Implementation and evaluation of reliable industrial wireless system based on ISA100.11a standard

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Contents

• Industrial wireless and ISA100.11a standard
• Implementation and Evaluation approach
• Applications
• Conclusion
Industrial wireless
Overview of ISA100.11a

Breakthrough technologies against the eleven user requirements:

1. State of art security
2. Mesh network, Duo-cast
3. Battery Management, Non-routing device
4. WCI interoperability conformance test
5. Multiple-subnet
6. TDMS/CSMA/ Hybrid
7. IPv6 address / Backbone Routing
8. 2.4GHz ISM Band, Country code
9. QoS mechanism (contracts)
10. Object oriented application, Tunneling
11. Backbone routing
Plant Wide Field Wireless System

- 500 devices, 20 subnets
- Full Redundant
- Flexible Topology & Installation

ISA100 Full Functional
Implementation and Evaluation approach for reliable wireless system

(1) Radio Level
- Long Range Communication
- Robust in "Pipe Jungle"
- Robust in Co-existence with Wi-Fi

(2) Network Level
- Redundant Radio Communication
- Redundant Network Architecture
- Flexible Network Topology

(3) Operation Factor
- Robust Operation
- Deterministic Control
- High Update Speed (1sec)

CUSTOMER’S BENEFITS

Application versatility:

Stable Network:

Reliable Radio:
(1) Radio Level

- Application versatility:  
  - Robust Operation  
  - Deterministic Control  
  - High Update Speed (1sec)

- Stable Network:  
  - Redundant Radio Communication  
  - Redundant Network Architecture  
  - Flexible Network Topology

- Reliable Radio:  
  - Long Range Communication  
  - Robust in “Pipe Jungle”  
  - Robust in Co-existence with Wi-Fi

Robust in pipe jungle:  
Almost 0% PER

Coexistence with Wi-Fi:  
5.5% PER

Stable in Pipe Jungle:  
- Comparison in the same installation  
  at a chemical plant  
- Phase-3 products (ISA100) error rate is very low

Evaluation result of Communication Distance:  
- Long-Distance Communication  
- ISA100 products cover wider area than other Products. (3 times longer)

50%  
0  
0  
16:26 17:24 18:21 19:19

Evaluation results of PER under the Multi Path Environment in the actual plant - “Pipe Jungle” -

- Phase-3 [ISA100] (avg.0.1%)
- Phase-3 [ISA100] (0.2%)
- Phase-3 [ISA100] (8.5%)
- Phase-2 (30.7%)
- Phase-2 (avg. 24.0%)

2.4GHz Radio

Stable in Pipe Jungle:  
- “Pipe Jungle” -
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Evaluation results of Robustness against radio Interference:  
- LAB testing of Wi-Fi Co-existence  
  - The result of Coexistence test with WiFi  
  - Phase-3 Product (ISA100) error rate is less than one-fifth of that of  
    Phase-2 Product using its blacklist function.

Robust in Co-existence with WiFi:  
- 5.6 times error

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Wireless Network Design
for reliable and deterministic communication

Long distance communication + repeater without line of site communication till 50m

Communicate from a height

GW

Repeater

Repeater (A)

300 m

600 m
(2) Network Level

**Reliable network:** Duocast

**Scalability:** IEEE1588 synchronization

**Application versatility:**
- Robust Operation
- Deterministic Control
- High Update Speed (1sec)

**Stable Network:**
- Redundant Radio Communication
- Redundant Network Architecture
- Flexible Network Topology

**Reliable Radio:**
- Long Range Communication
- Robust in “Pipe Jungle”
- Robust in Co-existence with Wi-Fi

**CUSTOMER’S BENEFITS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Speed</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Cable</td>
<td>100Base-TX / 100Mbps</td>
<td>0.1km</td>
</tr>
<tr>
<td>Optical Fiber Cable</td>
<td>100Base-FX / 100Mbps</td>
<td>2km</td>
</tr>
<tr>
<td>Wireless LAN</td>
<td>IEEE802.11 a/b/g / 11Mbps, 54Mbps</td>
<td>10km</td>
</tr>
<tr>
<td>2-Wire Cable</td>
<td>1Mbps</td>
<td>1km</td>
</tr>
</tbody>
</table>

**Flexible network:** Multi-media connection
Duocast
for improving the reliable radio communication

- PERa: Packet Error Rate of path-A
- PERb: Packet Error Rate of path-B

\[ \text{PER} = \text{PER}_a \times \text{PER}_b \]
Duocast

Evaluation result in the field

Theoretical PER = \( \text{PER}_a \times \text{PER}_b \)

\[
= 15\% \times 13\% \\
= 1.95\%
\]

<table>
<thead>
<tr>
<th></th>
<th>BBR-A</th>
<th>BBR-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>PER of Unicast</td>
<td>15%</td>
<td>13%</td>
</tr>
<tr>
<td>Theoretical PER of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duocast</td>
<td>1.95%</td>
<td></td>
</tr>
<tr>
<td>Evaluation result</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of PER</td>
<td>2%</td>
<td></td>
</tr>
</tbody>
</table>

✓ Observed PER (2\%) was almost equal to theoretical value (1.95\%)
Redundant Gateway

Evaluation of Redundancy

✔ Switch over time was less than 1 second without any data losses of wireless network
IEEE 1588 base time synchronization to coexist with multiple subnets
Interleaved hopping pattern 1 with 16 different hopping pattern offsets
Network configuration for ISA100 scalability test

Process Overview
Graphics

Field Control Station

20 Access Points

Field Wireless Management Station

MW100 DATA LOGGER

500 wireless Sensors
Multi-media interface between Gateway and BBR

Enhanced Field Devices

Field Wireless Access Point

Field Wireless Management Station

Max 500 Devices

*R1.5 current Field Devices can work in R2 Wireless Network

Max 20 APs

Enhanced Field Devices

Field Wireless Access Point

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Max 20 APs
(3) Application Factor

**CUSTOMER’S BENEFITS**

**Application versatility:**
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Dynamistic control
PID algoirm for wireless

Work easier and safer: Augmented Reality

Easy configuration: Network Mgt tools
Customer’s Benefits

ISA100.11a full functional provides

- **Reliable**: Robust, Redundant and Secure
  - Cover wide range applications from monitoring to control
    - Deterministic network
    - Reliable network
    - Scalable network
    - Control ready

- **Flexible**: Future proof
  - Cost effective network
  - Scalability of network

- **Open**: Interoperability certified by WCI
  - Multivendor solution
  - Choose the best in class device
Field Wireless Applications

Application 18. Chemical Company

- **Application:** As wireless analog output converter
- **Challenges:** Monitor of sound noise level and communicate to DCS
- **Field Wireless Solutions:**
  - Sound level meter has input sensor that can measure and indicates the noise level
  - The converted signal is scaled between 0mV and 10V and transmitted to remote DCS.

Application 22. Paper Plant

- **Application:** Flow, pressure, and temperature monitoring
- **Challenges:** Monitor points are almost at the ground level for level measurement and flow are at a height of over 3km from ground.
- **Field Wireless Solutions:**
  - Main storage yards are at the 4th location, in total there are 9 monitor points.
  - Repeater is installed on the 3rd floor.

Application 25. Gas Corporation

- **Application:** Monitoring pressure at bottom of tanks
- **Challenges:** The measurement point is bottom of tank, tank is huge metallic globe, and the direction of radio path had to be considered.
- **Field Wireless Solutions:**
  - The antenna is set on the roof of control room, and keep radio path to field device.
  - Pressure Transmitter is installed at pressure measurement port of tank.

Field Wireless Applications

- **Application 23. Oil Company (Oil refinery)**
  - **Application:** Temperature and pressure monitoring
  - **Challenges:** The distance is too long, but there are many pipes and tanks (“Pipe Jungle”) in the field.
  - **Field Wireless Solutions:**
    - Repeaters are installed on high place between control room and monitor position.
    - The extend cable is used for antenna of Gateway.
  - **Field Wireless Benefits:**
    - Eliminate wiring and maintenance costs
    - ISA100 robust communication and low Packet Error Rate (PER)
Conclusion

- We have developed and evaluated a new system implementing wireless technologies with flexibility, scalability, and reliability, all of which are targets of the ISA100.11a standard.

- This new solution has three major features:
  - Reliable: Full Redundant Architecture with Duocast Technology
  - Flexible: Installation Flexibility & Scalability
  - Open: Interoperability with wide portfolio application

- Commits continuous investment in total wireless solution to achieve customers’ Needs
  - Develops a new field digital features including “Field Digital” innovation that contributes to customers’ productivity improvement.
Thank you for your attention.