

The logo is a diamond shape with a white center containing the text 'ITSF 2019'. The diamond's border is composed of four colored segments: red (top), green (left), blue (bottom), and white (right).

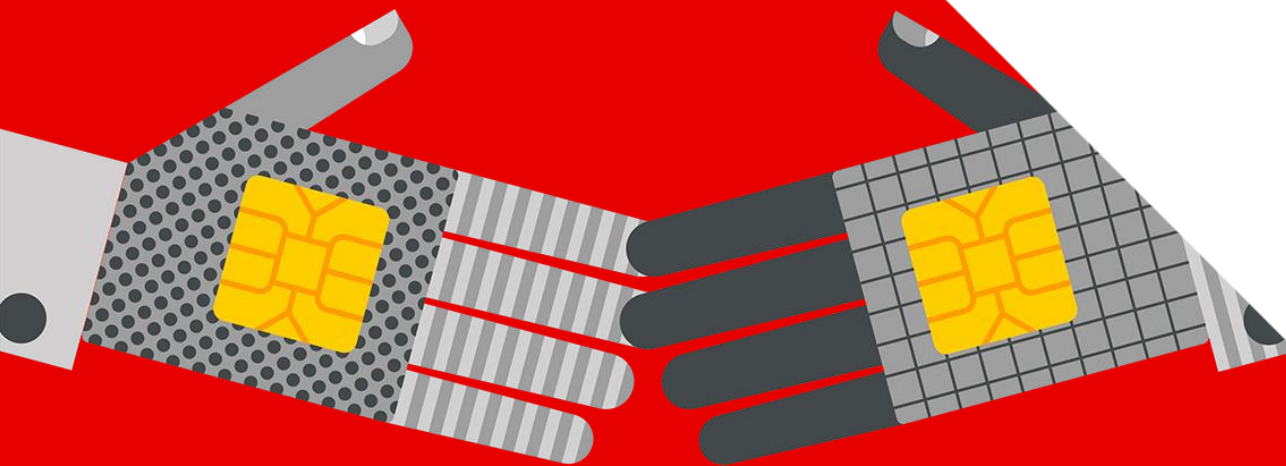
ITSF
2019

The Vodafone logo, a red speech mark inside a silver sphere, is positioned to the left of the title.

Synchronisation use cases and requirements in vertical sectors

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Outline

- ❖ Overview of 5G discussions in 3GPP
- ❖ Clock synchronisation and time domains
- ❖ Industrial 4.0 use cases and synchronicity requirements
- ❖ Audio-visual production use cases and synchronicity requirements
- ❖ Critical medical application use cases and synchronicity requirements





Standardisation Work in



Release 15 the advent of 5G

- New Radio (NR)
- 5G System (Phase 1)
- Massive IoT
- V2X Communications
- Mission Critical
- Mobile Communication System for Railways (FRMCS)

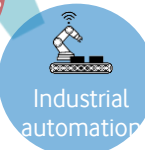
Release 16 Towards full 5G vision

- 5G System (Phase 2)
- 5G support for V2X
- Industrial IoT
- Ultra-Reliable and Low Latency Communication (URLLC) enhancements
- FRMCS Phase 2

Release 17 outlook

- 5G System Enhancements
- Satellite in 5G Systems
- Industrial IoT - TSC/URLLC
- 5G for unmanned aerial vehicles

Industrial use cases
drive innovative
solutions



2019 R-15 2020 R-16 2021 R-17 2022 2023 2024 2025



Partnerships are key for fostering new ecosystems

Industrial IoT

- Increase **flexibility, versatility, productivity, resource efficiency**
- **Connectivity** is a key enabler



5G system

- Strong focus on **machine-type communication**
- **URLLC** and **massive IoT** enable new applications



Industrial 4.0

Audio Visual Production
Critical medical application

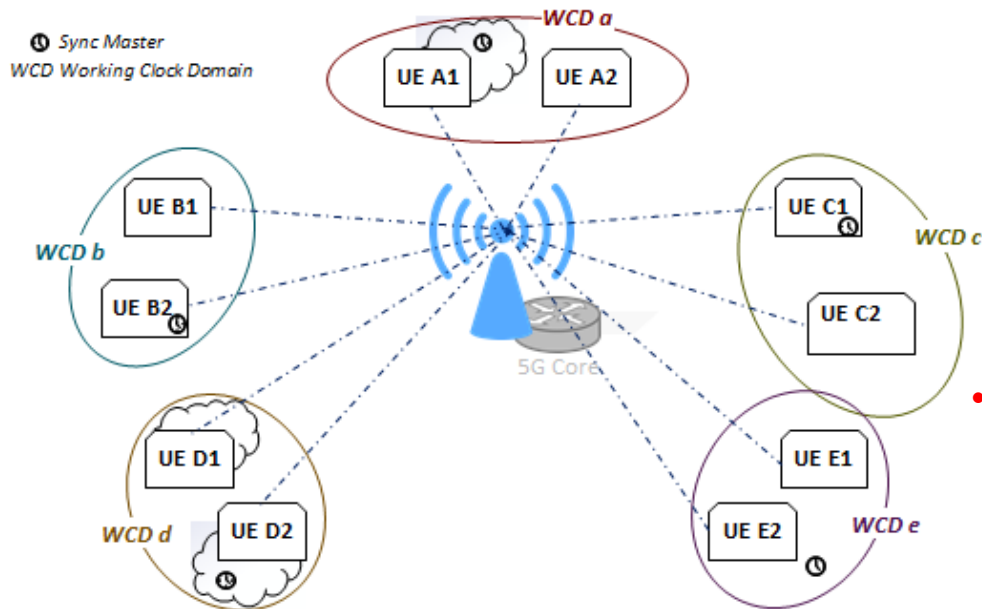
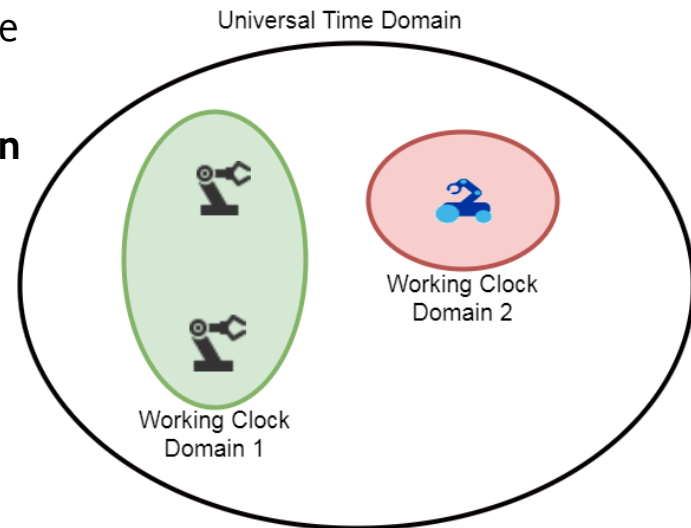


3GPP Market
Representation Partners
March 2019



Many vertical use cases have stringent clock synchronisation requirements

- **Synchronisation precision requirement:** the maximum absolute value of the time difference between sync master and a device
- Two time domains: **global time domain** & **working clock domain**

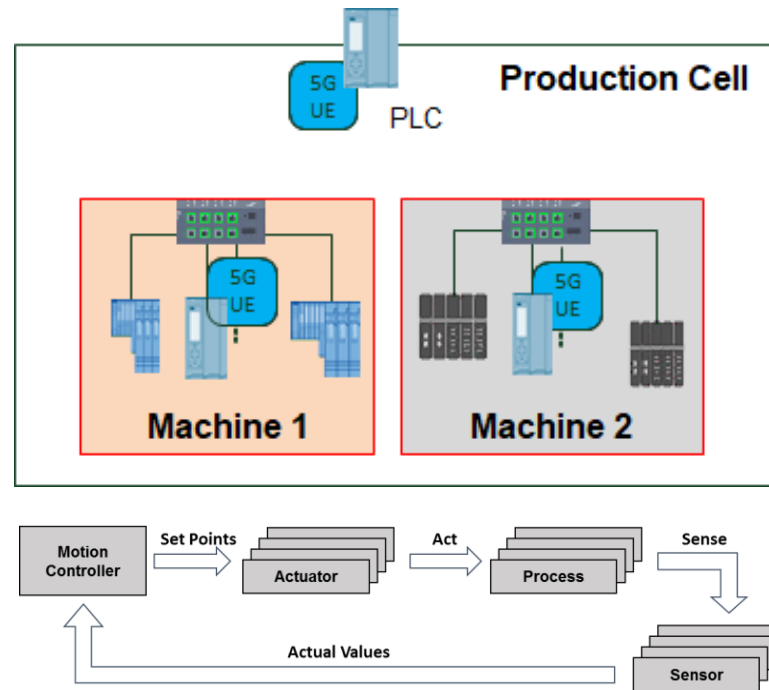


- A 5G base station may have to handle **multiple working clock domains**

Source: 3GPP TS 22.104

Motion Control in Factory Automation

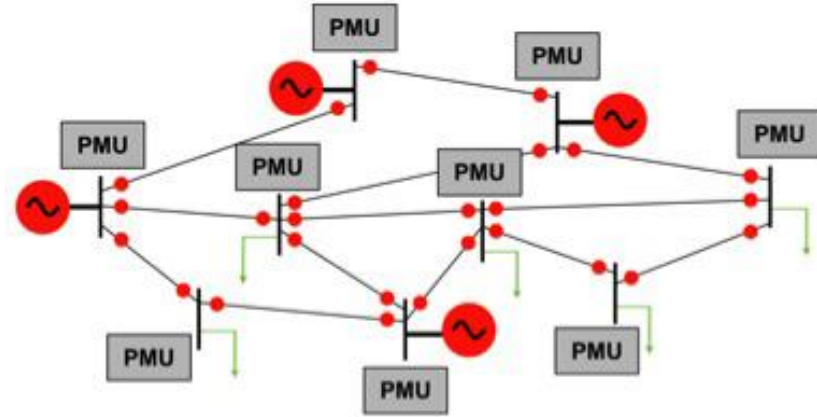
- **Motion control:** the most challenging closed-loop control application in industry
- A **motion control system:** responsible for controlling moving and/or rotating parts of machines
 - a motion controller periodically sends desired set points to one or several actuators
 - actuators perform corresponding actions on one or several processes
 - sensors determine the current process states and send the actual values back to the motion controller



Number of devices	Clock synchronicity	Service area
Up to 300 UEs	$< 1 \mu s$	$\leq 100 \text{ m} \times 100 \text{ m}$

Smart Grid: synchronicity between phasor measurement units (PMU)

- In electric power distribution, PMUs deployed along the power line provide real-time measurement of frequency/voltage/power to reflect the state of the system.
- When a fault happens, two PMUs, on both sides of the fault location, detect the waves by the change of frequency/voltage/power and record the time of receiving the wave. The server can then calculate the fault location according to the time difference of wave detection



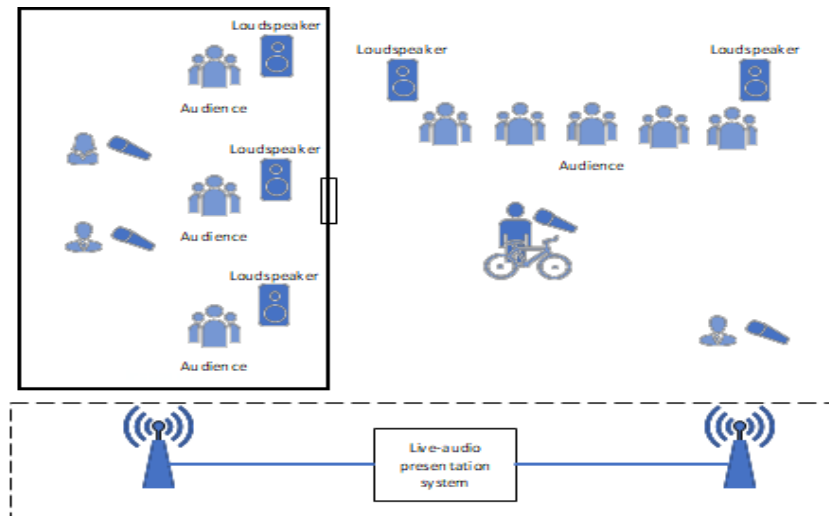
Number of devices	Clock synchronicity	Service area
Up to 100 UEs	< 1 μ s	< 20 km ²



Audio-Visual Production: On-site Live Audio Presentation

In a typical on-site live audio presentation situation:

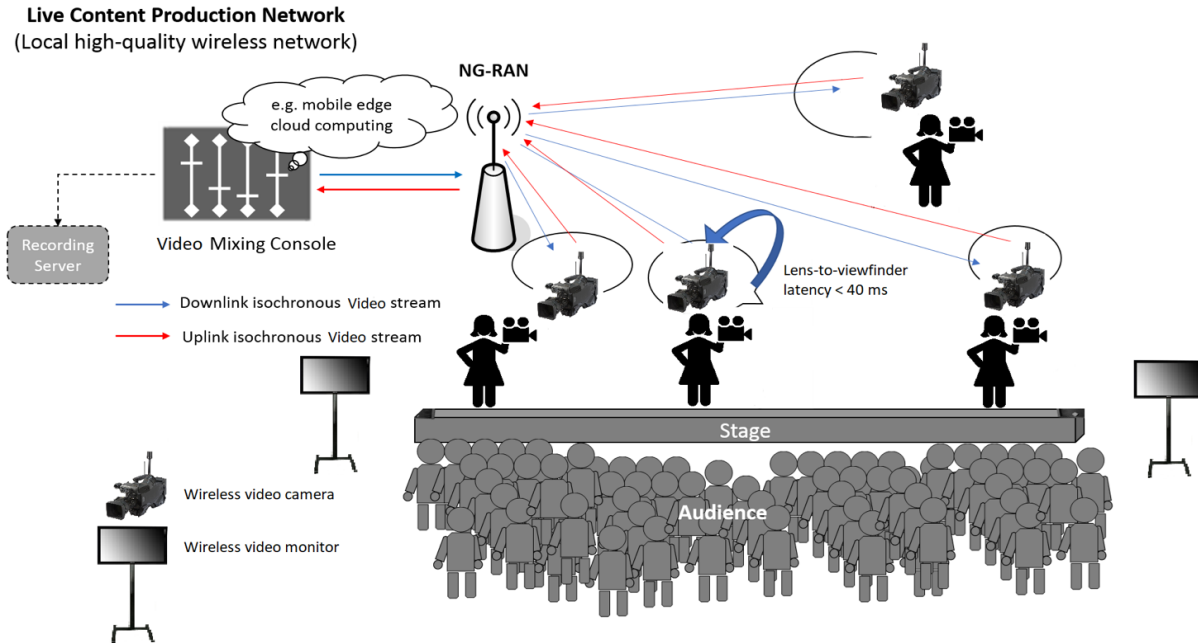
- one or several presenters are holding a talk in front of audience. The audience interacts with the presenters.
- Wireless microphones are used for capturing audio from presenters, which can be scattered into different rooms, stages or spaces within the same complex.



Number of devices	Clock synchronicity	Service area
5 - 300	5-500 μ s	Indoor: 100 m ² – 10,000 m ² Outdoor: 0.01 km ² - 1.5 km ²



Video Streaming in Professional Coverage of Live Performances



- Producing a live event involve many wireless links for the audio and video equipment.

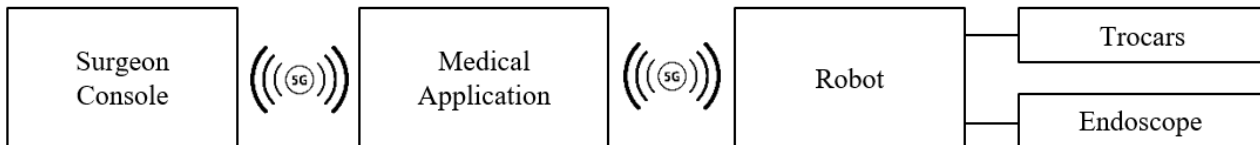
Number of devices	Clock synchronicity	Service area
5 – 10 (wireless cameras)	> 1μs	1000 m x 1000m (indoor/outdoot)



Critical medical applications: robotic aided surgery

- Robotic aided surgery is suitable to invasive surgical procedures. It is achieved through complex systems that translate the surgeon's hand movements into precise movements of tiny instruments that can generally bend and rotate inside the patient's body.
- Each equipment involved in a robotic tele-surgery setup is synchronised. The synchronisation is achieved through dedicated protocols.

Number of devices	Clock synchronicity	Service area
Up to 10 UEs	< 50 μ s	400 km



Typical Robotic Surgery System Setup



Questions?

