
GSM-R – railway communication
solutions from the market leader
NOKIA

Nokia GSM-R: The fast track to railway excellence

Communication and control are vital to railway operators. Conveying information on the go, across network boundaries and international borders and at high speeds is key to maximizing operating efficiency.

Unflagging commitment to GSM-R
Nokia designs, builds and maintains end-to-end solutions that encompass the latest technology developed by experts in railway communication and GSM-R terminals. The combination of expertise in mobile communications and railway engineering enables us to provide the best tailored solutions, making us the first-choice supplier of voice and data networks.

Nokia, the world market leader in GSM-R, offers premium solutions comprising telecommunication consultancy as well as train control and value-added services such as automatic ticketing, cargo tracking, and passenger information systems. They cover GSM-R networks' lifecycle from design, implementation, and operation to long-term maintenance.

Shaping the future with standards
Nokia is a leader in mobile comms and a charter member of GSM/GSM-R standardization bodies that drive railway standards such as ETSI and EIRENE. We support important railway associations, UIC and European Union Agency for Railways, in defining standards for next generation railway networks.

Nokia helps shape GSM-R strategies, standards, and interoperability principles. To this end, we joined forces with leading suppliers in the Railway Operational Communication Industry Group and represent this group in the several bodies at a European level.

Evolution to GPRS and LTE

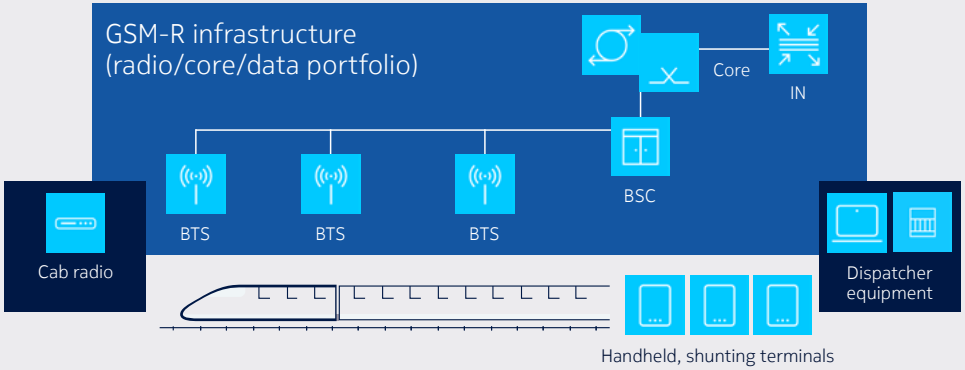
GSM-R, based on mature standards, is still evolving with hardware being modernized accordingly. IP transport, included in R4 core networks, is now also available in mobile backhaul that connects base stations.

Our GSM-R system integrates GPRS and EDGE and is therefore ready for evolution towards packet data in railway networks. Nokia expects the next generation railway telecommunication system to be based on LTE technology, the dominant mobile broadband communication technology not only for the public market, but also for mission-critical public safety communications with its similarities to railway communications.

Trendsetter in standardization

The ERTMS stakeholder platform under the control of the European Union Agency for Railways (which replaces the former ERTMS MoU Steering Committee) makes recommendations for GSM-R and ETCS implementation across Europe. As a Railway Operational Communications Industry Group (ROC-IG) delegate to the European Union Agency for Railways, we drive GSM-R standardization, and are regular members of both the ERTMS Control-Command and Signaling Working Party (CCS WP) and the Control Group (CG). The International Union of Railways (UIC) forms various GSM-R expert groups tasked to propose modifications, amendments, and improvements to the GSM-R specification and interoperability tests. Additionally we lead all relevant railway standardization in 3GPP and ETSI (TC RT).

Our engagement in standardized interfaces is in response to the needs of railway operators that operate across borders and who wish to be able to deal with different vendors for buying and integrating GSM-R solution components. Now all GSM-R interfaces are standardized, operators have access to an open, interoperable and international system that brings considerable savings.



Approved end-to-end solution for 20 countries

Top reliability for mission-critical communications

Our mobile core is one of the most reliable on the market. Nokia GSM-R core network components deliver dependability, scalability and a wealth of features. Satisfying demanding railway reliability requirements, they deliver geo-redundancy for the whole portfolio for disaster-proof operation even in the event of fire, flooding or earthquake.

GSM-R infrastructure contracts

Nokia was first in the lab with GSM-R technology, and with commercial projects in 20 countries to credit, we are also first in the field. Covering tens of thousands of track kilometers, countless tunnels and untold trains, Nokia GSM-R serves railways in Europe, the Middle East, Australia and Asia.

Sweden, Trafikverket
Sweden's national railway Banverket commissioned a GSM-R network in 1998, with the world's first commercial deployment following in 2000. Today a nationwide voice and data system is up and running, and cross-border tests with Nordic countries have met success.

Netherlands, Pro Rail
Several tracks are equipped with ETCS, such as the 200 km high speed line. The project, encompassing switching centers, IN systems, GPRS radio base stations, VMS and SMS, was completed in 2004.

Spain, ADIF
ADIF used Nokia for its first GSM-R implementation, consisting of a redundant Core Network and the Madrid-Barcelona High Speed Line in 2000. Subsequently, Nokia extended its solutions to major cities, as well as the suburban rail networks of Madrid and Barcelona.

Italy, Rete Ferroviaria Italiana and SIRTI Highspeed
Italy's national railway operator awarded a contract in 2002 for a full turnkey GSM-R system. High-speed lines are now running from Rome to Naples, Turin to Milan and Milan to Bologna.

Switzerland, SBB
SBB opted for a nationwide GSM-R project covering main lines in 2002, implemented in five phases over the ensuing years. The first lines are up and running with full ETC operation. In 2016, the Gotthard Base Tunnel opened, with Nokia playing a pivotal role by deploying the entire communications network for mission-critical operational and passenger services.

Belgium, Infrabel/SNCB
In 2003, Infrabel/SNCB chose Nokia as the turnkey supplier for a nationwide GSM-R system. The contract encompasses all GSM-R network elements and professional

services. In 2012, it was agreed to extend the network with Flexi Base Stations.

Finland, LiVi

In 2003, Likennevirasto commissioned Nokia to set up a countrywide GSM-R network including line communication, shunting and maintenance. The roll-out was completed in December 2011.

Norway, Jernbaneverket

The Norwegian rail administration Jernbaneverket opted for Nokia to roll out a national GSM-R system comprising more than 650 tunnels. The contract covers all GSM-R network elements, CAB radios for locomotives, and all civil engineering works.

India, NFR, ECR, NCR, NR

India's Ministry of Railways kicked off the first of several projects to equip large parts of the rail network with GSM-R infrastructure. In 2010 an additional contract for the Ghaziabad- Mughalsarai section of North Central Railways was awarded to Nokia.

In 2012 Indian Railways selected Nokia to equip the Kolkata metro line GSM-R infrastructure.

In 2016 Nokia signed a contract with Alstom Systems India Pvt Ltd for the Eastern Dedicated Freight Corridor (EDFC) covering 343 km from Bhaupur to Khurja.

Germany, Deutsche Bahn

In 2008, DB AG awarded Nokia a contract to extend its GSM-R communication system including delivery, installation and integration of a GSM-R radio solution. In 2015 DB Netz AG awarded Nokia an 8-year deal to modernize its GSM-R network in southern Germany.

China, Ministry of Railways

In 2007, the Chinese Ministry of Railways and China Railway Signaling and Communication Corporation awarded Nokia a deal to provide the GSM-R network for a high-speed line connecting Wuhan and Guangzhou.

Nokia's first project was the line from Jinan to Qingdao in 2004, with others including the Beijing-Tianjin high-speed line, the Wuhan-Guangzhou line and the JingHu line from Beijing to Shanghai.

Saudi Arabia, Saudi Railway

Saudi Railway Organization contracted the Dammam to Riyadh line in 2005. The first GSM-R/ETCS project in the Middle East, this milestone in modern train control was jointly achieved by Nokia and Siemens Transportation.

Saudi Arabia, North-South Mineral Line

In 2009, the North-South Railway GSM-R contract was awarded which covers an area linking northern Saudi Arabia with the Gulf Coast and Riyadh.

Greece, ERGOSE SA
ERGOSE SA set out to build a GSM-R network on the main north-to-south line in 2006. Nokia supplied the full turnkey GSM-R solution, including base stations, core network, IN, GPRS and railway tunnel communication solution and services, as well as a three-year network operation contract.

Turkey, TCDD
TCDD opted for the full GSM-R solution, including base stations, a core network, IN, and advanced tunnel communication solution and services from Nokia. Completed in 2008, this joint project with Siemens covers the high-speed line between Ankara and Eskisehir.

Tunisia, SNCFT
In 2008, the Tunisian Railway SNCFT chose Nokia to deploy a nationwide GSM-R network, with the first stretch running from Tunis to Sfax.

Australia, PTV Victoria
The Department of Transport Victoria picked Nokia to upgrade its analog railway communications and roll out Australia's first digital GSM-R system.

Denmark, Banedanmark
In June 2010 Banedanmark, selected Nokia to implement a country wide GSM-R network under a turnkey agreement.

The GSM-R network went live in January 2013, meeting the original time schedule.

Romania (CFR)
The project pilots the European Rail Traffic Management System (ERTMS) on the Buftea – Periş – Crivina – Brazi line. Nokia is providing two core and Intelligent Networks, ten BTSs, two BSCs and appropriate transport, services for network integration, a three year care phase and delivery.

Poland, PKP Polskie Linie Kolojewe
PKP is modernizing its high speed routes E-65 linking Warsaw with the northern Baltic port of Gdynia and E-20. For E-65 Nokia will provide GSM-R radio network equipment, including base stations, base station controller and the transmission backbone, as well as the dispatchers and hand-held terminals.

As a separate project, Nokia will also help extend ETCS Level 2 system based on GSM-R radio over a link between E-65 and Gdansk Airport. As for E-20, Nokia will provide GSM-R radio equipment including 49 base stations, a base station controller.

The leading GSM-R solution

The Nokia GSM-R solution comprises various state-of-the-art elements that are utilized both here and in many other Nokia communications solutions worldwide. These elements are flexible and interconnect with one another for maximum flexibility with reliability and availability. Interworking with other vendors is proven in interoperability test campaigns.

Geographic redundant R4 core
Nokia geographic redundant platforms include redundant hardware, functional units, data storage and software. Different core network elements are based on the same common COTS hardware platform like ATCA, HP or others.

The Nokia GSM-R Core is fully based on the most modern open core (MSS-server, MGW, GGSN, SGSN) and virtualized platforms. This allows the implementation of multiple nodes on multi-purpose hardware.

Open Mobile softswitching for railways with zero outage
Nokia MSC/VLR is delivered as R4 Architecture compliant MSS and MGW. This allows railways to use IP technologies and offers the operator, in combination with sophisticated pooling and load sharing, a disaster tolerant system. Resilience mechanisms like MSS pooling, MGW cluster with virtual MGW concept and multihoming for BSC and SIGTRAN connections, ensure there is no single point of failure in the R4 system.

GPRS network
The GPRS network, allowing the subscriber to access packet data services, employs two nodes, the Gateway GPRS Support Node (GGSN) and the Serving GPRS Support Node (SGSN). These enhance the network to fulfil ETCS level 2 requirements. The Nokia GGSN is a highly intelligent node providing enhanced functionality such as QoS control at application level.

Intelligent Network and NT HLR/ One NDS

The Intelligent Network (IN) also known as Railway@vantage provides an EIRENE (European Integrated radio Enhanced Network) standard compliant feature set for GSM-R networks:

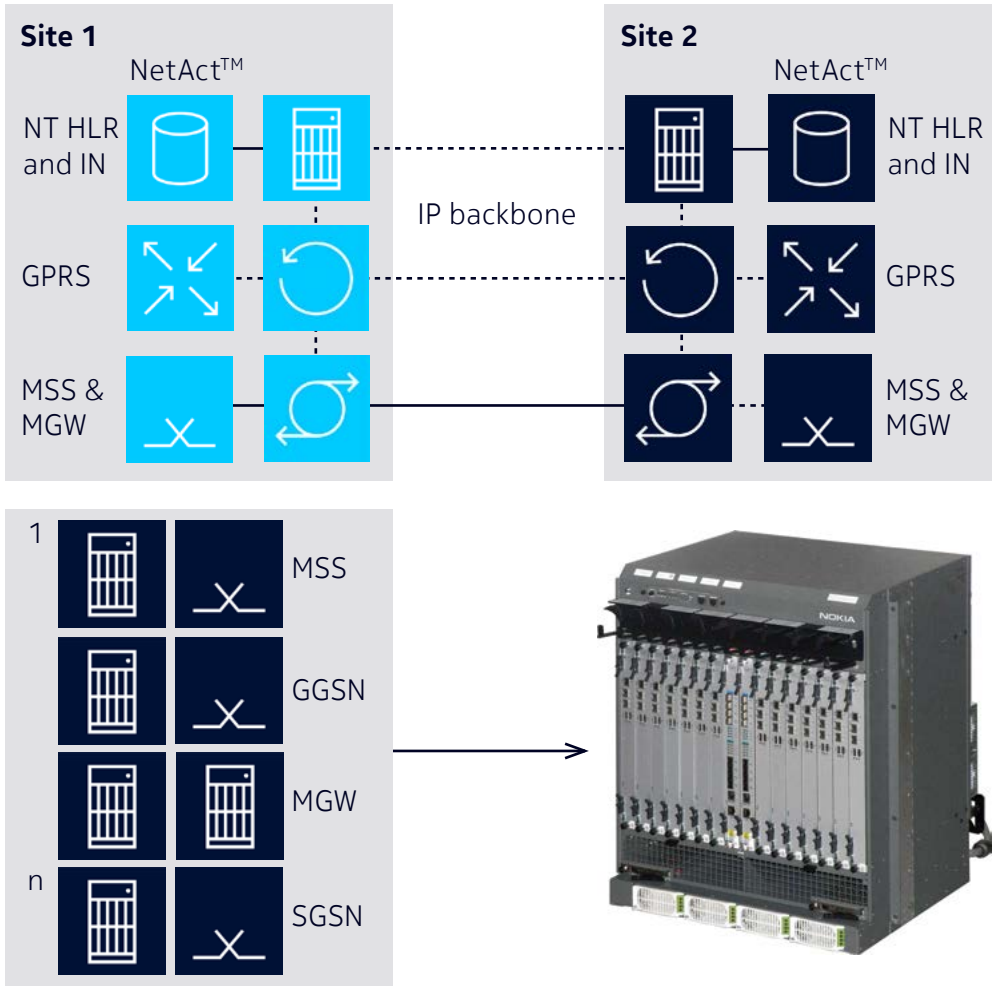
- EIRENE numbering support, i.e. Follow Me Functional Node (FFN) functionality enabling functional numbering and administration via USSD
- Basic Location Dependent Addressing (LDA)
- Additional administration and authorization functions (such as Access Matrix)

Railway@vantage also provides many smart optional features to support the operational needs of railway operators. These include an Acknowledgment Center (ACKC) integrated in the IN, a direct interface to railway positioning elements allowing enhanced Location Dependent Addressing (eLDA) calls with exact train position, on-board functional calling and more.

SIM Profile Management can be optionally integrated.

NT HLR (OneNDS) and IN system are built on server blade architecture, making maximum use of virtualization.

Nokia is using its globally successful geo-redundant subscriber database OneNDS. This can be distributed via two or more geographical locations in combination with the HLR front end to deliver an HLR with no single point of failure.



Radio

The Base Station Controller (Flexi BSC) and the Transcoder and Rate Adaption Unit (TRAU) are implemented on one platform. Railways can choose delivery as separate elements or combined in one node. For interconnection, copper or fiber may be used, with the choice of SDH, PDH and IP. This supports full IP connectivity for Flexi Base Stations, making the solution both cost-effective and future-proof.

Nokia Flexi Base Station's modular design makes site acquisition and installation easier, speeds up the roll out of network coverage in a new area and enables existing site space to be re-used.

The unit can even be distributed over multiple sites to meet coverage needs. For example, the Nokia Tunnel Solution provides coverage for short and medium length tunnels with no additional equipment. This caters for most railway tunnels (about 80 percent), reducing complexity and OPEX considerably while increasing network quality.

Two Flexi Base Station types are available for railways - 2G Flexi EDGE Base Station and the latest Flexi Multiradio 10 Base Station.

The Nokia Flexi Multiradio 10 Base Station supports flexible migration needs from GSM-R to Future Railway Mobile Communication System (FRMCS) with the same hardware for GSM-R and LTE. With the Flexi Multiradio 10 Base Station, railway operators can benefit from RF resource sharing between both radio access technologies. In addition, the base station offers flexible distributed Remote Radio Head (RRH) deployments to optimize network planning, improve handover performance and for installation in tunnels.

Network Management

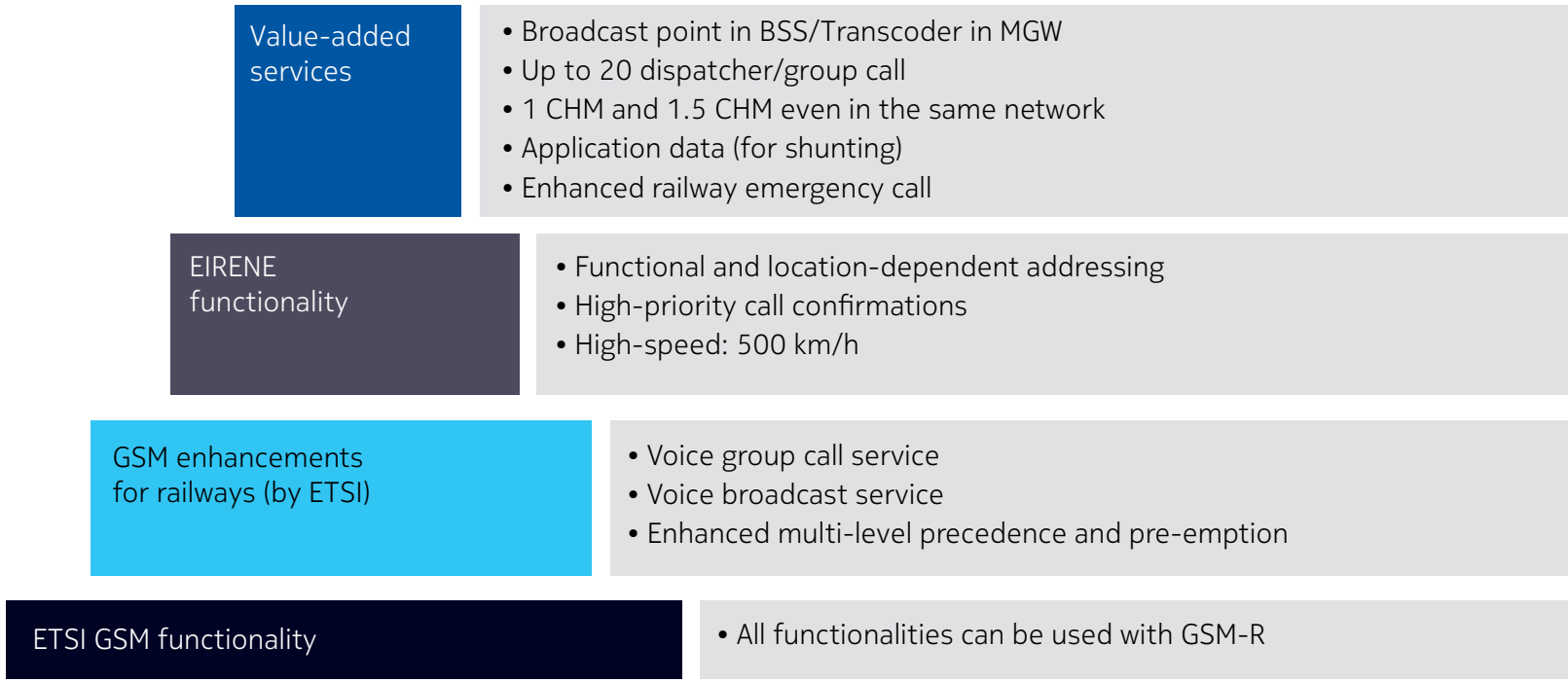
The Nokia NetAct® platform uses all element managers and features umbrella management that includes enhanced performance monitoring and disaster management.

Fixed backhaul

Nokia offers a suite of IP/MPLS and optical transport products with high reliability, robust security, and deterministic quality of service (QoS). The backhaul is a converged IP/MPLS and optical networking infrastructure for GSM-R and other applications. It provides IP/MPLS VPN services, flexible deployment topology support, and multi-fault resiliency. Its many security features such as encryption and firewalls ensure protection for both the network infrastructure and application traffic.

Microwave transmission

The Nokia 9500 Microwave Packet Radio (MPR) product portfolio offers a wide range of deployment solutions, including full outdoor configuration for easy installation.



Nokia GSM-R: Value added services on top of a fully standard compliant solution.

Bringing unity with ERTMS

Now that GSM-R has been selected as the data carrier for the ETCS signaling system standard, it is an integral component of the ERTMS (European Rail Traffic Management System, comprising both GSM-R and ETCS). The benefits are considerable, for example, a continuous flow of information can now be provided to on-board computers for calculating speed and braking profiles.

Communication between drivers and other parties is handled by staff operating from control centers, using a Dispatcher Terminal that makes the most of GSM-R's advantages. In the event of an emergency, calls are recorded by an Acknowledgement Center, allowing fault analysis after the incident. Cab Radios from partner companies play a vital role within the GSM-R system. These incorporate all the EIRENE standards, ensuring safe, easy and efficient operation in any rail network equipped with GSM-R. With the introduction of ETCS over IP (GPRS) GSM-R is able to provide efficient capacity for mission-critical data transmission.

Safety features

GSM-R improves the security, reliability and safety of rail services. For instance, it significantly enhances communication with trains passing through tunnels, affording far greater safety in case of emergencies. GSM-R will eventually be deployed across entire continents. Its total interoperability and compatibility will vastly improve the safety and speed of all railway operational services. And train drivers will be able to communicate freely throughout their journeys, regardless of the country they happen to be in.

The Nokia performance promise

Nokia GSM-R solutions help railway companies provide better, safer service at lower operational cost. We are a partner with a genuine interest in making railways more attractive, efficient, and profitable. We have the skills and portfolio to deliver the full end-to-end package to your doorstep, and the financial strength to invest heavily in R&D.

What's more, we have the consulting expertise and insight required to create smart business models that smooth the way to success. And we have the communications technology, turnkey experience, logistical reach and railway engineering know-how to deliver.

Start with the solution you need now. As demand grows, you can easily satisfy your organization's need for communication power by growing the solution as you go. And benefit from the lower cost, higher safety, greater freedom of choice, and more promising business opportunities that come courtesy of open standards. GSM-R has never sounded better.

Abbreviations

ASCI Advanced Speech Call Items
BSC Base Station Controller
BTS Base Transceiver Station
CIU Central Integration Unit
EDGE Enhanced Data rates for GSM Evolution
EIRENE European Integrated Railway radio Enhanced Network
eMLPP Enhanced Multi-Level Precedence and Preemption
EUAR European Union Agency for Railways
ERTMS European Rail Traffic Management System
ETCS European Train Control System
ETSI European Telecommunications Standards Institute
GPRS General Packet Radio Service
GSM Global System for Mobile communications
GSM-R GSM for Railways
IN Intelligent Networks
LTE Long Term Evolution Coms standard
MORANE Mobile Railway radio Network for Europe
OPEX Operational Expenditure
ROC IG Railway Operational Communication Industry Group
SMS Short Message Service
UIC International Railway Union
VBS Voice Broadcast Service
VGCS Voice Group Call
COTS Commercial Off The Shelf
ATCA® Advanced Telecommunications Computing Architecture (or AdvancedTCA®)
PBX Private Branch Exchange
RBC Radio Block center

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