2019

SCI MULTICLIENTSTUDIES

CONTROL COMMAND AND SIGNALLING – WORLDWIDE MARKET TRENDS

Developments, Volumes, Projects, Players

CONTROL COMMAND AND SIGNALLING – WORLDWIDE MARKET TRENDS
Developments, Volumes, Projects, Players

Available in English from 06th June 2019.
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In its "Control Command and Signalling – Worldwide Market Trends 2019" MultiClient study, SCI Verkehr gives an overview of the international markets for CCS systems, their volumes, drivers, projects and main players.

Against the back-drop of an ever-growing Chinese market, Asia is now the biggest regional market and a Chinese supplier is the single-biggest player in terms of new development and upgrade projects. International suppliers, however, can count on increasing demand in urban rail transportation and on a dynamic market for train-centered signalling technology. As SCI Verkehr points out, the introduction of ETCS in European networks is heavily delayed already and further obstacles are likely to be upcoming due to political and strategic considerations.

SCI Verkehr processed all relevant information and presents a comprehensive overview of the worldwide CCS market.

In concrete terms, the market study includes:

- Project based analysis of regional and country markets for Control Command and Signaling services and products
- Analysis of 8 regional markets and 11 focus countries
- Differentiation of 4 products groups
    - Electronic Interlocking Technology
    - ETCS, CTCS and CBTC
    - Conventional train control systems
    - Operational Telematics / Train Communication
    - Other products

Explore our additional offer of the data annex in Excel format

- All in this study displayed figures and graphs concerning markets, installed bases and deliveries are transparently and comprehensively available
- Apply the data sets for an individual evaluation and configuration or to access and supplement available market data

This MultiClient Study is based on numerous information sources, which are continuously analysed and evaluated, and are recorded in SCI Verkehr's database system.

SCI Verkehr is an independent consultancy company for the mobility sector with activities around the world. We specialise in strategic advice to the railway and logistics industry. We have established an international network of professional experts. Our activities focus on companies in the transport and rail industry and in the transport operation, logistics and financial sectors, as well as the transport and economics departments at national, regional and municipal levels.

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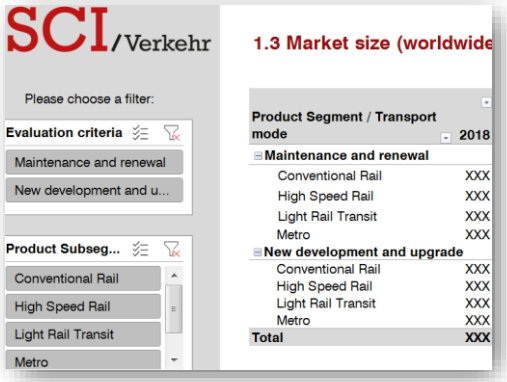

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Product Subsegment	Subcriteria	Unit	Year	Value
Electronic Interlocking	Total	Euro	2018	XXX
Electronic Interlocking	Total	Euro	2018	XXX
Electronic Interlocking	Total	Euro	2018	XXX
Electronic Interlocking	Total	Euro	2018	XXX
Electronic Interlocking	Total	Euro	2018	XXX
Electronic Interlocking	Total	Euro	2018	XXX
Electronic Interlocking	Total	Euro	2018	XXX
Electronic Interlocking	Total	Euro	2018	XXX
ETCS and CTCS	Total	Euro	2018	XXX
ETCS and CTCS	Total	Euro	2018	XXX

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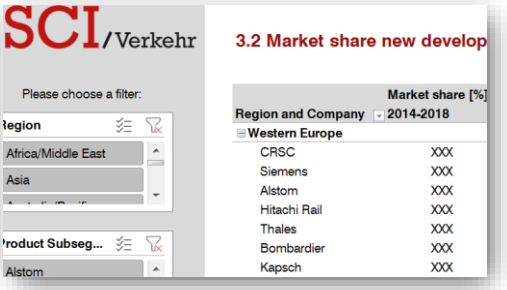

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Country	Product Subsegment	Subcriteria	Unit	Year	Value
Germany	Conventional Rail	Total	Euro	2018	XXX
Germany	High Speed Rail	Total	Euro	2018	XXX
Germany	Light Rail Transit	Total	Euro	2018	XXX
France	Conventional Rail	Total	Euro	2018	XXX
France	High Speed Rail	Total	Euro	2018	XXX

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Country	Completion planned	Transport mode	Length [km]	Level	Baseline
Germany	XXX	HSR	XXX	XXX	XXX
Germany	XXX	HSR	XXX	XXX	XXX
Germany	XXX	CR	XXX	XXX	XXX
Germany	XXX	CR	XXX	XXX	XXX
Germany	XXX	CR	XXX	XXX	XXX
Germany	XXX	CR	XXX	XXX	XXX
Germany	XXX	CR	XXX	XXX	XXX
Germany	XXX	CR	XXX	XXX	XXX

3 CCS Markets: Products and Services

Some technical systems within control command and signalling comprise, trackside and on board components as well as subsystems. Particularly in connection with the introduction of ETCS/ERTMS, the intention is to perform the previous functions of stationary systems (e.g. display of signal aspects, vehicle locating) by means of on board units. This study only takes into consideration stationary / track-side systems.

Current average market volume control command and signalling for new development and upgrade – Worldwide [EUR million]

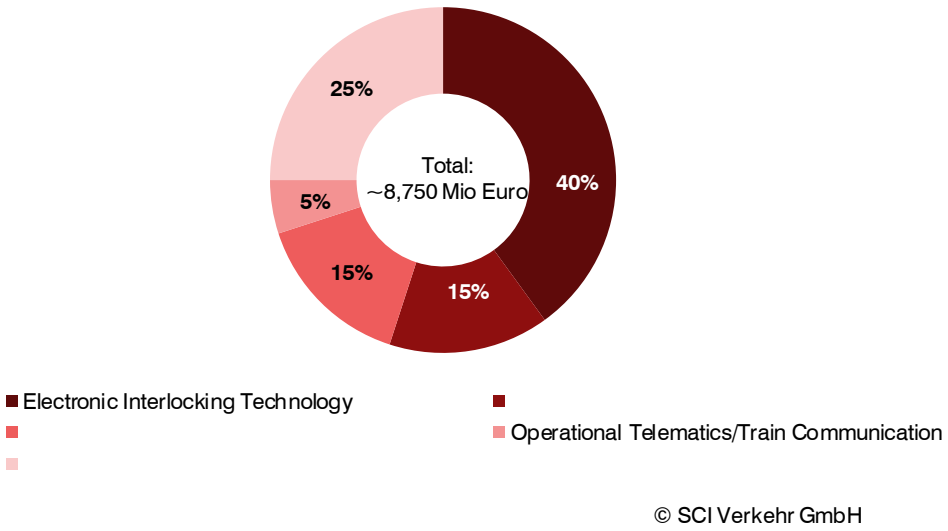

Figure 1: Current market shares in new development and upgrade by product groups

The worldwide market for new development and upgrade is mainly made up by electronic interlocking systems which make up ~ 40% of the EUR XXX million CCS market. The significant share of other products is driven by conventional interlocking systems. ETCS, CTCS and CBTC as the most modern train control systems for both conventional and urban rail systems (~XX% market share). Conventional train control systems (~15% market share) and Operational Telematics / Train Communication (~X% market share) make up smaller but also highly important shares of the world market. Other products cover conventional interlocking systems, operations control technology and local switch and control systems, level crossing protection systems.

3.1 Electronic Interlocking Technology

[...]

3.2 ETCS, CTCS and CBTC

[...]

3.3 Conventional train control systems (proprietary signalling technology)

[...]

3.4 Operational Telematics / Train Communication

The segment of operational telematics encompasses all technical equipment installed on the track to enable the transmission of operational information.

Systems, subsystems and components of this product segment:

Operational Telematics / Train Communication: Systems and components	
System	**Components**
GSM-R/ LTE	Transmitter mast Panel antenna Stationary end devices
Conventional radio systems (analogue and digital)	Repeater stations Radio mast Stationary end devices Switching and transfer technology
Remote reporting systems	
Reporting systems	Hot axle box detectors Blocked brake detectors Wind detectors
Tunnel safety equipment	Trespass alarms Fire alarms Air flow alarms Emergency call systems
Remote monitoring and control systems	
CCTV systems	
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Traditional communication systems include, e.g. the transmission of official messages using telecommunication technology as well as the information transfer between monitoring systems and central evaluating equipment.

Reporting systems and tunnel safety equipment cover technical solutions to detect trackside disorders and problems regarding the interaction of trains.

The transfer of information relevant for safety between interior and trackside installations of interlockings is covered in the product segments electronic/conventional interlocking technology.
Products in the fields of passenger information, passenger safety and ticketing (collective term: passenger-related information technology) are not covered in this study

The most important part in the field of operational telematics is GSM-R which is the information platform for exchanging speech and data between radio stations on the line and in the trains. GSM-R is controlled by the International Union of Railways (Union Internationale des Chemins de fer, UIC) under the project name EIRENE (European Integrated Railway Radio Enhanced Network).

Together with ETCS, GSM-R forms the European Rail Traffic Management system ERTMS. Instead of allocating fixed transmission channels, several trains are controlled through the same channel for ETCS communication. In the last 10 years, GSM-R has been widely installed over the European Network offering interoperability, enhancing functionality and improving safety and responsiveness. At this moment, it is still being implemented on a large scale even though its technical standard starts to be surpassed. As a second-generation telecommunications system, the GSM-R is less advanced than 4G or even 5G which is expected to be introduced around 2020. Obsolescence will then become a problematic issue. Providers are planning to maintain GSM-R up to 2030, but it will become increasingly

difficult, and expensive, for infrastructure managers to retain the same quality of service beyond that time limit.

As a response, the Long Term Evolution of GSM (LTE) and associated technologies are underway to become the new radio system for the railway sector.

The transition process in Europe is coordinated and planned by different institutions and working groups: the European Agency for Railways is the system authority for ERTMS and thus the head coordinator. It is supported by the International Union of Railways (UIC), which has established the Future Railway Mobile Communications System (FRMCS) group consisting of operators, infrastructure managers, and suppliers to monitor the preparation of specifications for a successor to GSM-R. A similar working group has been founded by the Technical Committee for Railway Telecommunications (TCRT) at the European Telecommunications Standards Institute (ETSI) and works together with the 3rd Generation Partnership Project (3GPP), which develops the standards for mobile communications in Europe.

Changes in the CCS TSI, migration strategies and implementation timelines were prepared by the end of 2018 and first implementation steps shall begin in 2022 but there are still a lot of issues of uncertainty. An essential topic that has to be dealt with is for example the question of whether 4G or 5G are supposed to be used as the basis radio transmission technology in future. Another very important issue is the spectrum allocation and the whether the same frequency band that is used for GSM-R shall be used for LTE too which could reduce the service level. Using a different frequency band, however, could drive costs since it would require new infrastructure components to be installed.

The manufacturers for GSM-R are Kapsch, Huawei and Nokia which will also lead the way for the LTE introduction but other companies will have the opportunity to develop their own solutions as well. Huawei is engaged in a lot of development and research activities and has already successfully installed the system on a Chinese mainline and on the heavy-haul Shuo Huang Railway. Furthermore, Huawei develops 4G LTE for metro networks with more than 20 applications in China.

In Europe, the estimated duration and feasibility of the migration process towards LTE differs a lot between the different countries. In some countries such as Switzerland and the Netherlands, the transition could be realised very quickly whereas other countries are still in the process of rolling out GSM-R as of today and are long away from introducing yet another system. Finland has already switched off GSM-R and uses its national Tetra network as an alternative. Germany and Britain have mature networks and are still deciding on whether they should be a pioneer and renew their system in five to seven years or wait for LTE to gain wider acceptance.

Market volume and market development

The total market volume for operational telematics is currently around EUR 850 million; this will increase in the near and mid-term future and cause a total CAGR of around XX% p.a. until 2023.

Worldwide average market volume Operational Telematics / Train Communication [EUR million]

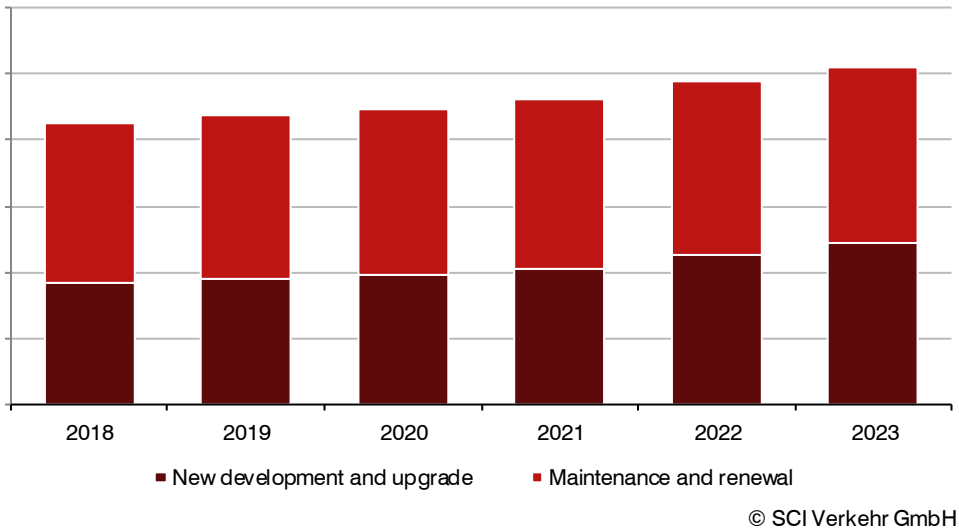

Figure 2: Worldwide market Operational Telematics / Train Communication

The market for renewal and maintenance is with EUR XXX million significantly bigger than the market for new development and upgrade with EUR XXX million. Due to new developments / upgrades in the field of train communication, the OEM market is likely to show a rather high growth rate of more than 5.5% (CAGR, p.a.).

Asia currently determines the market volume mainly due to extensive investments in conventional rail and the extension of the Chinese high speed network.

Current average market volume Operational Telematics / Train Communication for new development and upgrade [EUR million]

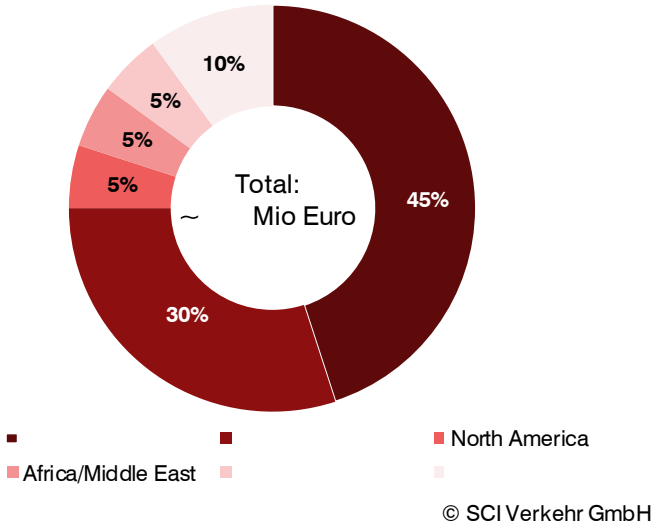

Figure 3: Current market volume Operational Telematics / Train Communication - new development and upgrade

GSM-R is only installed in China and India, but other parts of operational telematics is included in all conventional rail projects. Europe accounts for XX% of the market.

Supplier

The world market for operational telematics is very diverse since many smaller suppliers offer regional and / or niche solutions in this field.

Market share Operational Telematics / Train Communication 2014-2018 for new development and upgrade – Worldwide

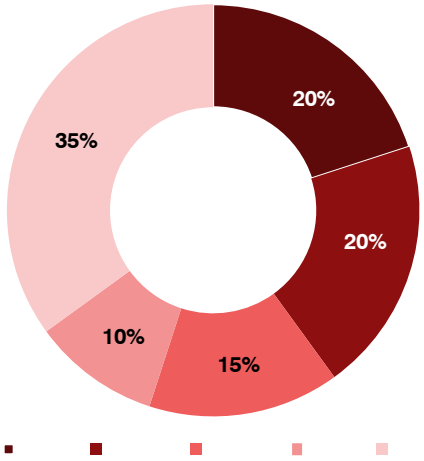

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Figure 4: Current market shares Operational Telematics / Train Communication in new development and upgrade by supplier

The main market driver is GSM-R which is rather limited to only a few suppliers. There are four companies offering comprehensive trackside solutions for GSM-R based communication. These are Kapsch, CRSC, Nokia, and Huawei. Component suppliers are – amongst others - Funkwerk IT, Wenzel Elektronik, Frequentis, Selex, Alstom and Sagem Communications.

Other operational telematics products are manufactured by e.g. Siemens (reporting systems and tunnel safety equipment), Mermec (reporting systems, tunnel safety equipment, CCTV), Voestalpine (reporting systems) and others. However, these products make up a minor share of the operational telematics market.

3.5 Other Products

[...]

4 Western Europe

4.1 Total Market

4.1.1 Market environment

Macroeconomic Overview	
Area 2017 [km²]	XXX
Population 2017 [million]	XX
Population Density 2017 [inh./ km²]	119
Population Growth 2017-22 [% p.a.]	XX
Level of Urbanisation 2017 [%]	79
Gross Domestic Product (GDP) in current prices 2017 [USD billion]	XXX
GDP per capita in PPP 2017 [USD]	45,471
GDP Growth 2017-22 [% p.a.]	XX
Inflation 2017 [%]	XX
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Rail Transport Data	Mainline Passenger	Mainline Freight	Urban Rail
Transport Performance 2017 [million pkm/tkm]	XX	302,228	XX
CAGR 2017-22 [% p.a.]	+1.7	XX	XX
Modal Share 2016 [%]	10*	XX	-

*estimated

Rail Network						
Network Data	HSR	CR	Metro	LRT	Total	Track Gauge for HSR and CR [mm]
Length 2018 [route-km]	XX	XX	2,570	XX	XX	1,435
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Main signalling systems	
Conventional train control	Communication based train control
The region´s network has a higher technological and quality level compared to Eastern Europe. The main signalling systems in Western Europe are Class B Systems with punctiform and linear train influencing. Each country has its own systems, which renders cross-border transport more difficult.	The still existing technical, operational and organisational differences in Western Europe tend to increase costs in cross-border transport. The new system ETCS should replace the different train protection systems operated in several countries. Practical trials of ETCS have been underway since the late 1990s and commercial projects were increasingly put into operation in the 2000s. Decisions regarding the implementation of ETCS are made at European level, but are accomplished at national level. Countries such as Germany, Luxembourg and Switzerland already have networks equipped with ETCS.

Market Volume and Market Development	Average Market Volume 2018 [EUR million p.a.]	CAGR 2018–23 [% p.a.]
Market volume for new development and upgrade		
High-Speed Rail (HSR)	390	XX
Conventional Railway (CR)	XX	+2.9
Light Rail Transit (LRT)	XX	XX
Metro (M)	XX	+2.8
Market volume for maintenance and renewal		
High-Speed Rail (HSR)	193	XX
Conventional Railway (CR)	XX	XX
Light Rail Transit (LRT)	XX	+2.1
Metro (M)	170	XX
Total	6,582	+3.0
		© SCI Verkehr GmbH

The Western European market is determined by a multitude of industrial nations, a high level of political stability and comparatively well-developed and sophisticated transport infrastructures and railway systems. Close co-operation between the countries on a bilateral level and within the European Union facilitates the implementation of cross-border infrastructure projects. Nevertheless, nationalist movements have been growing throughout Europe and the UK has even decided to leave the union in June 2016. Even though Brexit was decided almost three years ago, it is still unclear how the contractual termination will continue and what the consequences will arise for the participants. Due to the pending procedure, it is still difficult to foresee how these developments will influence the railway markets.

Western Europe has the highest network density worldwide and the highest proportion of electrified lines. Due to the high utilisation of railways, further upgrading of infrastructure will be necessary in the medium term, especially at junctions and port hinterland connections. In this context, the EU project for the TEN-T corridors is an important step to overcome infrastructure bottlenecks and to promote integration of the European railways. In addition, Europe has by far the largest urban transport network. Around XX% of the population in Western Europe live in conurbations. The densely populated conurbations in the core of this market region are of particular relevance as far as transport is concerned, e.g. the metropolitan regions of London and Paris, north-western Italy, the Rhine-Ruhr throughout area and Benelux. Because of their high transport volume and density, these are traditional fields of application for railway transport which place very high demands on functionality and efficiency of the means of transport. Population density and availability of a well-developed rail infrastructure are the main reasons for the fact that public transport is used more intensively in Europe than in other regions of the world with similar income situations (e.g. North America and Australia/Pacific).

Since 2001, the EU has implemented reforms in rail transport, particularly concerning the deregulation of the markets. While competition in other world market regions is mainly limited by infrastructure ownership (vertical integration), separation between network and operation plays an important role in Europe. This separation enables the existence of railway operators independent from the network and promotes railway competition.

An important synthesis of European rail transport policy was the adoption of the 4th railway package in 2016. The package is a set of rules aiming at removing the remaining barriers for a single European rail area. On the technical pillar, the package foresees simplifying required safety certifications by means of applications by the European Railway Agency (ERA), amending the directives on interoperability of the rail system in the EU and on railway safety. On the market pillar, the package aims at deepening the separation between infrastructure managers and transport operators, the opening of the domestic rail passenger markets, and increasing competition for public service

contracts. With the entry into force of the Fourth Railway Package, the national markets in the EU are required to be opened for competition by 2020. These regulations apply to long-distance and regional rail services and will increase competition in the medium to long term.

Besides increasing market liberalisation and incentives to competition, the European Commission has been sponsoring Shift2Rail, a joint technology initiative integrating the largest rail industry and operator players of Europe as well as small and medium size companies, in addition to research and development institutes. Shift2Rail aims at accelerating development and implementation of new technologies that will render rail transport more effective and efficient, thus, focusing on the competitiveness of this transport mode. The Shift2Rail Joint Undertaking was established in 2014 under Horizon 2020.

In spite of the efforts to improve railway technologies and to develop the modal split in favour of railways, differing train control and power systems still make cross-border transport difficult. The quick and comprehensive implementation of ETCS is therefore an essential part of the European solution to overcome interoperability barriers. Regulative requirements and the national implementation strategies of the countries in Western Europe are described in the following sections.

ETCS

Guidelines and requirements for the European implementation of ETCS are published in the document "Commission implementing regulation (EU) 2017/6 of 5 January 2017 on the European Rail Traffic Management System European deployment plan". Here it says: „The aim of the European Rail Traffic Management System (ERTMS) European deployment plan is to ensure that vehicles referred to in point 1.1 of the Annex to Commission Regulation (EU) 2016/919[2] equipped with ERTMS can gradually have access to an increasing number of lines, ports, terminals and marshalling yards without needing Class B systems in addition to ERTMS[.]". Furthermore, it states that „A deployment plan for the core network corridors should include stations, junctions, access to core maritime ports and inland ports, airports, rail/road terminals and infrastructure components as referred to in Article 11 of Regulation (EU) No 1315/2013 as they are essential to achieve interoperability in the European railway network." (both (EU) 2017/6).

Other than that, the regulation states that the technical requirements of cross-border lines have to be treated with urgency since these may lead to bottle-necks in the ongoing ETCS deployment process. Besides technical specifications (Level, Baseline, national requirements), the regulation points out that "Railway infrastructure managers shall equip the core network corridors with ERTMS and put ERTMS into operation in those corridors at the latest by the dates specified in Annex I to this Regulation, including in railway stations and junctions." (Article 2 of the regulation). The Annex referred to in the regulation includes timing of implementation until 2023 and beyond on single sections (see below).

Hence, the European Commission specifically sets:

- Technical requirements
- Priority networks / lines for implementation
- Timing for the implementation

According to the European Deployment Plan (EDP) and in compliance with the Commission implementing regulation (EU) 2017/6 the implementation of ETCS is supposed to be carried out by the member states on the national level by developing and implementing National Development Plans. Within the EDP, full compliance with the Technical Specifications for Interoperability Control Command and Signalling 2016/919/EC (CCS TSI) is a prerequisite. In this CCS TSI, rules for the deployment of the system in the vehicles are also included. The National Development Plans are urged to prioritize ETCS deployment along the most important European Corridors. The first national implementation plans were received in 2017 and will be updated every 5 years.

“European Corridors are the heart of the ERTMS deployment […]. To facilitate [the ETCS implementation] process, a number of transport corridors have been appointed as important for the early deployment of ERTMS […].These corridors represent only X% of the total European railway network but carry XX% of current freight traffic in addition to the most relevant international passenger services. https://ec.europa.eu/transport/modes/rail/ertms/ertms_deployment_en)

Regulation (EU) 2017/6 lays down the timetable for the deployment of the ERTMS on core network corridors (CNC) as set out in its Annex I schemes. Here, the CNCs reflect the European Corridors (see above). These CNC are:

CNC	CNC Description
Rhine-Alpine (RALP)	Amsterdam-Zeebrugge-Antwerp/Rotterdam-Duisburg-[Basel]-Milan-Genoa
Scandinavian-Mediterranean (SCM)	Finnland (Turku/Naantali-Kouvola-Hamina) Stockholm-Malmö-Copenhagen-Hamburg-Innsbruck-Verona-Roma-Napoli-Palermo
North Sea-Mediterranean (NSM)	UK (Glasgow-Edinburgh-Liverpool-Manchester-Birmingham-London-Dover) Rotterdam-Antwerp-Luxembourg-Metz-Dijon-Lyon/Basel-Marseille
Mediterranean (MED)	Algeciras-Valencia-Tarragona/Sevilla-Madrid-Zaragoza-Barcelona-Marseille-Lyon-Turin-Milan-Verona-Padua/Venice-Trieste/Koper-Ljubljana-Budapest-Zahony(Hungarian-Ukrainian border)/Budapest-Zagreb and Budapest-UA border
Rhine-Danube (RDN)	Prague-HorníLideč–Žilina–Košice-ČiernanadTisou (Slovak/ Ukrainian border)
Baltic-Adriatic (BAC)	Gdynia-Katowice-Ostrava/Žilina-Bratislava/Vienna/Klagenfurt-Udine-Venice/ Trieste/Bologna/Ravenna/ Graz-Maribor-Ljubljana-Koper/Trieste
Atlantic (ATL)	Sines-Lisbon/Leixões-Madrid-Medina del Campo/ Bilbao/San Sebastian-Irun-Bordeaux-Paris/Le Havre/Metz Sines-Elvas/Algeciras
Orient/East-Med (OEM)	Rostock/Hamburg/Wilhelmshaven/Bremerhaven-Dresden-Prague-Bratislava/Vienna-Budapest Arad-Timisoara-Vidin-Sofia-Thessaloniki-Athens/ Igoumenitsa
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In recent years, different delays occurred in the implementation process due to various reasons. In 2017, the European Court of Auditors (ECA) published a report jeopardizing if the goals set with respect to the ETCS implementation until 2030 can be reached since the current state implementation is rather sketchy. The court recommends to concentrate on ETCS implementation and to push the shutdown of all national systems. The most important reason for national states not to do so is that – especially the bigger countries – have working proprietary systems that are not close to the end of their lifecycle. Hence, the operators try to postpone the ETCS implementation to overlay the introduction of ERTMS and the end of the lifecycle of the national systems. Other than that are several operators speculating that the further development of both signalling and communication (e.g. introduction of ETCS L3 and LTE) is going to replace ETCS Level 2 before its even implemented causing future unforeseeable investments. The result is that a highly positive market development can be expected, decisions by single bigger operators can however change the picture profoundly.

4.1.2 Market size and structure

Important new development and upgrade projects

Major Projects in the region (without countries described in detail)					
Project title	**Country**	**Transport mode**	**Volume for CCS [EUR million]**	**Construction period**	**Description**

New double-track alignment Voss - Arna	Norway	CR	-	2017-2020	The 69 km long route will be upgraded and will have command control and signalling technology installed.
Tronderbanen: Trondheim - Steinkjer	Norway	CR	-	2018-2020	The XX km long route will be upgraded and will have command control and signalling technology installed.
CCS: Framework contract non-ETCS signalling Sandnes - Stavanger, Ganddal terminal, Hövik station	Norway	CR	-	2012-2022	A framework contract with Thales covers the supply of non-ETCS signalling over the next 10 years, with maintenance for 25 years. Specific contracts have been signed for the Sandnes - Stavanger line, Ganddal freight yard and Høvik station.
CCS: ETCS Level 2 - Jutland	Denmark	CR	XX	2016-2021	Banedanmark (danish infrastructure owner) has awarded the consortium of Thales and Balfour Beatty Rail a contract for the installation of ETCS signalling system on about XX km of rail lines across Jutland, what corresponds to XX% of Denmark's railway network. The project considers the installation of Thales ETCS Level 2 signalling solution and interlocking combined with rail field equipment and a traffic management system and the track-side installation being carried out by Balfour Beatty Rail in Denmark.
[…]					
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*estimated

Important new development and upgrade projects - ETCS

Projects				
Project title	**Transport mode**	**Estimated/announced volume for CCS [in EUR million]**	**Construction period**	**Description**
Emmerich – Basel ETCS L1 LS/L2 equipment	CR	n/a	2013 - 2023	By 2023, it is planned to fully equip the German part of the Rhine-Alpine corridor (RFC1) and the main border crossings with ETCS in order to ensure consistent, interoperable accessibility for transit freight traffic. The choice between ETCS level 1 LS and level 2 is made section by section. Level 2 is intended to be used on those sections with velocities higher than 160 km/h or on which level 2 equipment is at least as economical as level 1 LS.
[…]				
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Market volume

Western Europe accounts for around XX% of the worldwide market volume for control command and signalling. The market volume for maintenance and renewal makes up a major share. Western Europe not only has the longest lines fitted with signalling technology worldwide, the heavy load/capacity utilisation of the lines necessitates efficient control command and signalling. For many years, the railway technology industry has responded to the high demands of Western European network

operators and regulatory authorities regarding the quality of control command and signalling, especially in terms of safety aspects, with high quality products at relatively high prices.

The current market volume for new development and upgrade is around EUR XXXmillion and will grow dynamically at a CAGR of XX% per year up to 2023. SCI Verkehr expects all product segments to increase, although at different paces. The market for ETCS will maintain its important role in Western Europe in the medium-term and long-term future since it is developing continuously. It makes up around 10% of the new development and upgrade of CCS. The CAGR over the upcoming 5 years will be slightly higher than the market average for Western Europe. Since ETCS is mainly installed on the European rail corridors, orders are often placed for long network segments. Hence, coincidentally placed assignments for the installation of ETCS could change the market volume and outlook dramatically. Other than that, is the ongoing installation of ETCS causing positive effects on the market for interlocking and communication as well, since the remaining infrastructure has to be prepared for the deployment of ETCS. This causes the dynamic market development described above.

Market growth for operational telematics will slow down because many rail operators in Western Europe have already installed GSM-R on the majority of lines. The product segment “other” consists of level crossing protection systems but also different kinds of modern CCS innovations. Level crossing protection systems are considered potential danger areas in the railway system in Western Europe leading to a decrease in that field whereas investments in modern products such as traffic management systems or switch condition monitoring systems are increasing.

Average market volume control command and signaling for new development and upgrade 2018-2023 – Western Europe [EUR million]

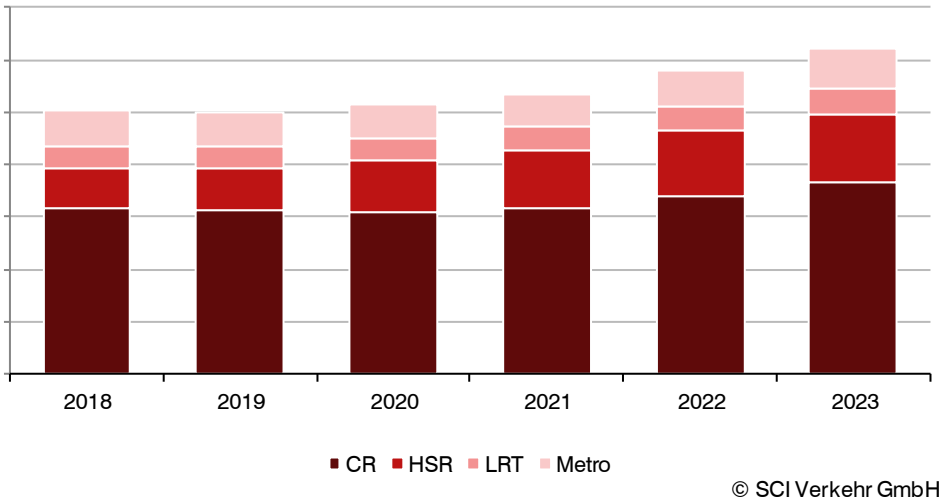

Figure 5: Market volume CCS for new development and upgrades – Western Europe

New development and upgrade projects in conventional railway transport are leading to a high market volume at present and a moderate growth at a CAGR of XX% p.a.

The market volume for new development and upgrade of mass transit infrastructures will remain at a constant high-level in the medium-term. Decreasing investments in new light-rail transit in France will lead to overall stagnation in this segment in medium-term.

The current market volume for maintenance and renewal is around EUR XXX million and will grow at a moderate CAGR of XX% per year up to 2023. Conventional railway is the determining factor for the level and development of the market volume for maintenance and renewal.

Average market volume control command and signalling for maintenance and renewal 2018-2023 – Western Europe [EUR million]

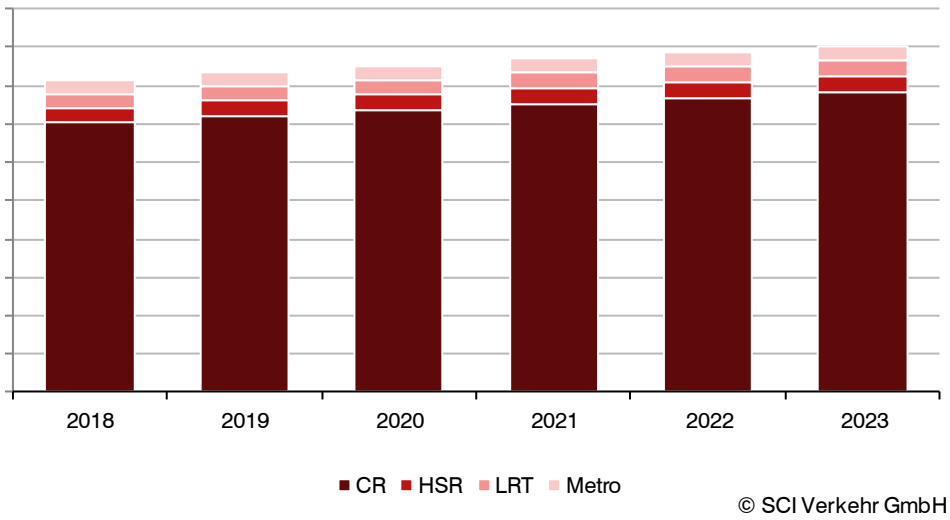

Figure 6: Market volume CCS for maintenance and renewal – Western Europe

Suppliers and market shares

Alstom, Bombardier, Hitachi Rail, Siemens and Thales as international players are leading the European CCS market.

Market share control command and signalling 2014-2018 for new development and upgrade – Western Europe

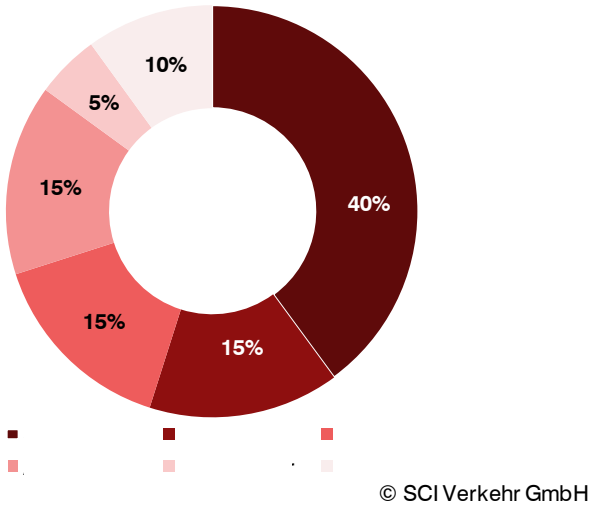

Figure 7: Market shares CCS for new development and upgrades – Western Europe

Siemens remains the strongest market player for CCS in Europe. The company received several contracts, such as the installation of ETCS solutions on the rail network in Belgium. Infrabel awarded Siemens a contract for fitting all 2300 track kilometre between 2014 and 2022 covered by a EUR XX million contract. Other than that, Siemens won several contracts e.g. in the UK, Spain and France.

After Bombardier lost the contract to fit London's underground lines with new signalling solutions, the respective contract to finalize the project until 2022 was awarded to Thales. The contract sums up to EUR XX million.

Beside winning several contracts all over Europe, e.g. Banedanmark (Denmark) awarded Thales a contract to equip limes with a combination of its traffic management system together with its latest ETCS update. Other than that, Thales is further developing its ETCS technology against the background of more than XX% of worldwide ETCS installations carried out already.

Several manufacturers often compete for one project with almost equally efficient platforms for specific applications. In general, specific customer requirements have increased in the signalling installation industry, which leads to a strengthening of niche providers. These manufacturers have specialised in meeting customers' specific requirements by producing individual structural and technical models in small quantities. Although the entire industry has seen a concentration process in recent years, niche suppliers have held their ground.

The niche and components suppliers who are also systems suppliers in some regions, include Scheidt und Bachmann, Funkwerk AG, Hanning & Kahl, Pintsch Tiefenbach, NKT Cables, Frauscher Sensortechnik, Prover Technology, Schneider Electric (former Televent), Balfour Beatty Rail and Alcatel Lucent.

In Western Europe, Nokia Network and Kapsch used to share the GSM-R market. Huawei, however, managed to penetrate the European market with some success in recent years. Huawei, for instance, - alongside Nokia - was chosen to retrofit the GSM-R network in Germany.

4.2 Germany

4.2.1 Market environment

Macroeconomic Overview	
Area 2017 [km²]	348,900
Population 2017 [million]	XX
Population Density 2017 [inh./ km²]	XX
Population Growth 2017-22 [% p.a.]	+0.02
Level of Urbanisation 2017 [%]	XX
Gross Domestic Product (GDP) in current prices 2017 [USD billion]	XX
GDP per capita in current prices 2017 [USD]	XX
GDP Growth 2017-22 [% p.a.]	XX
Inflation 2017 [%]	+1.6
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Rail Transport Data	Mainline Passenger	Mainline Freight	Urban Rail
Transport Performance 2017 [million pkm/tkm]	95,356	XX	XX
CAGR 2017-22 [% p.a.]	XX	+1.9	XX
Modal Share 2016 [%]	XX	XX	2
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Rail Network						
Network Data	HSR	CR	Metro	LRT	Total	Track Gauge for HSR and CR [mm]
Length 2018 [route-km]	1,530	XX	380	XX	XX	XX
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Electrification	
Network	Voltage systems
HSR	15 kV 16.7 Hz AC
CR	15 kV 16.7 Hz AC
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Main signalling systems		
Signalling systems	Description	Future development / Migration strategy
PZB (“punctiform train influencing”)	Cab signalling and train protection system of the family of the intermittent systems based on a magnet installed on the track. If the train goes too fast, the	ETCS will replace the existing systems (PZB/LZB) in the long term.

	system brakes it. PZB is mandatory for nearly every railway line (conventional railway) in Germany.	
LZB (“linear train influencing”)	continuous train control system specific for trains allowed to exceed speeds of 160km/h. Data transmission occurs through a cable between the rails. The train / driver is warned if the maximum speed is exceeded and the train is automatically braked. The high speed lines in Germany use LZB. For driving on non-LZB routes, PZB equipment is available on all vehicles equipped with LZB, what means that the vehicle has to be adapted to the route.	
SIFA/dead man´s switch (“safety driving switch”)	A press button or a pedal that monitors the alertness of the train driver. The aim is to make the driver press the button after determined intervals and if the train driver fails to press it, the train carried out a sudden stop. In Germany, this system is complementary to other systems such as PZB, LZB and ETCS and is used in ICE3, for example. The time-time SIFA is used. The driver holds a pedal/button pressed and it must be interrupted every 30 seconds.	

Market Volume and Market Development	Average Market Volume 2018 [EUR million p.a.]	CAGR 2018–23 [% p.a.]
Market volume for new development and upgrade		
High-Speed Rail (HSR)	37	XX
Conventional Railway (CR)	XX	+3.4
Light Rail Transit (LRT)	42	XX
Metro (M)	XX	+1.2
Market volume for maintenance and renewal		
High-Speed Rail (HSR)	29	XX
Conventional Railway (CR)	XX	XX
Light Rail Transit (LRT)	94	XX
Metro (M)	XX	+2.0
Total	XX	XX

Conventional train control systems

The current policy for class B control systems in Germany mainly foresees to double equip the infrastructure with ETCS and the old systems so that conventionally equipped vehicles can be operated on ETCS lines. The owners of older vehicles can decide by themselves at which point they want to carry out the conversion to ETCS. This strategy increases infrastructure maintenance costs, while the incentive to convert existing vehicles to ETCS is low. On the other hand, the RUs are not burdened with the costs of the vehicle-side conversion. The migration of the vehicles can partially be conducted without any actual vehicle modification and just by replacing older vehicles at the end of their life with new vehicles that were equipped from the beginning. LZB is planned to remain in use until 2030 and for PZB, no decommissioning is planned at all. In accordance with the above mentioned policy, on almost all the sections in Germany that are already equipped with ETCS, the system is installed in parallel with the class B systems. Only one route of 107 km between Ebensfeld and Erfurt is exclusively controlled by ETCS level 2.

ETCS

In total, the German rail infrastructure manager DB Netz is operating 252.4 km of ETCS equipped lines. The most famous ETCS project that is already completed is the VDE8 network, a high-speed line between Berlin and Munich which has been under operation since 2017 and works with level 2 ETCS train control.

Projects				
Section	**Transport mode**	**Length [km]**	**Level**	**Baseline**
Leipzig Messe – Gröbers	HSR	20	2	2.3.0d
Gröbers/Halle – Ammendorf – Erfurt main station	HSR	XX	2	2.3.0d
Erfurt main station – Unterleiterbach including a connection to Coburg	HSR	XX	2	2.3.0d
Unterleiterbach – Zapfendorf	CR	3	2	2.3.0d
Konstanz – Border	CR	XX	1 LS	3.4.0
Erzingen – Thayngen – Singen/Konstanz	CR	XX	1 LS	3.4.0
Hub Basel	CR	7	1 LS	3.4.0
© SCI Verkehr GmbH				

The specifications from the European Deployment Plan were integrated into a national implementation plan (NDP) according to which ~XX km of tracks will be equipped with ETCS until 2023. Projects regarding the equipment of cross-border sections are prioritised. In December 2017, the Federal Government and DB Netz signed a financing agreement for XX km of ETCS equipment at a total of seven border crossings. This prioritization of cross-border sections projects is also pursued beyond 2023. Furthermore, a focus is set on Germany's inland shares of the RALP corridor, which is prescribed by the EDP and also serves the German goal of pursuing interoperability in freight transport since the corridor is the busiest rail freight corridor in Germany. Finally, the NDP foresees the closing of 14 km equipment gaps on TEN core network corridors. In the long-term, DB Netz is aiming at equipping its shares in the international rail freight corridors with ETCS. In the context of the programme "Digitale Schiene" published in 2018, the German network operator DB Netz is aiming at spending approximately 35 billion Euros on the modernization of – amongst others – the signalling technology.
Several ETCS projects are planned in Germany in commuter rail service: In January 2019, the local Stuttgart parliament (Regionalversammlung) decided to equip the Stuttgart Commuter rail (S-Bahn) hub and 58 new Commuter trains with ETCS level 2 to improve capacity and punctuality with commissioning planned for 2025. Furthermore, Siemens and DB decided to develop an automated commuter rail service in Hamburg to be controlled by ETCS level 2 by 2021.
Regarding most of the projects of the period until and beyond 2023 in Germany, there are only focus points known (without timing or technical specifications). Regarding a network-wide installation of ETCS, there is no conclusive plan known so far. The German Ministry for Transport and Digital Infrastructure (BMVI) is investigating the nationwide introduction of ETCS in combination with electronic interlockings in form of a feasibility study launched in 2017.

Operational Telematics / Train Control

The owner of the German GSM-R network is DB Netz AG which is also responsible for planning, development and operation of the network. In 1999, DB AG presented its plans to develop a GSM-R network and intentions to install GSM-R on around XX km of its XX network-kilometres operated. Analogue train radio systems are gradually being replaced by GSM-R. The high-speed line Cologne–Rhine/Main went into operation on 1st August 2002 as the first line based only on GSM-R. There were plans to use GSM-R in shunting radio systems in XX shunting yards although planning was not possible in around 30 yards due to lack of frequencies.

In 2008, Deutsche Bahn AG and Nokia Networks signed a framework agreement to expand the GSM-R based mobile communication systems along an additional XX km on passenger transport lines. The

system carries signalling and operational information directly to the driver. Under the contract, Nokia Networks is supplying complete GSM-R radio solution, including base stations, base station controllers, network management as well as integration, installation, upgrades and services for 15 years support. The project has been started in the first quarter of 2008. As of 2018, more than 29,000 km of the German network are equipped with GSM-R. However, there are more than a thousand locations in this network with insufficient radio coverage, some of them of up to one kilometre in length. According to DB Netz, the radio coverage is limited to about 250 sections with varying dimensions, usually a few hectares. The DB has developed a fall-back strategy to cope with those supply interruptions.

In 2015, Deutsche Bahn AG awarded contracts to modernise the GSM-R network. The contracts were divided in to two lots: The South lot, worth 60% of the total volume, went to Nokia Networks, while the North lot, worth 40%, went to a consortium between Siemens Convergence Creators and Huawei. Up to XX base stations are to be replaced by 2024, as well as their corresponding 38 control facilities. These are computers at which the signal connections of multiple base stations are monitored. The contracts also cover maintenance and repairs of the new network components up to 2033. Controversial discussions about data security led to uncertainties as to whether the contract with Huawei would be maintained but in the end it was decided to keep the agreement with the Chinese telecommunication provider after all. The introduction of the new railway radio technology LTE in Germany has been discussed in expert circles for quite some time, but nothing has been decided in that regard, as of 2019.

Electronic Interlocking

The network of DB has developed historically and does not follow a superordinate construction plan. The current infrastructure is characterised by a diversity of types and various interlocking generations in terms of interlocking technology. Technologies are not standardised and their performance criteria are not comparable.

In 2016, the railway infrastructure of DB Netz AG comprised around 2,776 interlockings (thereof 361 electronic interlockings). The service life of a growing number of mechanical and relay-based interlocking models has been exceeded. In addition to this, younger interlocking models will also be replaced in the coming years as their electronic technology has a shorter service life than the aforementioned systems. When it comes to replacement investments, DB AG faces the challenge of maintaining availability and safety while reducing complexity and manufacturer dependency. As a solution for long-term cost reduction, standardisation efforts are of considerable importance. The integration of ETCS as the new European train control system adds additional requirements to this system since older interlockings need updates when they are integrated into parts of the network where ETCS is installed. While the ETCS equipment in Germany is essentially based on the national implementation plan, infrastructure manager DB Netz is pursuing a strategy for the nationwide introduction conversion to digital interlockings (DSTW) until 2040. In 2017, the Federal Ministry of Transport commissioned a feasibility study to validate DB Netz's ETCS strategy independently and to draw up a recommendation for the federal government.

Other Products

The number of level crossings in Deutsche Bahn’s railway network has dropped constantly in the past few decades. As of 2016, around 17,000 level crossings in Germany are operated by Deutsche Bahn. In Germany, level crossings are not permitted on railway lines with speed limits of more than 160 km/h. When new railway lines are built, even if the speed limit is less than 160 km/h, the construction of new level crossings generally is no longer approved. The Railway Crossing Act (Eisenbahnkreuzungsgesetz, EKrG) regulates this in more detail. There are on-going endeavours to reduce the number of level crossings on the main lines in Deutsche Bahn’s network. These are being closed without a replacement or are replaced by underpasses or bridges. However, there is still a market for replacement protection systems.

The newest innovations developed by DB and currently tested in Germany are different sensor technologies installed on the tracks or near the tracks to monitor the track condition and the condition of switches. The system DIANA (diagnosis and analysis platform) works with sensors installed on the interlocking which can detect switch defects by measuring the current flow of the electronic interlocking engines. The biggest electronical interlockings in Germany like in Hannover, Berlin, Frankfurt, Karlsruhe and Munich are already equipped with those sensors. Furthermore, there is a system detecting wholes in the ballast by measuring potential dropping of sleepers in case of a train crossing. It is called KONUX and is used for high speed sections. Another important new technology is the application of optical fibre cables laid along the tracks which are meant for track surveillance. Three projects for testing the fibre optic sensing have been successfully finished in 2018.

4.2.2 Market size and structure

Important new development and upgrade projects

Major CCS Projects (Conventional Rail, High Speed Rail, Light Rail Transit, Metro)				
Project title	**Transport mode**	**Volume for CCS [EUR million]**	**Construction period**	**Description**
CCS upgrade in Commuter Rail Berlin	CR	XX	2011-2020	The Berlin suburban train will rely on ATP (ZBS). The about XX km project is a development of S-Bahn Berlin GmbH, DB Netz AG and Siemens. The existing electronic interlockings will need to be replaced, but new interlockings will be designed to work with the new equipment.
CCS in Commuter Rail Hamburg: Line S21 automation	CR	-	2019-2021	German state railway DB, Siemens and the city of Hamburg will develop a fully automated S-Bahn line. The agreement calls for the conversion of the XX km eastern section of Line S21 between Berliner Tor and Aumühle for fully automatic operation and to equip four trains with the technology required for the operation. They will operate on European Automatic Train Operation (ATO) standard in combination with ETCS Level 2.
[…]				
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*estimated

ETCS plans – overview of network sections to be equipped

Projects					
Section	**Completion planned for**	**Transport mode**	**Length [km]**	**Level**	**Baseline**
Berlin – Dresden	n/a	HSR	175	2	2.3.0d
Nuremberg – Ingoldstadt – Munich	2021	HSR	XX	2	2.3.0d
[…]					
© SCI Verkehr GmbH					

Market volume

Germany remains Europe's largest national market for control command and signalling. This is the result of high market volumes for renewal and maintenance. In the field of new development and upgrade, Germany is the second largest CCS market in Europe behind the UK. The market volume totals around EUR XX million at present; this will grow moderately at a CAGR of XX% per year up to 2023.

Further, ETCS and electronic interlocking installations are leading to solid growth and the market for other digitalisation products such as track condition and switch sensors is also increasing. A large part of the German railway network is already equipped with GSM-R. Nevertheless, Huawei was assigned to build a second generation GSM-R network for a total project investment of half a billion EUR. This decision was made in spite of controversial political discussions about whether the Chinese telecommunication supplier can guarantee data security. Further large market volumes in the field of operational telematics could be expected if the new railway radio system LTE would become established in the German railway market, but nothing has been decided in that regard, as of 2019, even though the introduction of LTE has been discussed in expert circles for quite some time. Furthermore, DB has been investing in electronic interlocking technology for years. The substitution of conventional interlocking technology by electronic interlockings, digital interlockings in particular, will also continue in the future.

The market volume for the new development and upgrading of urban rail systems will remain at a stable level up to 2023. Introduction of new technologies especially in more efficient operations, control, and extension of existing network leads to high market volumes in the urban rail new development and upgrade segment in Germany, besides the fact that Germany already has well-developed urban rail infrastructure with corresponding modern CCS technologies.

Average market volume control command and signalling for new development and upgrade 2018-2023 – Germany [EUR million]

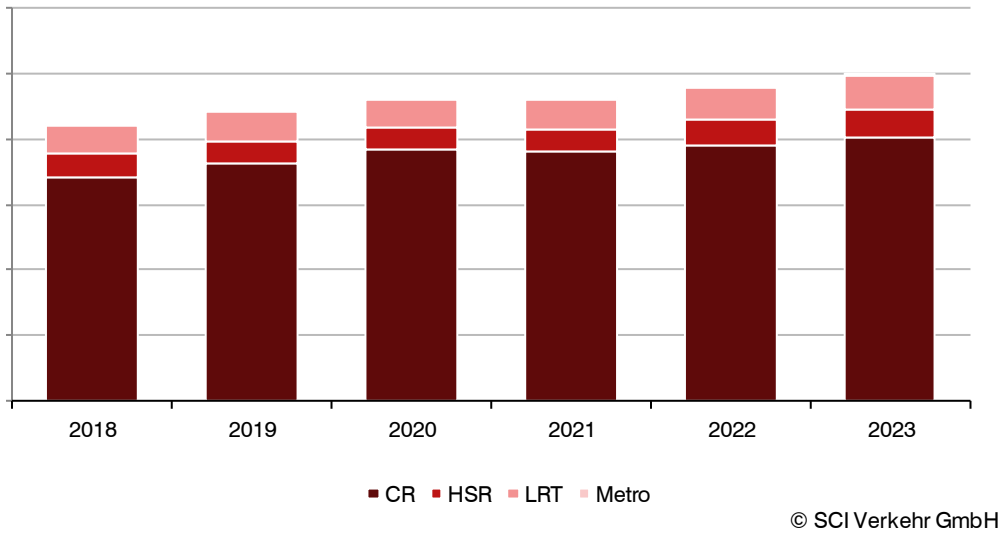

Figure 8: Market volume CCS for new development and upgrades – Germany

SCI Verkehr GmbH expects slow growth in the market volumes for maintenance and renewal, despite the anticipated increase in labour costs and product prices. DB AG's cost reduction strategy and the declining network will have a negative effect on this market in the medium to long term.

Average market volume control command and signalling for maintenance and renewal 2018-2023 – Germany [EUR million]

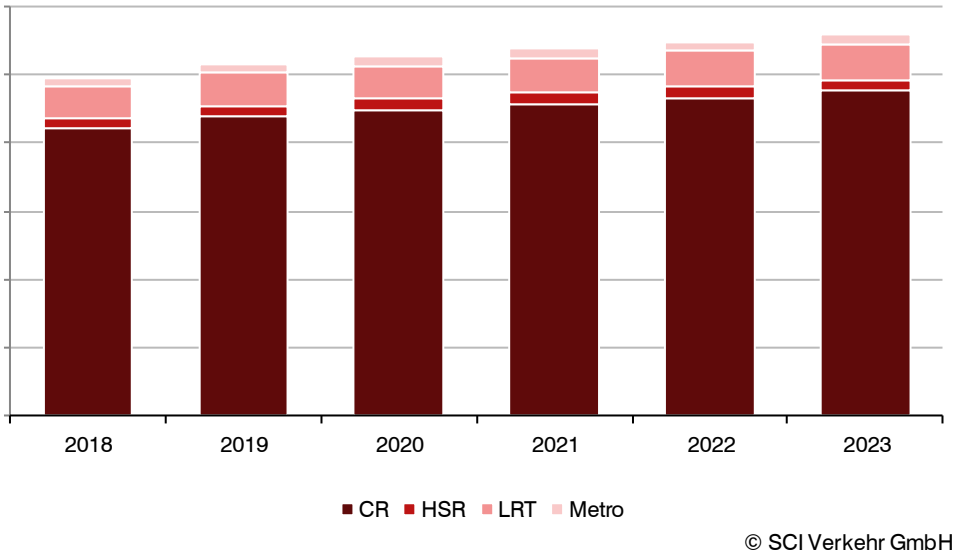

Figure 9: Market volume CCS for maintenance and renewal - Germany

Suppliers

The two large suppliers Siemens and Thales traditionally enjoy large market shares. Deutsche Bahn AG is also strongly represented as a manufacturer (signalling plant Wuppertal and branches), and as a construction and planning service provider. Similarly to the track construction sector, there are a large number of installation companies here in sectorial and regional market niches, some of which focus on the maintenance of conventional, technologically outdated systems.

In contrast to other countries (e.g. Japan), there is no standardised electronic interlocking technology in Germany. Therefore, there are a large number of manufacturers active in the market. The leading manufacturers of electronic interlocking technology are Thales and Siemens. Siemens offers interlockings of the type Simis and Thales, Locktrac. As niche suppliers in the field of interlocking technology in Germany, Funkwerk and Scheidt und Bachmann are particularly successful.

Kapsch, Nokia Network and Huawei share the GSM-R market in Germany since Huawei's successful introduction into the market. The network itself is operated by DB Netz, which took over business from DB Systel in 2012.

Major contracts awarded in recent years are:

- Saarbrücken–Mannheim (Ansaldo STS, Hitachi Rail)
- Berlin–Rostock (Ansaldo STS, Hitachi Rail)
- Nuremberg–Ingoldstadt–Munich (Thales)
- Ebensfeld–Erfurt (Siemens)

Other bigger contracts are still pending but will be tendered in the upcoming years.

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