Wireless in nuclear applications – development in the USA

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Agenda

- Introduction
- Background
- Field trip USA
- Strategies
- Summary & Conclusions
- Recommendations
- Takeaways from team
- Discussions/Questions

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Introduction

- Presentation of the team
  - Fredrik Bengtsson, AFRY
  - Petri Pyykko, Fortum
  - Samuel Axelsson, Ringhals
  - Patrik Larsson, Ringhals
  - Tobias Hillbom, Forsmark

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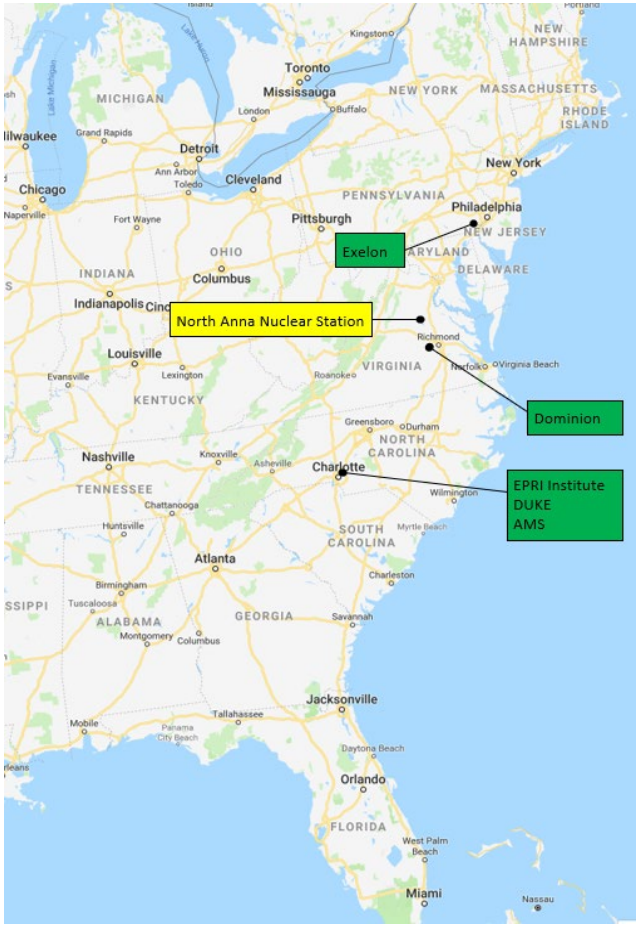
Background

- Objective from ENSRIC
  - Increase knowledge on opportunities and challenges regarding wireless installations by studying U.S. nuclear applications.
  - EPRI, DUKE, AMS
  - Dominion
  - Exelon



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EPRI

- Electric Power Research Institute (EPRI)
- Primary purpose is to conduct research and development relating to the generation, delivery and use of electricity for the benefit of the public.
- Member organization
- Studied the use of wireless solutions in nuclear business and gain a lot of experience.
- EPRI research documentation are available for their members or could be purchased.

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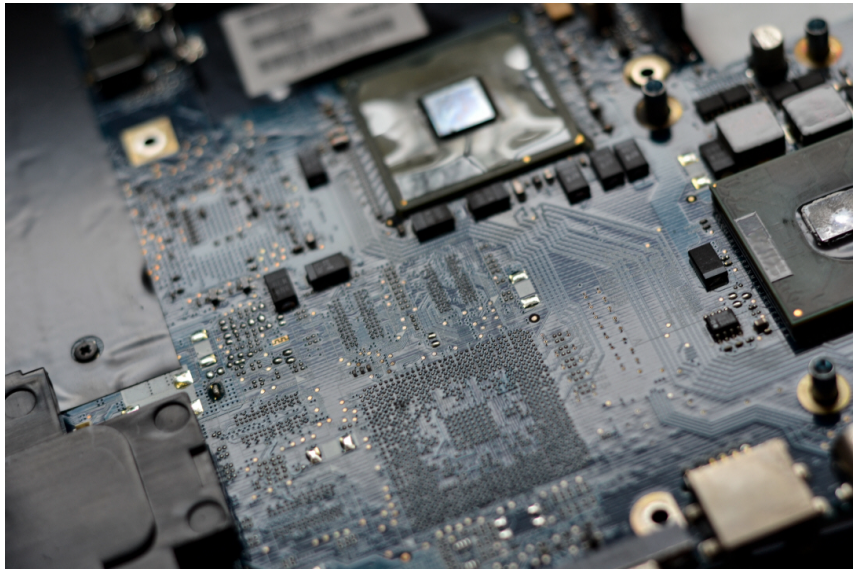
EPRI - Wireless

- Current status of wireless network in USA's Nuclear Power Plants.
  - Office areas
  - Workshops
  - Majority of turbine buildings
  - Reactor and Auxiliary building there are very few installations but some projects are planned.
  - Few plants have necessary coverage to support moderate plant monitoring but many plants are looking for solutions.
  - WI-FI is currently dominating but they are also looking for DAS systems.



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EPRI - Electromagnetic Compatibility

- Tested equipment and their immunity against electromagnetic energy
  - pressure, level and flow transmitters
  - various relays
  - seismic instrumentation
  - control system
  - Nuclear instrumentation
  - Solid State Protection System
  - Not seen any problem with EMC for frequencies above 1 GHz. Some equipment had vulnerability for some spectrum below 1 GHz.
- Tested wireless sensors with a mix of propriety and standard protocols
  - EMI/RFI measurements at 1 meter distance are well below acceptable levels. Low power sensor devices do not pose a significant risk.
- Tested Mobile Devices such as common Phones, Laptops and Tablets
- Exclusion zones is one way to addressing EMI/RFI - but it can in limit wireless installations.
- In-situ susceptibility testing of plant equipment – reduce or exclusion zone
- Frequency management plan

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Utilities

- Common for all
  - tough competition
  - “Nuclear Promise”
  - improve efficiency and lowering production cost
  - Transformation from traditional working methods towards new improved methods and here are digitalization necessary
  - perform maintenance based on condition instead of time
- One way to reduce production loss is to increase monitoring and diagnostic of plant components.
- For fleets a centralized monitoring center could improve plant production.
- Additional monitoring requires more sensors in the field and biggest cost for installing sensors are related to cable pulling. That’s were wireless solutions could be a key factor.

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Utilities

- Portfolio of actions and tools
  - Electronic Workpackage
  - Monitoring and Diagnostic
  - Drones
  - Cameras
  - Fire Watch Cart
  - Wireless sensors
    - Gauge readers
    - Vibration
    - Valve monitoring

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Infrastructure

- Backbone
  - Regardless of which wireless technology that should be used
  - Fiber
  - Oversize

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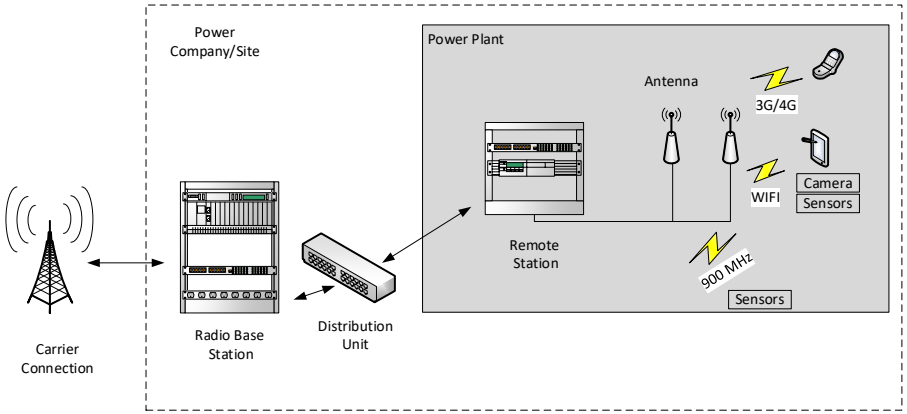
Infrastructure

- WI-FI
  - WI-FI is widely used in NPP's
  - Several standards
  - Technology are continuously evolving



- Distributed Antenna Systems (DAS)
  - Commonly used in the society to enable cellular communication within big arenas
  - Used in Nordic NPP's
  - Could be designed with modularity -> several different applications
    - Mobile phone
    - Wi-Fi
    - Wireless sensors

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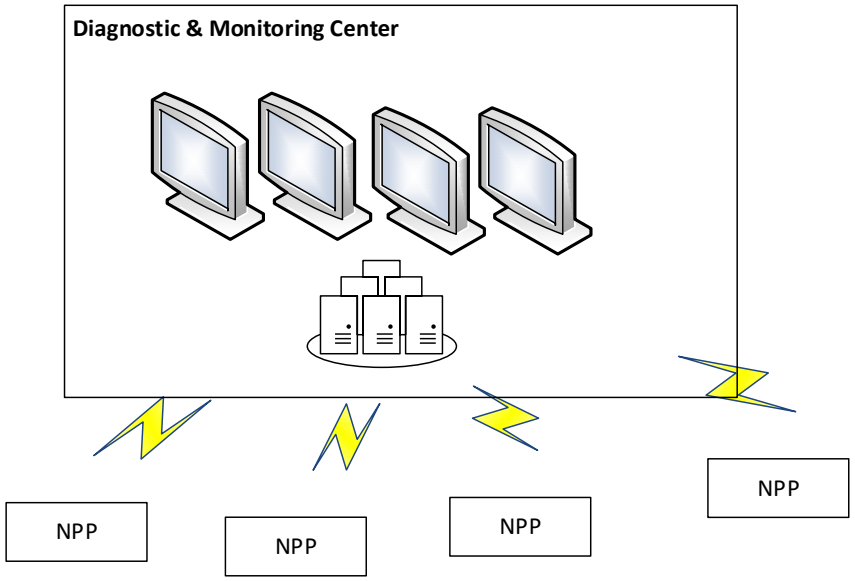
Exelon – Monitoring & Diagnostic Centere

- The Monitoring & Diagnostic Centre monitor all of Exelon Nuclear power plants (22) located at 11 different sites.
- Data from each plant are collected and analyzed at this Centre - computerized
- The Centre consist of a crew of 7 people which working daytime.
- The crew has Thermal Performance specialists which try to identify performance issues and when found they notify the plant.
- Efficient and increased production.



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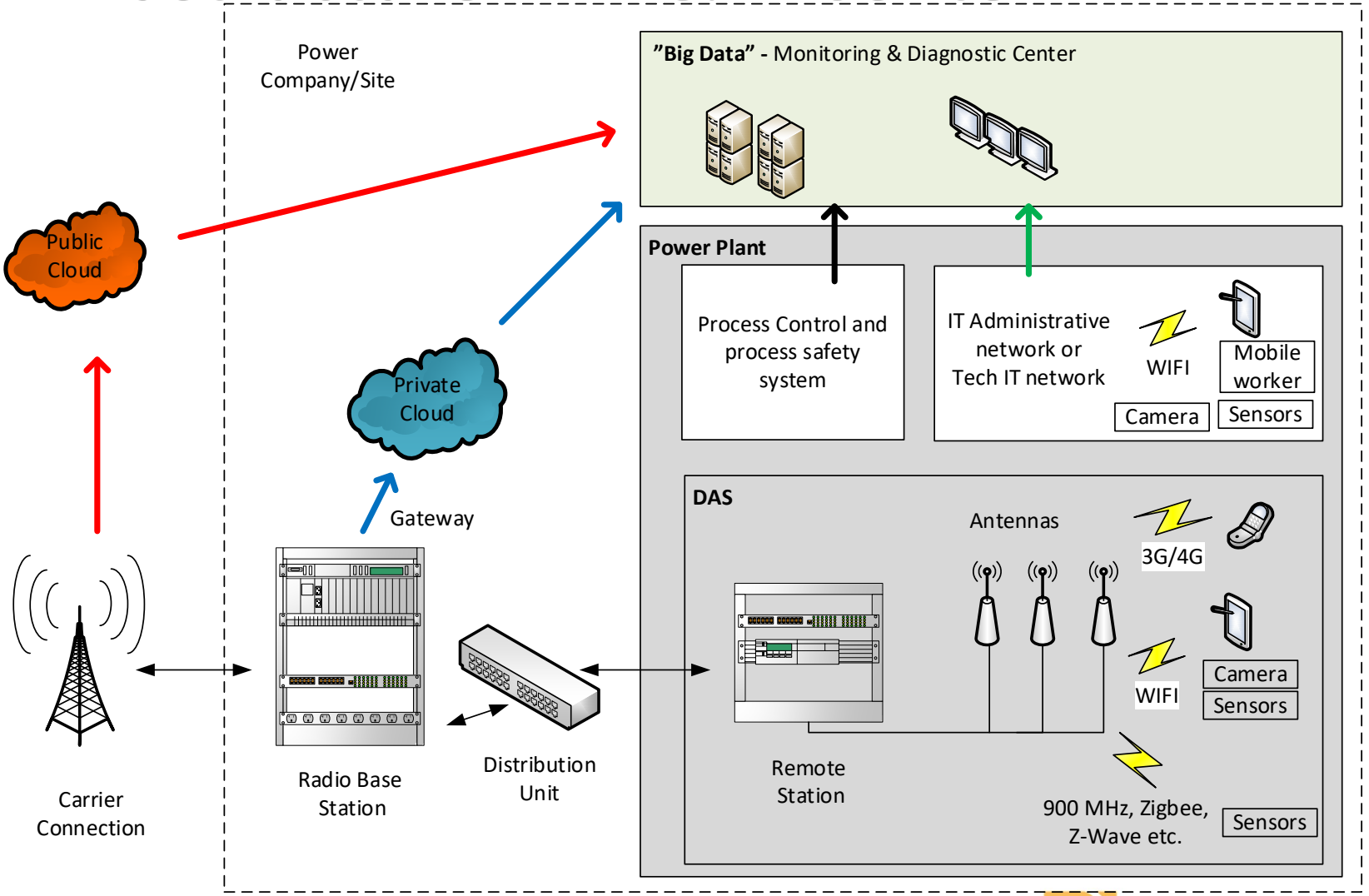
Infrastructure – M & D Center



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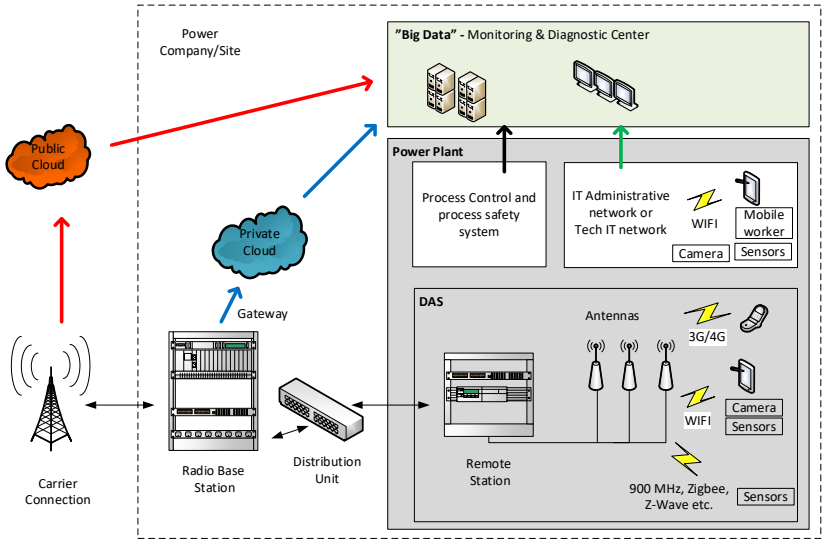
Strategies - Infrastructure

- Prerequisite for digitalization is the infrastructure the so called enabler
- Case by case
  - Network Backbone
  - Use cases
  - Established Consolidated Infrastructure
  - Modular Design
  - Cooperation with IT



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Summary and Conclusion

- Common for all visited company was that the nuclear power plant's has to reduce cost in order to be competitive at the market. The common denominator for all utilities that were visited was the digitalization.
- More measurements and data will enable power plants to go from a time based maintenance to maintenance based on condition instead.
- Electronic Workpackage was another goal for all/many of the powerplants.
- Prerequisite for digitalization is the infrastructure the so called enabler. There is not one kind of solution that suite all NPP's instead this need to be analysed case by case.
- Exclusion zones for wireless equipment are used in USA to solve the issue with interference of sensitive equipment.

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Recommendations

- **Energiforsk and/or corporate level**
  - Backbone
  - DAS Solution - Modular system and Private cloud solution
  - Exclusion zones
  - Monitoring & Diagnostic center
  - Big Data – environment, supporting applications/tools
  - Use case for Motor/Pump application

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Recommendations

- **Nuclear Power Plants**
  - Build backbone
  - Analyze what kind of data that is available and how to centralize this data
  - Analyze how to use existing data to improve maintenance and implement condition based maintenance
  - Fix it now team
    - Wireless needs
    - Analyze team
  - Analyze Competence – Digitalization and wireless technology competence

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Takeaways from NPP experts

- Petri Pyykko, Fortum
- Samuel Axelsson, Ringhals
- Patrik Larsson, Ringhals
- Tobias Hillbom, Forsmark

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Discussion and questions

- Fredriki Bengtsson, AFRY
- Petri Pyykko, Fortum
- Samuel Axelsson, Ringhals
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- Tobias Hillbom, Forsmark

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Thank you

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