5G and Industrial Internet – Revising IoT

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Impact of IoT on Networks

IoT vision has gone through several transformations. We can indentify e.g. following communication, network and protocol generations:

- **1st Generation** – RFID and near field communication systems to support data exchange
- **2nd Generation** – Direct Internet connectivity (IP) of resource restricted devices and web programming (6LoWPAN)
- **3rd Generation** (still ongoing) – aiming to support interactions between things and services running in cloud within silo-ed platforms (NB-IoT, LoRaWAN, virtualization and cloud IoT platforms)

Impact of IoT on Networks (cont.)

- Development on upcoming years devoted to support the **seamless integration of platforms** to enable IoT resource access beyond ”Internet of Platforms” model
  - *Things* identification across the platforms and secure management / governance of resources, semantic interoperability, protocol interoperability
- New identification, authentication and accounting solutions are needed (e.g. IETF ACE wg, IRTF ICNRF wg etc.)
- Heterogeneity along several dimensions e.g. access technology, naming/addressing, traffic patterns etc. requires highly flexible network
  - flexibility beyond current software defined networking and network function virtualization and slicing concepts in mobile networks
  - Programmability of end devices in order to react changes in working environment

Impact of IoT on Networks (cont.)

- Due to increasing amount of data, our communication infrastructure must turn into computing and communication infrastructure, in which data processing and fusion can be performed in any of its component
  - Extending the current edge cloud and edge computing to cover the whole end-to-end chain from network leaves and *things* to core Internet devices and nodes
- IoT revolution will happen if **”reasonable” level of security** can be guaranteed (current TLS/DTLS profile for constrained devices is not enough in all the cases)

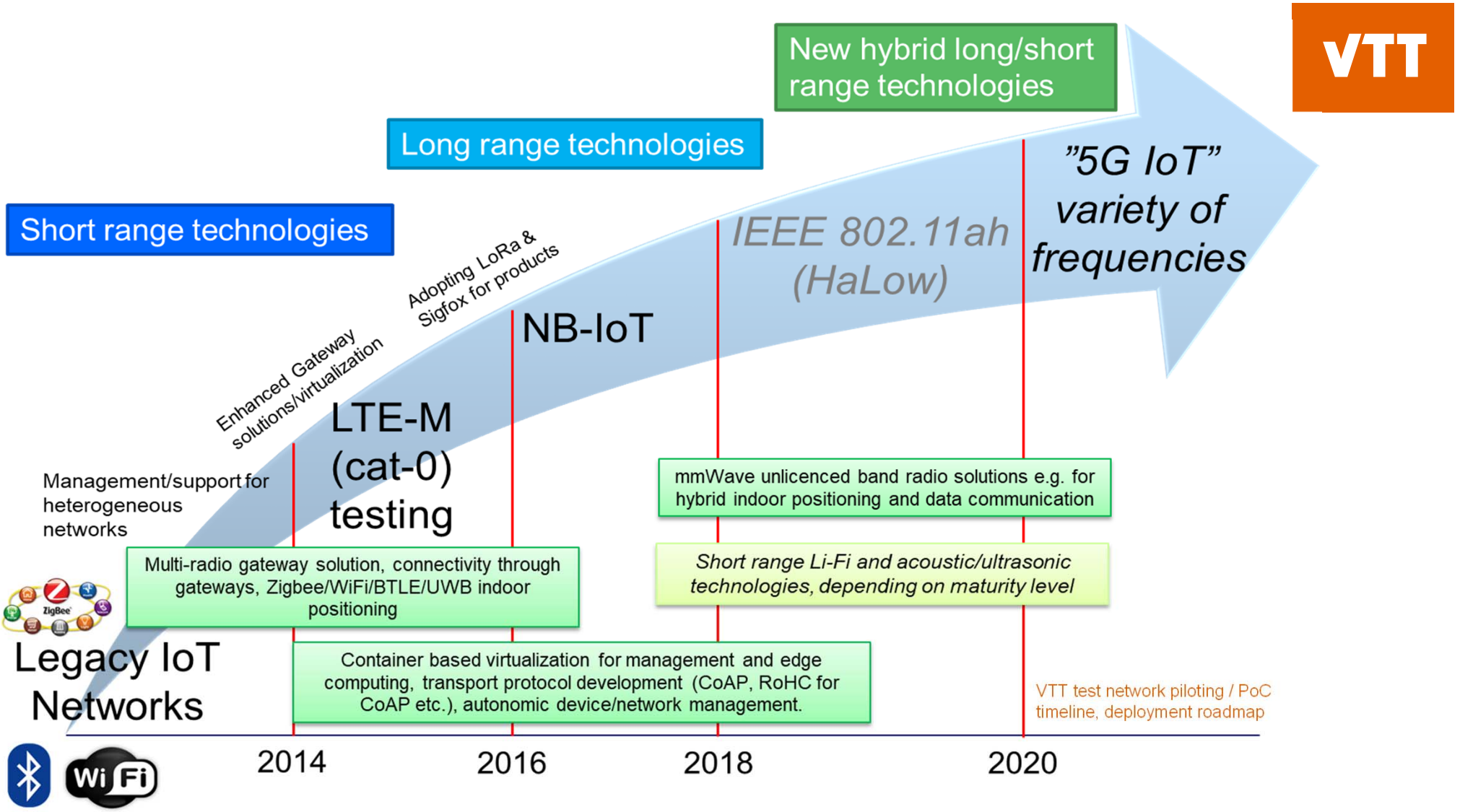
Some Specific Challenges in Industrial Domain

- Working environment (e.g. in factories) has lots of interference and radio communication is challenging
- Environments are also dynamic (e.g. locations of containers causing interference in harbors and terminals etc. are changing,…)
- Some use cases and fuctions need extreme reliablity from communication system as well as low latency communications
- Heterogeneity of devices and platforms (legacy and new solutions, different manufacturers)
- Strict security requirements, e.g. based on Gartner estimation by 2020 more than 25% of recognized attacks on enterprices are through IoT devices
- Minimize the machinery downtime caused by communication and ICT infra
- Data storage and processing of massive amount of data

What about 5G

What 5G Should Provide For Industrial IoT?

5G is only a part of the solution

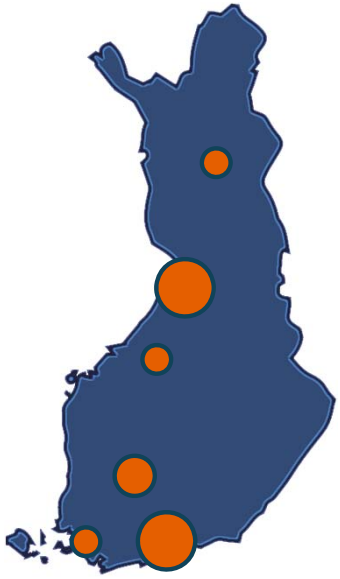

New hybrid long/short range technologies
Long range technologies
Short range technologies
"5G IoT" variety of frequencies
IEEE 802.11ah (HaLow)
Adopting LoRa & Sigfox for products
NB-IoT
Enhanced Gateway solutions/virtualization
LTE-M (cat-0) testing
Management/support for heterogeneous networks
mmWave unlicenced band radio solutions e.g. for hybrid indoor positioning and data communication
Multi-radio gateway solution, connectivity through gateways, Zigbee/WiFi/BTLE/UWB indoor positioning
Short range Li-Fi and acoustic/ultrasonic technologies, depending on maturity level
Legacy IoT Networks
Container based virtualization for management and edge computing, transport protocol development (CoAP, RoHC for CoAP etc.), autonomic device/network management.
VTT test network piloting / PoC timeline, deployment roadmap
2014
2016
2018
2020

Some of the needed 5G functionalites for Industrial IoT

- Common solution for massive machine type communications (mMTC) and ultra reliable and low latency communications (URLLC)
- Better tolerance for interference in industry use and variety of frequencies to use in different use cases (outdoor/indoor), potentially able to support spectrum sharing
- Improved security, authentication and user/device management compared to current IoT solutions (applying e.g. ML methods for automatizing management)
- Slicing support and improved traffic prioritzation and network sharing
  - supporting distributed IoT cloud infrastructure over multiple domains
- Support for time sensitive networking (TSN) over the wireless
  - precise time synchronization is necessary also e.g for postitioning

Building the IIoT 5G enablers at 5GTNF

Open Innovation Ecosystem for 5G Technology and Service Development coordinated by VTT



- For 5G large scale trials and pre-commercial deployments
- To test 5G and beyond solutions enabling new products and services
- State-of-the-art technologies from leading vendors
- Flexible service configurations using standardized and open interfaces

Examples of Enablers

Reference

Micro-segmentation for mobile network security

Micro-segmentation concept for enhancing mobile network security.
Dynamic network security can be applied to use cases (e.g. IIoT) with fluctuating requirements.

Challenge

- There is a need for different levels of security at application or at organizational domains
- Bulk traffic might not need a secure communication.
- There is a need for strict access control for management and control messages e.g. in an industrial network.
- Software defined networking (SDN) architecture assists to create and maintain dynamically managed networks.

Solution

- Micro-segmentation of SDN networks:
  - Small virtual slices, which can have different customizable security levels.
  - Security level can be customized
  - Every micro-segment has its own monitoring and dynamic handling of faulty traffic.
- Focus on small virtual slices
  - The network traffic becomes more homogeneous, making threats and attacks easier to detect for security monitoring.

Benefits

1. **Network operator can use its network more efficiently.**
2. **Different levels of security at the micro-segment are possible.**
3. **Dynamic creation, usage and termination of microsegments is possible.**
4. **Homogeneous traffic flows make it simpler to**
   - **enforce fine-grained access control,**
   - **customize authentication,**
   - **monitor specific attacks.**

Reference

https://youtu.be/xfuBEpt4l8Y?t=37

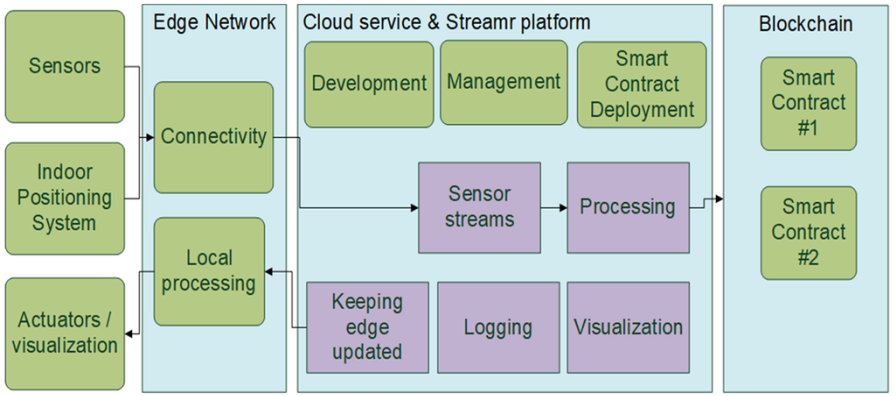
Reference

Asset Tracking with Smart Contracts

- Supply chains and asset tracking are essential part of e.g. manufacturing process
- Smart contracts can further automate the supply chain process
- Integrating IoT and sensor information to smart contracts, it is possible to validate also asset status and validity during shipment
- Depending on set terms and conditions, solutions can be applied also for e.g. sensors and devices to recognize change in behavior or validity

Solution: a layered achitecture

- the edge network devices increase the system responsiveness
- the cloud service enables programmability and orchestration, and
- Blockchain provides an immutable storage for transactions.



Demonstration based on orientation sensors, UWB positioning, Streamr platform for building backend applications and Ethereum blockchain

Reference

Multi-access IoT Edge Gateway (PoC)

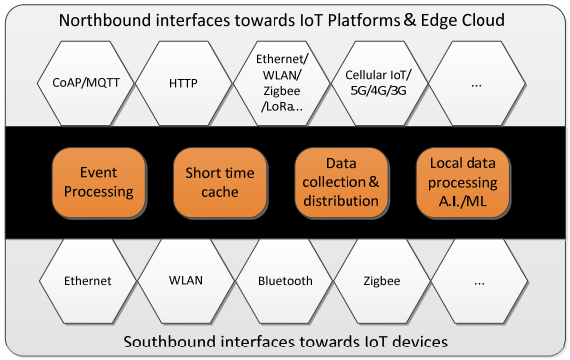
Multiradio IoT Edge GW software with data processing capabilities based on software defined networking and container virtualisation solutions

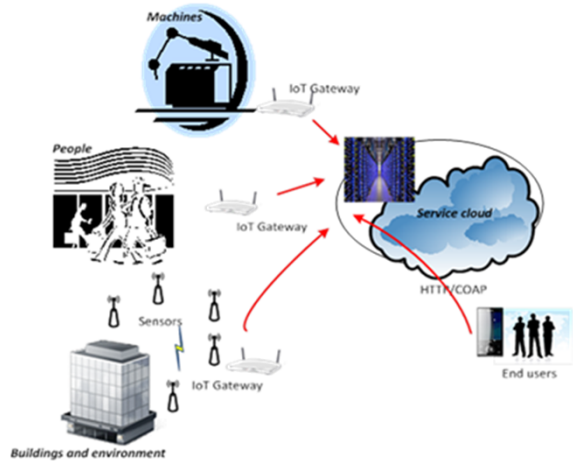
Challenge

- Arranging connectivity for legacy IoT solutions and novel solutions
- Support for several radio tehnologies needed
- Data processing at the leaf of the IoT network as requirement
- Fast response and data fusion near end devices
- Remotely managed and updated, automized functions as self-healing

Solution

- Software defined gateway architecture for collecting and distributing data
  - Supporting multi-radio HW design with COTS components
- Modular solution – each interface and functionality as virtualised function
  - Container virtualisation used to provide lightweight solution
- Application and virtualised function orchestration
- Architecture applicable also for edge servers





beyond

the obvious

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