

Trends in Rail Electrification

International Conference on Decarbonization of Indian Railway –
Mission Electrification

René Wimmer

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Megatrends Require
Mobility Solutions

Rail Electrification Systems
Overview

Rail Electrification
Requirements

Rail Electrification
in the Smart Grid Age

Trends in Monitoring &
Maintenance

References



Two new city dwellers per second! The dawn of the “urban millennium” has started!

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Urban Millennium

Population

In 2007 ~50% of the world's population was living in cities, an increase from 3.5B to 4.7B until 2030

Regional powerhouses

50% of world GDP is produced in cities with a population over 750K

Major energy and climate factor

75% of energy consumed in cities; 80% of CO₂ emissions are produced in cities

The transportation of people and goods has top priority for cities as ...

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... #1 on mayors' political agendas¹⁾

“We are investing billions in improving the transport network and easing the burden for millions of commuters. And the whole purpose of that investment is making public transport better and easier for people to use.”

Boris Johnson, Mayor of London

Heathrow Central
Terminals 1, 2 & 3

¹ Source: Megacity Challenges Study by GlobeScan and MRC McLean Hazel

The transportation of people and goods has top priority for cities as ...

SIEMENS

... most important driver for “Quality of Life”

“Congestion has several effects on travelers, businesses, agencies and cities. One significant element is the value of the additional time and wasted fuel. 1.9 billion gallons of fuel were wasted in the 439 U.S. urban areas. This amount of fuel would fill 38 super-tankers or 210,000 gasoline tank trucks.”

Texas Transportation Institute



The transportation of people and goods has top priority for cities as ...

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... key success factor for global competitiveness

“Today, 64% of all travel kilometers made are urban... Being able to get around urban areas quickly, conveniently and with little environmental impact is critical to cities’ success”

Arthur D. Little, Management Consultancy



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**Rail Electrification Systems
Overview**

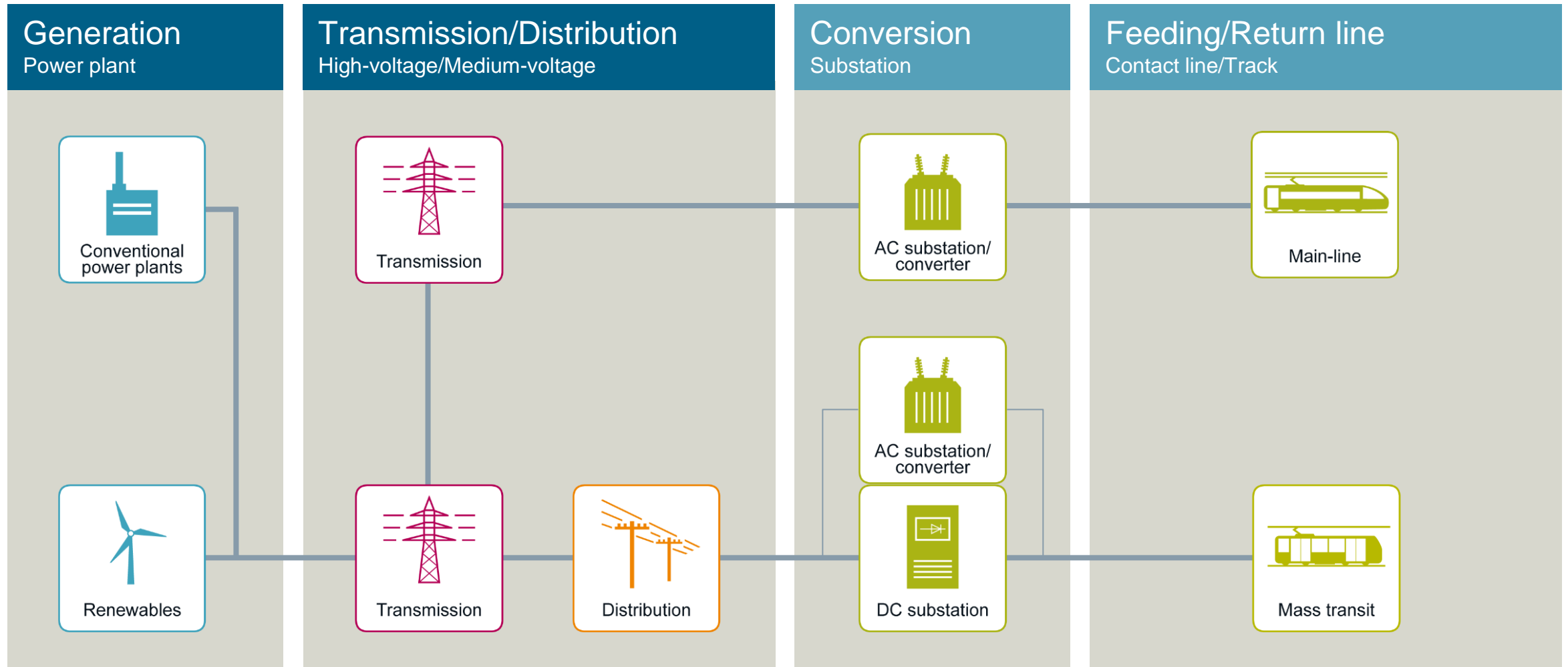
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Energy flow Rail Electrification



Market segments

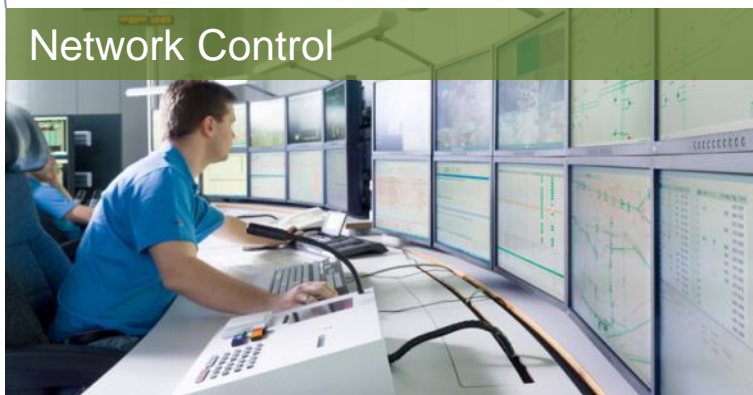
Contact Line for Main-line Railways



Contact Line for Mass Transit



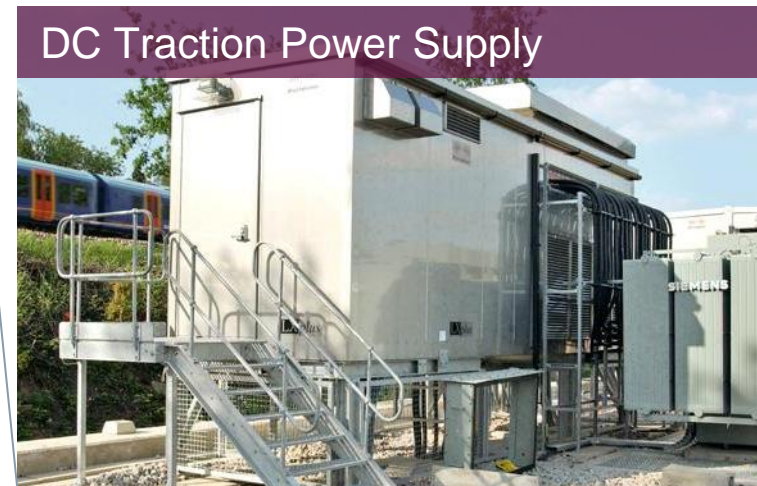
Network Control



AC Traction Power Supply



DC Traction Power Supply



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Safety of Personnel
and Installations



Maximum
Availability



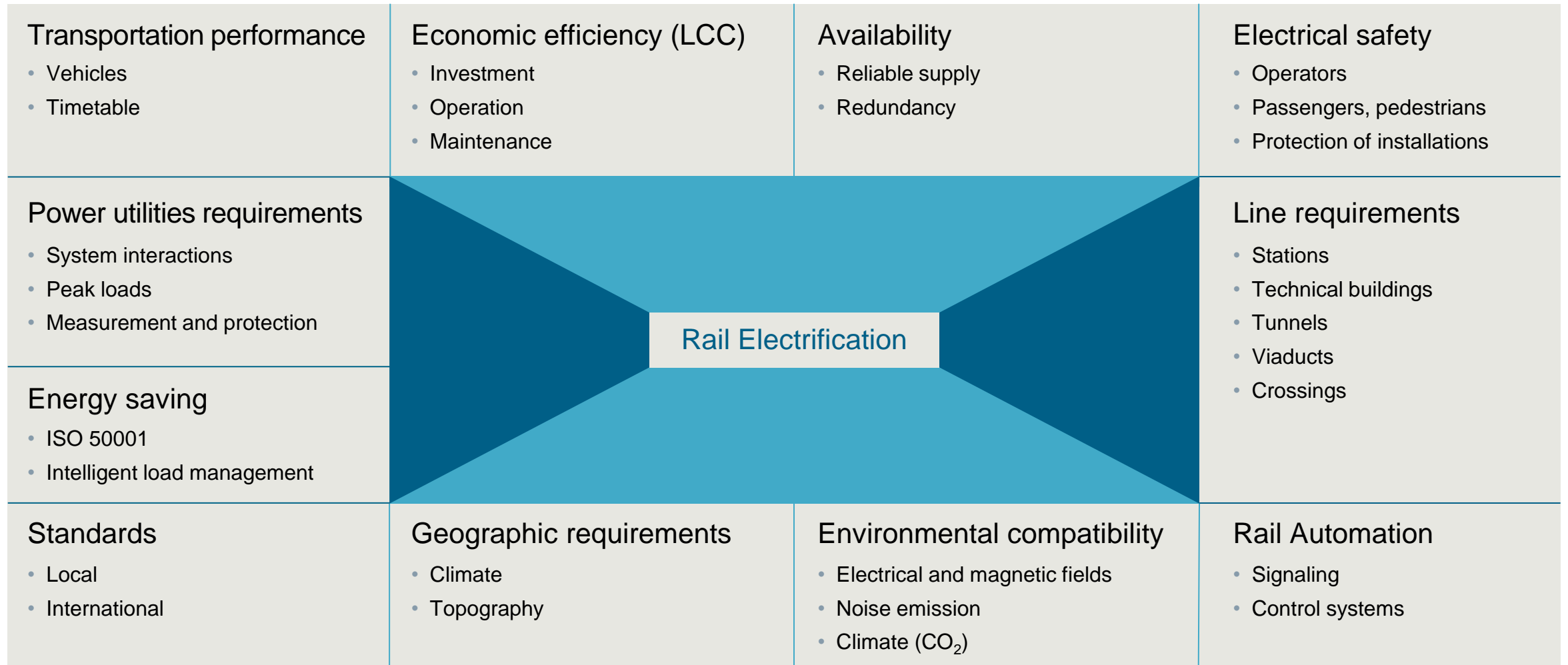
Minimum Life
Cycle Costs



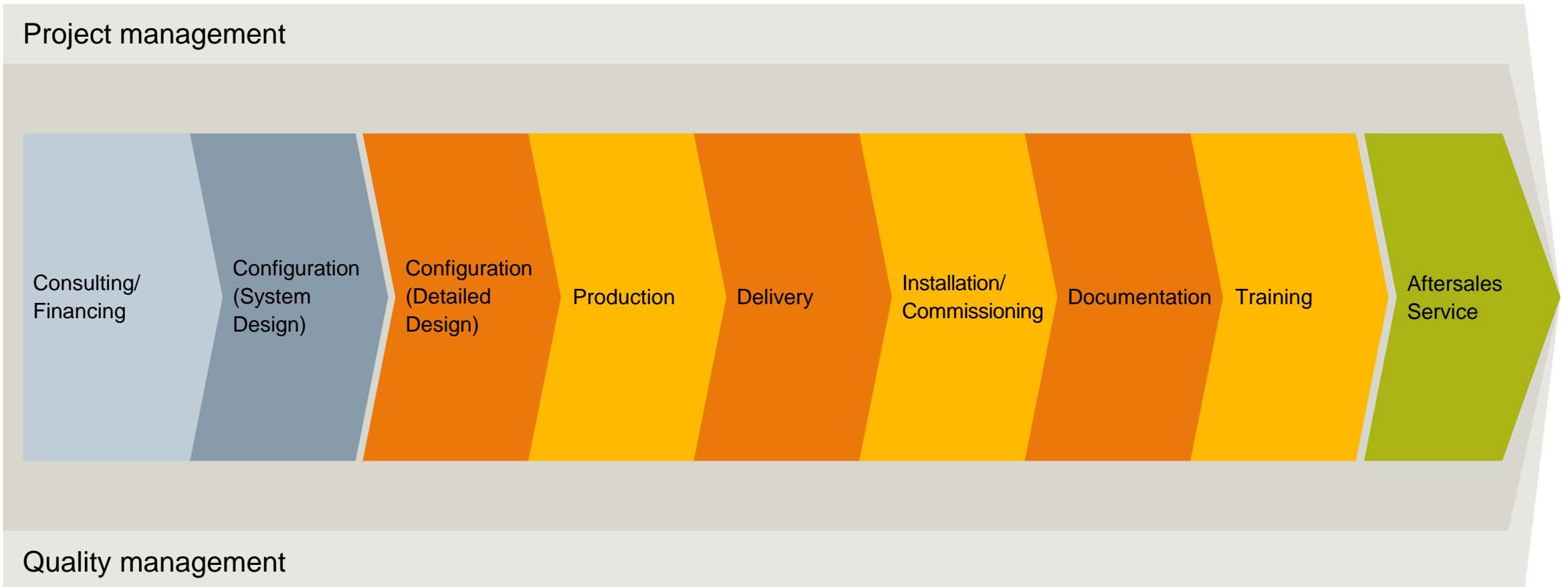
Ideal Rail
Electrification
System

Stakeholder requirements

Rail Electrification



The complete range of services from a single source



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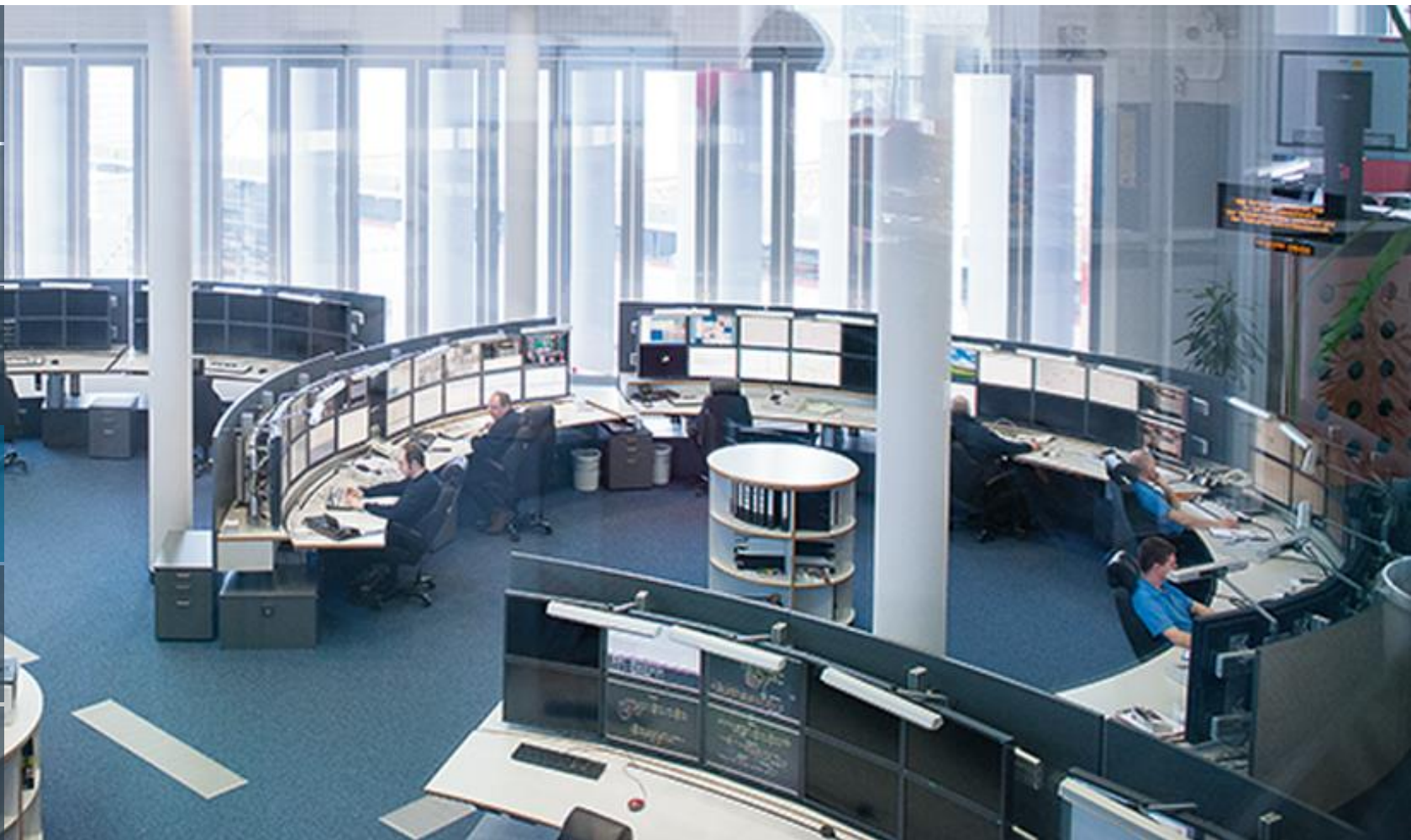
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What is Smart Grid?



Rail Electrification in the Smart Grid Age – Traction power systems as part of changing energy systems

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Challenges in energy system

Renewable energy and distributed generation

Limited grid and generation capacity

Aging and insufficient infrastructures

Cost and emissions of supply

Smart Grid solutions

Balance of generation and demand, new business models

Load management and power quality

Reliability through monitoring, automatic power failure avoidance and troubleshooting

More efficiency in generation, transmission, distribution and consumption

Two power grids converge

Integration of grids

- Integration of regenerative energy sources
- Recovery: bi-directional transfer of active power
- Power quality for both grids together

- Generation and demand at the same time
- Load management
- Smart controls

Public grid

Traction power grid

- Recovery within traction power grid
- Monitoring
- Network control
- Energy Management

Information exchange

- Smart monitoring solutions for both grids

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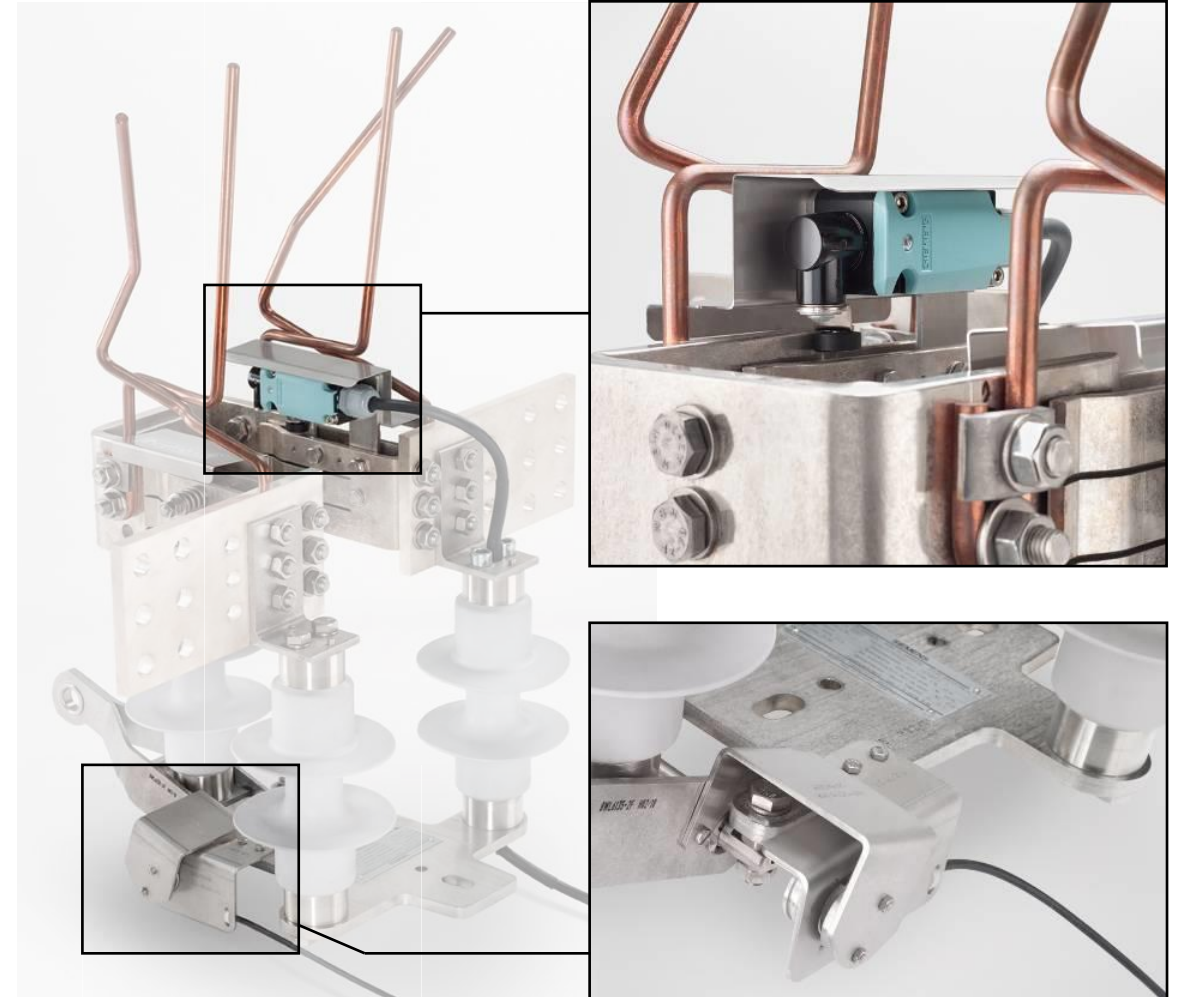
How to increase safety for Disconnectors?

Disconnector monitoring system Sicat DMS

SIEMENS

The Sicat DMS Disconnector monitoring system serves for safe detection and indication of the switch position.

- Contactless measuring method
- No influence on disconnector
- Reliable position indication directly on disconnector
 - By default on earth potential
 - Optional on contact line potential
- For all Siemens OCL disconnector types available
- Integration into control of drive mechanism or external evaluation unit
- Safety approved version available (SIL 1)



How to reduce maintenance for Disconnectors?

Low Maintenance Disconnector up to 25 kV AC (Sicat 8WL6144)

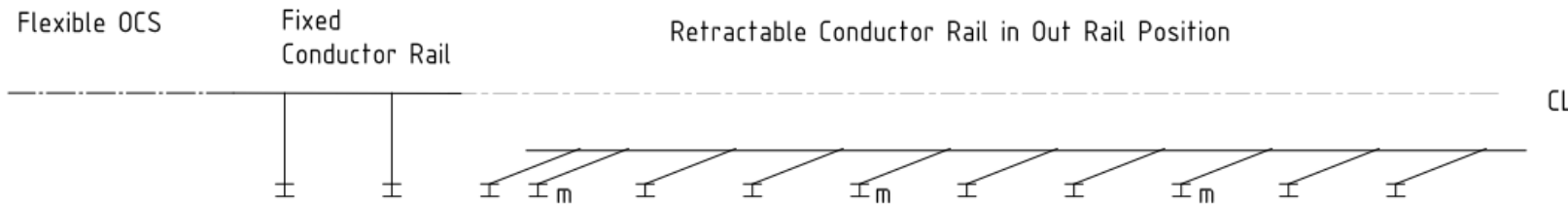
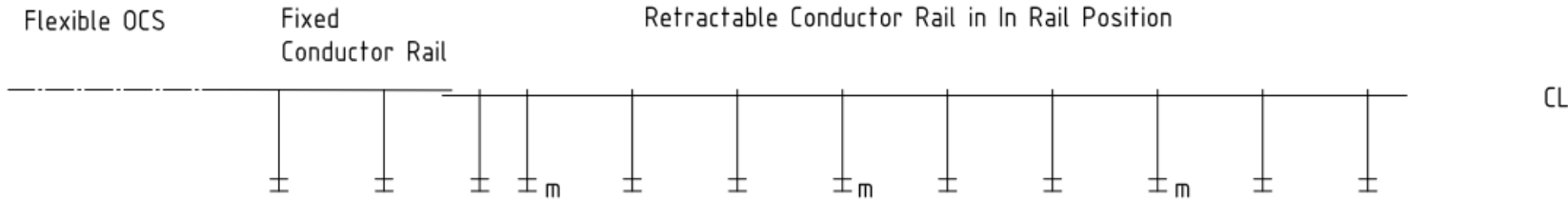
- Low-maintenance due to self-lubricating characteristic of silver graphite plated contact set
- Minimum wear at arc extinguishing due to tungsten tips at the arcing horns (load breaker function up to ten switchings)
- Long service life and low-maintenance due to corrosion resistant materials and hydrophobic surface of composite insulators
- Easy installation and resistant against vandalism due to shatter-proof composite insulators
- Higher current load-capacity and environmental resistance for certain variants due to silver-coated contacts



- Thanks to their modular design, suitable as disconnectors with and without earth contact in single-phase AC systems and autotransformer systems

How to improve my Depot?

Moveable overhead conductor rail



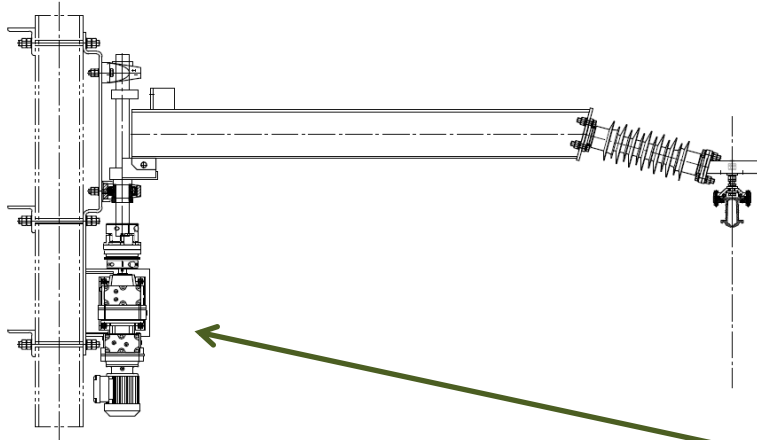
- Every 12 meter one support
- Motorized brackets
- Horizontal rotation of 84°
- Free area from centerline from 1,80 to 2,80 meters

In In-Rail position – the train can be supplied with electric power via overhead contact rigid and train’s pantographs.

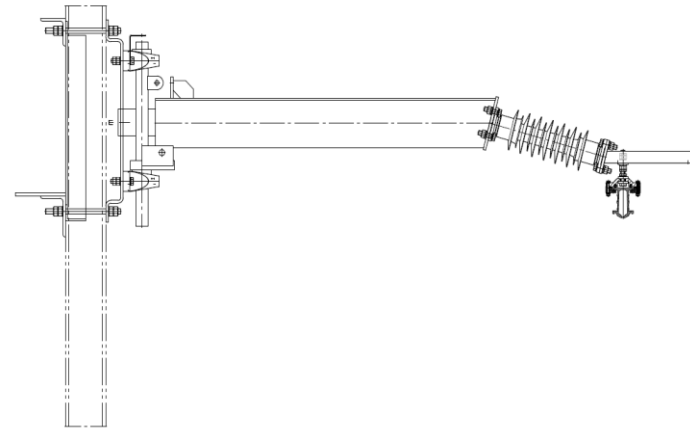
In Out-Rail position – maintenance work can be done with full access to the train and without the risk of electric shock by touching the contact rail.



Moveable overhead conductor rail Support Design



Motorized Support



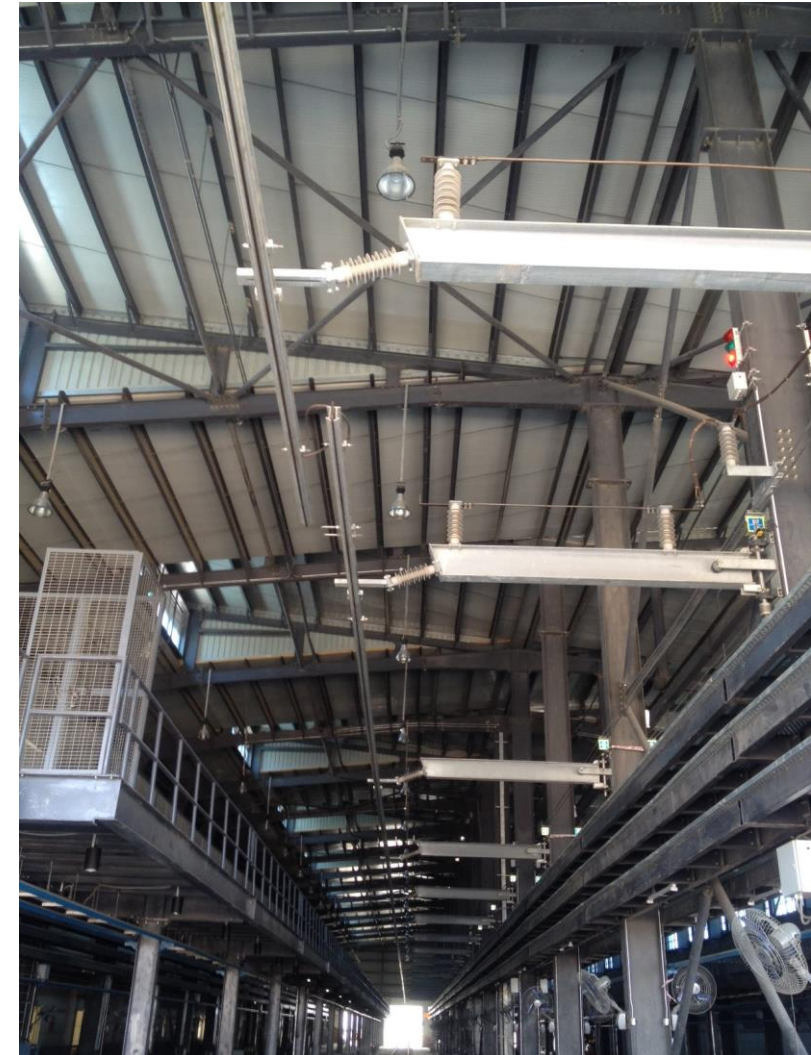
Non - Motorized Support

Moveable overhead conductor rail

Customer Requirements

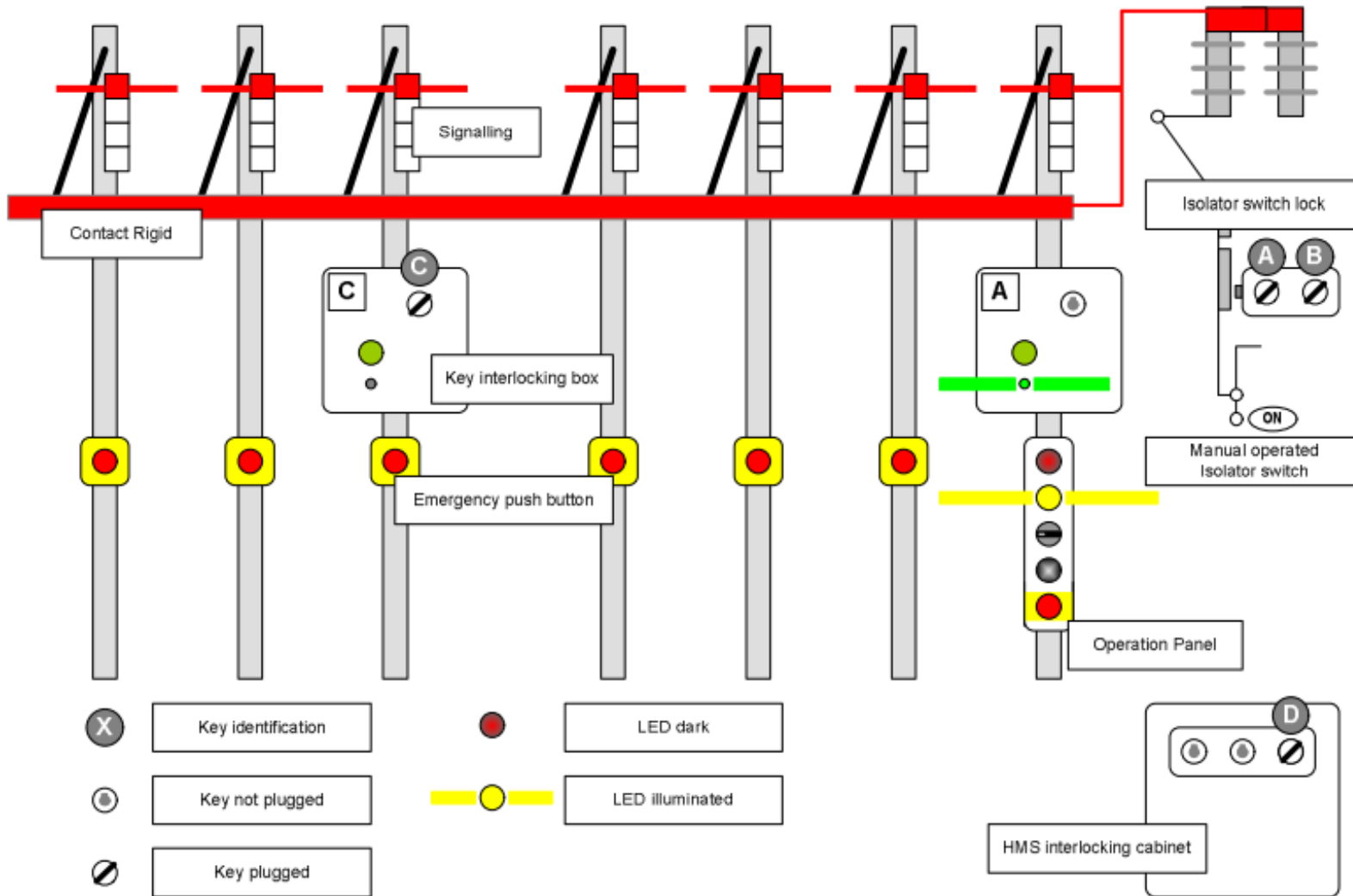
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- **Safety concept based on the five security rules including earthing**
- **Key Concept to protect for operation errors and secure a safe working environment**
- **Visual and acoustic status indication**
- **Interlocking with other systems like crane and doors access**
- **High availability of the products and the complete system**
- **Monitoring of the system**



Moveable overhead conductor rail

SICAT SRD meet all requirements of the customer



- **Disconnecter with Earthing function**
- **Interlocking concept**
- **Emergency Button on all motorized supports including monitoring**
- **Signal Beacons**
- **Control Panel for operation**
- **Status Monitoring and product failure diagnostic**
- **Products and Solution from one supplier**

How to increase the availability and reduce maintenance for the overhead conduct line?



Damages in the Overhead contact line is one of the main problems for Train operator



videoplayback.mp4

Sicat PMS

Pantograph monitoring system for OCS

SIEMENS

- Reliable measured value acquisition by laser sensor even in adverse weather conditions
- Measurement redundancy thanks to optional optomechanical angular position sensor
- Simple and reliable train identification by means of RFID technology
- Sicat PMS detects defective or improperly adjusted pantographs
- Forwards this information to a control centre
- Concerned trains can be stopped or rerouted in time



Increase system and operational safety!

Sicat® PMS – Pantograph Monitoring System

Main components – Measured value acquisition

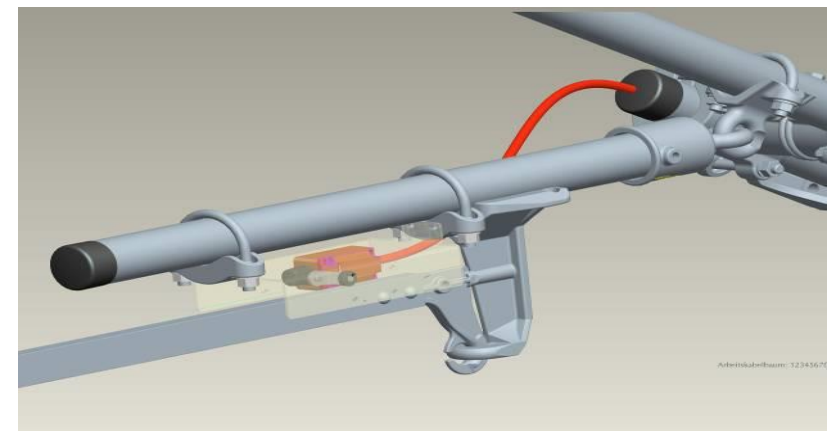
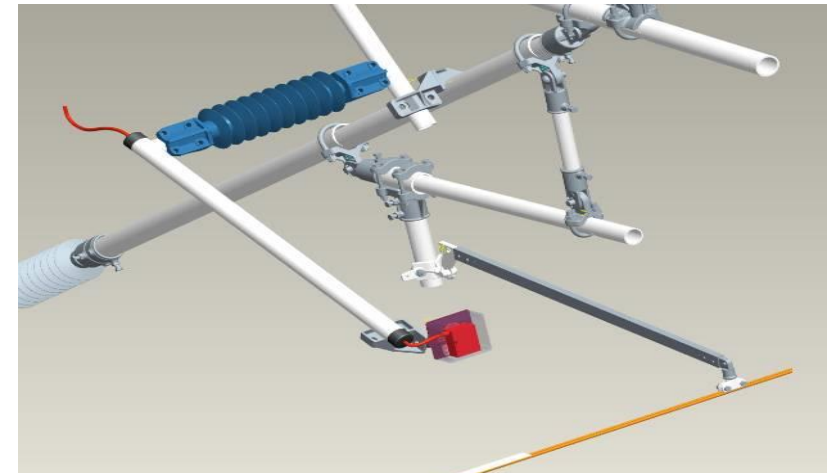
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Uplift measured by laser sensor

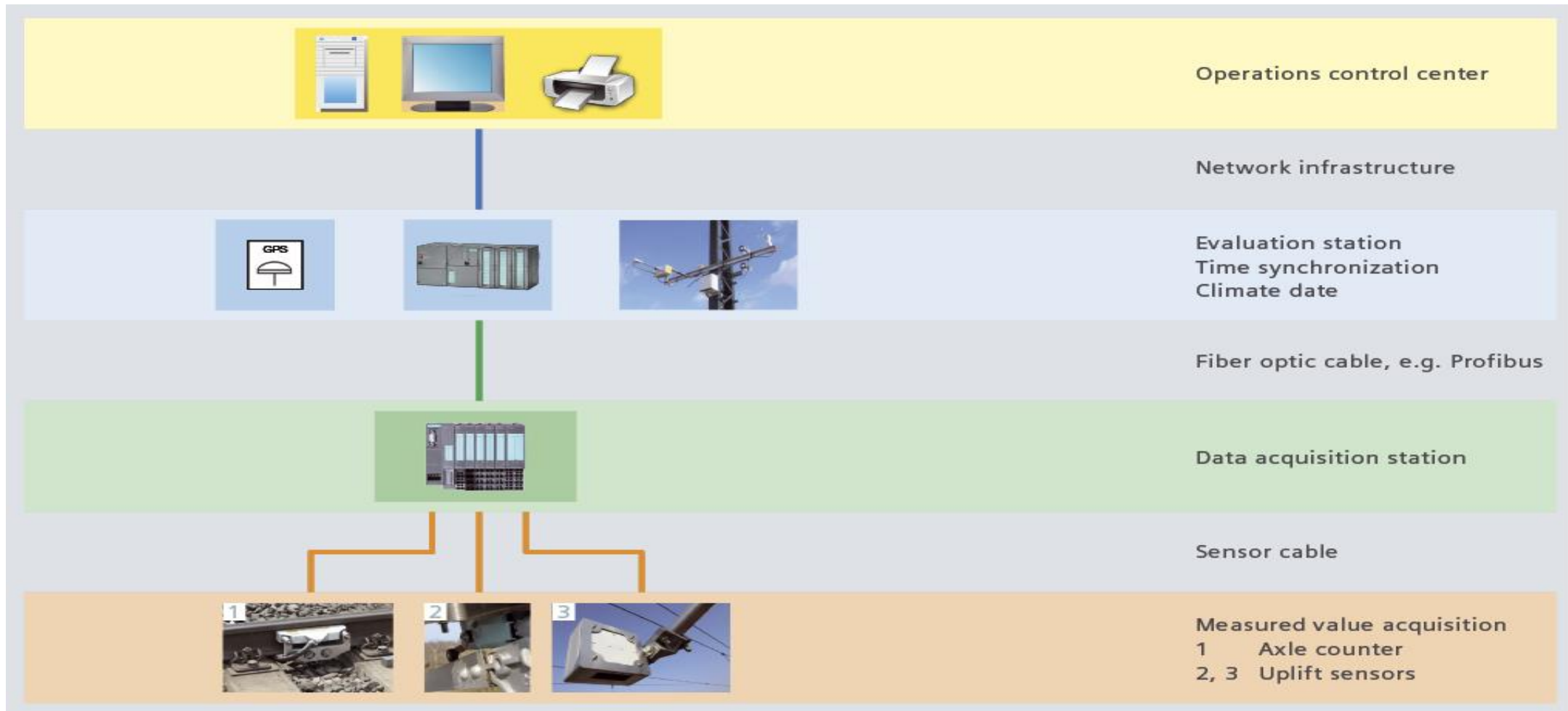
- Directly above the contact wire
- Metal plate, mounted on the contact wire, reflects the laser signal
- The power supply cable to the sensor will be encased by high voltage insulation

Uplift measurement by potential free optomechanical angular position sensor (optional)

- Mounted on



Sicat® PMS – Pantograph Monitoring System Design - System topology



Sicat CMS can be installed in all tension wheel equipment of Siemens with weight sets and can be retrofitted in existing installations as well.

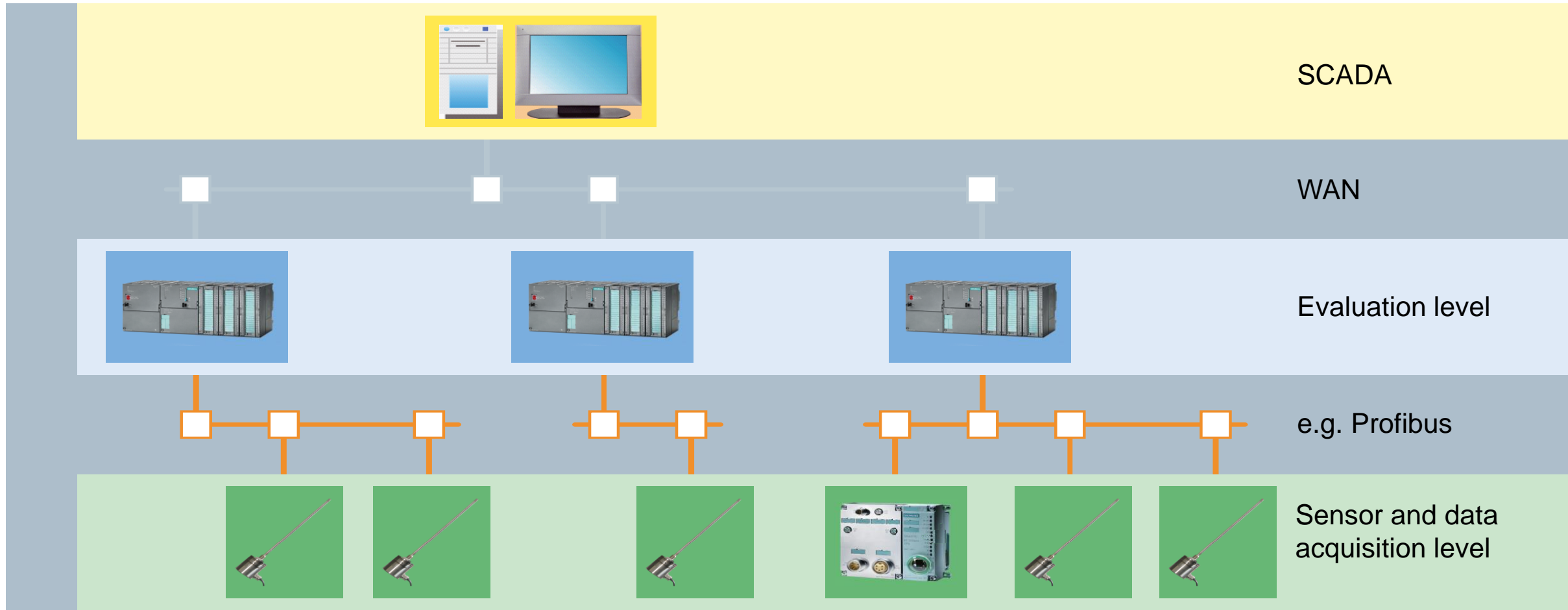
Functions

- Status monitoring of the overhead contact line
- Status monitoring of the tension wheel equipment
- Detection of tensile forces in the catenary system
- Detection of wire ruptures
- Detection of significant changes in the tensile force attributable to external influence



Sicat[®] CMS – Catenary Monitoring System

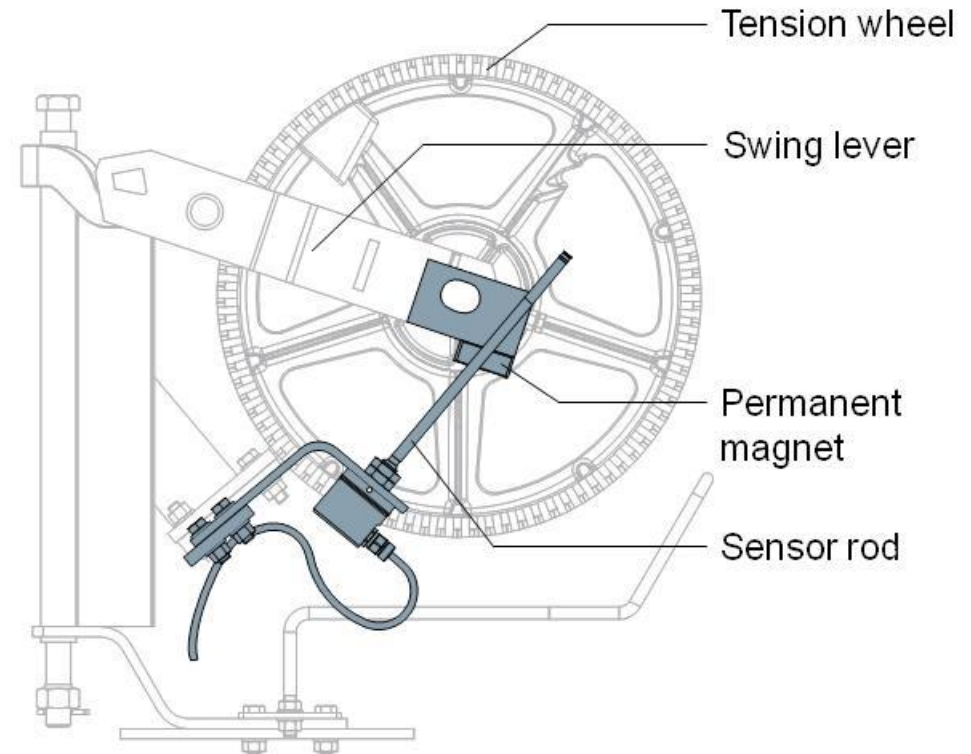
System topology



Example of the topology of a Sicat CMS: hierarchical cross-linking

Main components

- Sensors
- Data acquisition stations and evaluation stations (integrated if necessary)
- Fiber optic cable network
- Central or distributed power supply



Sicat CMS continuously monitors the tensile forces in the contact wire and catenary wire and passes the sensor information on to the control center.



- Increase of availability of electrified lines
- **Reduce of malfunction period due to quick detection, analysis and localization of faults**
- Prevention or limitation of subsequent damages
- Reduce of delays in operation
- Increase of security of systems and operation
- Reliable fault detection with geographical reference
- **Support of status-oriented maintenance due to early detection of faults and divergation of thresholds**

Improvement of availability and reduction of lifecycle costs with Aluminum Cantilever

SIEMENS

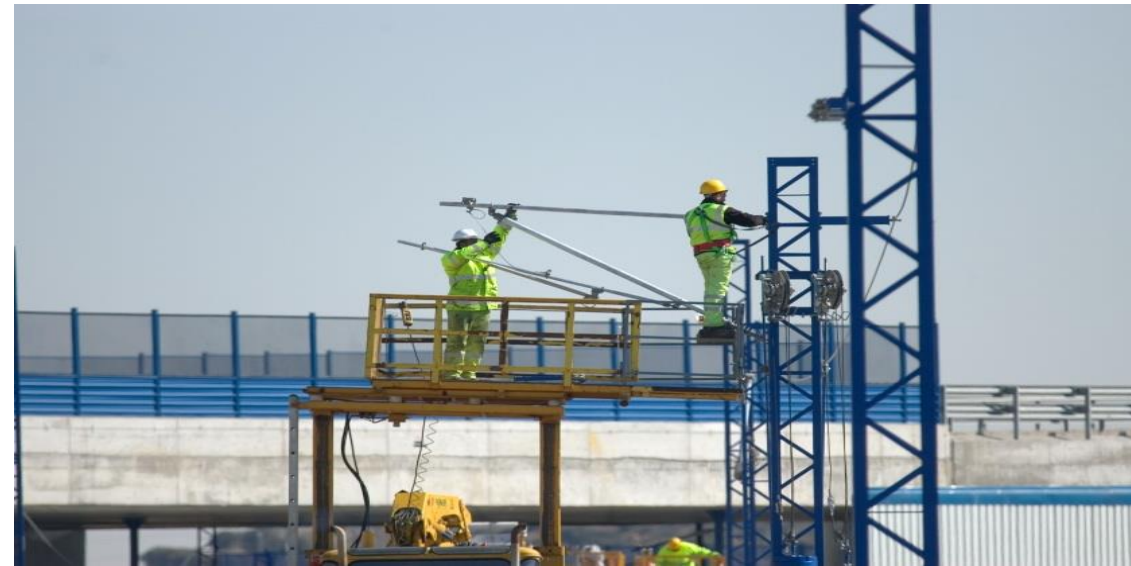
- ❑ **Made of lightweight aluminum tubes compared to existing GI Cantilevers** – easy to install - Aluminum-tubes are easy to produce and easy to adjust (cut through)
- ❑ Great **mechanical strength** as well as an elegant metal design with a **long service life, high reliability leading to low maintenance cost, resistance to corrosion**, fit for > 200 kmph for Indian Railways (high speed applications).
- ❑ **Preassembly or delivery** of complete cantilever assemblies is possible (no cutting tasks on site), pre calculated fixing points of cantilever components reduces adjustment works on site, only one type of tool is needed from complete installation, lesser installation time i.e. 35 mins only no need of crane, only 2 workers on platform needed at time, indirect cost savings, **it will help in achieving IR vision of fast track Railway Electrification > 3,000 RKM.**
- ❑ Better Environment sustainability (less amount of material used) and operational safety (better short circuit withstand capability of Aluminum)



Installation of preassembled cantilever (Reduction in man hours)



Prepare installation



Installation without crane, only 2 workers *on platform* needed



Fixation

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Rail Electrification – Milestones

Siemens: Innovator, Provider and Partner No. 1

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Rail Electrification across all continents



Metro Lima, Peru

Challenge

- Seamless integration of new lines 2 and 4 into the existing metro system under consideration of customers CO₂ saving targets
- Minimal costs for civil works by optimal system engineering and use of space-saving equipment
- Strict EHS-requirements and high expectations on network power quality
- Highly available network control for traction power and infrastructure facilities

Solution

- Selection of space-saving GIS-types, which suit the requirements on low noise and electro-magnetic emissions for installation in residential areas
- 24-pulse rectifiers to fulfill requirements on low harmonics to the network
- Comprehensive Sitras RSC network control including backup operation control center and SIL 2 certification

Customer benefit

- Robust electrification systems with lowest life cycle costs
- Adherence to requirements from public grid system
- Savings on operational- and training costs due to a uniform and modern Scada systems for traction power supply and rail infrastructure (BMS)



Bayovar Passenger Station, Lima, Peru

Metro Riyadh, Saudi Arabia

Challenge

- With six lines and a total route length of 175 kilometers, Riyadh is planning the world's largest subway project.
- Riyadh is growing rapidly: Since 1990, the population has doubled to more than five million inhabitants.

Solution

- Siemens is to supply the entire turnkey system for two driverless metro lines in the capital of Saudi Arabia.
- Siemens equips Lines 1 (Blue Line) and 2 (Red Line) of the six lines with Inspiro metro trains, the electrification and the signaling and communication systems for driverless operation.

Customer benefit

- One single point of contact
- Sustainable solutions for the city's local traffic problems
- Proven interfaces, performance and reliability in all implemented projects
- Fulfillment of highest safety standards for operating the system



Metro Riyadh, Saudi Arabia

Rail Electrification Program, Denmark

Challenge

- Doubling the number of electrified tracks in Denmark
- New TSI-approved system that is both innovative and proven in operation
- Off-the-shelf components

Solution

- Overhead catenary system Sicat SX
- Siemens standard 8WL components

Customer benefit

- Reliable system
- Low investment cost
- Reduced cost throughout the complete lifetime of the system



Destination – Smart Rail Electrification

Siemens provides innovative solutions, systems and products for traction power supply, contact lines and network control technology for the rail traffic of the future.

Siemens is the only provider in the industry offering a complete portfolio. From consulting to finance, from system design to implementation and aftersales service – Siemens implements projects around the world, always tailored to the individual requirements of the rail operator.

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