Alliance for
Internet of Things
Innovation

Webinar • 11 May 2022

Standardisation Report Presentation

High Priority Edge Computing Standardisation Gaps and Relevant SDOs

Computing Continuum Scenarios, Requirements and Optical Communication enablers

Welcome & Opening

Damir Filipovic, AIOTI Secretary General

AIOTI

Agenda

Agenda (I)

15.00h Opening and Welcome
Damir Filipovic, AIOTI Secretary General

15.05h Presentation of the report High Priority Edge Computing Standardisation Gaps and Relevant SDOs

Introduction and overview of the report
Georgios Karagiannis, AIOTI WG Standardisation Chair, Huawei (20 min)

The Key Edge Computing Gaps and Recommendations
Orfeas Voutyras, Institute of Communication and Computer Systems (ICCS) (15 min)

Questions and open discussions (15 min)

15.55h Short break

Agenda (II)

16.00h Presentation of the report Computing Continuum Scenarios, Requirements and Optical Communication enablers

Introduction and overview of the report
Ronald Freund, AIOTI TF Computing Continuum Chairman, Fraunhofer HHI (10 min)

Presentation of examples:
Use Cases, Ricardo Vitorino, Ubiwhere (15 min)
Optical Enablers, Marcus Brunner, Huawei (15 min)

Questions and open discussions (15 min)

16.55h Wrap-up and end of Webinar
Georgios Karagiannis, AIOTI WG Standardisation Chair, Huawei

About AIOTI WG Standardisation

Leadership and Vision

Chair

Georgios Karagiannis

Huawei

Co-Chair

Antonio Kung

Trialog

Vision:

To be recognized as a major contributor to the worldwide interoperability, security, privacy and safety of IoT and Edge Computing systems and applications, and particularly for the development of the market in Europe

Deliverables:

https://aioti.eu/standardisation/

AIOTI

Scope

Task Force	Lead	Deliverable
IoT Landscape	Georgios Karagiannis (Huawei)	
IoT Landscape maintenance	Georgios Karagiannis (Huawei), Tom de Block (Navigio)	last version focusing on edge computing landscape maintenance published in September 2021
Gap Analysis and recommendations	Georgios Karagiannis (Huawei)	3rd release published in April 2022, focusing on edge computing gap analysis
Cooperation with SDOs/Alliances	Georgios Karagiannis (Huawei)	report published in September 2021
IoT relation and impact on 5G	Georgios Karagiannis (Huawei)	report published in April 2022
Computing Continuum	Ronald Freund (Fraunhofer)	
High Level Architecture	Marco Carugi (Huawei)	
IoT Reference Architecture		
IoT identifiers	Juergen Heiles (Siemens)	1st release published February 2018
Guidance for the Integration of IoT and Edge in Data Spaces	Antonio Kung (Trialog)	to be published in 2022
Semantic Interoperability	Martin Bauer (NEC Lab) Laura Daniele (TNO)	Ontology Landscape Report published in Dec 2021
IoT Privacy	Arthur van der Wees (Arthur's Legal)	
IoT Security	Arthur van der Wees (Arthur's Legal) Jacques Kruse-Brandao (SGS)	

Highlights

Relevant facts:
103 member organisations, **183** participants

Main achievements:

Deliverables	Collaborations	Events
• IoT Landscape Reports • High priority gaps Reports • IoT relation and impact on (beyond) 5G Reports • High Level Architecture and IoT Identifier Reports • Guidance on Risk Classification of IoT Devices • Semantic Interoperability Joint White Papers • Ontology Landscape	• Cooperation with SDOs/Alliances to foster co-creation and interworking (MoUs and Liaisons) • SNS Partnership • Trans Continuum Initiative • Stand.ICT - EU OS • Gaia-X	• AIOTI signature event 2020/2021/2022 • IoT Week – lead standards track • IoT and Edge computing workshops • Chariot project webinar • Navigating IoT Architectures and Standards Days Event • Edge Computing Forum • ETSI IoT Week • Policies to support Data Markets

High Priority Edge Computing Standardisation Gaps and Relevant SDOs

Georgios Karagiannis, AIOTI WG Standardisation Chair, Huawei

Goals of the Report

Published on 1 April 2022:
https://aioti.eu/wp-content/uploads/2022/04/AIOTI-High-Priority-Edge-Computing-Gaps-Final.pdf

Goal of report:

Introduces an approach for the definition and identification of key edge computing and/or combination of IoT/IIoT, edge computing and cloud computing standardisation gaps in several initiatives

Method of collecting information:

- Using pre-defined template
- Input provided discussed and approved by AIOTI members

Content of the Report

Section 2.15: Identified research & standardisation challenges

2.15.1 Interoperability in IoT and edge computing systems:
2.15.2 Standardization & regulation framework, and interoperability,
2.15.3 Enhanced approach to certification for IoT and edge computing devices and systems
2.15.4 Trustworthiness and dependability in IoT and edge computing systems:
2.15.5 IoT and edge computing in Digital service transformation, with a high level of resource abstraction, via open APIs that impose standardisation challenges, such as interfaces, data models and ontologies
2.15.6 IoT and edge computing coexistence across sectors, where a standardisation challenging task from the point of interoperability (interfaces, data models and ontologies), security and privacy models
2.15.7 AI/ML enabled Network and Services, where end, end-to-end interoperability is a must
2.15.8 Service discovery is essential, where the architecture will have to become much more dynamic and where service provisioning, management, and security are critical and security models must evolve
2.15.9 Authentication of services and service providers,
2.15.10 Privacy and data management,
2.15.11 Policy descriptions, rules, and constraints
2.15.12 Novel programming models and languages
2.15.13 Devices and open device management, where new interoperable advanced network reorganization and dynamic function reassignment mechanism are needed; as well new IoT interoperable device management techniques are needed that are adapted to the evolving distributed architectures for IoT and edge systems based on an open device management ecosystem
2.15.14 Edge, Mobile Edge Computing and Processing, imposing standardisation challenges on the open distributed edge computing architectures, interfaces and data models, end-to-end distributed security, trustworthiness and privacy models.
2.15.15 IoT and X-Continuum Paradigm: requiring support of: • continuum of technologies across sensors, connectivity, gateways, edge processing, robotics, platforms, applications, AI, and analytics, including underlying technologies like optical, wireless (cellular and non-cellular) and satellite communications; • continuum of intelligence and IoT edge capabilities • continuum of IoT edge applications across vertical sectors and seamless integration
2.15.16 use of end-to-end capabilities of IoT technologies across the edge granularity and beyond impose continuum standardisation challenges, such as support of interoperability by the means of new interfaces, data models, security and privacy models and security and privacy models.
2.15.17 IoT Swarm Systems: imposing standardisation challenges in the required architecture, such as interfaces, data models and ontologies and as well security and privacy models
2.15.18 Decentralized Distributed IoT Edge Systems
2.15.19 Federated Learning and AI for IoT Edge: imposing standardisation Challenges - workflow standardization, interfaces edge/cloud, orchestration, model contamination, and pipes for handling distributed traffic
2.15.20 OSs and Autonomous Orchestration Concepts:
2.15.21 IoT Systems integration: requiring a standardized reference architecture with new/modified interfaces
2.15.22 IoT sectorial and Cross-Sectorial Open Platforms, where a common framework is needed for verification, validation, testing, and certification of different IoT implementations based on agreed performance requirements; Moreover, validation verification methods for task development of edge IoT intelligent multi-agent system architecture
2.15.23 IoT and edge computing Platforms: imposing standardisation challenges such as modification of interfaces, data models, security, and privacy models
2.15.24 IoT Distributed and Federated Reference Architectures integrated with the 5G architecture and AI, addressing the convergence of (low latency) Tactile Internet, Digital Twin edge processing, AI, and distributed security based on ledger or other technologies and the use of multi-access edge computing
2.15.25 Charging aspects for Edge Computing Systems for End User of IoT edge application, impacting charging architecture, functions and procedures

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- Georgios Karagiannis, Huawei
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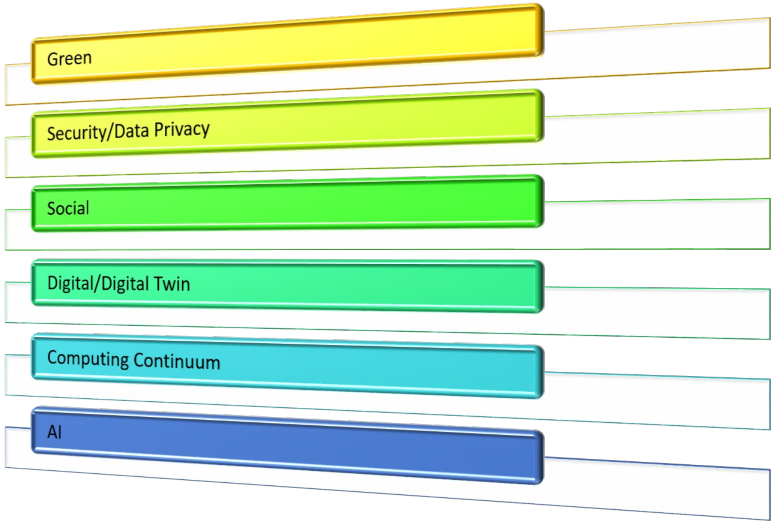
Categories of standardisation challenges (I)

1. Regulations, Rules, and Processes
2. Semantics, Models, and Languages
3. Taxonomies, Ontologies, Data Models, and Architectures
4. Metrics, KPIs, Benchmarks, and Quality Assurance
5. Identification, Authentication, and Discovery
6. Management, Comms, Protocols, Interfaces, and Platforms

Challenges presented in detail in	SCC1 – Rules	SCC2 – Semantics	SCC3 – Structure	SCC4 – Measuring	SCC5 – Accessing	SCC6 – Managing
Section 2.1	legal/ethical/ social adoption	semantic interoperability				
Section 2.2		novel model & languages	distributed architectures	edge-specific constraints		device/agents management
Section 2.3					service discovery	infrastructure interoperability
Section 2.4	EU Green Deal			CO_2 footprint measurability		energy-efficient protocols
Section 2.5	EU Green Deal		data-models, ontologies	CO_2 footprint measurability		comms. energy usage control
Section 2.6	ESG regulations (e.g., SFDR)	impact definition	ESG Data Taxonomy	define ESG scoring/ratings		connectivity, interoperability
Section 2.7	ethical principles	meaningful explanations				
Section 2.8	data privacy	semantic annotation				large-scale computation
Section 2.9		models	knowledge graph			
Section 2.10				testing methods/ techniques		
Section 2.11						seamless MEC deployment
Section 2.12						seamless MEC transition
Section 2.13			NGIoT architecture			orchestration, interoperability
Section 2.14		context/models coherency	data meta-models		search, trade, trackability	connect spaces, interoperability
Section 2.15.1	interoperability on policy level	interoperability on meta-data				
Section 2.15.2	regulation framework					coexistence of intelligent IoT
Section 2.15.3				IoT/edge certification		
Section 2.15.4	non-functional properties					
Section 2.15.5			data-models, ontologies			Interfaces & APIs
Section 2.15.6			data-models, ontologies			IoT/edge coexistence
Section 2.15.7			5G networks architecture			network management
Section 2.15.8					service discovery	
Section 2.15.9					services authentication	
Section 2.15.10	legal/moral restrictions					
Section 2.15.11		policy description				
Section 2.15.12		models, languages				
Section 2.15.13						devices management
Section 2.15.14						responsive connectivity
Section 2.15.15						computing continuum
Section 2.15.16						computing continuum
Section 2.15.17						IoT intelligence clustering
Section 2.15.18						decentralized IoT-edge
Section 2.15.19						Federation, orchestration
Section 2.15.20						autonomous orchestration
Section 2.15.21			reference architecture			
Section 2.15.22				testing, validation	AAA[8] mechanisms	
Section 2.15.23		semantic interoperability	layer-oriented approach			
Section 2.15.24			IoT reference architecture			

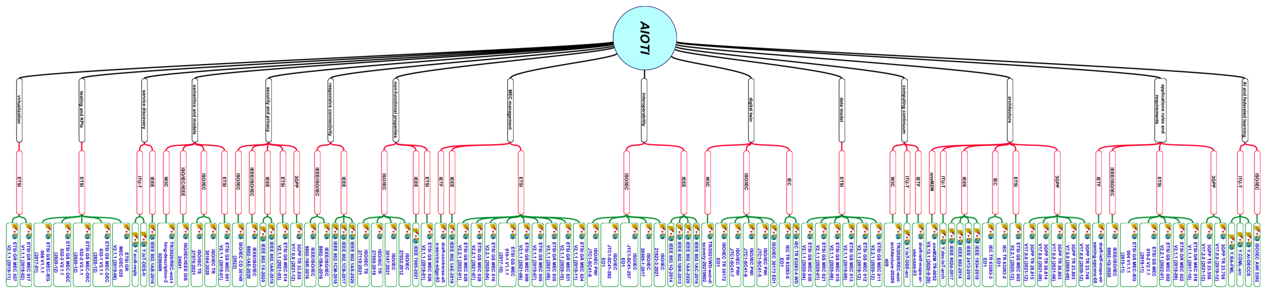
Categories of standardisation challenges (II)

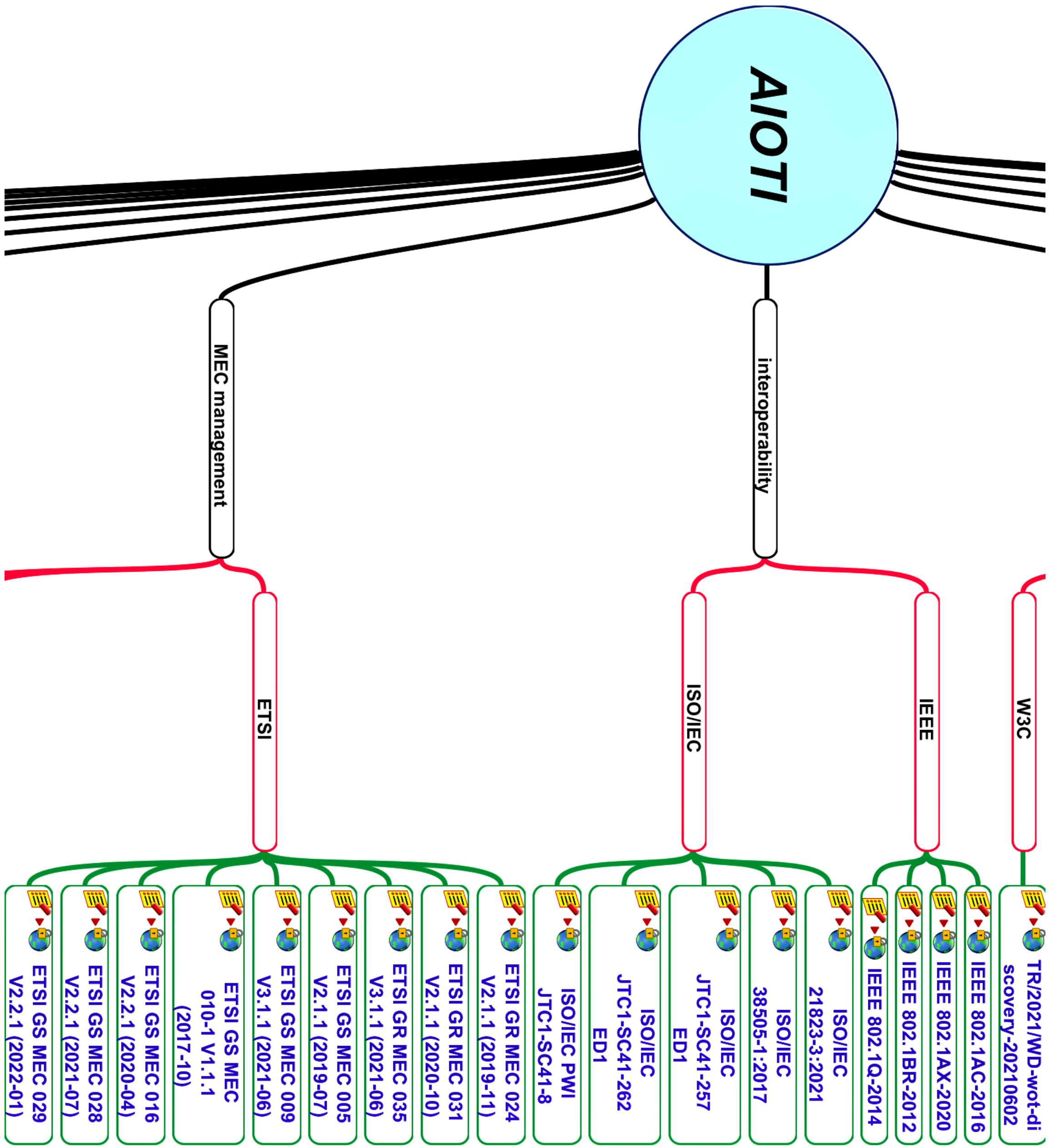


Challenges presented in detail in	Green	Security/ Data Privacy	Social	Digital/Digital Twin	Computing Continuum	AI
Section 2.1		intelligent approaches			interoperability, orchestration	
Section 2.2	energy costs balance	distributed security			federation, cross-platform	network optimization
Section 2.3		users trust, fault tolerance	agile pricing		systems' collaboration	
Section 2.4	energy /CO_2 footprint	solutions evaluation		massive IoT applications		green AI
Section 2.5	energy /CO_2 footprint	solutions evaluation				
Section 2.6	environmental impact score	GDPR compliance	ESG monitoring	metrics collection		performance acceleration
Section 2.7						explainable AI, common sense
Section 2.8		confidentiality, non-repudiation		digital twins, physics realism		explainable AI, interpretability
Section 2.9		digital attestations		digital twins, data spaces		federated learning
Section 2.10				new solutions certification		
Section 2.11					MEC, connectivity	
Section 2.12					MEC hosts, interoperability	
Section 2.13		access, share, store, threats	human-centric		microservices, scaling, planes	distributed AI, fed. learning
Section 2.14	environmental meta-model		societal context, buy-sell	model coherency	interoperability, internet space	
Section 2.15.1					interoperability, ecosystems	
Section 2.15.2					coexistence rules	
Section 2.15.3				devices/systems certification		
Section 2.15.4		trustworthiness, dependability		non-functional properties		
Section 2.15.5				digital service transformation		
Section 2.15.6		security/privacy models			interoperability, coexistence	
Section 2.15.7						cognitive digital services
Section 2.15.8			socio-economic impact	service discovery	end-to-end interoperability	
Section 2.15.9		service security, security models				
Section 2.15.10		services authentication	micropayments			
Section 2.15.11	policy descriptions		policy descriptions			
Section 2.15.12				novel models/ languages		
Section 2.15.13				distributed devices	reorganization, reassignment	

Challenges presented in detail in	Green	Security/ Data Privacy	Social	Digital/Digital Twin	Computing Continuum	AI
Section 2.15.14					responsive connectivity	AI on the edge
Section 2.15.15					X-continuum paradigm	
Section 2.15.16					granularity, interoperability	
Section 2.15.17					swarm systems	intelligence clustering
Section 2.15.18				distribution, decentralisation		cognition
Section 2.15.19						fed. learning, AI for edge
Section 2.15.20				virtualisation, automation		
Section 2.15.21					systems integration	AI-based edge applications
Section 2.15.22		federated AAA[9]		digital twin, IoT certification	infrastructures merging	
Section 2.15.23					interoperability, merging	
Section 2.15.24		distributed/ ledger security		digital twin		distributed AI

Mind map of SDO specification and standardisation challenges





AIOTI

The Key Edge Computing Gaps and Recommendations

Orfeas Voutyras, Institute of Communication and Computer Systems (ICCS)

AIOTI

Examples of SDO activities focusing on Edge computing challenges (identified by AIOTI)

SDO	Specification			Relevant AIOTI identified challenges
	Title	URL	Abstract	Labels & Sections
3GPP	3GPP TR 28.815 V17.0.0 (2021-12): Study on charging aspects of edge computing	https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3758	The present document studies the charging aspects of Edge Computing based on architecture, procedures and information flows for enabling Edge Applications over 3GPP network as well as capabilities for 5GS to support edge computing. The investigation includes different charging scenarios with potential business requirements, alternative solutions with potential impact on charging architecture, charging functions and charging procedures.	scenarios, architectural considerations (Section 2.15.25)
3GPP	3GPP TR 23.803 V7.0.0 (2005-09): Evolution of policy control and charging	https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=883	The document studies: a) the complete harmonization and merger of the policy control and flow based charging architecture and procedures; b) possible architectures and solutions for adding end-user subscription differentiation and general policy control aspects to the policy- and charging control; c) alternative solutions for binding bearers to services (provided today by the authorization token). This includes studying solutions for the network to control bearer usage by service flows.	policy control architecture (Section 2.11, 2.15.25)
3GPP	3GPP TR 23.748 V17.0.0 (2020-12): Study on enhancement of support for Edge Computing in 5G Core network (5GC)	https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3622	The Technical Report studies and performs evaluations of potential architecture enhancements to support Edge Computing (EC) in the 5G Core network (5GC). Specifically, two objectives are included: a) to study the potential system enhancements for enhanced Edge Computing support, and b) to provide deployment guidelines for typical Edge Computing use cases, e.g. URLLC, V2X, AR/VR/XR, UAS, 5GSAT, CDN, etc.	use cases, 5G networks architecture (Section 2.2, 2.3)
3GPP	3GPP TR 26.803 V17.0.0 (2021-06): Study on 5G Media Streaming Extensions for Edge Processing	https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3742	The document is a study of use cases for multimedia processing in the edge and the potential 5G media streaming architecture extensions to enable them.	use cases, architecture (Section 2.2, 2.3)
3GPP	3GPP TS 23.558 V17.2.0 (2021-12): Architecture for	https://portal.3gpp.org/desktopmodules/Specifi	The document specifies the application layer architecture, procedures and information flows necessary for enabling edge applications over 3GPP networks. It includes architectural	requirements, architecture, layer-oriented

SDO	Specification			Relevant AIOTI identified challenges
	Title	URL	Abstract	Labels & Sections
			existing WIs, documents these gaps and recommends the necessary normative work to close these gaps.	
ETSI	ETSI GS MEC 030 V2.1.1 (2020-04): Multi-access Edge Computing (MEC); V2X Information Service API	https://www.etsi.org/deliver/etsi_gs/MEC/001_099/030/02.01.01_60/gs_mec030v020101p.pdf	The document focuses on a MEC Vehicular-to-Everything (V2X) Information Service (VIS), in order to facilitate V2X interoperability in a multi-vendor, multi-network and multi-access environment. It describes the V2X-related information flows, required information and operations. The document also specifies the necessary API with the data model and data format.	data-model, API, information service, V2X interoperability (Section 2.2, 2.11, 2.14, 2.15.15)
ETSI	ETSI GR MEC 017 V1.1.1 (2018-02): Mobile Edge Computing (MEC); Deployment of Mobile Edge Computing in an NFV environment	https://www.etsi.org/deliver/etsi_gr/MEC/001_099/017/01.01.01_60/gr_mec017v010101p.pdf	The document describes solutions that allow the deployment of MEC in an NFV environment. For each solution, it describes the motivation for the solution, its architectural impacts and the necessary work to enable it. The document provides recommendations as for where the specification work needs to be done.	virtualization infrastructure (Section 2.11, 2.12, 2.15.14)
ETSI	ETSI GR MEC 027 V2.1.1 (2019-11): Multi-access Edge Computing (MEC); Study on MEC support for alternative virtualization technologies	https://www.etsi.org/deliver/etsi_gr/MEC/001_099/027/02.01.01_60/gr_mec027v020101p.pdf	The document focuses on identifying the additional support that needs to be provided by MEC when MEC applications run on alternative virtualization technologies, such as containers. The document collects and analyses the use cases relating to the deployment of such alternative virtualization technologies, evaluates the gaps from the currently defined MEC functionalities, and identifies new recommendations. As ETSI NFV is also working on alternative virtualization technologies, the MEC work should be aligned with NFV where applicable. The document also recommends the necessary normative work to close any identified gaps.	virtualization technologies (Section 2.11, 2.12, 2.15.14)
ETSI	ETSI GS MEC 011 V2.2.1 (2020-12): Multi-access Edge Computing (MEC); Edge Platform Application Enablement	https://www.etsi.org/deliver/etsi_gs/MEC/001_099/011/02.02.01_60/gs_mec011v020201p.pdf	The document focuses on the functionalities enabled via the Mp1 reference point between MEC applications and MEC platform, which allows these applications to interact with the MEC system. Service related functionality includes registration/deregistration, discovery and event notifications. Other functionality includes application availability, traffic rules, DNS and time of day. It describes the information flows, required information, and specifies the necessary operations, data models and API definitions.	data-models, (de)registration, discovery, API (Section 2.3, 2.15.8)
ETSI	ETSI GS MEC 012 V2.1.1 (2019-12): Multi-access Edge Computing (MEC); Radio Network Information API	https://www.etsi.org/deliver/etsi_gs/MEC/001_099/012/02.01.01_60/gs_mec012v020101p.pdf	The document focuses on the Radio Network Information MEC service. It describes the message flows and the required information. The present document also specifies the RESTful API with the data model.	data-models, API (Section 2.11)
ETSI	ETSI GS MEC 016 V2.2.1 (2020-04): Multi-access Edge Computing (MEC); Device application interface	https://www.etsi.org/deliver/etsi_gs/MEC/001_099/016/02.02.01_60/gs_mec016v020201p.pdf	The document contains the API definition for the lifecycle management of user applications over the Mx2 reference point between the device application and the User Application LifeCycle Management Proxy (UALCMP) in the MEC system. The document covers the following lifecycle management operations: user application look-up, instantiation and termination. In addition, a mechanism is specified for the exchange of lifecycle management related information	API, lifecycle management (Section 2.11, 2.12, 2.15.14)

AIOTI

Considerable (high priority) standardisation gaps

Considerable (high priority) standardisation gaps related to identified edge computing challenges of (red colour):

- Digital Twins (Sections 2.4, 2.5, 2.9);
- ICT/IoT and policies description and languages supporting the Environmental, Social and Governance (ESG) monitoring (Sections 2.6, 2.15.11, 2.15.12);
- Federated Learning and AI (Sections 2.7, 2.15.7, 2.15.19);
- Devices and IoT swarm systems management (Sections 2.15.13, 2.15.17).

Activities could be initiated for creation of standardisation specifications covering challenges of (brown colour):

- IoT and edge computing coexistence/integration/interoperability and continuum across several sectors and platforms (Sections 2.14, 2.15.6, 2.15.5, 2.15.6, 2.15.15, 2.15.16, 2.15.20, 2.15.21, 2.15.22, 2.15.23);
- Services discovery and authentication (Sections 2.15.8, 2.15.9).

Section	Standards	Section	Standards	Section	Standards	Section	Standards
2.1	26	2.11	30	2.15.7	1	2.15.17	0
2.2	41	2.12	15	2.15.8	3	2.15.18	5
2.3	12	2.13	9	2.15.9	2	2.15.19	1
2.4	1	2.14	3	2.15.10	7	2.15.20	3
2.5	1	2.15.1	7	2.15.11	1	2.15.21	2
2.6	2	2.15.2	6	2.15.12	0	2.15.22	4
2.7	1	2.15.3	6	2.15.13	0	2.15.23	4
2.8	7	2.15.4	6	2.15.14	14	2.15.24	6
2.9	1	2.15.5	4	2.15.15	2	2.15.25	2
2.10	6	2.15.6	4	2.15.16	3		

Questions and Discussion

- Questions to the audience:
  - Is this report useful for your community?
    - ✓ If yes, we can have one-to-one meetings to discuss details on topics interesting for your community
  - Are there any other Edge Computing standardisation challenges that are relevant for you and not included in this Release?
    - In EU and national funded research and/or commercial projects?
    - In SDO/Alliance/OSS initiatives?
    - ✓ If yes, we can have one-to-one meetings to discuss the way on how this input can be provided to AIOTI

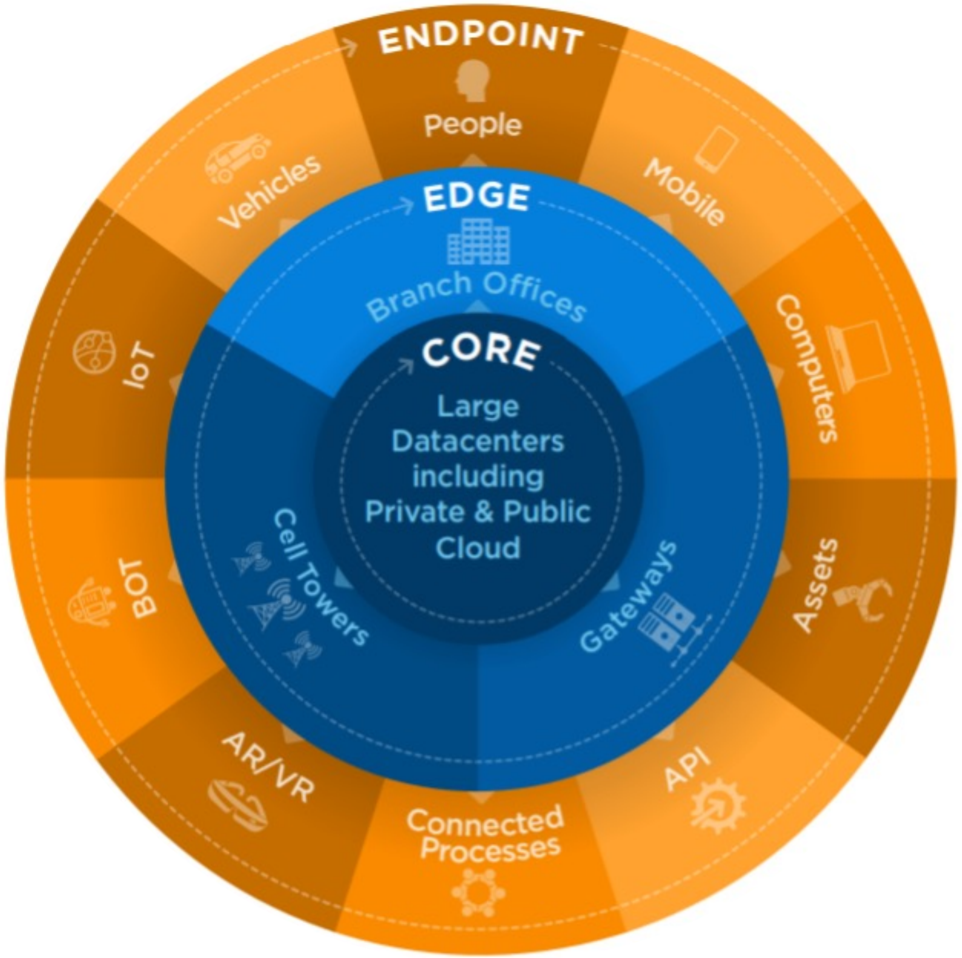
- Open Discussion

Computing Continuum Scenarios, Requirements and Optical Communication enablers

Ronald Freund, AIOTI WG Standardisation TF Computing Continuum Chair, Fraunhofer HHI

Data-driven World: Endpoints and Core

- Optical transport plays a crucial role!
- Data flows in a constant stream from endpoints and the edge to the core and back out to the edge and endpoints
- Raw data will be analyzed on the edge first, and then the results will be sent back to the core for deeper analysis
- The core plays a critical role by providing centralized storage and archiving, service delivery, deeper-level analytics, command and control, and regulatory compliance…



Source: The Digitization of the World From Edge to Core. IDC, November 2018

Goals of the Report

Published on 7 April 2022:
https://aioti.eu/wp-content/uploads/2022/04/AIOTI-Computing-Continuum-Final.pdf

Goals of the report:

- Use cases and their requirements
- Enabling technologies
- Implementation relevant aspects
- Recommendations

Method of collecting information:

- Using pre-defined template
- Input provided discussed and approved by AIOTI members

Content of the Report

Table of Contents

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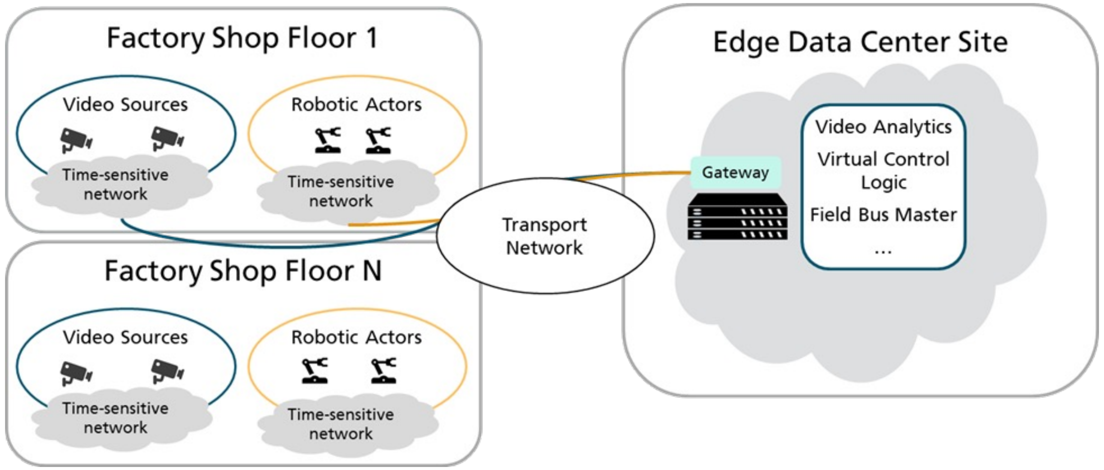
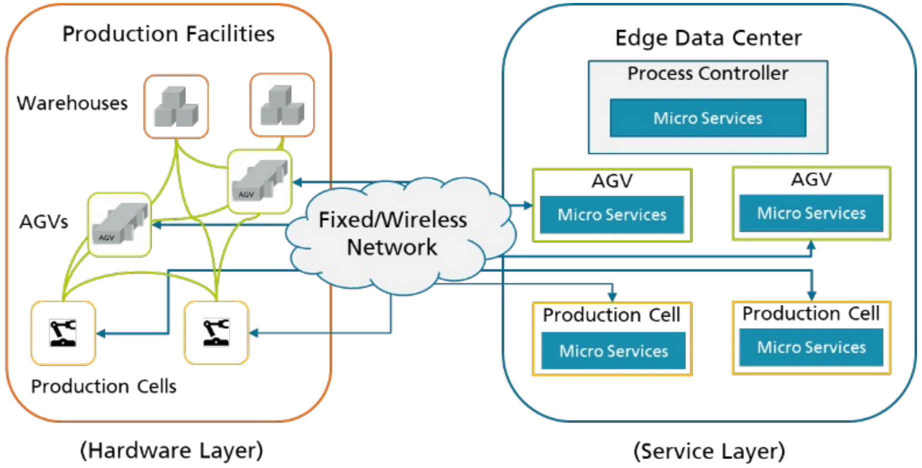
Use Cases: I4.0 (and more later)

- Cloud-based visual inspection
  - 5G/TSN communication service between cameras, edge cloud and robotic actors
  - Converged transport network
- Cloud-based control of automated guided vehicles (AGV)
  - Wireless communication service between AGV and edge cloud
  - TSN communication service between production cells and edge cloud





I4.0 Requirements

Target KPI (Cloud based Inspection via fibre)	Value
Upstream data rate per vision inspection station	1 Gbit/s (single GigE Vision camera) – 20 Gbit/s (4× USB3 Vision cameras)
Downstream data rate per vision inspection station	> 400 kbit/s (control signals only)
End-to-end cycle time*	5 - 10 ms typical < 2 ms time-critical scenarios
Reach (max. distance to edge data centre)	< 80 km

Target KPI (Cloud based Inspection via OWC)	Value
OWC cell (coverage area)	4 m x 5.5 m x 5 m (height x width x length)
Minimum achievable speed inside a OWC cell	100 Mbit/s
Minimum achievable speed in backhaul	1 Gbit/s
End-to-end roundtrip latency	< 10 ms*

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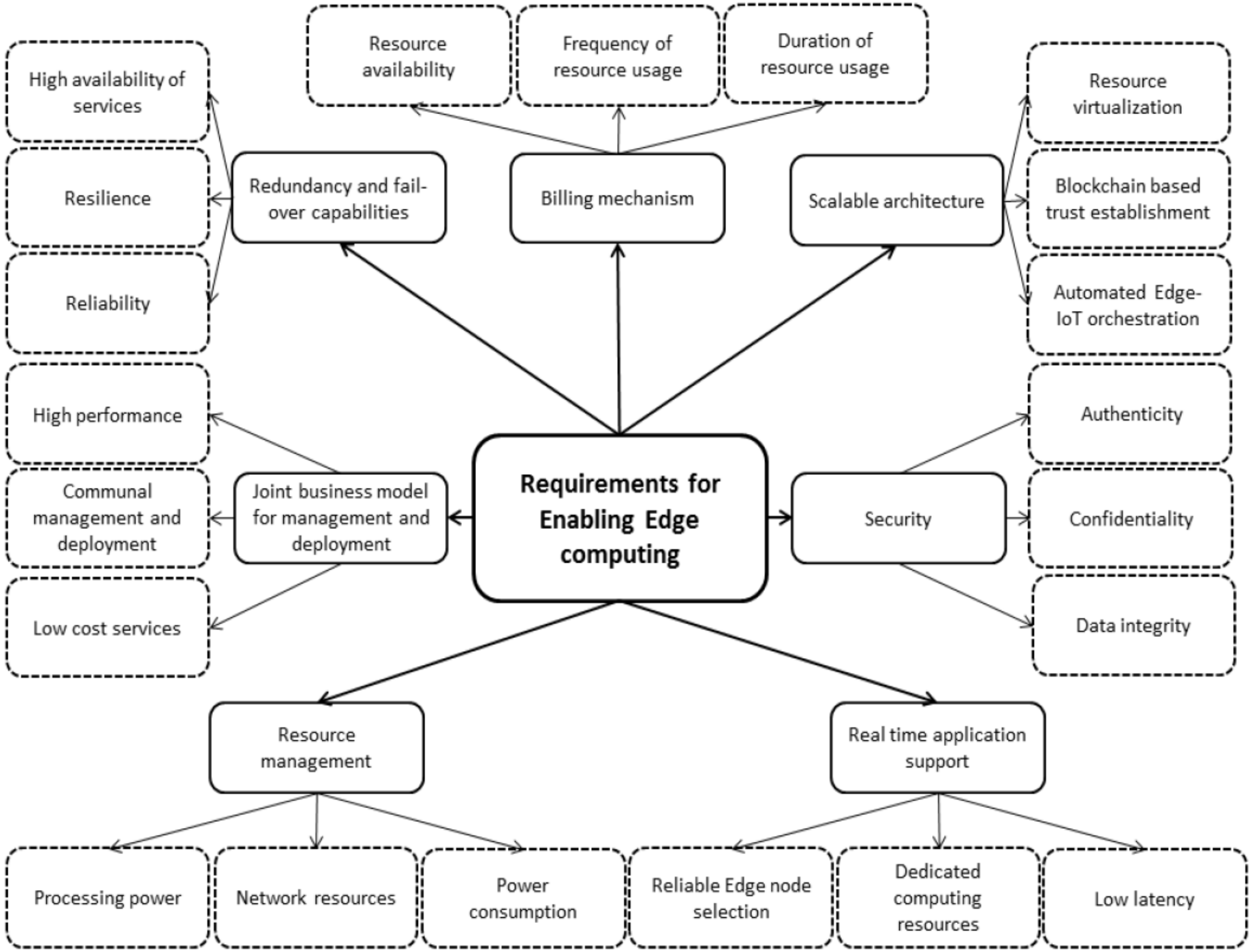
Computing Continuum: Other Requirements

- **Collaborations between Heterogeneous Edge Computing Systems**: due to the fact that the ecosystem of Edge computing systems consists of a collection of different processing/computing points, i.e., cloud data centre, edge computing systems and end devices, and different underlying communication infrastructures, makes the collaboration between such systems a challenging task
- **Optical networks:** network service provider and operator need to support flexible resource allocation to match the bandwidth, latency and resilience needs



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Computing continuum
together with optical communication
provides support for
very high-end/mission critical
IoT applications

Use Cases Presentation

Ricardo Vitorino, Ubiwhere

“

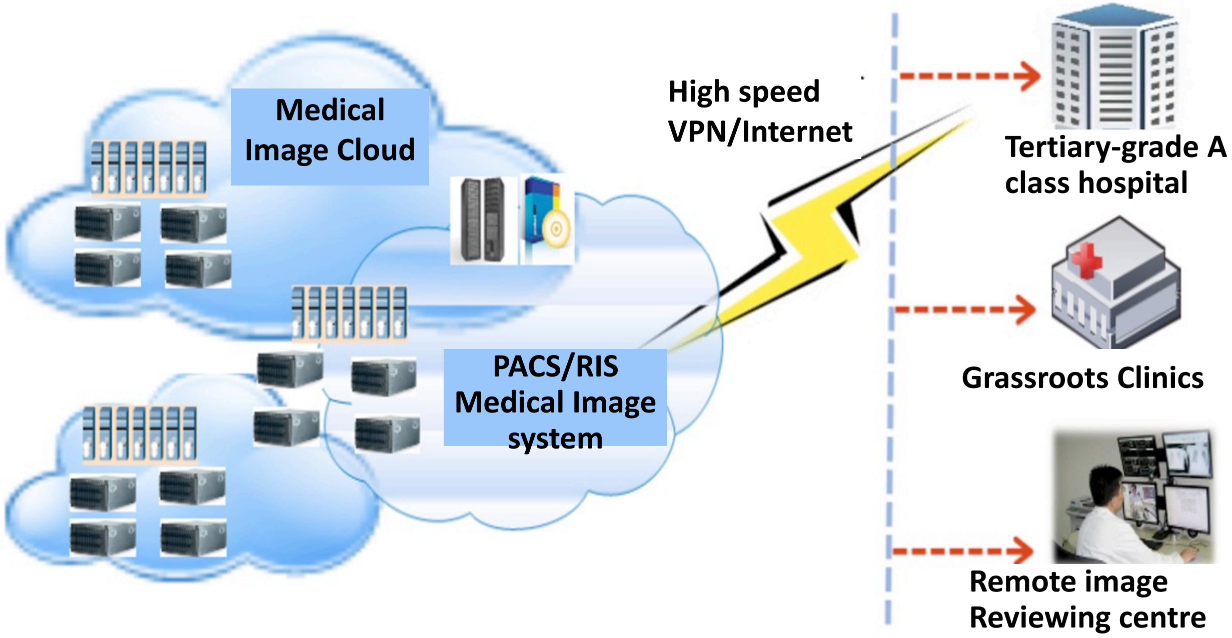
Europe’s ambition for digital autonomy and leadership on data economy builds on the availability of a secure, interoperable, and sustainable computing infrastructure from cloud to edge to IoT.

Medical domain

Cloud-based medical imaging

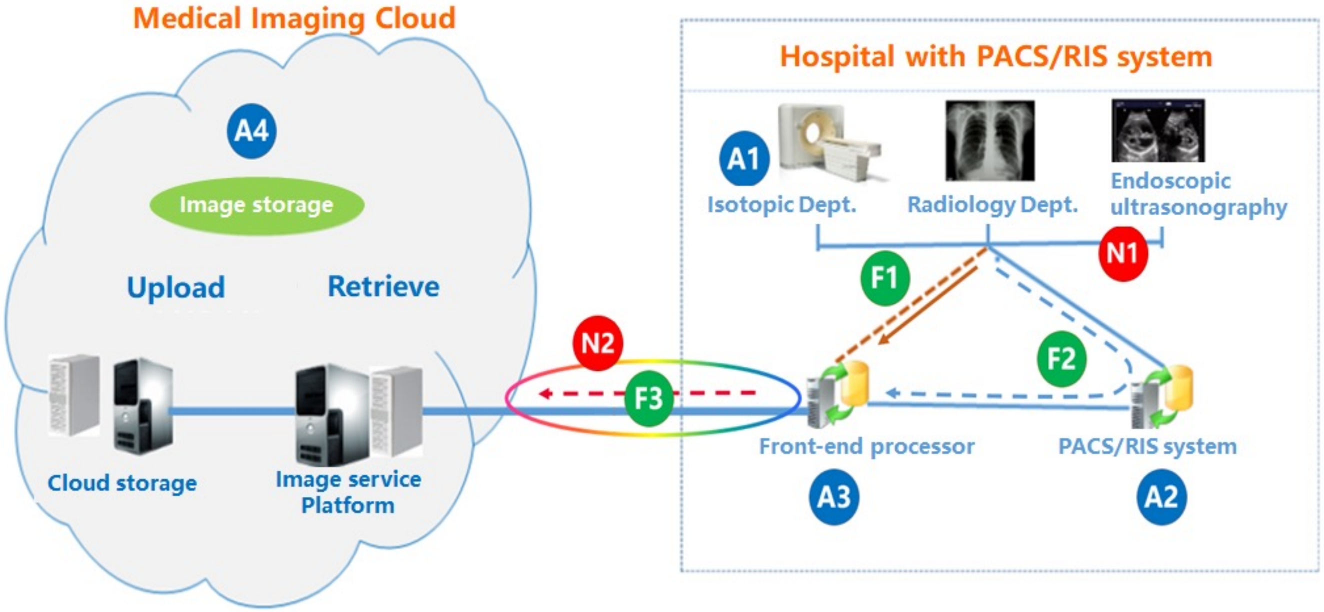
- Cloud services for remote consultation, imaging specialist diagnosis, teaching, mobile image reading/consultation and image big data analysis services.
- Quickly query and search for medical records, improving efficiency of work and scientific research.
- The medical image cloud provides necessary resources for AI-based image analytics.

Source: ETSI ISG F5G, DICOM Standard



Cloud-based medical imaging

- **F1 data flow**: the data generated by image terminals is sent directly to the front-end processors deployed in hospitals.
- **F2 data flow**: When there is a local medical image storage system, the data generated by the image terminal is first stored in the local medical image storage system, and then sent to the front-end processor deployed in the hospital.
- **F3 data flow**: After local image data is processed by the front-end processor in the hospital, the image data is uploaded to the medical imaging cloud deployed outside the hospital.



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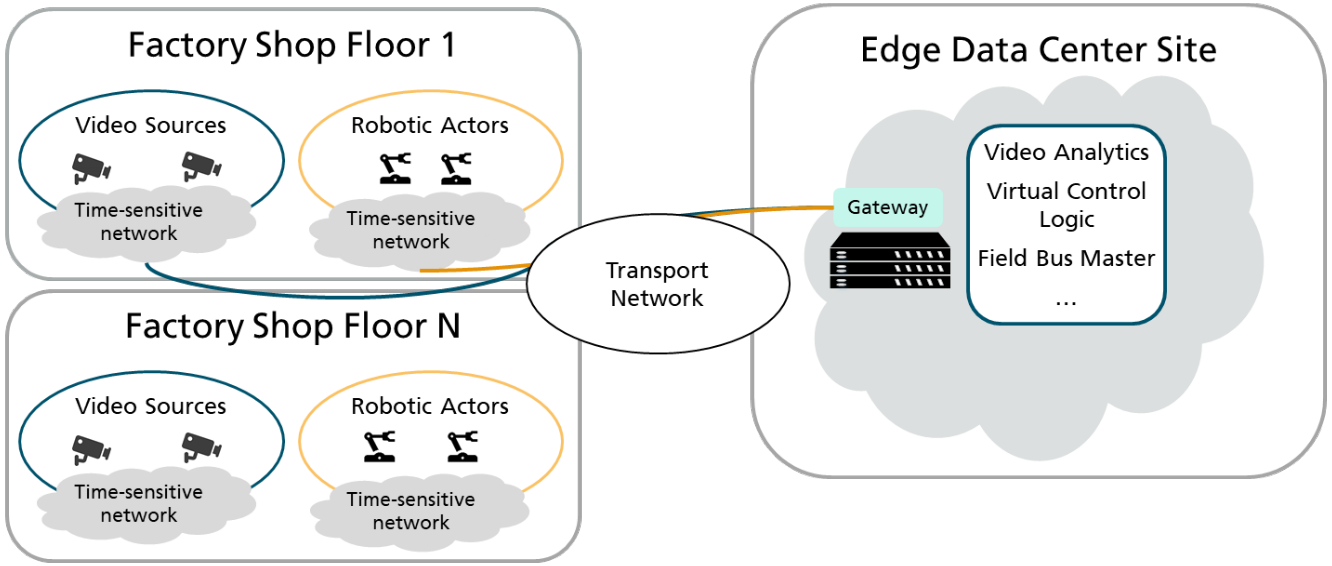
Industry domain

Cloud-based visual inspection in production

- Quality assurance of industrial production processes supported by visual inspections with video analytics
- Video streams of industrial-grade video cameras are transported in real-time to edge data centres to extract metrics and estimate quality of products.
- Metrics fed to the virtual control logic by directly controlling robotic actors over a time-sensitive Ethernet network connection.



Source: ETSI ISG F5G DGR/F5G-008

Cloud-based visual inspection in production

- Production lines are monitored by cameras, transporting video streams in real-time over a time-sensitive network to an edge data centre hosting video analytics and virtual control logic functions
    - These assess the quality of the produced parts and report metrics to the virtual control logic

- When a regulatory action is required, a vPLC communicates the appropriate control signals via time-sensitive network to the robotic actor at the production line
    - The robotic actor performs the required regulatory action on the produced parts, completing the control loop

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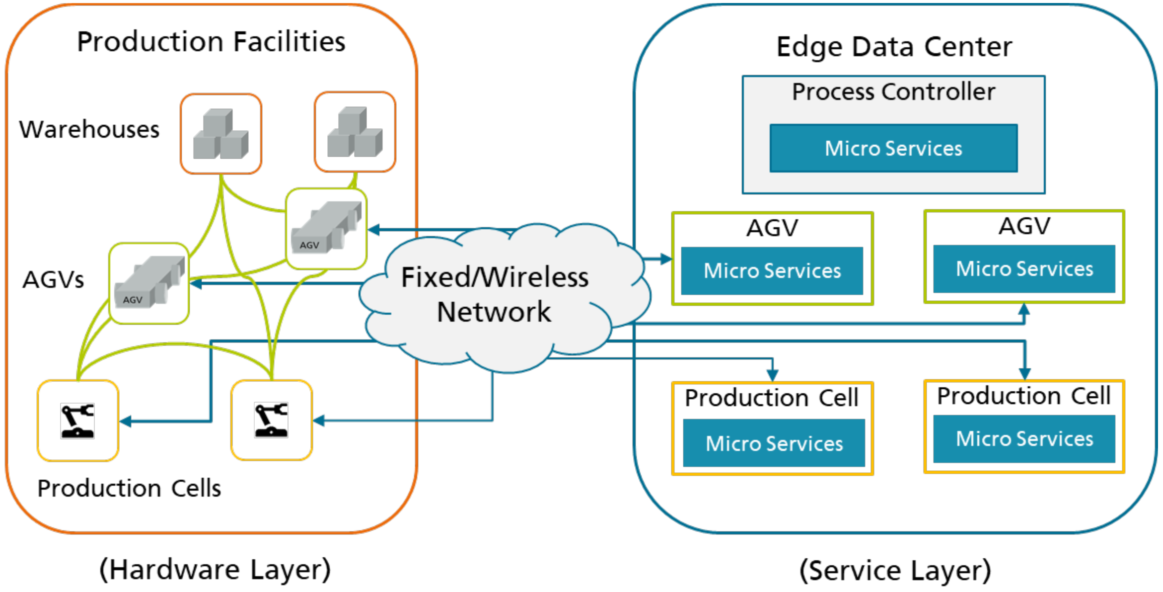
Cloud-based control of AGVs

- Modern production facilities support on-demand product customization to satisfy customer needs
- Automated Guided Vehicles (AGVs) distribute raw materials and parts on the factory shop floor and among different manufacturing halls and warehouses
- AGVs' navigation on the factory shop floor / outdoor areas is a computationally complex and requires computing resources
- To save battery life and minimize downtimes, navigation and control algorithms are offloaded to the edge, where there are GPUs and TPUs for AI acceleration



Source: ETSI ISG F5G DGR/F5G-008

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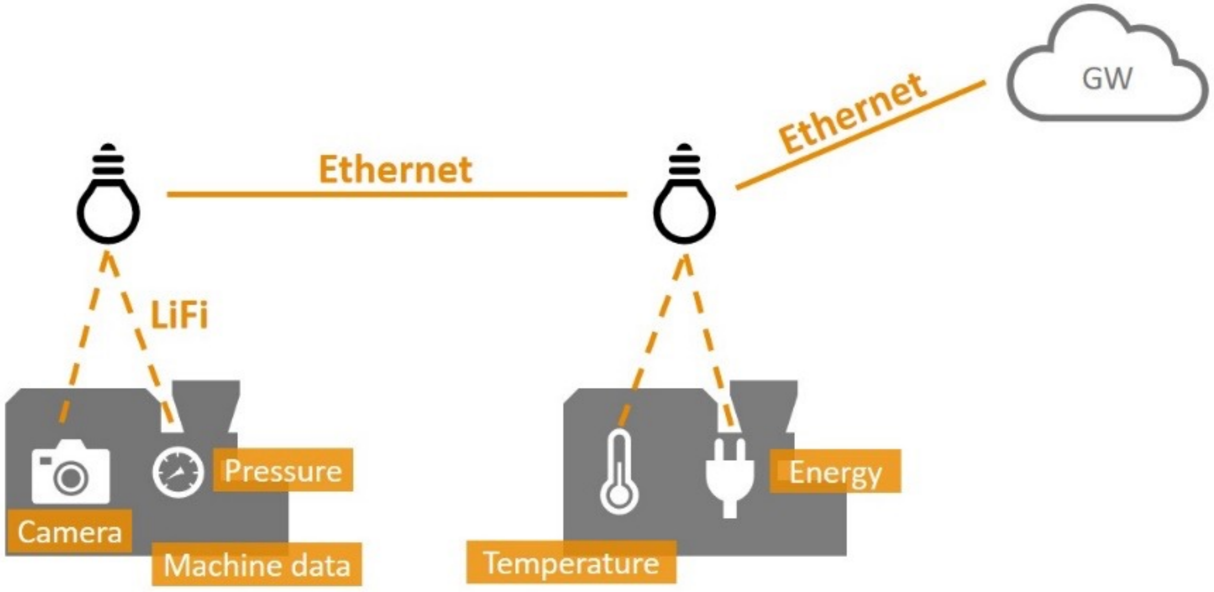
Cloud-based control of AGVs

- AGV communicates its sensor data to the service layer
- Process information, navigation and guidance control systems in the service layer are updated and control information for the AGV is generated
- Control information is communicated back to the AGV
- AGV performs the required actions

Cloud-based control of production via optical wireless communications

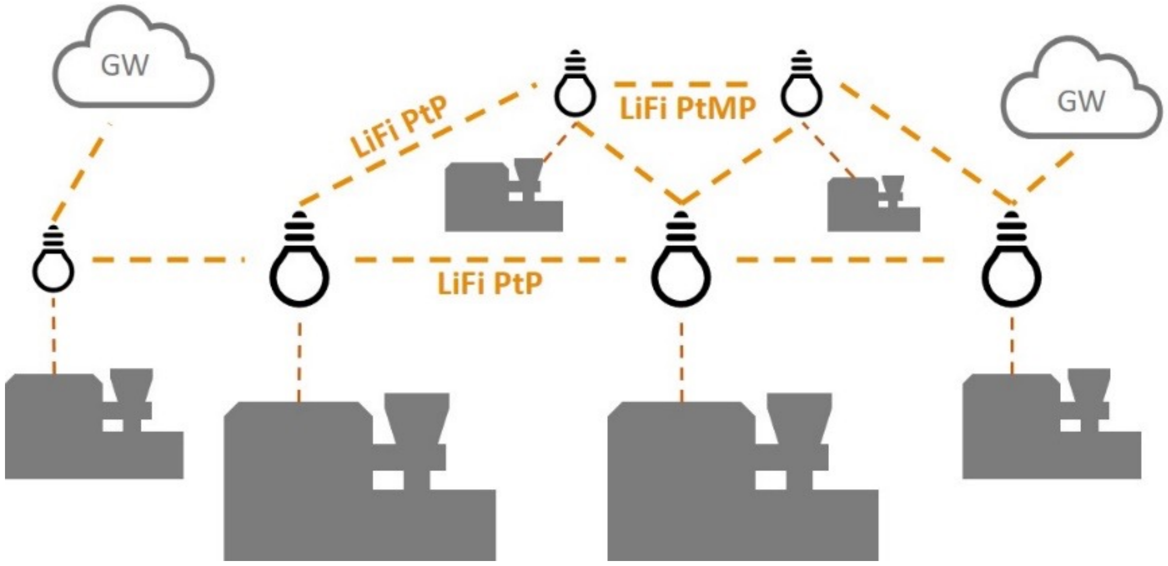
- Digitisation of production and factories require reliable wireless communication infrastructure
- Wireless connectivity must meet the quality standards of cable connections
- Optical Wireless Communication (OWC) systems use light as the communication medium, well suited for dense deployments



Source: H2020 ELIoT

Cloud-based control of production via optical wireless communications

- OWC systems can be installed in parallel to existing infrastructure and exchange data with the factory network. System architecture is similar to WiFi deployment
- OWC Access Points (AP) must be deployed in the production area, in order to provide sufficient area coverage
- As the corresponding standardization is still under development, a seamless handover between WiFi and OWC systems needs to be provided for as a separate solution

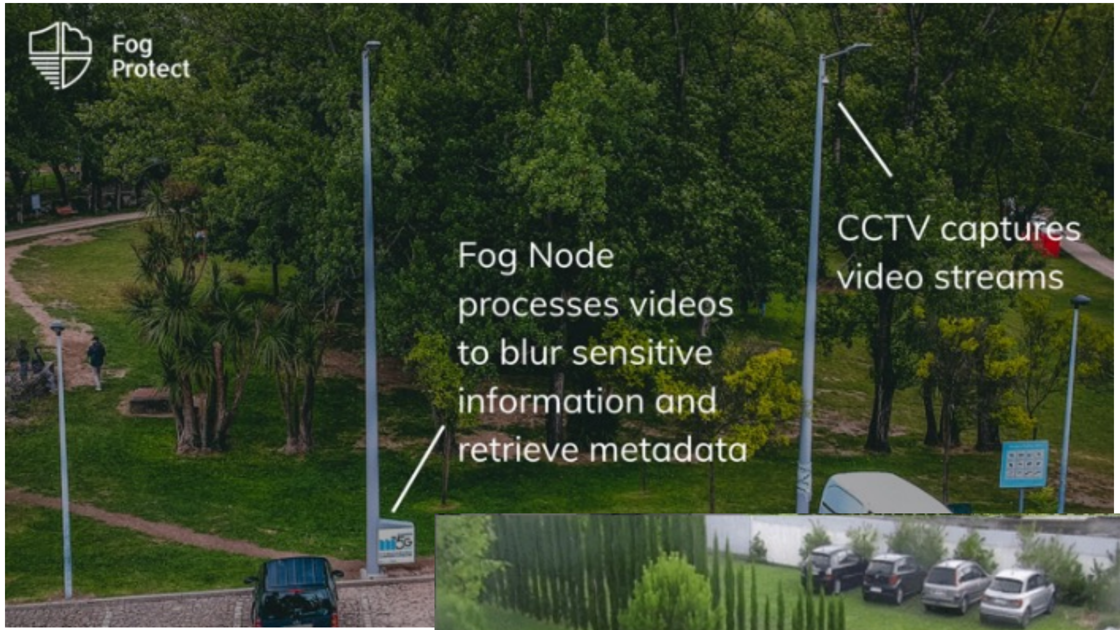


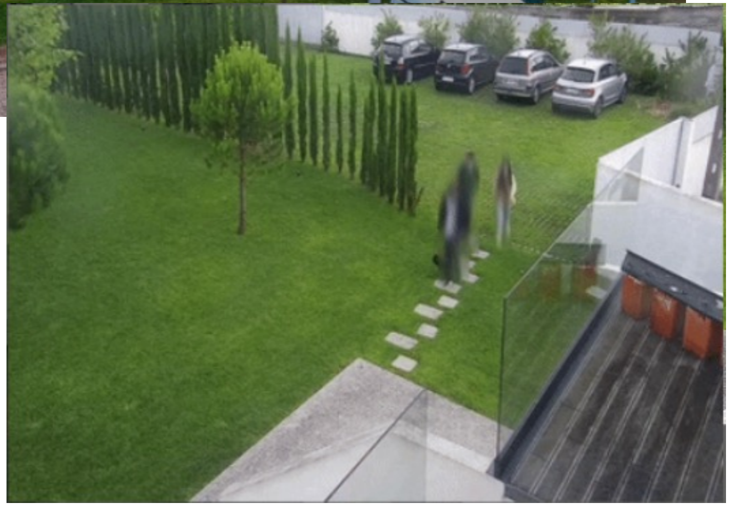
Smart Cities domain

Protecting sensitive data within smart cities

- Street furniture with video camera and fog node capable of processing and storing video streams
- Urban Platform running on a Cloud Center capable of receiving requests from users and understanding which fog nodes to contact
- Mobile application that users can use to report occurrences
- Urban Platform dashboard capable of communicating with the Cloud Center to showcase the information based on roles and policies

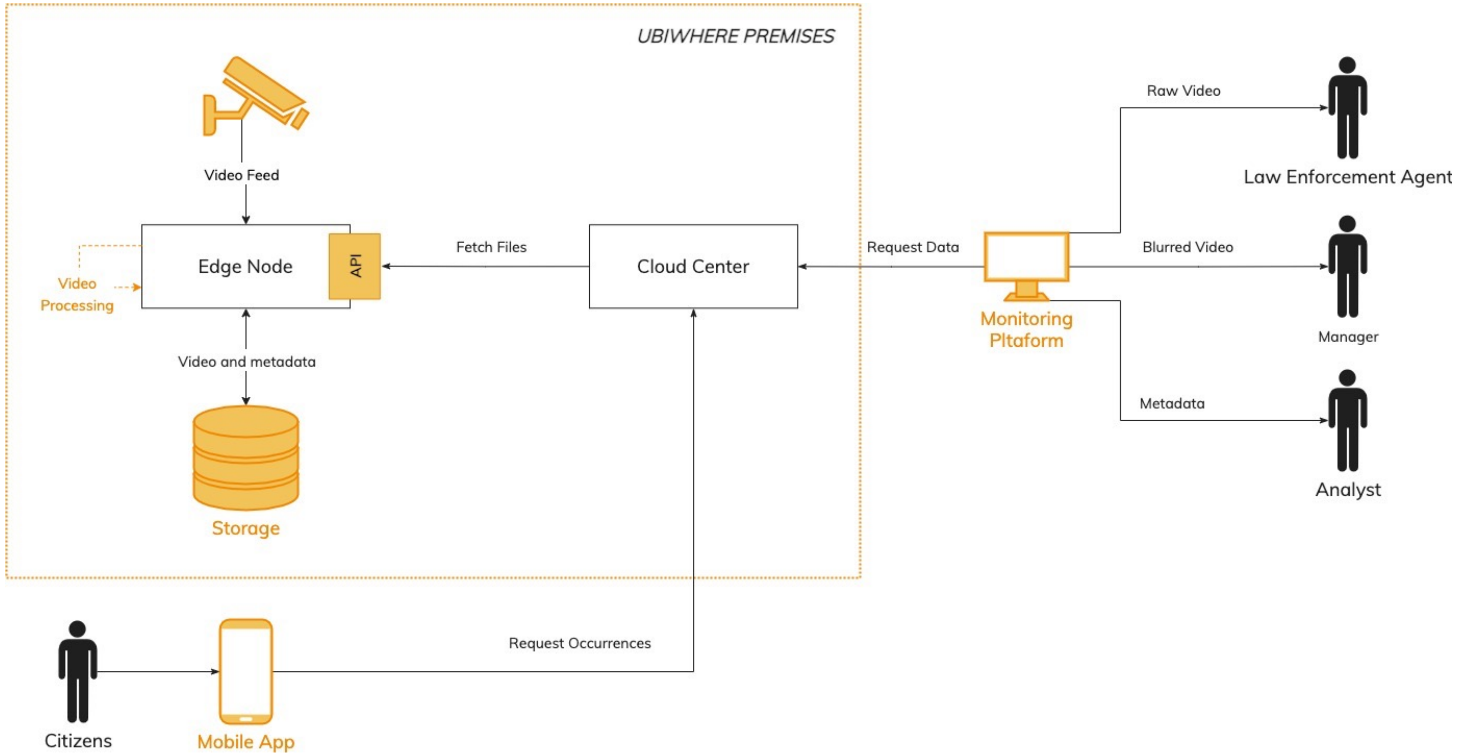
Source: H2020 FogProtect





Protecting sensitive data within smart cities

- Areas of the city are monitored through video cameras, whose video streams are processed and stored locally for a given period of time
- Citizens report occurrences that happen around the city
- End-users of the Urban Platform receive notifications of the occurrences in the platform and, if necessary and given their level of access, request data from the relevant fog nodes
- End-users analyse the video/data their policies and roles allow and act accordingly



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Optical Enablers

Marcus Brunner, Huawei

“

In fact, the only reason we don’t have fiber connected right to our smartphones is because we’d be less mobile.

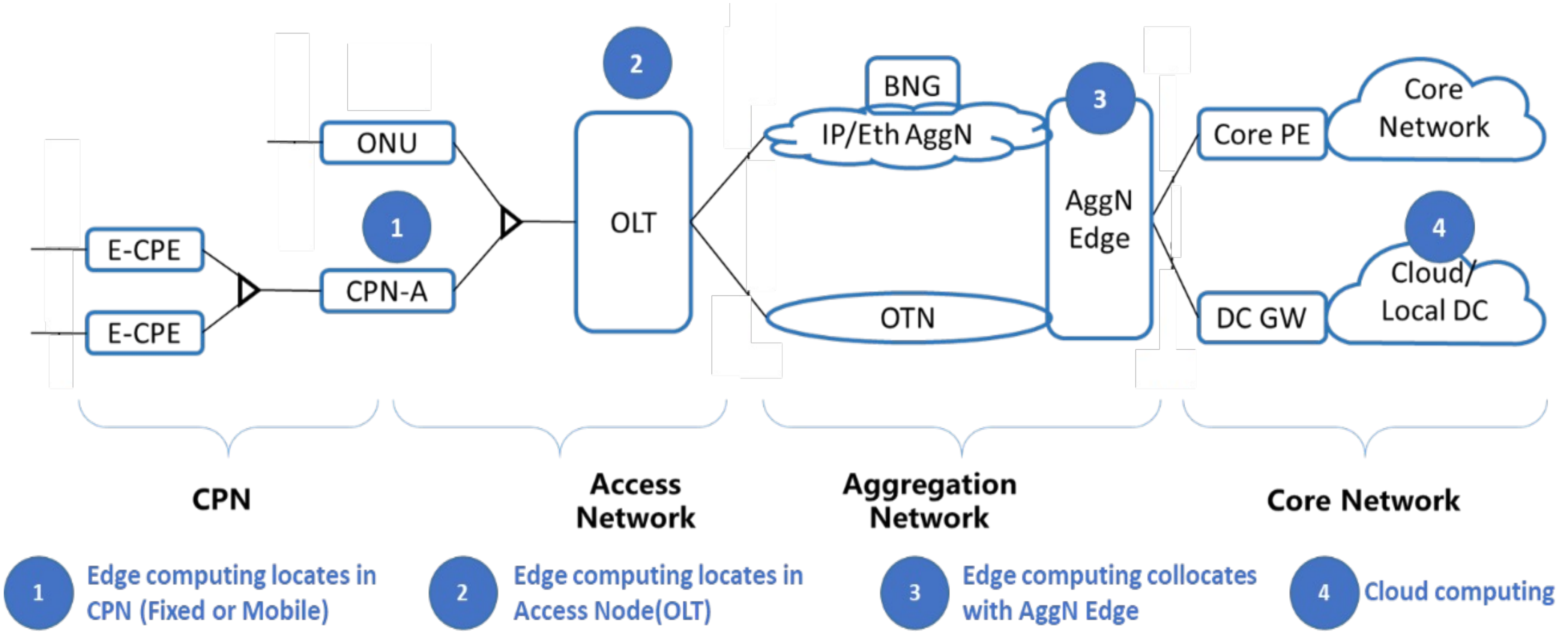
Brian Lavallée

Technological Directions

- Slicing for IoT with soft or hard isolation
- Guaranteed Network Performance (OTN)
- Time-sensitive Networking over PON
- 50G-PON (seen by many as the next step after 10G-PON)
- AI based application perception and mapping to proper connections
- Fibre to the Edge (FTTE), e.g. by Cascaded PON

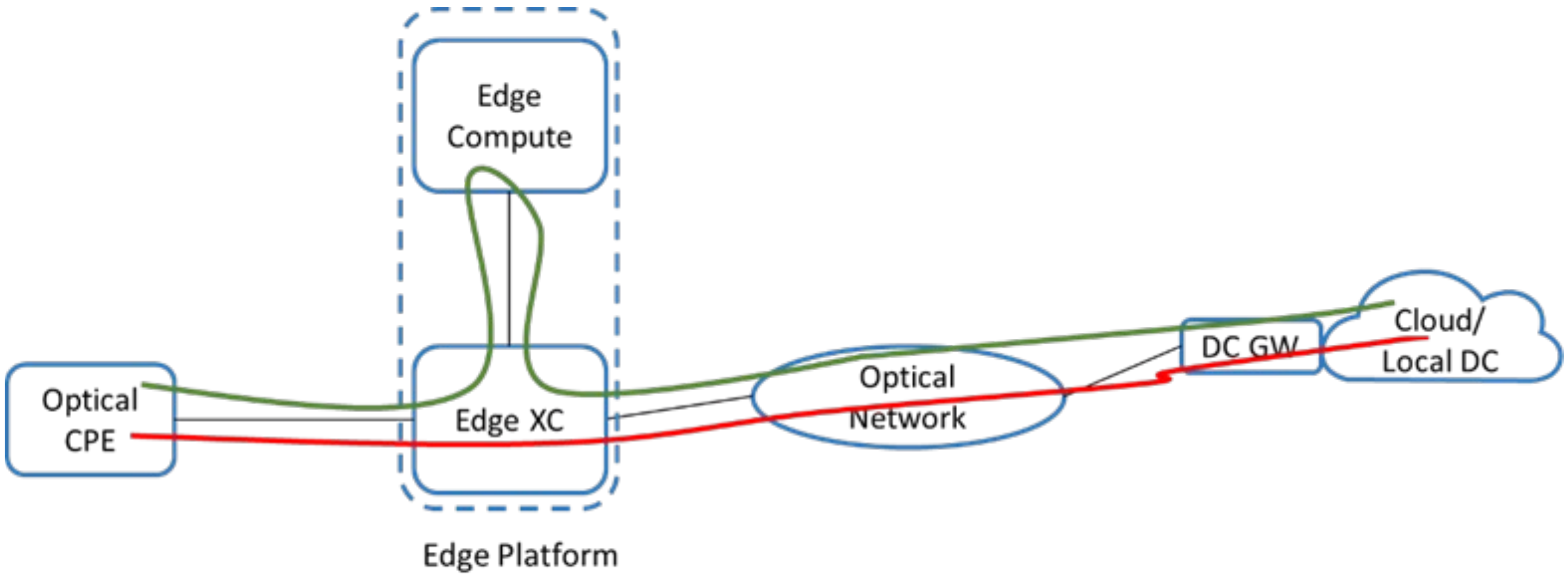
Edge computing support in Optical Communication

- Joint compute and network resources placement and planning
- Trade-off between resource location, service reaction times/latency, and multiplexing gain



Cut-through Support

- Flexible Workload placement
- Need for Computing Continuum Platform support
- Improve degree of sharing through low-latency optical communication

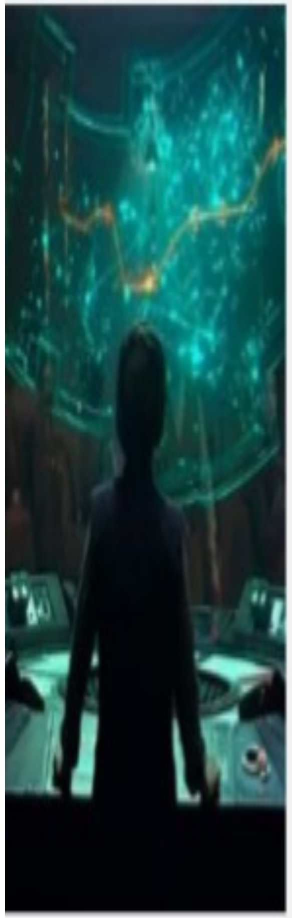


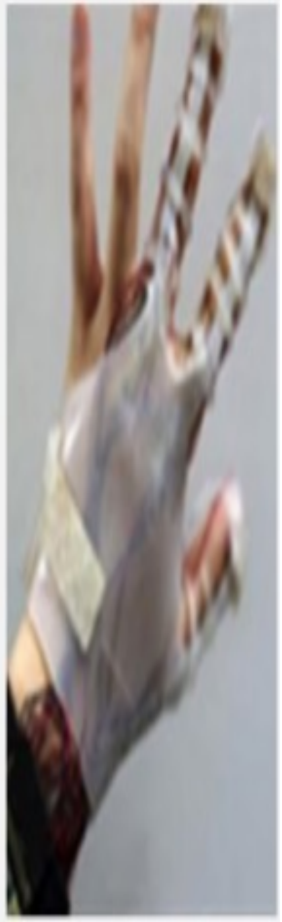
Security and Management

- **Orchestration and computing continuum**
  - Joint Workload placement (algorithms taking networking and compute into account)
  - Adaptation to changing demands
  - Combined Switch-over (compute and network) for high resiliency
- **Security for computing continuum**
  - Security for third-party code on edge computing platforms
  - Data protection for edge computing platforms

Conclusions and recommendations

- **Flexible placement of IoT workload** without constrains in the optical network depending on the application needs
- **Standardize integration of optical network and cloud technologies** for a powerful computing continuum
- **Evolve the F5G optical network architecture** to make it an even more scalable architecture for mass-deployment of a plethora of new IoT devices and applications
- **Extend the slicing concept** to cover also edge compute resources
- **Research the use of optical communication and fibre technologies** to be used for optical sensing oriented applications





F5G: ETSI ISG F5G on Firth Generation Fixed Networks

https://www.etsi.org/technologies/fifth-generation-fixed-network-f5g

Questions and Discussion

- Questions to the audience:
  - Is this report useful for your community?
    - ✓ If yes, we can have one-to-one meetings to discuss details on topics interesting for your community
  - Are there any other computing continuum use cases that are known to you and not included in this Release?
    - Are there additional computing continuum requirements derived from such use cases?
    - Are there additional computing continuum KPIs for optical communications?
    - ✓ If yes, we can have one-to-one meetings to discuss the way on how this input can be provided to AIOTI
  - Are there any other computing continuum optical based enabling technologies that are known to you and not included in this Release?
    - ✓ If yes, we can have one-to-one meetings to discuss the way on how this input can be provided to AIOTI

- Open Discussion

Thank you for listening

Any questions?

You can find us at @AIOTI_EU or email sg@aioti.eu

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