
5G IM DIALOG

IOT, REDCAP UND TSC – 5G KOMMUNIKATION FÜR DIE INDUSTRIE

Fraunhofer IIS, 2021-04-14

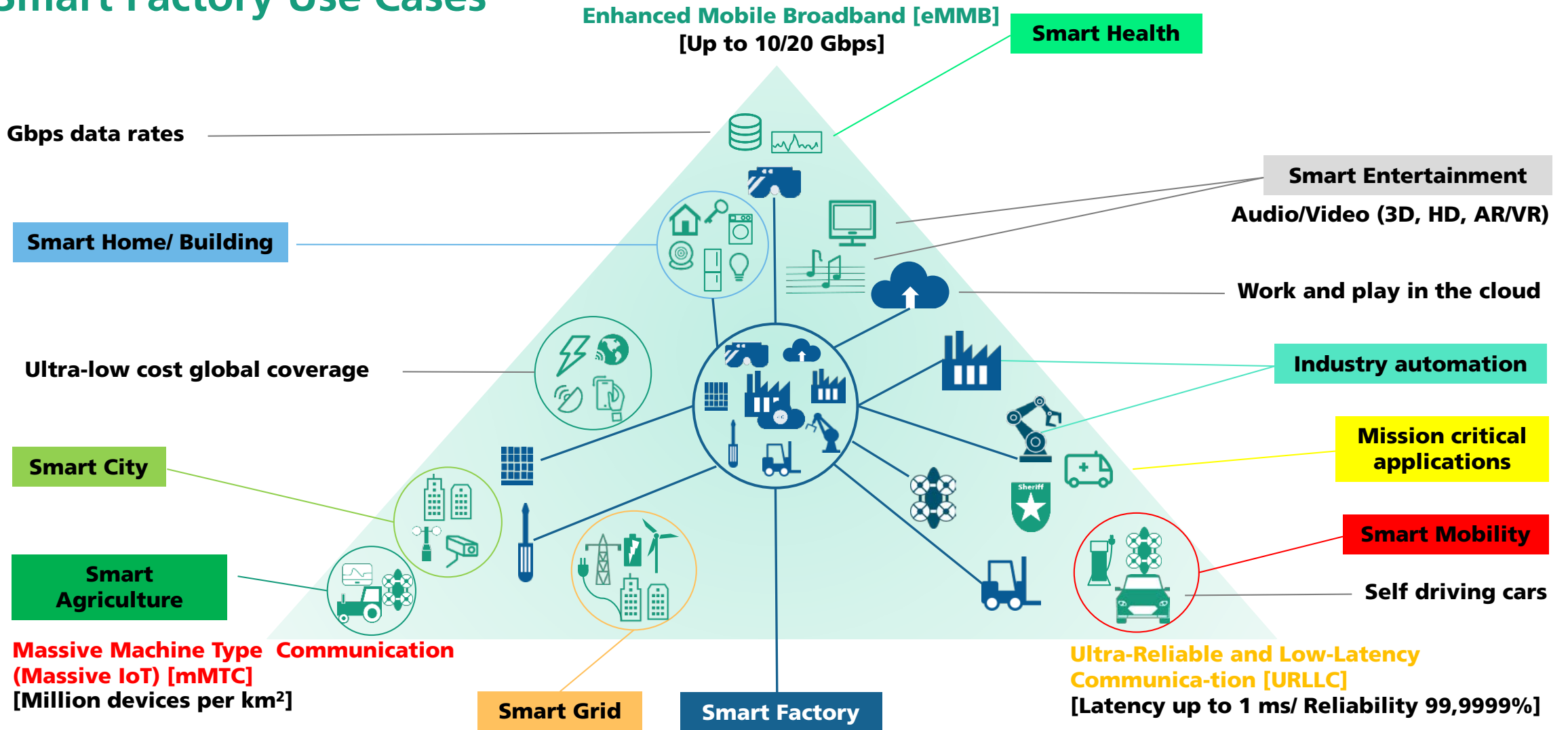
Julian Popp



© Victoria - Fotolia.com

3GPP Use Case Groups

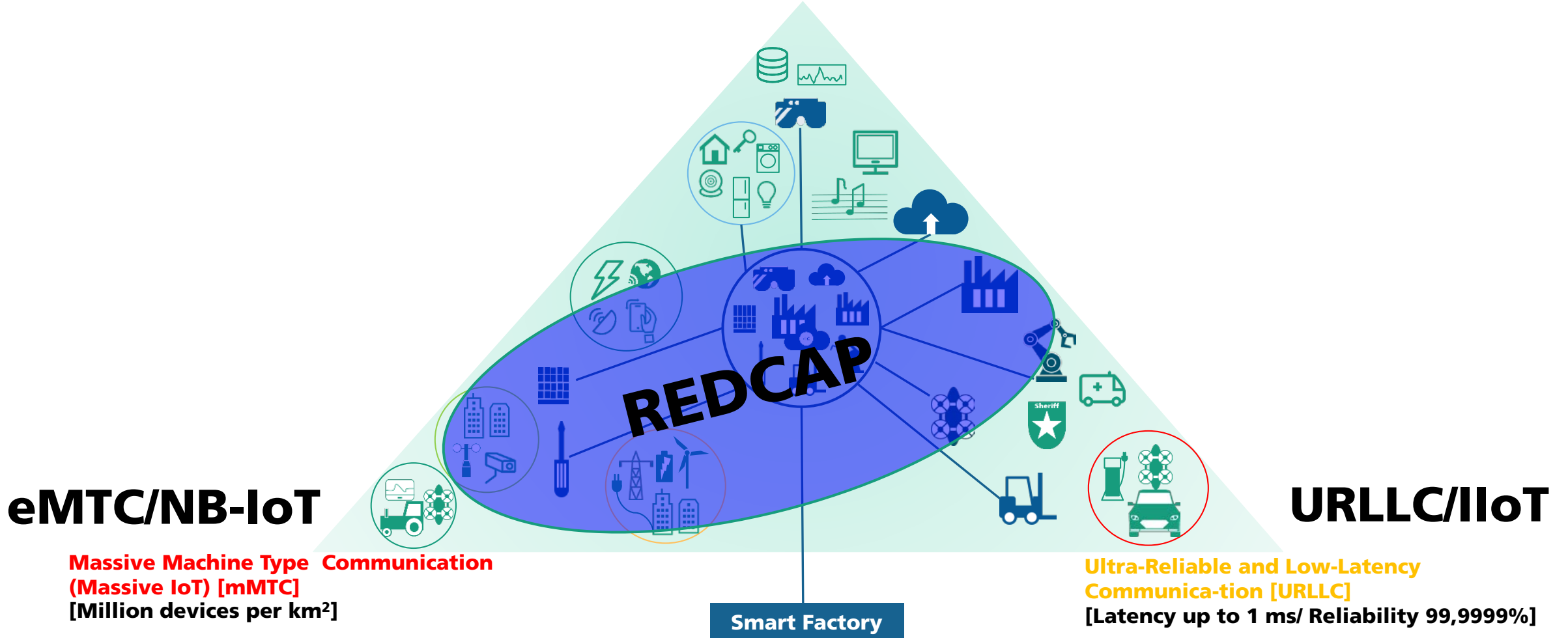
Smart Factory Use Cases



IoT Technologies in 3GPP From Narrowband to IIoT

5G SA

Enhanced Mobile Broadband [eMBB]
[Up to 10/20 Gbps]



Massive Machine Type Communication

IoT Technologies in LTE

- Solutions for **3GPP 5G Release 16**
 - LTE-M – LTE for Machines (eMTC)
 - 1.4 – 20 MHz bandwidth
 - NB-IoT – Low-cost/low-data narrowband IoT
 - 180 kHz bandwidth
 - Very low data rate (~500kB/month)
- Further development in Release 17 ongoing

| IoT Application | Reporting Interval (RI) [min] | Payload per RI [bytes] | # Devices per cell |
|----------------------|-------------------------------|------------------------|--------------------|
| Smart Metering | 1, 5, 10, >60 | 100-1k | 10k-30k |
| Home Security | 10 | 20 | 2k-10k |
| Credit Card Terminal | 1-30 | 24 | 100-1k |
| Traffic Lights | 1 | 1 | 10-1k |
| Traffic Sensors | 1 | 1 | 100-1k |

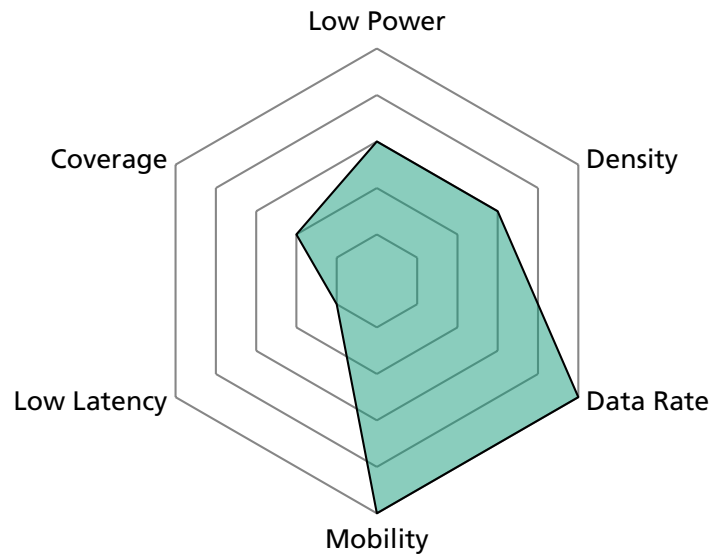
Source: Wong, Schober; Key Technologies for 5G

Massive Machine Type Communication

LTE Categories for IoT

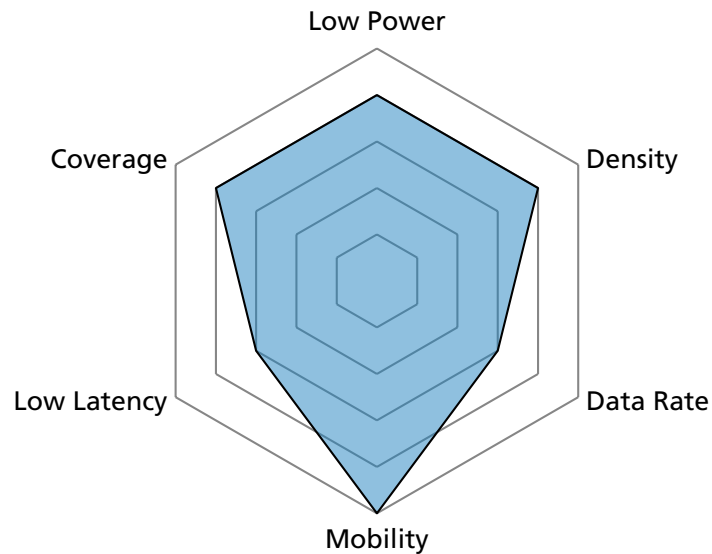
| Downlink Category | Release | Peak data Rate [Mbps] | MIMO Layers | 256-QAM |
|-------------------|---------|-----------------------|-------------|---------|
| M1 | 13 | 1 | 1 | NO |
| M2 | 14 | 4 | 1 | |
| 0 | 12 | 1 | 1 | |
| 1bis | 14 | 10 | 1 | |

**LTE Cat-1
Smartphone**



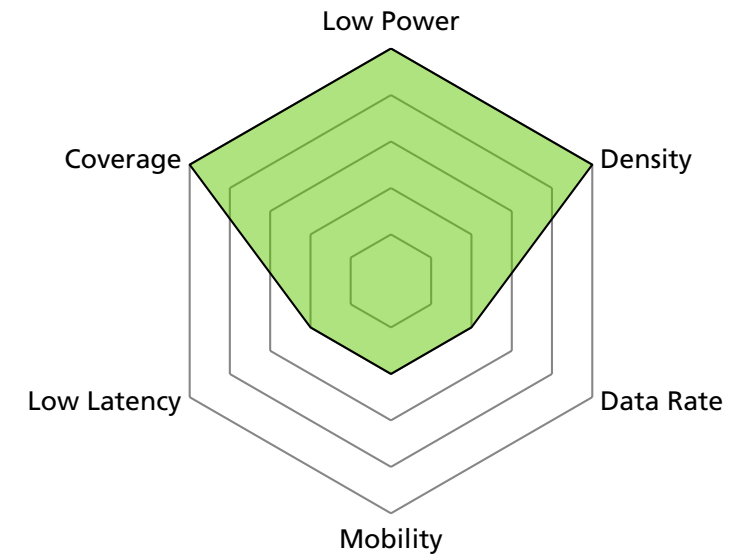
| Uplink Category | Release | Peak data Rate [Mbps] | 64-QAM | 256-QAM |
|-----------------|---------|-----------------------|--------|---------|
| M1 | 13 | 1 | NO | NO |
| M2 | 14 | 6 | | |
| 0 | 12 | 1 | | |
| 1bis | 12 | 5 | | |

**LTE Cat-M1
MTC device**



| NB Category | Release | Peak data Rate [Mbps] | |
|-------------|---------|-----------------------|--------|
| | | Downlink | Uplink |
| NB1 | 13 | 0,68 | 1 |
| NB2 | 14 | 2,5 | 2,5 |

**LTE Cat-NB1
Narrowband IoT**



New 3GPP Work Item

Reduced Capability Devices

* Study Item in 2020; Work Item in 2021

■ **RedCap** – Use cases:

- Industrial wireless sensor networks (IWSN)
 - 99.99% availability
 - 100ms e2e latency, safety 5-10ms
 - < 2 Mbps asymmetric (mainly UL)
- Wearables
 - DL 5-50 Mbps, UL 2-5 Mbps
 - Peak data rate 150/50 Mbps
- Video surveillance
 - 99%-99.99% reliability
 - < 500ms latency
 - Eco 2-4 Mbps, HD up to 25 Mbps

■ **Work Item:** Support for reduced capability NR devices

- FR1: max. 20MHz bandwidth
- FR1: Down to 1 RX branch/antenna
- Reduced processing capabilities, relaxed measurements for neighbor cell
- Extended DRX (Discontinuous Reception)
- Optional 256QAM modulation
- “The work defined as part of this WI is not to overlap with LPWA use cases.” (RP-210918)

FR1 – Frequency Range up to 7 GHz

Time Sensitive Networks (TSN)

IEEE 802.1 (et. al.)

- Time Sensitive Networks (IEEE)
 - Originally for Audio/Video Bridging via Ethernet

IEEE Protocol Standards

| | | | |
|--|---|---|--|
| IEEE 802.1Qat Stream Reservation Protocol | IEEE 802.1AS | IEEE 802.1AS rev. Timing & Synchronisation | IEEE 802.1ca Path Control and Reservation (PCR) |
| IEEE 802.1BA AVB Bridging | IEEE 1733 Layer 3 Transport Protocol | IEEE 802.1Qbu Frame Preemption | IEEE 802.1CB Frame Replication |
| | IEEE 1722 Layer 2 Transport Protocol | | |
| IEEE 802.1Qav Forwarding & Queuing | IEEE 1588 Precision Time Protocol (PTP) | IEEE 802.1Qbv Time Aware Shaper | IEEE 802.1Qcc Stream Reservation Protocol (SRP) |
| AVB | | TSN | |

Time Sensitive Networks in 5G

From TSN to TSC

- 5G is IP but not Ethernet
- Application – UE – gNB – Fronthaul – Backhaul – Data Network
- QoS via Network Slice and SDN technologies

RE – Radio Equipment
REC – Radio Equipment Control
TSC – Time Sensitive Communication
SDN – Software Defined Networks

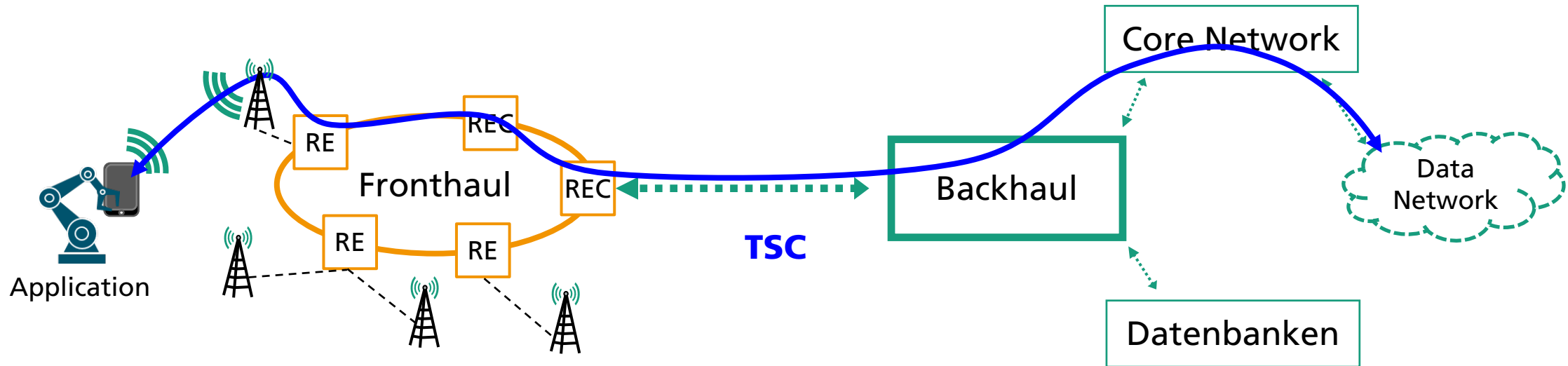
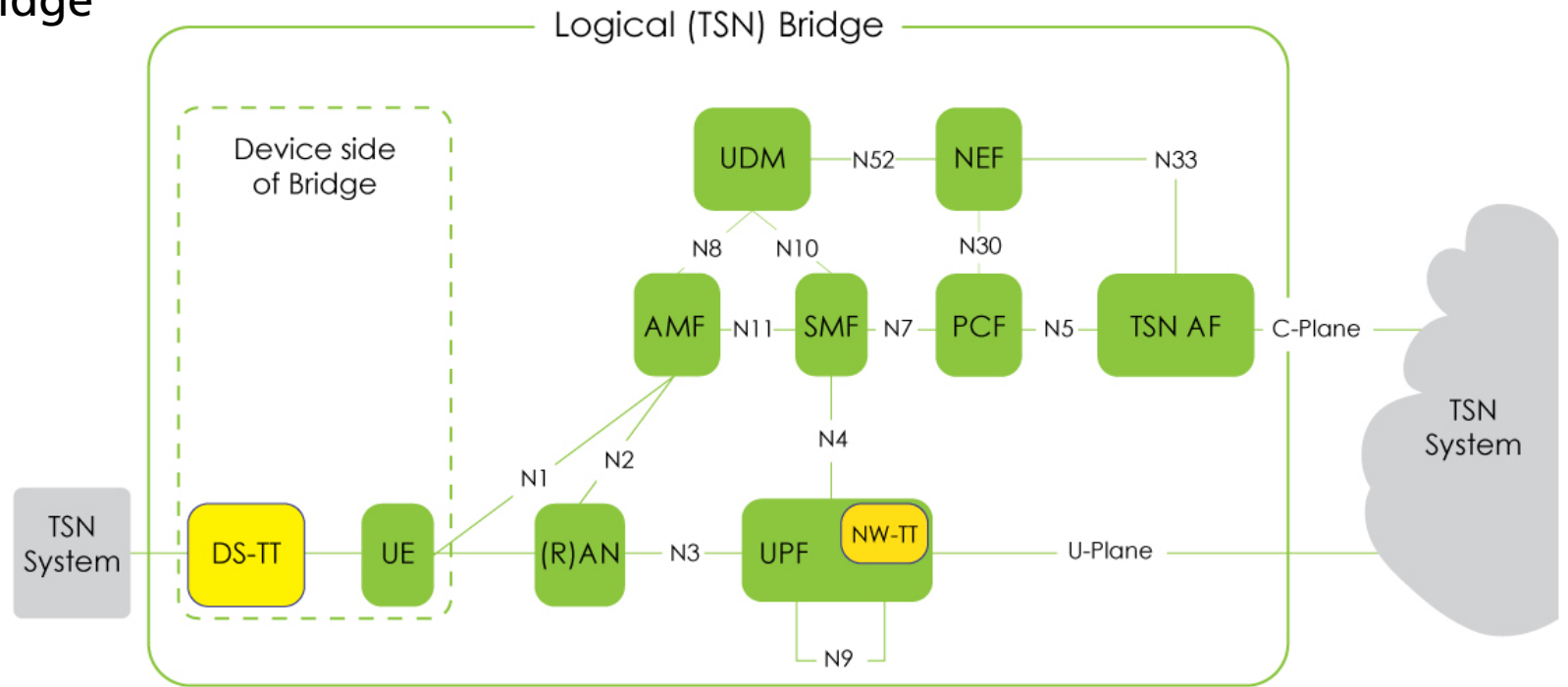


Illustration only!

5G and Time Sensitive Networks

From TSN to TSC

- 5G System appear as Logical Bridge
 - TSN Translator required!
 - DeviceSide (DS)
 - Network (NW)
- Sync to 5G Grandmaster (PTP):
 - DS-TT
 - UE (User Equipment)
 - gNB (RAN)
 - UPF (User-Plane Function)
 - NW-TT

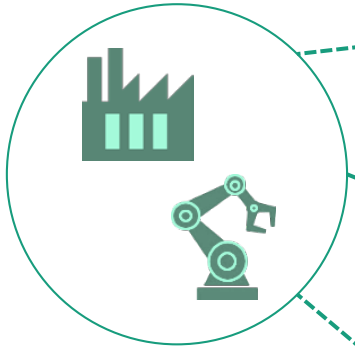


- TSN aware scheduling required!  System architecture view with 5GS appearing as a Time-Sensitive Networking bridge

TS 23.501

Use Case Scenario

Industry Automation



Human Machine Interaction

e.g. maintenance worker (Augmented Reality)

- High Data Rate, low latency
- Accurate positioning

[eMBB]

Sensors

e.g. for process optimization, building automation, logistics

- High connection density

[mMTC]

Process control

e.g. robotics, automated guided vehicle

- low latency, reliability and safety
- Accurate positioning

[URLLC]

Possible realization

- private network (Campus Netz)
- MEC for local data processing

Department Broadband and Broadcast @ Fraunhofer IIS

Contact Information

Julian Popp

Senior Engineer, 3GPP Delegate

Tel.: +49 9131 776-4062

E-Mail: julian.popp@iis.fraunhofer.de

Internet: <http://www.iis.fraunhofer.de/en/ff/kom.html>

