

Reliable rugged communications solution for Spanish railway

RUGGEDCOM switches and routers interconnect traction substations along new AVE high-speed train line between Barcelona and France

Objective

Provide a highly available, multi-layer communication network that ensures reliable IEC 61850 communications between protection, automation and control systems that are distributed at multiple traction power substations along the new high-speed train line.

Solution

A wide area network (WAN) consisting of a layer 3 fiber optic backbone ring based on the RUGGEDCOM RX1000 router. The solution spans across all substations and has multiple interconnected layer 2 networks based on the RUGGEDCOM RS900 switch, providing local connectivity to protection and control equipment.

Adif, the Administrator of Spanish Railway Infrastructures, is a state owned company reporting to the Ministry of Public Works and Transport (Ministerio de Fomento) of Spain. Adif plays a leading role in promoting the Spanish railway sector and decided on Siemens and SICA S.A. (Sistemas de Computacion y Automatica General) for the high-speed rail project on the Barcelona-French Border. Siemens delivered protection and control technology for traction substations as

well as provided support and close collaboration in all stages of the project including design and engineering of the communications architecture. Whereas SICA was assigned the role of system integrator for the project. SICA designs and manufactures automation and communications products for electrical power and railway sectors. Apart from their own products and software, SICA also provides services including design, engineering, integration, implementation, installation and maintenance of automation and control systems manufactured by third party companies – for example, the RUGGEDCOM family of utility-grade communication solutions.

Customer Requirements

The AVE High-Speed Train project, which connects Spain and France, required electrification of 150 km of railway between Barcelona and the Spanish city of Figueras located near the French border. The Barcelona-Figueras section was the last remaining component of the high-speed line that has a total length of 804 km and was designed for speeds of up to 350 km/h in nearly 86% of the route.

The traction power network that supplies electricity to the 150 km high-speed Barcelona-Figueras line consists of three 400/2x25 kV substations and fourteen 2x25 kV auto-transformer sites.



400kV/2x25kV traction substation

The customer wanted to implement a distributed control system for the protection and automation part of the electrical substations. This distributed architecture should be robust, flexible and based on international standards. It was decided that IEC 61850 communications architecture would be used thus facilitating interoperability between intelligent devices from different vendors. IEC 61850 was implemented on top of the Ethernet communications network allowing multiple applications to share a secure broadband communications infrastructure.

The requirements of the communications equipment for traction substations had to comply with industry standards. These requirements are specified in the IEC 61850-3 document, which describes the environmental conditions that the equipment is expected to operate under. The ratings the equipment is expected to meet or exceed in terms of temperature, humidity, EMI radiation and immunity are specified. Furthermore, factors that would increase the network's reliability in terms of MTBF and MTTR were considered essential. As such, equipment with dual power supplies, self-monitoring capabilities and extended warranties were given preference.

The customer wanted all inter-switch links to be fiber optic, both in the substation LAN as well as in the WAN backbone network interconnecting substations. The backbone devices are to be equipped with fiber interfaces suitable for long distance links, interconnecting substations that are dozens of kilometers away. It was also specified that the architecture would be redundant and resilient, ensuring that a single point of failure would not disrupt the network and that continuous energy supply to the high-speed train will be guaranteed.

Application and implementation

The distributed protection and control systems implemented at all traction substations of the Barcelona-Figueras high-speed line was based on SIPROTEC and SIMATIC technologies from Siemens. SIPROTEC relays and SIMATIC PLCs had been

integrated via IEC 61850 communications standard into SIMATIC WinCC SCADA system. SICA S.A. engineered the whole system and performed integration and commissioning according to detailed Adif procedures.

The RUGGEDCOM RS900, RS900G and RX1000 switches and routers have been selected to fulfil Adif requirements for utility-grade communications compliant to IEC 61850-3. Each traction substation and auto-transformer site has a number of IEDs that needed to be interconnected into the Local Area Network (LAN). And all substations and transformers distributed along the train line had to be interconnected together. The overall solution was a two layer network consisting of multiple LANs built with a total number of 142 units of the RS900 compact switch and a WAN network composed of 26 RUGGEDCOM RS900G switches and 26 RUGGEDCOM RX1000 routers. Substation local area networks have been implemented with multimode fast Ethernet fiber links and ring topology was selected in order to ensure redundancy and resiliency to failures. Wide area network between substations was also based on ring topology, however Gigabit single mode fiber was chosen as a physical media, thus enabling long distance and high data capacity backbone links.

Redundancy was achieved in the substation local area networks with the use of RSTP protocol between RUGGEDCOM switches and in the wide area networks including the VRRP protocol configured in two redundant RUGGEDCOM RX1000 routers installed at each substation or auto-transformer site.

The use of routers permitted proper segmentation of the network and traffic management. In each substation only the designated devices and applications have been granted access to the backbone network. This way most of the network traffic is contained within each substation and does not affect local area networks in other stations. Apart from traffic and bandwidth management, routers increase security by being central access points to each site. The backbone network has been built on top of a communications architecture that provisioned dedicated fiber channels between each RUGGEDCOM WAN device, which made the network fully independent and facilitated a reliable and deterministic communications.



Local control panel at traction substation



RUGGEDCOM RS900G



RUGGEDCOM RX1000

Product features and benefits

RUGGEDCOM RS900G key features:

- Enhanced Rapid Spanning Tree Protocol (eRSTP) for ultra fast network fault recovery (<5ms)
- Robust design with -40°C to +85°C operating temperature range
- VLANs for segregation of a physical network into separate logical networks
- Gigabit ports allowing long distance fiber links of up to 70 km

RUGGEDCOM RX1000 key features:

- Integrated router/firewall/VPN/IPSec/NAT
- Layer 3 protocols allowing network segmentation into multiple IP domains
- Multiple WAN interfaces and IEC 61850 GOOSE tunnelling support
- Rugged Rated for reliability in harsh environments

Benefits:

- Enhanced monitoring and diagnostic capabilities reducing the time and cost of maintenance
- Multi-layer communications architecture with optimized traffic and bandwidth management
- High level of security and application isolation due to Layer 3 capabilities
- Scalable and flexible network design based on utility-grade communication devices

Security information

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions only form one element of such a concept. For more information about industrial security, please visit www.siemens.com/industrialsecurity

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