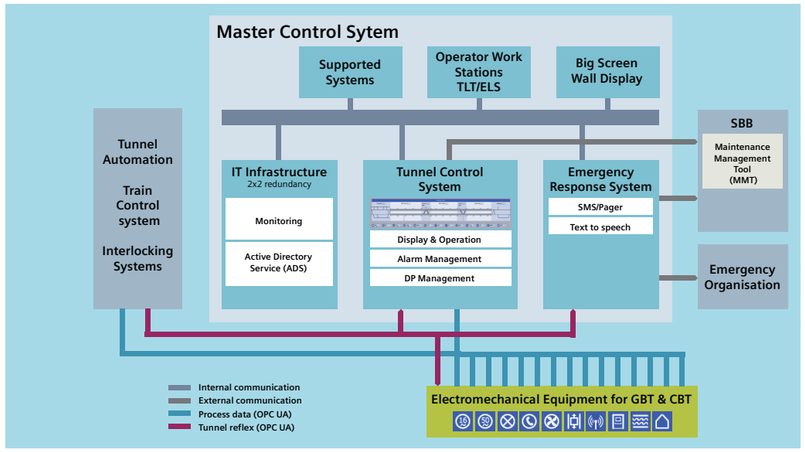
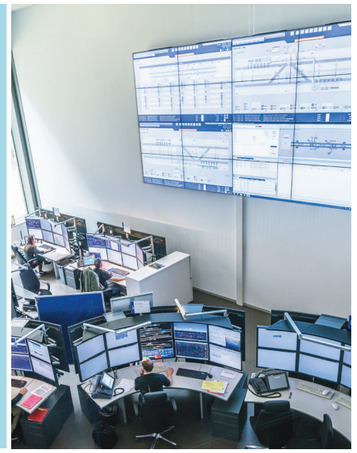


System overview of the Gotthard and Ceneri Base Tunnel Master Control System



Command Center in Pollegio with big screen wall display

Fully integrated systems in the Gotthard Base Tunnel

All the systems necessary for incidents (Emergency Response System), train operation (Train Control System) and maintenance (Maintenance Management Tool) are integrated into the Tunnel Control System, based on Siemens SCADA system WinCC OA, allowing the systems to exchange relevant notifications and information with each other directly.

Tunnel Control System highlights

- Redundant Tunnel Control System
- End-to-end IT infrastructure including operator stations
- Big screen wall display
- Emergency Response System
- Maintenance Management Tool
- Standardised user interface covering all systems
- Around 70 000 input/output messages and commands in the final configuration
- Easily expandable with, for instance, the Ceneri Base Tunnel as a southern extension of the NRLA (New Railway Link through the Alps)

Integrated systems

- Power supply
- Catenary system
- Ventilation and air conditioning
- Lighting
- Drainage
- Lifts
- Data network
- Tunnel radio
- Communication equipment
- Door and gate operation
- Building control system

Client

On 4 May 2007 Alp Transit Gotthard AG, the building controller for the NRLA, appointed the TransTec Gotthard consortium as general contractor for the installation of rail technology in the Gotthard Base Tunnel. TransTec Gotthard comprises the following companies:

- Alpiq InTec AG
- Alcatel-Lucent Schweiz AG/Thales RSS
- Renaissance Construction GmbH
- Balfour Beatty Rail GmbH

In 2008 Alcatel-Lucent Schweiz AG awarded Siemens Switzerland Ltd the contract to install and implement the Tunnel Control System.

Outlook

The Ceneri Base Tunnel is an extension of the new NRLA to the south of the Gotthard Base Tunnel. The client also commissioned us to install the Ceneri Base Tunnel's Control System, which will be integrated into the Gotthard Base Tunnel's Control System. The Ceneri Base Tunnel is scheduled to enter into commercial operation in 2019–2020.

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Order-No.: MOMM B10134-00-76CH | HTS 9067/316

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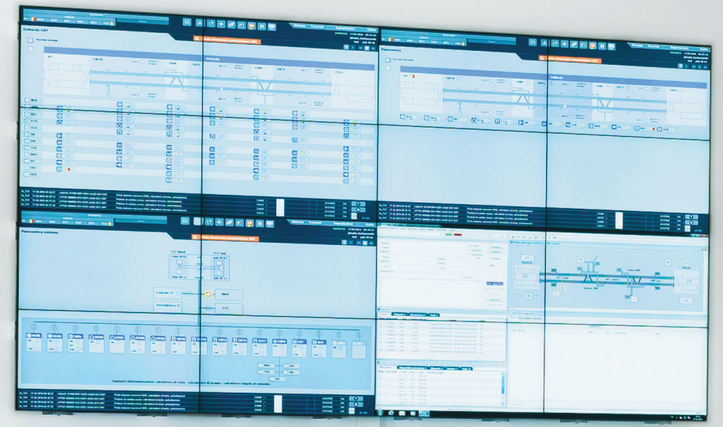


Master Control System

Fully integrated Tunnel Control System for the new Gotthard Base Tunnel

siemens.ch/mobility

The world's longest railway tunnel

Operator station

Tunnel tubes

The 57-km Gotthard Base Tunnel was built between Erstfeld and Bodio (CH), and will enter into commercial operation in December 2016. The centrepiece for monitoring the complete tunnel railway infrastructure is the Siemens AG Tunnel Control System.

To ensure problem-free operation of the Gotthard Base Tunnel, 100% availability of the master system is required at all times. To achieve this, the Gotthard Base Tunnel's south and north portals are each equipped with a Tunnel Control Center (TCC) where the two Tunnel Control Systems monitor and control all the integrated systems and facilities. All the data necessary for this purpose is collected, consolidated and visualised on the Tunnel Control System based on Siemens SCADA system WinCC OA. A fully integrated Maintenance Management Tool and Emergency Response system also form part of the Tunnel Control System with its big screen wall display.

To meet high availability requirements, the IT infrastructure is physically separated into the TCC south and TCC north. The fully redundant systems are housed in different technical rooms at the two Tunnel Control Centers. In doing so, we achieve 2x2 redundancy and guarantee a high level of safety against failures: if, for instance, one of the TCC computers fails at the south end, its tasks will be taken over by the second computer there. If both computers fail, the Tunnel Control Center at the north end will automatically maintain emergency operation. Besides the Tunnel Control System, additional systems such as the data and server networks and power supply, etc., are configured in redundancy.

Extensive monitoring

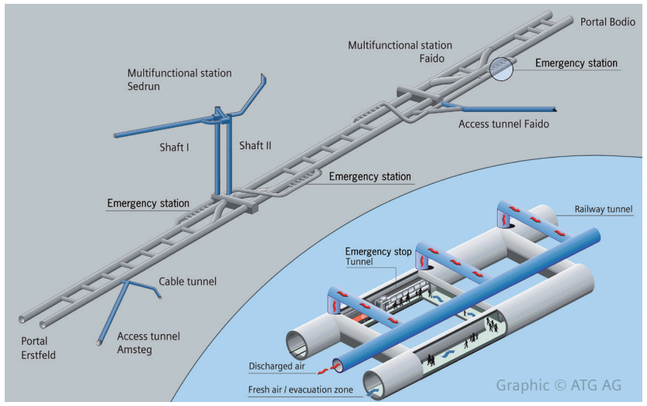
All the tunnel's electromechanical equipment, such as the ventilation, lighting, gate and drainage systems are monitored continuously. Besides the current system status, the Tunnel Control System's user interface immediately displays any malfunctions on the operators' screens. The universal message navigation system directs the operator straight to the source of the problem. This is important as the system monitors and visualises over 70 000 data points. The Tunnel Control System's user interface also displays all messages that are relevant to operations, such as:

- Status of radio coverage
- Situation of emergency calls
- Flow & air temperature readings
- Status of lighting systems

The clear and easy-to-read display of subsystem information ensures tunnel operators always have a complete overview of the tunnel's systems. The statuses of the electromechanical equipment, the location of trains in the tunnel as well as any irregularities or malfunctions are displayed. The images can be accessed on operator station monitors as well as shown on the big screen wall display.

Emergency scenarios

Emergency scenarios are very important for the Gotthard Base Tunnel. Their starting point is the monitoring of rail traffic by the Train Control System. The Train Control System detects any malfunctions and communicates the corresponding data as a «tunnel reflex» to all relevant systems, which then commence automatically running through



Schematic diagram

Gotthard Base Tunnel

all possible scenarios for managing the situation. For example: emergency ventilation systems in the tunnel are activated, lights are switched on at the emergency stop closest to the affected train and the emergency doors at that stop are opened. If necessary, further actions may be taken, for instance draining the storm water reservoir at the north or south end so that it will be available to hold contaminated run-off from firefighting operations. Additionally, it might be necessary to switch over the ventilation of the tunnel's technical rooms to prevent smoke from damaging the equipment. The Tunnel Control System monitors the emergency procedures and ensures they are carried out correctly in such emergency scenarios. For this purpose, it also initiates timekeeping checks and monitors the individual steps. If these are not performed automatically and correctly, the system informs the operator.

The Emergency Response System, which is part of the Tunnel Control System, also launches all other measures necessary for managing the emergency. Specific information and decision-making steps are stored in the system and can be utilised in line with the situation. They help the emergency operations manager decide who needs to be alerted in an emergency, such as the police, fire and/or ambulance services. The system also allows easy monitoring of the intervention areas.

Maintenance

An extensive maintenance plan is necessary for a railway tunnel the size of the Gotthard Base Tunnel. As an additional component of the Tunnel Control System, the SAP-based maintenance management tool allows centralised planning of maintenance work. It keeps a record of all installed system components to an appropriate level of detail necessary for maintenance activities. The system knows which company supplied a component, where spare parts are stored, which tools are required to exchange spare parts and where the corresponding maintenance manual can be found. Any malfunctions to the Tunnel Control System's electromechanical equipment are reported automatically by the system to the Maintenance Management Tool, thereby serving as the basis for maintenance planning. The scope of supply also includes a mobile solution for operation and maintenance of the system with access to images and systems as well as a training and simulation system. A copy of the productive system is installed on a neutral platform at SBB and is equipped with a teacher and student operator station. This training system allows tunnel operators to be trained and higher-level operating processes to be additionally tested and trained on.

Extensive tests

During the project lifecycle comprehensive tests were performed to ensure functionality of the complex tunnel control system. These tests comprised of the Master Tunnel Control System, Emergency Response System, Maintenance Management Tool and the IT infrastructure. The first pilot 1:1 test was performed over a six month test period between December 2013 and June 2014 in the tunnel section between Faido und Bodio west. The findings we gained allowed us to further optimise the system prior to fully expanding it.

Test operation commenced in October 2015, and the project teams really put the system through its paces. This included train journeys at the maximum speed limit of 250 km/h. On 31 May 2016 we handed over our system to SBB AG through our client (ATG). SBB AG put the system into trial operation and is testing it under commercial conditions. Besides the operation of commercial freight and passenger trains, emergency scenarios, event mode, malfunctions and maintenance procedures, etc. will be extensively run through and tested. The system is due to enter into commercial operation on 11 December 2016.