The role of Edge Cloud Compute in 5GIIoT

30th October 2019

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...develop industrial IoT (IIoT) solutions, and a deal with network operator China Unicom to deploy a private LTE set-up for BMW in China.

Telia and Nokia to build industrial 5G ecosystem in northern Finland

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Industrial north – the port of Oulu, in Finland. will be threaded with 5G technologies

Scandinavian operator Telia is to follow its early deployment of 5G in Helsinki, in Finland, by connecting the city of Oulu, in the north of the country, to 5G technologies to serve smart city and industrial applications. Finnish vendor Nokia is handling the network upgrade.

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BT Views: Society has to matter to 'Industry 4.0'

BT has co-authored a plan for Scotland to adopt an ethical approach to AI and technological change. Mark Dames writes that it offers the chance to set a gold standard for the 'Fourth Industrial Revolution'

MTC launches factory in a box Industry 4.0 initiative

By Stuart Nathan 26th March 2019 8:30 am

The Manufacturing Technology Centre's Factory In a Box initiative promises to spread the benefits of Industry 4.0.

Orange on URLLC (and private 5G): "The economics favour public networks"

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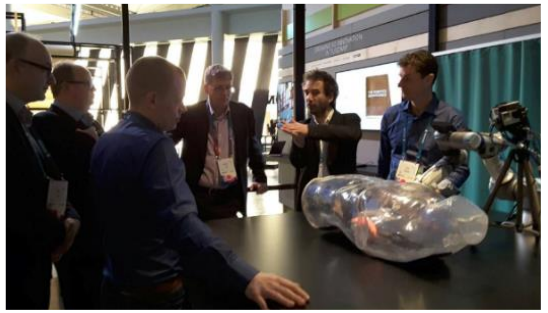
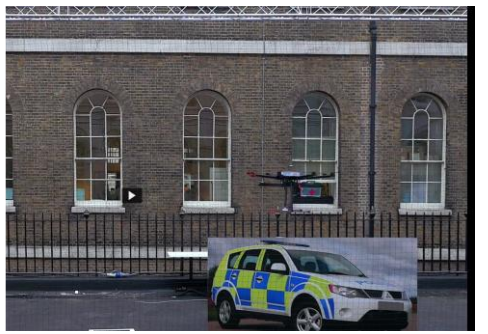
Remote diagnostics



Autonomous Control of UAVs



5G Connected ambulance – remote diagnostics

Robo-glove lets clinicians treat ambulance patients over internet

Mark Bridge

Superfast 5G broadband will enable hospital specialists to make a diagnosis remotely while patients are still in the ambulance.

In the first demonstration of its kind, NHS workers showed how faster connections allowed paramedics to perform ultrasound scans as clinicians watched the footage live and offered guidance using a robotic glove.

It is hoped that the technology will boost survival rates by allowing accurate early diagnosis in cases involving major trauma, chest pains and suspected strokes, among others. This can enable paramedics to administer more targeted treatment in the ambulance and hospitals to get patients into surgery faster on arrival.

The system was shown at Queen Elizabeth Hospital in Birmingham after BT's mobile arm EE launched the faster mobile broadband in parts of the city. The West Midlands is a testbed for 5G technologies that could be introduced nationwide.

While a paramedic performed ultrasound scans inside an ambulance, the footage was streamed live over the 5G network to screens viewed by doctors who communicated with him over video and audio connections. A hospital specialist was able to remotely guide the hand of the paramedic that was holding the ultrasound probe to obtain the most useful images. Tom Clutton-Brock moved a joystick to send signals to a lightweight "haptic" glove worn by the paramedic. This could generate a gentle vibration in the paramedic's little finger to tell him to move the probe to the right, or a buzzing in the thumb to say move left, for example.

The test was carried out on a sophisticated dummy, which contains air and fluid sacks that show up in scans. The paramedic also scanned his own hand to demonstrate the technology on human tissue.

The transmission of high-quality ultrasound images, enabling synchronised viewing over a distance, was not possible with 4G, which has slower data-transfer speeds.

Dr Clutton-Brock said: "This allows us to do what we have not done before. It will improve the efficiency of healthcare by putting the right patients in the right places. It will also improve survival rates and patient outcomes, because there'll be a large reduction in delays getting people to theatre as diagnoses will be done on the way."

He gave the example of an ill baby. "The symptoms of a baby that is poorly, breathless and blue can be diagnosed as clinicians know whether it has a hole in its heart and needs surgery, or if it's just sepsis and it can go to a children's hospital. It happens all the time that a baby arrives one place and has to be conveyed elsewhere."

Cameron McVittie, a paramedic with West Midlands Ambulance Service, who tried out the technology, said: "As a paramedic I want something that is effective and simple to use and reliable, which is what the demonstration showed. This improves communication and gets patients a better outcome. It is all about time — time saves lives."

He added: "It can also save resources. In the West Midlands we have six air ambulances and remote diagnosis can mean they're not sent where they're not needed."

A trial in Scotland used a satellite communications system to transfer scans from ambulances travelling over long distances in the Highlands to a hospital in Inverness. However, BT says that 5G is faster and cheaper and therefore more suitable for general rollout.

University Hospitals Birmingham said that it could be ready to adopt the technology within 12 to 18 months pending further testing and approval.

Sixteen UK cities will soon be equipped with 5G, up from six. The next-generation mobile internet will enable new technologies such as car communications between driverless cars

How it works

An ultrasound scan is performed by a paramedic wearing a special glove to guide his hand as he moves the ultrasound probe

1 Paramedic

Haptic glove

2 Scan data is sent over the 5G network from the ambulance to the hospital

3 Doctors or surgeons viewing in real time use a joystick to send instructions to the paramedic's hand to obtain the clearest images

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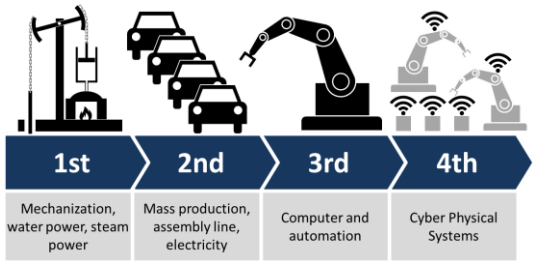
What is 5G Industrial IoT?



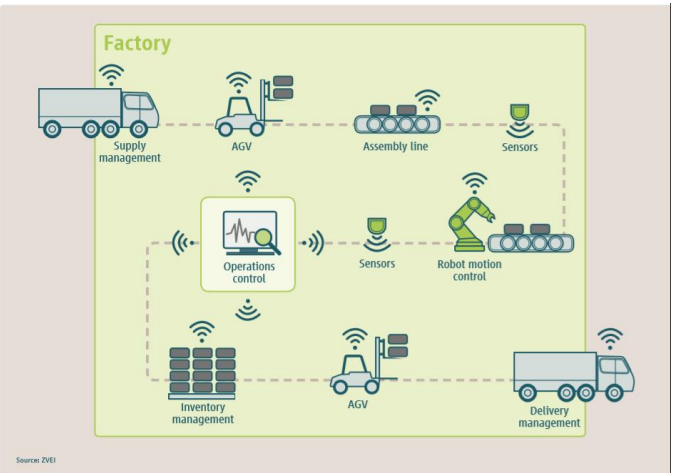
3GPP TS 22.261 - Service for the 5G system; Stage 1
6.28 Cyber-physical control applications in vertical domains

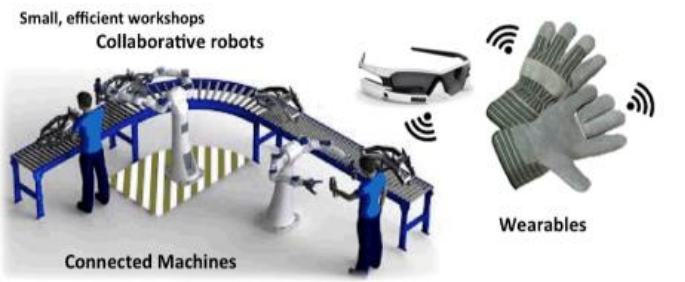
Automation refers to the control of processes, devices, or systems in vertical domains by automatic means. The **main control functions** of automated control systems include *taking measurements, comparing results, computing any detected or anticipated errors, and correcting the process to avoid future errors*. These functions are **performed by** *sensors, transmitters, controllers, and actuators.*

Cyber-physical systems are to be understood as systems that include engineered, interacting networks of physical and computational components. **Cyber-physical control applications** are to be understood as applications that control physical processes. Cyber-physical control applications in automation follow certain **activity patterns**, which are open-loop control, closed-loop control, sequence control, and batch control.

Communication in automation in vertical domains follows certain **communication patterns**. The most well-known is *periodic deterministic communication*, others are *a-periodic deterministic communication* and *non-deterministic* communication.

Communication for cyber-physical control applications supports operation in various vertical domains, for instance **industrial automation and energy automation**.





https://www.5g-acia.org/fileadmin/5G-ACIA/Publikationen/Whitepaper_5G_for_Connected_Industries_and_Automation/WP_5G_for_Connected_Industries_and_Automation_Download_19.03.19.pdf

Wide set of use cases & associated performance requirements

3GPP TS 22.104 - Service requirements for cyber-physical control applications in vertical domains

Table 5.3-1: Aperiodic deterministic communication service performance requirements

Characteristic parameter (KPI)				Influence quantity					
Communication service availability	**Communication service reliability: mean time between failures**	**Max Allowed End-to-end latency (note 1)**	**Service bit rate: user-experienced data rate**	**Message size [byte]**	**Survival time**	**UE speed**	**# of UEs**	**Service Area (note 3)**	**Remarks**
> 99,9999 %	~ 1 week	10 ms	> 10 Mbit/s			≤ 50 km/h	≤ 100	≤ 1 km^2	Mobile robots – video streaming (A.2.2.3)
99,9999 % to 99,999999 %	~ 1 month	< 30 ms	> 5 Mbit/s			< 8 km/h	TBD	TBD	Mobile control panels - parallel data transmission (A.2.4.1)
99,9999 %	–	< 50 ms	0,59 kbit/s 28 kbit/s	< 100	–	stationary	10~100 /km^2	TBD	Smart grid millisecond level precise load control (A.4.5)
> 99,9 %	~ 1 month	< 10 ms				< 8 km/h	≥ 3	20 m x 20 m x 4 m	Augmented reality; bi-directional transmission to image processing server (A.2.4.2)
99.9999 % to 99.999999 %	~ 10 years	< 1 ms (note 4)	25 Mbit/s			stationary	2 to 5	100 m x 30 m x 10 m	Wired-2-wireless 100 Mbit/s link replacement (A.2.2.4)
99.9999 % to 99.999999 %	~ 10 years	< 1 ms (note 4)	500 Mbit/s			stationary	2 to 5	100 m x 30 m x 10 m	Wired-2-wireless 1 Gbit/s link replacement (A.2.2.4)

NOTE 1: Unless otherwise specified, all communication includes 1 wireless link (UE to network node or network node to UE) rather than two wireless links (UE to UE).
NOTE 2: (void)
NOTE 3: Length x width x height.
NOTE 4: Scheduled aperiodic traffic with transfer interval (max end-to-end allowed latency < transfer interval).

"Communication services supporting cyber-physical control applications need to be ultra-reliable, dependable with a high communication service availability, and often require low or (in some cases) very low end-to-end latency."

- Ultra low latency
- Ultra High reliability and availability
- Clock synchronisation - time-sensitive networking
- High positioning performance
- Ethernet transport services
- Proximity Services
- Integrity, confidentiality – physically local storage and processing

Hybrid edge?

What is the role of edge cloud compute? What "type" of edge?

Edge Cloud Compute is assumed to be a "must have" to deliver:

- Latency
- Security
- Reliability

However, industry seems to be assuming that customer-based Edge Cloud Compute capabilities are the only answer.

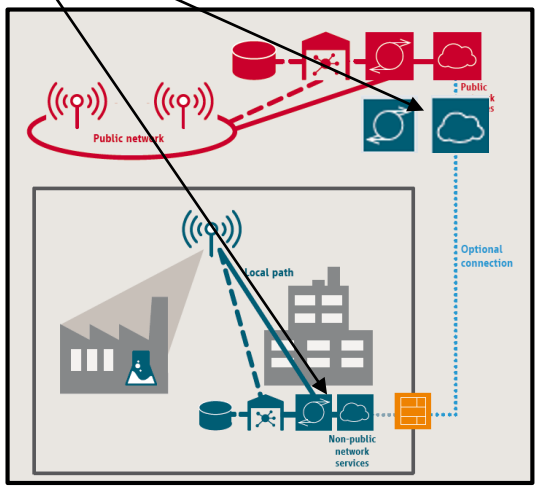
Agree that on-premise Edge Cloud Compute can help deliver:

- Ultra-low latency
- Reliability / availability
- Security
- Transport savings

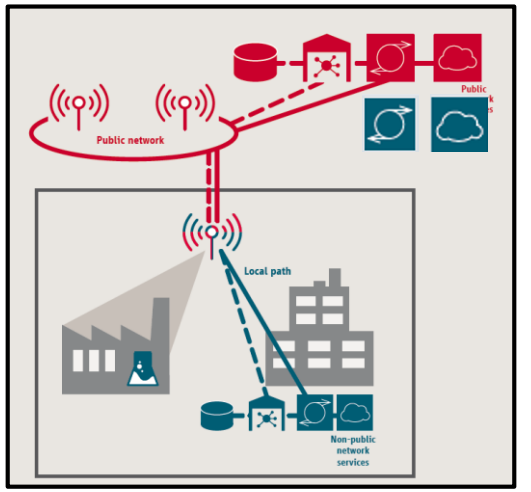
However, operator-provided edge capabilities may also have a role to play to provide additional:

- Processing capacity / scalability
- Failover options
- Support for wide-area / multi-site private network services

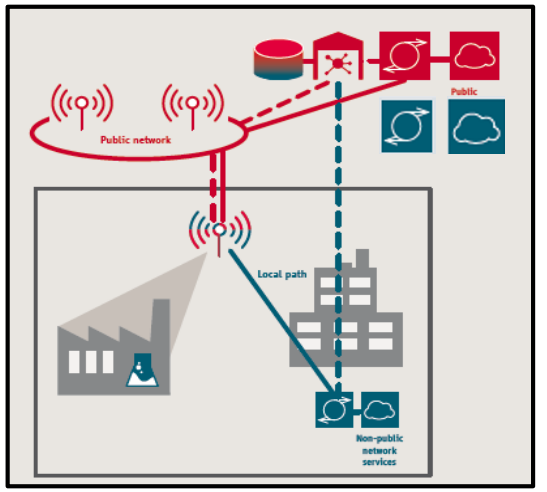
Would a "hybrid edge" cloud compute model be the answer???



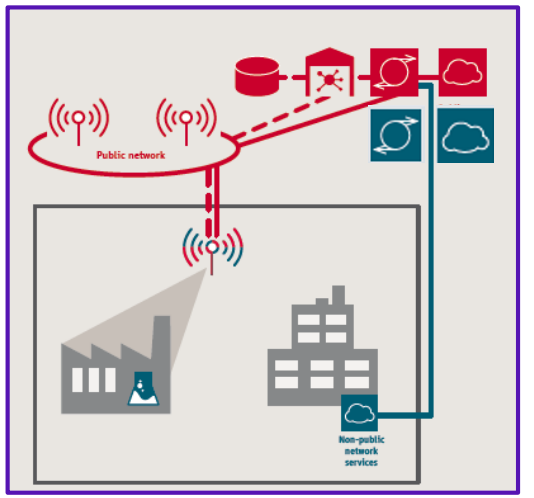
Deployment as an isolated network



Deployment with shared Radio Access Network



Deployment with shared RAN and control plane



Non Public Network (NPN) in public network

https://www.5g-acia.org/publications/5g-non-public-networks-for-industrial-scenarios-white-paper/

Conclusions

- There are significant benefits and industry activity on **5G-enabled Industrial IoT opportunities**
- A wide range of performance and functional requirements need to be supported – a **very flexible and future-proof architectural solution is key**
- **Edge Cloud Compute** has a key role to play to fulfil 5GIIoT various use cases (together with other capabilities such as URLLC, network slicing, time sensitive networking, Ethernet Transport etc.)
- However, Edge Cloud Compute capabilities can be located in the **customer premise or the operator** – depending on the use case a different approach may be required
- **Non-Public network solutions** (also referred to as Private Networks) need to take account of both models – customer and operator-based Edge Cloud Compute

Thank you