WHAT´S NEXT? HOW INDUSTRIAL APPLICATIONS CAN BENEFIT FROM 5G

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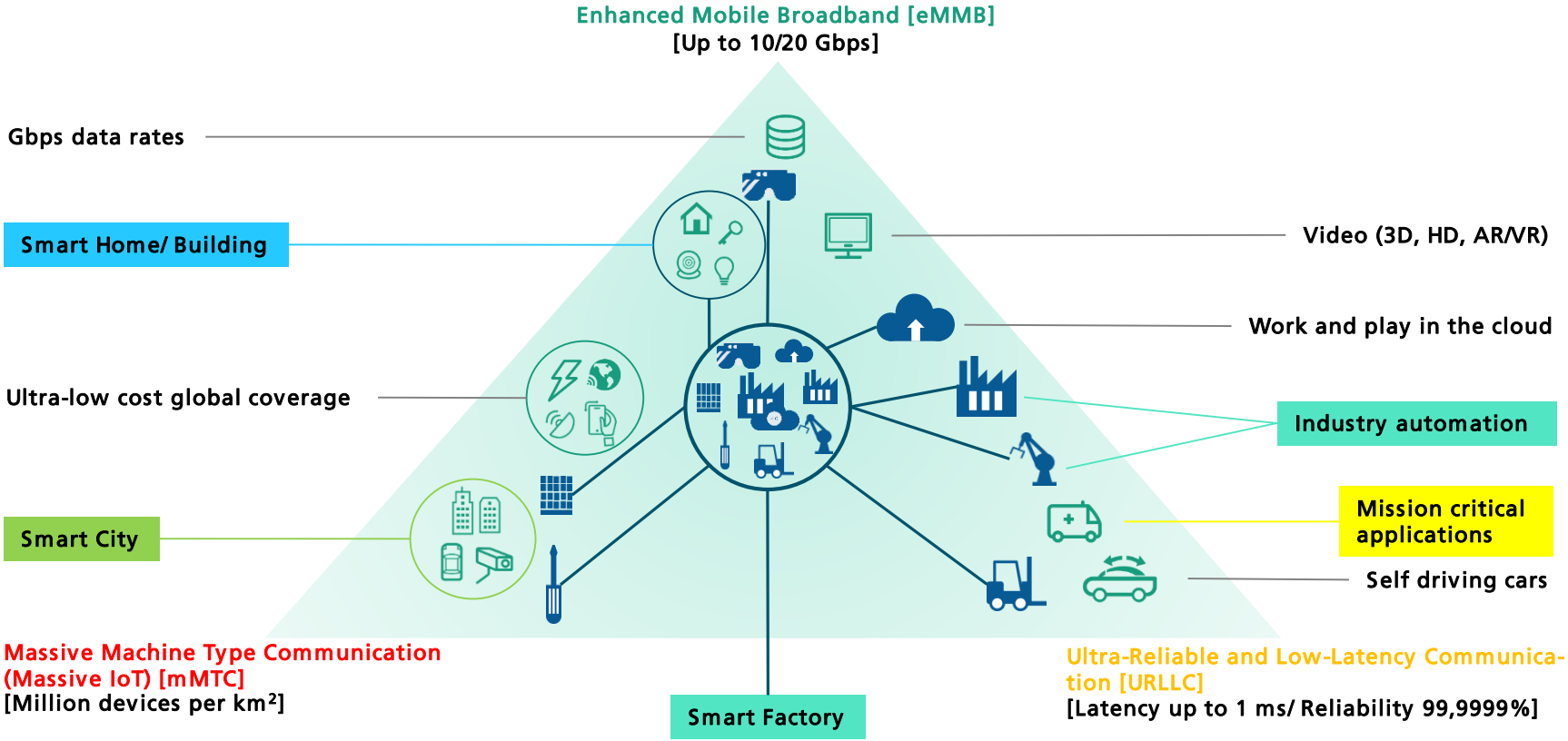
What's 5G New Radio?



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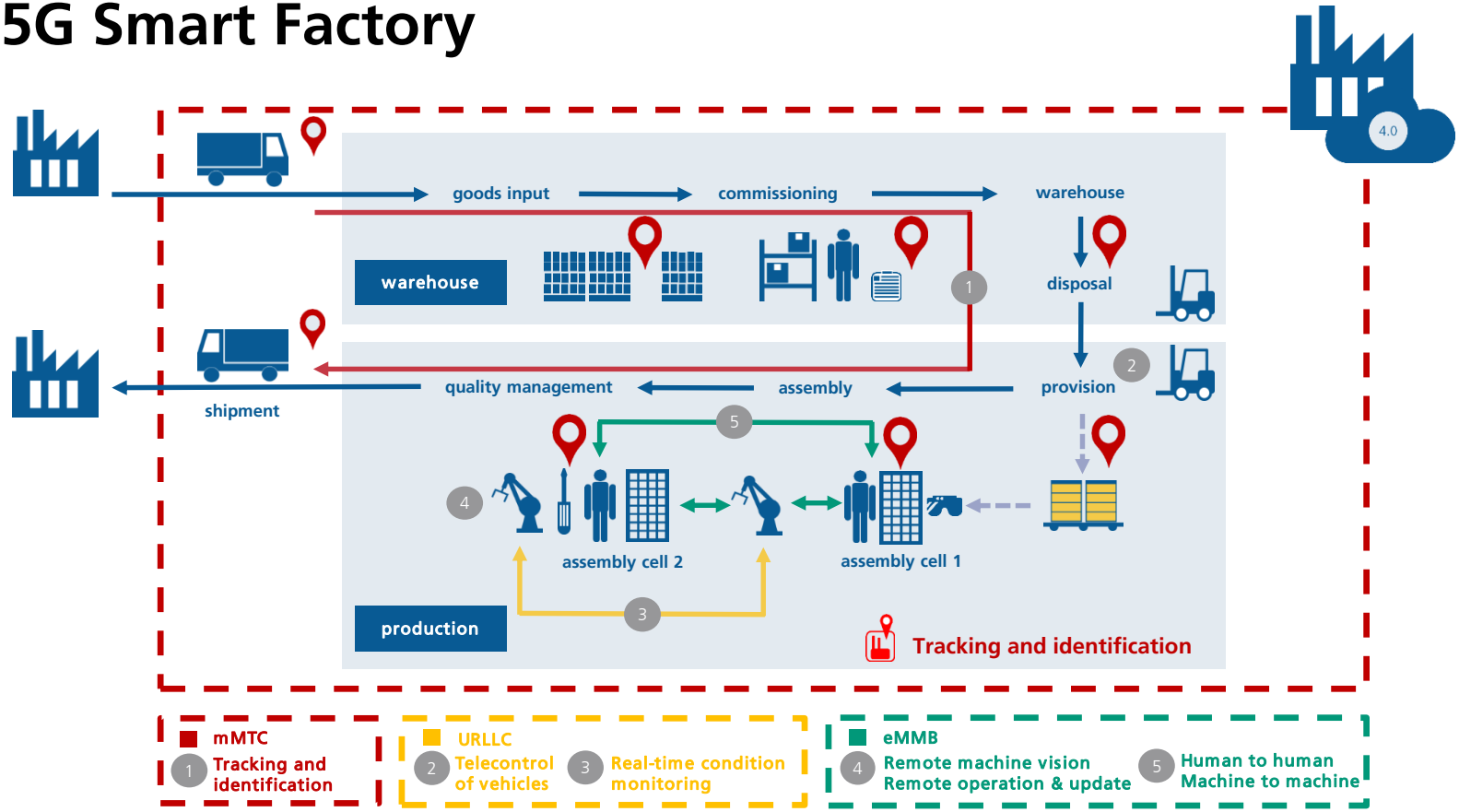
5G Smart Factory



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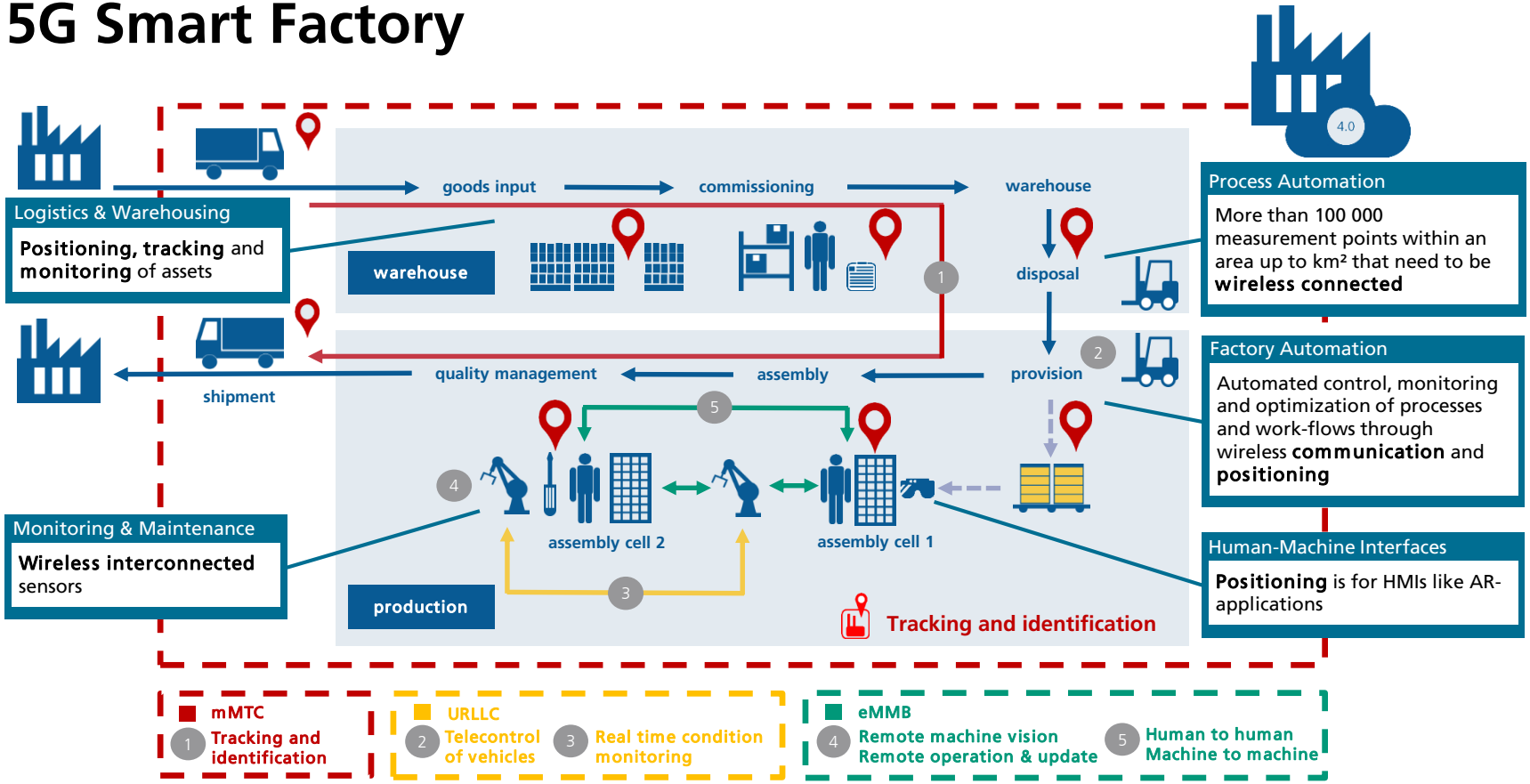
5G Smart Factory



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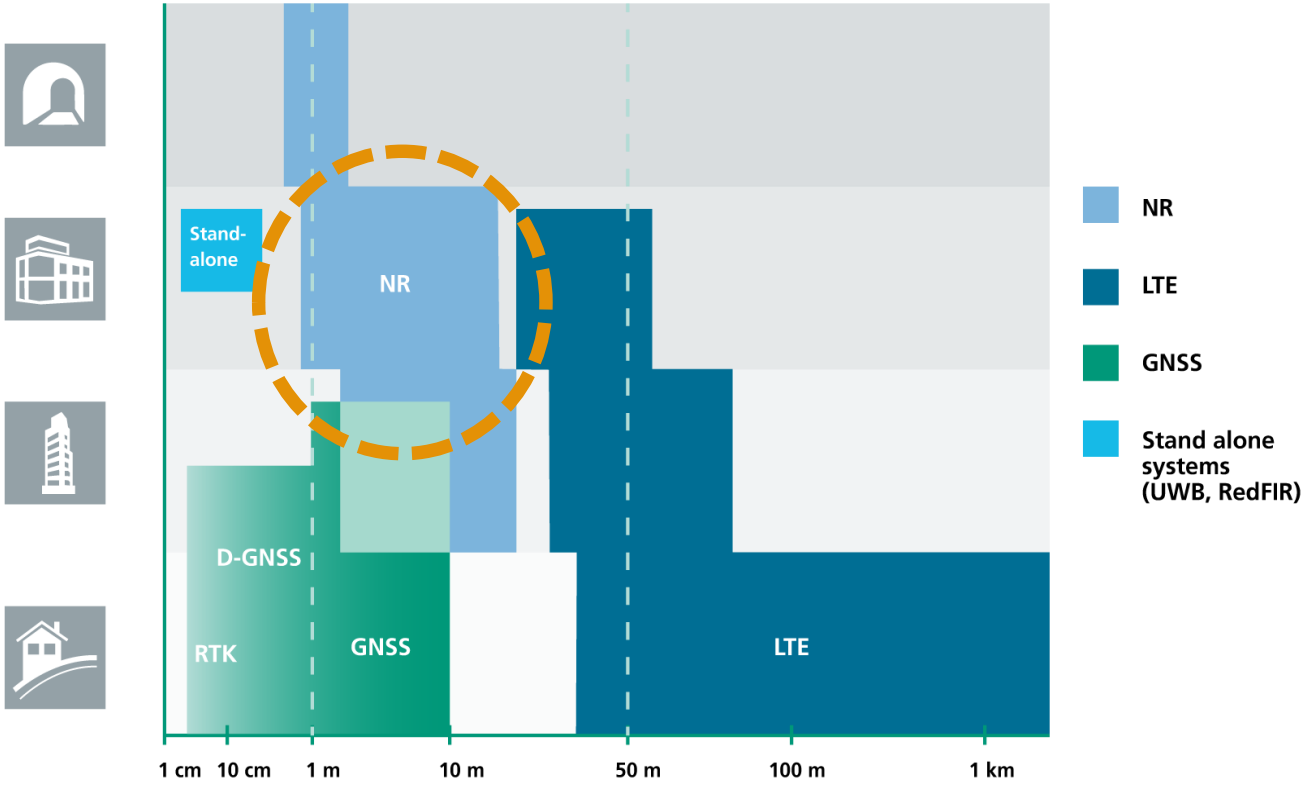
5G Positioning for Industrial Applications



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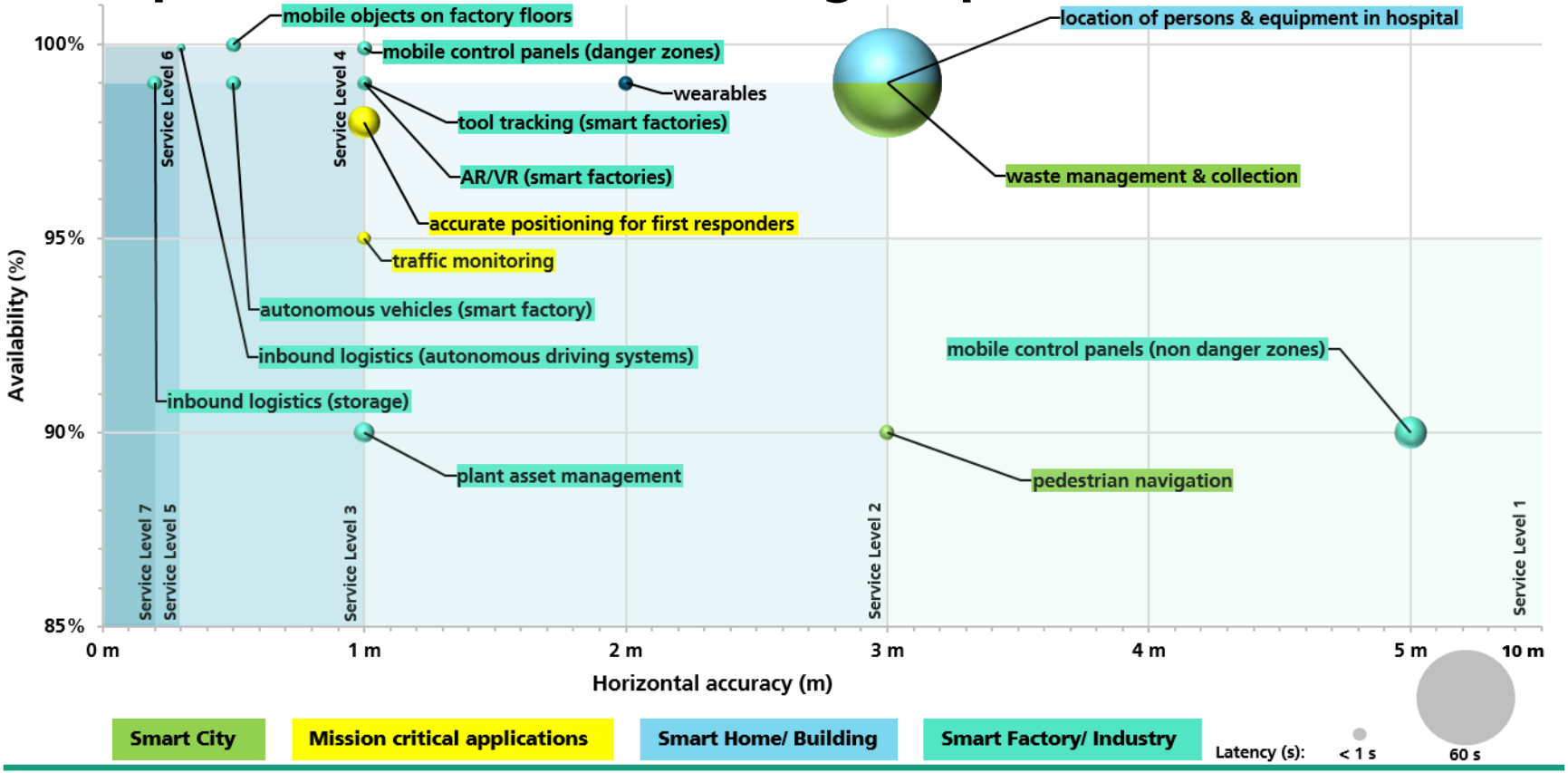
Example Use Cases: Positioning Requirements



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Positioning Service Levels Like Defined in 3GPP SA1

Absolute Positioning

1 — 10 m hor., 3 m ver., 95 % Av.

2 — 3 m hor., 3 m ver., 99% Av.

3 — 1 m hor., 2 m ver., 99% Av.

5G

Positioning Service Levels

4 — 1 m hor., 2 m ver., 99,9 % Av.

5 — 0,3 m hor., 2 m ver., 99% Av.

6 — 0,3 m hor., 2 m ver., 99,9% Av.

Relative Positioning

7 — 0,2 m hor., 99 % Av.

3GPP SA1: Positioning Service Levels (TS 22.261)

3GPP SA1: Positioning Requirements (TS 22.104)

Scenario	Horizontal accuracy	Availability	Heading	Latency for position estimation of UE	UE Speed	Corresponding Positioning Service Level in TS 22.261
Mobile control panels with safety functions (non-danger zones)	< 5 m	90 %	N/A	< 5 s	N/A	Service Level 2
Process automation – plant asset management	< 1 m	90 %	N/A	< 2 s	< 30 km/h	Service Level 3
Augmented reality in smart factories	< 1 m	99 %	< 0,17 rad	< 15 ms	< 10 km/h	Service Level 4
Mobile control panels with safety functions in smart factories (within factory danger zones)	< 1 m	99,9 %	< 0,54 rad	< 1 s	N/A	Service Level 4
Flexible, modular assembly area in smart factories (for autonomous vehicles, only for monitoring proposes)	< 0,5 m	99 %	N/A	1 s	< 30 km/h	Service Level 5
Inbound logistics for manufacturing (for driving trajectories of autonomous driving systems)	< 0,3 m (if supported by further sensors like camera, GNSS, IMU)	99,9 %	N/A	10 ms	< 30 km/h	Service Level 6
Inbound logistics for manufacturing (for storage of goods)	< 0,2 m	99 %	N/A	< 1 s	< 30 km/h	Service Level 6
Flexible, modular assembly area in smart factories (for tracking of tools at the workplace location)	< 1 m (relative positioning)	99 %	N/A	1 s	< 30 km/h	Service Level 7

TS 22.104: The table handles positioning use cases like mobile control panels, autonomous driving systems, modular assembly areas, augmented reality and storage of goods. As vertical accuracy was not studied in TR 22.804 vertical accuracy is not included in TS 22.104. Nevertheless the column on "Corresponding Positioning Service Level in TS 22.261" links the scenarios to the service levels defined in TS 22.261. This service levels include the necessary vertical accuracy requirements.

Available Positioning Solutions

Example of RAT-dependent techniques

- Enhanced Cell ID
- Observed Time Difference of Arrival (OTDoA)
- Uplink Time Difference of Arrival (UTDoA)

Example of RAT-independent solutions

- Global Navigation Satellite System (GNSS)
- WLAN
- Terrestrial Beacon Systems (TBS)
- Barometric Sensors
- Bluetooth
- IMU

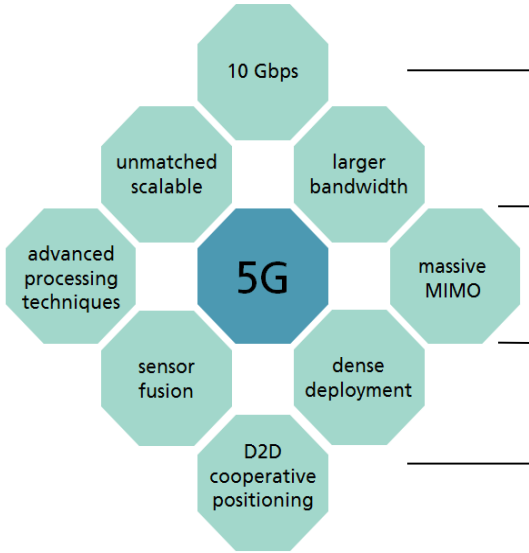
Example of stand-alone system

- Ultra Wideband-based Positioning Systems
- High Performance TDoA-based System

RAT= Radio Access Technology
RAT-dependent techniques rely on measurements carried out by the Radio Access Network.

How to Obtain Position Indoors with 5G

Positioning in 5G offers huge benefits compared to 4G and solutions based on GNSS for use cases like Industry 4.0. These benefits are grounded on improvements in accuracy and availability due to a larger bandwidth of higher frequencies and dense deployments.



mm-Wave - mm-Wave transmission allows accurate positioning using larger bandwidths and taking advantage of the beamforming approaches

Massive MIMO - antenna arrays consisting of a large number of antenna elements to allow precise positioning

Dense Deployment - improves the performance through redundancy and achieving a better geometry.

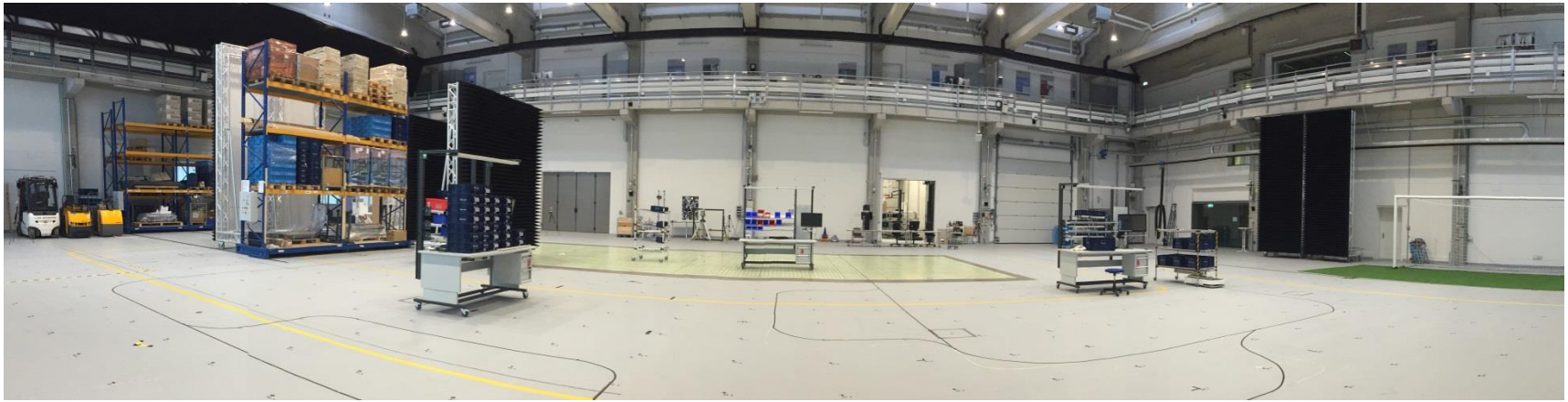
D2D Positioning - due to D2D communication, mobile terminals can collaborate to help each other to determine their own position

Current Status in Standardization (1Q 2019)

- The current NR Positioning Study Item in RAN has to be the starting point of a longer development towards a comprehensive positioning solution in 3GPP.
- With regard to RAT-dependent positioning methods coming from LTE, the initial technology step targeting accuracy of < 3 m indoors is even considerable.
- RAN has also just started to discuss many single positioning methods (e.g. uplink versus downlink or combinations, angular and time measurements).
- Also the possibility to use single methods together (hybrid positioning/sensor fusion) bears huge potential to archive higher performance values.
- The fact that indoor dense deployments are foreseen supports the idea that high performance positioning indoors using cellular positioning methods is realistic in the future.
- Positioning functionality not implemented in 3GPP Rel. 16 (Standards available 2020 approx.) is expected for Rel. 17 (Standards available 2022 approx.) for implementation.

Test and Application Center L.I.N.K.

Pushing the Limits of 5G



Our test and application center bundles the flagship technologies positioning, identification, navigation and communication. The L.I.N.K. offers the ideal combination of technological environment and true-to-life application-oriented test conditions:

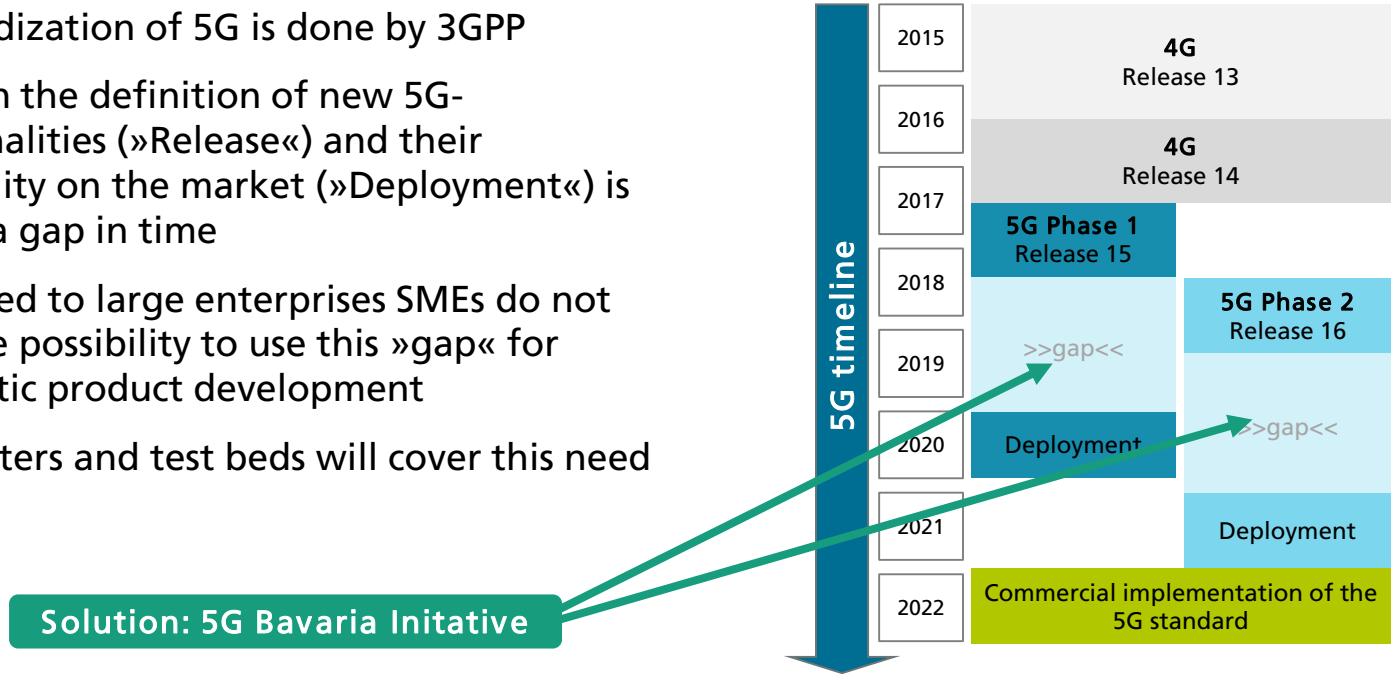
- Possibility of testing the limits of 5G technology in specific environments and use cases
- Best place to generate ideas where 5G might replace common solutions

Project Example: Outlook on Industrial Indoor Application

The video explains the results of a joint research project with Deutsche Telekom to evaluate the future potential of 5G NR Positioning.

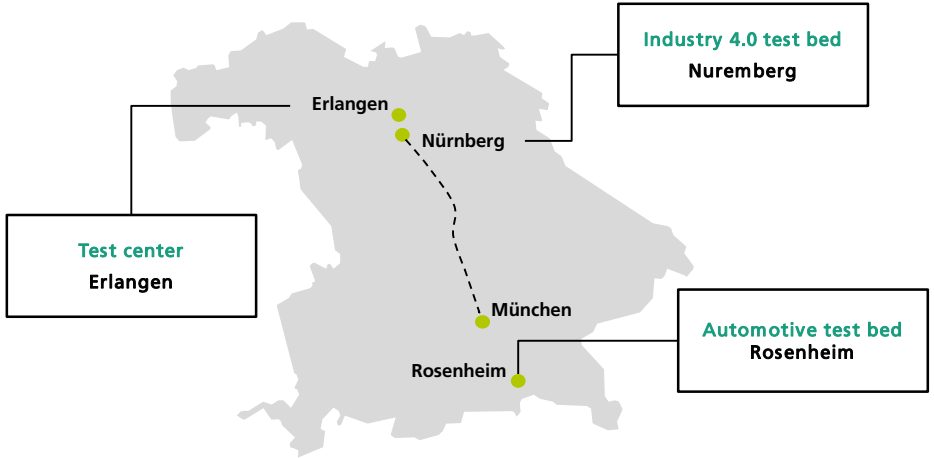
Challenges of Implementing 5G
»From the virtual to the real world«

- Standardization of 5G is done by 3GPP
- Between the definition of new 5G-functionalities (»Release«) and their availability on the market (»Deployment«) is usually a gap in time
- Compared to large enterprises SMEs do not have the possibility to use this »gap« for systematic product development
- Test centers and test beds will cover this need



5G Bavaria

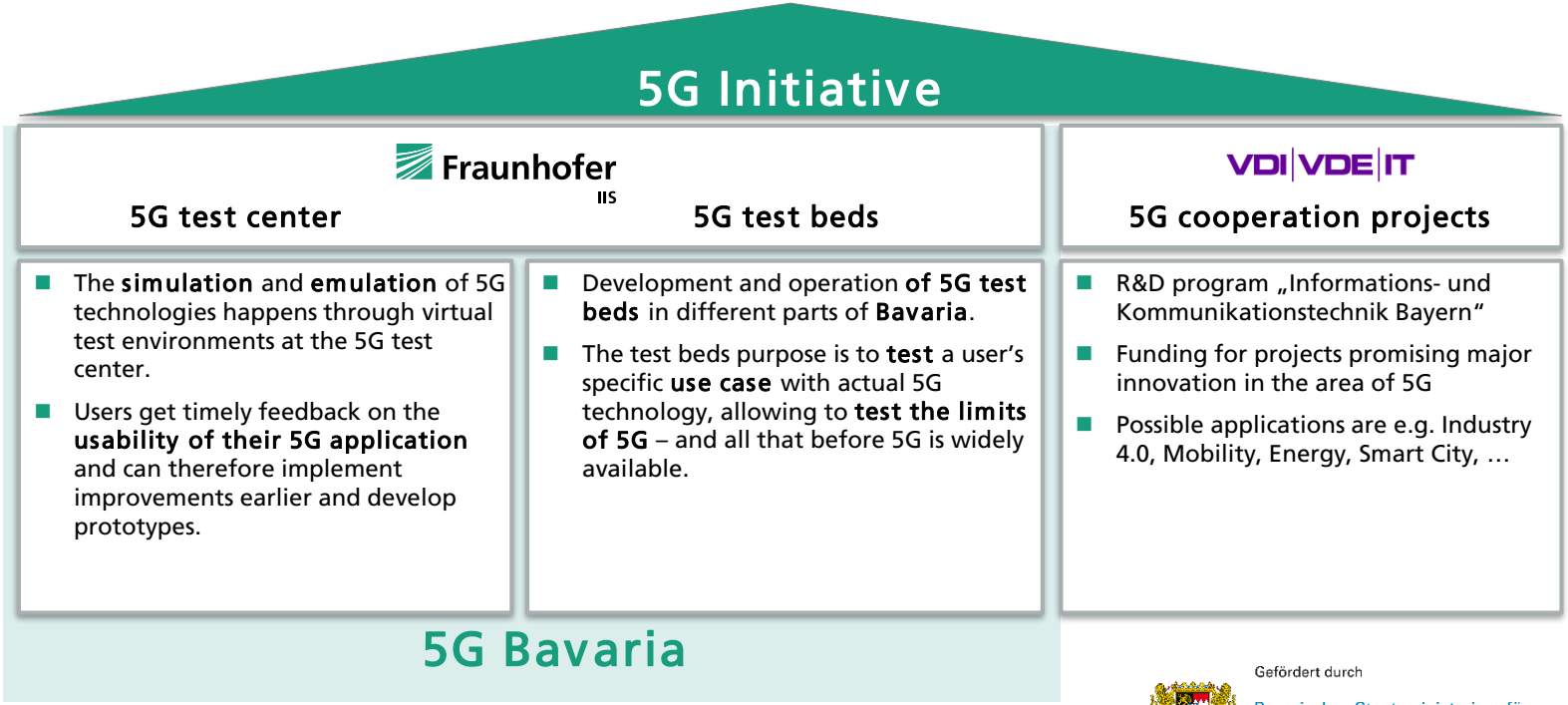
Test Beds and Test Center in Bavaria



- Within the **5G Bavaria** project, Fraunhofer IIS is deploying in phase I a **5G test center** in Erlangen, an **Industry 4.0 test bed** in Nuremberg as well as an **Automotive test bed** in Rosenheim
- Enhancements / further test beds are following in phase II

5G Bavaria

Organizational Structure



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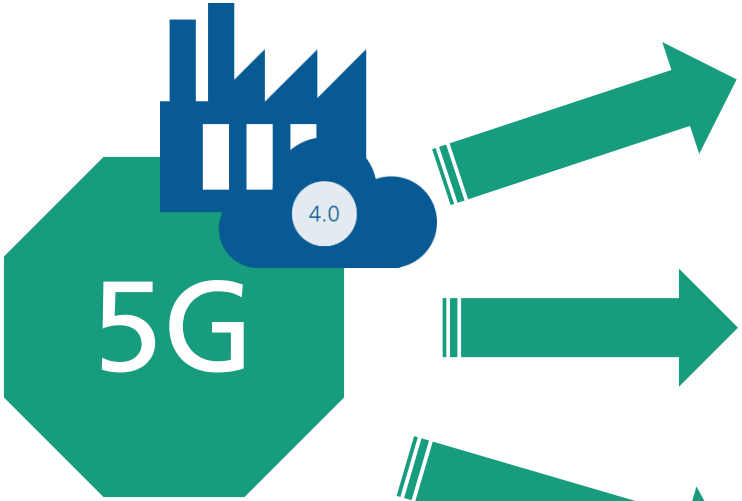
Bayerisches Staatsministerium für Wirtschaft, Landesentwicklung und Energie

5G NR – New Possibilities for Industrial Applications



provides **one technology** for **communication and positioning**

will provide **flexibility**, **mobility** and **versatility** required for Industry 4.0 applications

can revolutionize **production**, **shipment** and **service** cycles

Integration of Communication and Positioning in the Best Possible Way

5G is being developed with particular emphasis on keeping pace with the rapid multiplication of services that demand a wireless connection like for IoT and Industry 4.0.

Positioning in 5G offers huge benefits for use cases like in the area of Industry 4.0.

Fraunhofer IIS will provide independent advice, technology consulting and the customized development of positioning solutions.

Fraunhofer IIS at Hannover Messe

Fraunhofer IIS

- 5G Positioning
- Smart Objects
- RFID
- easyPILOT Follow

Where you can find us:

Fraunhofer IIS

- UWIN – Ultra-Reliable Low-Latency Wireless Industrial Networks

Thanks for your attention!

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