ISA100 WCI Webinar
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End to end SIL2 wireless

Presenter:
Dräger

Ådne Baer-Olsen
Adne.Olsen@drager.com
Agenda

1. Introduction Industrial Wireless
2. ISA100 Wireless Industry Standard
3. Technology for wireless gas detection
4. System Architecture
5. SIL Certification and Safety Function
6. SafeWireless and PROFIsafe
7. Fault Tolerant Wireless Network
8. Case Study
9. Summary
Introduction to industrial Wireless

Applications examples
- Machine health monitoring
- Basic process control
- Monitoring of well heads
- Remote process monitoring
- Leak detection monitoring
- Diagnosis of field devices
- Condition monitoring of equipment
- Environmental monitoring
- Tank level monitoring
- Gas detection
- Fuel tank gauging
- Steam trap monitoring
- Open loop control
- Stranded data capture
- And more
ISA100 Wireless Fast Facts

- International standard IEC 62734 since 2014
- Complies with ETSI EN 300 320 v1.8.1 (LBT)
- Broad Multi-Vendor Portfolio of ISA100 Wireless Devices
- ISA100 Wireless enables SIL-2 Certification
- Ensured Interoperability - best-in-class solutions from best-in-class suppliers
- Readily available ISA100 Wireless Modules and Stacks
- Enable fast-track development and go to market
## Benefits of ISA100 Wireless Instrumentation

| Cost Savings                                                                 | • Up to 90% of installed cost of conventional measurement technology can be for cable conduit and related construction.  
| • Typically: 1/5 the time, 1/2 the cost.  
| • New and scaled applications are now economically feasible.  |
| Improved Reliability                                                        | • Wired sensors may be prone to failure in difficult environments.  
| • Wireless can add redundancy to a wired solution.  |
| Improved Visibility                                                         | • Condition monitoring (equipment)  
| • Process monitoring                                                        |
| Improved Control                                                            | • Add wireless to existing processes for more optimal control.  |
| Improved Safety                                                             | • Safety related alarms  |
ISA100 Wireless Product Portfolio

Infrastructure
- Independent Gateway
  - Honeywell, Yokogawa
- Access Point (AP)
  - Honeywell, Yokogawa
- Integrated Gateway/AP
  - Honeywell, Yokogawa, CDS, Nexcom
- GW/AP + Recorder
  - Yokogawa
- Adapter (HART, etc.)
  - Honeywell, Yokogawa

Measurement & Control
- Temperature
  - Honeywell, Yokogawa
- Pressure / Flow
  - Honeywell, Yokogawa
- Level
  - Honeywell, Yokogawa
- DI/DO, AI
  - Honeywell, Yokogawa
- Valve Position
  - Eltav, Flowsolve, Honeywell

HSE + Life cycle
- Corrosion
  - RCS, Honeywell
- Steam Trap
  - Spirax Sarco, TLV, Armstrong, Bitherm
- Vibration
  - GE, Divigraph
- Gas
  - GasSecure, Scott Safety, New Cosmos, Riken Keiki
- pH
  - Honeywell, Yokogawa
Online resources

www.isa100wci.org

• Learning Center with White Papers
• Articles, End-user stories, Forum
• Receiving over 20,000 web views per month
• Full list of certified/registered ISA100 Wireless devices
• And more useful content for you and your business

ISA100 Wireless Interest Group

• Latest news, end-user and expert discussions, insights
• 540 members currently and growing (please join!)
• Receiving over 5,000 web views per month
Agenda

1. About the speakers
2. Introduction Industrial Wireless
3. ISA100 Wireless Industry Standard
4. Technology for wireless gas detection
5. System Architecture
6. SIL Certification and Safety Function
7. Wireless Communication
8. Summary
9. Q&A
GS01 Wireless Gas Detector
Features and Benefits

Reliable single-beam, triple-wavelength MEMS IR technology ensuring lifetime detection stability, with no need for re-calibration

Outstanding performance:
Only wireless device to combine 5 sec response time with low power operation and long battery life

SIL2 capable – SIL2 approval covers hardware, software and wireless communication, for seamless integration into safety instrumented systems

Truly wireless, no cables:
Ultra-low power consumption of ~5 mW allows for a battery life of up to 24 months

Intrinsic safety approval with field-replaceable battery packs

Significant savings on total project cost due to reduced engineering; wiring, installation and documentation demand

Hydrocarbon Detection
GS01 Device Alternatives

- GS01 (standard)
- Fixed 2 dBi antenna
- Cable
- Installed with two 8mm bolts areas
- Antenna pointing up or down

- GS01-EA
  - Extended 6 dBi antenna
  - 5, 10 or 20m
  - Improves flexibility in
  - With weak radio coverage
MEMS for Gas Detection

• The GasSecure MEMS filter is key to the following achievements:

- Reduce the power consumption with 3 orders of magnitude (from watt to milliwatt).
- Thereby enabling up to 2 years battery life.
- High-speed (1 kHz) operation of the optical bench for short response times.
MEMS, Micro Electromechanical System

- GasSecure optical bench replaces conventional infrared components with MEMS.
Wireless Gas Detector EC

Robust design for reliable usage in harsh environments

A variety of sensors detect a wide range of hazardous gases

SIL2 capable – SIL2 approval covers hardware, software and wireless communication, for seamless integration into safety instrumented systems

Truly wireless, no cables: Ultra-low power consumption of ~5 mW allows for a battery life of up to 24 months

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Electro Chemical
Polytron 6100 EC WL

- Supports all DrägerSensors (EC, 140 gases)
- ISA 100.11a communication
- SIL 2 capable
- No cable
- Battery Lifetime >24 month (battery pack, soldered)
- Bluetooth interface for easy maintenance
- Hand Held as GUI (Windows 10, Polysoft)
- Intrinsically safe (no hassle with declassifications)
- Extended antenna (5, 10 & 20m)
- Performance certification
- Dust approval
- Local power possible
- Option without sensor compartment as repeater
Electrochemical
Technical details
DrägerSensors: Specification

- Temperature range -40°C to 65°C (-40°F to 150°F)
- Humidity continuously 5% to 95% r.h.
- 100% leak-proof because of patented vent system
- Huge electrolyte reservoir for long lifetime (usually >5 years)
- Length 67 mm (2.64”), dia 50 mm (1.97”)
- 3-electrodes electrochemical
- Colour-code for easy identification
- Replaceable dust- or gas-filter
- Orientation independent
System Architecture

Wireless communication
ISA100 Wireless / PROFIsafe

Wired communication
Modbus TCP/RTU
PROFINET / PROFIsafe

Field devices
Wireless gas detectors

Network infrastructure
Access points and gateways, in redundant setup if required

Central Control Room
Data acquisition, safety-related controllers and connection to actuators
Wireless Network Range & Size

50m / 160ft Wireless Range
Dense pipework, machinery, structures; eg. offshore platform, pipe racks, etc.

200m / 650ft Wireless Range
Minor structures, machinery; eg. refinery, terminals

500m / 1640ft Wireless Range
Open space without obstacles; eg. tank farms, pipeline facilities

Network Size (Yokogawa)

- Gateway: 60 to 120 GS01
- Access point: Up to 32 GS01
- GS01 Router: Up to 15 GS01

Radio link (or «hop»)
GS01 SIL2 Certification

• The SIL2 assessment included
  – GS01 Hardware
  – GS01 Software
  – Wireless communication (PROFIsafe)

• Key SIL parameters
  – \( \lambda_{DU} = 1.08 \times 10^{-7} \text{ h}^{-1} \)
  – SFF = 91 % (for HFT = 0)
  – PFD_{AVG} = 1.61 \times 10^{-3} \text{ (for } T_P = 2 \text{ years)}

• Note
  – PFD_{AVG} is well within the allowed range for SIL2 (< 0.01)
  – PFD_{AVG} is claiming less than 35% of this range (< 3.50E-03)
GS01 Safety Function

Safety function
The detection of potentially explosive gas concentrations in %LEL. The gas concentration is converted into a digital measured value and provided as a PROFIsafe message to a safety controller.

Failsafe
Internal diagnostic functions provide Failsafe Values (NaN*) for gas concentration. Communication issues result in a PROFIsafe safe state to flag unavailability of field devices.

Timeout
Unavailability is flagged within predefined time limits (process safety time typically 60 sec in hydrocarbon gas detection).

* NaN = (0x7FC00000) per float definition in IEEE754
GS01 Wireless Communication

- Based on the ISA100 Wireless™ Standard
- ISA100 Wireless Strengths
  - "Tunnelling" of foreign protocols through the network facilitates the integration of safety protocols.
  - Contract based communication (uplink and downlink) guarantees Quality of Service through limits for bandwidth, latency, and priority.
  - Superior coexistence with WiFi
  - Device interoperability supports communication of devices from multiple vendors on one network.

Suitable for fast and low-power safety communication
SafeWireless™

SafeWireless is a communication concept to combine low power with short response time developed by GasSecure.

Principle

Different response time in the presence and absence of hydrocarbon gas

- Short publish rate (all timeslots used) when GAS
  - Default = 2 sec
- Longer publish rate (not all timeslots used) when NO GAS
  - Default = 12 sec

SafeWireless supports cyclic communication, as required for SIS

- Request from controller must be answered within “process safety time”
- Detector “armed” with safe downlink packet
- Response delayed, but instantly when gas detected
SafeWireless™ - Cyclic Communication

Legend

- Uplink slots
- Downlink slots
- Comm. w/o gas
- Comm. with gas

Controller

Gateway

GS01
PROFIsafe Protocol

PROFIsafe
- Protocol developed by PROFIBUS and PROFINET International (PI)
- An additional layer on top of PROFINET
- Certified for up to SIL3 use

Black channel principle means
- PROFIsafe is independent of the communication method.
- Covering the entire communication path from the sensor over the controller to the actuator on one channel.
- Protection for all eventual failures in communication.
Wireless Network with PROFIsafe

GS01 gas detectors

ISA100 Wireless

ISA100 gateway with PROFINET

PROFINET

Safety controller

PROFIsafe

Black Channel

PROFIsafe
## Handling Security Threats to ISA100 Wireless Systems

The combination of four security elements provides full cover.

<table>
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<tr>
<th>Wireless Defence</th>
<th>Wireless Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data Sniffing</td>
</tr>
<tr>
<td>Data Encryption</td>
<td>Secure</td>
</tr>
<tr>
<td>Device Authentication</td>
<td>Secure</td>
</tr>
<tr>
<td>Data Authentication</td>
<td>Secure</td>
</tr>
<tr>
<td>Data Freshness</td>
<td>Not Secure</td>
</tr>
</tbody>
</table>

The combination of four security elements provides full cover.
Availability versus Functional Safety

• Redundancy improves availability and on-time.
• Availability requirements are the driver to select redundant devices.
• Redundancy does have no impact on the detector safety function.
• The SIL rating determines the required average probability of failure on demand.
• SIL2: $PFD_{AVG}$ at least $1.0E-02$
• GS01: $PFD_{AVG}$ = $1.61E-03$ (for TP = 2 years) / $1.22E-03$ (for TP = 1 year)
• The SIL rating does not determine the availability.
Fault-tolerant Wireless Network Design

Redundancy implemented at all levels (GS01, AP, GW)
GS01 Primary link
GS01 Secondary link
Design without any “single point of failure”
Wireless Can Enhance Safety

Flexibility due to simple mounting (two 8mm bolts)

- Freedom for optimal detector placement
- Deployable in hard-to-wire areas (turrets, cranes, confined spaces)
- Easy to rearrange detectors (upgrades, revamps)
- Simple to extend coverage with additional detectors (extensions)
From SIL-capable Detector to Safety Integrated System
Risk Analysis (described in IEC 61508 / 61511)

- Gas Detection
- Emergency shut-down
- Ventilation rate
- Air inlet positioning

risk

dangerous

safe

risk reduction

actual risk reduction

necessary risk reduction

residual risk

tolerable risk
## GS01 Case Study

<table>
<thead>
<tr>
<th>Client / Country</th>
<th>Equinor Refining / Denmark (formerly Statoil)</th>
</tr>
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<tr>
<td>Project / Facility</td>
<td>Fire &amp; Gas Extension / Kalundborg Refinery</td>
</tr>
<tr>
<td>Process / Plant / Application</td>
<td>Fill-in detectors for 3 process areas after risk assessment determined inadequate coverage by current system</td>
</tr>
<tr>
<td>Equipment / Infrastructure</td>
<td>114 units GS01 / 8 units GS01-EA / Other detectors 3 Gateways / 18 Access Points / Siemens S7</td>
</tr>
<tr>
<td>Design</td>
<td>SIL certified detectors and controller, gateway with PROFINET / PROFIsafe, client assessments &amp; verifications → SIL2 capable</td>
</tr>
<tr>
<td>Challenges</td>
<td>Large, congested plant area. Enclosed spaces.</td>
</tr>
<tr>
<td>Key Notes</td>
<td>Significant cost reductions with wireless.</td>
</tr>
</tbody>
</table>
GS01 Case Study

Aerial View

- Project was split into 3 phases (3 geographical areas)
- Placement of access points was based on existing knowledge for wireless on this site

Area covered with wireless gas detection
(about 75.000 sqm)
GS01 Case Study
Site Layout

Phase 1 Block 1

Detector locations

Green = GS01
Purple = Other

Block 1 area has wireless challenges due to heavy machinery blocking communication.

Detectors with extended antenna were chosen to overcome this challenge.
GS01 Case Study
Site pictures

- Elevated dual access points for good radio coverage
- GS01-EA, detector with extended antenna
Summary of Experiences from Kalundborg

• Planning of wireless infrastructure placement can largely be done by visual inspection.
• Recommended to have some extra infrastructure and instruments ready for use in case challenges occur during commissioning.
• Wireless technology increases the flexibility in placing and moving of equipment.
• Expanding wireless installations is very easy.
• Using wireless for safety is a step change for any organization. Local competence of wireless has to be developed.
Wrap-up

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For Your Attention!
Questions?

Ådne Baer-Olsen
Adne.Olsen@drager.com