Tunnel 4.0 – Tunnel sensors fit for the Future

Tunnel Safety & Ventilation Graz, 03.12.2020, René Jung

DURAG GROUP

Contents

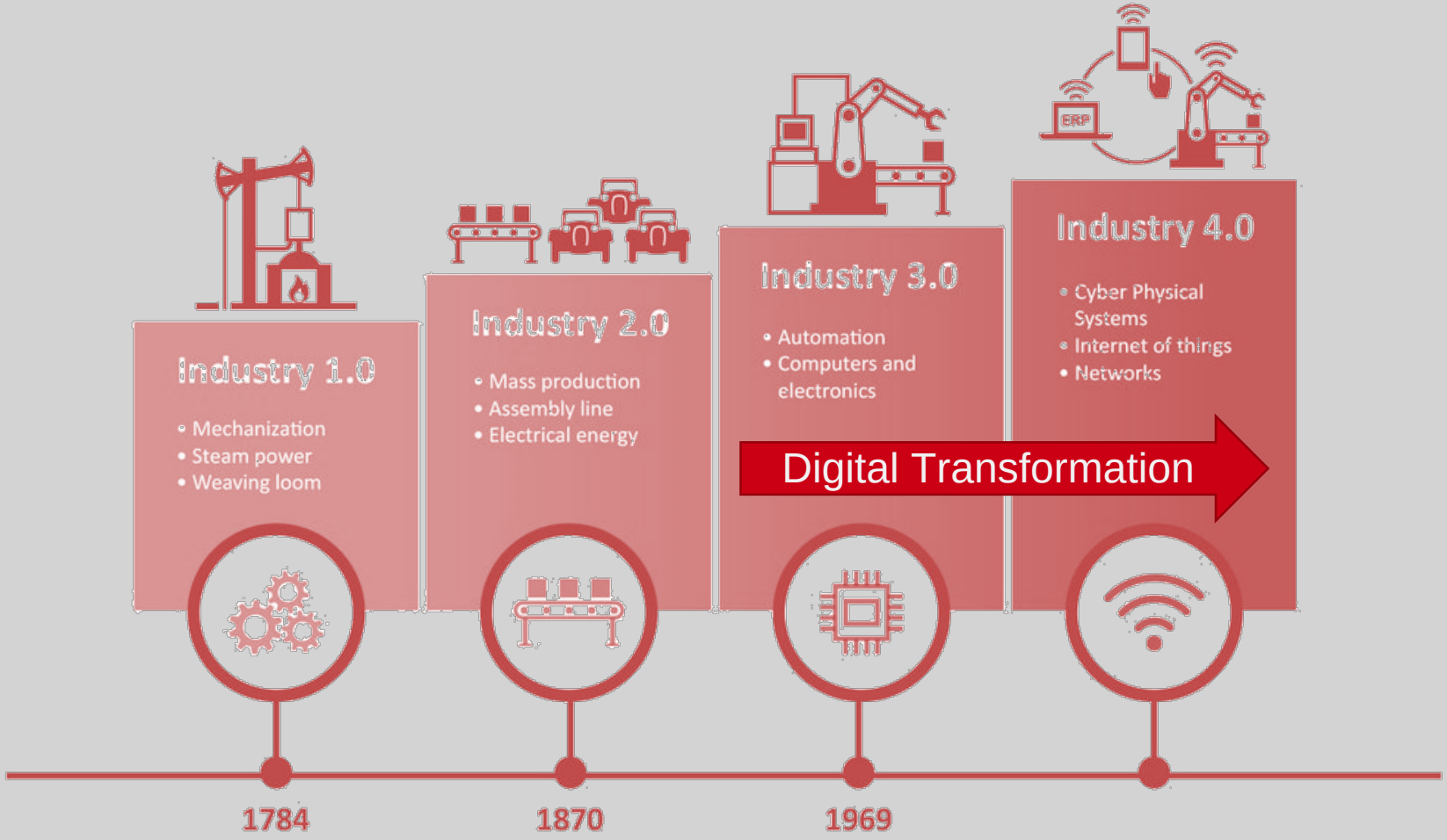
Contents

Goalsof digitisation

- More flexible and efficient workflows for work, production and business processes
- Modernisation of existing or development of new products, services and business models
- Optimisation of customer relationships and communication
- Implementation of new ideas and products
- Opening of new business areas and markets

Digitisation is not a goal itself but must pursue clear goals and add value!

Industry 4.0
Implementation in tunnels



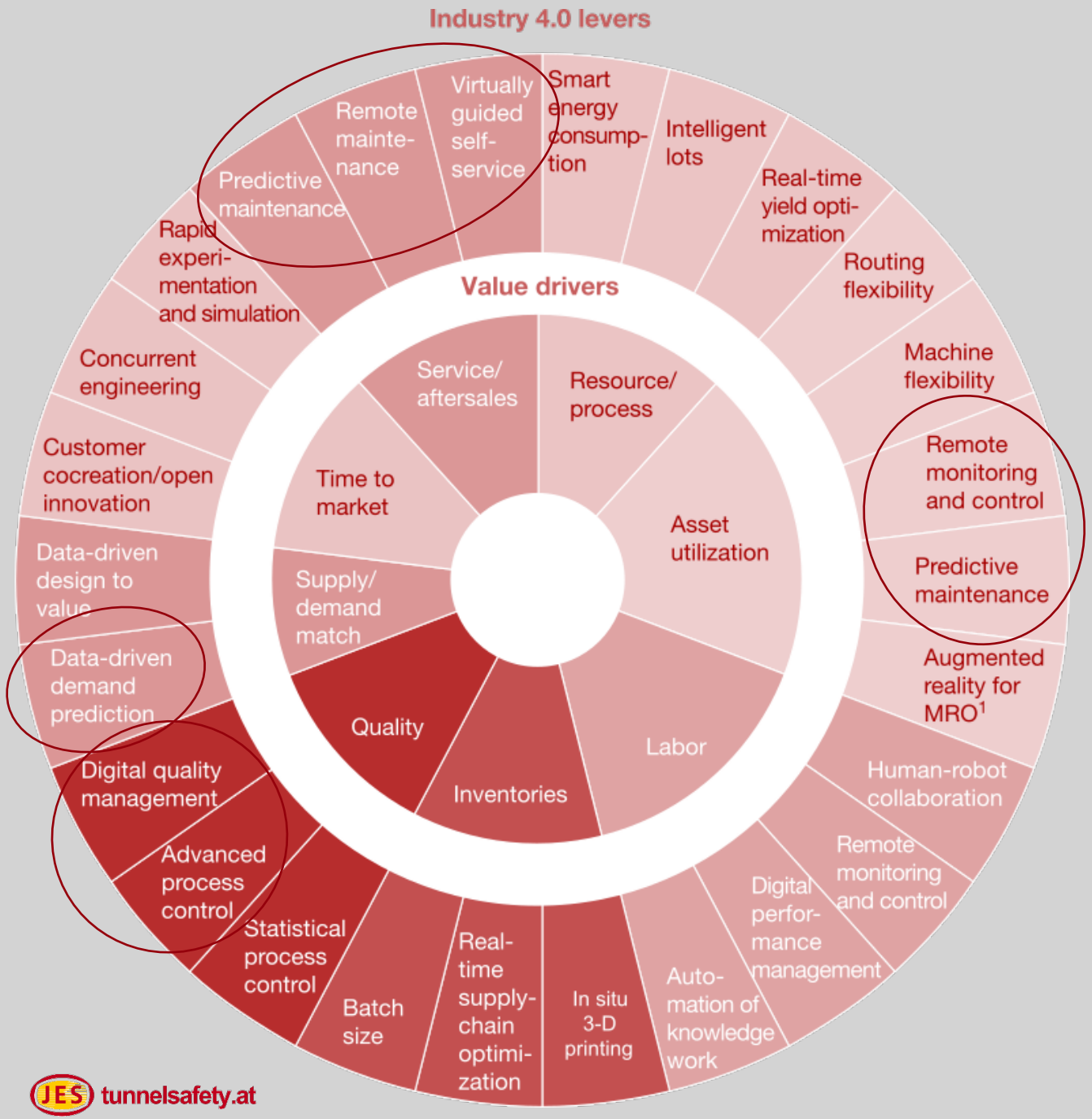
- IP networks in traffic infrastructure have quickly developed in the last years
- Sensor signals (analogue or digital) still picked up by PLCs
- Digital sensor interfaces lack standardisation
- Field bus topologies unfavourable
- Most sensors have no native IP interface

Source: https://www.btelligent.com/en/portfolio/industry-40/

Industry 4.0
Design principles

- **Interconnection:** The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of things, or the internet of people (IoP)
- **Information transparency:** The transparency afforded by Industry 4.0 technology provides operators with vast amounts of useful information needed to make appropriate decisions. Interconnectivity allows operators to collect immense amounts of data and information from all points in the manufacturing process, thus aiding functionality and identifying key areas that can benefit from innovation and improvement.
- **Decentralised decisions:** Interconnection and information transparency allow for operators to make decisions both inside and outside of production facilities. This ability to combine local and global information at the same time helps to drive better decision-making and increase overall productivity.
- **Technical assistance:** Industry 4.0 shifts the role of humans from an operator of machines to a problem solver and decision maker. Assistance systems are designed to support operators that need to make informed decisions to solve urgent problems on short notice.

Source: https://blog.viscosity.com/blog/what-is-industry-4.0-and-what-does-it-mean-for-my-manufacturing



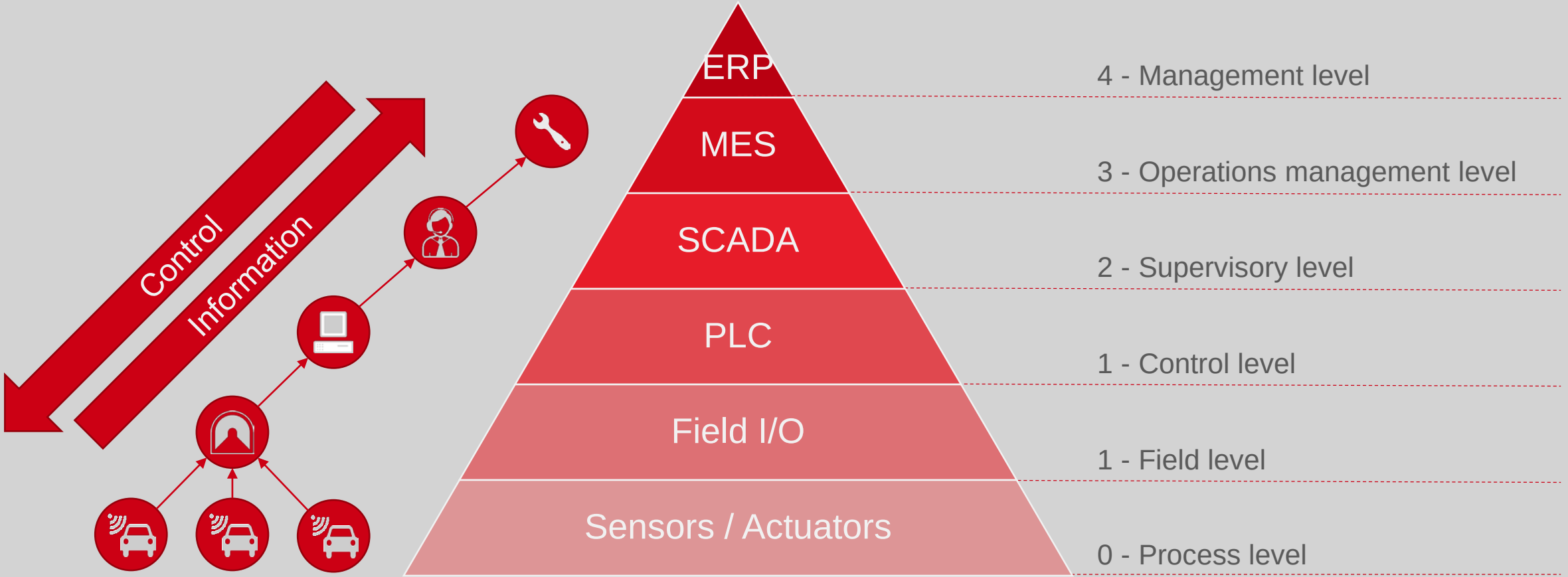
tunnelsafety.at

Digitisation and interconnection by networks are the prerequisites for leveraging Industry 4.0

Quelle:
https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/getting%20the%20most%20out%20of%20industry%204%200/mckinsey_industry_40_2016.ashx

Contents

Traditional Automation Pyramid



ProcessLevel
Today‘s„analogue“ and digital sensors

„Analogue“

+

- Standardised output signals (e.g. 4-20 mA)
- Easy digitisation by analogue inputs of PLCs
- Simple, robust sensors

–

- Limited number of outputs
- Need for measuring ranges
- Loss of information at transition from sensor to field level (often by an intermediate analogue signal)

Digital

+

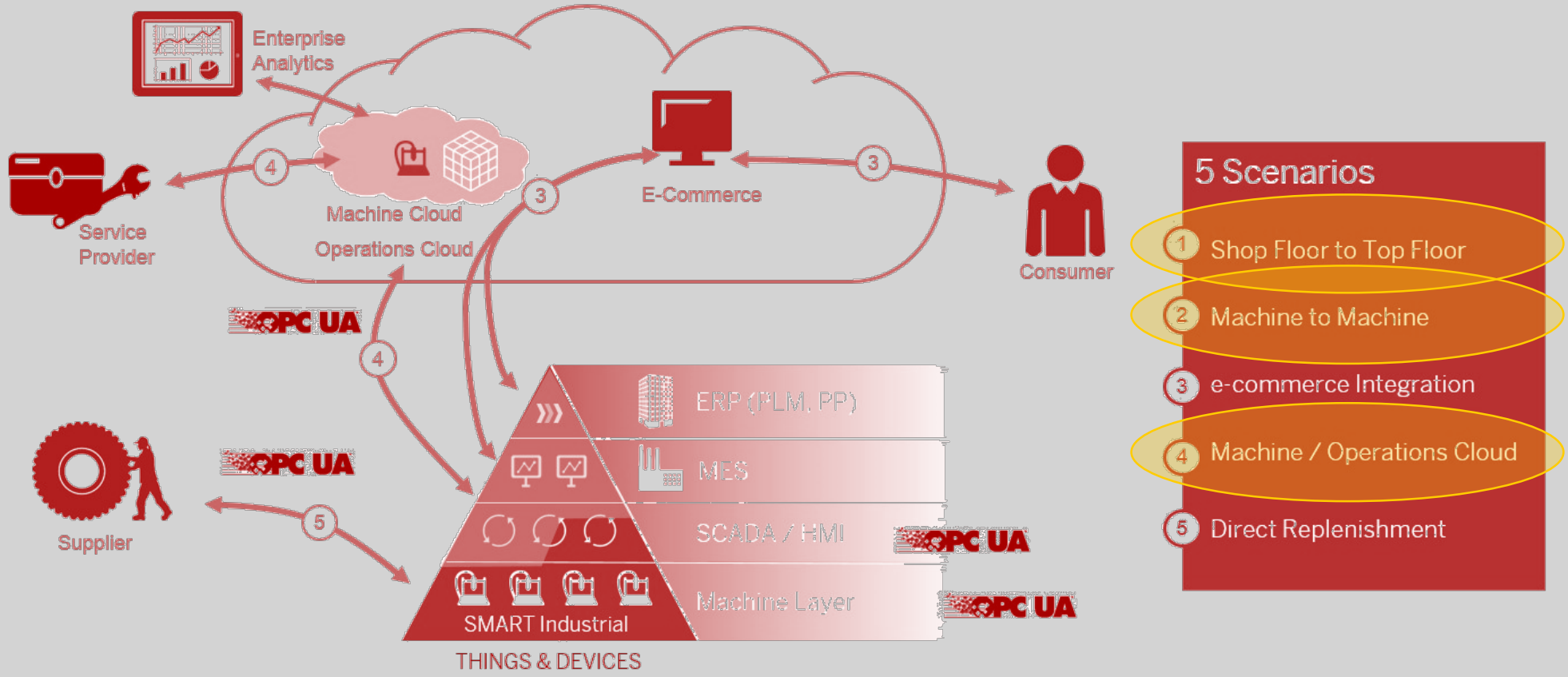
- Number of outputs theroretically unlimited
- External availability of diagnostic data
- Larger measuring ranges

–

- Numerous manufacturer-specific interfaces and protocols
- Unfavourable bus topographies

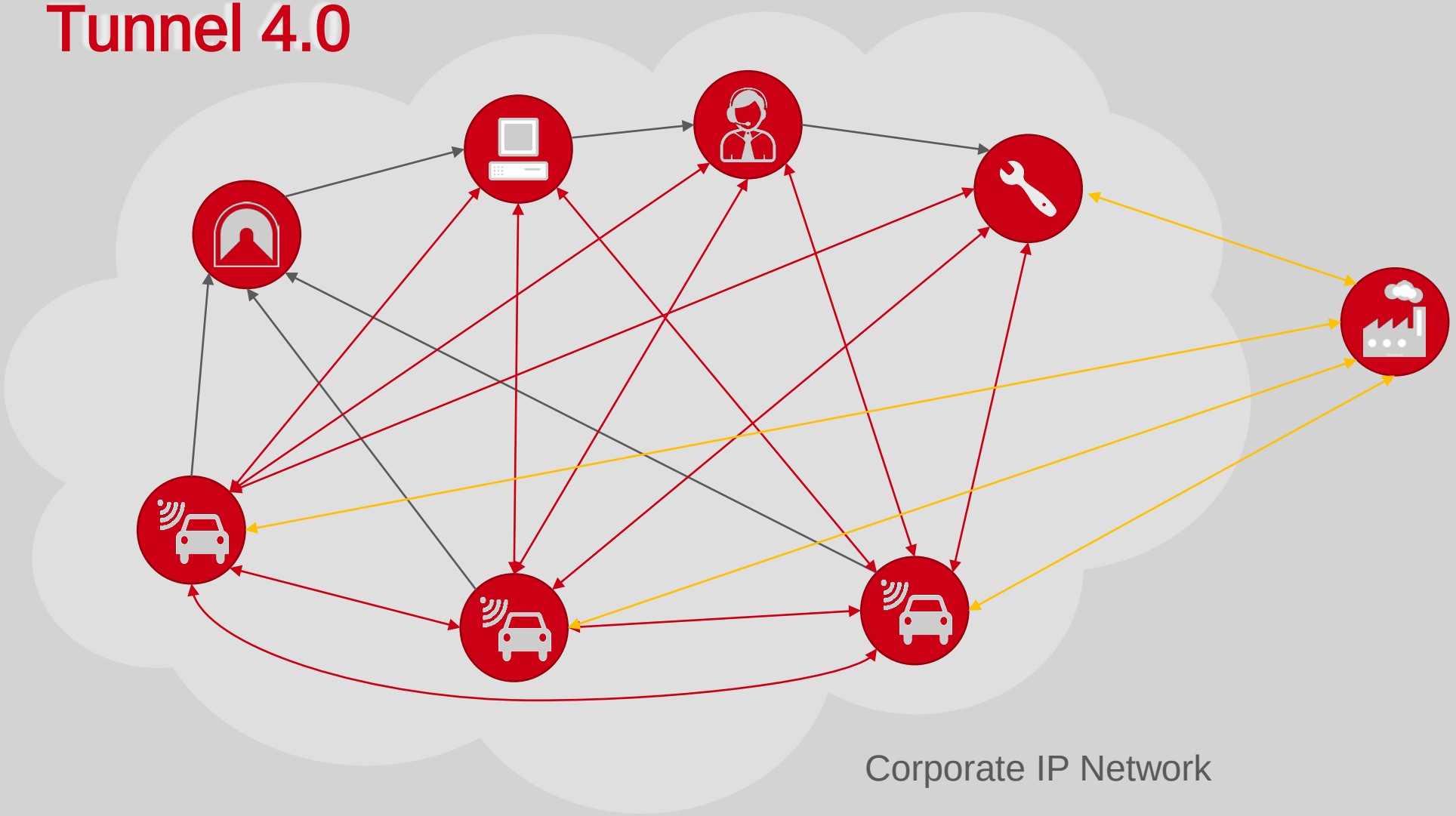
A lack of interoperability and strict hierarchies in automation prevent the “Digital Transformation"!

Interconnection requires interoperability
5 Scenarios



Source:https://opcconnect.opcfoundation.org/2016/03/reshape-the-automation-pyramid/

The future is interconnected!
Tunnel 4.0



External Partner:
Manufacturer
Service Provider

Corporate IP Network

Contents

Tunnel Sensors fit for the future
Challenges

Remote access, Configuration, Visualisation, Asset Management

Internet of People

Usable in traditional environments, interfacing other systems of operator, manufacturer or service provider

Interoperability

Communication between sensors

Internet of Things

Standardised interfaces

OPC UA
MODBUS/TCP
traditional field buses
Sensors should have standardised information models

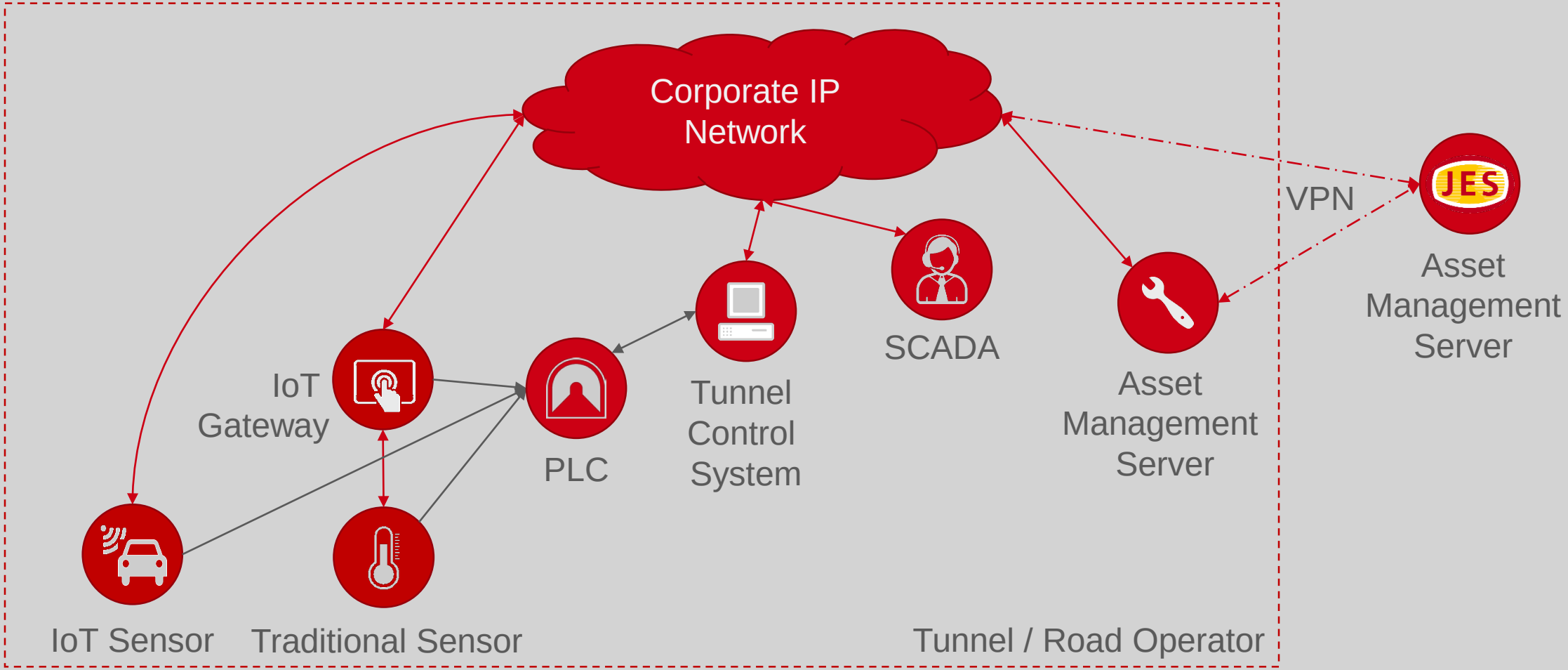
Maintenance

Condition monitoring

Alerting,
Predictive Maintenance,
Firmware Management,
Documentation

Recognition of trends, reliability → measures, savings

Tunnel Sensors fit for the future
JES smart/Architecture



Tunnel Sensors fit for the future
IoT Sensor

- Web Services
  - OPC UA
  - MODBUS/TCP
  - .json, XML
  - Traffic industry-specific like TLSoIP, NTCIP (optional)
- Field bus interfaces (optional)
  - MODBUS RTU
  - Profibus DP
- Analogue and relay outputs (optional)

- Web server (Internet of People)
  - Visualisation and data logging
  - Sensor Configuration
    - Outputs
    - Inputs
    - Alarms
  - Informational attributes
  - Network and security configuration
    - Encryption
    - IP Settings
    - Users and User rights
  - Simulation
  - Diagnosis

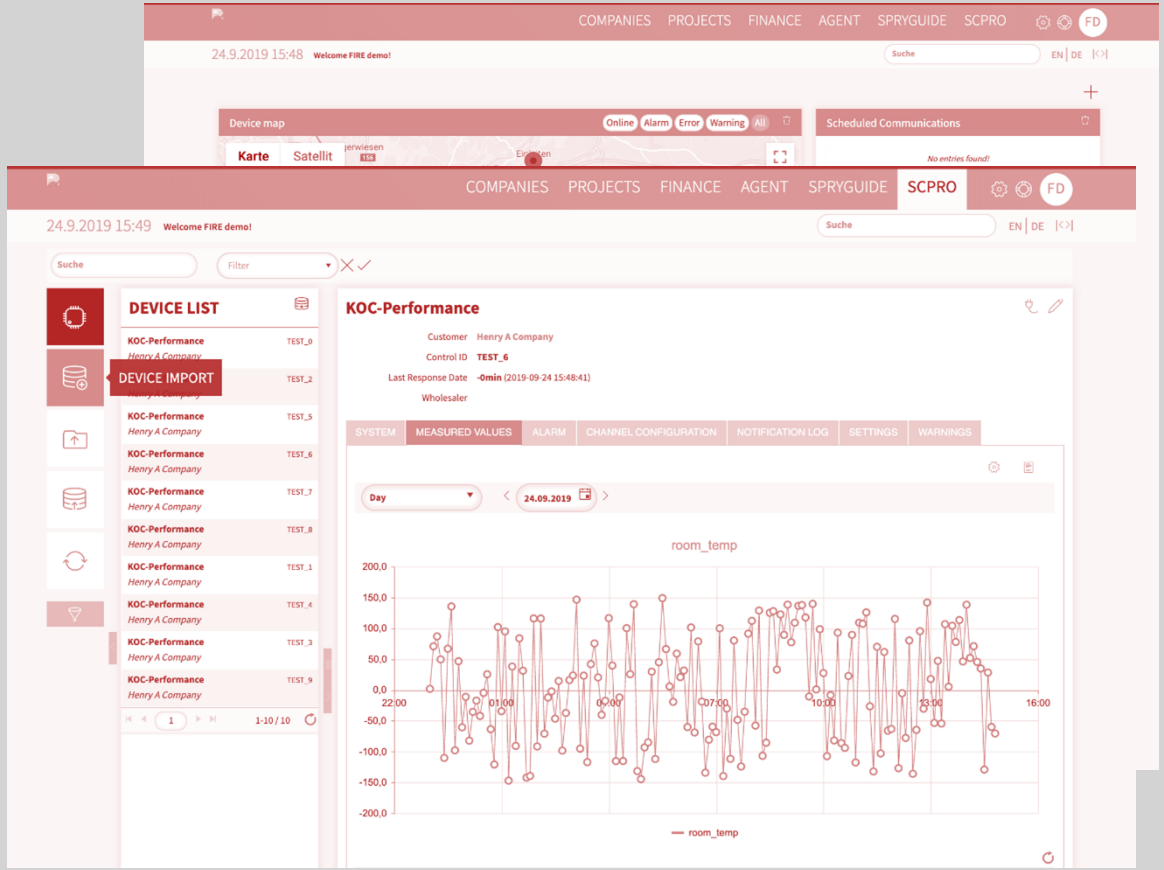
Tunnel Sensors fit for the future
IoT Gateway and Hub

- Outputs similar to IoT Sensor
  - Web Services
  - Field bus interfaces (optional)
  - Analogue and relay outputs (optional)
- Data collection from IoT Sensors
- Inputs for traditional sensors
  - Analogue inputs
  - Inputs to exchange data with sensors over field buses with manufacturer-specific protocols
- Web server similar to IoT Sensor
- Application
  - Sensor Hub to connect 1 or more traditional sensors
  - Touch Operating Unit
  - Road Weather Station (RWIS)

Hub acts like a multiple IoT Sensor and makes traditional sensors smart!

Tunnel Sensors fit for the future
Asset Management Server

- Collect, aggregate and analyse sensor data
  - Archive measured values
  - Evaluations and Analyses
  - Messaging and Alerting
- Administration of all connected sensors
  - Configuration
  - Diagnosis
  - Software Updates
- Interface to operator‘s data warehouse

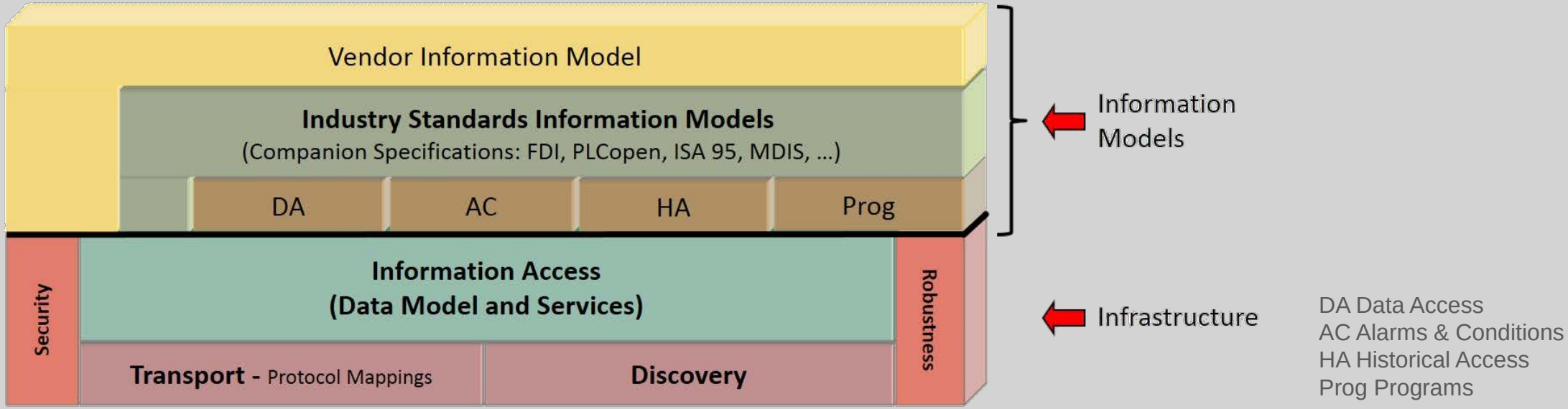


Tunnel Sensors fit for the future
Standardised interfaces to automation – Problem

- Implementation of available application protocols are proprietary and communication between devices of different manufacturers requires interfaces and gateways.
  - MODBUS/TCP
  - Profinet
  - EtherCAT
  - EtherNet/IP
- Even if communicating devices use the same protocol, the format of the data is again proprietary.
- System integrator would still need to implement vendor and sensor-specific parts of software in tunnel control system, sensors of different manufacturers are not exchangeable (unlike using analogue and relay outputs)

Tunnel Sensors fit for the future
Standardised interfaces to automation – OPC UA?

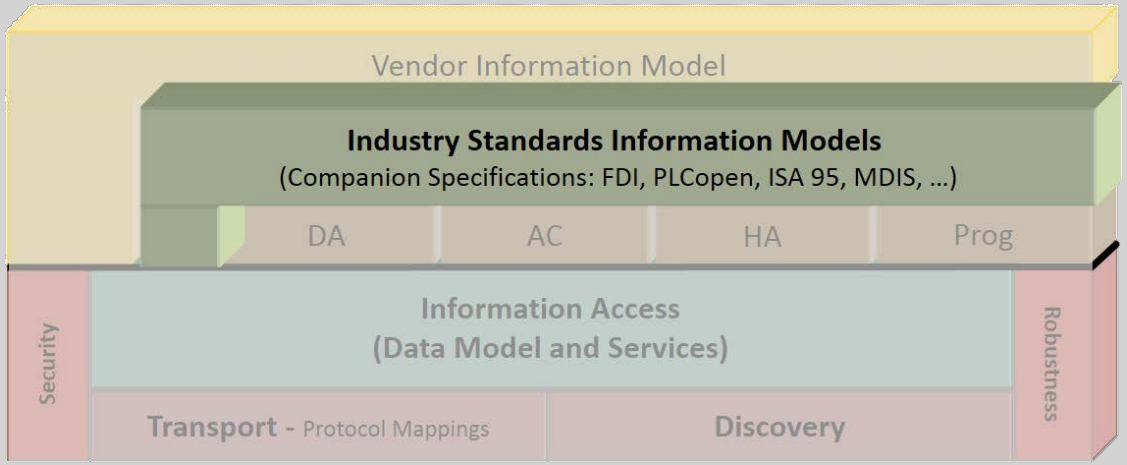
- Platform independent, scalable and high-performance communication infrastructure
- Focus on communicating with industrial equipment and systems for data collection and control



DA Data Access
AC Alarms & Conditions
HA Historical Access
Prog Programs

Tunnel Sensors fit for the future
Standardised interfaces to automation – OPC UA?

- Defining industry information models for transport infrastructure applications would finally make vendor- and sensor-specific pieces of software obsolete and sensors easily exchangeable
- Austrian road operator ASFINAG has already defined such in its specification PlaPB 800.566.2600 Tunnel – Steuerung but there is no international information model based on OPC UA yet



Tunnel Sensors fit for the future
Standardised information model?

- Problem of lacking interoperability and interchangeability between computers and electronic traffic control equipment from different manufacturers is not new
- Earlier efforts to standardise communications and data models
  - TLS, TLSoIP
  - NTCIP
- None of these protocols fits into the OPC UA
- If tunnel and road operators want to push standardisation further, they should jointly with manufacturers develop a Companion Specification for OPC UA.

Contents

Tunnel 4.0 Technologies

- Future generations of sensors connect directly to an IP network
  - Analogue and relay outputs and field buses used in traditional automation environments can remain in parallel (for a transition period)
- No major new challenges regarding cybersecurity
  - Usually used in corporate networks (not publicly accessible)
  - Sensors use standard technologies IT staff knows how to deal with
  - Operator‘s own IT security concepts and guidelines can be applied
- All other devices within the same IP network can remotely access the sensors through different web services
  - Web server (https://) for configuration, remote maintenance, maintenance documentation
  - Tunnel Control System via MODBUS/TCP, OPC UA, TLSoIP, NTCIP, etc.
  - Asset management system
  - Other operator software (reliability, data warehouse, maintenance software)
  - Sensor-to-sensor communication

Tunnel 4.0
Applications with Tunnel Sensors

- Remote Maintenance
  - Remote Support
  - Condition Monitoring and Predictive Maintenance
  - Data-driven demand prediction (expendables)
- Asset Management
  - Aggregated and detailed views of all sensors and actuators
  - Condition, warnings and errors
  - Sensor and network configuration
  - Central user rights administration
  - Update and upgrade roll-out
- Digital Quality Management
  - Documentation of commissioning, maintenance, repairs
  - Reliability statistics
  - Automated test scenarios
- Sensor-to-sensor communication for plausibility checking (e.g. air flow measurement)

Tunnel operators would like to optimise their asset utilisation!
Manufacturers want to gain business in digital services and aftersales!

Tunnel 4.0
Advantages

- Simpler cabling by use of Ethernet
- Power over Ethernet possible for sensors with little power consumption
- Separation of the sensors from the project-specific implementation of the Tunnel Control System
  - Asset Management System and sensor embedded web server provide access to all sensor data for the operator to efficiently control maintenance
  - Automation provider can focus on the data relevant to the process control level (measured values, error messages)
- Implementation of modern maintenance strategies
  - Remote maintenance
  - Predictive maintenance
- Cost Savings

Tunnel 4.0
Open Items

- IoT sensors for the tunnel
- Roll-out of IP networks “to the sensors”
- Standardisation of data exchange
  - Web Services
  - Data Information Models

JES launches its smart/Architecture now!
When will you implement the „Digital Transformation“?


Thank you for your attention!