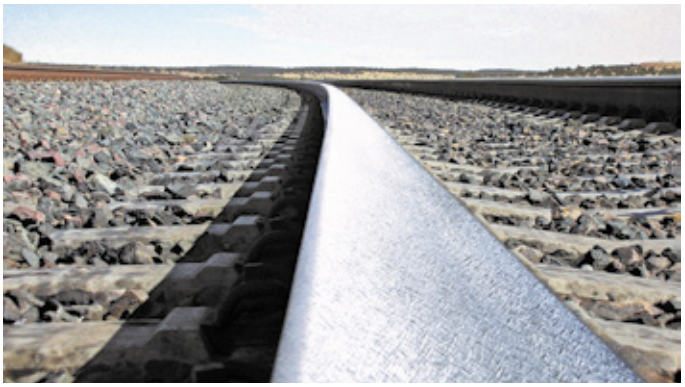
LONG-TERM REDUCTION OF COSTS

Using cost simulations based on reference projects and studies in combination with a mapping of typical railway lines, Vossloh illustrates at InnoTrans how selecting the right products, materials, services or technologies can significantly reduce the costs of a railway track in all phases of its lifecycle.

Already the decision which infrastructure components should be installed plays a key role. Design parameters, as well as technical and material-specific characteristics, define a permanent durability and robustness. Aspects such as quality of the products and components and/or the materials and technologies used in their production as well as the optimum interaction of the system components, determine the maintenance intervals in addition to temporal and budgetary costs during the operating phase.

Also regarding rail and turnout grinding, economic considerations across the complete service life of the railway infrastructure are at the focal point. Cost-saving potential for specific examples will be illustrated that can be attained by the preventive use of the HSG technology, as well as by corrective rail milling.

Under the motto "connecting expertise", Vossloh is also presenting at InnoTrans 2016 (stand 310, in hall 26) the new sales formation and its essential advantages for customers like the integrated range for rail infrastructure in the form of bundled offers that are not yet available from a single source anywhere else. ◀



Throughout the world, Vossloh offers integrated rail infrastructure solutions from a single source

WBN Waggonbau Niesky GmbH: developing a flexible platform of freight wagons

There is a fast growing demand in the logistics sector for faster and more flexible transport solutions, and one outcome of that is that there are new functions to be fulfilled by transport using freight wagons. There are challenges that have to be met successfully if the transport of goods by rail is not going to slip into the role of a mere niche product in the logistic chain. WBN Waggonbau Niesky GmbH has indeed faced up to such challenges by developing an innovative, modular platform solution for freight wagons.

Tradition since 1835
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CEO Dr. Thomas Steiner
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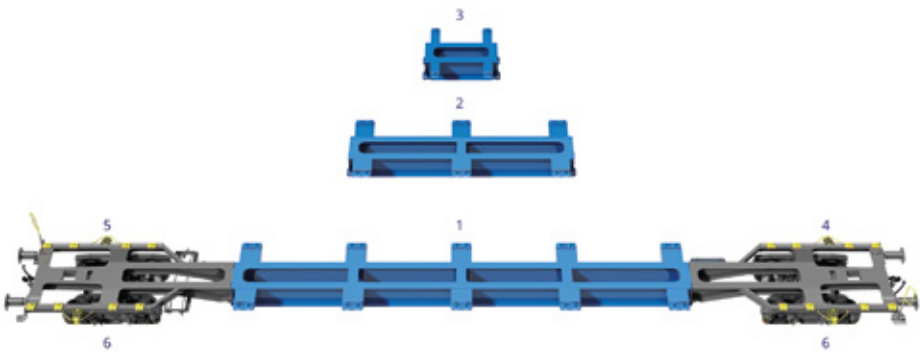
▶ The target set for Niesky's wagon builders is to improve the economics and flexibility of transporting freight by rail with new multifunctional wagons and, in particular, not to forget the less-than-wagonload segment of the market. Working from their base in the federal state of Saxony, they have developed a new modular design for freight wagons that is innovative, lightweight and easy-to-maintain. The wagon's structure is comprised of a functional central module constructed around a centre girder, to which two additional modules are attached, one on at either end. The two end modules rest on DRRS25LD bogies from the same manufacturer; their features are disc brakes, energy efficiency and low noise. It has furthermore proved possible to integrate all the pneumatic brake equipment in a single module, and this is housed in one of the two end modules. Here too, the manufacturer's modular approach has resulted in the benefits of a clearly improved braking system and one that requires less time for replacement, maintenance and overhaul jobs.

Quite apart from the platform's flexibility, it has also been optimally equipped to meet the future requirements of the various cargoes. It is feasible, for instance, to fit an electrical power supply and a digital information system. With that, it is possible, firstly, to keep the consignment's temperature under control throughout the transport operation and to supply energy to the built-in sensors and, secondly, to capture accurate data regarding the location and condition of the cargo and the wagon. This data can be used, for example, for the early detection of wear suffered by the wagon or damage done to it and to initiate appropriate remedies.

VARIABLE CENTRE-GIRDER MODULE FOR MAXIMUM FLEXIBILITY

It takes only a short sequence of actions to insert the centre-girder module between the two end modules. It has been designed to carry all sorts of containerised wagon superstructures, and three versions of it are already available, making it possible to adapt the wagon platform to carry superstructure elements of various lengths (45´, 60´ and 80´). The advantage for the client (who may be a shipping company, a wagon lessor or a transport undertaking) is that a single purchasing order covers an extensive range of container-wagon configurations but requires only one type of wagon. Niesky is currently developing solutions for other modules with a view to extending the range of applications for its flexible freight-wagon platform. The yardstick it has imposed on its developers is to produce a much quieter, lighter-weight wagon that will offer users a reduction in their capital outlay as well as their logistics and transport costs, an improvement in the payload/tare ratio and as high a degree of flexibility as possible. ◀

(1) 80-foot centre-girder module / (2) 60-foot centre-girder module / (3) 45-foot centre-girder module / (4) End module / (5) End module with braking-equipment module / (6) DRRS25LD (quiet, low-wear bogie with disc brakes)



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Our door systems offer safety, reliability and financial efficiency.

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Our service is highly efficient with respond times as fast as no other. Bode has a word-wide reputation also in this respect.
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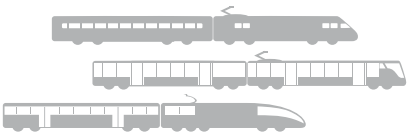

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BODE

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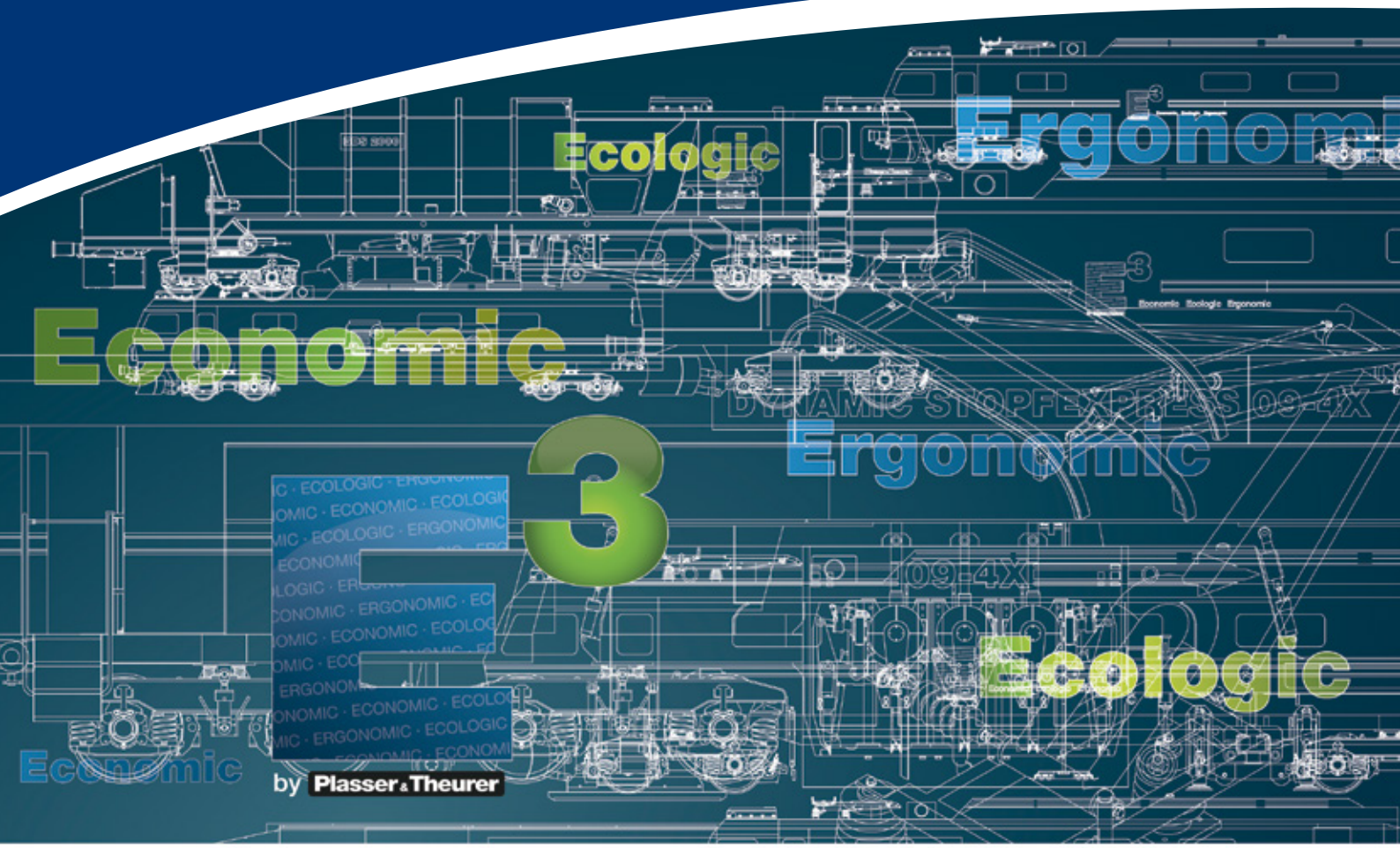

E3 Economic Ecologic Ergonomic

The next step - the machine with hybrid drive

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