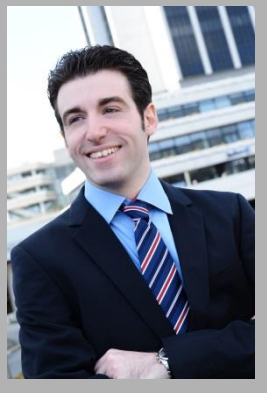
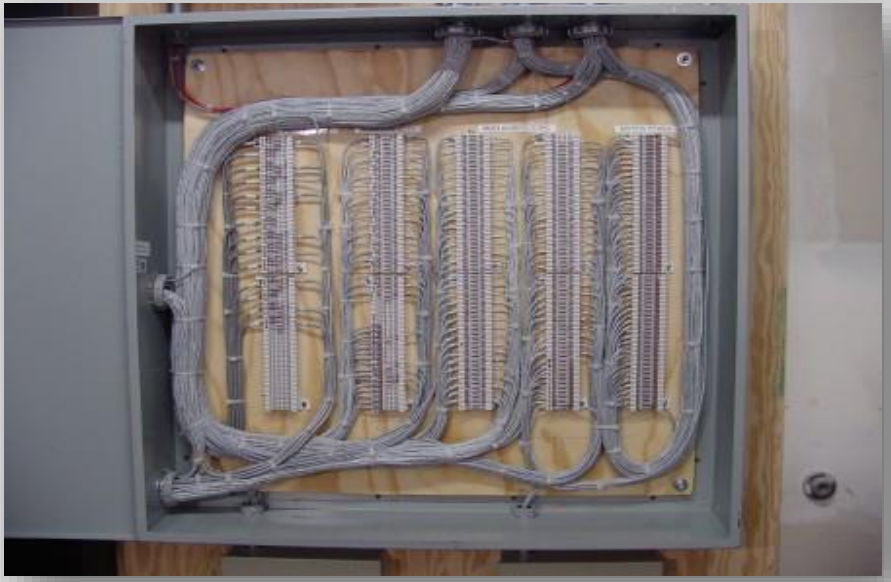
Wireless gas detection in monitoring and safety applications

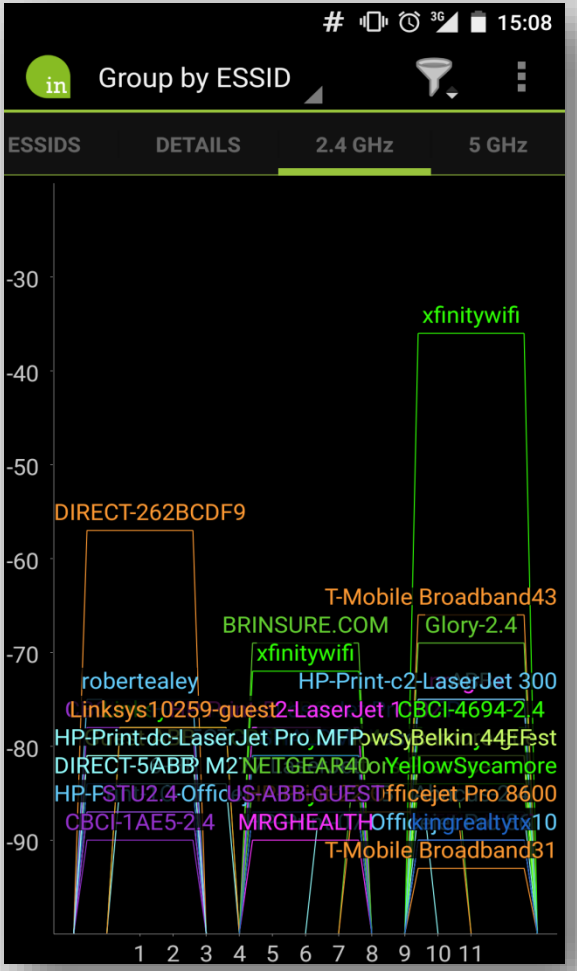
Design and performance criteria for devices & networks

Houston, 06/29/2016, Florian Dahm, Global Marketing Manager Oil & Gas



Wireless Technology
Pros and cons

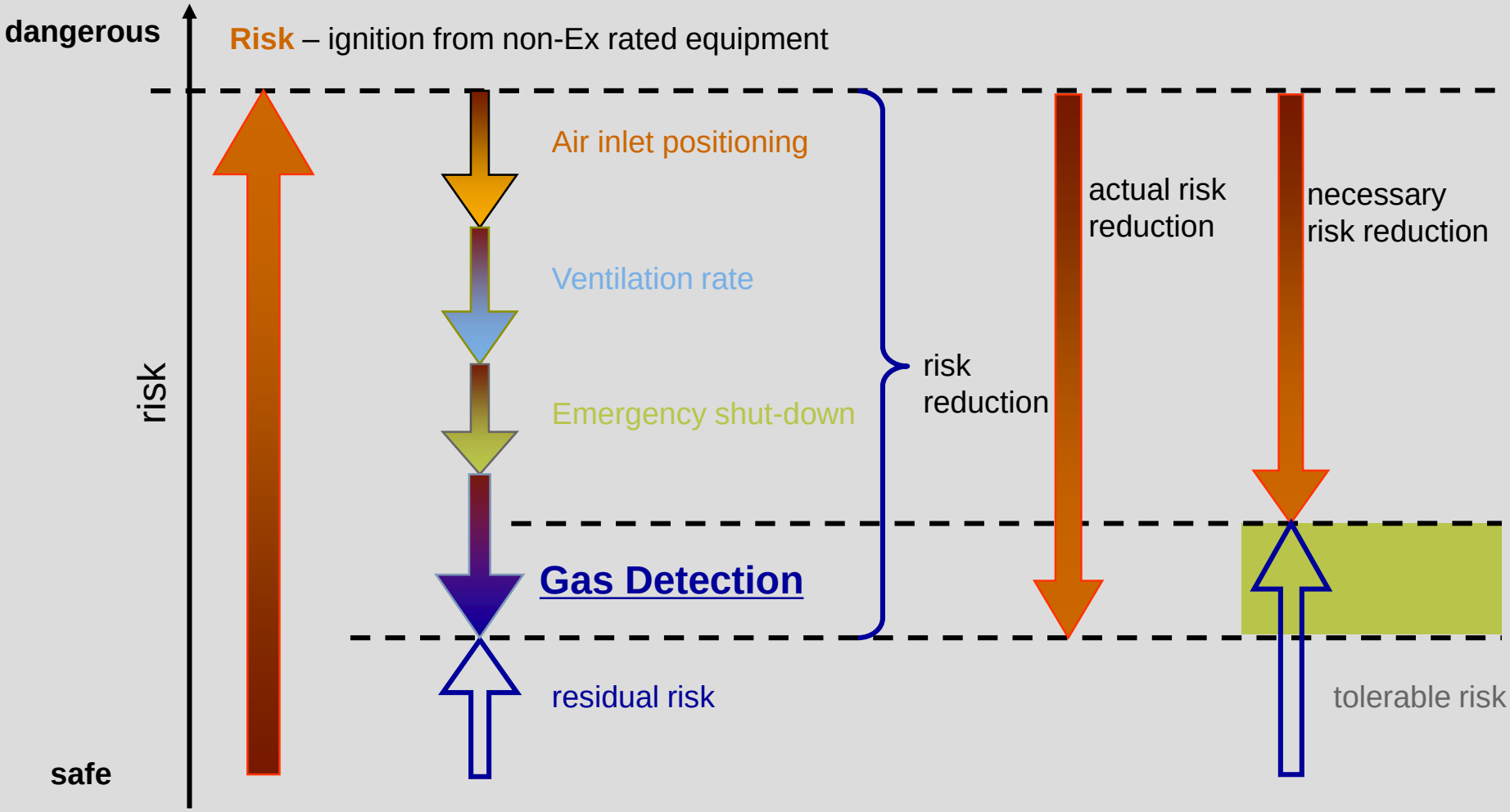




Wireless offers the possibility to **significantly save on cabling, engineering, documentation and labor** –

but wireless networks have to be very **carefully designed** to offer a comparable level of performance!

Monitoring or Safety?
A risk-related view



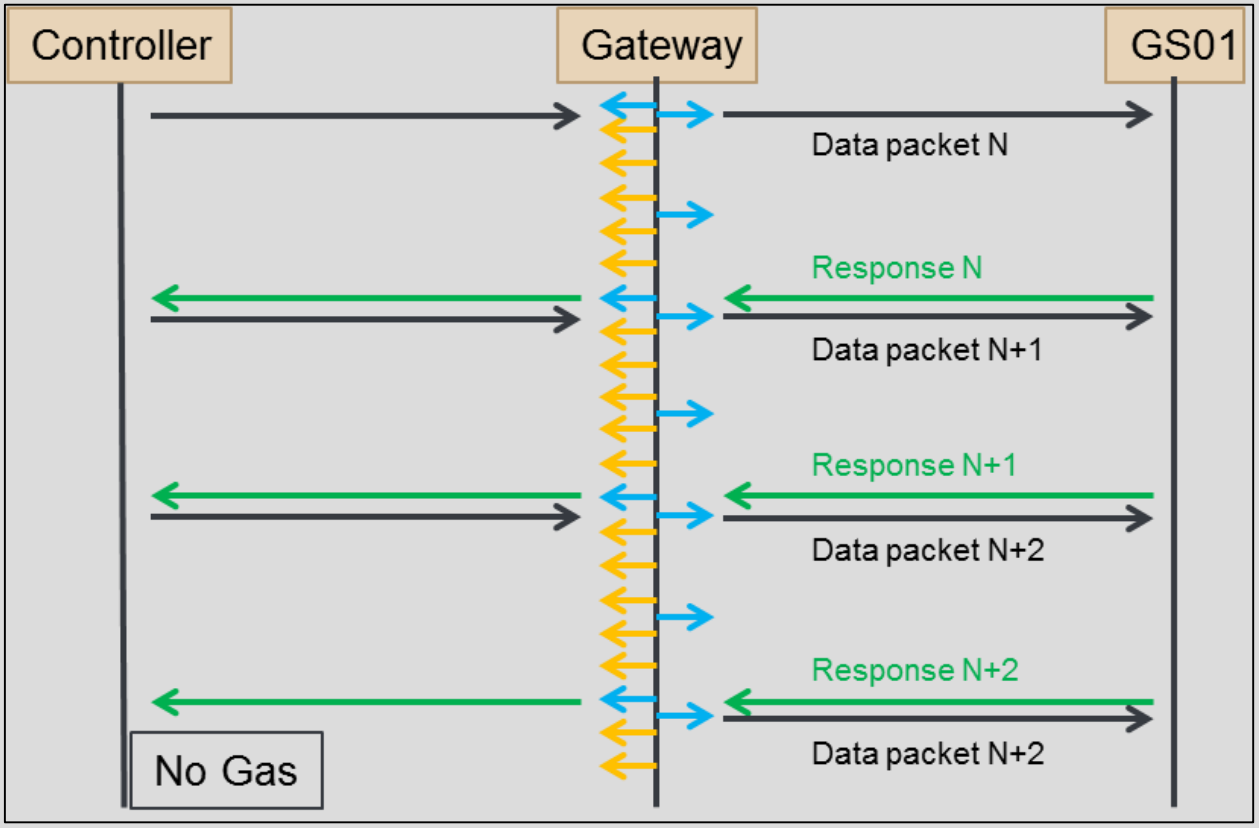
(Wireless) Gas Detectors in Safety Applications
Design & performance criteria

- High availability
  - No lapse in detection coverage due to “blind” times or loss of packages
  - Communication patterns that allow for fast response times – **balanced with battery lifetime** for wireless applications
- High reliability
  - Reliable detection technology with no false alarms
  - Long maintenance intervals, little/no drift in between test intervals
  - Suitable for use in **SIL applications**

⇒ Safety protocol – deployment environment – configuration

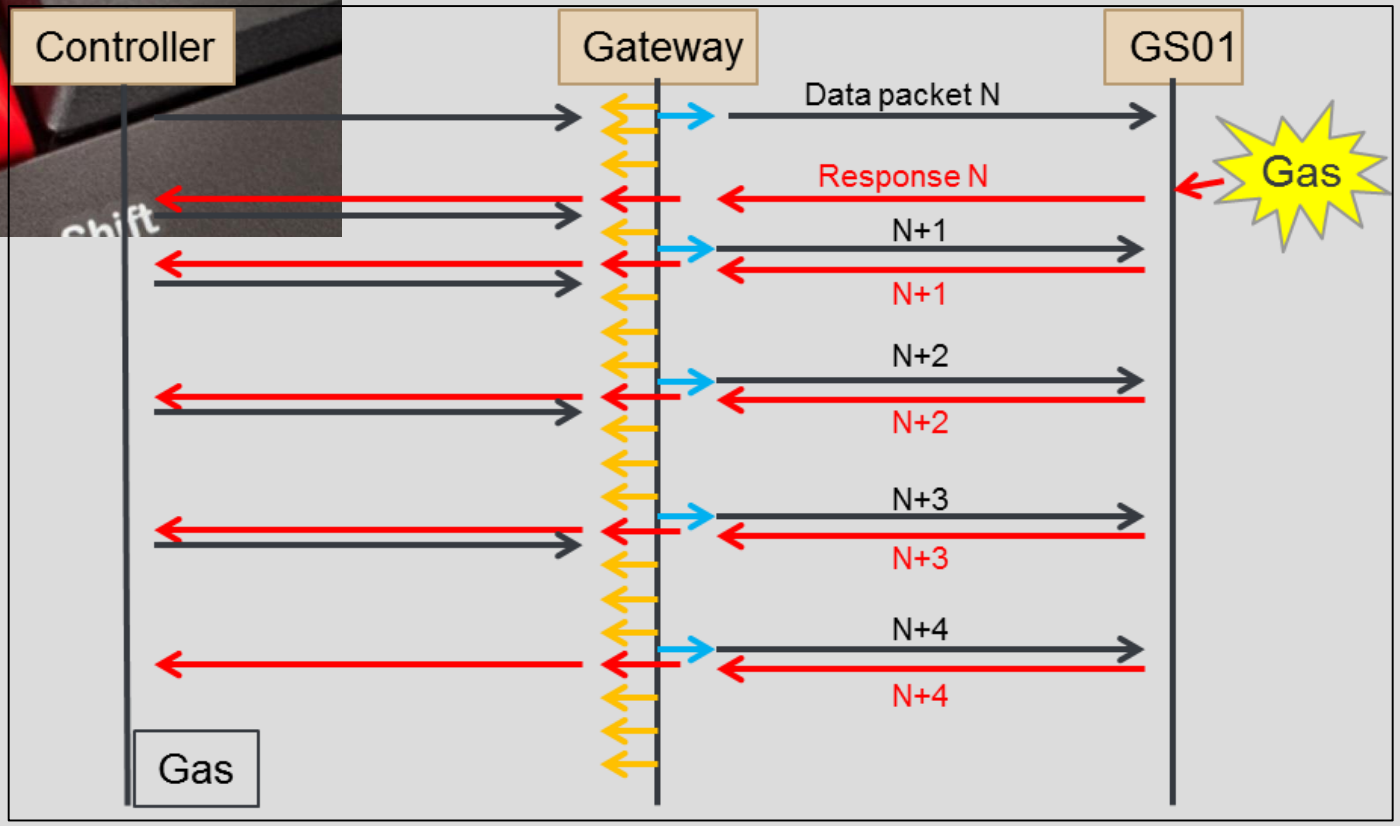
Wireless Networks in Safety Applications
Device communication patterns (1/2)

Balancing requirements for **long battery life** with **acceptable response time** – a trade-off?



Wireless Networks in Safety Applications

Device communication patterns (2/2)



Wireless Networks in Safety Applications
Criteria for network protocols (1/4)

- End-to-end **safety protocol according to IEC 61784-3** is required in SIL environments, which means that
  - Tunnelling/mapping of foreign safety related protocols such as PROFIsafe through the network is needed

- Quality of Service through limits for bandwidth, latency, and **priority** is ensured
- Integrity/**secure** (encrypted) wireless communication is provided
- Device **interoperability** supports communication of devices from multiple vendors on one network is feasible

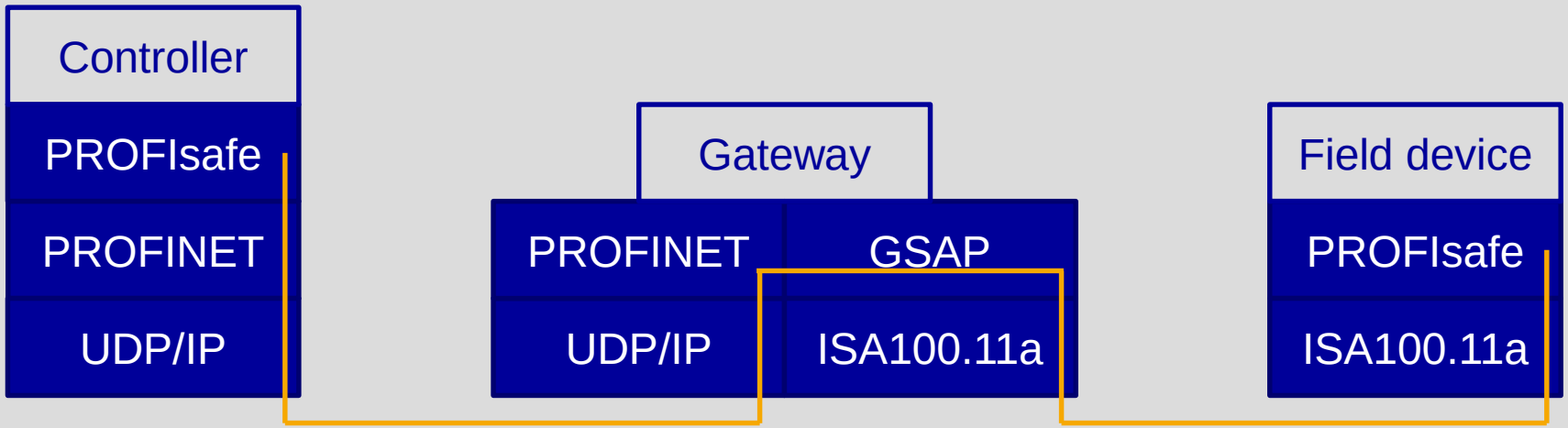
- ISA100.11a provides for all of this!

Wireless Networks in Safety Applications
Criteria for network protocols (2/4)

PROFIsafe is a safety related profile **defining application specific functionality** on top of PROFINET. PROFIsafe is SIL3 certified!

Black channel principle

- Independent of the communication method
- Covers the entire communication path from the sensor to the controller – the gateway needs to support PROFINET
- Protects for eventual failures in communication wrt to SIL capability



Error-handling mechanisms addressed by PROFIsafe: Safety-related protocols need to be able to mitigate a range of errors if used in SIL environments:

Failure/Remedy	Sequence Number	Time-out with Receipt	Codename for Sender and Receiver	Data Consistency Check
Repetition	X			
Deletion	X	X		
Insertion	X	X	X	
Resequencing	X			
Data Corruption				X
Delay		X		
Masquerade		X	X	X
FIFO failure		X		

Only the combination of **ISA100.11a and PROFIsafe** currently allows us to implement all 4 mechanisms!

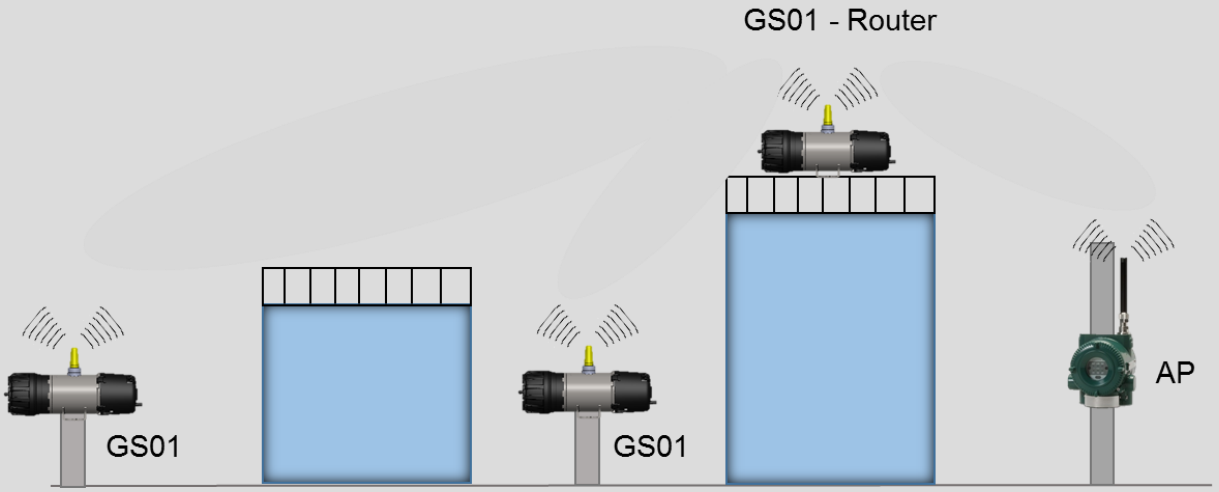
Wireless Networks in Safety Applications
Criteria for network protocols (4/4)

Quality of Service can give priority to packages from certain devices, protocols etc.

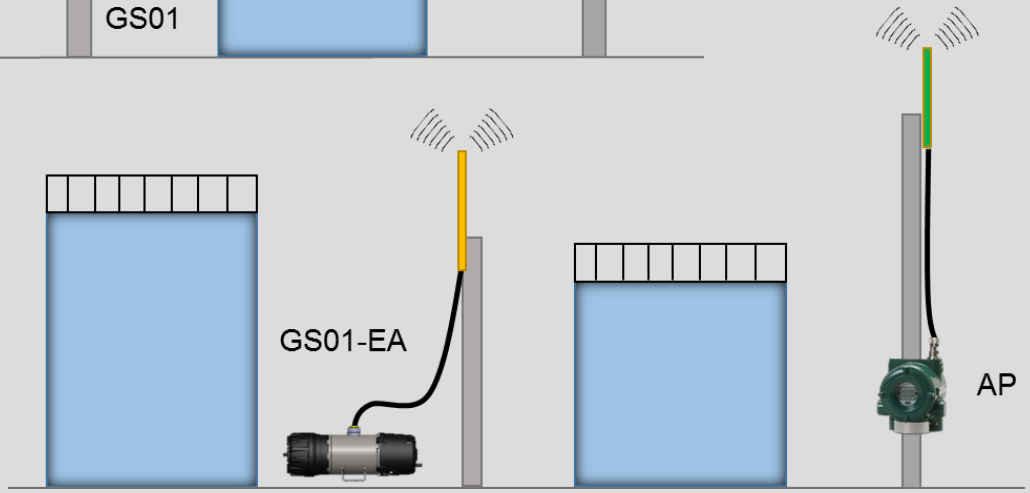
In safety-related applications, this can be used to **give priority/reserve bandwidth/ensure low latency** for safety-related packages as opposed to e.g. monitoring packages.

Wireless Networks in Safety Applications
Deployment environment (1/3)

Even if we use a safety-related protocol, we still need a **reasonable level of control over the deployment environment** to ensure a high level of performance…



Practical solutions: Use of **routers** (within hop limit spec) or **extended antennas** (careful with attenuation though)



Wireless Networks in Safety Applications
Deployment environment (2/3)

Co-existence with **IEEE 802.11g WiFi**, without CCA: Assessment of package error rate in % with a WiFi node transmitting 20 dBm EIRP, using channel 6. The field is forced to use the channel shown below:

Separation (m)	Channel 17	Channel 18	Channel 19	Channel 20
67.4	**100**	**100**	**100**	**0**
75.6	**100**	**100**	**100**	**0**
84.8	**100**	**100**	**96**	**0**
95.2	**94**	**100**	**52**	**0**
106.8	**63**	**80**	**19**	**0**
119.8	**21**	**36**	**2**	**0**
134.4	**0**	**10**	**1**	**0**
150.8	**0**	**1**	**0**	**0**
169.2	**0**	**0**	**0**	**0**
189.9	**0**	**0**	**0**	**0**

Solution: ISA100.11a provides for "**clear channel assessment**" (listen before talk)

Wireless Networks in Safety Applications
Deployment environment (3/3)

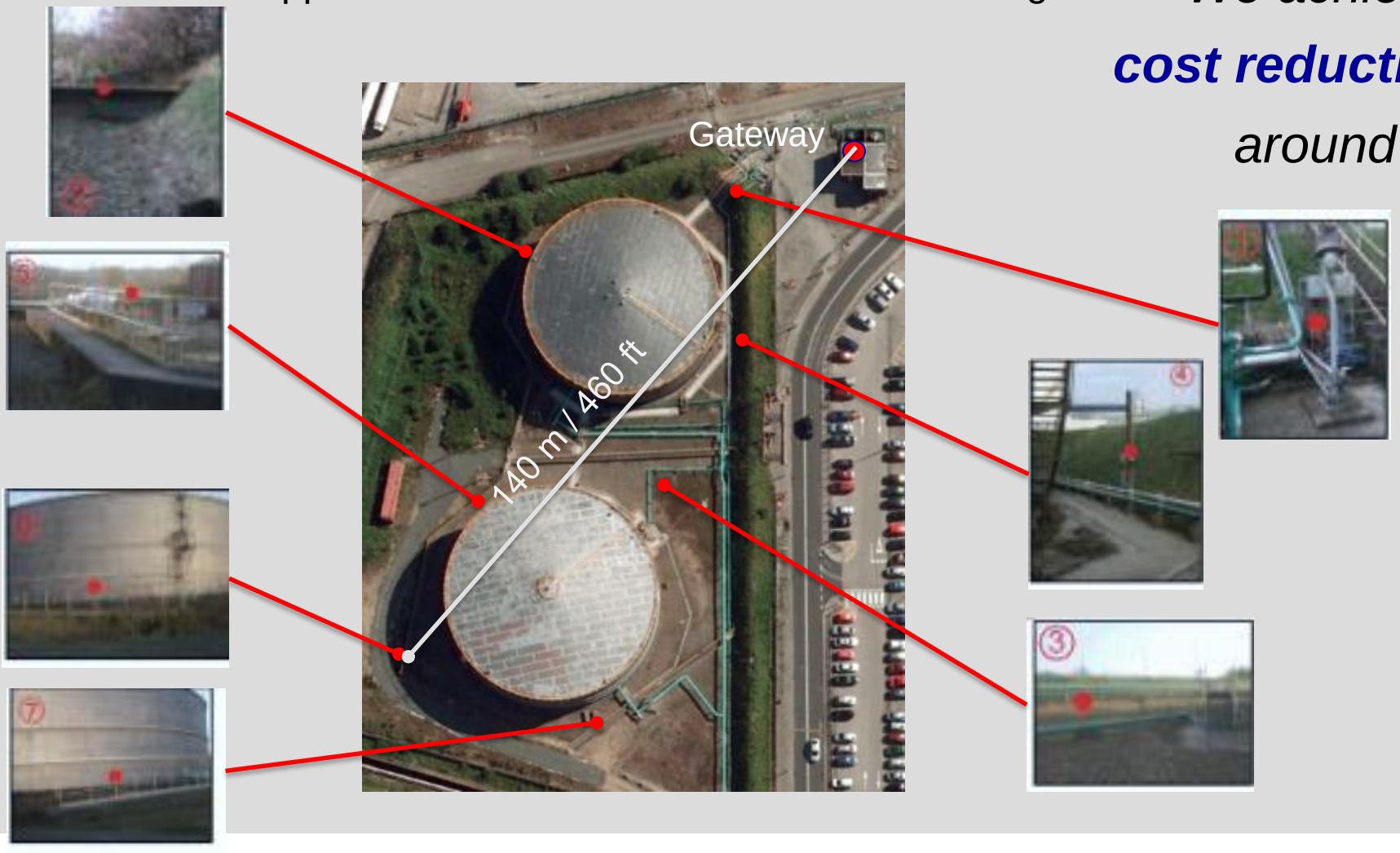
Co-existence with **additive white Gaussian noise** (AWGN) simulating a range of random noise sources: Assessment of package error rate with CCA turned off at different channels, example see below…

AWGN (dBm) at 50m distance	Calculated received noise power for a 2 MHz wide channel (dBm)	Package error rate (%)
0	**-74.68**	**0**
1	**-73.68**	**1**
2	**-72.68**	**4**
3	**-71.68**	**26**
4	**-70.68**	**66**
5	**-69.68**	**91**
6	**-68.68**	**100**

Solution: site surveys that **measure the noise floor for each channel**, channel blacklisting is then applied as required

Wireless Networks in Safety Applications
Settings and configurations (1/2)

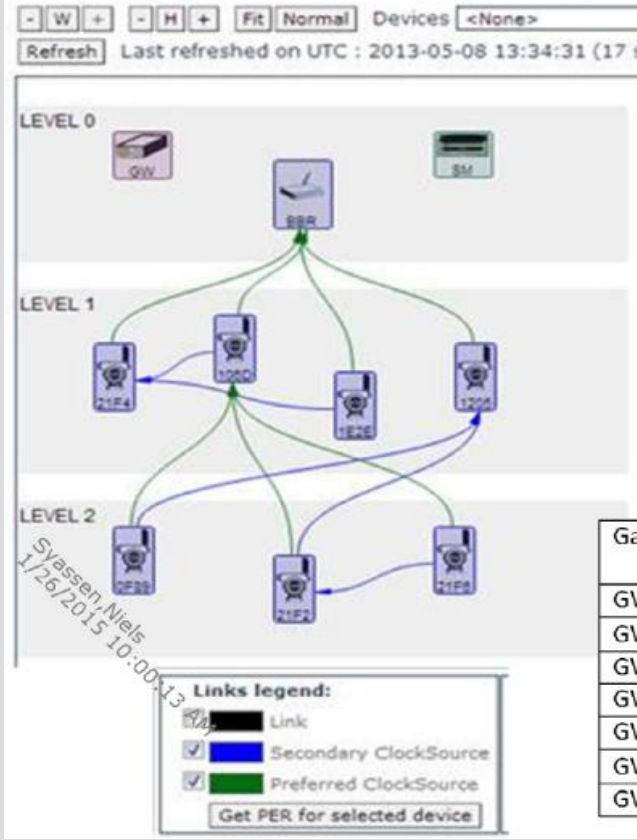
Application: BP Hull methanol tank monitoring



*We achieved a **cost reduction** of around 60%!*

Application: BP Hull methanol tank monitoring – commissioning

Final Network Topology & Signal Strength.



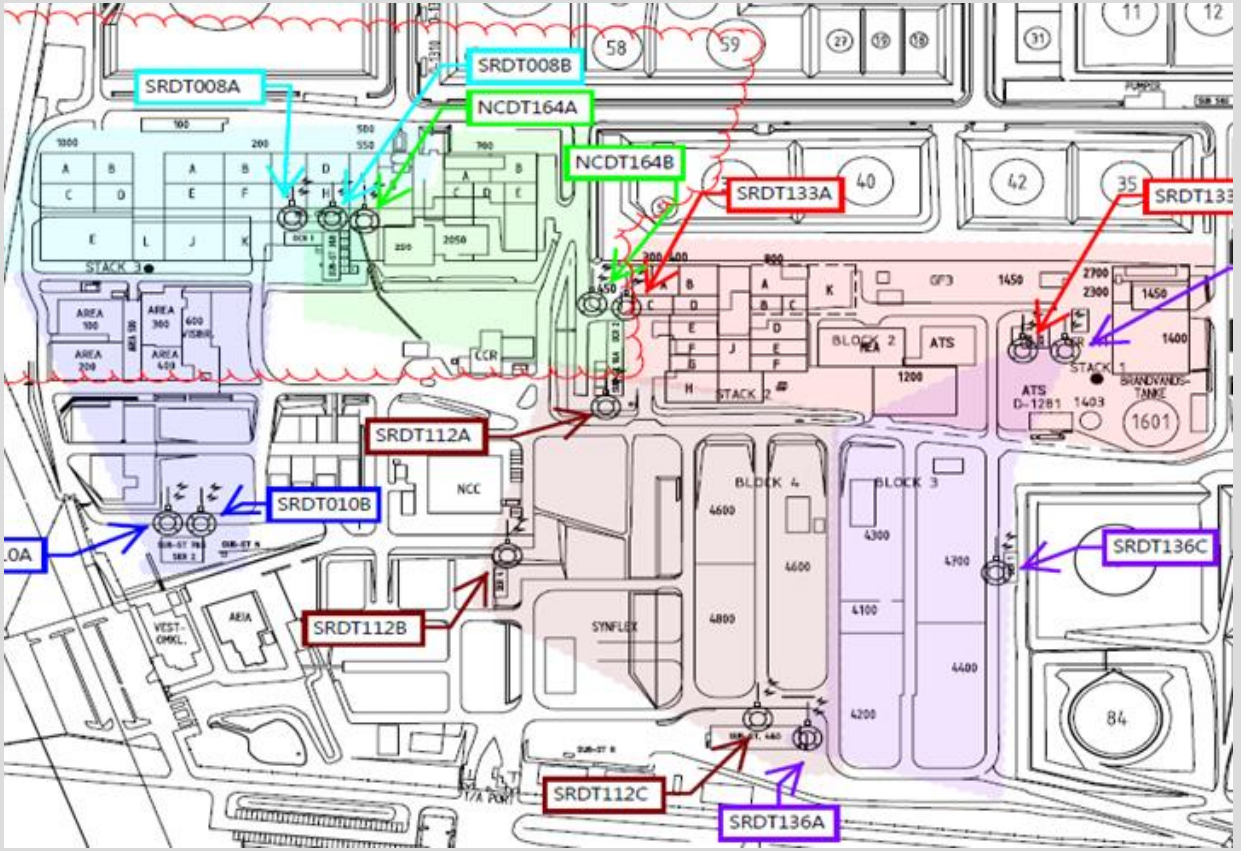
All nodes have alternative routes, which means that taking down a detector (replacing battery etc) will not influence the other detectors.
The signal strength comparison indicates a clear improvement on all the links.

Gateway links:	Old antenna	New antenna
GW - #20 (1E2E)	-76dBm (86)	-69dBm (123)
GW - #24 (1205)	-99dBm (1)	-76dBm (79)
GW - #29 (106D)	-82dBm (57)	-78dBm (70)
GW - #30 (21F4)	-88dBm (30)	-86dBm (35)
GW - #31 (0F89)	-	-
GW - #36 (21F2)	-	-83dBm (44)
GW - #38 (21F6)	-	-

Case Study
Fill-in detectors for Kalundborg refinery (1/3)

	CASE: ONSHORE/REFINERY
Client / Country	Statoil Refining / Denmark
Project / Facility	Fire & Gas Extension / Kalundborg Refinery
Process / Plant / Application	Fill-in detectors for 3 process areas after risk assessment determined inadequate coverage by current system
Equipment / Infrastructure	111 units GS01 / 11 units GS01-EA / Other detectors 3 Gateways / 14 Access Points / Siemens S7
SIL or Non-SIL	SIL2 capable
Main Challenges	Large, congested plant area. Enclosed spaces.
Key Notes / Key Sales Points	Cost reductions with wireless – initial cost was estimated to be around USD 20 mil. for HC and H2S detectors. With wireless hydrocarbon detectors, costs could be brought down to roughly USD 7 mil.

Case Study
Fill-in detectors for Kalundborg refinery (2/3)



- Phase 1 indicated by red clouded area and includes 1x Gateway / 2x Wireless Access Points
- Phase 2 includes 1x Gateway / 3x Wireless Access Points
- Phase 3 includes 1x Gateway / 3x Wireless Access Points

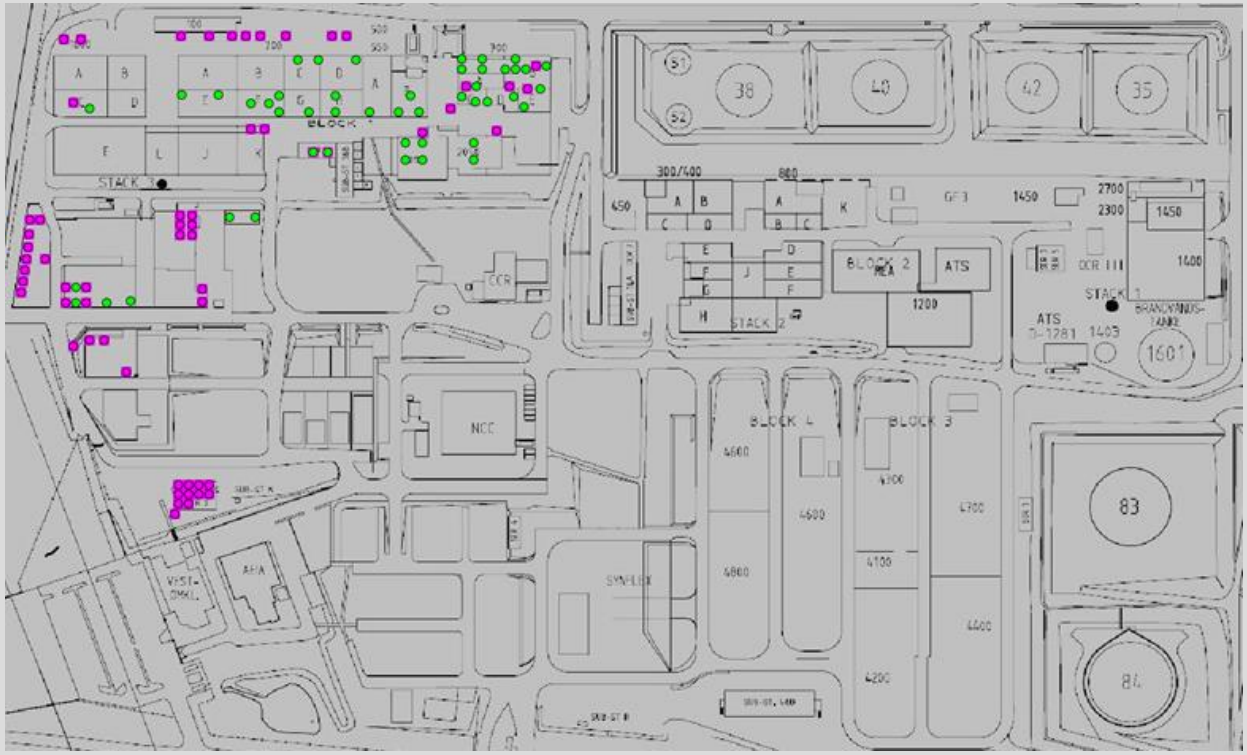
Case Study
Fill-in detectors for Kalundborg refinery (3/3)

Phase 1 Block 1

Detector locations

Green = GS01

Purple = Other



GasSecure is providing a **turnkey service** with wireless planning, system design, setup, integration and commissioning including other F&G equipment to achieve a **SIL2 compliant system**.

Phase 1 equipment online as per 22-Jan-2016.

Thank you for your attention.

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