WIRELESS OR WIREMORE?

Theory and practice for Industrial WLAN installations

HIRSCHMANN
MULTIMEDIA

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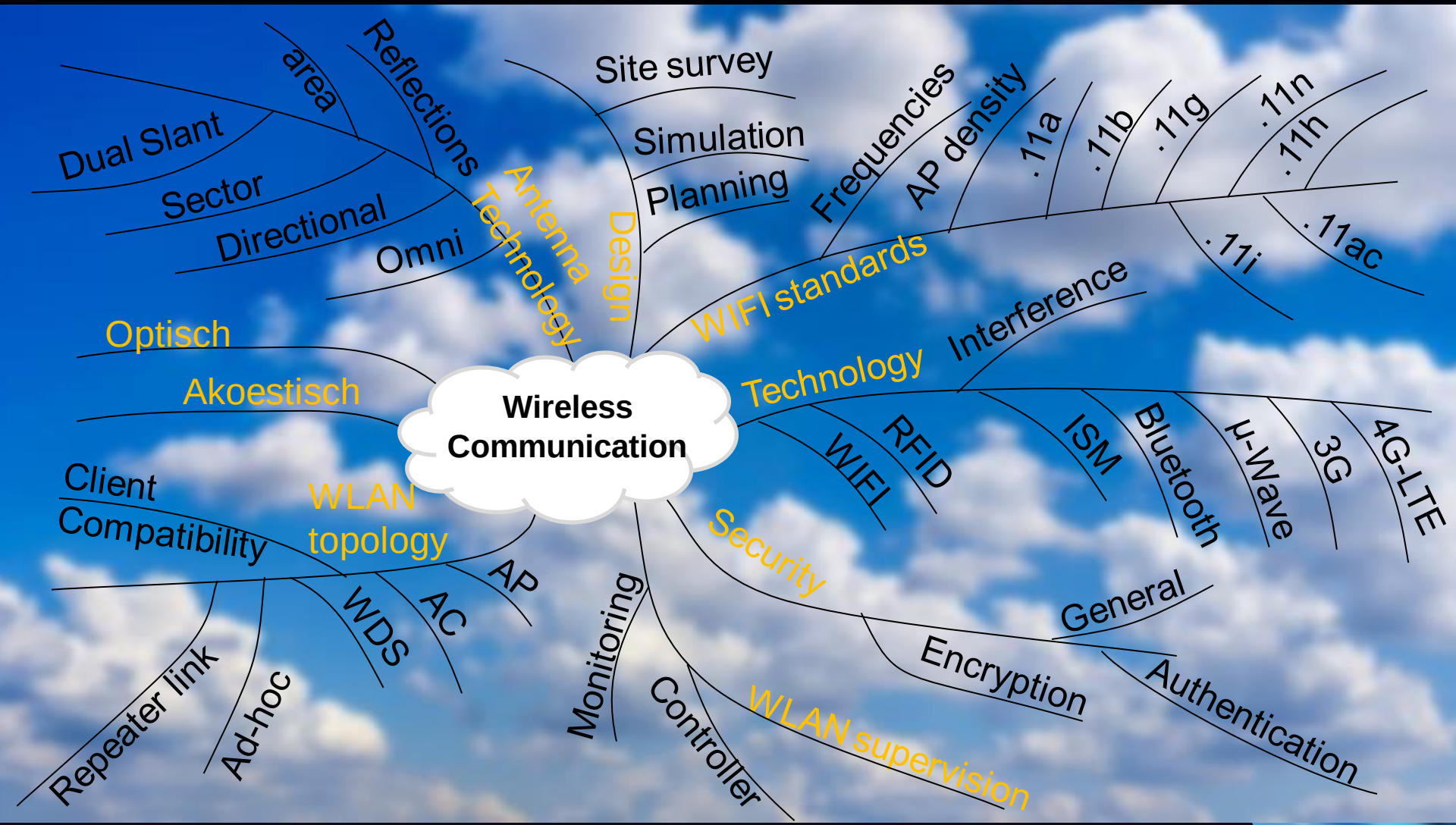
1986- 1999: RF & CATV development
1999- 2015: Industrial Networks
Engineering, Support & Consultancy

THE WIRELESS COMMUNICATION MAP



Industrial Ethernet

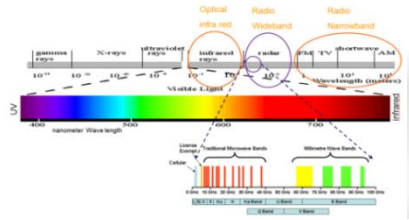
ACCOUSTIC COMMUNICATION IS NO OPTION

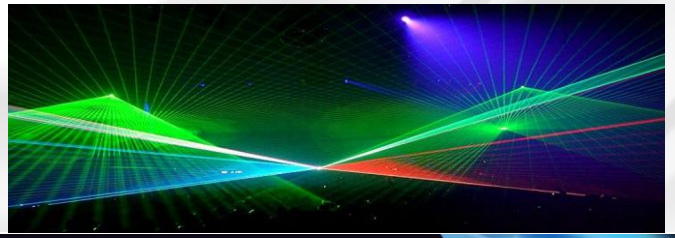
- Acoustic is also wireless,
  - but no option for modern industrial communication
    - Please be aware: the air is a shared medium

- Electromagnetic waves are a better solution.
  - If we can reach and connect only the communication participants… Comparable with audience in a stadium.
    - Please be aware: the air (ether) is a shared medium

- The air is full of EM signals
  - Fortunately we can't see most of them…

- But if we could…





THE WIRELESS CHALLENGE

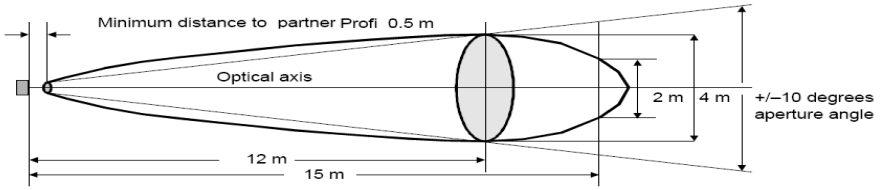
- No discussion:
  - A wired connection is most reliable
- but:
  - Now a growing number of applications need or like to have wireless

- WirelessTarget:
  - Optimal application connectivity
- but:
  - Wireless link is least reliable chain, so WLAN optimalization is the challenge!
- Obvious solution:
  - High density of AP's and antennas, resulting in a lot of cabling

Wire more for Wireless is sometimes the result

OPTICAL WIRELESS

- Only for line of sight applications
- Insensible for radio interference
- Wavelength in Infra red spectrum



- LED systems
  - Due to optical divergence, applicable only for short distances and low data rate (Profibus at several meters)

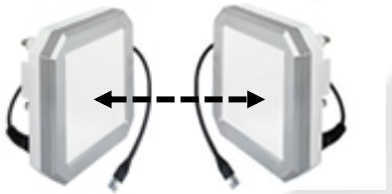
- Lasersystems
  - Depending on transmit power, applicable for several kilometers with high data rate (GigabitEthernet at several kilometers)

785 nm, 4 x 25 mW = 1000mtr

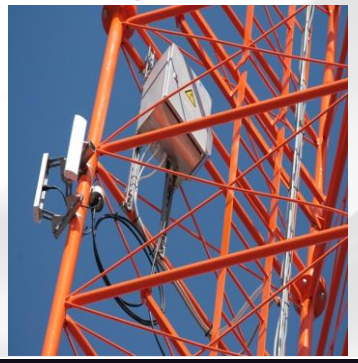
RF WIRELESS (BROADBAND)

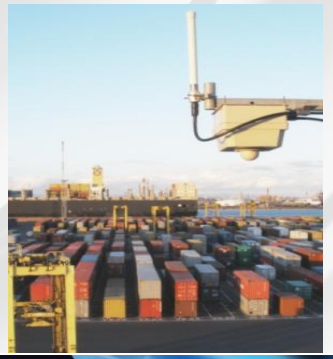
- Operates with line of sight and through obstacles
- Relative insensible for weather conditions
- Licenced and Licence free frequencies
- Be aware of the WLAN overhead data
  - Gross data is almost double the net data

- Point-to-(Multi)Point connections
  - Directional antennas create a long traject (1 → 1000 Mbps at 15 → 1 kilometers)



- Area coverage
  - Communication is possible. Depending on antenna type and -position, TX-power, obstacles and process environment (1 tot 300 Mbps at centimeters up to several hundreds of meters)





WIRELESS… GETTING STARTED

Approach:

- By trial and error…Just buy and try
- Or by engineering:

- Determine the level of engineering
  - *Simulation and if possible: Passive Site Survey or Active Site Survey*

- Determine the technology (application requirements for data capacity)
  - What kind of clients are to be used?
  - Origin of data: SCADA, (non) critical control data, RIO, Video, Audio, combinations
    - *Prefer the technology*

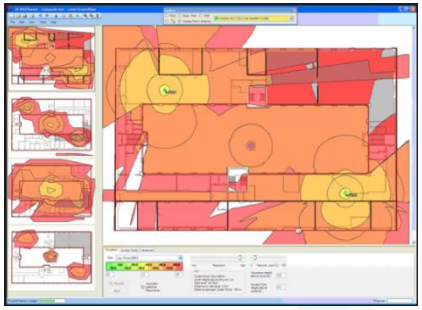
- Determine the topology and type of connection
  - PtP, WDS, Area coverage, Roaming clients
    - *Prefer the topology and antenna types*

- Determine the environmental conditions
  - *Select the technology, antenna types and accessories*

- Determine the required configuration and security level
  - *Implement the required configuration*

STEP 1a: SIMULATION

- Software tools to create 2D or 3D simulations:
  - BAT Planner *(by Belden-Hirschmann™)*
  - Ekahau Site Survey *(by Ekahau)*
  - AirMagnet *(by Fluke Networks)*
  - RF3D *(by Psiber)*
  - Visiwave *(by AZO Technologies, Inc)*
  - Acrylic Heatmaps *(by Tarlogic Security)*
  - Tamograph *(by Tamos)*
  - Fortiplanner *(by Fortinet)*
  - LAN Planner *(by Motorola)*
  - FL WST *(by Phoenix Contact)*
  - Sinema *(by Siemens)*

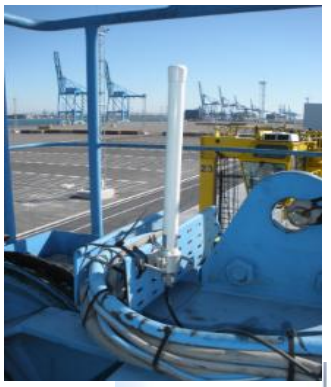


Signal / Noise Ratio SNR = 10 * log10 PSignal/PNoise	
SNR > 30 dB	VERY GOOD
25 dB < SNR < 30 dB	GOOD
20 dB < SNR < 25 dB	SATISFACTORY
ADEQUATE possible packet loss	15 dB < SNR < 20 dB
POOR high packet loss	10 dB < SNR < 15 dB
NO RECEPTION	SNR < 10 dB

- Especially observe:
  - Signal strength
  - Signal to Noise Ratio (SNR)

STEP 1b: SITE SURVEY - GOAL 1

- Goal 1: Determine optimal antenna locations
  - Advice for hardware and antenna locations
  - Observing the structural condition
  - Often a dilemma between RF-Optimal and realizable





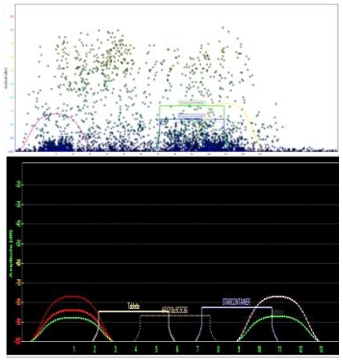

Heat, Wind, Moisture, Reflections, Moving Clients, Aggressive H_2S gas, Rocks, Flames, Vibrations

STEP 1b: SITE SURVEY – GOAL 2

➔ Goal 2: Advice for frequency use

- Even if there is nothing to see

- There is a lot to measure

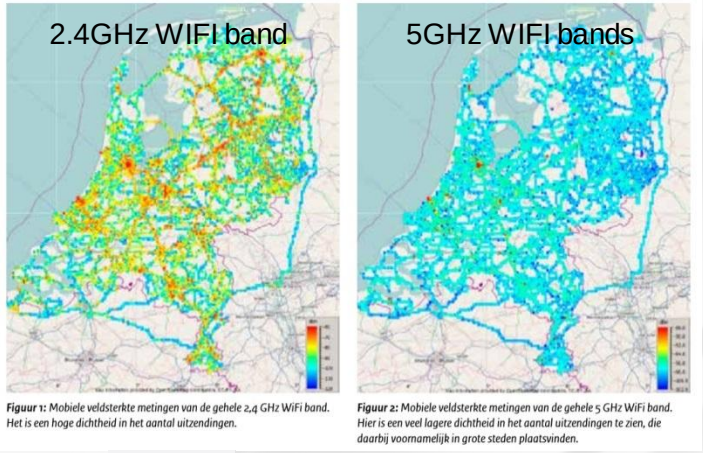


- Like already occupied channels

➔ Check channel availability

- 2.4 GHz is most used ISM band..
  Jokingly called “The Toy Band”

- 5 GHz has more capacity,
  but is not integrated in all industrial equipment yet

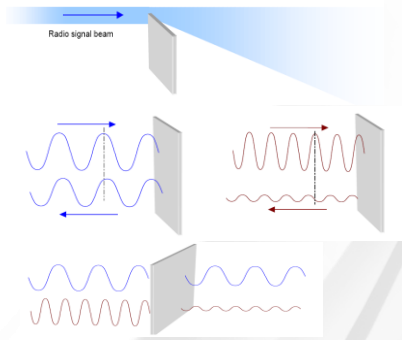


source: Telecom 2013

STEP 1b: SITE SURVEY – GOAL 3

- Goal 3: Understanding the operational situation on site
  - Environmental conditions and structures (deflection, reflection, attenuation)
  - Propagation changes depending on process steps





Heat, Wind, Moisture, Reflections, Moving Clients, Aggressive H_2S gas, Rocks, Flames, Vibrations

STEP 2: TECHNOLOGY SELECTION

RFID

- ✓ Passive clients, low cost, quick connection
- ✗ Low data rate, client identification only

WirelessHART
IEEE 802.15.4

- ✓ 2.4 GHz DSSS, time synchronized, self-organizing, self-healing mesh architecture, embedded in sensors
- ✗ Rel. short distances (<100m), sensor data only (250 kb/s)

IEEE 802.15.1
Bluetooth

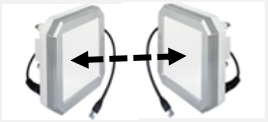
- ✓ 2.4 GHz frequency hopping technology, Easy set up
- ✗ Rel. short distances (<100m), control data only (1 Mb/s)

Wi Fi
IEEE 802.11

- ✓ 2.4 GHz & 5 GHz standards, Scalable, High capacity, Roaming Clients, Video suitable, Development of “state of the art standards”
- ✗ BYOD & RADAR disturbance, Rogue AP’s (Man i.t. Middle)

MMW

- ✓ 60 – 86 GHz applications, PtP Privacy, very high capacity,
- ✗ Line of sight only, static locations

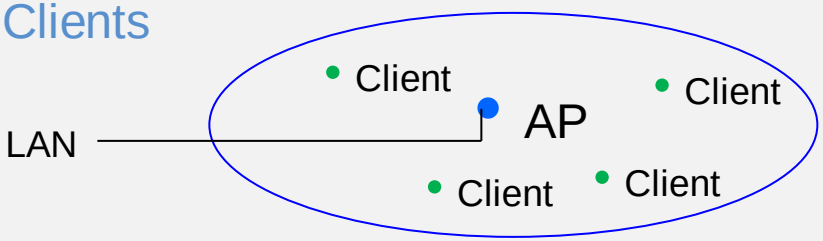


STEP 3: TOPOLOGY SELECTION

- Depending on the application, one of the following topologies will be applicable

Access-Points and Clients

Standardized "infrastructure" network

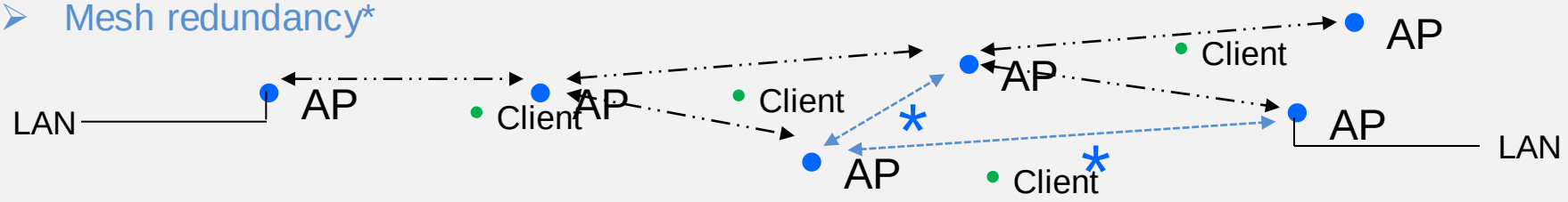


Point-to-Point links = Bridge links (with or without Clients)

Non-standardized

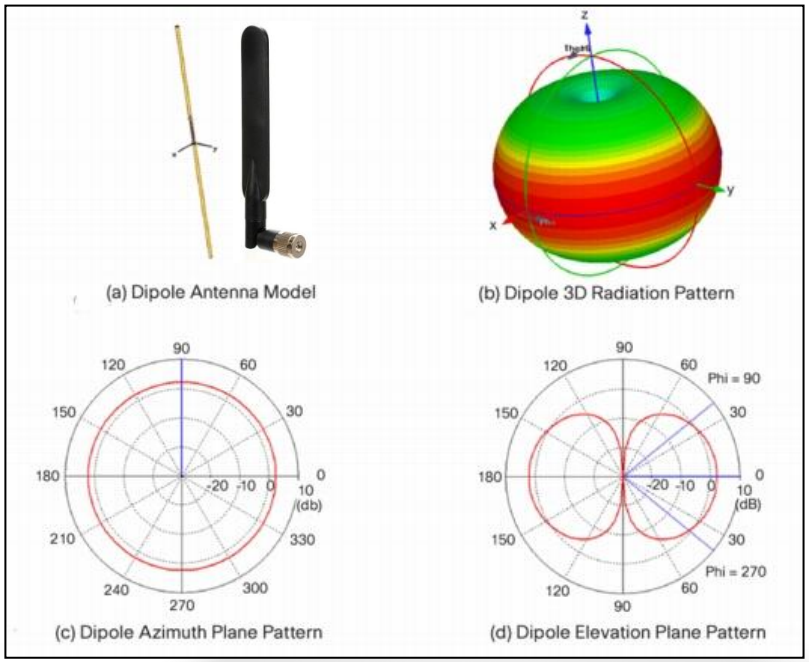
Wireless Distibution System = multi-hop-PtP link (with or without Clients)

Mesh redundancy*

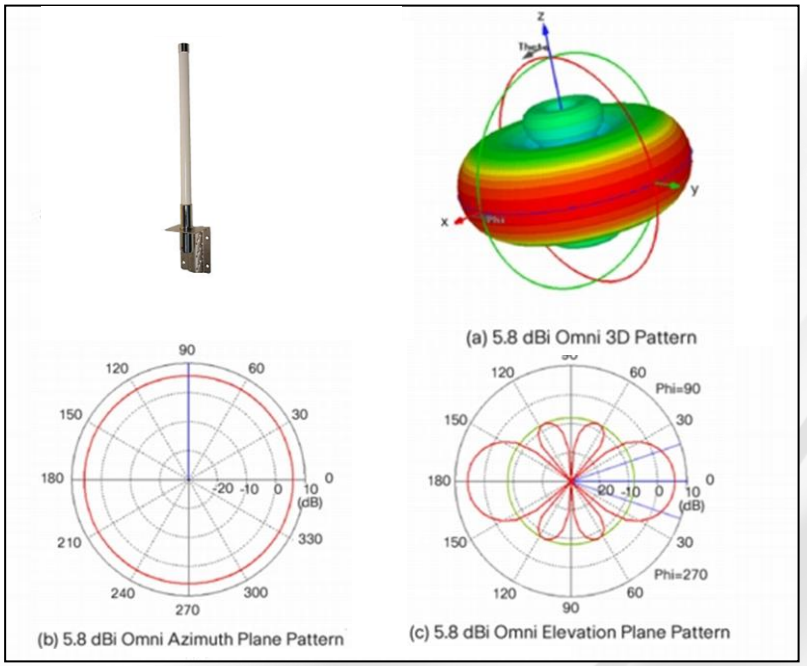


STEP 3: ANTENNA RADIATION MODEL SELECTION (1)

- Depending on the application, one of the following radiation models will be applicable
  - *Omni directional antennas*



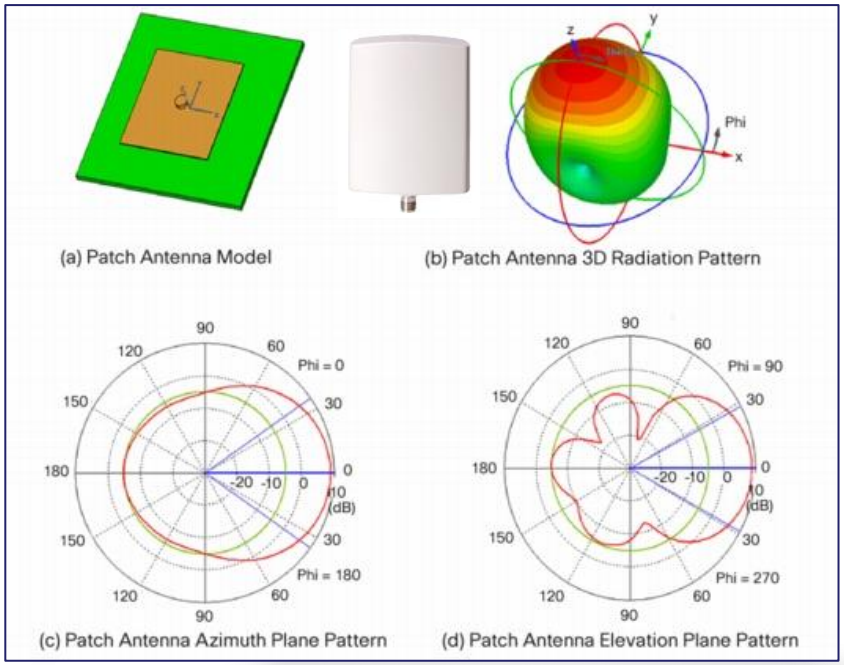
G = 2 dBi



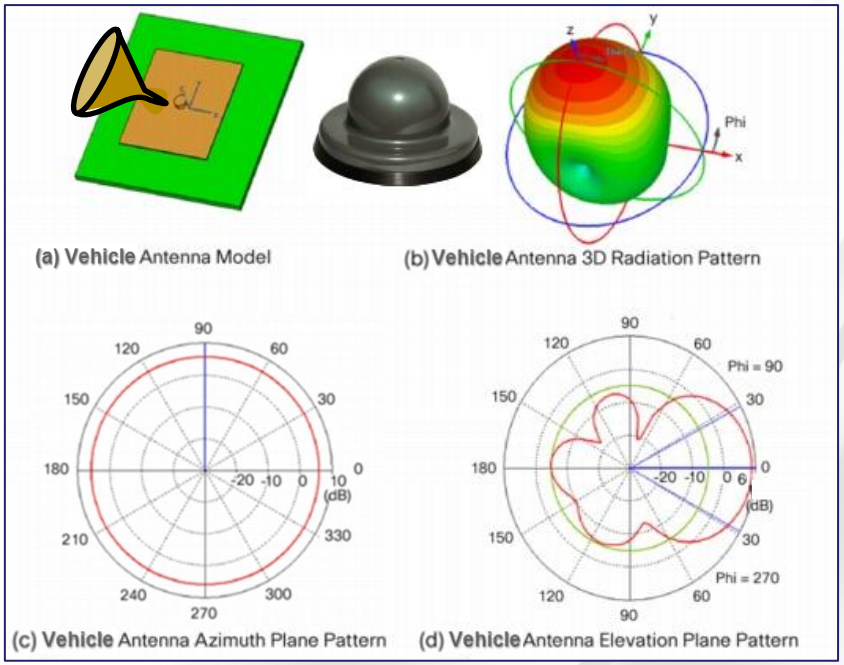
G = 6 dBi

STEP 3: ANTENNA RADIATION MODEL SELECTION (2)

- *Directional (patch) antennas & vehicle antennas*



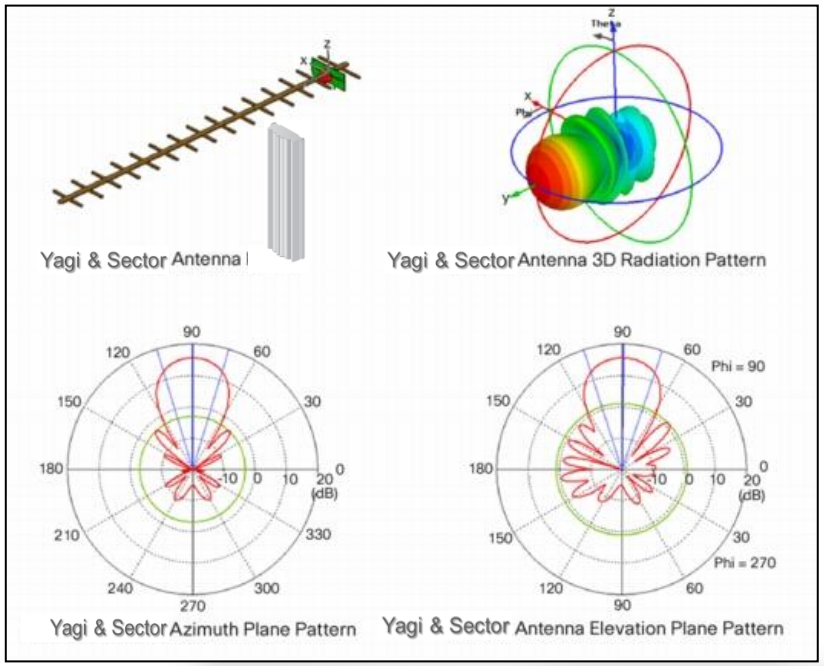
G = 9 dBi



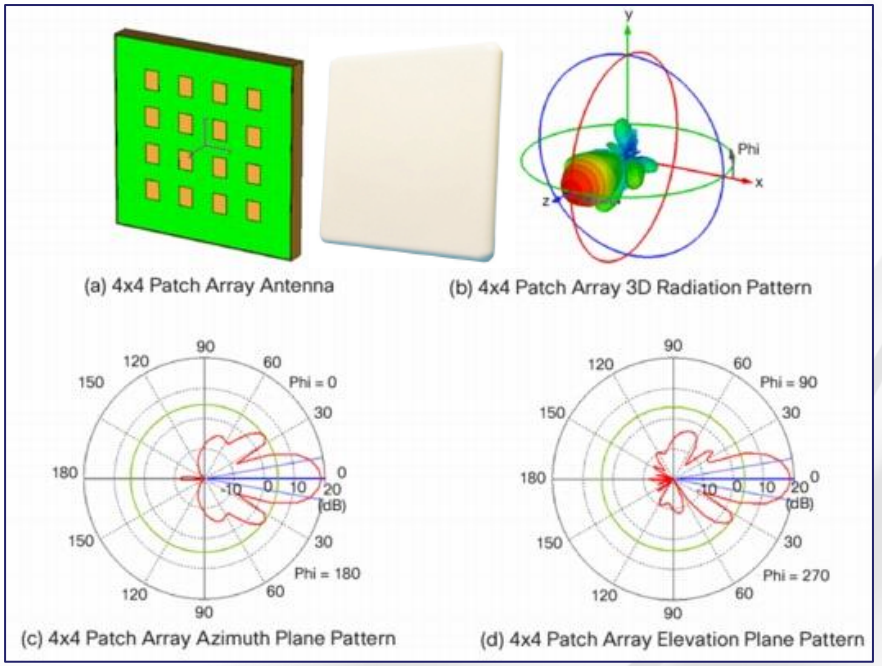
G = 6 dBi

STEP 3: ANTENNA RADIATION MODEL SELECTION (3)

- *Sector antennas*



G = 16 dBi

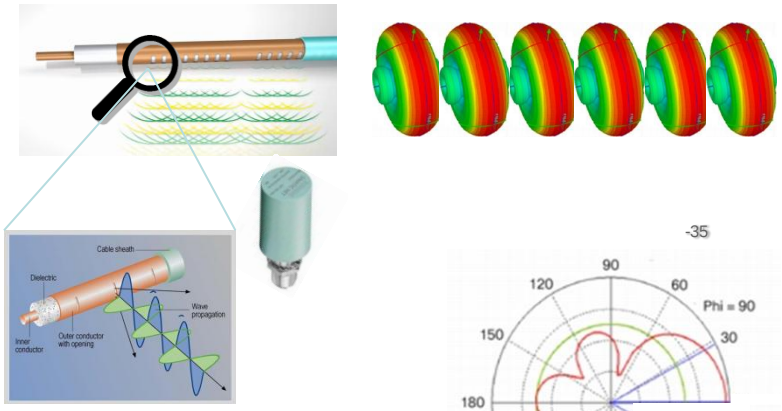


G = 20 dBi

STEP 3: ANTENNA RADIATION MODEL SELECTION (4)

- *Special antennas*

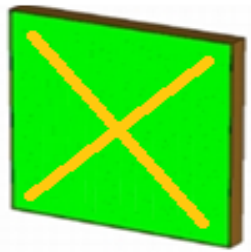
Radiating Cable

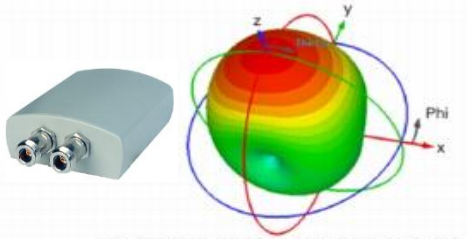


Distance to compatible mobile antenna ± 10 cm.

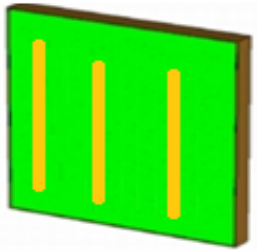
G = -35 dBi

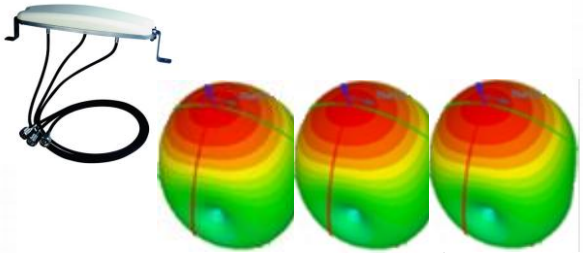
Dual Slant & MIMO antennas





(b) Patch Antenna 3D Radiation Pattern





G = depending on model

STEP 4: SELECTING THE RIGHT EQUIPMENT

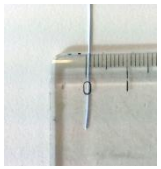
- Take notice of the environmental conditions
  - An Antenna is just some (printed) wire in a box, so why the expensives?
  - My Access Point is a A-brand, so why the expensives?

- Reliable Industrial applications deserve well protected devices
  - Water, aggressive gasses, flames, high temps, temp shocks, wind, salt, surges, etc..

Industrial Ethernet

STEP 4: SELECTING THE RIGHT ACCESSORIES

- Take notice of the possibilities of installing equipment
  - There are many coax cables…. Choose the right one




Devices internal
(<10 cm.)

Inside cabinets
(1-3 m.)


!

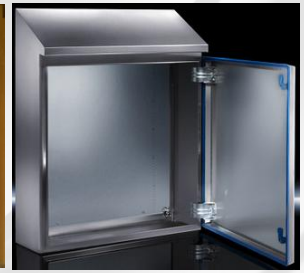
Outside cabinets (2 – 20 m.)

- Industrial applications deserve well protected devices
  - Water, aggressive gasses, flames, high temps, temp shocks, wind, salt, surges, etc.




Surge Protectors



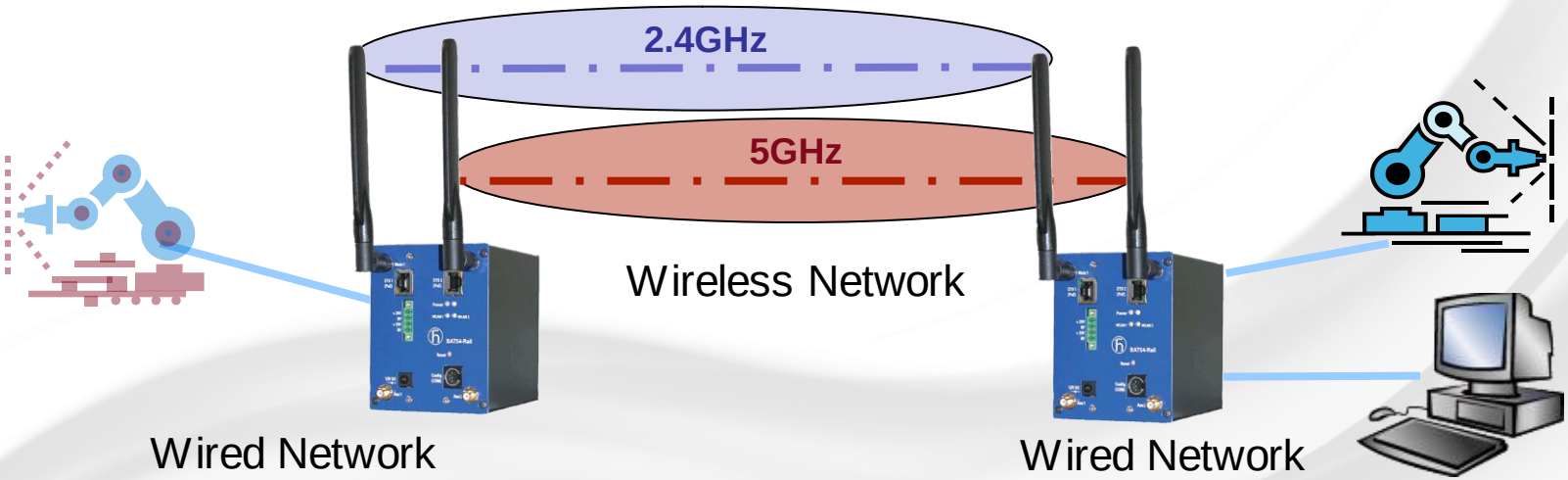
Cabinets for protection against:
temp extremes, chemicals, water, etc

STEP 5: IMPLEMENT THE OPTIMAL CONFIGURATION

- Autonomous or Controller based WLAN?
  - Depending on the number of AP's and manageability requirements
- Single SSID, Multiple SSID, VLAN over WLAN?
  - Depending on the number of applications and demand for data separation
  - Depending on specs and applications
- Access Point or Access Client mode?
  - AP: Infrastructure mode, Ad-hoc mode, Point-to-(Multi)Point,
  - AC: Roaming parameters
- RF-path Redundancy?
  - Spanning Tree / PRP
- Security
  - Intrusion protection, 802.11i (WPA2/PSK) or 802.1x (server) Authentication, Encryption
  - White listing, Black listing, MAC listing, interstandard compatibility
  - Firewalling

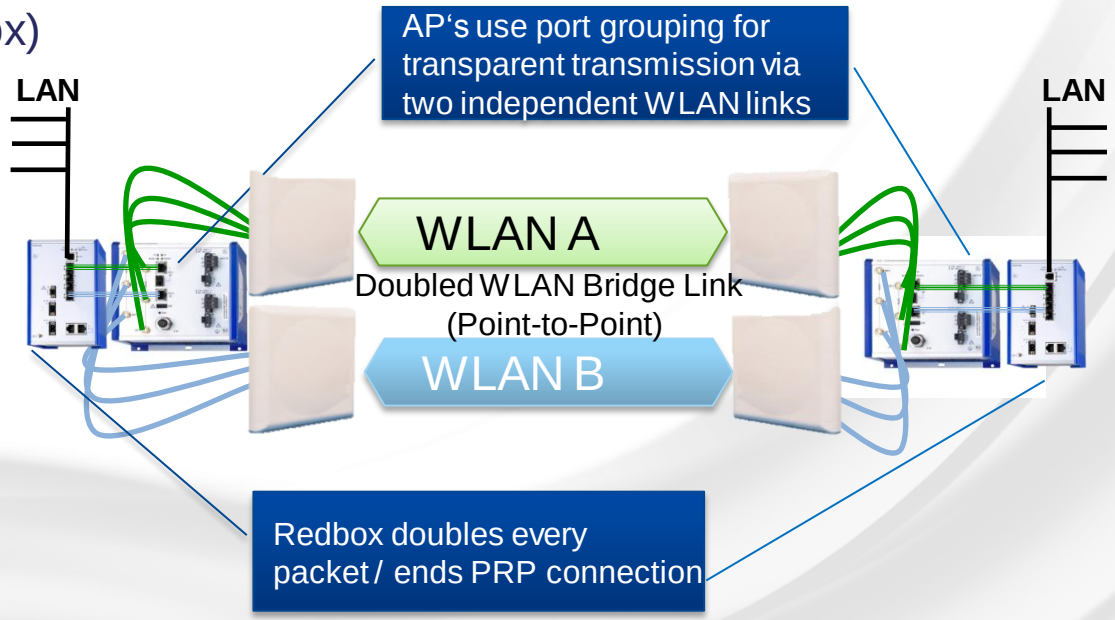
RF-REDUNDANCY.. TRADITIONAL PROTOCOL

- Increased reliability: one RF path in stand by
  - Two radios per device
  - Redundancy based on LAN-protocol STP
  - Recovery time in seconds
  - Transparent for Industrial Ethernet protocols
  - Two simultaneous WLAN links



RF-REDUNDANCY.. PRP IN POINT-TO-POINT-CONNECTIONS

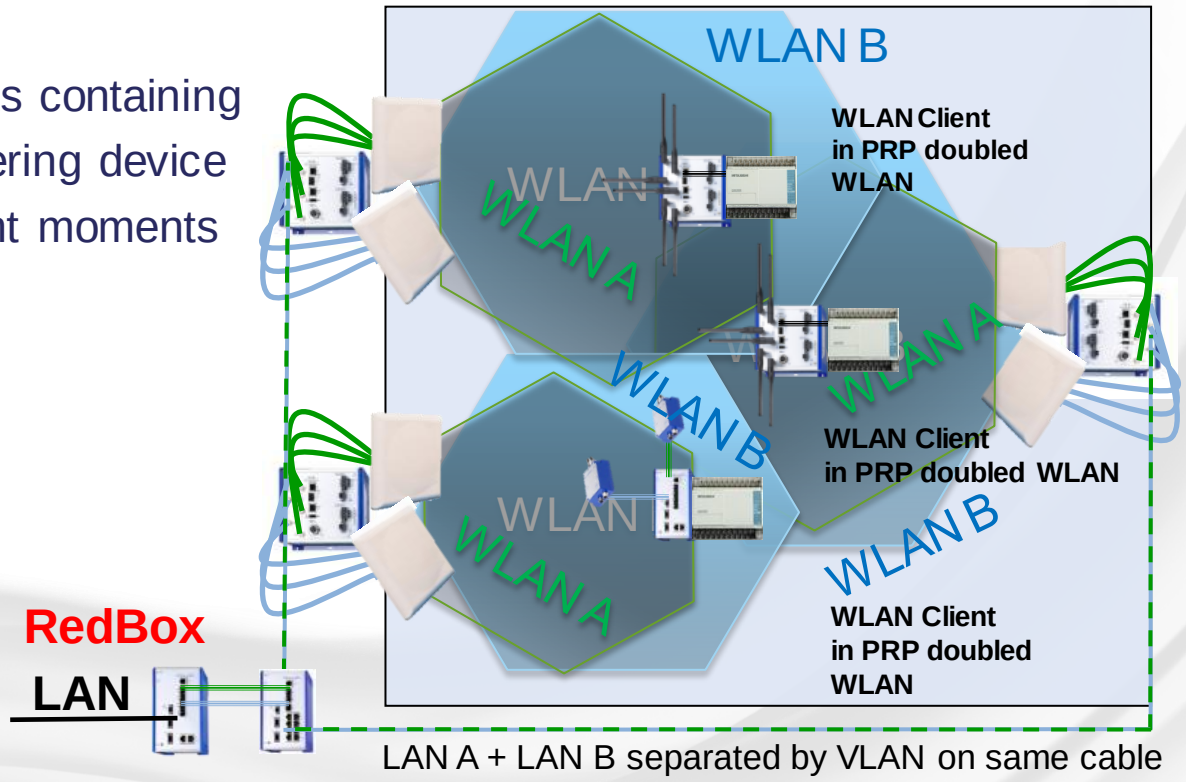
- Increased reliability: Two active RF paths
  - Two radios per device
  - Redundancy based on IEC62439-3 PRP
  - Recovery time 0 seconds
  - Transparent for Industrial Ethernet protocols
  - Two simultaneous WLAN links containing identical data: Redbox is filtering device
  - Redundancy Box (Redbox)



- **Wireless is Wiremore!**

RF-REDIMDANCY.. PRP IN SMART ROAMING INFRASTRUCTURE NETWORKS

- Increased reliability
  - Two radios per device (AP and AC)
  - Redundancy based on IEC62439-3 PRP
  - Transparent for Industrial Ethernet protocols
  - Recovery time 0 seconds
  - Two simultaneous WLAN links containing identical data: Redbox is filtering device
  - Client radios roam on different moments
  - Connection guaranteed by at least one WLAN



- **Wireless is wiremore!**

Industrial Ethernet

PITFALLS FOR NON-RF TECHNICIANS

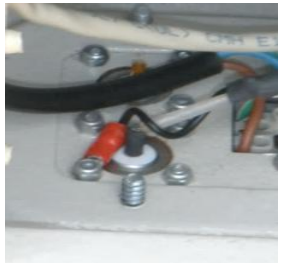
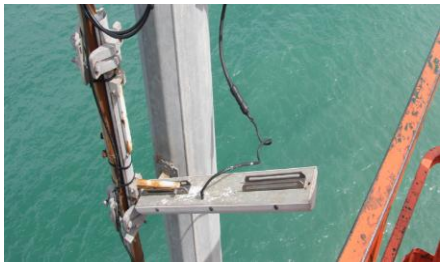





Environmental conditions: Heat, Wind, Moisture, Rocks, Flames, Aggressive H_2S gas, Vibrations, taping

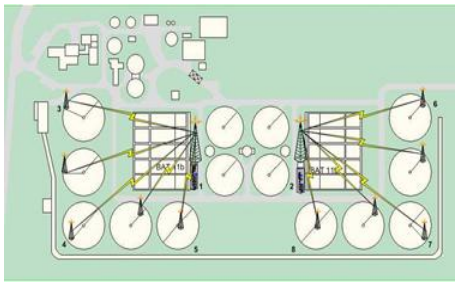
RF knowledge: Reflections, screening, Grounding, Bending radius, Propagation, Polarization Antenna pattern,



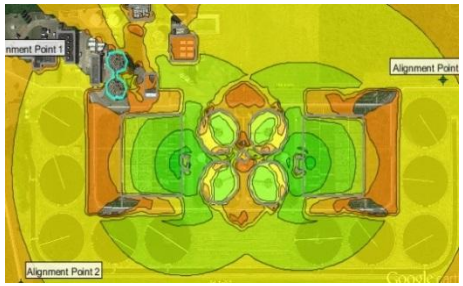



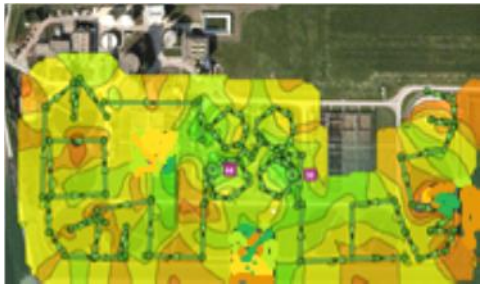

RESULT EXAMPLE OF ENGINEERING APPROACH (1)

- Project: waste water installation 2.4 to 5 GHz migration


- View in Google Earth → Define required applications and connections → site survey



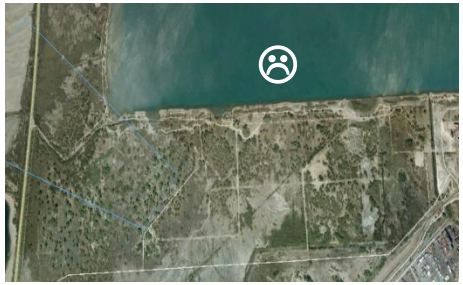
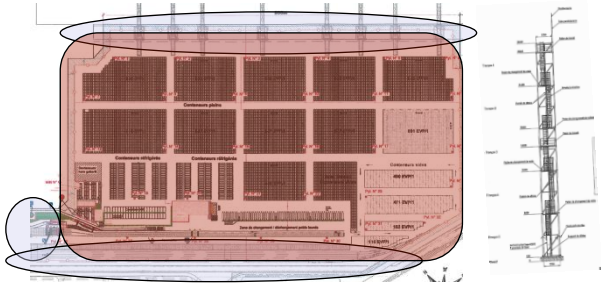


- Simulation heat map →As-built heatmap → Result: stable operation

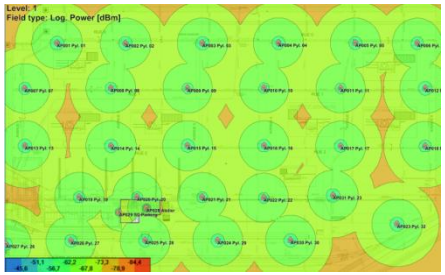
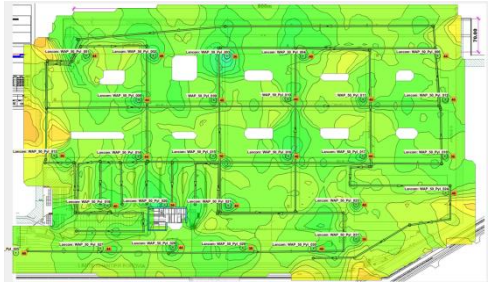
Projectpartners: ABB HIRSCHMANN MULTIMEDIA

RESULT EXAMPLE OF ENGINEERING APPROACH (2)

- Project: New Container Terminal 2.4 & 5 GHz

- View in Google Earth → Define required connections → Site Surveys at several stages

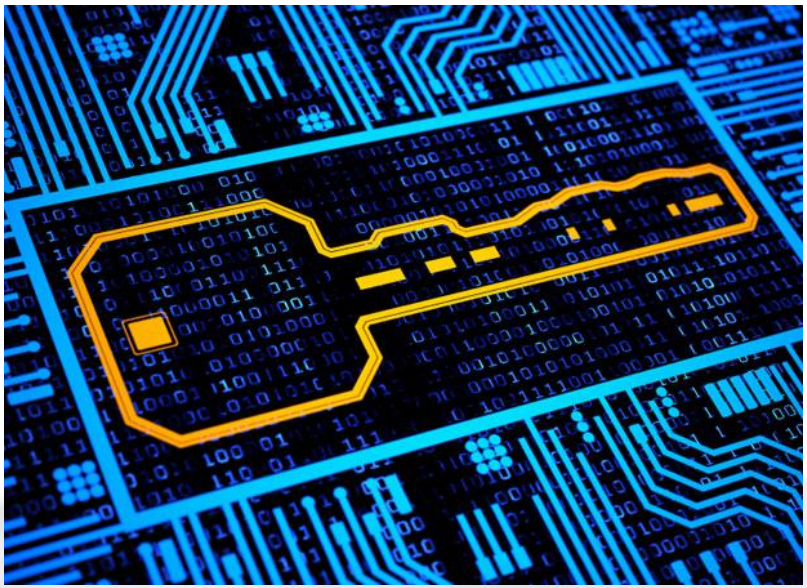
- Simulation heat map →As-built heatmap → Result: Interruption free operation

Projectpartners:

QUESTIONS?

HIRSCHMANN
MULTIMEDIA

Please visit us at the exhibition floor



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