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Trends in Industrial Wireless Communication and Applications

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Abstract The importance of automation in the industries has increased dramatically in recent years. Industrial communication is one of the keys to increasing efficiency, reducing total cost of ownership, and improving productivity. The huge potential, especially of wireless communication, opens up new perspectives here – from partial modernization of plants, right up to optimizing complex logistics or production processes.

Keywords: *engineering, automotive, industrial automation, LAN, wireless communication*

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1. Introduction

Smart factories presently frequently represented by term "Industry 4.0" or the fourth industrial revolution, is a collective term embracing a number of contemporary automation, data exchange and manufacturing technologies. It had been defined as a collective term for technologies and concepts of value chain organization which draws together Cyber-Physical Systems, the Internet of Things and the Internet of Services. [1]

2. Smart Factories

Industry 4.0 facilitates the vision and execution of a "Smart Factory". Within the modular structured Smart Factories of Industry 4.0, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real time, and via the Internet of Services, both internal and cross-organizational services are offered and utilized by participants of the value chain. [2,3]

When it comes to industrial networking today, many factories and process control facilities around the world are focused on upgrading to manage Ethernet networks. With the long, useful life of industrial devices, there is plenty of old equipment using legacy industrial protocols in active service. Indeed, much of our business involves helping companies upgrade to structured, reliable and easy-to-maintain industrial Ethernet infrastructure.

High-performance, reliable communication technology will exceed what is currently in use. This technology will make it possible to:

- Transfer large amounts of data in real-time and with minimum delay
- Connect a large number of individual devices in a very reliable manner and with the highest standards of data security
- Utilize more and more wireless technologies, both within the plant and for remote connectivity
- Operate in an energy-efficient manner.

This paper discuss about available suitable wireless technologies for implementation above mentioned vision.

Siemens offers solutions for reliable automation with industrial wireless communication based on Wireless Remote Networks, Industrial Wireless LAN, and Wireless HART.

2.1. Wireless Remote Networks

Continuous communication between widely separated plant sections in the area of water/wastewater, or high-speed remote maintenance access to machines and plants on the other side of the world - these are just two of the countless ways you can reap the benefits of Wireless Remote Communication. Thanks to integration in the SINAUT telecontrol system or an HMI/SCADA system, transferred process data is available at any time via mobile radio.

2.2. Industrial Wireless LAN

Wireless solutions are increasingly becoming a matter of course in machines and plants. In the case of high data communication requirements, Industrial Wireless LAN (IWLAN) backs innovations like deterministic radio and the Industrial Ethernet standard PROFINET. But IWLAN is also being widely used in industry-oriented applications. The high data transfer rates required there allow applications in association with video streaming as well as the transmission of visualization or language data. High

deterministic or redundancy concept requirements can be covered by the IWLAN infrastructure. [4,5,6]

2.3. Wireless HART

Wireless HART is an open industry standard, developed for the particular requirements of wireless communication at the field level in the process industry. It meets all specific requirements for reliability, security, economy, and user-friendly operation system-wide. With more than 30 million installed devices worldwide, HART technology is the most frequently used communication protocol for intelligent process instrumentation at the field level. Wireless HART is backwards compatible with wired HART technology and thus offers maximum investment security. [7,8,9]

3. IWLAN for Industrial and Industry-Related Areas

IWLAN is especially suitable for demanding industrial applications that require end-to-end, reliable and secure radio communication:

- For implementation at industrial and automation customer sites
- For outdoor environments with demanding climatic requirements
- For low-cost integration in the control cabinet or in devices.

Thanks to the use of mobile devices linked via wireless data networks (e.g. wireless LAN), the efficiency of processes can be significantly improved. The primary benefit of wireless solutions is the simple and flexible availability of mobile or hard to access stations.

Mobile communication increases a company's competitiveness, as it helps achieve greater flexibility through the use of wireless communication to automation devices and industrial terminal devices. As a result you can simplify maintenance work, reduce service costs and downtimes and deploy your personnel optimally.

Industrial Wireless LAN (IWLAN) is based on the WLAN standard IEEE 802.11 and provides extensions that are particularly suited to demanding industrial applications with real-time and redundancy requirements. Customers are thus provided with a single wireless network for both process-critical data and uncritical communication.

SCALANCE W products are characterized by the reliability of their radio channel and the rugged type of construction with high requirements with respect to mechanical durability for which SIMATIC is known. To protect against unauthorized access, the products provide modern standard mechanisms for user identification (authentication) and encryption of data, and can at the same time be easily integrated into existing security concepts. These are based on international standards in accordance with IEEE 802.11 at 2.4 GHz and 5 GHz, and data transfer rates of up to 450 Mbit/s.

Below are presented some applications IWLAN from SIEMENS. All applications are described in the following forms:

- Task specification
- Solution
- Benefits.

3.1. Intralogistics

Task specification

- Manufacture of high-quality steel from scrap metal for the automotive, machine construction, and appliances Industries
- Processing of approx. 600 000 tonnes of scrap metal per year
- Use in extremely harsh environments
  - Production of smoke and dust
  - Exceptionally high temperatures
  - Strong vibrations
- Optimum positioning/locating of antennas since the entire building contains steel, e.g. cranes, racks, doors, assembly lines
- Ensured reliability of motion sequences in the process
- Assured production continuity and quality Demands placed on all electronic controls and components:
- Maximum reliability even under difficult conditions; a failure could have devastating effects on productivity and safety.

Solution

Wireless monitoring of the scrap metal vehicles:

- Wireless data transfer between the conveying equipment and the control system
- Monitoring of transport and feeding of the track-based scrap metal vehicles – exact determination of usage/storage of more than 10 types of scrap.

Classical crane control:

- Reliable wireless data transmission
- Determination of exact position of factory crane in order to optimize movements and routes.

Benefits

- Fast and secure data transfer:

The quality of the radio signals which reach the control system's receiver despite the harsh ambient conditions is so high that further protection of the radio data can be omitted

3.2. Automotive Production

Task specification

- The number of nutrunners used in vehicle final assembly should be reduced. The existing solution uses one nutrunner for each cycle and each barcode detection
- Since the hard-wired solution with slip rings results in high maintenance costs, a reliable wireless communication solution is required to increase efficiency and reduce setup times
- The products should be industrialized and available worldwide
- Investment protection is also required by ensuring the long-term availability of the components used

Solution

- The IWLAN RCoax Cable −a silicon-free radiating cable is used along the coding rail to enable wireless data transfer. It generates a defined conical and reliable radio field, which is easy to route. The RCoax Cable is therefore ideal for use in demanding

radio environments and in all types of rail-mounted vehicles.

- IWLAN access points with data transfer rates up to 54 Mbit/s are used as the supply station for the RCoax cable.
- By using the client module as a mobile station, the same mobile unit can be used for all applications, and consequently one mobile nutrunner can be employed for multiple cycles.

Benefits

- Low investment costs owing to the reduced number of nutrunners
- Reduction in maintenance costs and downtimes thanks to a reliable wireless and wear-free data transfer to mobile communication partners
- Increased plant availability thanks to reliable, contactless transmission of power and data
- Reduction of operator activity, for example scanning, cycle transfer, travel time allows higher throughput
- Easy to change models, dependent only on material logistics
- Possibility of integrating additional quality assurance applications
- Complete nutrunner data can be loaded via the IWLAN line.

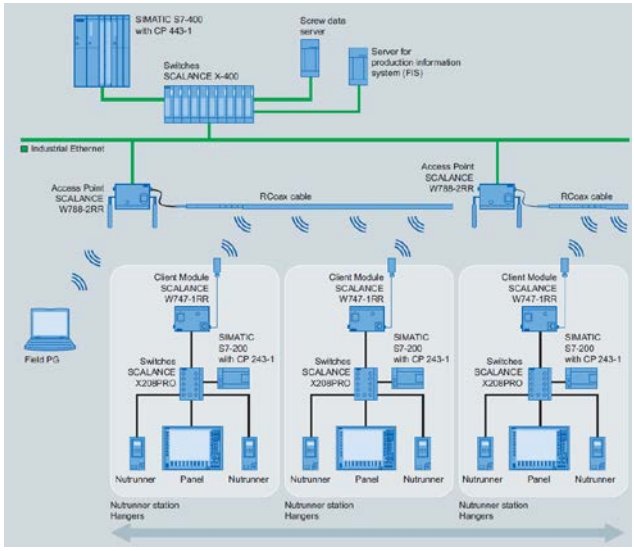

Figure 1. Configuration example with RCoax cable using example of a nutrunner control in automobile production

3.3. Crane Control

Task specification

- Safe and reliable transport system in harsh environment
- Cost-effective solution
- Reduced maintenance outlay
- Fast installation and startup
- Simple connection to the control and MES levels
- The solution should be reliable and high-performing and offer high availability.

Solution

- Wireless connection of two automated transport cranes
- Wireless communication with two automated guided vehicles (AGV)
- IO controller and IO devices on the mobile units
- Industrial Ethernet for the network infrastructure
- HMI devices on mobile units on site

Benefits

- High flexibility and plant availability
- Fast installation and commissioning thanks to reliable Industrial Wireless LAN components
- Simple connection to the control and MES levels.

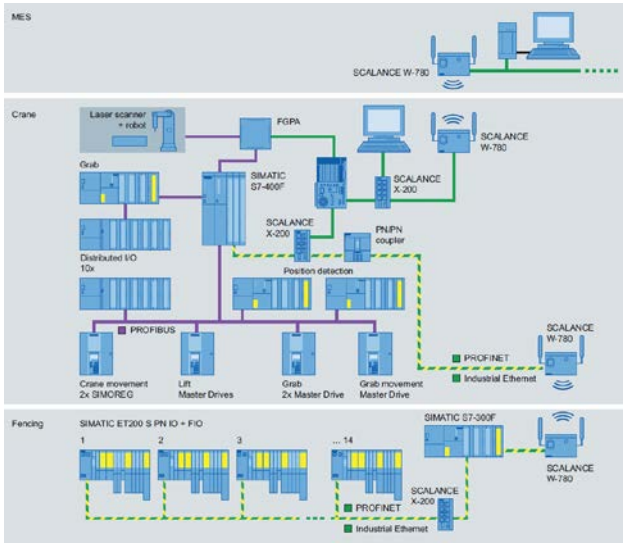

Figure 2. Automated crane control with SCALANCE W

3.4. Harbor plant / Container Logistics

Task specification

- A rugged radio system should be installed for outdoor use in a container handling system at the port of Hamburg. It should be possible to load and unload containers via IWLAN using automated guided vehicle systems (AGV). Both the driving area and the lanes between the storage blocks should be inspected reliably and economically, the system should be expandable and be insensitive to interference even as the number of vehicles rises
- The system should be reliable and work together with other networks that are already in place, as the changeover to the new system can only take place step by step
- Solid, expert support should be provided by the manufacturer during implementation and installation

Benefits

- Interference-free operation thanks to the excellent functioning of the radio network.
- Savings in costs, as the existing infrastructure (masts and antennas) could be retained
- Easy operation and configuration of all access points through the use of IWLAN controllers
- Targeted on-site support during implementation and commissioning
- Expandable radio network for further investments in the future.

Solution

- For the coverage of the driving area and lanes in-between, SCALANCE W access points are used to operate 54 automated guided vehicles (AGV), guaranteeing optimum coverage of the radio area involved.
- The radio network is based on the IEEE 802.11 standard and is therefore reliable and free from

interference. The roaming function enables the automated guided vehicle systems to move freely within the radio field.

- Coordination with existing networks was already taken into consideration during advance planning, and successfully put into practice.

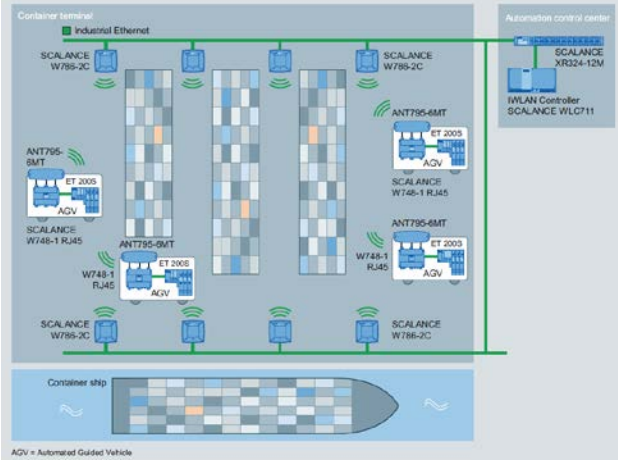

Figure 3. Application example for controller-based IWLAN applications with a large number of access points, e.g. in a container terminal

3.5. Safety-related Operation of Robots

Task specification

- In the production of visually guided gantry robots, a scalable, expandable automation platform should be established for general tasks, such as palletizing and depalletizing heavy goods at high speed and with high precision
- The aim is to significantly cut installation and commissioning costs, as large distances have to be covered in the plant
- Commercially available components should be used to achieve the solution
- A wireless, open and user-friendly safety system should be installed

Solution

- To achieve the solution, a single network is established for standard and safety data
- SCALANCE W access points with rapid roaming function are used
- An integrated engineering support environment is installed

Benefits

- Easier operation due to the use of a single network for all applications (image processing, safety, peripherals, motor control)
- Wireless and safety components are contained in a single network, simplifying engineering and diagnostics
- Cabling costs are cut by 30%, installation time is reduced and commissioning is facilitated

3.6. Equipment for the Public Transport System

Task specification

Bidirectional transmission of data

- Out of the train: Live streams of video monitoring (CCTV), passenger counting, ticketing, telemetry etc.
- Into the train: Real-time IPTV, infotainment, WLAN hotspot
- Control of up to 32 access points per tunnel, and additional redundancy if a controller fails

Solution

Implementation of train-to-trackside coupling using broadband WLAN

- Installation of a WLAN infrastructure along the route/track
- Equipping trains with switches and WLAN clients (dual-client)
- Two SCALANCE WLC711 Industrial Wireless LAN controllers with expansion license for up to 32 access points each are used per tunnel and configured for redundant operation. This means that a controller can monitor up to 64 access points.

Benefits

- Extremely rugged IWLAN products, which are unaffected by shaking and jolting and can be used in a broad temperature range of -20 °C to +60 °C
- The radio network's excellent functioning and IEEE 802.11b (11 Mbit/s) radio standard ensure interference-free operation
- SCALANCE W products are standard products
- Siemens guarantees that spare parts will be kept in stock for 10 years

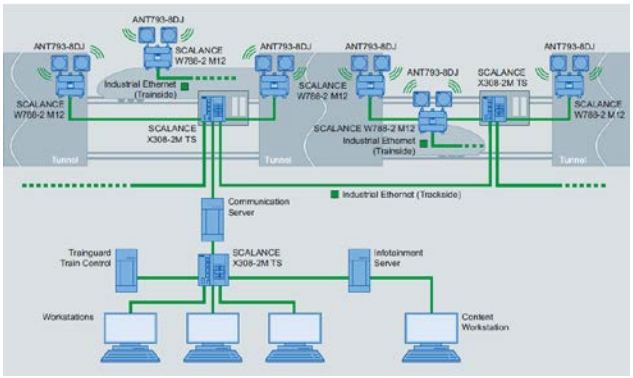

Figure 4. Data transfer in trains with SCALANCE

4. Industry-standard Products for Wireless Communication

IWLAN/PB Link PN IO

The IWLAN/PB Link PN IO is a compact router between Industrial Wireless LAN (IWLAN) and PROFIBUS, and allows wireless connection to an IWLAN (e.g. SCALANCE W access points) in accordance with IEEE 802.11 at up to 54 Mbit/s with 2.4 GHz and 5 GHz. It supports the use of an IWLAN, for example with RCoax radiating cables, for wireless data transmission in the case of suspended monorails, storage and retrieval systems, or other applications with mobile stations. Support of PROFINET means that the wide variety of PROFIBUS system services, such as diagnostics over the bus, can still be utilized.

The IWLAN/PB Link PN IO offers:

- High, deterministic data throughput and very fast roaming through support of iPCF; the iPCF mechanism represents an extension of the IEEE

802.11 standard and must be available both on the station and on the access point.

- PROFINET IO proxy functionality Connection of PROFIBUS DP slaves to PROFINET IO controller according to PROFINET standard:

  - From the viewpoint of the IO controller, all DP slaves are handled like IO devices with Ethernet interface, i.e. the IWLAN/PB Link PN IO is their proxy

  - From the viewpoint of the DP slaves, the IWLAN/PB Link PN IO is the DP master

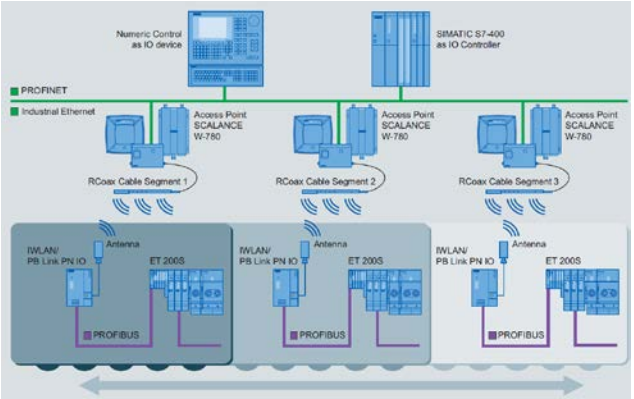

Figure 5. System solution with IWLAN/PB Link PN IO using example of suspended monorails

5. Advantages at a Glance

■ Reliable radio link, e.g. by using MIMO technology, redundant connections, and monitoring of the radio link

■ Predictable data traffic (deterministic) and defined response times on the radio link with the assistance of iFeatures

■ Cost savings due to one single radio network both for process-critical data and for non-critical communication

■ Investment security because all products are compatible with the internationally recognized WLAN standard IEEE 802.11, suitable for license-free 2.4 GHz and 5 GHz frequency bands (ISM bands)

■ Operational reliability in industrial environments, e.g. thanks to rugged housing and industrial approvals

■ Reduced operating costs, because there is no wear of rotating and moving plant sections

■ Cost-effective connection to devices which are remote, difficult to access or mounted in hostile environments

■ Increased reliability when operating the IWLAN through complete, coordinated portfolio of controllers, industrial access points and SCALANCE W client modules, as well as the suitable accessories (antennas, connecting cables, power supplies).

Acknowledgement

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