





The Fraunhofer FOKUS 5G Playground:

Prototyping 5G-Ready Infrastructures and Applications
in the 5G Capital Berlin

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BEST PRACTICE EXAMPLE FOR R&D

There are some R&D steps which cannot be missed for reaching relevant research and innovation results

- Motivating Research – showcasing the possibility of a new technology
- Novel Ideas – direction, planning, literature study and hands-on implementations
- Simulation Environment – evaluations of ideas on complex models
- Prototyping in Real Environments – realistic, comprehensive PoCs
- Product Prototyping – and the appropriate counterpart network environment
- Integration, Inter-op and Trials – comprehensive environments
- Product Implementation and Marketing



OPEN BATON



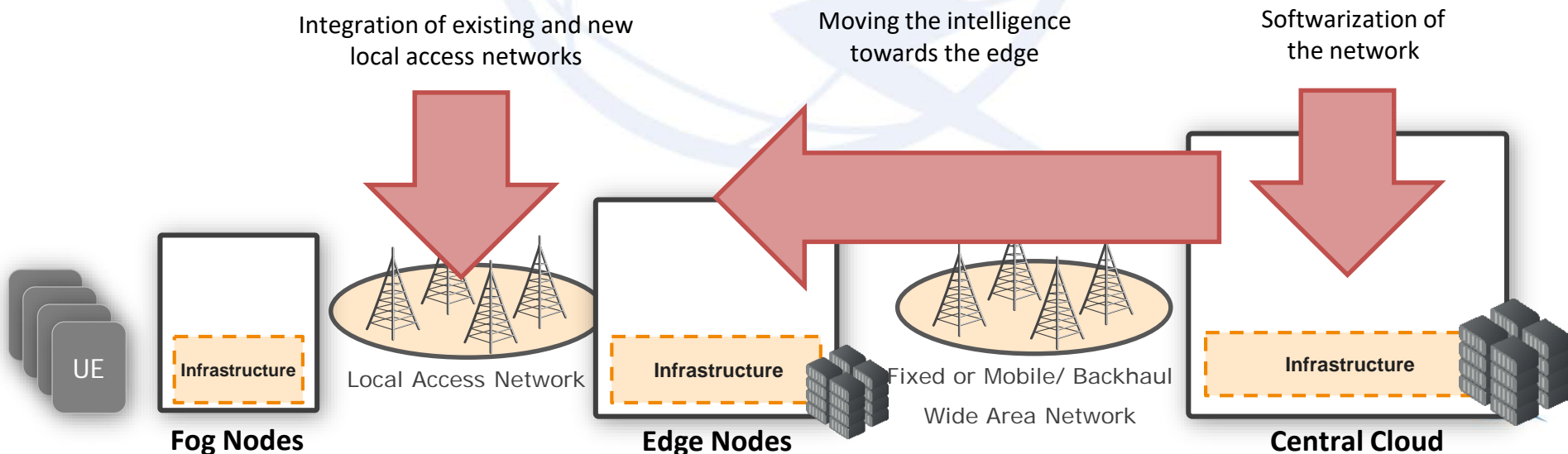
5G READY TRIAL PLATFORM



Key Communication Changes with 5G

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

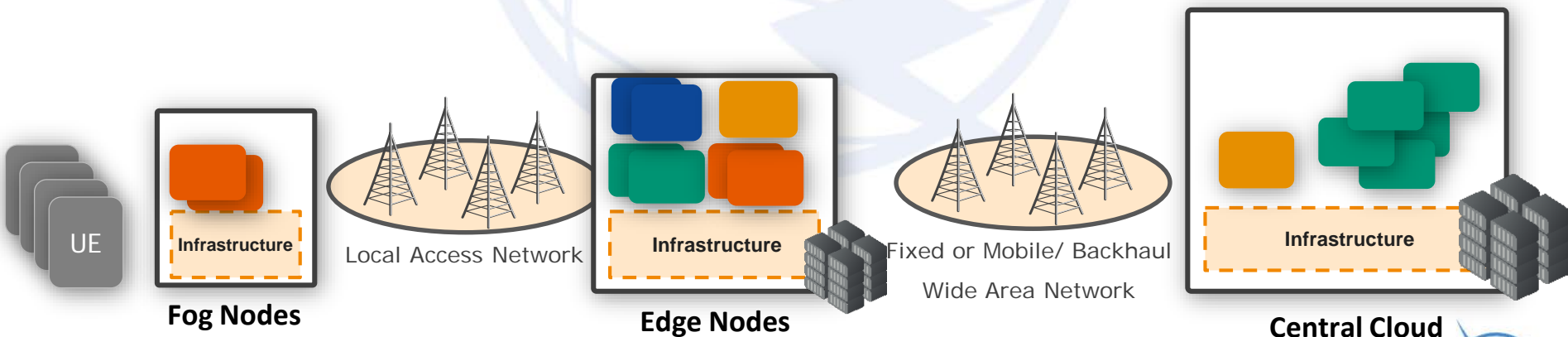
- The network functions are becoming software only → convergence with IT
 - More flexible network infrastructures (growing on demand, adapting to changes)
 - Enabling the parallel deployments of multiple dedicated networks
- Network functions can be installed in compute nodes at the edge of the network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



Major Advantages of the 5G Evolution

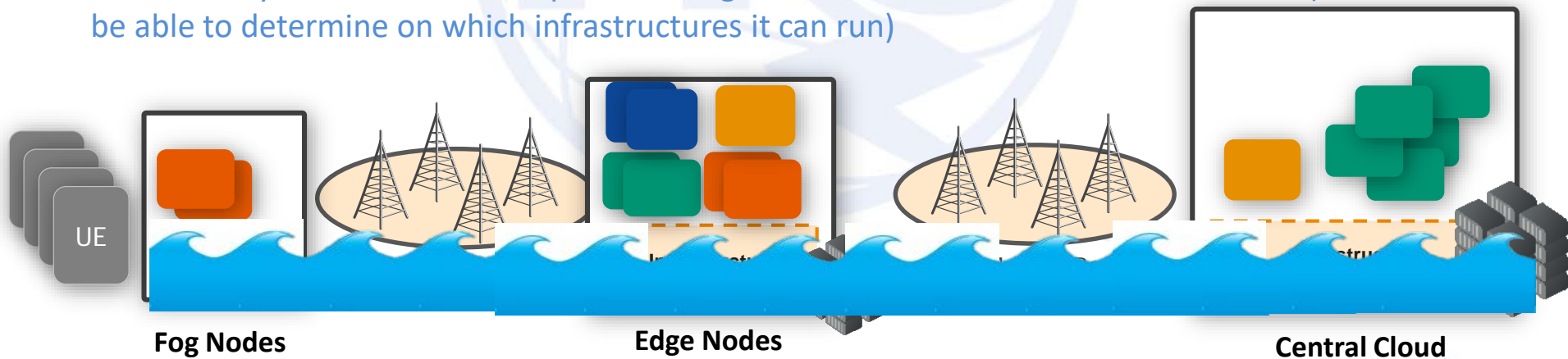
The 5G ecosystem takes advantage of these changes when implementing the network functions able to seize the infrastructure advantages

- Communication can be executed through dedicated networks
 - Using the same network functions
 - Customized for the needs of the use cases
- Network functions can be placed in different network locations
 - Providing differentiated services, security and resilience
- Local access networks can use carrier-grade network technologies
 - Addressing the vertical requirements with the same technologies
 - Enables anybody with communication requirements to install a network



The Network Functions Perspective

- The 5G system is a distributed system
 - The network functions should be able to understand the underlying connectivity
 - Network functions should be properly synchronized
 - The 5G system is a software system
 - Performance depends on the underlying uncertain infrastructure
 - New mechanisms for ensuring resilience and security
 - With different levels of trust on the infrastructure
- ➔ The 5G system should be adaptable enough to run on the available infrastructures (or at least be able to determine on which infrastructures it can run)

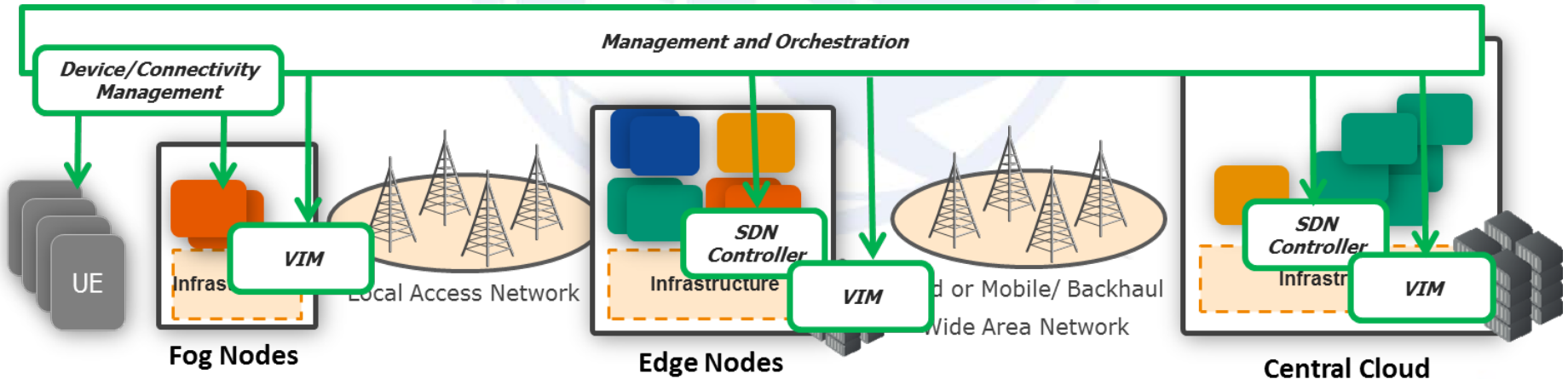


The Infrastructure Perspective

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

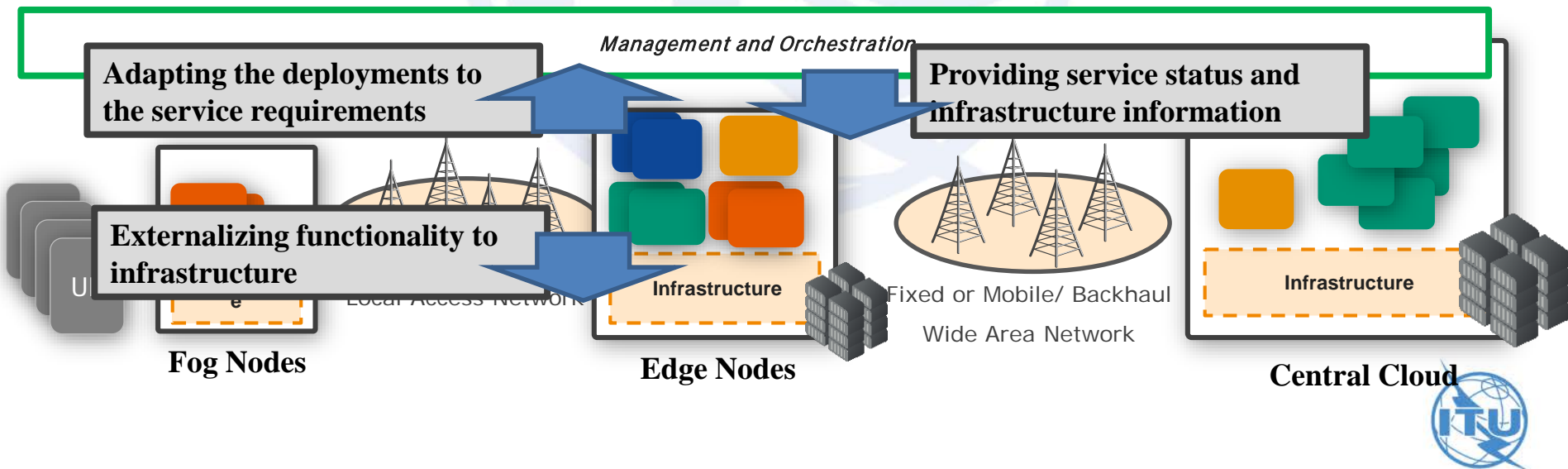
- Performance enhancement – load balancing and high availability
- Resilience of the end-to-end communication
- Security at infrastructure level
- Secure and Reliable Connectivity management
- Real-time orchestration of functionality



The Integrated Perspective

Providing a cross-layer communication between the network functions and the infrastructure level

- Adapting the deployments to service requirements – dynamically adding network functions according to the service administrator's needs, adapting the service based on momentary status
- Externalizing functionality to infrastructure – load balancing, high availability, security, backhaul selection
- Providing service status and infrastructure information – on the externalized functionality, on the current status of the system



What is the 5G Playground

5G Playground provides a single stop for a comprehensive set of toolkits with virtually all that 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).



open5GMTC

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.



open5Gcore

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

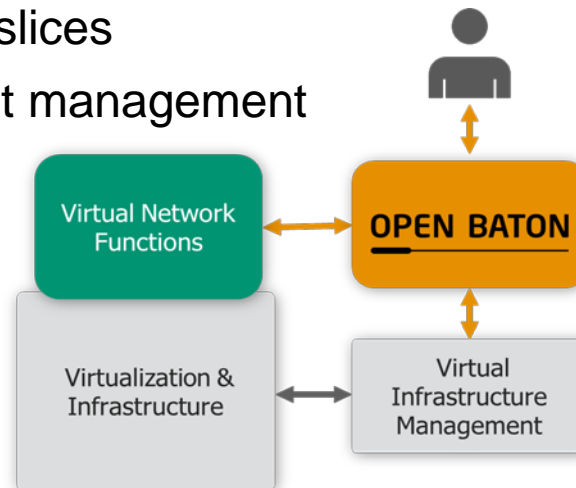
- A methodology and tools for benchmarking 5G prototypes and products.
- A commodity providing cost efficient automatic installation and experiment control.



What is the 5G Playground made of

OPEN BATON

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



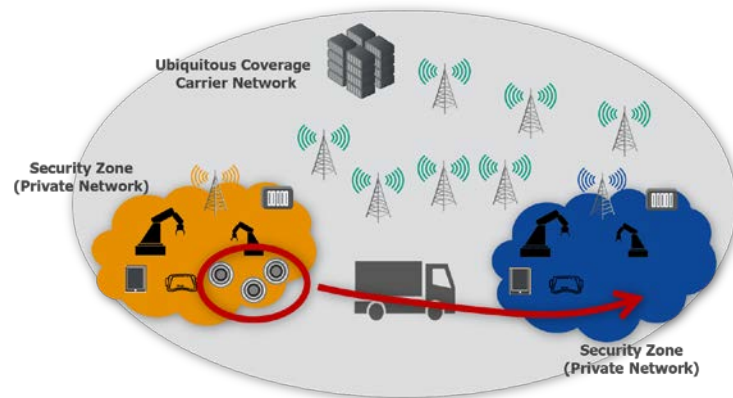
What is the 5G Playground made of

OPEN BATON



open5GMTC

- A new approach to device communication, M2M and multimedia
- Addressing connectivity of a large number of devices
- Connectivity control on top of heterogeneous environments
 - Security
 - Customized connectivity
 - Service capabilities
- Based on standard protocols
 - OMA LW M2M, eSIM, etc.



What is the 5G Playground made of

OPEN BATON

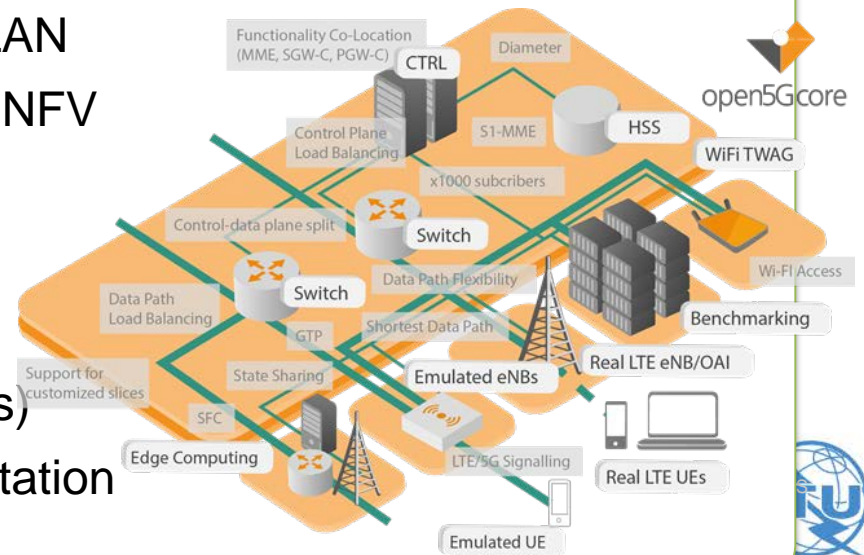


open5GMTC



open5Gcore

- R&D prototype of mobile core networks beyond 3GPP Release 13
- Support for (5G), LTE and WLAN
- Cloud-native core network for NFV
- Seamless elasticity
- Mobile edge network support
- Service-oriented data paths
- Highly customizable (for DCNs)
- Benchmarking and experimentation

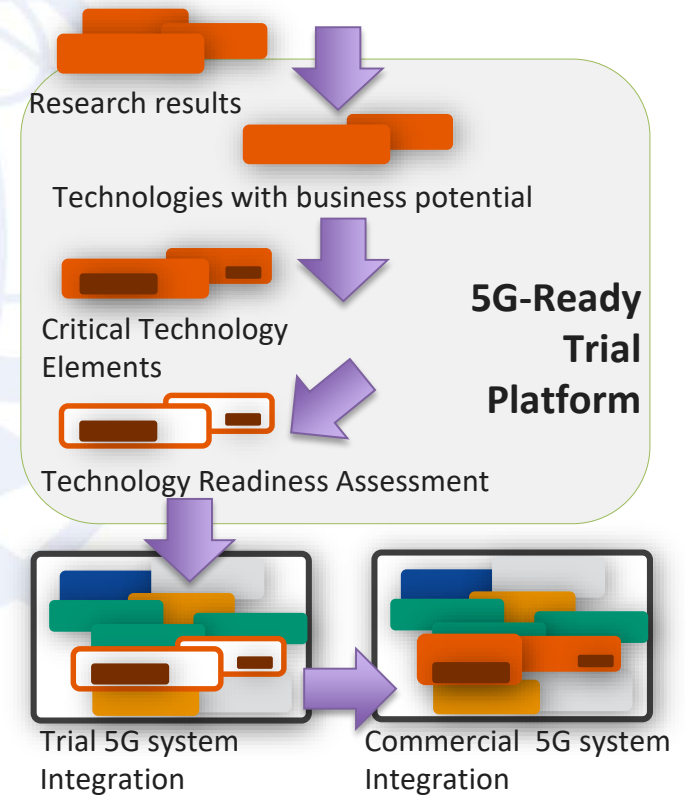


What is 5G-Ready Trial Platform?

5G READY
TRIAL PLATFORM

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

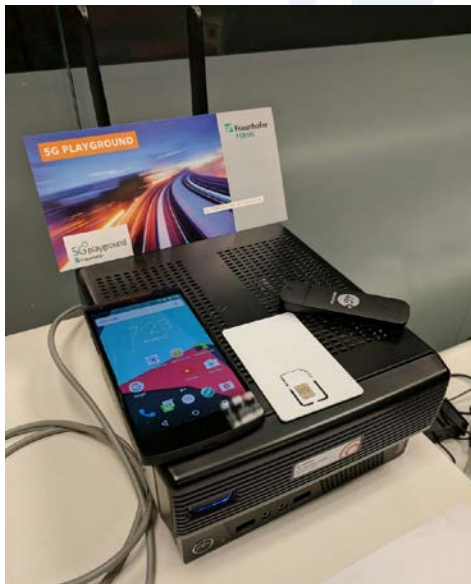
- Provides a consolidated turn-key solution of the Fraunhofer FOKUS software components
- Integrates with selected access networks
- Provides the basis for showcasing new use cases
- Includes benchmarking and assessment mechanisms
- Comprehensive 5G ecosystem
- Pragmatically addressing the demonstration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



Edge Instantiation

- Enabling micro- operators/local networks
- Providing customized IoT connectivity for x100 devices

Edge Instantiation



Data Center Instantiation

- Multi-slice environment
- Providing support for massive IoT
- Providing support for multimedia

Data Center Instantiation

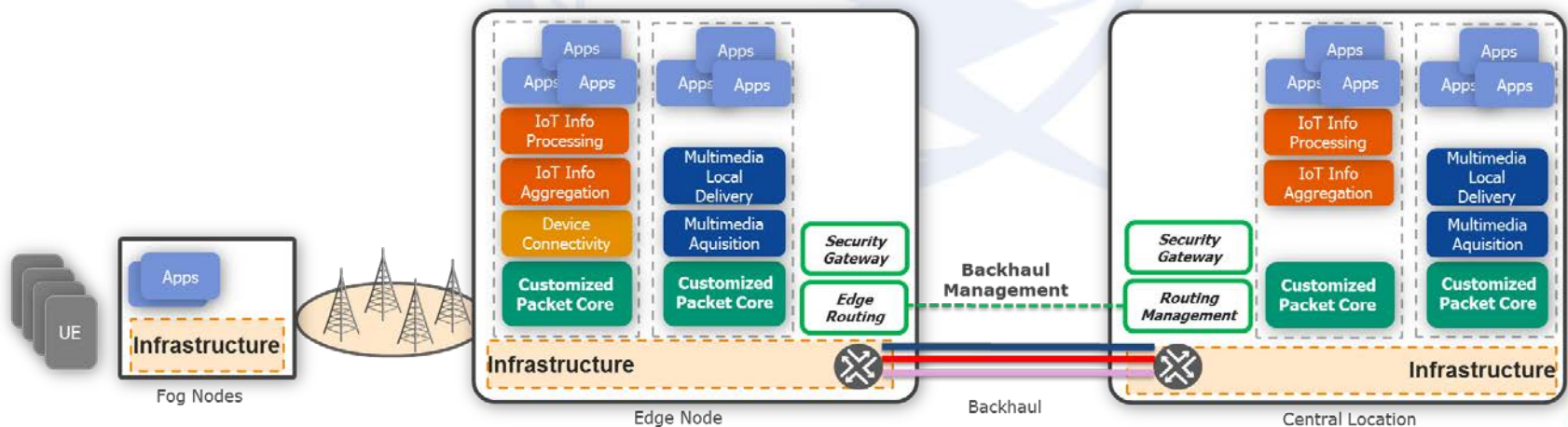


5G-Ready Trial Platform Architecture

5G READY
TRIAL PLATFORM

Includes three types of functional features (which may be combined in different forms depending on the use cases)

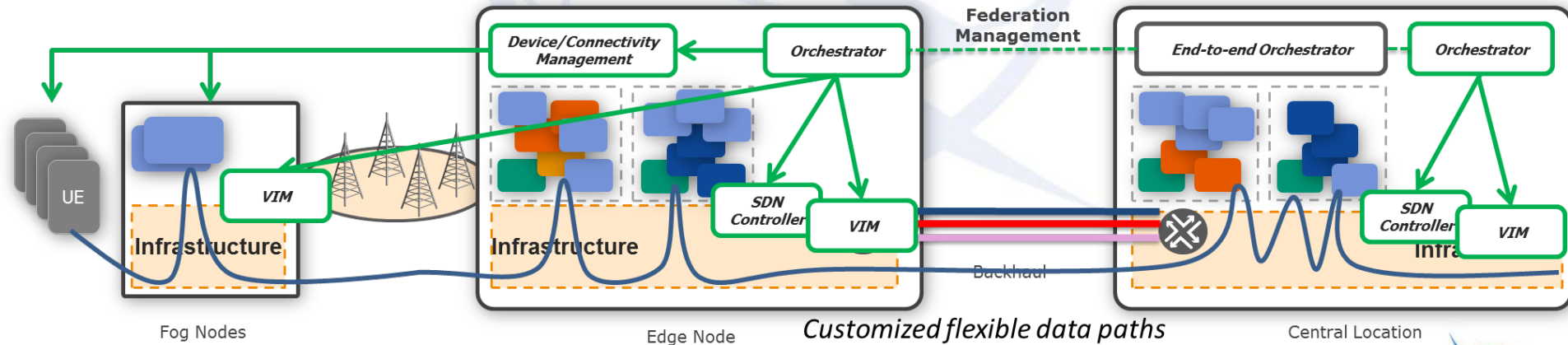
- Customized packet core
 - adapting control and data plane processing to the size and QoS requirements of the applications
- Generic enablers addressing:
 - IoT deployments – device connectivity, device management, information aggregation and processing
 - Multimedia enablers – IMS and media servers enabling multimedia acquisition and delivery
- Backhaul management
 - Secure, dynamic edge network selection
- Integrating with IoT convergence (at application level) and third party applications



Providing flexible management of the integrated infrastructure

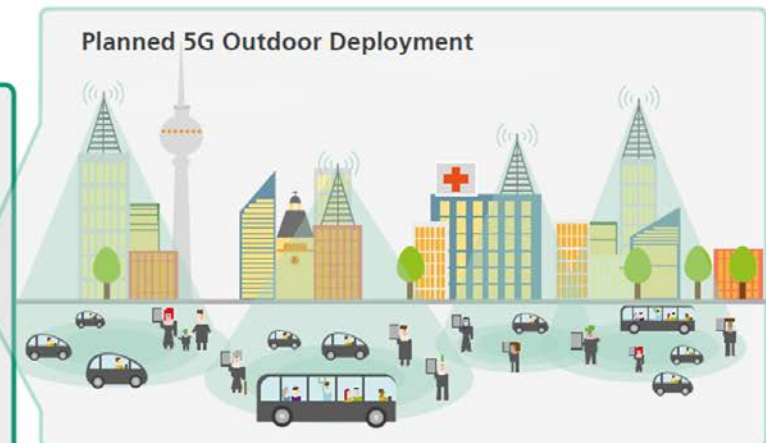
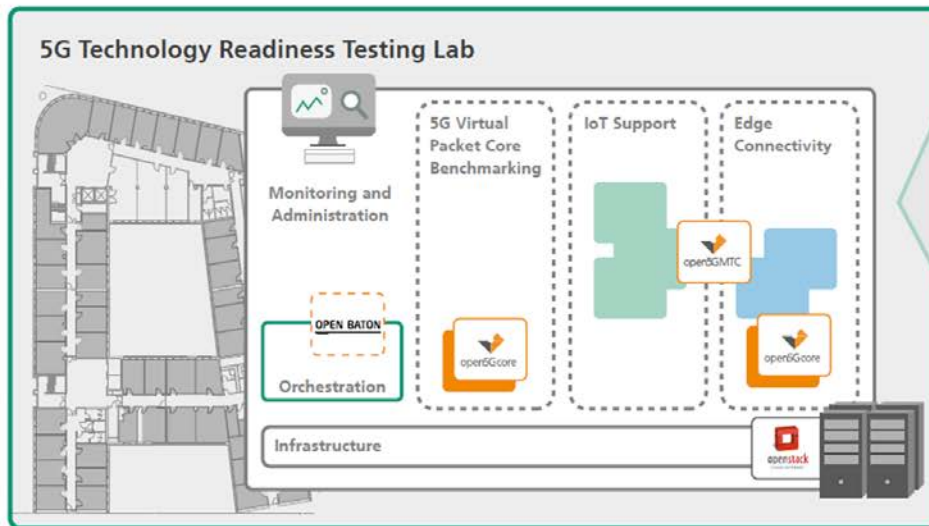
- Supporting dynamic adaptations of the virtual network functions
- Orchestrating the fog, edge and central nodes into an end-to-end infrastructure
- Providing the management of the different Virtual Infrastructure Managers
- Providing device/connectivity management to the dynamic infrastructure
- Integrating with the infrastructure SDN control for customized flexible data paths

Dynamic network functions placement



What Is The 5G-Ready Trial Platform good for? (next steps)

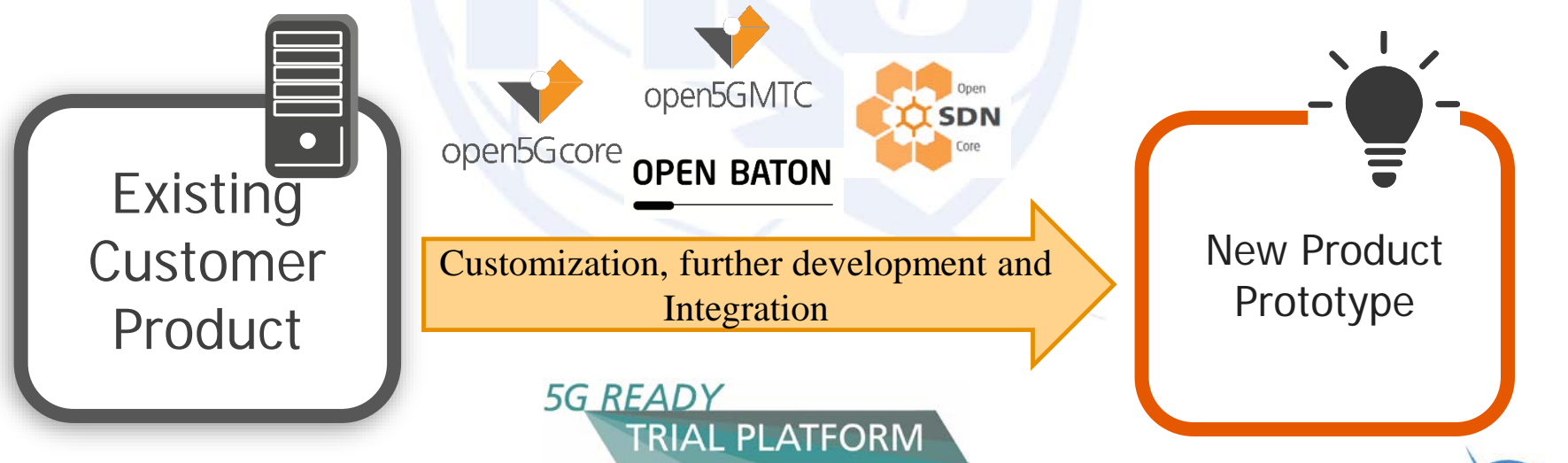
- Trial technologies before deploying them into outdoor testbeds
 - Ensuring a minimal maturity level across the technologies
 - Ensuring interoperability/configuration flexibility testing before trials
- Providing an efficient means to initially evaluate use cases
 - With a large number of possible network conditions (covering exceptional cases)



Create Advanced Prototypes

Ongoing experimentation continuously advances the 5G Playground

- In course of the ongoing 5G development, the 5G Playground @ FOKUS continuously adopts relevant outcomes of experiments and trials ...
 - Based on the existing product base of customers (or third parties);
 - From experiences with customized versions of the Fraunhofer FOKUS toolkits;
 - From research collaboration and prototyping new products.
- Aiming to maintain the relevance of the testbed environment provided and opening new market opportunities through raising awareness (demos, whitepapers).



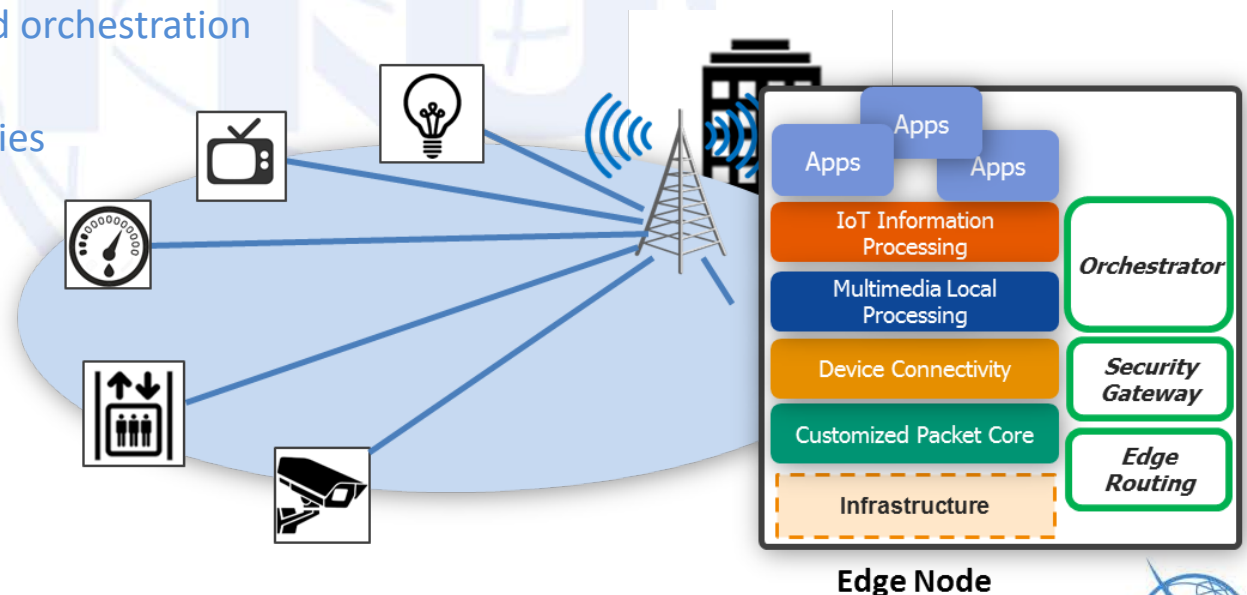
Edge Intelligence



Example Use Case: Edge Intelligence in Enterprise Networks

Development of a secure overlay for bringing edge intelligence in existing enterprise networks

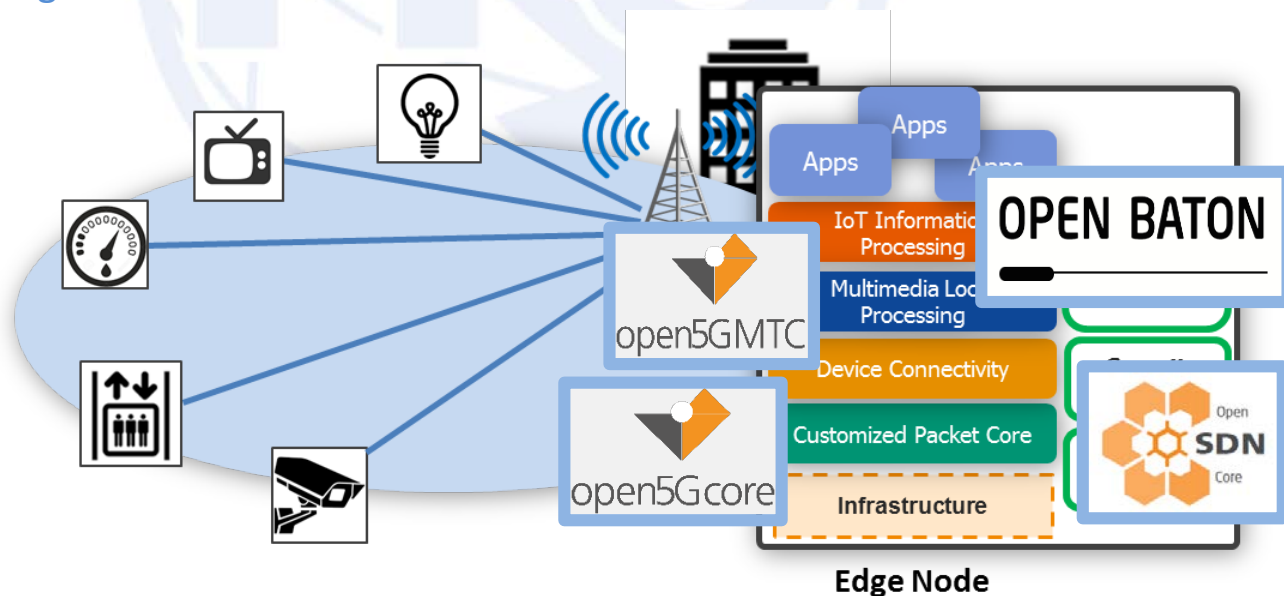
- Secure and customized local access network (e.g., local WiFi, NB-IoT, LoRa network)
- Provide customized connectivity
- Secure backhaul connectivity
- Backhaul selection and aggregation
- Remote management and orchestration
- Can be done with customized 4G technologies
- No need to wait for 5G



Example Use Case: Edge Intelligence in Enterprise Networks

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

- Open5GCore – R&D prototype of software core networks (3GPP Release 11) extended with support for NB-IoT
- OpenSDNCore – SDN platform showcasing added value in flexible routing, virtual environments, secure and resilient backhauls
- Open5GMTC – efficient support for device connectivity & management and IoT information control
- OpenBaton – management and orchestration of virtual network environments



Remote eHealth

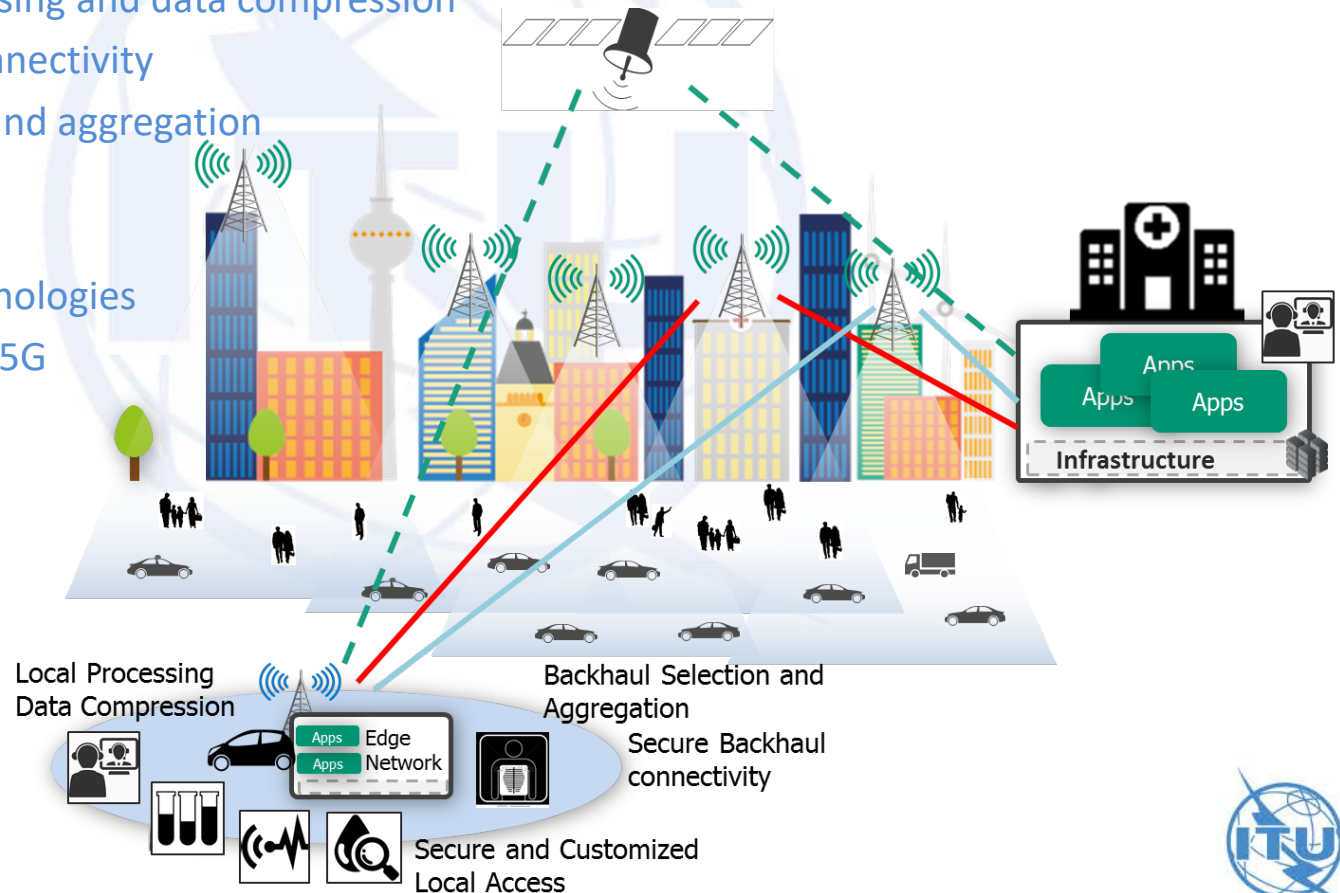


Providing mobile wireless connectivity and data acquisition for eHealth

Example Use Case: Sister Agnes

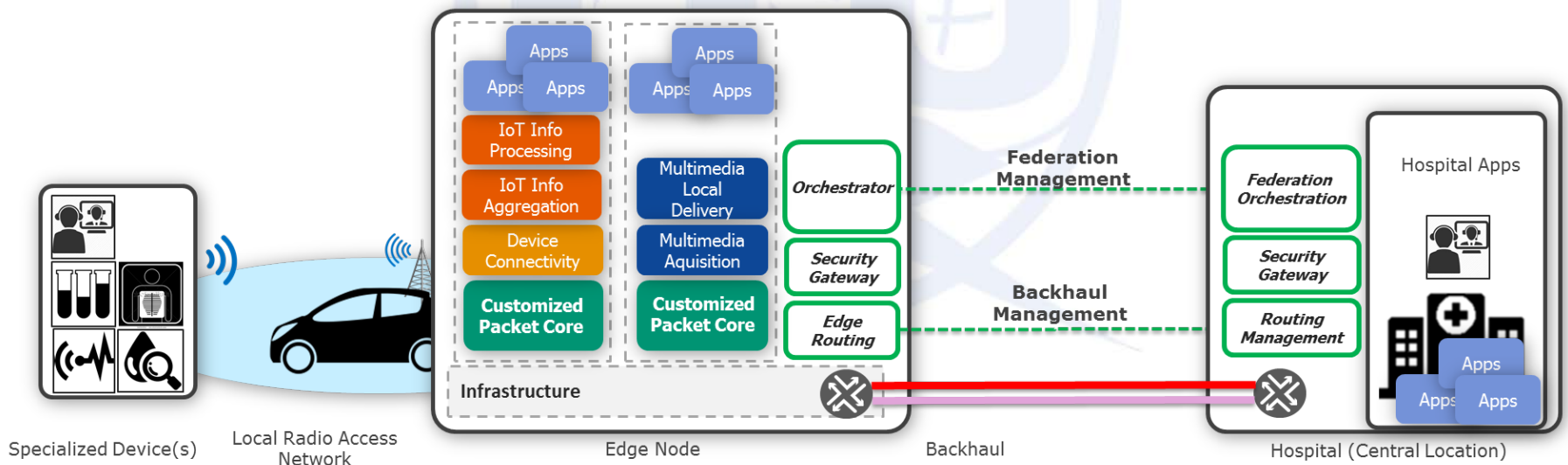
Development of a secure dedicated network providing the specific requirements

- 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

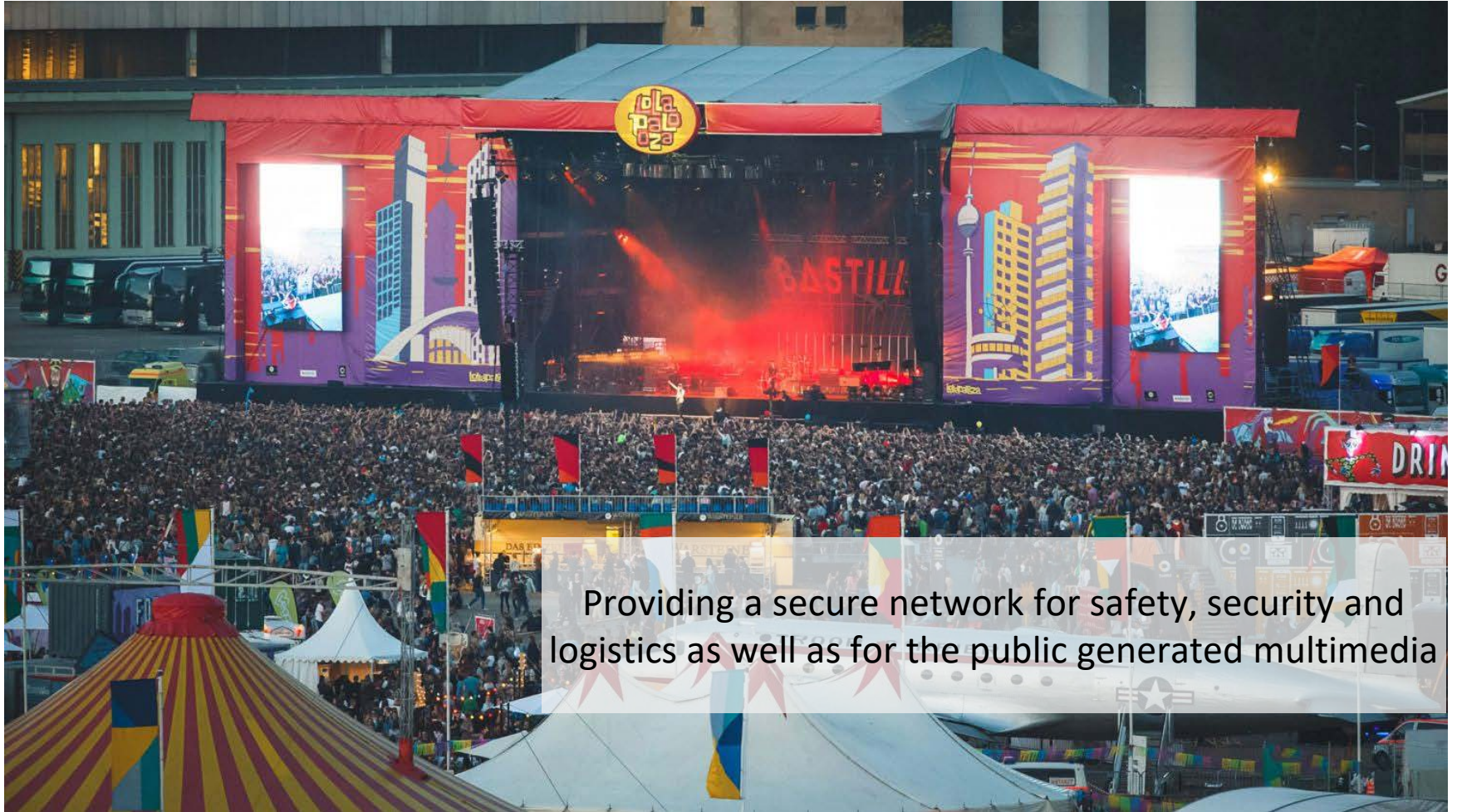


Example Use Case: Sister Agnes

- Providing secure customized connectivity to specialized devices
- Integrating a local access network
- Generic enablers for IoT connectivity (Data processing, data aggregation)
- Generic enablers for multimedia: acquisition and local delivery
- Connectivity to local applications presenting the information
- Providing secure, best available backhaul to the central location
- Managing remotely the network functions (no need for local service)



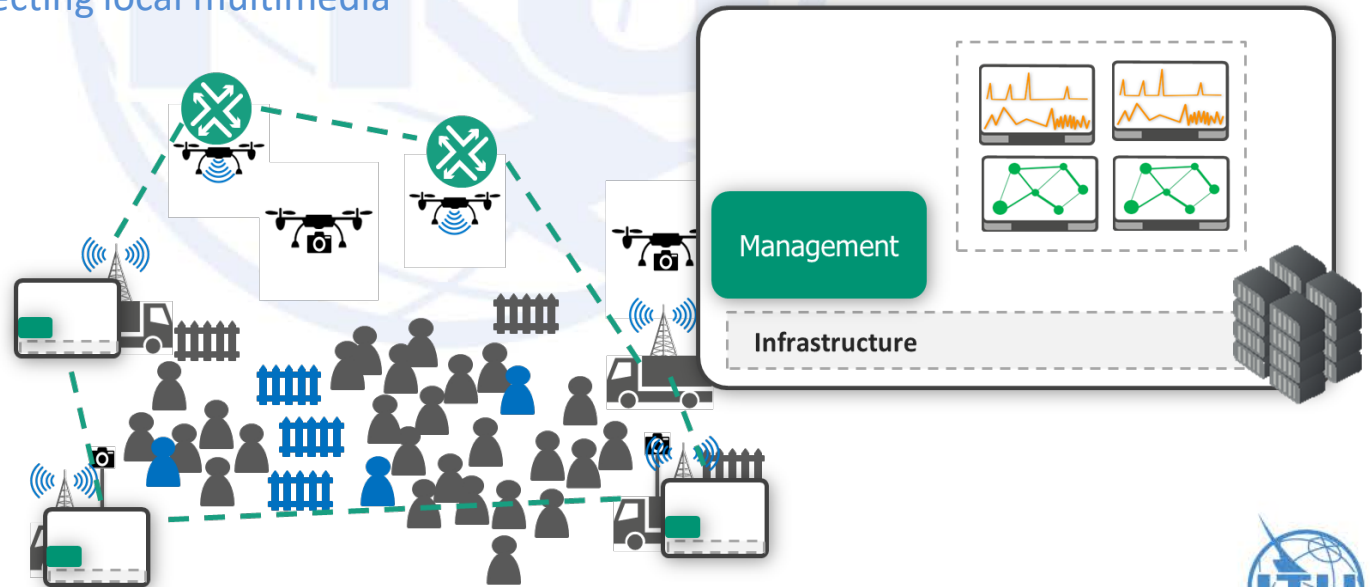
Dedicated Networks for Public Events



Providing a secure network for safety, security and logistics as well as for the public generated multimedia

Edge Network Use Case – Dynamic Network Composition

- Bringing together dynamically multiple edge nodes
- Providing efficient communication over the dynamic infrastructure
- SDN secure composition of edge infrastructure
- Usage scenarios:
 - Safety and security network: following a public event
 - Logistics: providing a communication network for the event organizers
 - Multimedia: collecting local multimedia



Dedicated Networks for Factory Shop-Floor Communication

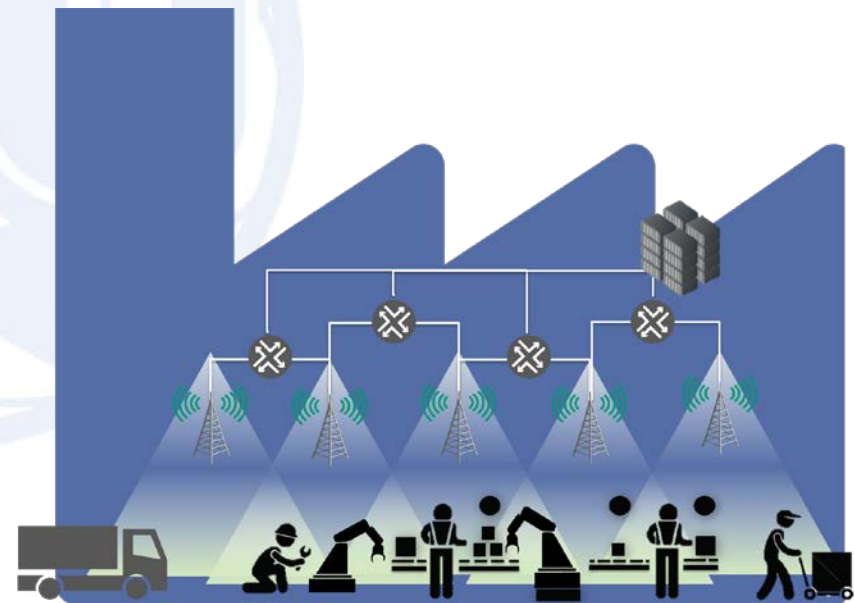


Providing a secure and reliable wireless communication for the dynamic factories of the future

Addressing Vertical Markets – Industrial Communication

Focus topic: Enabling reliable wireless shop-floor communication through local 5G network deployment

- Development of suitable mixed wireless/wired architecture for in-factory communication
 - Flexible, ultra-low delay and interference tolerant radio technologies
 - Low-delay in-site backhaul and low delay cross-site communication
 - Easy to configure and maintainable networking infrastructure
 - Easy adaptation to changing shop-floor environment and production processes
- Communication environment characteristics
 - Communication and non-communication (machines) radio interferers
 - Coexistence with existing systems
 - Many communicating devices (machines, goods, tools, controllers, transportation ...)
 - Extended demands on reliability, long term operations, maintenance, security ...



Clone and Customize Your Own 5G Playground

- The 5G Playground was designed from the initial phases for commodity for being deployed at customer premises
 - Mirroring the advancements from the FOKUS and the Berlin testbed
 - Providing a separate isolated testing facility
 - Including only the interesting functionality from the comprehensive environment
 - Customizing the test environment for the specific requirements



5G playground
Fraunhofer



**Your
Premises**



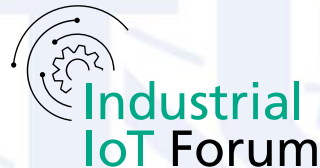
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