

5G CLARITY

Newsletter

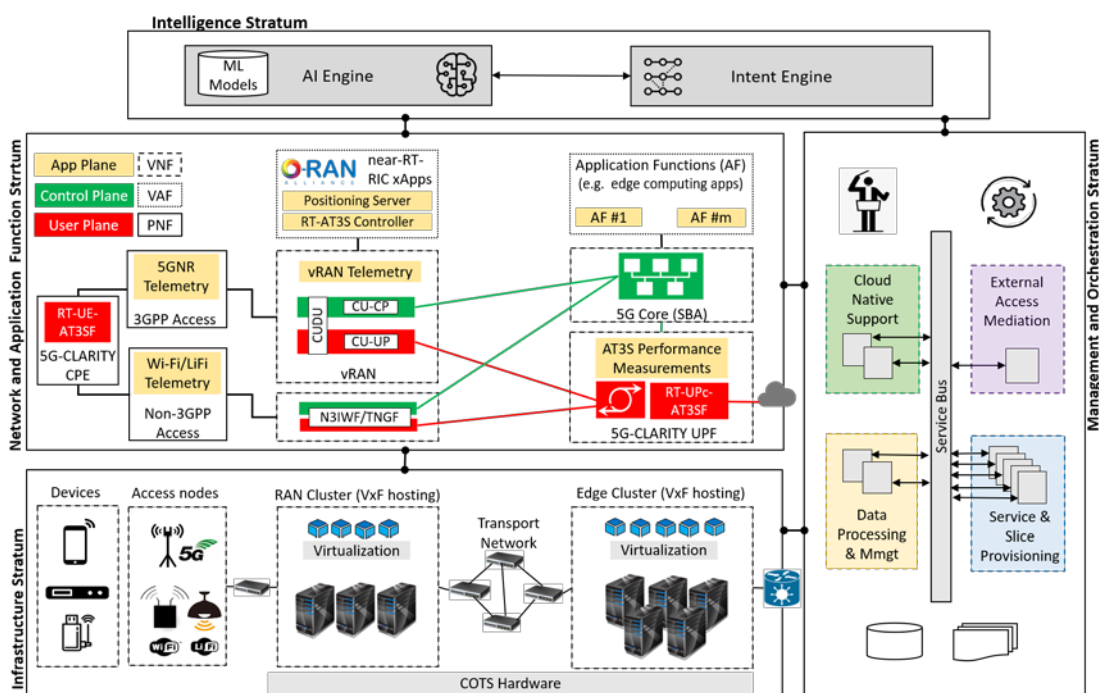
Beyond 5G Multi-Tenant Private Networks Integrating Cellular, Wi-Fi, and LiFi, Powered by Artificial Intelligence and Intent Based Policy

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5G-CLARITY System Architecture

5G-CLARITY proposed architecture is structured in four strata to allow for a rich set of capabilities in private networks. These capabilities can be flexibly adapted, combined and extended to support a wide variety of services for both public and non-public use, including infrastructural services and communication services. Each 5G-CLARITY stratum has a specific scope and technology pace as,

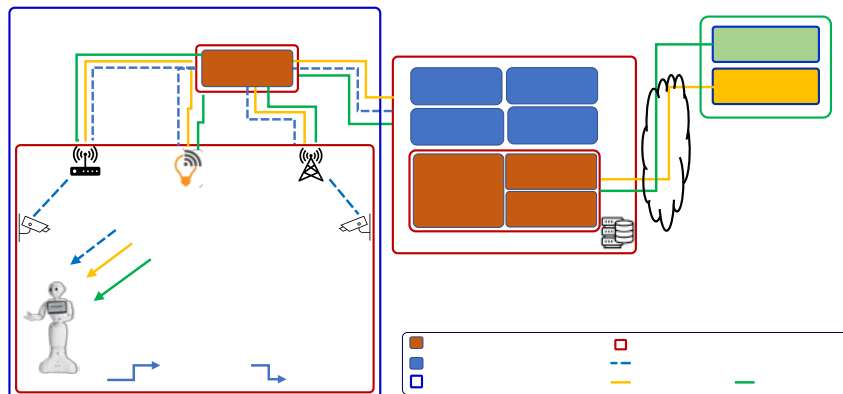
- i) *Infrastructure Stratum*, formed of all the on-premise hardware and software resources building up the 5G-CLARITY substrate, including user equipment and a wide variety of compute, storage and networking fabric;
- ii) *Network and Application Function Stratum*, which conveys the 5G-CLARITY user, control and application plane functionality, including all virtualized network and application functions that can be executed atop the 5G-CLARITY cloud infrastructure;
- iii) *Management and Orchestration Stratum*, which encompasses all the necessary functionalities, including provisioning functions (for lifecycle management), monitoring functions (for data collection and processing) and other supporting functions, to deploy and operate the different 5G-CLARITY services (and associated resources) throughout their lifetime, from their commissioning to their de-commissioning;
- iv) *Intelligence stratum*, which hosts the Machine Learning (ML) models and related policies to provide Artificial Intelligence (AI)-driven and intent-based operation capabilities to the overall 5G-CLARITY stratum.



5G-CLARITY Use Cases

Use Case 1 (on Smart Tourism): Enabling Enhanced Human-Robot Interaction

This use case aims to design, deploy, validate, and demonstrate a B5G non-public network (NPN) in public venues (such as museums) with capability to enable intelligent, pervasive, and robust interactions between a robot --as a tour guide-- and humans. The infrastructure will also enable on-demand services such as public safety systems and third-party special events. In this sense, use case is used to attest the 5G-CLARITY framework and infrastructure benefits to enhance tourism and entertaining sectors in public spaces while supporting the emergency/surveillance services for public safety and third-party special event services, e.g., conferences, seminars, etc. The connectivity and setup are described in the figure, while more details can be found in [5G-CLARITY D5.1](#).



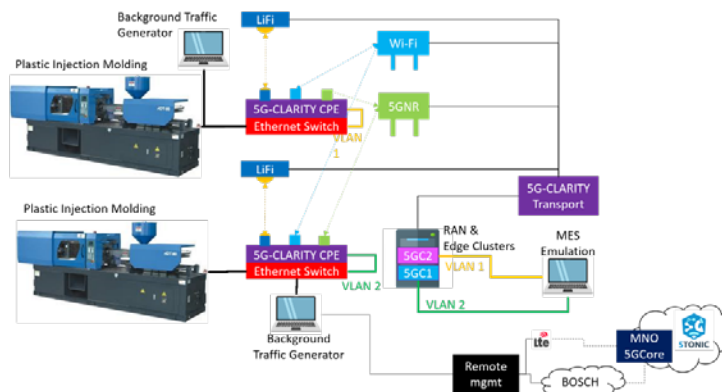
5G-CLARITY 'Enhanced Human-Robot Interaction' use case setup and connectivity

Use Case 2.1 (on Industry 4.0): Alternative Network for Production Data Exchange

This use case is aimed to demonstrate 5G-CLARITY key innovations in improving the in-factory connectivity toward future Industry 4.0 scenario networks. It will be implemented in RBEF (Robert Bosch España Fábrica Aranjuez), a Bosch factory located in Aranjuez near Madrid, Spain. The main objective is to validate the feasibility of replacing current Ethernet wired connections used to connect Manufacturing Execution System (MES) enabled production lines in the factory floor by the combination of wireless technologies proposed in 5G-CLARITY. By deploying the 5G-CLARITY infrastructure and solutions in this scenario, an improvement in data transmission speed is expected while reliability, latency, data security and response time are maintained. The benchmark will be the currently in-place wired network performance.

Figure 5-1 depicts the current setup used to connect a production line to a MES server, where only two production lines are shown, out of many, for the sake of clarity. Every production line is equipped with several Programmable Logic Controller (PLC) to control different processing units along the production line. Each PLC is connected to a head-of-line (HoL) Ethernet switch via an Ethernet cable. Each MES server controls several production lines, while several MES are located in a technical room.

Further information on the use case is found in [5G-CLARITY D5.1](#).



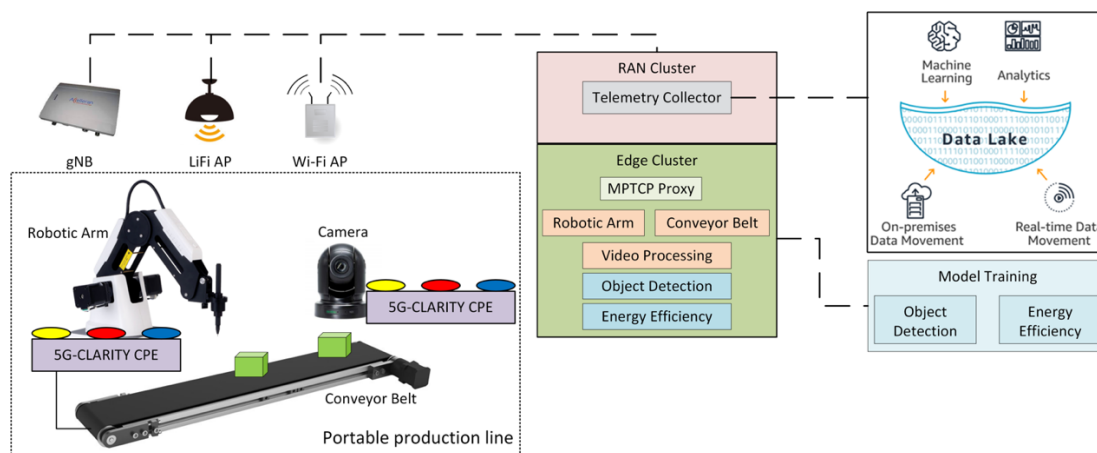
5G-CLARITY in-factory emulated production line

5G-CLARITY portable production-line testbed

The portable production line testbed is a small-scale production line that is used to mimic a realistic factory production line. The idea is to have such a small-scale, portable testbed to do preliminary integration of different 5G-CLARITY components and demonstrate them without any interruption to actual production line.

The portable testbed will be composed of a conveyor belt, robotic arm and a camera as depicted in the figure below. The camera has wireless connectivity via a 5G-CLARITY CPE while another 5G-CLARITY CPE is used to provide wireless connectivity for the robotic arm and the conveyor belt. With such setup, the portable production line components are connected to 5G-CLARITY integrated 5G/Wi-Fi/LiFi network. The robotic arm is used to pick up the objects/products and place them on the conveyor belt. While the conveyor belt is carrying the objects/products along the production line, the camera monitors the products in real-time by recording and streaming a video. The video will be streamed to an edge device that will process the video, analyse the objects/products and control the camera, e.g., zoom-in to improve object detection performance.

For further information refer to [5G-CLARITY D5.1](#).



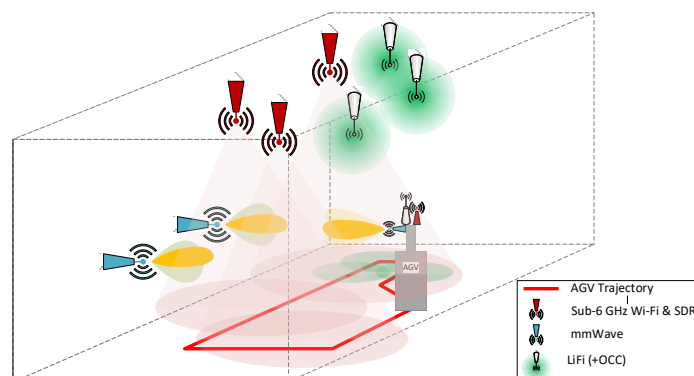
5G-CLARITY portable production line testbed and its integration to 5G-CLARITY system architecture

Use Case 2.2 (Industry 4.0): Enhanced AGV Positioning for Intralogistics

This use case aims at enhancing the positioning of an Automated Guided Vehicle (AGV) in the shop floor of a Bosch factory. It will include an AGV operating on a shuttle service between a warehouse and a production shop floor, in RBEF, Bosch factory located in Aranjuez near Madrid, Spain. To obtain the accurate position of an AGV in real time, a multi-technology positioning system will be implemented that is able to retrieve real time information about the position of the AGV within the premises. Achieving a real time positioning of the AGV with cm precision and retrieval of the disturbances on the AGV route is the target.

The figure below shows a 3D-sketch of the scenario including the AGV route and millimetre wave (mmWave), LiFi and Sub-6 GHz Wi-Fi and Software Defined Radio (SDR) access points. The trajectory of the AGV will be monitored in real time and a visualization tool will be used to display the route, route parameters and incidents on screen. As well the achieved positioning error by each of the technologies can be displayed.

Further information on the use case is found in [5G-CLARITY D5.1](#).



3D representation of the AGV positioning scenario and access points

5G-CLARITY News

Deliverables

The project submitted a number of technical deliverables in this period which describe the project vision, innovations, system architecture, and implementation plans for further developments.

All deliverables are publicly available from the project's webpage at:

<https://www.5gclarity.com/index.php/deliverables/>

Here is a list of main submitted deliverables:

- 5G-CLARITY D2.1, "Use Cases and Requirements," February 2020.
- 5G-CLARITY D3.1, "State-of-the-Art Review and Initial Design of the Integrated 5G NR/Wi-Fi/LiFi Network Frameworks on Coexistence, Multi-Connectivity, Resource Management and Positioning," August 2020.
- 5G-CLARITY D4.1, "Initial Design of the SDN/NFV Platform and Identification of Target 5G-CLARITY ML Algorithms," October 2020.
- 5G-CLARITY D2.2, "Primary System Architecture," October 2020.
- 5G-CLARITY D5.1, "Specification of Use Cases and Demonstration Plan," January 2021.

Publications

The updated list of all accepted publications can be found on the project webpage, under '[Publications](#)'.

Specially, 5G-CLARITY architecture was presented at EuCNC-2020, the manuscript is on the website for interested readers.

5G-CLARITY: Integrating 5G NR, WiFi and LiFi in Private Networks with Slicing Support

Daniel Camps-Mur¹, Mir Ghoraihi², Jesus Gutierrez³, Jose Ordonez-Lucena⁴, Tezcan Cogalan⁵, Harald Haas⁵, Antonio Garcia⁶, Vladica Sark³, Erik Aumayr⁷, Sven van der Meer⁷, Shuangyi Yan⁸, Alain Mourad⁹, Oscar Adamuz-Hinojosa¹⁰, Jordi Pérez-Romero¹¹, Miguel Granda¹², and Rui Bian¹³

Expert Panel in 5G World 2020 Event

'[Private Network Coexistence with MNOs: Challenges, Technical Innovations and Business Opportunities](#)'

5G-CLARITY organised this expert panel in 5G World, November 2020 (virtual event), where an expert panel discussion was organized on by 5G-CLARITY. The list of expert panelists are as follows:

- Andreas Muller (BOSCH Spain) 'The Vertical View'
- Luis Miguel Contreras (Telefonica Spain) 'The Operator View'
- Alain Mourad (Interdigital UK) 'Private Networks in B5G Roadmap'
- Daniel Camps Mur (5G-CLARITY Technical Coordinator, i2CAT Spain) '5G-CLARITY Innovations Beyond 3GPP Rel-16'

The panel moderator was Mir Ghoraihi (5G-CLARITY Project Manager, Gigasys Solutions).

Talks and Presentations

Find more on project presentations in '[Talks and Panels](#)' section of the webpage:

- '5G-CLARITY Architecture, Innovations and Use Cases,' presented by Jose Ordonez-Lucena (TID) and Daniel Camps-Mur (I2CAT) in 5G-PPP Architecture Working Group, January 22, 2021.
- '5G-CLARITY RAN Evolutions Beyond Rel 16, Integrating 5G NR, Wi-Fi, and LiFi,' presented by Daniel Camps-Mur (I2CAT) in 5G-PPP Technical Board Tele-Meeting, December 9, 2020.

Contribution to Standardization

Thanks to project's active partners, Interdigital UK (IDCC), Telefonica Spain (TID), Ericsson LMI, Accelleran, pureLiFi and IHP, 5G-CLARITY has made a considerable impact on the standardization of related technologies. Table below shows the list of such contributions made during the first year of the project lifetime.

Standard	Work Item	SDO	Contribution ID	Contribution Title	Date	Contributor	Status
3GPP SA5	FS_OAM_NPN (Rel-16)	3GPP	S5-201594	pCR 28.807 Solutions and conclusions for mgmt of SNPN	Feb.20	TID	Accepted
3GPP SA5	OAM_NPN (Rel-17)	3GPP	S5-204463	pCR 28.557 Roles related to NPN management	Aug.20	TID	Accepted
3GPP SA5	OAM_NPN (Rel-17)	3GPP	S5-204465	pCR 28.557 Structure content on concepts and overview of NPN management	Aug.20	TID	Accepted
IETF	ANIMA	IETF	https://tools.ietf.org/html/draft-bernardos-anima-fog-monitoring-02	Autonomic setup of fog monitoring agents	May.20	IDCC	Accepted
IETF	RAW	IETF	https://tools.ietf.org/html/draft-bernardos-raw-mec-00	Extensions to enable wireless reliability and availability in multi-access edge deployments	Jul.20	IDCC	Accepted
ETSI	MEC	ETSI	MEC(20)000258r2	MEC036 Update to Section 4 Overview	Sep.20	IDCC	Accepted
ETSI	MEC	ETSI	MEC(20)000259r2	MEC036 Use case Zero Defect Manufacturing	Sep.20	IDCC	Accepted
ETSI	MEC	ETSI	MEC(20)000261r2	MEC036 Use case Mission critical vehicular and mobile node application	Sep.20	IDCC	Accepted
3GPP SA5	OAM_NPN (Rel-17)	3GPP	S5-205403	pCR 28.557 Add use case on SNPN provisioning	Oct.20	TID	Accepted
3GPP SA1	FS_Resident (Rel-18)	3GPP	S1-204435	pCR 22.858 Use case on seamless switching from a UE-to-UE direct communication to an indirect communication via a residential gateway	Nov.20	IDCC	Accepted
3GPP SA1	FS_Resident (Rel-18)	3GPP	S1-204436	pCR 22.858 Use case on seamless switching to a service hosting environment via an evolved residential gateway	Nov.20	IDCC	Accepted
3GPP SA5	FS_OAM_NPN (Rel-16)	3GPP	S5-202339	pCR 28.807 Additional considerations on NPN	Apr.20	TID	Accepted
3GPP SA5	FS_OAM_NPN (Rel-16)	3GPP	S5-205338	pCR 28.807 Ad requirements for management of SNPN and PNI-NPN	Apr.20	TID	Accepted
3GPP SA5	OAM_NPN (Rel-17)	3GPP	S5-211479	pCR 28.557 Add CAG management	Jan.21	TID	Accepted
3GPP SA5	OAM_NPN (Rel-17)	3GPP	S5-205402	pCR 28.557 Add generic management aspects	Sep.20	TID	Accepted

5G-CLARITY Project

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