

“5G Ready Testbeds: Enabling Early Prototyping and Experimentation”

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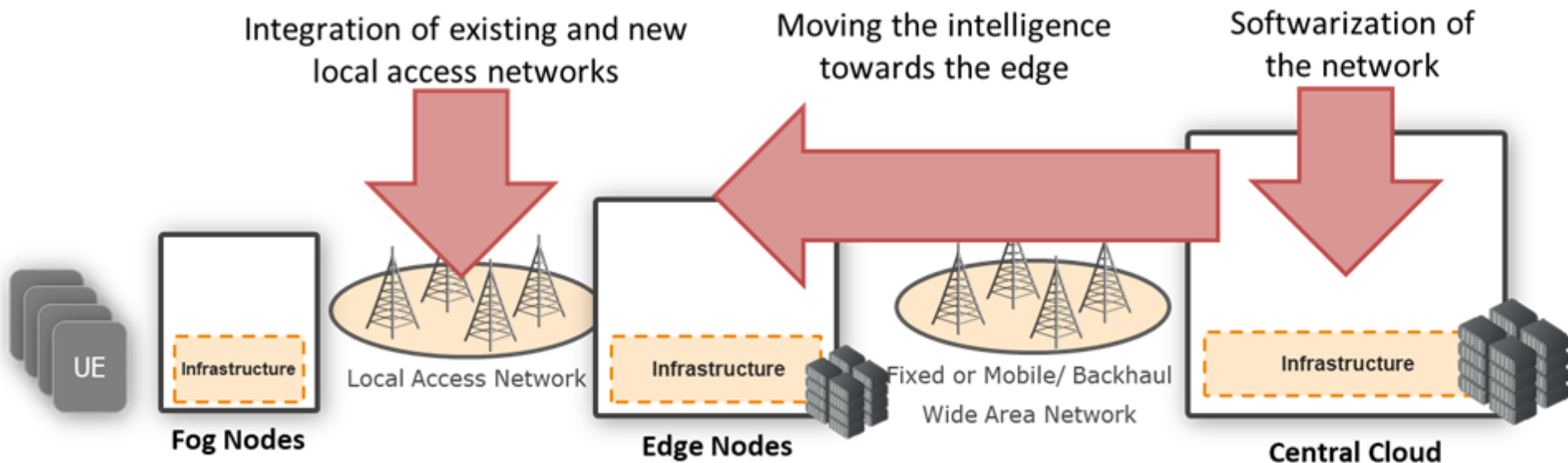
OPEN BATON



Key Communication Changes with 5G

5G is based on a comprehensive software system that is using all the available resources

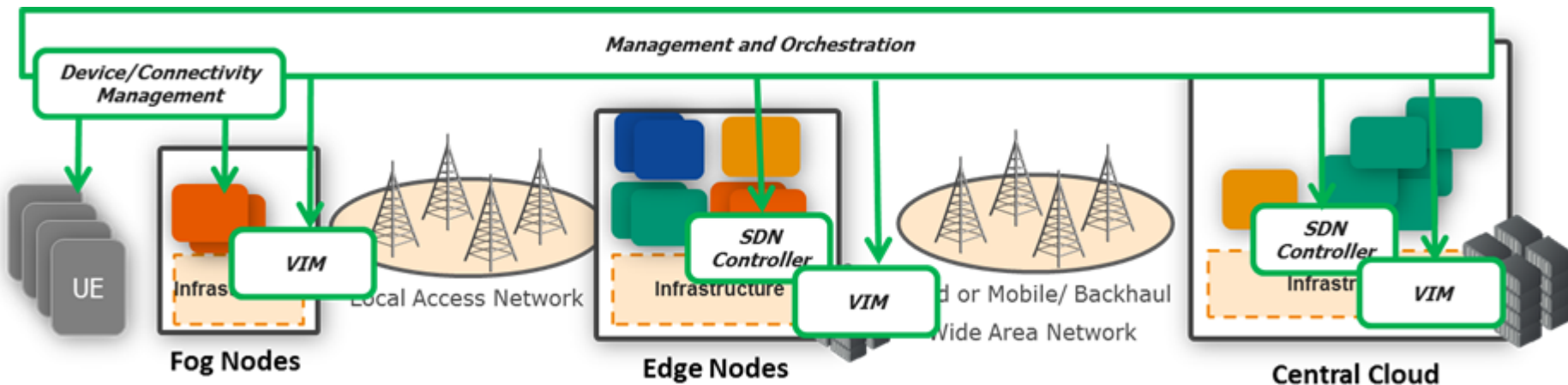
- The network functions are becoming software only → convergence with IT
 - More flexible network infrastructures (growing on demand, adapting to changes)
 - Enabling the parallel deployments of multiple dedicated networks
- Network functions can be installed in compute nodes at the edge of the network
- Development of new types of local access networks (and integrating existing ones)



The Infrastructure Perspective

Providing mechanisms and features needed for distributed system deployments (on Device/Fog, Edge, Central nodes)

- ➔ Moving mechanisms from the 5G system level to the new infrastructure middleware
- Performance enhancement – load balancing and high availability
 - Resilience of the end-to-end communication
 - Security at infrastructure level
 - Secure and Reliable Connectivity management
 - Real-time orchestration of functionality

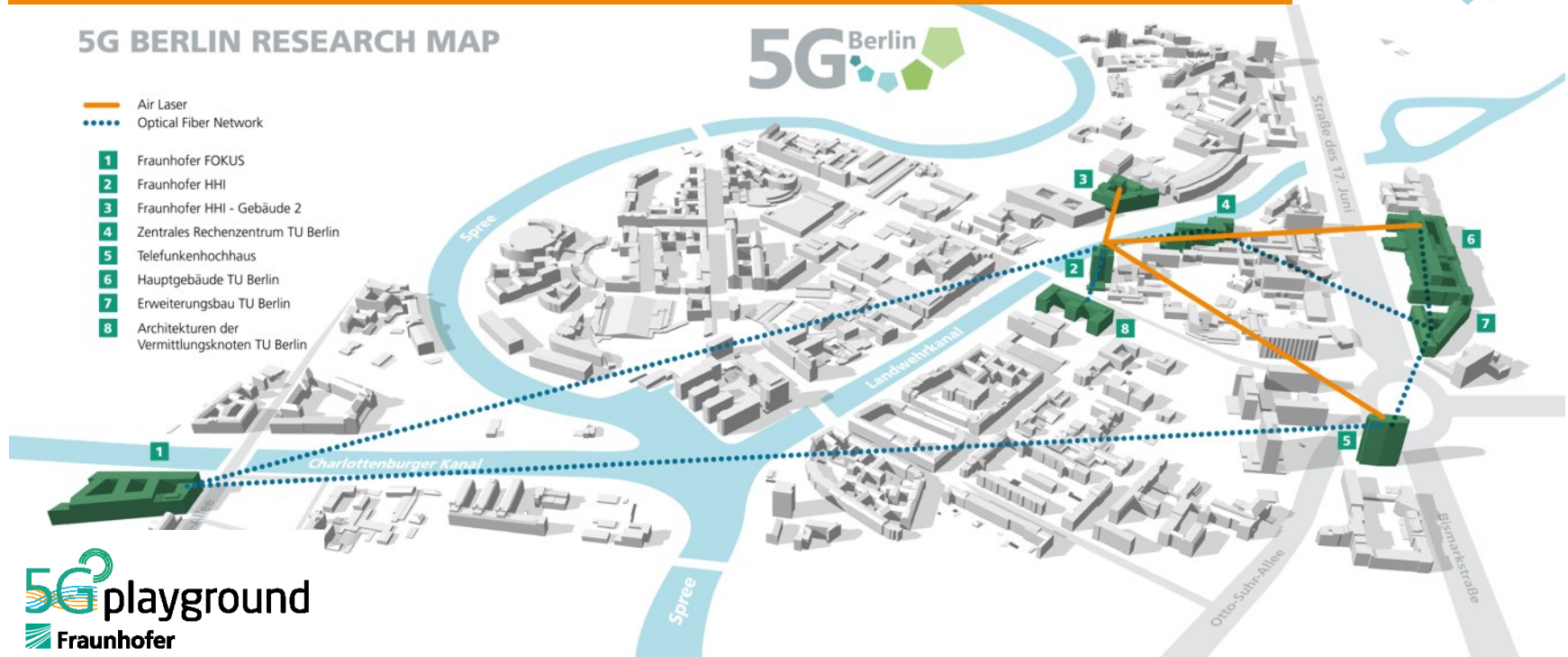


5G Berlin

- Berlin, the capital city of Germany and a world metropolis and the most representative city of Germany for research, digital world and politics
- Fraunhofer institutes in Berlin are worldwide known for their live testbed deployments addressing in a pragmatic way the needs of the industry and collaborative projects since more than 15 years
- Supported by a young active population and by an environment fostering innovation, Berlin is currently a very active hub in the developments of new technology oriented business reflected in the high number of SMEs
- Build on top of a generous infrastructure, the city of Berlin is currently re-gaining its top position within the German industry through massive investments of large and medium companies
- Featuring very prestigious universities acting as accumulators of knowledge potential, the city of Berlin is building a competitive and adaptable work force
- The government of Berlin is supporting 5G Berlin



5G Berlin Testbed Enables 5G Prototyping



5G READY
TRIAL PLATFORM

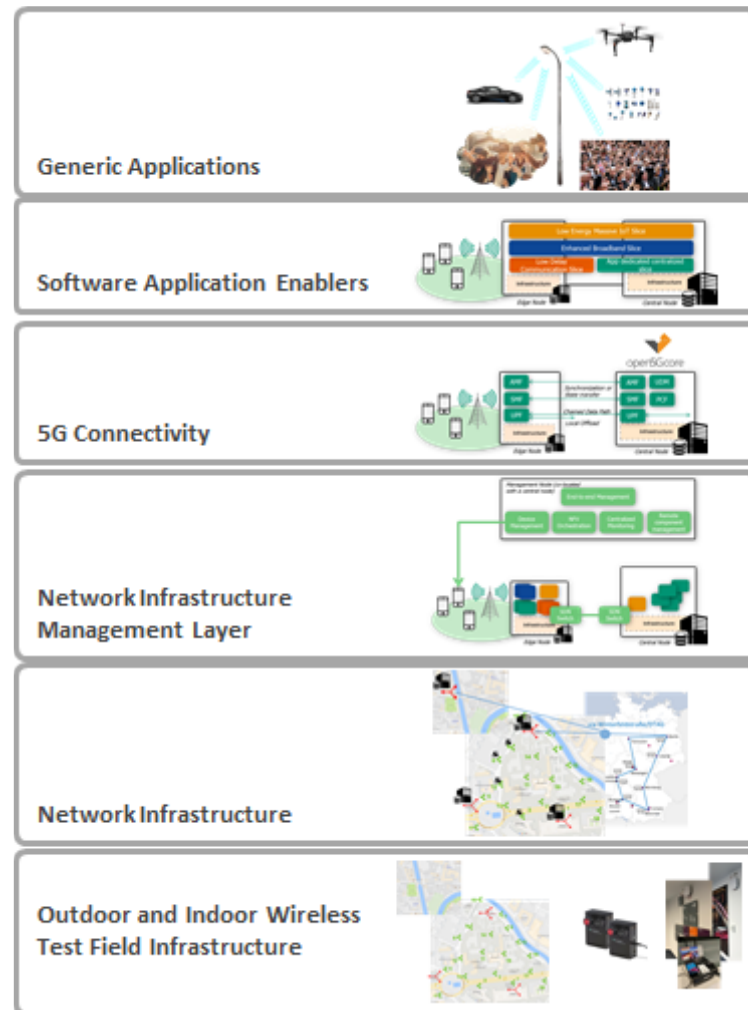
5G Playground and 5G Ready Trial Platform

5G playground is an 5G Testbed integrated within the 5G Berlin initiative, which is part of the Excellence Center for Digital Transformation.

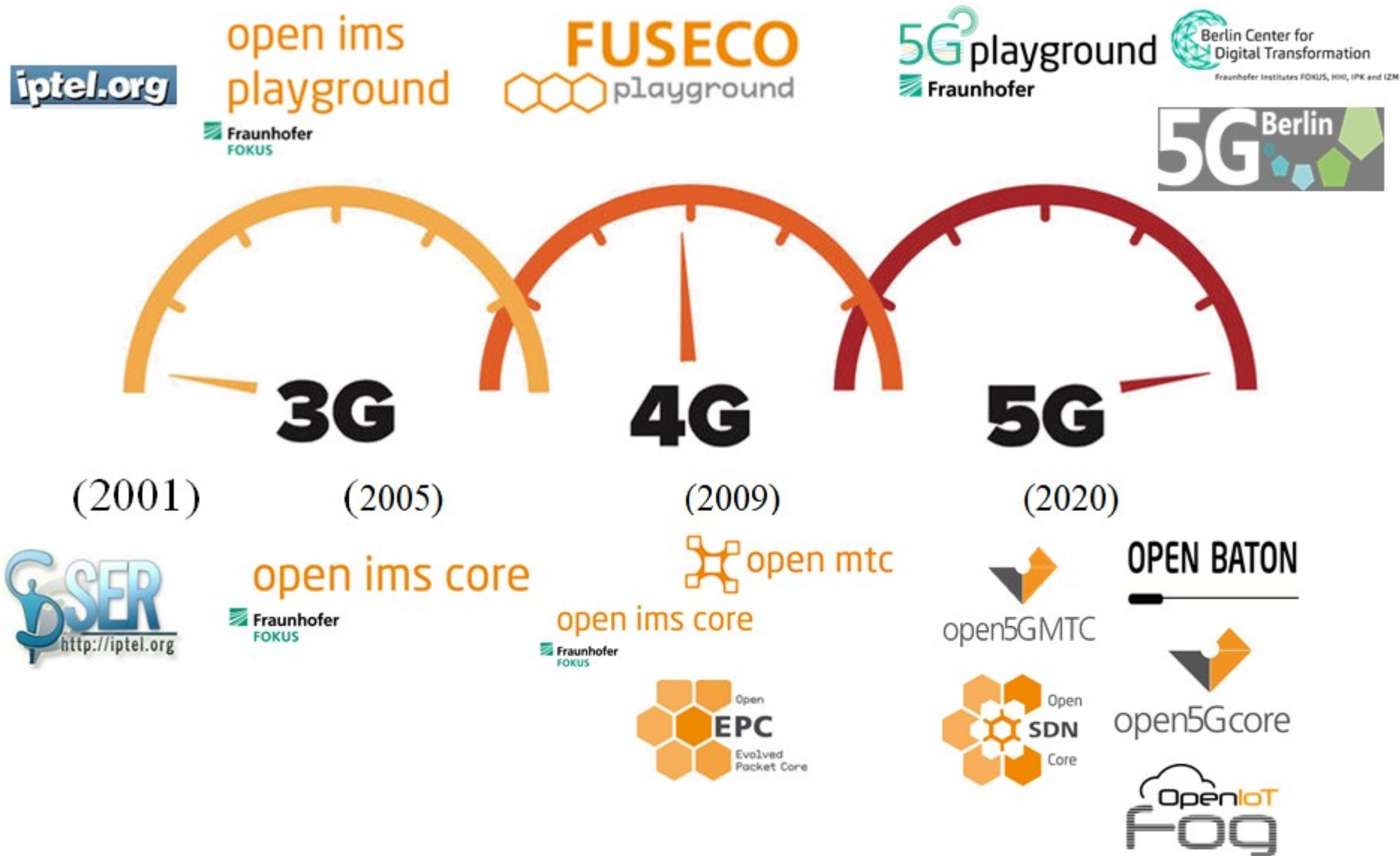
The 5G Playground enables the 5G ready trial platform, which offers agile MEC/FOG computing capabilities and is connected to multi-access networks within 5G Berlin

What is 5G Berlin?

- 5G Berlin is a comprehensive end-to-end testbed infrastructure
 - Relying of multiple layers of infrastructure and software components
 - Enabling the direct integration of third party components and applications
 - Enabling the demonstration and validation of end-to-end use cases
- 5G Berlin relies on the following major layers:
 - An outdoor test field infrastructure
 - An indoor test field infrastructure
 - A network infrastructure
 - A large set of components managing the network infrastructure
 - A layer of software components enabling 5G connectivity
 - A layer of software application enablers
 - (massive IoT, enhanced broadband and low delay support)
 - A set of generic applications, enabling the easy demonstration of use cases



FOKUS Testbed and Toolkit Evolution (since 2001)



What is the 5G Playground

5G Playground provides a single stop for a comprehensive set of toolkits with virtually all that it is needed to be installed for a live 5G testbed

- A comprehensive set of software toolkits enabling setup and development of 5G applications in an end-to-end testing environment.

OPEN BATON

Management and orchestration for NFV environments, running on top of OpenStack (and soon OpenMANO).



A new, efficient approach for remote connectivity management of M2M and multimedia, based on standard protocols.



Extensive platform for SDN added value features for flexible routing, virtual environments and core network data paths.

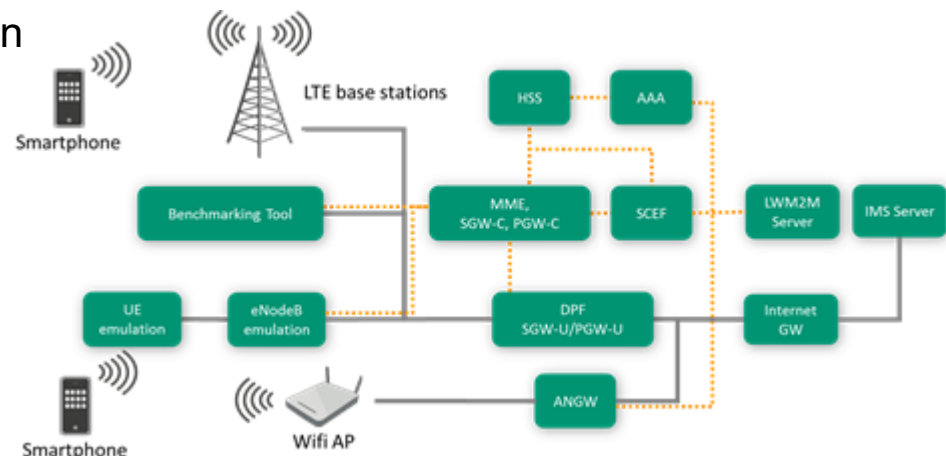


R&D prototype for mobile core networks beyond 3GPP Release 13, supporting 5G, 4G (LTE) and WLAN.

- A methodology and tools for benchmarking prototypes and products.
- A commodity providing cost efficient automatic installation and experiment control.

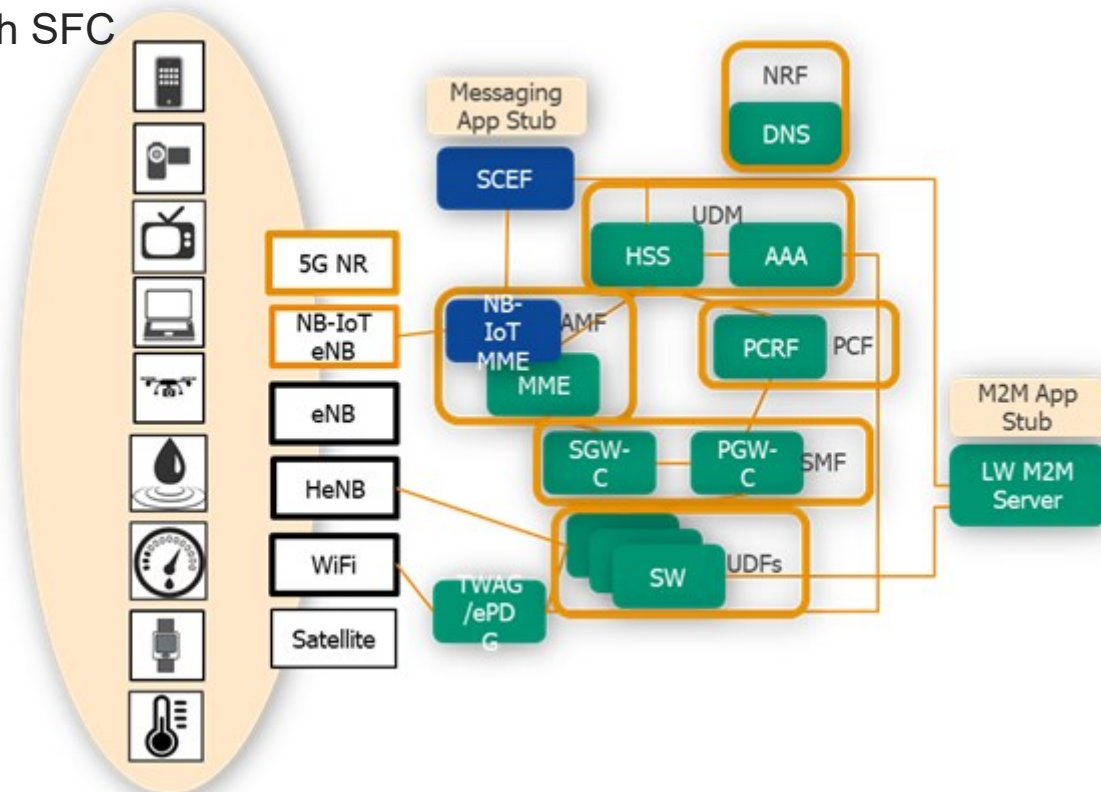
OPEN5GCORE REL. 3

- R&D prototype of mobile core networks following 3GPP Release 13+ especially concentrating on the seamless broadband connectivity, multimedia delivery and massive IoT support
- Support for (5G), LTE and WLAN – integrating with a very large number of off-the-shelf base stations
- Cloud-native core network for NFV – can be deployed using OpenBaton as VMs on top of virtually any type of Linux OS (e.g. VMs, containers, namespaces, x64 or ARM based)
- Seamless elasticity – several selected components are scaling
- Mobile edge network support – edge/central split
- Highly customizable for dedicated core networks
- Benchmarking and experimentation
 - Highly configurable metrics
 - With synthetic workloads & replaying real workloads



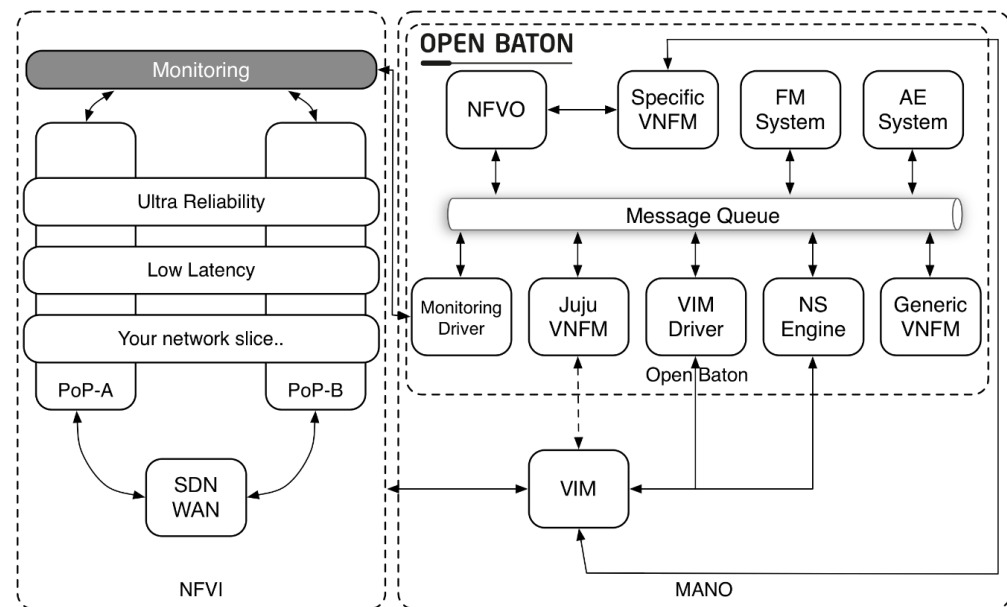
Open5GCore for 5G and NB IoT

- Open5GCore implements the basic 3GPP Release 14 NB-IoT functionality
- The Open5GCore components map directly to the new 5G components
- Next steps in functionality development:
 - Merging of HSS and AAA
 - Integration with the new radio
 - Redesign of the AMF-SMF split
 - Redesign of the data paths with SFC



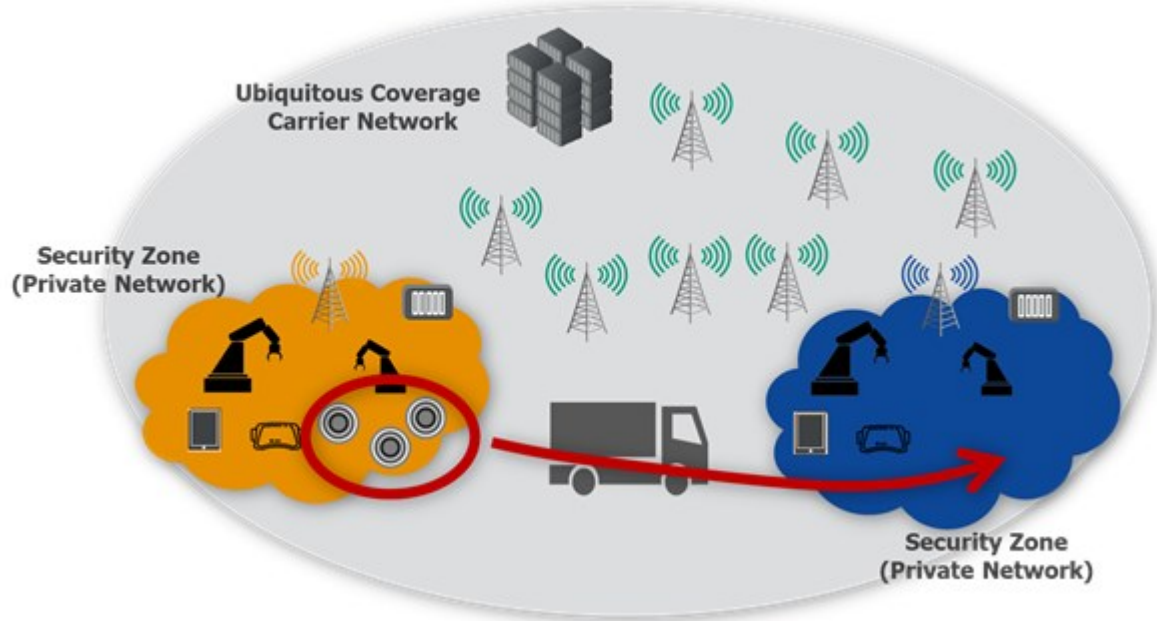
OPENBATON REL. 3

- A standard aligned implementation of the ETSI NFV MANO
- Running on top of OpenStack with VMs and containers
- Providing independent infrastructure slices on top of heterogeneous and distributed infrastructures
- Support for runtime elasticity and fault management
- A large amount of use cases
 - Core networks, multimedia, etc.
- Available on github:
 - <https://github.com/openbaton>



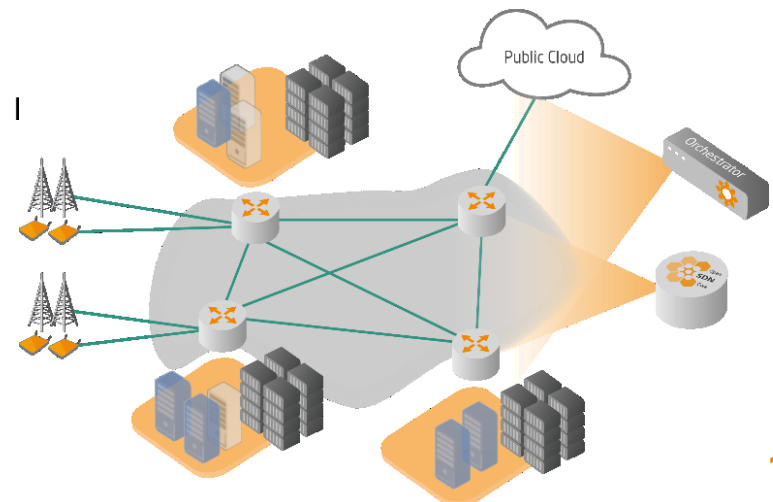
Open5GMTC

- A new approach to device communication, M2M and multimedia addressing especially the flexibility in identity and access control rights
- Addressing connectivity of a large number of devices – simplified management protocols and time-based sharing of the capabilities
- Connectivity control on top of heterogeneous environments
 - Security
 - Customized connectivity
 - Service capabilities
- Based on standard protocols
 - OMA LW M2M, eSIM, etc.



OpenSDNCore Rel. 4

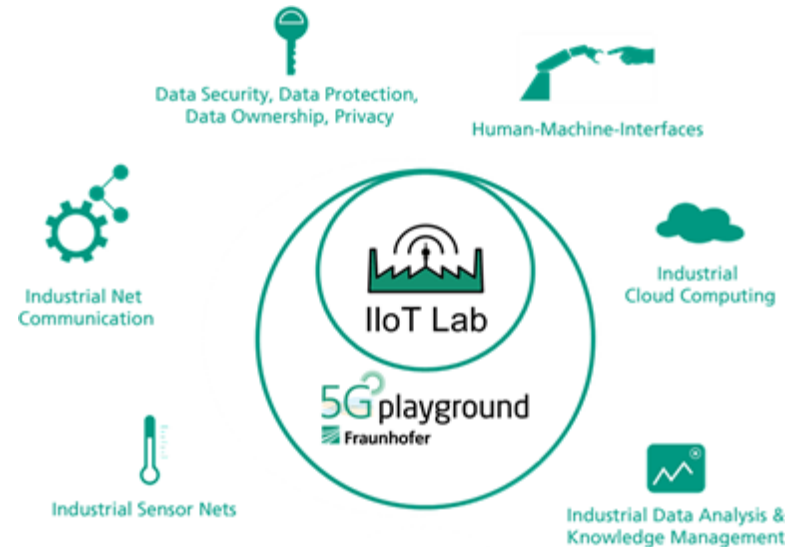
- Providing an extensive platform for SDN added value features – wherever software based dynamic forwarding is needed within the software network environment
- Based on standard components (IETF, ONF, etc.) – especially relying on the OpenFlow and Service Function Chaining
- Establishment of dynamic data paths – used for dynamic network environments such as tenant networks in NFV
- Backhaul control for dedicated networks – enabling the backhaul selection and QoS
- Data center networking – integrating with the OpenStack Neutron and replacing OVS
 - Plain routing at the data center level (replacing a bunch of bridges)
 - High availability and load balancing transparent to tenant network
 - Acting as security gateways/firewalls
- Deep data plane programmability – P4 based
- Service Function Chaining



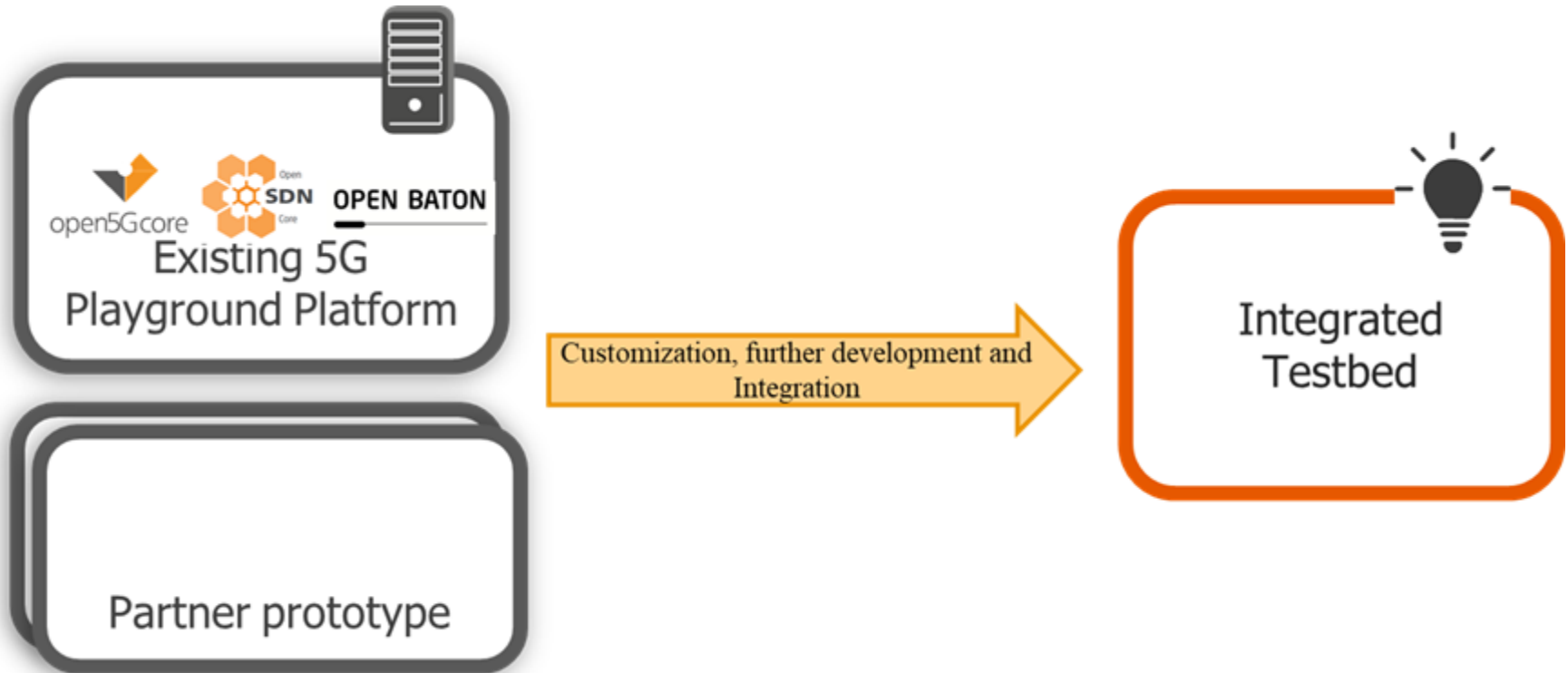
The Industrial IoT (IIoT) Lab Extension of the 5G Playground



- 5G-based Test Infrastructure for developing and testing Industrial IoT / Industry 4.0 applications
- Ultra-low communication latency through 5G-based Fog and Mobile Edge computing:
 - Intelligent M2M/IoT Nodes and Edge-based Gateways
 - Fog/Edge/Cloud-Orchestration for distributed Analytics based on OpenBaton
 - Industrial sensor data aggregation, actuator control
 - Distributed data analytics, filtering and protection
 - New Toolkit: [OpenloTFog.org](https://openloTFog.org)
- Robust Industrial Wireless through dynamic spectrum management, SDN and NFV
- Extensions: Industrie 4.0 protocols (e.g. OPC UA), field buses (e.g. SCADA over IP, SCADA over LTE) and industrial wireless nets (e.g. ISA 100 Wireless, IEC 62734)
- Industrial IoT application examples: Industrial safety, augmented reality based assisted systems, human-machine interfaces, industrial data protection, logistics and enterprise asset management, distr. video analytics for quality control, predictive maintenance, etc.
- For more see: [Internet-of-things-lab.org](https://internet-of-things-lab.org)



Create integrated prototypes

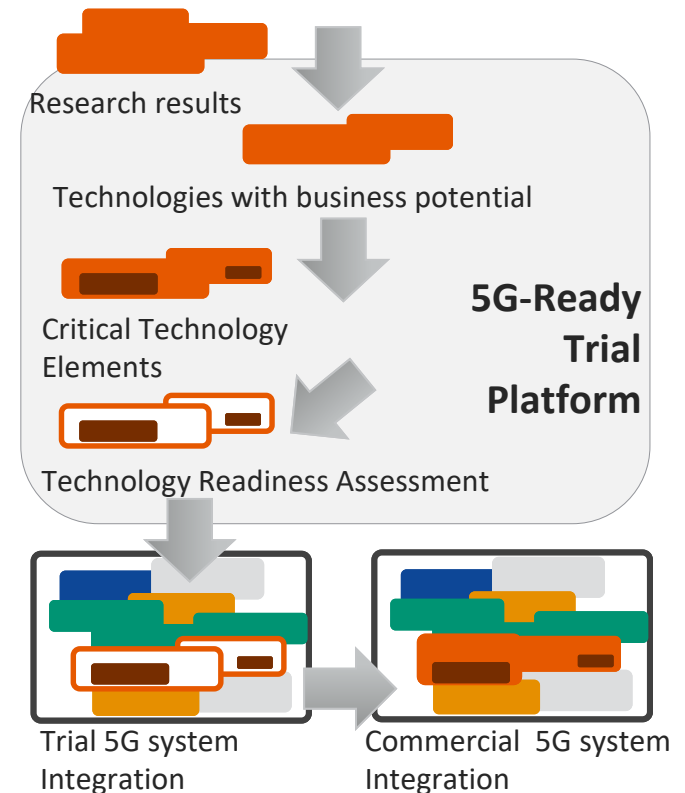


What is 5G Ready Trial Platform?

5G READY TRIAL PLATFORM

5G Ready Trial Platform aims to provide the support for the technology development between practical implementation and commercial systems

- Provides a consolidated turn-key solution of the Fraunhofer FOKUS software components
- Integrates with selected access networks
- Provides the basis for showcasing new PoC
- Includes benchmarking and assessment mechanisms
- Comprehensive 5G ecosystem
- Pragmatically addressing the demonstration of 5G use cases
- Providing the basis for new prototypes
- Enabling the evaluation and optimization of products
- Designed to address large and small deployments



Accelerating your product with 5G Ready

5G READY
TRIAL PLATFORM

1. Create advanced prototypes using already developed FOKUS toolkits
 - Provide a demonstration on how the product may look like
 - Extend the product offering with features not yet implemented
2. Integration within the existing platform
 - Provide trust into the product by integration within a reference system
 - Customize and parametrize the system for the specific end-to-end scenarios
 - Assess the viability of the products in end-to-end scenarios
 - Optimize the product depending on the assessment results
3. Increase the capabilities of the product
 - Provide trust into the product readiness to be deployed in telco cloud infrastructures
 - Assess and increase the resilience and the security
4. Provide compelling product demonstrations
 - Using the 5G Ready enablers to build up the complete environment
 - Underlining the advantages of the product within a complete environment

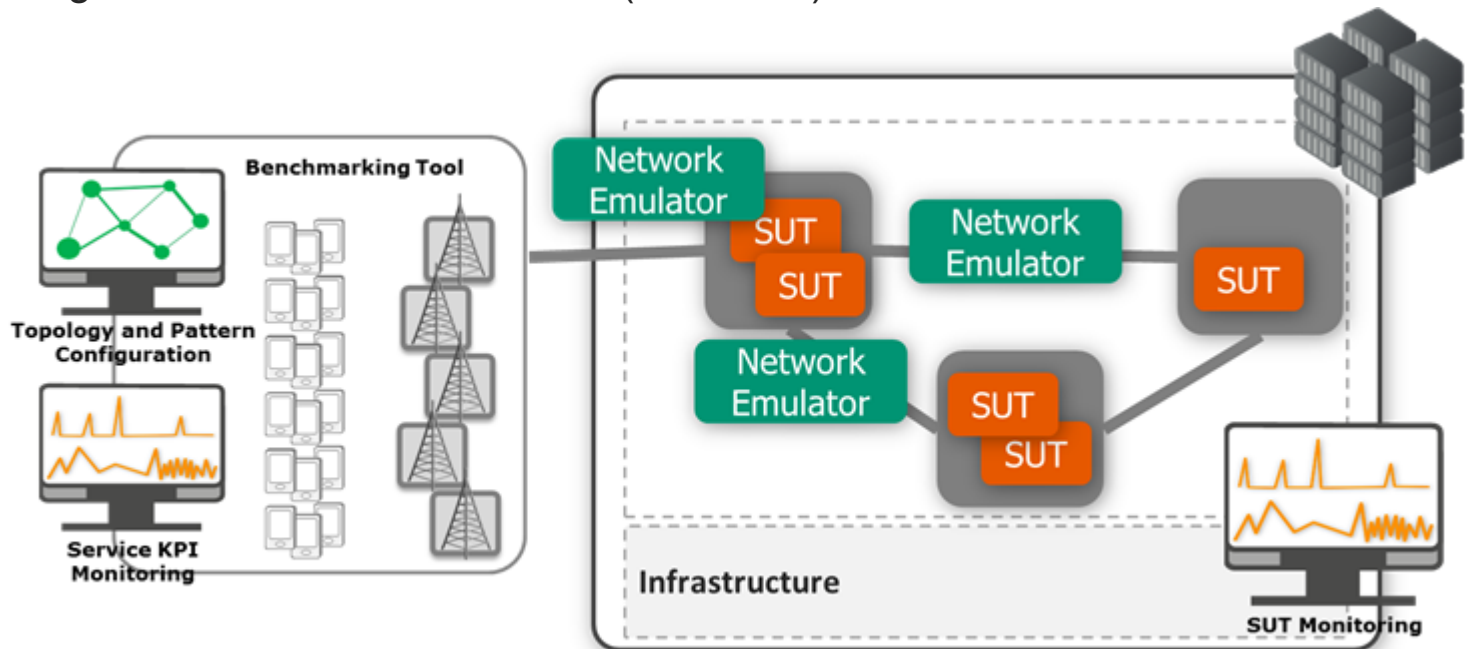
The 5G Ready Trial Platform represents the Minimal Viable Product (MVP) for supporting a large number of use cases

- Integrating with the devices, access networks and applications of the specific use case
- Customizing the connectivity/IoT/Multimedia support services
- Telco cloud and multi-slicing support
- Edge Intelligence
- Remote mobile networks
- Industrial connectivity
- Massive IoT
- Critical Infrastructures
- Smart office

Cross topic: Benchmarking


Providing quantitative or comparative evaluations of different network architectures on top of heterogeneous, reproducible network conditions

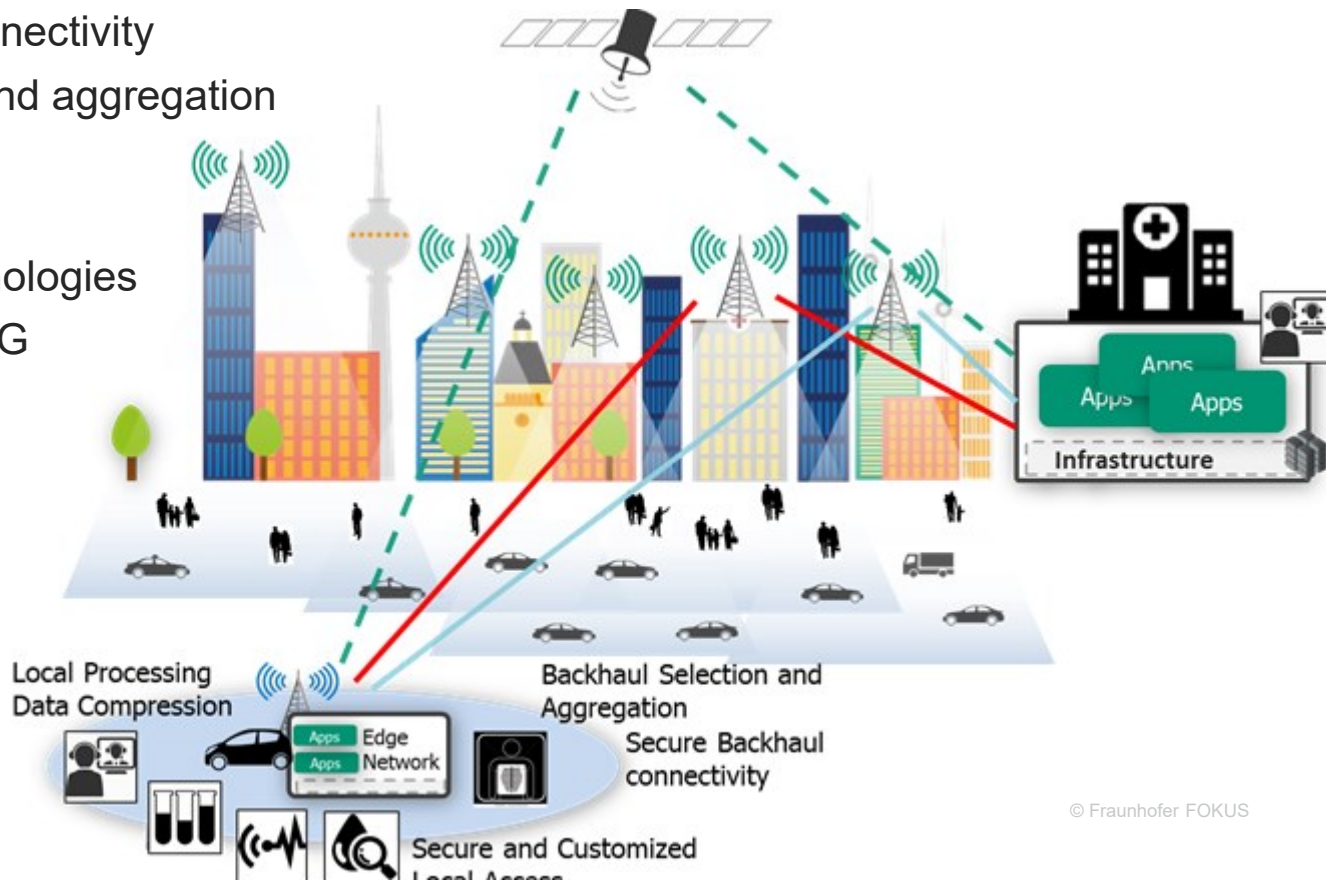
- Support for different syntethic workload or real life workloads replay
- Emulation of complex network topologies within a single data center
- Monitoring the service KPIs: delays, successful procedures, interrupted sessions
- Monitoring of used resources: CPU, memory, storage
- Interworking with real devices and radio (if needed)



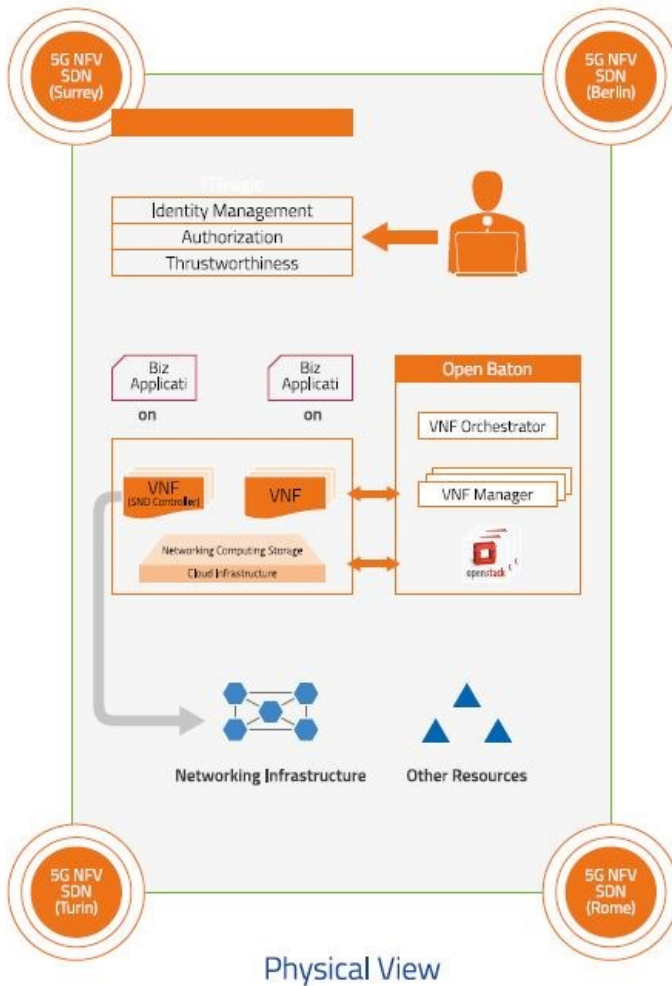
Example Use Case: Sister Agnes

- Secure and customized local access network (e.g. LTE-U

- network)
 - Provide local processing and data compression
 - Secure backhaul connectivity
 - Backhaul selection and aggregation
 - Can be done with customized 4G technologies
 - No need to wait for 5G
- 
- A stylized illustration of a city skyline featuring several communication towers and a satellite. The towers are depicted in various colors (blue, grey, yellow) and have green concentric circles around them, representing signal waves. A satellite is shown in the upper right corner, connected to the ground stations by a dashed green line. The background is white, and the overall style is clean and modern.



SOFTFIRE PROJECT



Experimental infrastructure within FIRE+

Key elements assessed by SoftFIRE:

- programmability
- interoperability
- Security

The project aims at creating a broad ecosystem of companies engaged with the evolution of SDN/NFV technologies.

Open Calls and specific events (Hackathons, InterOpTest).

<https://www.softfire.eu>

Partners



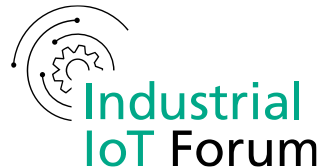
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