Setting the Standard for Automation™

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

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Yokogawa Electric Corporation

Standards
Certification
Education & Training
Publishing
Conferences & Exhibits

Presenter

- Toshi Hasegawa is a Manager of industrial automation technology marketing, particularly with wireless. Toshi has been working for Yokogawa Electric Corporation for 23 years, and he has worked for development of Distributed Control Systems (DCS). His current activity is mainly on standardization and marketing of industrial wireless network. He is a voting member of ISA SP100 Wireless System for Automation. And he is a district leader of the ISA100 Wireless Compliance institute (WCI) Asia Pacific. Toshi is also member of the Japan national committee of IEC/TC65/SC65C/WG17 (Wireless communication network and communication profiles-Coexistence). He is a chairman of Wireless working group of Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA).

YOKOGAWA

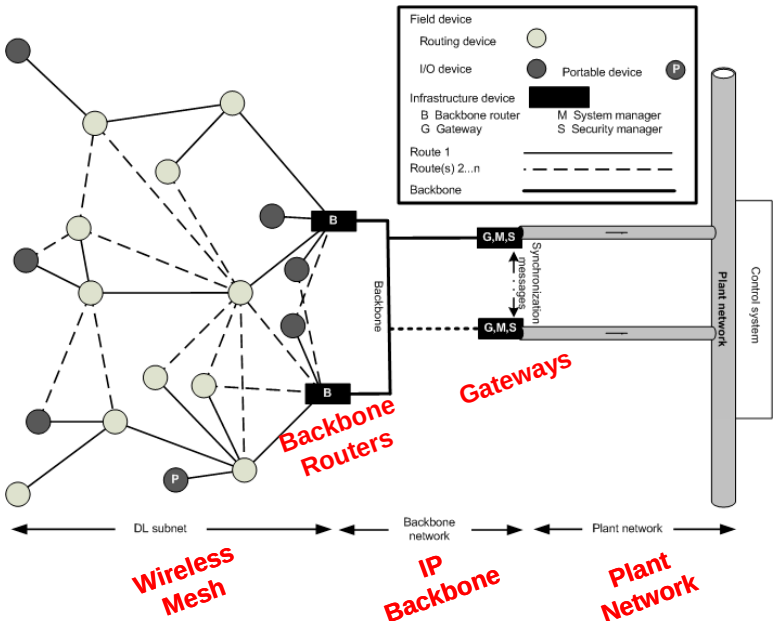
Contents

- Industrial wireless and ISA100.11a standard
- Implementation and Evaluation approach
- Applications
- Conclusion

Industrial wireless

Overview of ISA100.11a

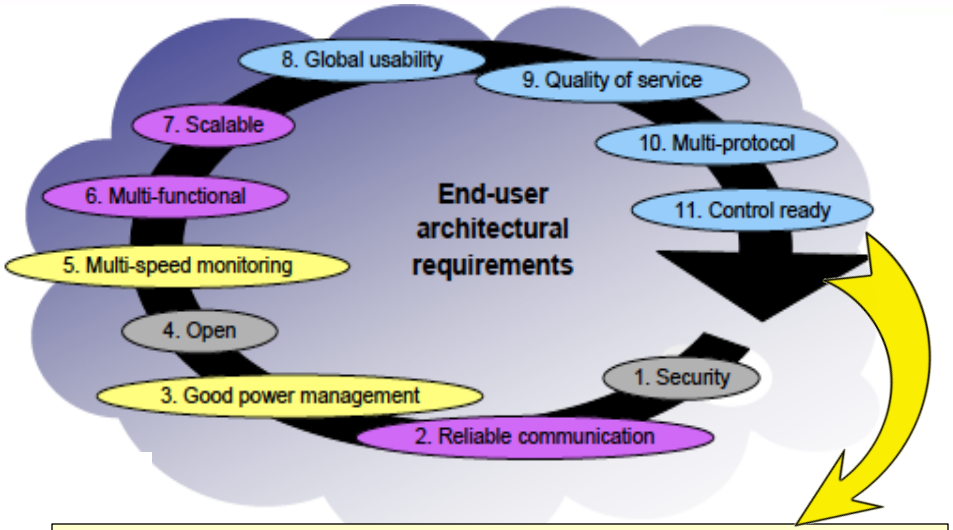
ISA100.11a Architecture



Safety	0	Emergency action	Always critical	Safety interlock Emergency shutdown Automatic fire control
Control	1	Closed loop Regulatory control	Often critical	Control of primary actuators High frequency cascades
	2	Closed loop Supervisory control	Usually non-critical	Low frequency cascade loops Multivariable controls Optimizers
	3	Open loop control	Human in the loop	Manual flare Remote opening of security gate Manual pump/valve adjustment
Monitoring	4	Alerting	Short-term consequences	Event-based maintenance Battery low indicator Asset tracking
	5	Logging Downloading/ uploading	No immediate consequences	History collection Preventative maintenance rounds Sequence of events (SOE) reporting

More Performance

More Devices



Breakthrough technologies against the eleven user requirements:

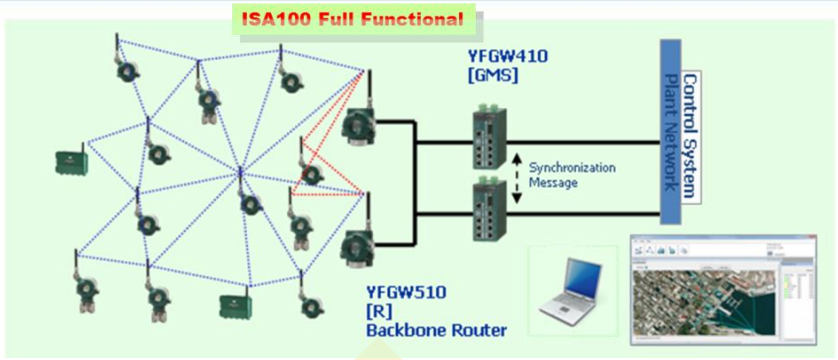
1. Sate of art security
2. Mesh network, Duo-cast
3. Battery Management, Non-routing device
4. WCI interoperability conformance test
5. Multiple-subnet
6. TDMS/CSMA/ Hybrid
7. IPv6 address / Backbone Routing
8. 2.4GHz ISM Band, Country code
9. QoS mechanism (contracts)
10. Object oriented application,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

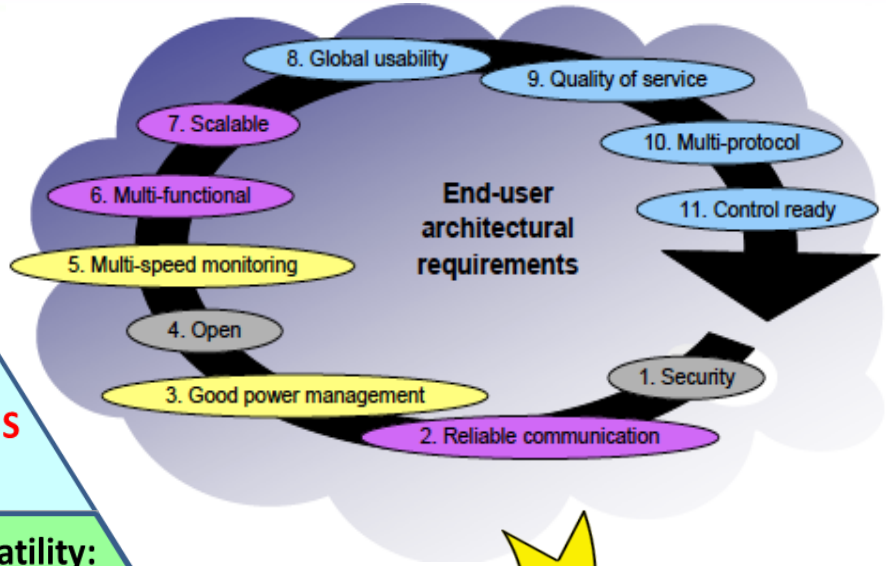
Plant Wide Field Wireless System

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

ISA100 Full Functional

Implementation and Evaluation approach for reliable wireless system





(3) Operation Factor

(2) Network Level

(1) Radio Level

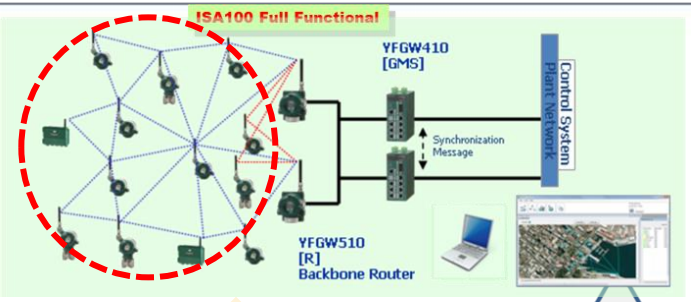
CUSTOMER'S BENEFITS

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

(1) Radio Level



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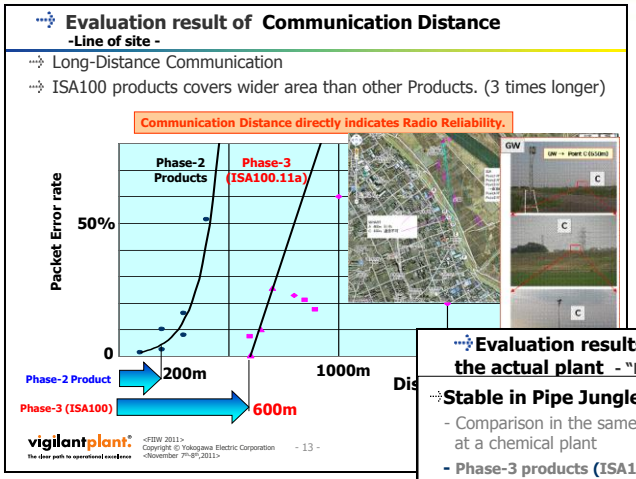
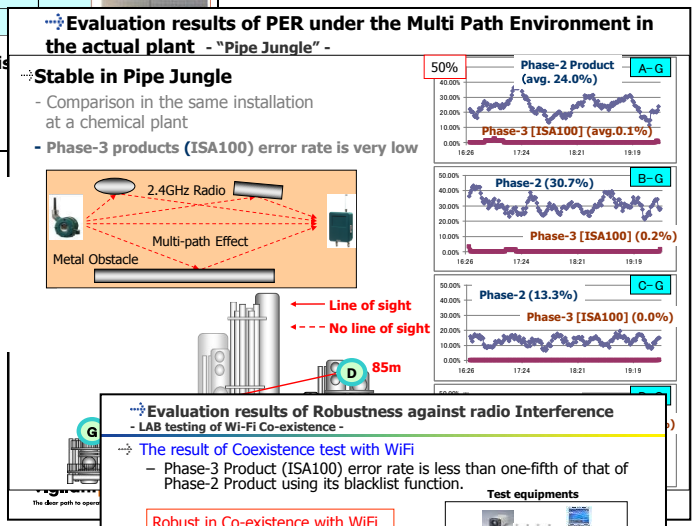
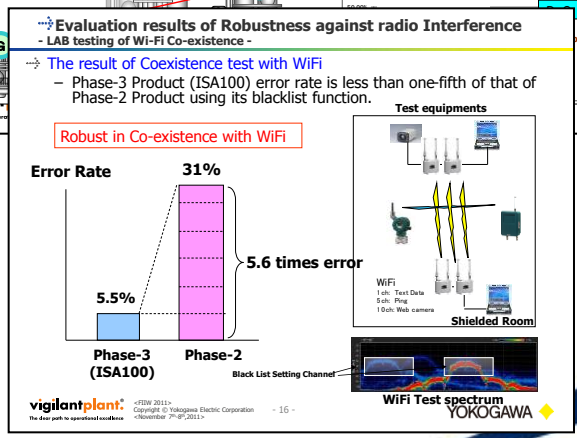


Long range: 600m



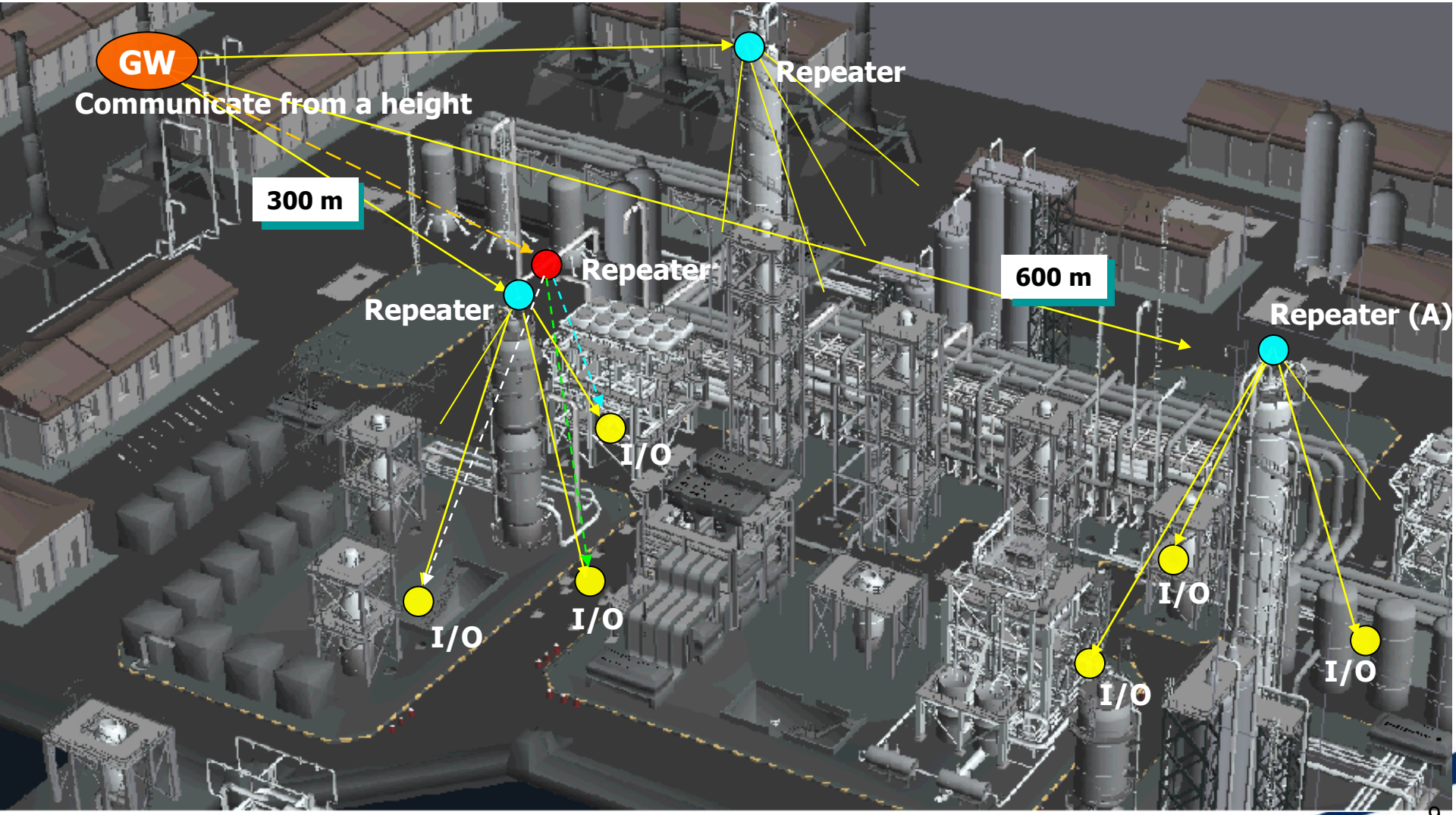
Robust in pipe jungle: Almost 0% PER



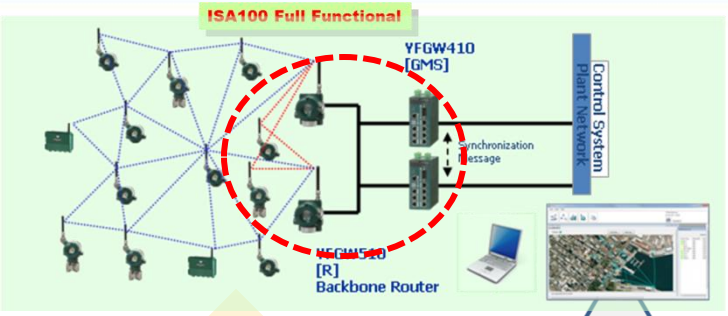
Coexistence with Wi-Fi : 5.5% PER

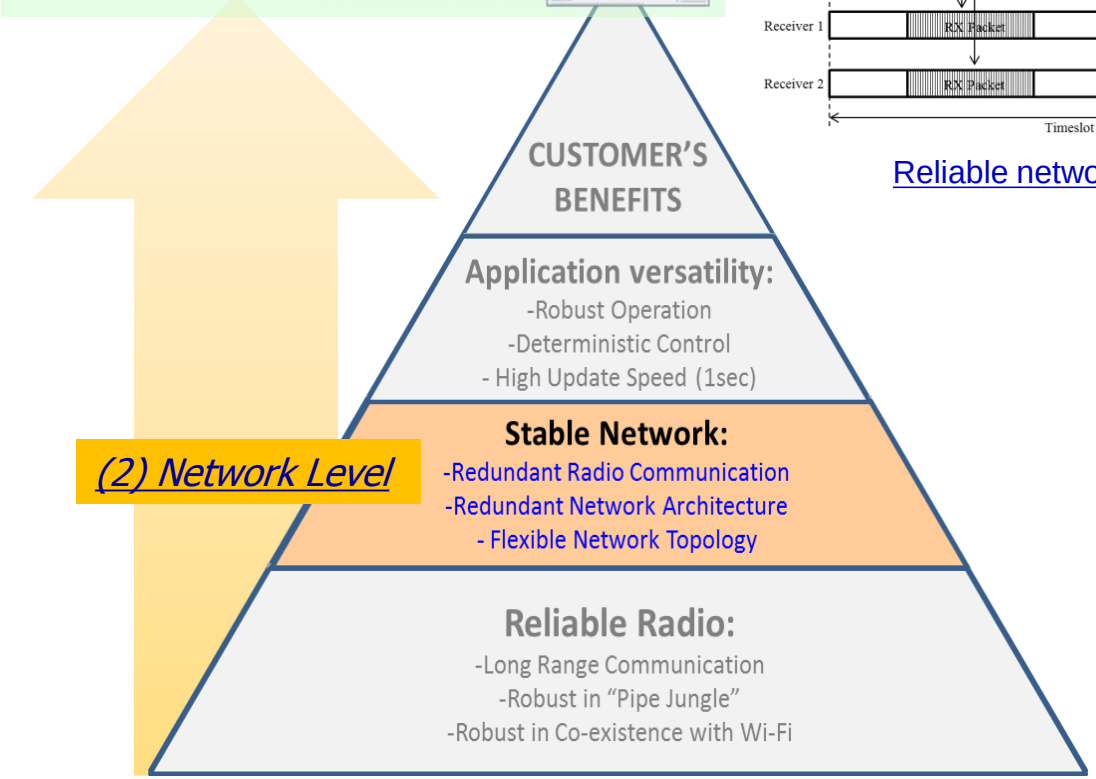
Wireless Network Design for reliable and deterministic communication

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



(2) Network Level





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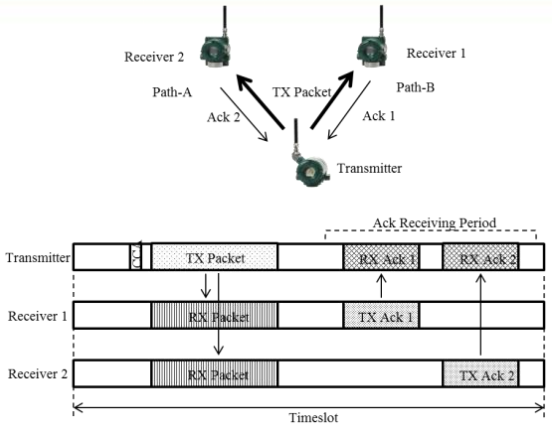
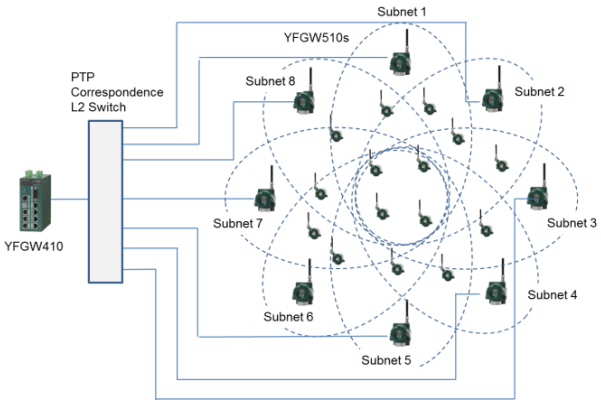
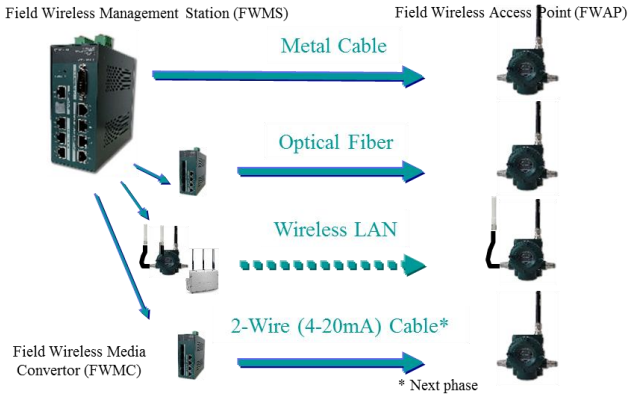


Reliable network: Duocast



Scalability: IEEE1588 synchronization

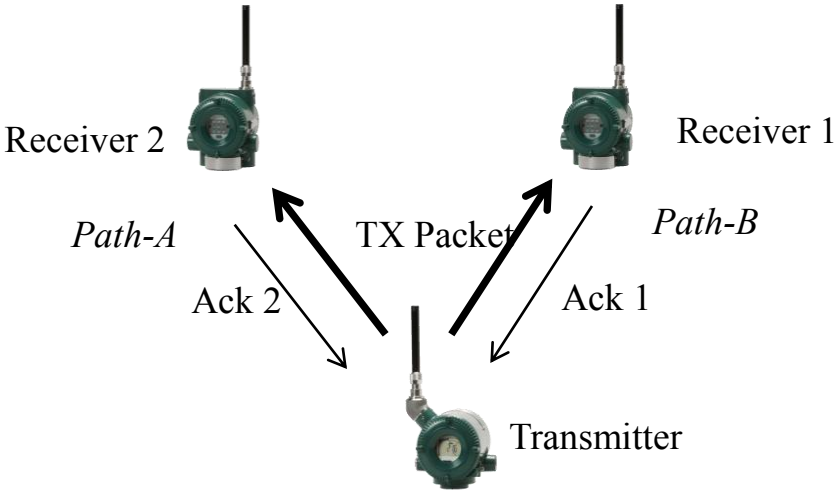


Type	Speed	Range
Metal Cable	100Base-TX / 100Mbps	0.1km
Optical Fiber Cable	100Base-FX / 100Mbps	2km
Wireless LAN	IEEE802.11 a/b/g / 11Mbps, 54Mbps	10km
2-Wire Cable	1Mbps	1km

Flexible network: Multi-media connection

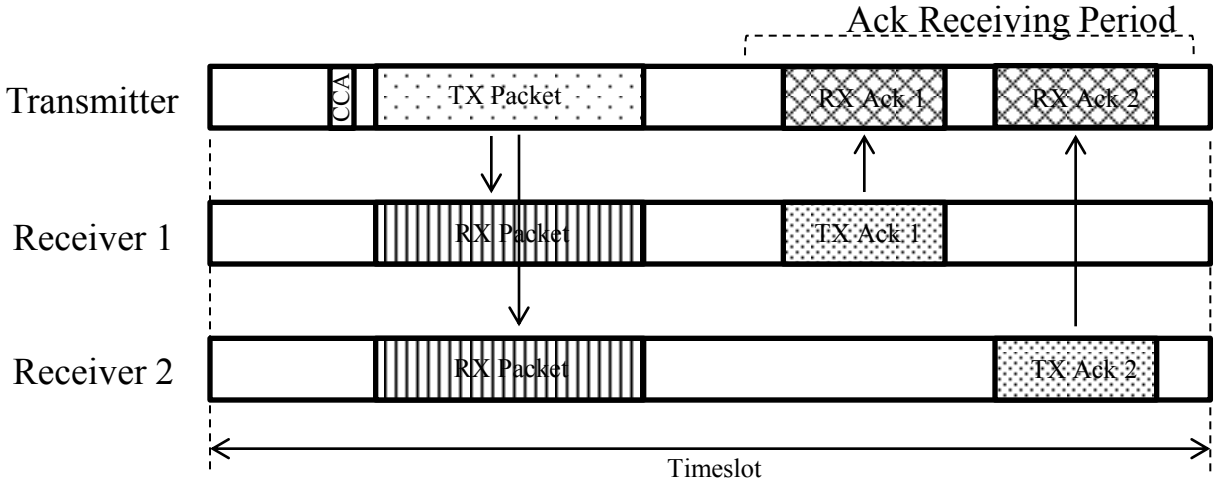
Duocast

for improving the reliable radio communication



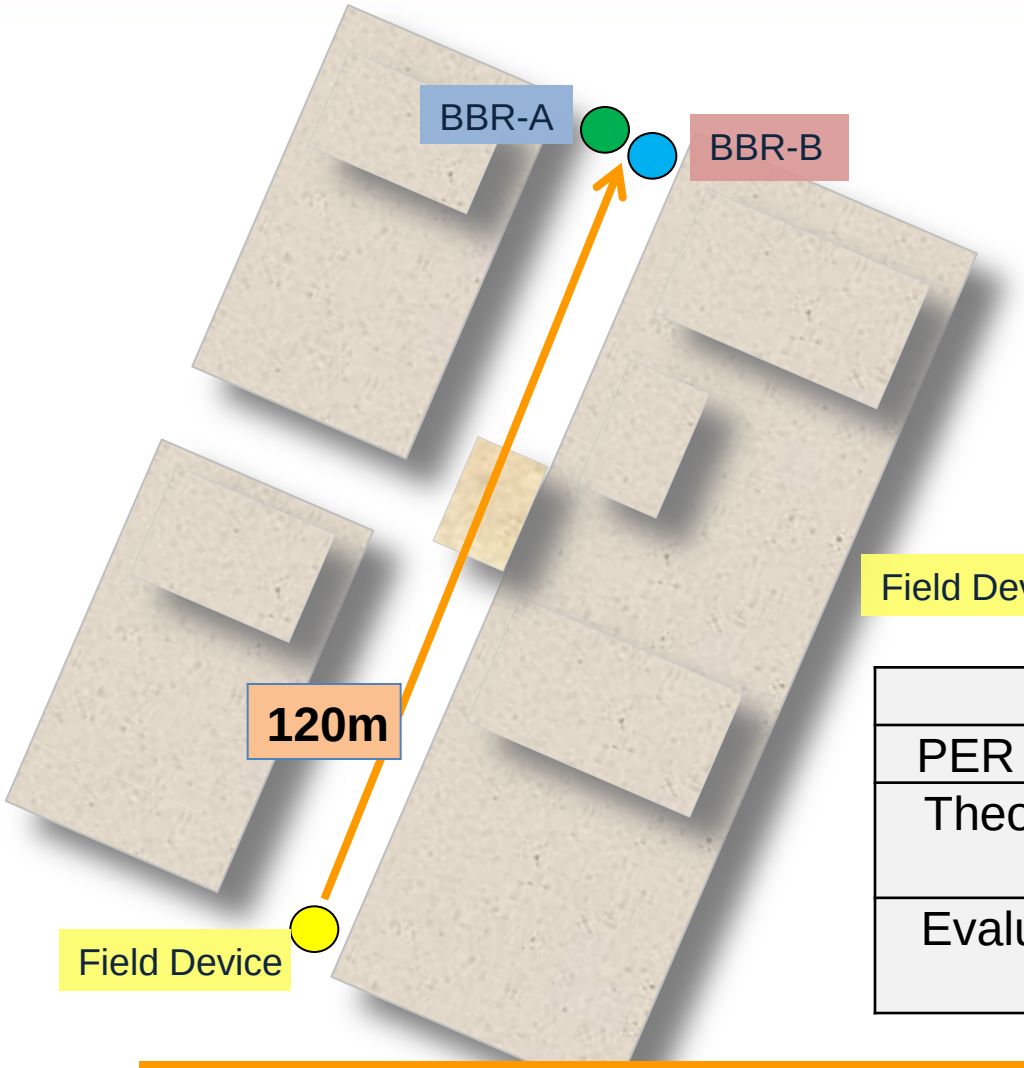
- PERa: Packet Error Rate of path-A
- PERb: Packet Error Rate of path-B

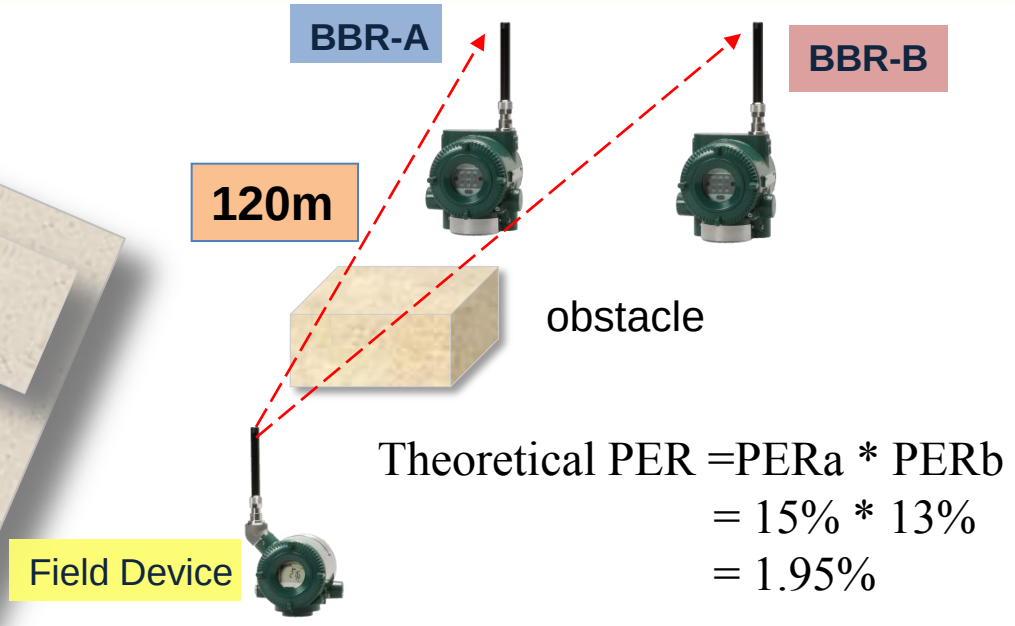
PER =PERa * PERb



Duocast

Evaluation result in the field



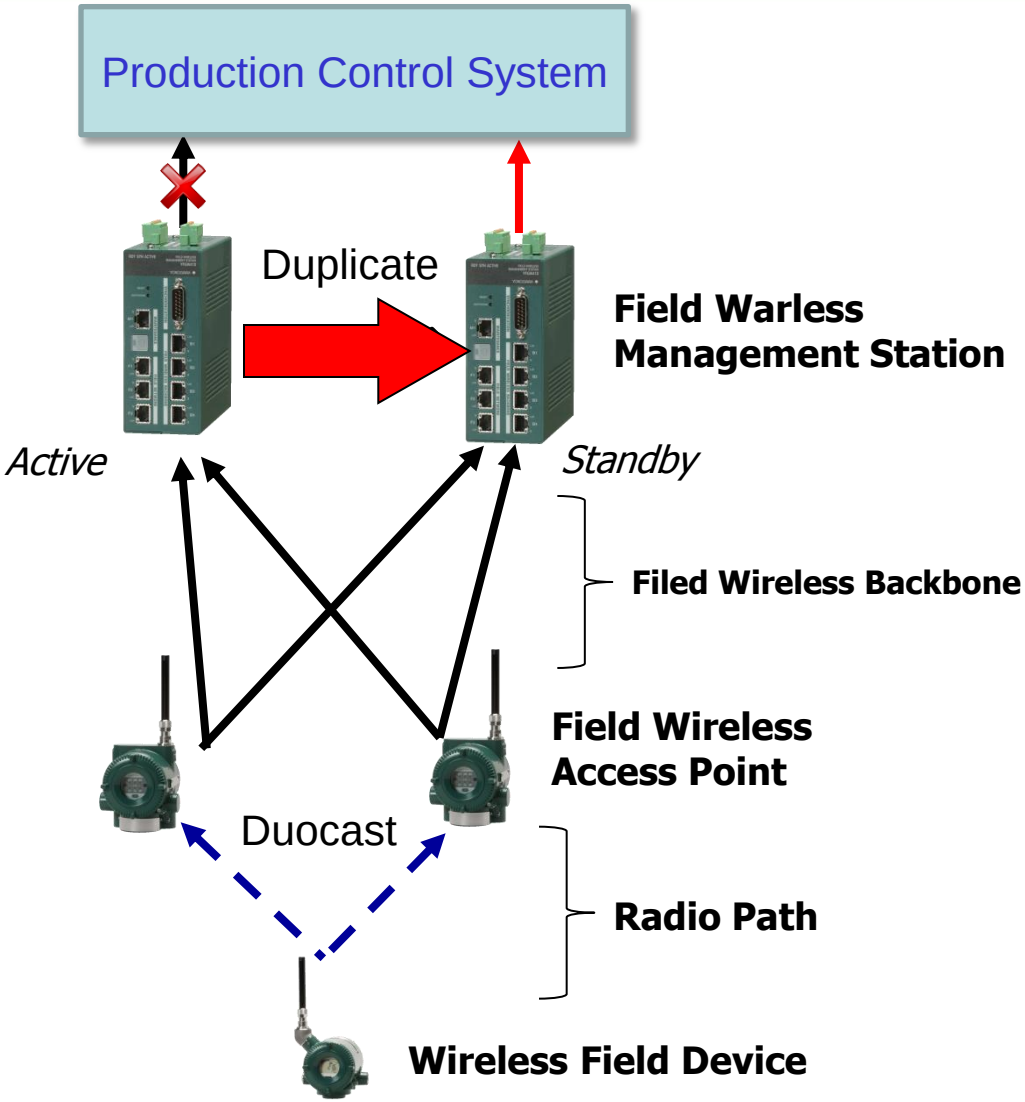


Theoretical PER =PERa * PERb
= 15% * 13%
= 1.95%

	BBR-A	BBR-B
PER of Unicast	15%	13%
Theoretical PER of Duocast	1.95%	
Evaluation result of PER	2%	

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

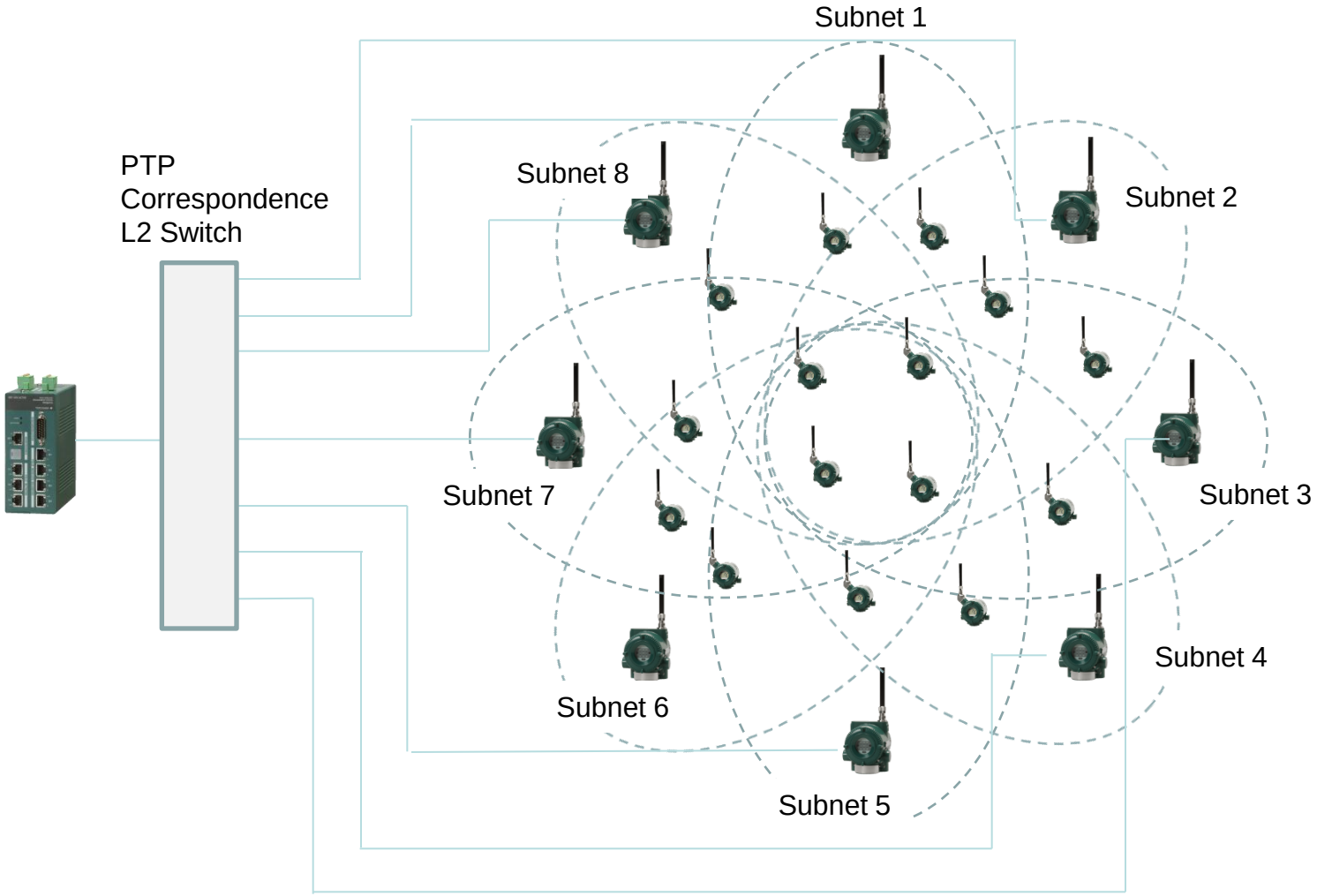
Redundant Gateway



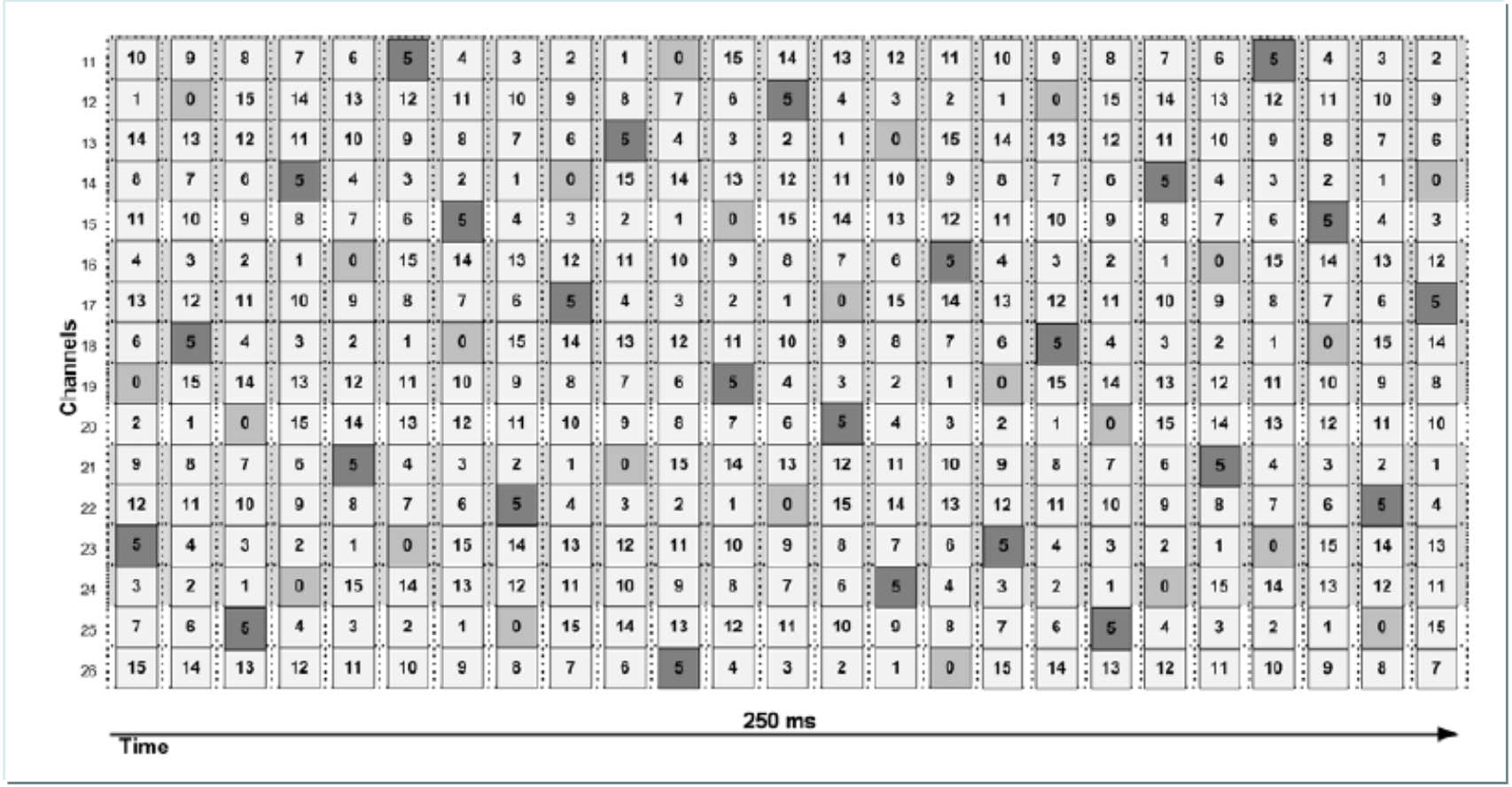
Evaluation of Redundancy

- ✓ 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

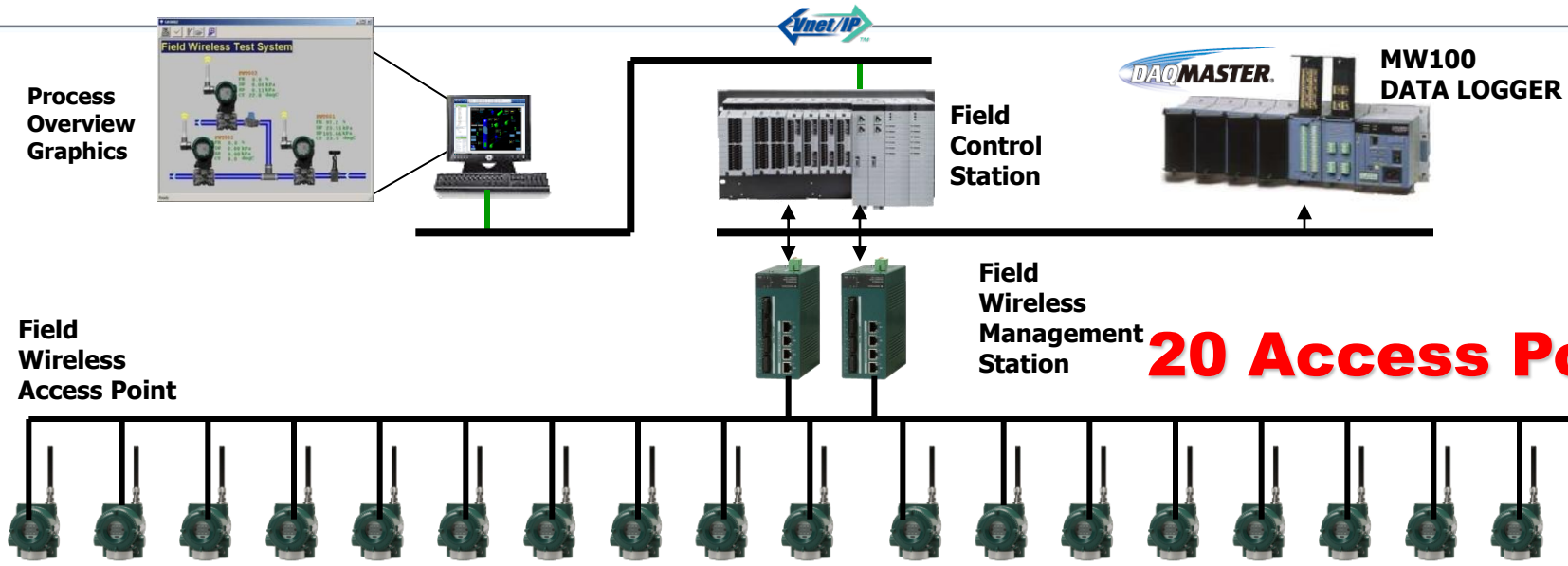


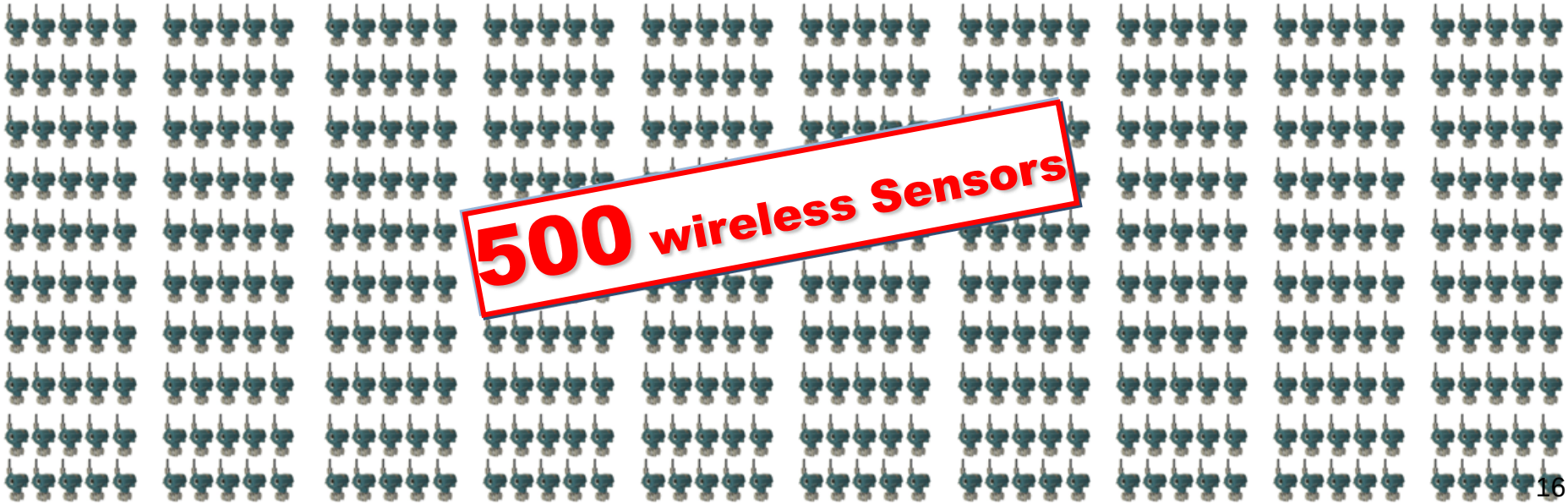
ISA100.11a Interleaved hopping



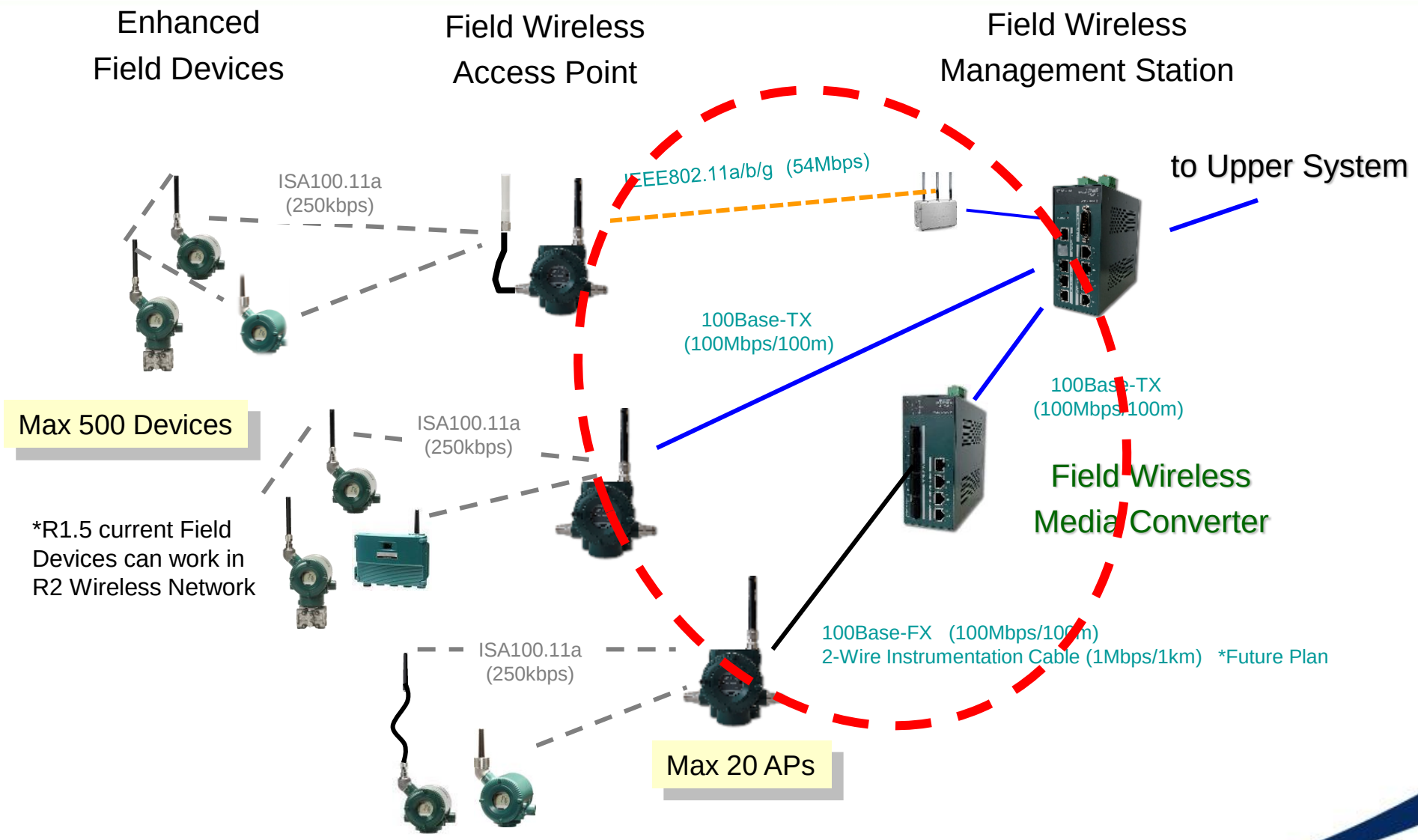
Interleaved hopping pattern 1 with 16 different hopping pattern offsets

Network configuration for ISA100 scalability test

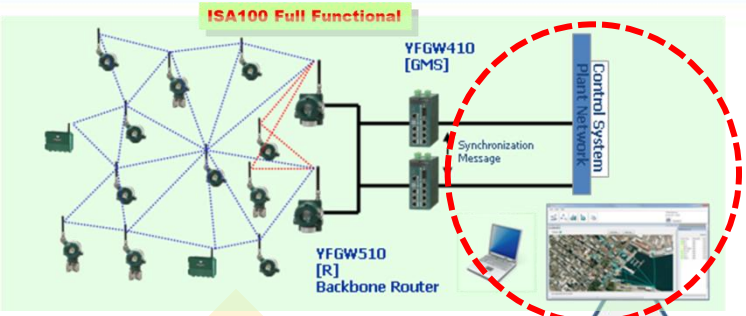


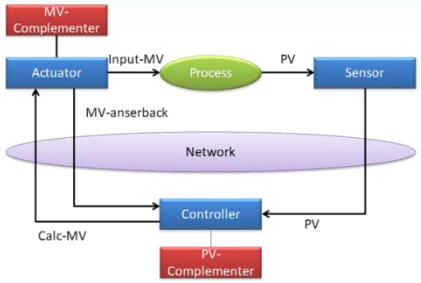


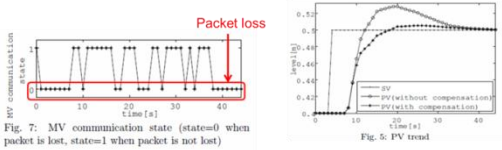
Multi-media interface between Gateway and BBR



(3) Application Factor



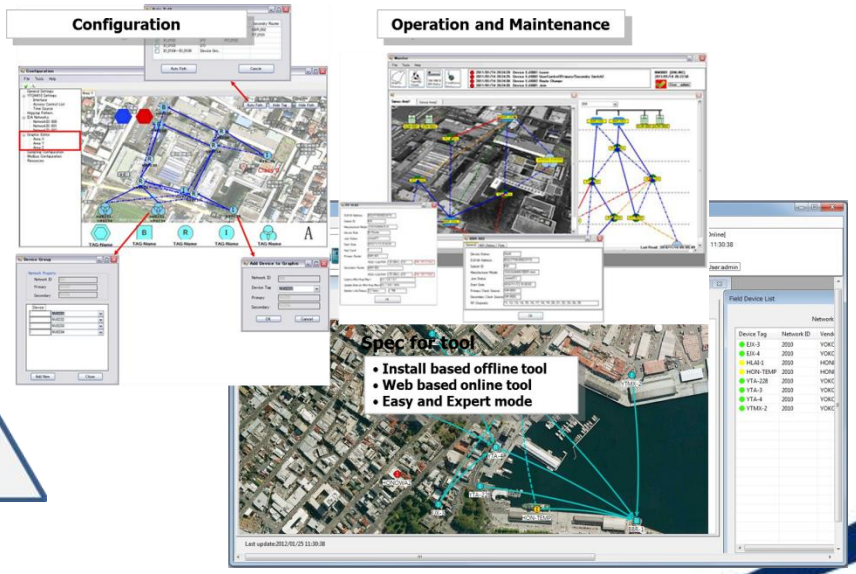




[Work easier and safer: Augmented Reality]

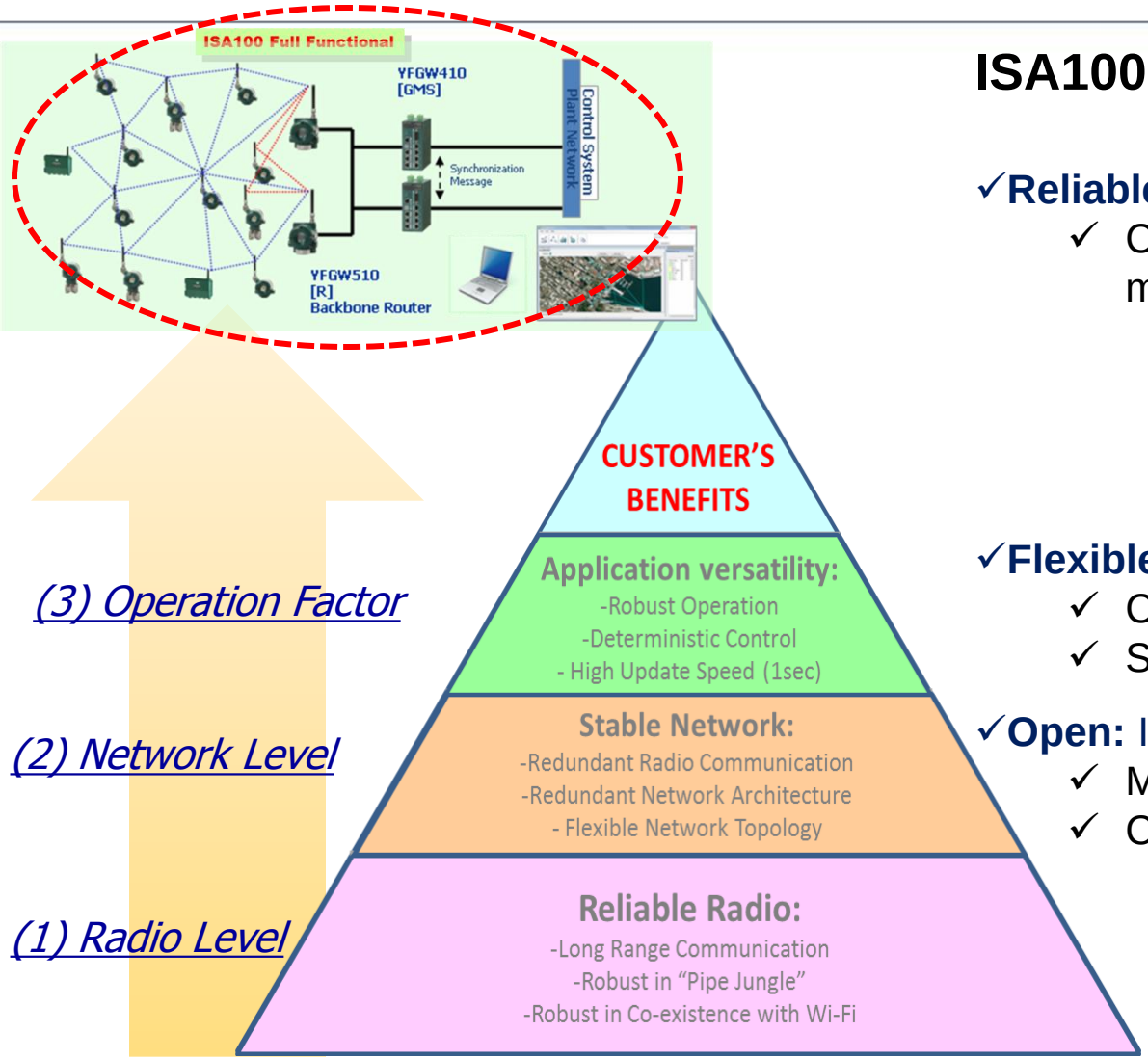
[Deterministic control
PID algorism for wireless]

(3) Application Factor



[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
- Monitoring of sound noise level that is generated from factory

Challenges
- Monitor of sound noise le
and communicate to DCS

Field Wireless Solutio
- The sound level meter ha
and indicates the noise le
- The DC voltage output is
- The converted signal is c
resister, and YTA can rec
- The noise level data is se
- Repeater is installed on t

Field Wireless Benefi
- Flexible monitoring points
- Eliminate wiring and mai

Application 22. Paper Plant

Application: Flow, pressure, and temperature monito
- Diesel tanks that feed fuel to their diesel generator's which are at three
from each other.

Challenges
- The monitor points wae almost at the ground level for level measureme
flow are at a height of over 1m from ground.
- There are a lot of trees from around in between the measuring location

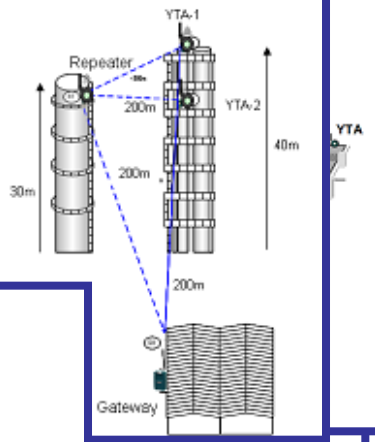
Field Wireless Solutions
- Main storage yards are at fourth location, in total there are 9 monitor p
- The monitoring before was just through dip rods and estimation.
- Correct positioning of Repeater at each of the measuring

Application 24. Chemical Company

Application: Test the wireless communication quality at high position

Challenges
- The position of Transmitters are very high (30m to 40m).

Field Wireless Solutions
- Repeater is installed on the top of 30m height tower.
- 2 Temperature Transmitters (YTA) are installed on the 5th and 7th floor of another tower.
- The distance of Gateway to Repeater and Repeater to YTA are approximate 200m.



Field Wireless Benefits
- Established high quality communication by ISA100 Wireless;
Packet Error Rate (PER) 0% to 3%

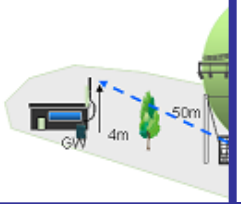
Application 25. Gas Corporation

Application: Monitoring pressure at bottom of tanks
- Monitoring the pressure of gas tank.
- There are 5 tanks in the yard.

Challenges
- The measurement point is bottom of tank.
- This place is enclosed in the cage of metal.
- Tank is huge metallic globe, so the direction of radio path had to be cared.
- There are some trees between the field device and control room.

Field Wireless Solutions
- The antenna is set on the roof of control room, and keep radio path to field device.
- Pressure Transmitter (EJX) is installed at pressure measurement port of tank.

Field Wireless Benefits
- Eliminate wiring and maintenance costs
- Established high quality communication by ISA100 Wireless;
Packet Error Rate (PER): Max 4%



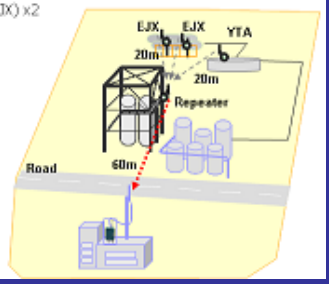
Application 23. Oil Company (Oil refinery)

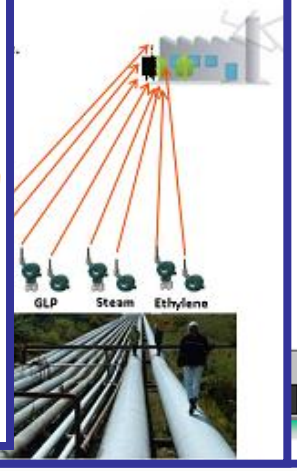
Application: Temperature and pressure monitoring
- Monitoring temperature of reactor and pressure of circulation filter.
- The distance between monitor point and control room is about 80m.

Challenges
- The distance is not so long, but there are many pipes and tanks ("Pipe Jungle") in the field.
- Had to avoid the obstacles and take care multi path condition.

Field Wireless Solutions
- Repeater is installed on high place between control room and monitor position.
- The extend cable is used for antenna of Gateway.
  - Temperature Transmitter (YTA) x1, Pressure Transmitter (EJX) x2

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.