5G support for verticals: Exemplary use cases

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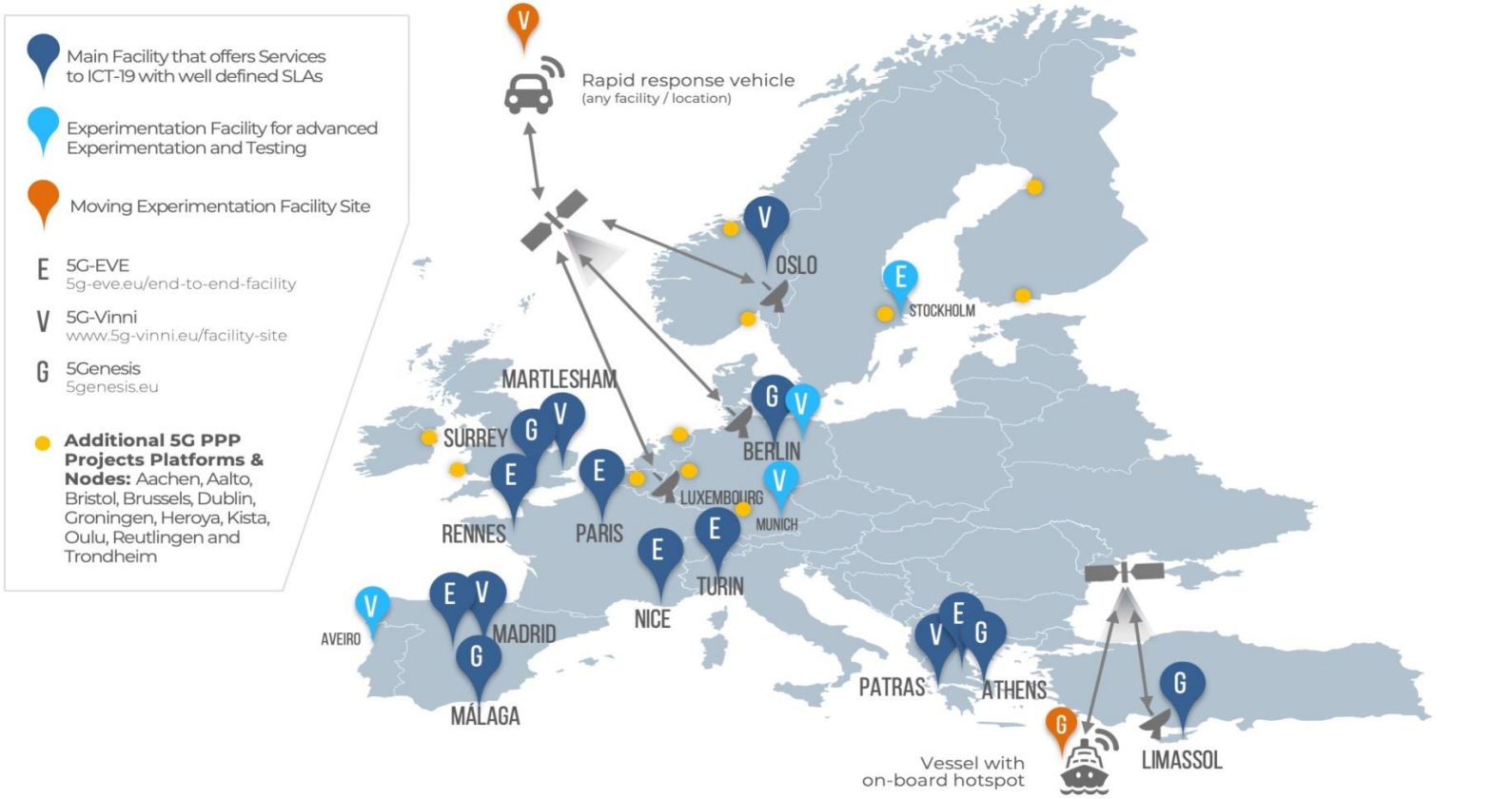
Phase III projects: Infrastructure platforms



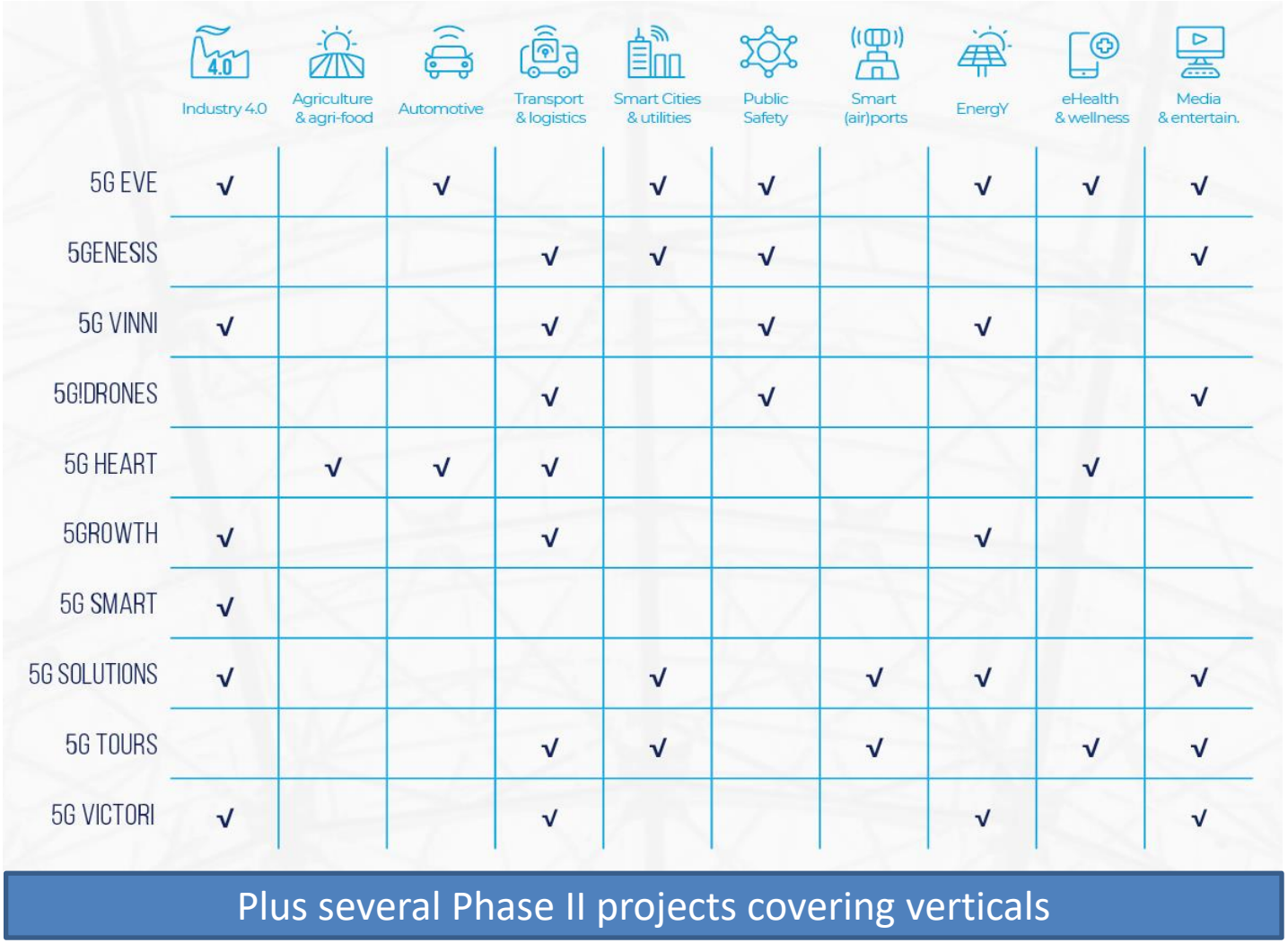
Source: https://5g-ppp.eu/wp-content/uploads/2020/03/5PPP_VTF_brochure_v2.1.pdf

Phase III projects: Advanced 5G validation trials across multiple vertical industries

	5G EVE	5Genesis	5G-VINNI
5G!DRONES	√	√	
5G HEART	√	√	√
5GROWTH	√		√
5G smart	√		
5G Solutions for European Citizens	√		√
5G-TOURS	√		
5G VICTORI	√	√	√

Source: https://5g-ppp.eu/wp-content/uploads/2020/03/5PPP_VTF_brochure_v2.1.pdf

5G PPP: Engagement in vertical sectors

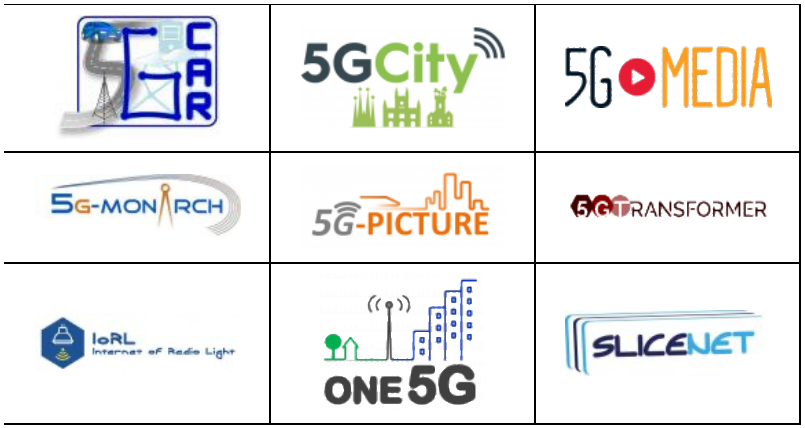


	Industry 4.0	Agriculture & agri-food	Automotive	Transport & logistics	Smart Cities & utilities	Public Safety	Smart (air)ports	EnergY	eHealth & wellness	Media & entertain.
5G EVE	√		√		√	√		√	√	√
5GENESIS				√	√	√				√
5G VINNI	√			√		√		√		
5G!DRONES				√		√				√
5G HEART		√	√	√					√	
5GROWTH	√			√				√		
5G SMART	√									
5G SOLUTIONS	√				√		√	√		√
5G TOURS				√	√		√		√	√
5G VICTORI	√			√				√		√

Plus several Phase II projects covering verticals

Source: https://5g-ppp.eu/wp-content/uploads/2020/03/5PPP_VTF_brochure_v2.1.pdf

Exemplary vertical use cases from 5G PPP projects

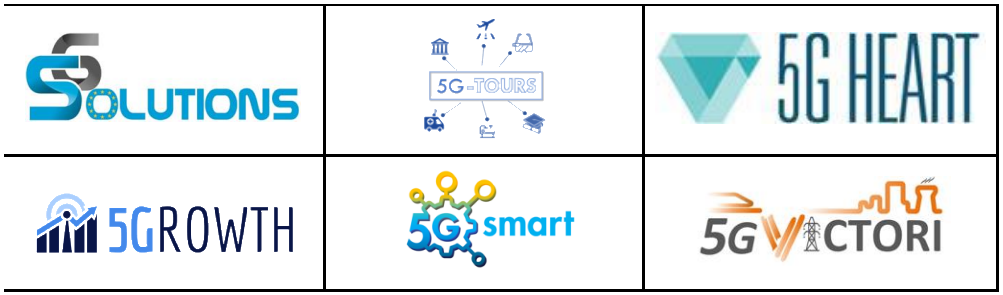


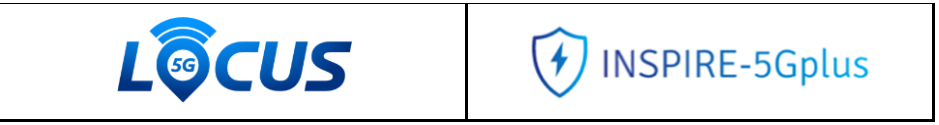
Phase 2: project

Phase 3, Part 1: Infrastructure projects

Phase 3, Part 2: Automotive projects

Phase 3, Part 3: Advanced 5G validation trials across multiple vertical industries

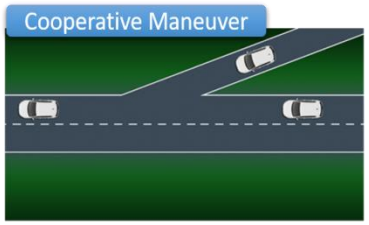




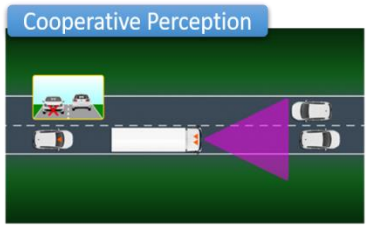
Phase 3, Part 4: 5G Long Term evolution

Examples of 5G applications in Connected and automated mobility

1. Cooperative maneuvers
2. Cooperative perception – situation awareness
3. Cooperative safety
4. Intelligent autonomous navigation
5. Remote driving
6. High definition mapping
7. Anticipated cooperative collision avoidance
8. Video streaming for infotainment
9. Platooning

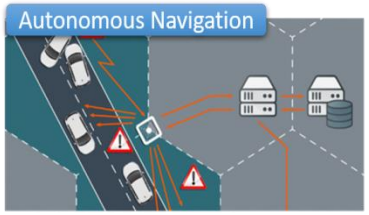


Lane merge

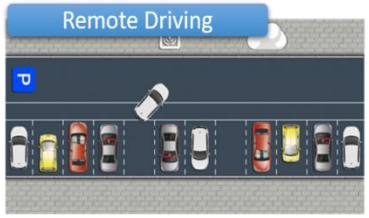


See-through

Network assisted vulnerable pedestrian protection



High definition local map acquisition



Remote driving for automated parking

Source: https://5gcar.eu/wp-content/uploads/2019/08/5GCAR_D1.3_v1.0.pdf

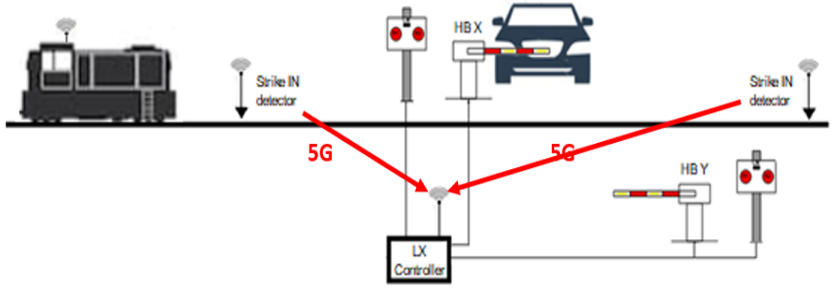
5G PPP trials are demonstrating that 5G characteristics such as 5G NR, network slicing, edge computing, location services and context awareness, softwarization, guaranteed QoS, additional spectrum & coverage and intelligent security solutions will be key enablers for autonomous driving.

Examples of 5G applications in Transportation

1. Rail transportation
   a. Multi-tenant support
   b. High bandwidth internet access
   - Converged wireless-optical domains
   - Service continuity and guaranteed Qos
2. Railway safety critical communications (reliability, availability, low latency)
3. Bus transportation
   a. Infotainment services
   b. Public safety critical services

Source: https://www.5g-picture-project.eu/download/5g-picture_D6.3.pdf

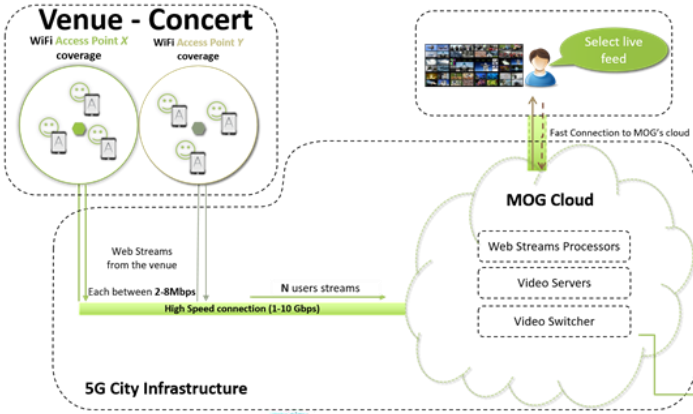
Source: http://5growth.eu/

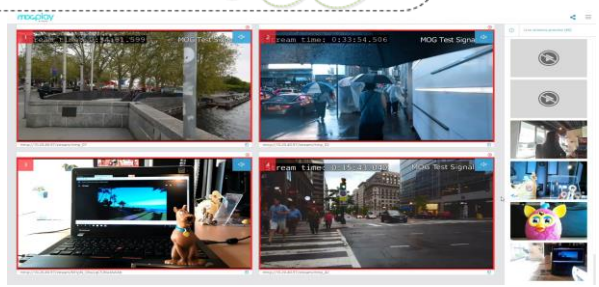


The transport section will benefit considerably from the use of advanced 5G solutions that indicatively include: mobile edge computing, 5G NR (including RAN functional split), location services and context awareness, guaranteed QoS and additional spectrum and coverage capabilities.

Examples of 5G applications in Media

1. Support of ultra high definition streaming services
2. Video acquisition and production for live events – cooperative media production
3. On-site live events - Deploy services at the edge (near the end users)
4. Support 360º high quality video & immediate live broadcasting
5. Media related solutions for home environments (4K/8K streaming of media, VR multiplayer gaming)
6. Personalized education with AR/VR
7. Instantiation and scaling of media services on demand



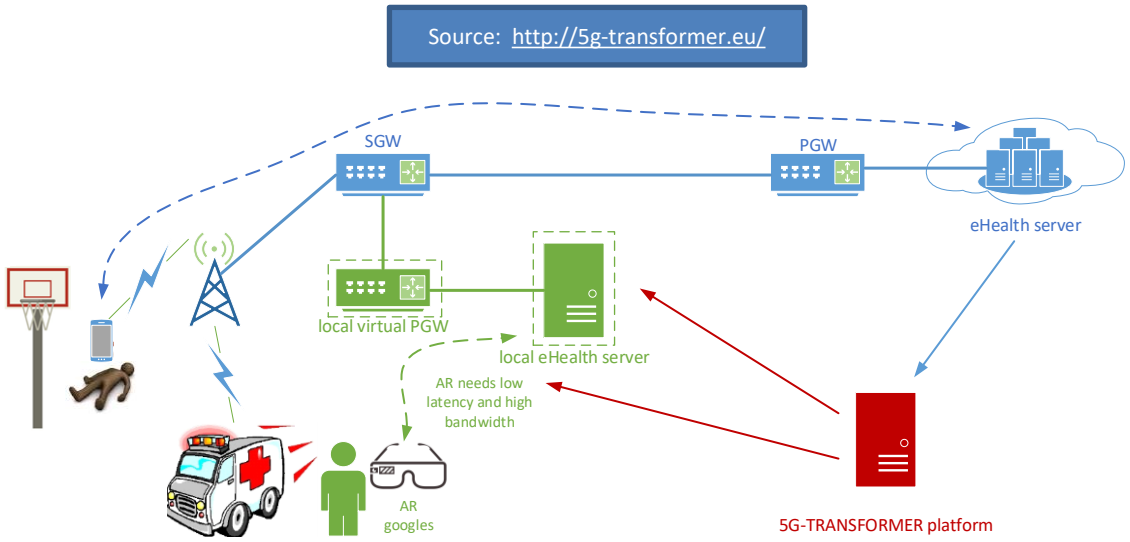


Source: https://www.5gcity.eu/

Media is another vertical industry where 5G capabilities are expected to provide a paradigm shift on the production of new services both for indoor and outdoor environments. As already proven by 5G PPP projects, network slicing, edge computing, traffic steering, smart network management, location and context awareness, the enhanced 5G NR capabilities and the ability to use multiple new radio access technologies, the dynamic chaining of virtual functions are expected to revolutionize this sector.

Examples of 5G applications in Telemedicine/eHealth

1. 5G eHealth Ambulance
   a. On-board real-time video streaming
   b. On-line diagnosis for stroke
2. Periodic health status report from wearable devices
   a. Dynamic deployment of edge services
   b. Use of AR/VR
   c. Video streaming
3. Wireless operating room (guaranteed QoS)
4. Optimal ambulance routing (Location accuracy)

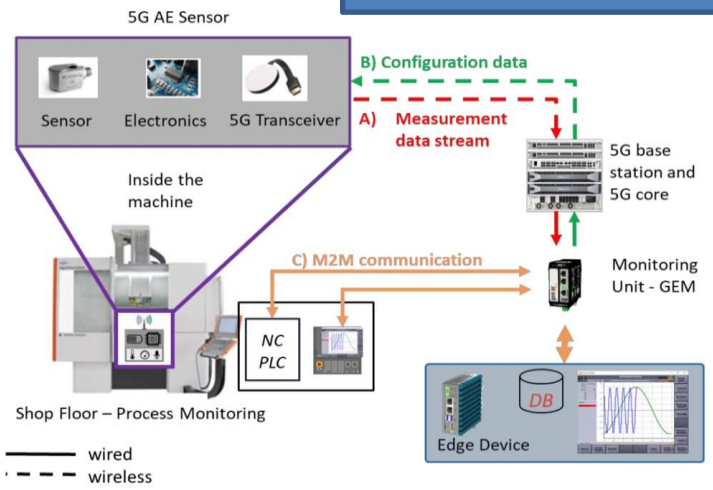


In the context of the 5G PPP several solutions have demonstrated or are in the process to be validated in the vertical domain of energy. 5G networks appear to provide significant enhancements with the use of network slicing, the enhanced 5G NR capabilities, smart network management solutions and guaranteed QoS of services.

Examples of 5G applications in Factories of the Future

1. “Digital Twin” (virtual representation of the production line)
2. Zero-defect manufacturing system
3. Cloud based mobile robotics
4. Acoustic emission sensor system
5. Connected worker (Remote operation)
6. Automated Guided Vehicle (Accurate localization) in seaport activities

Source: https://5gsmart.eu



Source: http://5growth.eu/

Digital twin

Real plant

5G networks can increase the productivity in smart factories. The currently active projects are developing solutions that among other 5G features are relying in smart slicing, edge computing, the enhanced 5G NR capabilities, advanced security, location and context awareness mechanisms as well guaranteed QoS.

Examples of 5G applications in Smart cities

1. Detection service for unauthorized waste dumping
   a. Video streaming
   b. Machine learning-based Infringement Recognition

   -Automatic orchestration of resources
2. Public lighting management
   a. Efficiently manage energy consumption
   b. Secure remote control
3. Location services in public areas (e.g., shopping malls, airports) such as personalized shopping recommendations, navigation instructions etc.

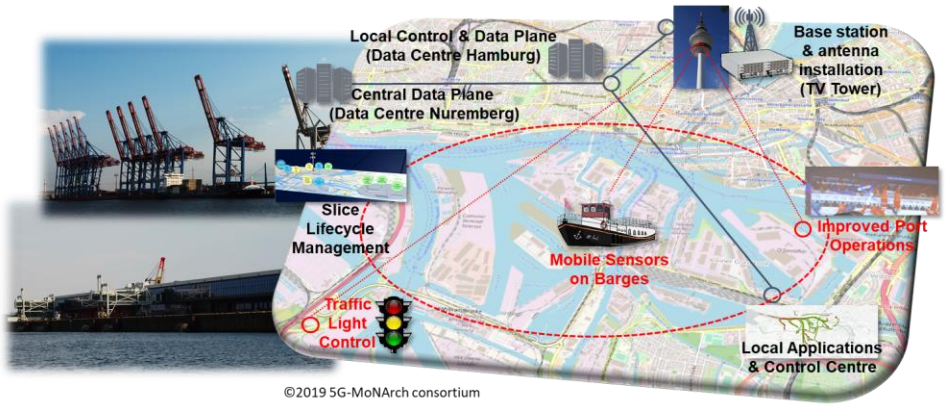
Source: : https://www.5gcity.eu/

Smart cities are expected to make significant use of the 5G capabilities to improve the life of the citizens. 5G PPP projects have already demonstrated that there are viable business opportunities that rely on network slicing, edge computing, advanced security schemes, the evolved NR capabilities, the use of contextual information (e.g., location) and the provision of guaranteed QoS.

Examples of 5G applications in (Air)ports

1. Flexible deployment of network service with significant operational benefits
2. Support demanding requirements for security and privacy
3. Support reliable wireless services for port control activities (traffic monitoring/lights etc.)
4. Support public safety services (e.g., airport evacuation)
5. Airport Follow-Me service (feeding HD video to the Airports Operations Center)
6. Smart parking service for an airport

Source: : https://5g-monarch.eu/



Ports and airports are complex operational environments where multiple stakeholders execute complex tasks. 5G features such edge computing and location accuracy services enable the development of innovative applications and services, network slicing enables the coexistence of these innovative applications on the same network infrastructure with different QoS, thus, invoking the economies of scale, and flexible deployment of network functions enables the efficient use of network computing, communication and memory storage resources. It has been already demonstrated and proved that the deployment of 5G networks will be an enabler for cost reduction and service performance enhancements.

Demonstrated and planned 5G functionalities in verticals

5G Features	Automotive	Transportation	Media	Smart City	Healthcare	Smart Factories	Energy	Public Safety	(Air)Ports	Tourism	Agrifood
Network Slicing	X	X	X	X	X	X	X	X	X	X	X
Mobile Edge Computing	X	X	X	X	X				X	X	X
Functional Split in RAN		X	X								
Advanced Security	X			X					X		
Smart network management			X	X	X		X	X			
Location services & Context Awareness	X	X	X		X	X		X	X		
5G NR capabilities	X	X	X	X	X	X	X	X	X	X	X
Softwarization	X		X		X				X		
Service chaining		X	X		X						
Traffic steering			X								
Spectrum and Coverage	X	X	X								
Guaranteed QoS	X	X		X	X	X	X				

Demonstrated and planned 5G functionalities in verticals

5G Features	Automotive	Transportation	Media	Smart City	Healthcare	Smart Factories	Energy	Public Safety	(Air)Ports	Tourism	Agrifood
Network Slicing	X	X	X	X	X	X	X	X	X	X	X
Mobile Edge Computing	X	X	X	X	X				X	X	X
Functional Split in RAN		X	X								
Advanced Security	X			X					X		
Smart network management			X	X	X		X	X			
Location services & Context Awareness	X	X	X		X	X		X	X		
5G NR capabilities	X	X	X	X	X	X	X	X	X	X	X
Softwarization	X		X		X				X		
Service chaining		X	X		X						
Traffic steering			X								
Spectrum and Coverage	X	X	X								
Guaranteed QoS	X	X		X	X	X	X				

Lessons learned

- 5G networks are not only about faster and more reliable networks.
- 5G is bringing on a level of flexibility in the deployment of new services, which have a diverse set of characteristics, for which 4G networks would not be able to support.
- Researchers are enabled to create rather novel services, parts of which can be even implemented over different network slices.
- 5G networks have been designed to be fully modular and allow the dynamic chaining of virtual functions and allocation of resources.
- These characteristics are the catalyst for the creation of an innovation ecosystem that is expected to shape the full digitization of vertical industries.

Thank you for your attention

For more information about 5G PPP activities please visit https://5g-ppp.eu

The white paper is available at https://5g-ppp.eu/white-papers/

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