Safety and alarming applications using ISA100 Wireless

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1 March 2016
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The History of Radio

• Marconi had an early interest in science, and was especially interested in the work of Hertz

• He quickly realized the potential of wireless transmission and filed a British patent
  – Awarded on 2nd July 1897, GB12039

• At 12:00pm on the 12th December 1901 Marconi sent and received the first Transatlantic radio transmission
The History of Radio

- On Sunday evening 14th April 1912 the largest passenger ship in the world, Titanic struck an iceberg.
- The radio operators onboard were employed by Marconi International Marine.
- They sent a distress signal **alerting** the world and the Carpathia: “CQD CQD SOS Titanic Position 41.44 N 50.24 W.…….”
- **Radio had proven it worth**...

*Wireless safety application has been started over 100 years ago.*
Today’s topics

1) Motivation of wireless for plant safety
2) Benefits
3) Key requirements
4) ISA100 Wireless solutions
5) Applications
6) Summary
• **Preventive measures**
  - Process condition / status monitoring: Temperatures / Pressures / Flows / Levels / etc.
  - Asset condition monitoring: Vibration / Corrosion / Temperature / etc.

• **Accident avoidance / Limit the extent of damages**
  - Alarm / Warning: *Gas leak detection* / Safety shower detection / *Tsunami detection*
  - Emergency shutdown: *Remote valve control* for safety mode

• **Human safety**
  - People tracking on site / Communication to navigate for evacuation / etc.

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Gas explosion ➔ Plant wide monitoring

Tsunami disaster ➔ Predictive monitoring

Fire of floating-roof tank ➔ Emergency shutdown
Unique benefits of wireless

Even more remarkable points are

- Robust to physical damages
- Easy expansion for additional measurement points
Key requirements for safety

- **Robust communication**
  - Committed reliability and availability
    - Reliable radio / Fault tolerant system
- **Emergency actions**
  - Committed deterministic performance
    - Timeliness / Rapid response time
- **Plant wide coverage**
  - Committed large scale configuration
    - Long range communication / Flexible configuration

**Dependable wireless system is required**
How to realize dependable wireless system?
ISA100 Wireless solutions

Field devices

✓ Long distance communication (600m line of sight)
✓ Safety layer is implemented on the top of ISA100 Wireless stack
✓ Multivendor interoperability for best in class solution

Wireless Infrastructure

✓ Redundant Gateway for highest reliability
✓ Multiple access point for scalable and flexible network
✓ 500 devices can be managed per one Gateway
✓ Coexistence management with CCA/Ch Black listing

Network Engineering

✓ Sky mesh concept (Installation guide) for scalable and stable network
✓ Support safety protocol (PROFIsafe) to connect SIL compliant system

Network Maintenance

✓ Network monitoring tool for visualize condition of the network
✓ Predictable & Long battery life by well managed NW
ISA100 Wireless (ISA100.11a / IEC 62734)
Industrial wireless network standard

**Plant wide solution:**
- Industry
- Oil & Gas, Petrochemicals, Powers, Metals, etc.
- Applications
- Process monitoring
- Process control
- Asset management
- Safety alarm management
- Energy monitoring
- Environmental
- etc.

**Breakthrough Technologies:**
- Two layered Security, OTA
- Mesh / Star / Duocast
- Battery Alert
- Interpretability
- Multiple subnets (co-existing)
- Bandwidth management
- Backbone network (Small-Large)
- Country code
- QoS (contracts)
- Multi-protocols by Tunneling
- Publish / Subscribe

**Assure multivendor interoperability**
- ISA100 compliance test
- Developing Implementation specifications

**Provide Solutions**

**Standardization**

**Implementation**

- ISA100.11a Architecture

- Open Expert Involvement Yielding Best in Class Designs
ISA100 Wireless System

- Temperature Transmitter YTA510
- Field Wireless Access Point YFGW510
- Field Wireless Management Station YFGW410
- Field Wireless Access Point YFGW510
- Temperature Multiplexer YTMX580
- Field Wireless Media Converter YFGW610
- Pressure transmitter EJX510B
- Pressure transmitter EJX118B/EJX438B
- Flange mounted Differential Transmitter EJX210B
- Differential Transmitter With Diaphragm Seal EJX118B/EJX438B

Multiprotocol Wireless Adapter
ISA100 Wireless System
ISA100 Wireless System
1. Reliability

Fault Tolerance

Redundant Gateway and Duocast

ISA100 Wireless Architecture
2. Timeliness

- **TDMA**: Time Division Multiple Access
- **Publish / Subscribe**: Periodic data transmission
- **The “Sky Mesh”**: Network planning concept

1) **Deterministic communication with short latency** (minimizing hops)
2) Reliable communication with **redundant paths**, Predictable battery life
3. Scalability

Plant wide large scale wireless infrastructure

ISA100 Full Functional

Redundant Gateway
1 sec Switchover

20 Access Points

500 devices@5sec update
200 devices@1sec update
4. Security

- Sniffing
- Data falsification
- Spoofing
- Reply attack

Secure A-I-C
A: Availability
I: Integrity
C: Confidentiality

ISA100 Wireless Network

Spread spectrum modulation
Channel hopping
Mesh network
Re-try
Duocast, Redundant GW
Provisioning
Network Join
Hop-to-hop security
End-to-end security

Encrypted data

Wireless device

Control system
5. Engineering

RF network planning tool

- Fix communication paths visually on graphic display
- Press auto paths button so that communication paths are automatically indicated: Easy engineering
6. SIL2 certification

SIL2 Gas detection system

- Wireless protocol: ISA100 Wireless
- Safety protocol: PROFIsafe over PROFINET
Summary
ISA100 Wireless key implementations

1. Reliability
   - Robust radio
   - Ch hopping
   - DuoCast
   - Redundant Gateway

2. Timeliness
   - TDMA
   - Sky Mesh design
   - Publish/Subscribe
   - Non-routing function

3. Scalability
   - IP Backbone
   - Mesh / Multi-hop
   - Long distance communication

4. Security
   - Device & Message authentication
   - AES-128 encryption key
   - Time stamp
   - Predictive battery life
   - Manageable network configuration
   - Multi-vendor interoperability

5. Engineering
   - Safety protocol
   - Event notification
   - Black Channel principle
   - Device diagnostics

6. SIL2 certification

Dependable wireless infrastructure for safety applications
Applications

1: World first SIL2 Wireless Gas detector

System overview

- The system uses GS01 wireless gas detectors (GasSecure - A Dräger Company) to measure hydrocarbon gas concentrations and Yokogawa ISA100 Gateway.
- Rapid response including gas-detecting time & communication
- Low energy consumption
- The gateway has PROFINET implemented in order to communicate with the controller which has PROFIsafe.
**RSSI & PER**

The ISA100 wireless system reliability, interoperability, and stability were put to test for six (6) months by monitoring the Received Signal Strength Indicator (RSSI) and the Packet Error Rate (PER).

Robust and Reliable Wireless Network of 5km with Received Signal Strength Indicator (RSSI) of approximately 60dBm and Packet Error Rate (PER) of 0%

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http://www.isa100wci.org/en-US/Learning-Center/White-Papers
2: Tsunami warning system

Lessons learned from the great east Japan earthquake disaster

Level meters equipped with the wireless adaptor are installed on a storm surge barrier near the plant to monitor the tide level. Because a tsunami is usually preceded by a sudden ebb tide, detecting a sudden lowering of tide level may indicate a tsunami.

System overview

- Level meter is connected ISA100 Wireless adapter
- Long range communication from field wireless device to Access Point without repeaters (up to 600m)
- Duocast for redundant communication
Wireless Adapter - Supports multiple protocols

- Supports multiple protocols
- Examples:
  - Limit switch
  - Transmitter (4-20mA)
  - Solenoid valve

- Models:
  - FN310-M
  - FN310-J
  - FN510

- Protocols:
  - SENCOM (MODBUS)
  - Wired HART®
  - Diagnostic (pH, ORP, Temp.)

- Functions:
  - ON/OFF status
  - ON/OFF control
  - PV/ SV Diagnostic

- Ex. Devices:
  - FU20F -NPT
  - Transmitter (HART)
  - Limit switch
  - Solenoid valve
  - Transmitter (4-20mA)
Modularizing wireless components to accelerate product development

- Certified radio regulations
- Certified Intrinsically Safety

ISA100 Wireless radio module

ISA100 Wireless communication functions are encapsulated in the antenna radio module

Antenna

ISA100 Wireless Stack & RF circuit

Serial I/F

Wireless Adapters

Rader level meter

Paperless recorder with Gateway

Valve control box for emergency shutdown
Serious fire accident was happened at the tank firm in northern part of Japan after the big earthquake.

Floating roof tank was shaking and oil was leaked via the drain for rain water. Then fire accident was happen by ignition on leak oil.

System overview
- Rapid response for controlling valve
- Read back status can be monitored
- 10 years battery life
- Compliant to Japanese regulations regarding to the earthquake and tsunami for hazardous materials facilities

Close drain valve to avoid fire accident when big earthquake occurred.
Summary

• Industrial wireless technology creates great opportunities to provide new paradigm for plant safety

• Dependable plant wide infrastructure must be required to cover variety of wireless safety applications

• World first SIL 2 wireless gas detection system has been realized with co-innovation of multiple vendors and multiple breakthrough technologies on the ISA100 Wireless
Thank you for your attention

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