5GRONINGEN ROADMAPS 2017 - 2020

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TNO innovation for life

5GRONINGEN VERBONDEN MET DE TOEKOMST

DISCLAIMER

- The 5Groningen roadmaps in this document solely reflect the independent advice of TNO and in no way reflect the future plans and/or strategies of the Founding Fathers nor does it intend to coordinate such future plans and/or strategies.

- This is a working document.

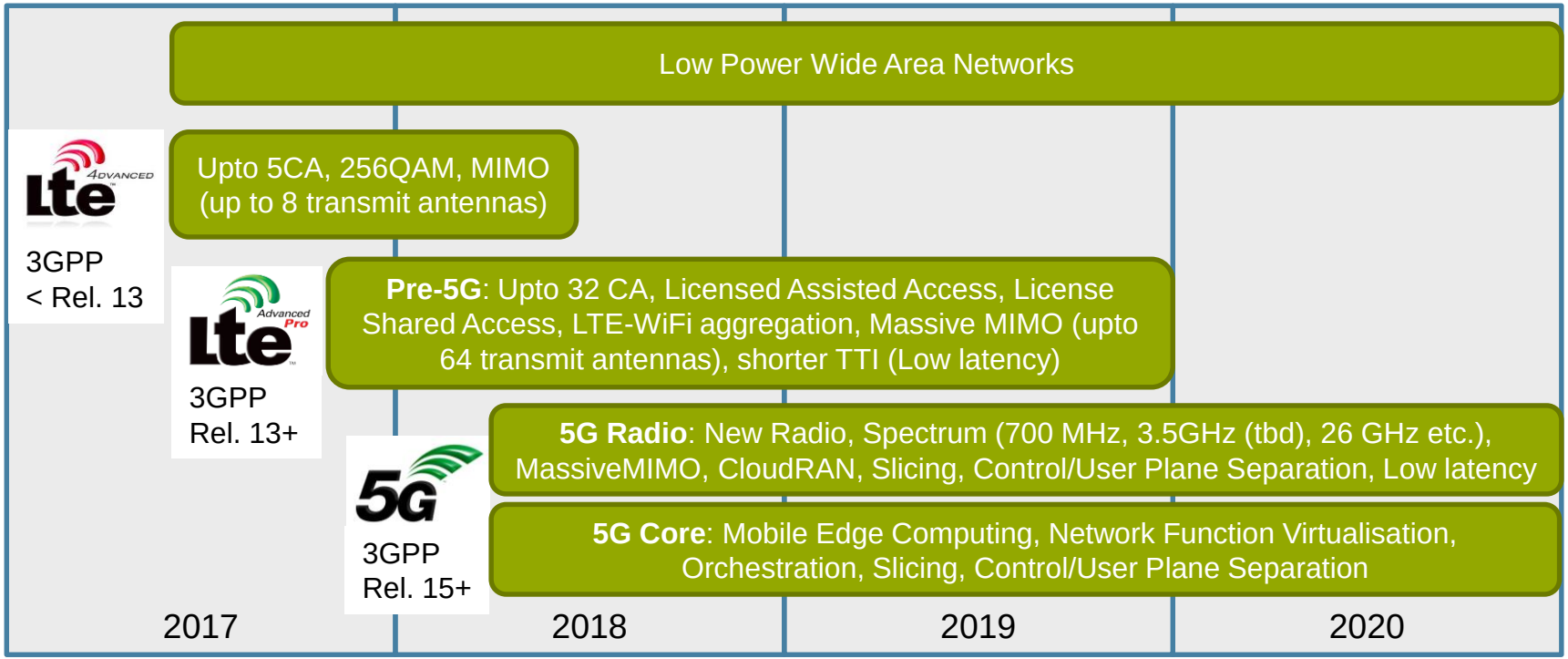
INTRODUCTION

- TNO has the role to develop the 5Groningen roadmaps. This is done in cooperation with consortium partners (“Founding Fathers”), in conformity with antitrust laws and regulations.

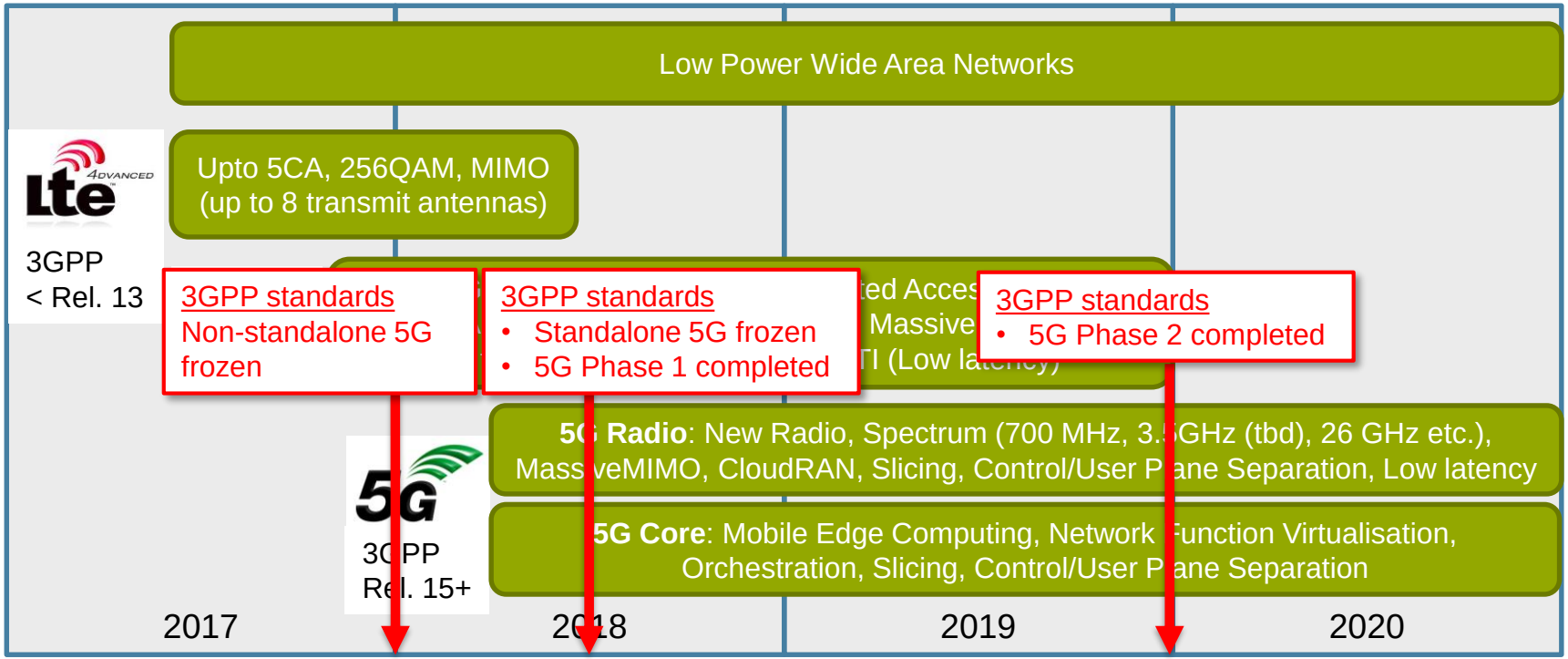
- TNO is developing *two roadmaps* showing *existing & targeted technologies and services* in 5Groningen for *2017 to 2020*. The roadmaps are living documents that will be updated periodically.
  - **Technology roadmap**
    - Enabling technologies (e.g. “Massive MIMO”, “MEC”, “New Radio” etc.).
  - **Service roadmap**
    - Major services & products that the Proeftuin plans to offer (e.g. “Smart Potato”, “VR”, etc.).


5GRONINGEN
TECHNOLOGY
ROADMAP

5GRONINGEN TECHNOLOGY ROADMAP



5GRONINGEN TECHNOLOGY ROADMAP




5GRONINGEN
SERVICE
ROADMAP

THE 5GRONINGEN TRIANGLE OF SERVICES

Enhanced mobile broadband

Massive machine type communications

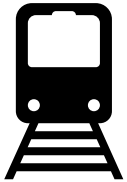
Ultra-reliable low latency communications

ENHANCED MOBILE BROADBAND: EXPERIENCED SPEED

REQUIREMENTS HIGHLY DEPEND ON SCENARIO

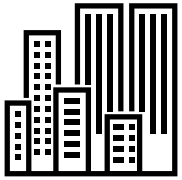
Rural macro
50 Mbps DL / 25 Mbps UL
100 users / km^2

Indoor hotspot
1 Gbps DL / 500 Mbps UL
250000 users / km^2

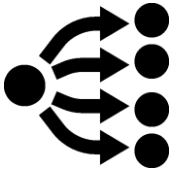


High-speed train
50 Mbps DL / 25 Mbps UL
1000 users / train
Up to 500 km / h

Urban macro
50 Mbps DL / 25 Mbps UL
100000 users / km^2



Dense urban
200 Mbps DL / 50 Mbps UL
25000 users / km^2



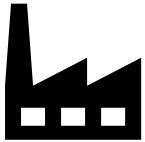
Broadcast
Max 200 Mbps DL per channel

DL: Downlink (from base station to mobile terminal)
UL: Uplink (from mobile terminal to base station)

Reference: 3GPP TS 22.261

ULTRA-RELIABLE LOW LATENCY COMMUNICATIONS

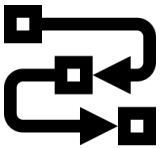
REQUIREMENTS HIGHLY DEPEND ON SCENARIO



Discrete automation - motion control
1 ms latency
99,9999% reliability
100 x 100 x 30 m

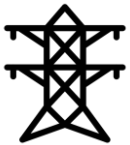
Intelligent transport systems
Platooning < 3 ms latency
Cooperative manoevres < 10 ms latency
Course driving < 100 ms latency
99,9999% reliability
2km along road

Drones & remote farm machinery
10 to 30 ms latency
99,9 to 99,9999% reliability
Several km^2 area



Process automation
50 ms latency
99,9 to 99,9999% reliability
300 x 300 x 50 m

Remote medication & surgery
10 to 100 ms latency
99,9999% reliability
Wide range of coverage areas



Smart Grid: Electricity distribution
5 to 25 ms latency
99,9 to 99,9999% reliability
100 to 200 km along power line

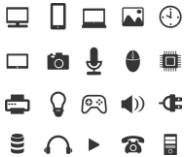
Reference: 3GPP TS 22.261

MASSIVE MACHINE TYPE COMMUNICATION

4G IOT TECHNOLOGY ALREADY FULFILS MANY OF THE REQUIREMENTS

Throughput
A few kbps to
1 Mbps

Coverage
Extreme indoor coverage
(Maximum coupling loss ~164 dB)



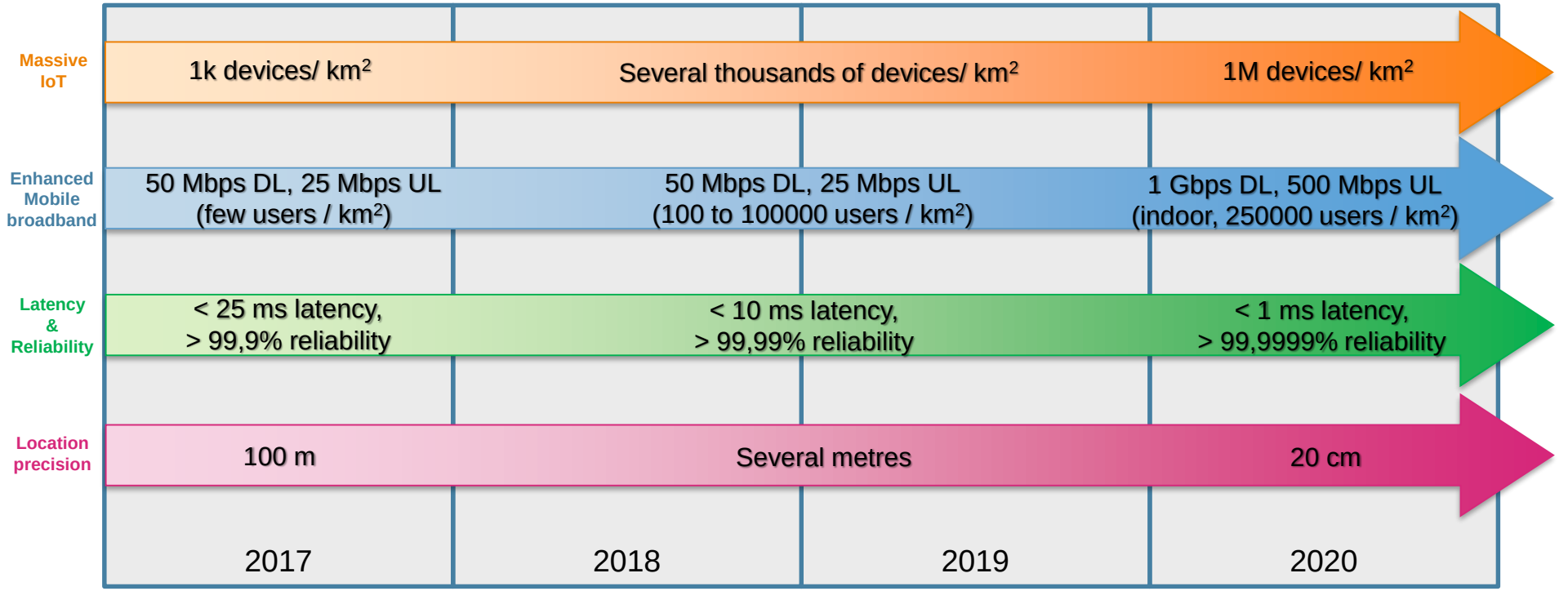
Density
1 million per km^2

Battery life
10+ years

Mobility
Idle mode mobility and/or
connected mode mobility

Cost
Few Euros per device

5GRONINGEN SERVICE ROADMAP (KPIs)

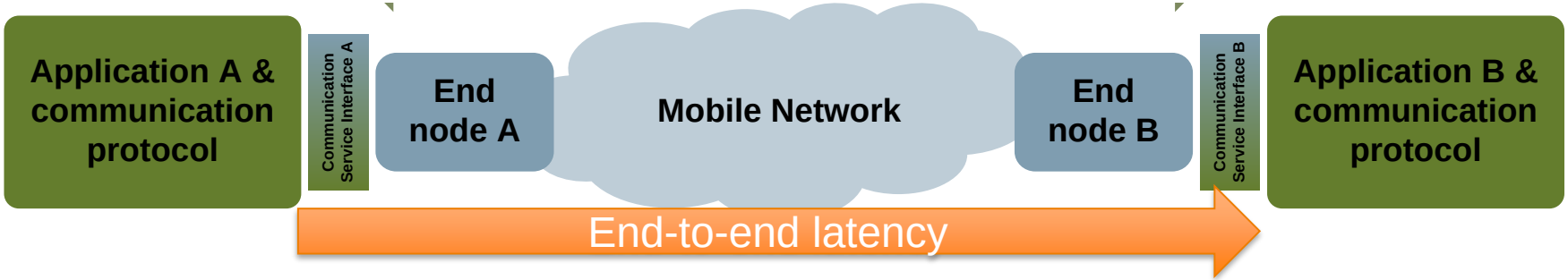


N.B. Achieving the above KPIs depends on availability of spectrum and ongoing standardisation developments.


APPENDIX:
DEFINITIONS

END-TO-END LATENCY

3GPP DEFINITION



- 3GPP definition (from *3GPP TS 22.261*) of End-to-end latency: “the time that takes to transfer a given piece of information from a source to a destination, measured at the communication interface, from the moment it is transmitted by the source to the moment it is successfully received at the destination”.

- End-to-end latency – key aspects
  - One way
  - At the application layer, between a node/server *in* the mobile network and a device
  - Includes latency in both radio + core network

RELIABILITY

3GPP DEFINITION

- Percentage value of the amount of sent network layer packets successfully delivered to a given node within the time constraint required by the targeted service, divided by the total number of sent network layer packets (from *3GPP TS 22.261*).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