



PUBLIC-PRIVATE PARTNERSHIP

5G INFRASTRUCTURE PPP

PPP PROGRAMMATIC OPERATION PROJECTS HERITAGE AND INTERACTIONS

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INTRODUCTION

The 5G Infrastructure Public Private Partnership (PPP) Programme comprises 93 projects (listed in Section “Editors and Champions”) organized in three distinctive phases, namely specification, development and experimentation/pilots. Almost all PPP projects have now completed their work, with few remaining Phase 3 projects running until beginning of 2024. The 93 PPP projects achieved outstanding results and impact, as it has been regularly highlighted in the PPP Programme (<https://5g-ppp.eu/>) and the corresponding project websites. The PPP projects have created a plethora of advanced European telecommunication solutions. They also ensured an extremely high momentum and dynamism for the actual trials of these solutions as well as the further development of 5G systems on the road towards 6G networks, including 6G Smart Networks and Services (SNS) Joint Undertaking (JU).

The broader context and overall panoramic perspective of the progress and achievements that the 5G Infrastructure PPP Programme has produced can be directly accessed on the PPP website, in the PPP Verticals Cartography, through specific White Papers and via the multiple webinars organized by the 5G PPP at the Programme and projects levels.

Given the vast amount of work being carried out by the portfolio of 5G Infrastructure PPP projects, this PPP Projects Heritage Brochure and related Heritage Figure are summarizing the interconnections between the PPP projects under three specific categories:

1. Projects follow-up (*captured in orange solid lines in the figure*),
2. Components use/re-use (*captured in light blue dashed lines in the figure*) and
3. ICT-19 Verticals Pilots / ICT-17 Platforms use (*captured in dark blue dashed lines in the figure*).

The work is consolidating and concluding the initial work achieved with the PPP Heritage Figure Version n°1 released in June 2020 (<https://5g-ppp.eu/5g-ppp-heritage/>) and that was one of the PPP “Reference” Figures, widely used to depict the Programmatic connections between projects.

We sincerely hope that you will enjoy reading this Brochure as much as we did while putting it together. We thank all PPP Technology Board (TB) projects Technical Managers and Deputies (listed in Section “Editors and Champions”) who so constructively contributed to the overall PPP projects and Programme impact. We also warmly thank Miguel Alarcón for the very great creativity and design of the brochure and the outstanding related Heritage figure.

*Didier Bourse, Alexandros Kaloyilos, Mikael Fallgren
who had the opportunity and privilege to chair sequentially the PPP Technology Board.*

PROJECTS FOLLOW-UP

The following Table summarizes the PPP Phase 1 -> Phase 2 follow-up Projects.

Phase 1 Projects	Phase 2 Projects
5G-Crosshaul	5G-TRANSFORMER
5G-NORMA	5G-MoNArch
5G-Xhaul	5G-PICTURE
Euro-5G	To-Euro-5G
FANTASTIC-5G	ONE5G
SELFNET	SliceNet
SESAME	5G-ESSENCE
SONATA	5GTANGO
SUPERFLUIDITY	NGPaaS

The following Table summarizes the PPP Phase 2 -> Phase 3 follow-up Projects.

Phase 2 Projects	Phase 3 Projects	Phase 2 Projects	Phase 3 Projects
5GCAR	5GCroCo	Global5G.org	Full5G
5GCity	5G-CLARITY	IoRL	6G-BRAINS
5G-MoNArch	5G-TOURS	MATILDA	DEDICAT 6G
5G-PICTURE	5G VICTORI 5G-CLARITY	Metro-Haul	TeraFlow DEDICAT 6G
5GTANGO	TeraFlow	ONE5G	DEDICAT 6G
5G-TRANSFORMER	5Growth	SliceNet	6G-BRAINS
5G-XCast	5G-TOURS 5G-RECORDS	To-Euro-5G	Full5G

The following Table summarizes the PPP first Phase 3 Projects -> latest Phase 3 follow-up Projects.

Phase 3 Projects	Latest Phase 3 Projects
5G-EVE	DEDICAT 6G
5G-VINNI	FUDGE-5G
5GENESIS	DEDICAT 6G
5G-CARMEN	DEDICAT 6G
5G-MOBIX	DEDICAT 6G
5G!Drones	DEDICAT 6G
5G HEART	DEDICAT 6G
5G-SOLUTIONS	5G-ROUTES 5GMediaHUB 5G-EPICENTRE VITAL-5G
5G-TOURS	DEDICAT 6G
MonB5G	MARSAL
TeraFlow	DEDICAT 6G

PROJECTS COMPONENTS USE / RE-USE

The following Table summarizes the PPP Phase 1 -> Phase 2 components use/re-use.

Phase 2 Projects	Phase 1 Projects	Components Use / Re-use
5GCity	Charisma	Know-how on orchestration and RAN slicing.
	5G-Crosshaul	Know-how and NFV software libraries for SDK and 5G App & Services Catalogue.
5G-MEDIA	CogNet	Design of the Monitoring, Analysis, Planning and Execution (MAPE) loop and Cognitive Network Optimizer (CNO).
	SELFNET	Design and core development of the Service Catalogue.
	SONATA	Integration of SONATA Emulator (son-emu) embraced into Open Source MANO (vim-emu) into the 5G-MEDIA SDK coming from SONATA.
blueSPACE	5G-Crosshaul	Components of the orchestrator developed in 5G-Crosshaul re-used in the development of the NFV orchestrator for blueSPACE.

The following Table summarizes the PPP Phases 2 / 1 / 3 -> Phase 3 components use/re-use.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-17 Infrastructure		
5G-EVE	5G-TRANSFORMER	Leveraged results and software prototypes.
	5G-MEDIA	Leveraged results and software prototypes.
	5GCity	Leveraged results and software prototypes.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-17 Infrastructure		
5G-VINNI	5GEx	Leveraged telemetry, slice description and capability exposure.
	5G-TRANSFORMER	Leveraged telemetry, slice description and capability exposure.
	5GTANGO	Leveraged telemetry, slice description and capability exposure.
	SaT5G	Leveraged SatCom integration into 3GPP 5G Core Network architecture.
5GENESIS	5G-PHOS	Key infrastructure components for the 5GENESIS Berlin Platform.
	5G-ESSENCE	Backhaul connectivity and software components for the Athens5Glink testbed (the basis of the 5GENESIS Athens Platform).
	MATILDA	Backhaul connectivity and software components for the Athens5Glink testbed (the basis of the 5GENESIS Athens Platform).
	SaT5G	Integrated SaT5G Satcom in to 5G and multi-linking.
	5G-MEDIA	Leveraged results and components.
	NRG-5	Leveraged results and components.
	5GTANGO	Leveraged results and components.
ICT-18 Automotive		
5G-CARMEN	5G ESSENCE	Leveraged initial version of LightMANO.
	5G-TRANSFORMER	Leveraged the platform/orchestration.
5GCroCo	5G-TRANSFORMER	Used an extended version of the Vertical Slice in one of the trials of 5GCroCo (Barcelona).
	5GCity	Used multi-tier orchestrator and experimental area in Barcelona for small trial.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-18 Automotive		
5G-MOBIX	5G-EVE	5G-EVE Athens 5G testbed used for the testing and validation of the WINGS OBU and Application, before deployment at the borders.
	5GCAR	Cooperative perception for manoeuvres of connected vehicles (through on-board camera and laser support).
	INSPIRE-5Gplus	Aligned testing scenarios with 5G-MOBIX with a reference vehicular test-case provided with cybersecurity and GDPR assurance modules.
ICT-19 Advanced 5G validation trials across multiple vertical industries		
5G HEART	5G-VINNI	Norwegian testbed: 5G NSA core and RAN used for healthcare and fishfarming use-cases. Utilized KPI performance test tools.
	5GENESIS	5GENESIS: 5G SA testbed consisting of Rel. 16 5G core and RAN nodes used mainly for transport use-cases and KPI performance testing.
5Growth	5G-TRANSFORMER	Leveraged slice/automation and Verticals support.
	5GEx	Leveraged multi-domain and federation topics.
5G-SMART	METIS-II	Reused algorithms and analysis of spectrum deployment options, latency and capacity assessments.
	5G-EVE	Built on concepts regarding 5G deployment developed for 5G-EVE.
	5G-RECORDS	5G-RECORDS was using parts of the same 5G infrastructure that 5G-SMART used.
5G-SOLUTIONS	METIS-II	5G RAN, spectrum management architecture, air interface harmonisation, resource management framework used and extended to assist with the definition of a functional architecture, the technical specifications, the network service interfaces, spectrum management and 5G components integration.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-19 Advanced 5G validation trials across multiple vertical industries		
5G-SOLUTIONS	Flex5Gware	Reconfigurable hardware and software platforms developments used for developing effective network slices.
	SONATA	Cloudband & NFVO used and created the necessary plugins to orchestrate cross-testbed provisioning and management of various vertical applications (VNFs) being monitored as part of the KPIs validation.
	SUPERFLUIDITY	Cloudband & NFVO used and created the necessary plugins to orchestrate cross-testbed provisioning and management of various vertical applications (VNFs) being monitored as part of the KPIs validation.
	CogNet	Machine Learning approaches used to (1) analyse 5G KPI metrics and process results from data feeds in real-time, (2) deploy a testing framework to automate and boost reliable validation of network KPIs, (3) produce reports for homogenised evaluation based on a consistent contrast of KPIs with normalised and comparable values considering concurrent slices and (5) enforce testing accountability with auditable validation reports; Practical application of COGNET smart engine in vertical environment.
	5GEx	Leveraged multi-party service orchestration abstractions and models for further modelling and design of the APIs needed by the vertical (tenant) enterprise customers. All main 5G-Ex services categories and supporting mechanisms considered, such as assured service quality connectivity, NFVI or VNF Slice as a Service, including mechanisms for monitoring and SLA assurance in multi-actor service contexts.
	5G-MoNArch	5G architecture, slicing, use of SDN and NFV, used as guidelines for the 5G-SOLUTIONS system architecture design and the setting-up and execution of the Living Labs.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-19 Advanced 5G validation trials across multiple vertical industries		
5G-SOLUTIONS	5G-TRANSFORMER	E2E Network slicing schemes used for advanced SDN-enabled intra and inter-domain slicing schemes for validating the stringent KPIs in the Media & Entertainment Living Lab over heterogeneous NFV-based infrastructures.
	5GTANGO	Immersive E2E streaming service, able to fuse video streaming as 360° in AR/VR personalised content as well as the VNFs (Content Management, Aggregator, reverse proxy, streaming servers) used in the smart cities Living Lab.
	5G-MEDIA	Video contribution and content production applications for VNF-based environments leveraged to validate the performance of 5G infrastructures for media production and contribution scenarios.
	5G-EVE	5G-EVE Turin facility used for conducting field trials for the use-cases related to the Smart Energy Living Lab.
	5G-VINNI	5G-VINNI facilities used for conducting field trials for the use-cases related to the Factories of the Future (Ireland, Brussels, Norway), Smart Cities Ireland), Smart Ports (Norway) and Media & Entertainment Living Labs (Patra and Norway).
5G-TOURS	5G-Xcast	Implemented the 5G-Xcast Point-to-Multipoint Network Functions (XUF, and XCF) for the trials of 5G-TOURS.
	5G-MoNArch	Leveraged the AI-based algorithms for the elastic management of the network. Reutilized the knowledge of the Touristic City testbed.
5G-VICTORI	SliceNet	SliceNet framework leveraged in 5G-VICTORI to extend the facility to support a flexible E2E network slicing with QoS support.
	5G-TRANSFORMER	Relevant building blocks of the 5G-TRANSFORMER edge computing used to extend the 5G-EVE facility for 5G-VICTORI use-cases.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-19 Advanced 5G validation trials across multiple vertical industries		
5G-VICTORI	5G-Xcast	Broadcast and multicast point-to-multipoint capabilities for 5G with a focus on media and entertainment applications developed in 5G-Xcast leveraged in 5G-VICTORI in media use-cases.
	5G-PHOS	Fibre deployed in 5G-PHOS provided high-speed connectivity available for 5G-VICTORI activities.
	5G-PICTURE	Programmable hardware for high data rate and ranging simultaneous capabilities at mmWaves used in 5G-VICTORI and SDN Wi-Fi technology also leveraged.
	Metro-Haul	Optical transport network data and control plane developments exploited in 5G-VICTORI platform.
	5G-EVE	5G-EVE facility extended and integrated with 5G-VICTORI local cluster, based on the OpenAirInterface and Mosaic-5G platforms, to implement and demonstrate digital mobility and smart energy use-cases.
	5G-VINNI	Nomadic remote installations of Open5G core provided and access to backend facility that hosts the 5G/NB-IOT Core, OSM MANO functionality and a Cloud infrastructure for hosting the various vertical services.
	5GENESIS	Open5Gcore, 5G Playground with deployment and fully programmable millimeter wave solution for deploying additional small cells used to support specific vertical use-cases (transportation, media).
ICT-20 5G Long Term Evolution		
5G CLARITY	5G-VINNI	Applied 5G-VINNI slice capability exposure model into private network environments, extended it for further XaaS delivery models.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-20 5G Long Term Evolution		
5G CLARITY	5Growth	Leveraged deployment scenarios on public-private network integration and 5Growth solution on model-based telemetry (data semantic aggregator). Leveraged testbeds on zero-defect manufacturing and robotic telepresence along with telemetry (data lake), edge and E2E 5G connectivity solutions, extending them for multi-connectivity. Data Semantics Fabric component extended in 5G-CLARITY to integrate with Data Lake.
	5GCity	Slice Manager, extended to support configuration of radio infrastructure. Accelleran dRAX built on 5GCity baseline, extended it to 5G and multi-WAT aspects.
	5G-PICTURE	RAN Controller, extended to support Accelleran 5G NR and LiFi. The synchronization component, to optimize the synchronization and localization interdependencies in 5G networks.
	5G-Xhaul	The ranging algorithms at Sub-6 and mmWave. 5G-CLARITY performed localization with an enhanced version of these algorithms and introduced architectures of the localization system.
	5GENESIS	5GENESIS IHP's proprietary mmWave units used to carry out the indoor localization activities.
	Metro-Haul	VPN connectivity across multiple consortium members to manage the orchestration of the components within a unified test network (5G-CLARITY pilot environment).
5G COMPLETE	5G-TRANSFORMER	Vertical Slicer: Software prototype provided functionalities for the modelling, instantiation and orchestration of Vertical Services across Network Slices. The component has been evolved for supporting Vertical Service deployments across 5G end-to-end Network Slices (i.e., including the provisioning and configuration of radio, core, and transport network elements together with Vertical Application's components).

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-20 5G Long Term Evolution		
5G COMPLETE	5G-PICTURE	Architecture definition and optical transport network solution: Disaggregated 5G network architecture employed advanced and heterogeneous transport network solutions supporting jointly BH and FH services. Advanced optical network solution relied on the concept of Time Shared Optical Network (TSON), able to support increased 5G transport network requirements in terms of bandwidth, latency, flexibility, granularity and resilience
5G ZORRO	5GCity	Evolved the 5GCity orchestration platform towards Multi-operator scenarios.
INSPIRE 5G-Plus	5GENESIS	Re-used 5GENESIS KATANA Slice Manager and Service Function Chaining.
	5G-CARMEN	Reused 5G-CARMEN Network system modelling and security assessment.
	5Growth	Enhanced 5Growth Security Data Collector with ML.
LOCUS	5G-VINNI	Large scale device free localization experimentation performed in 5G VINNI premises at BT Labs.
MonB5G	5G-MONARCH	Open5Gcore, 5G Playground with deployment and fully programmable millimeter wave solution for deploying additional small cells used to support specific vertical use-cases (transportation, media).
	5G-TRANSFORMER	Leveraged the Vertical Slicer and Orchestrator concept to deal with requirements of generalized services, not only communication ones, and also federated the management of networking and compute resources. Implemented data-driven control mechanisms to automate VNF scaling, configuration and error correction.
	MATILDA	Leveraged analytics for profiling to exploit machine learning for the network management, and employed network-wide statistics to optimize network performance.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-20 5G Long Term Evolution		
MonB5G	SliceNet	Leveraged centralized monitoring and AI data-driven control to develop auto-encoder based compression and feature extraction mechanisms with hierarchical distribution, in order to significantly reduce the amount of raw data exchanged, enhancing scalability.
	CogNet	Built on the CogNet concept, which used conventional ML algorithms such as Support Vector Machines (SVMs) to develop beyond AI algorithms (e.g., Deep Reinforcement Learning, Federated AI, Generative Adversarial Networks, etc.).
	SELFNET	Leveraged ML techniques to progress on beyond Deep Learning algorithms and relied on Federated AI, auto-encoder based compression and feature extraction mechanisms.
	SESAME	Leveraged techniques for the access spart to develop a hierarchical solution that built on highly distributed Engines that extend to multiple technological domains (i.e., the RAN, Core, MEC and cloud).
TERAWAY	5G-PHOS	Leveraged optical beamforming techniques developed on TriPleX platform for V-band.
	5G!Drones	Leveraged wireless communication techniques between a drone and a fixed node.
ICT-42 5G Core technologies innovation		
5G-LOGINNOV	5G-EVE	Extended the functionality of the big data domain to accommodate the unique semantics of logistics environments. Update robotics/AGV autonomous functionality.
	5G-MOBIX	Extended automated, secure logistics and customs operations components, such as OBU, cargo control, mobility/traffic predictions.
	5G-SOLUTIONS	Enhanced and extended the validation methodologies to support new verticals (automotive, transport & logistics, etc.).

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-42 5G Core technologies innovation		
5G-LOGINNOV	5G-TOURS	Leveraged centralized monitoring and AI data-driven control to develop auto-encoder based compression and feature extraction mechanisms with hierarchical distribution, in order to significantly reduce the amount of raw data exchanged, enhancing scalability.
	5G-HEART	Built on the CogNet concept, which used conventional ML algorithms such as Support Vector Machines (SVMs) to develop beyond AI algorithms (e.g., Deep Reinforcement Learning, Federated AI, Generative Adversarial Networks, etc.).
5G-RECORDS	5G-MEDIA	Edge Computing solution for remote production.
5GMETA	CogNet	Leveraged experience on CogNet common infrastructure for monitoring, processing, policing and evaluation.
	5G-MOBIX	MEC broker interconnection mechanism.
Affordable5G	5GTANGO	Leveraged results about NFV orchestration from 5GTANGO.
	5GCity	Leveraged results about slicing from 5GCity.
	5GENESIS	Used Malaga testbed from 5GENESIS.
FUDGE-5G	5G-VINNI	NG-RAN in Norway operated by Telenor.
	MATILDA	Ubitech's Vertical Application Orchestrator.
Int5Gent	5G COMPLETE	SDN-enabled mmWave mesh node in support of P2MP edge network segments.
	MATILDA	Vertical Application Orchestrator extended with new interfaces towards the slice manager and with new resource management features for applications.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-42 5G Core technologies innovation		
Int5Gent	blueSPACE	Network Slice Management Function. Parts of NFV&MEC orchestrator.
	5G-PHOS	DSP engines for analog Radio-over-Fiber transceivers.
ICT-53 5G for Connected and Automated Mobility (CAM)		
5G-Blueprint	5G CroCo	Leveraged the results of the Teleoperated Driving along the cross-border corridor France, Germany and Luxembourg.
	5G-MOBIX	Leveraged seamless 5G connectivity in the cross-border corridors rolled out in Europe and in Asia. Leveraged the results on the use-cases dedicated to trucks platooning and vehicle remote control.
	5G-CARMEN	Leveraged the service continuity over multiple operator's domains in the cross-border area. Leveraged the results on the use-cases dedicated to the cooperative manoeuvring and situation awareness.
5G-ROUTES	5G-SOLUTIONS	Extended the functionality of the KPI visualisation system to cover the cross-border context and the additional KPIs in the Tenant Web Portal. Enhanced and extended the validation methodologies to support new verticals (automotive, railway, transport & logistics, etc.) across cross-border scenarios.
	SPEED-5G	Distributed resource management, extended for conducting resource selection in cross border situations (from distributed single domain to involving the domains of two operators). Cooperation and preparation of the two domains, in order to ensure service continuity at similar quality levels.
	ONE5G	Slicing / Slice negotiation: Vertical stakeholders (e.g., content providers, logistic operators) enabled to negotiate and optimise the slices obtained for offering their services in cross border contexts (i.e., by interacting with the domains of two operators).

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-53 5G for Connected and Automated Mobility (CAM)		
5G-ROUTES	5GTANGO	Immersive E2E streaming service, able to fuse video streaming as 360° in AR/VR personalised content, as well as VNFs (Content Management, Aggregator, reverse proxy, streaming servers) used in V2X, transport & logistics tracking and in infotainment use-cases.
	SaT5G	Acquired know-how on integrated satellite / terrestrial architectures (satellite broadcast/multicast, backhaul, direct access...) and related concepts introduced in 3GPP NTN related SI (i.e. multi-link access, edge deliver, etc.) capitalised and partially implemented in the use-cases and field trials, enabling a truly integrated 5G Sat/Terr network.
	5G-TRANSFORMER	E2E Network slicing schemes used to serve as a base for advanced SDN-enabled intra and inter-domain slicing schemes for validating the stringent KPIs in the field trials over NFV-based infrastructures.
	MATILDA	Automated Slice optimisation (NFV Convergence Layer) extended with AI mechanisms for inter-domain slicing support.
	5G-MOBIX	Automated, secure logistics and customs operations components, such as OBU, cargo control, mobility/traffic predictions, extended to include the multimodal goods-transfer facet in 5G-ROUTES.
5GRAIL	5GVICTORI	Connections with 5GVICTORI rail test cases over 5G investigated.
	5Growth	Connections with 5Growth trough the video used in their railway pilot investigated.
5GMED	5GCroCo	Edge Infrastructure with V2X support.
	5G-MOBIX	Trialing and KPI evaluation of 5G for CAM at cross borders. 5GMED extended with new insights evaluations of advanced 5G SA functionalities (e.g., slicing and roaming) as well integration of hybrid communications (C-V2X, satellite communications) targeting two different verticals: CAM and railway.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-53 5G for Connected and Automated Mobility (CAM)		
5GMED	5G-CARMEN	Further elaborated on the cost models and business cases for V2I and V2N deployments.
	5G-PICTURE	mm-wave train access network focusing on high speed trains.
	5GCAR	5G assets and vertical applications developed in 5GCAR used as background developments.
	5G-VICTORI	Small Cell Amarisoft train use-case.
	5GCity	5G service platform and the edge virtualisation extensions developed in 5GCity, used to contribute to the 5GMED multi-tenant infrastructure.
	5GTANGO	5GMED use-case services supported by a vendor-independent NFV platform for developing and validating network services (packaged VNFs as forwarding graphs) developed in 5GTANGO.
ICT-52 Smart Connectivity beyond 5G		
6G BRAINS	IoRL	Leveraged Remote Radio Light Head (RRLH) for building a quasi-indoor 5G Non-public network using a distributed intelligent IAB.
	SliceNet	Extended SliceNet network slicing for massive indoor connectivity, including AI-based directional RAN slicing, optimised backbone slicing, autonomous IAB E2E network slice control, management and orchestration, and high scalability for ultra mMTC and ultra high-speed networks.
	SELFNET	Extended Network Flow Monitoring Agent (FMA) to provide network slicing KPIs.
	ARIADNE	Extended channel models for combining THz and VLC. New waveforms for OWC and THz links.
AI@EDGE	5G-ESSENCE	Leveraged the 5G-EmPOWER SD-RAN Controller developed within 5G-ESSENCE, as basis for the project ORAN Near-RT RIC. The 5G-EmPOWER controller has been extended in order to support additional telemetry data.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-52 Smart Connectivity beyond 5G		
AI@EDGE	5G-CARMEN	Leveraged the LightEdge edge computing platform and basis for the project ETSI MEC compliant implementation effort. Moreover also the generic distributed MEC orchestration concepts originally devised in 5G-CARMEN has been embraced and extended in AI@EDGE.
	COHERENT	RAN control and coordination concept at the basis of the AI@EDGE disaggregated RAN.
	SESAME	Non 3GPPP radio access SD-RAN Platforms.
	5GCity	MTO used to leverage its ability to manage multiple orchestrators from the SMO layer, and extended to accept a further range of deployment requirements and their interaction with intelligent modules.
	5G-CLARITY	Leveraged the non-RT RIC to manage the policies of the near-RT RIC and the xAPPs of the project via O-RAN AI interface. Extension of the AI interface to support the exchange of Enrichment Information.
	FUDGE-5G	Leveraged MEC-based architectural concepts and core network software components.
DAEMON	5G-TRANSFORMER	Designed orchestration mechanisms for multi-timescale edge computing services, serving different vertical use-cases.
	5G-MoNArch	Extended the knowledge of the AI algorithms developed within the project, especially for the ones using deep learning.
	5Growth	Leveraged AI/ML workflows for a number of network intelligence use-cases, including capacity forecasting and anomaly detection. Extended next-generation RAN innovations, including reliability of virtualized gNBs and the integration of O-RAN.
	5G-TOURS	Integrated and extended the service layer concept for the closed control loop between service providers and network, using AI.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-52 Smart Connectivity beyond 5G		
DEDICAT 6G	COHERENT	Extended the coordinated control and spectrum management for 5G heterogeneous radio access networks studied in the earlier project.
	MATILDA	Extended the Automated Slice optimisation (NFV Convergence Layer) for supporting intelligence distribution in several IaaS.
	Metro-Haul	Extended network resource allocation algorithmics related to network service/slice instantiation.
	ONE5G	Extended optimized functionality placement and resource allocation in a CRAN/DRAN context for dynamic intelligence distribution, to be combined with machine learning and applied on actual robots, drones and cars.
	5G-EVE	Leveraged and extended diagnostics and orchestration, exploited parts of the 5G-EVE and 5G-TOURS infrastructure as a platform for validation.
	5GENESIS	Used the Surrey Platform and the Surrey core for parts of the smart highway scenario.
	5G-CARMEN	Leveraged distributed mobile edge cloud spanning from the vehicle itself to the centralised cloud for optimal computation offloading in DEDICAT 6G.
	5G-MOBIX	Automated vehicle functionalities exploited for turning cars into Mobile Access Points in the scope of DEDICAT 6G.
	5G!Drones	Outputs of 5G!Drones leveraged to build the Public safety use-case.
	5G HEART	Leveraged the connected vehicle platforms developed in 5G HEART.
	5G-TOURS	Leveraged and extended diagnostics and orchestration, exploited parts of the 5G-EVE and 5G-TOURS infrastructure as a platform for validation.
5GZORRO	Extended the procedures for the application metrics monitoring developed in the eLicensing Manager.	

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-52 Smart Connectivity beyond 5G		
DEDICAT 6G	TERAFLOW	Leveraged and extended network management from a distributed cloud-native architecture.
	5G EPICENTRE	Reference open and evolutionary end-to-end 5G infrastructures federation for experimenting PPDR applications.
HEXA-X	METIS-II	Used methodology for use-case analysis, requirement engineering, traffic demand analysis, and spectrum review as starting point for the work.
	FANTASTIC 5G	Considered work done on waveforms.
	mmMAGIC	Considered work done on roadmaps, design methodology, system concepts, and basic mmW design ideas as input for the work on beyond 100 GHz.
	5G-NORMA	Used architecture concepts, building principles, models and modelling methodology as well as terminology as input and starting point.
	5G MoNArch	Used architecture concepts, building principles, models and modelling methodology as well as terminology as input and starting point.
	5G-ESSENCE	Used architecture concepts, building principles, models and modelling methodology as well as terminology as input and starting point.
	5GTANGO	Used architecture concepts, building principles, models and modelling methodology as well as terminology as input and starting point.
	SELFNET	Considered developed AI-based network concepts, data synthesis and learning strategies, evaluation methodology, AI implementation options.
	SliceNet	Considered developed AI-based network concepts, data synthesis and learning strategies, evaluation methodology, AI implementation options.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-52 Smart Connectivity beyond 5G		
HEXA-X	5G ENSURE	Considered SWOT analysis results, evaluation methodology, attack vectors, and concepts as input and starting point.
	ONE5G	Considered terminology, use-case descriptions, commonly agreed metrics, and requirement engineering methods as important input.
	5G-CLARITY	Leveraged design principles from 5G-CLARITY Management Orchestration stratum (e.g. service based management architecture, model-driven operation, capability exposure for third party integration) for the definition of HEXA-X Management and Orchestration fabric.
MARSAL	5GPHOS	Leveraged knowledge from fronthaul interfaces for C-RAN architectures to develop a Hybrid MIMO solution in an NG-RAN architecture, supporting beam-steering and beam-sharing towards adaptive topologies of cell-free APs.
	5G-COMPLETE	Leveraged knowledge to develop an NG-RAN and a distributed Edge architecture with Radio Edge and Regional edge nodes, and a Distributed Cloud Solution, together with a hierarchical control plane.
	5GCity	Leveraged MEC to adopt the Cloud-Native paradigm which represents the future of vertical application development. Supported the disaggregation of cloud-native MEC apps, under ML driven orchestration and target the integration of the MEC system with the 5G Core.
	Metro-Haul	Leveraged the ETSI OSM WIM plugin framework, and proposed the joint orchestration and coordination of the Edge SDTN controllers, that control the MARSAL Optical Midhaul, and a hierarchy of disaggregated RAN SDN controllers.
	5G-TRANSFORMER	Served vertical industries through containerized MEC applications supporting Cloud-Native technologies, technology stack for vertical development. Moreover, MARSAL offered Self-Driven coordination and federation of the MEC system with the NFVO.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-52 Smart Connectivity beyond 5G		
MARSAL	SliceNet	Advanced the concept of cognitive network management towards Self-Driven Infrastructures, that jointly optimize MEC applications, 5G Network Services and Network Slices.
	5G-CROSSHAUL	Leveraged C-RAN architecture to develop a distributed Edge architecture with disaggregated SDN control for the RAN and Optical Transport, federated under an NFV Orchestrator.
	5G-ZORRO	Leveraged 5G-ZORRO multi-tenant architecture with a novel security framework offering privacy-preserving representation of data modalities for downstream ML training, an NFS gateway offering policy-driven anonymization and integrity assurance, as well as perpetual data security via storage resources fragmentation.
REINDEER	METIS-II	Leveraged findings regarding overall 5G-RAN architecture, and diversity of use-cases with corresponding technical requirements to be supported. Partners in REINDEER that were also involved in METIS-II could in particular ensure learnings are passed through.
	5G-SMART	Leveraged the experimental results with deploying large antenna systems in highly reflective industrial environments, and corresponding channel measurements and models.
TeraFlow	5GTANGO	Leveraged results about NFV orchestration with interdomain Data Centres using WIM from 5GTANGO.
	Metro-Haul	Optical transport network control plane developments integrated and extended in TeraFlow.
ICT-41 5G innovations for verticals with third party services		
5GASP	SELFNET	Considered developed AI-based network concepts, data synthesis and learning strategies, evaluation methodology, AI implementation options.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-41 5G innovations for verticals with third party services		
5GASP	MATILDA	Leveraged some project core results on intelligent and unified orchestration mechanisms related to the PPDR vertical use-case.
	5G-VINNI	5G-VINNI Univ. of Patras facility for conducting field trials for the use-cases related to PPDR. Moreover, 5GASP used the open source project Openslice for E2E slice and service management, management and orchestration across facilities.
	5G-TOURS	Leveraged the knowledge acquired and especially with respect to the development of applications enabled by 5G technology that are needed for the envisioned use-cases and deployment of three large-scale field-trials.
	5G-MOBIX	Use results and experience from the execution of CCAM trials.
5G-EPICENTRE	5GENESIS	Used the UMA 5GENESIS testing facility as one of the base platforms of 5G-EPICENTRE as a stable starting point for experimentation in 5G technologies.
	5G-SOLUTIONS	Leveraged the KPI visualisation system, APIs, network/service-level KPIs for minimisation of service creation time for PPDR applications, as well as technological/business model validation methodologies.
	MonB5G	Leveraged zero touch management and orchestration capabilities for facilitating easier and faster service provisioning.
5G-ERA	5G-TOURS	Leveraged the knowledge acquired to address technological and business validation of 5G technology.
	5G-MOBIX	Use results and experience from the execution of CCAM trials.
	MonB5G	Leveraged the experimental results on orchestration towards mobile Edge computing.
	5G!Drones	Experienced Vertical specific network application development and evaluation.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-41 5G innovations for verticals with third party services		
5G-IANA	MATILDA	Application Orchestration framework extended towards management of mobility VFNs with dynamic application component deployment and application life-cycle management.
	5G-TRANSFORMER	Interfaced with Application orchestrator and Extensions towards mobile edge computing capabilities (on vehicle edge).
	5G-MEDIA	5G Apps and Services Catalogue (based on ETSI GS NFV SOL001, SOL004 and SOL005).
5G-INDUCE	MATILDA	Vertical-oriented OSS/BSS system. Extended towards open interfaces with standardised ETSI MANO and in support of distributed multi-tenant operation for both Application and Network Functions. Orchestrator for application deployment. Extended towards the full support of containerized component deployment. Automation in the graph composer mechanism. Network Application API for porting of new services through a friendly UI.
5GMediaHUB	5GTANGO	5GMediaHUB's DevOps framework extended the work of 5GTANGO, mainly focused on the development processes, and offered emulators for service verification. 5GMediaHUB focused instead on the Operations processes of media services.
	5G-SOLUTIONS	Up-graded CTTC's 5G testbed to support R.17 features. Extended the functionality of the KPI visualisation system to cover the secure Experimenters Portal context and the additional network and service-level KPIs including minimisation of service creation time for the media applications. Extend the methodologies for the creation of 3rd party markets for SMEs and start-ups.
	5G-VINNI	5G-VINNI node in Norway up-graded to 5G-VINNI-Next to support virtualised and software implemented functions that represent a redesigned virtualised access/core network.
	MonB5G	Leveraged the functionality of Slicing Trust Management Module that implemented AI/ML based malicious traffic pattern detection mechanisms and fused it with 5GMediaHUB's security framework to ensure slice security and isolation.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-41 5G innovations for verticals with third party services		
5GMediaHUB	5G-TRANSFORMER	Leveraged the E2E Network slicing schemes to provide advanced SDN-enabled intra and inter-domain slicing schemes for validating the stringent KPIs in the trials over NFV-based infrastructures.
	Metro-Haul	Leveraged and extended the functionality of the WAN Infrastructure Management plugin to enable the communication between the Network Applications layer and the 5G infrastructure layer.
EVOLVED-5G	5G-MEDIA	CI/CD and SDK developments as inputs for the EVOLVED-5G Network Applications workspace.
	SONATA	CI/CD and SDK developments as inputs for the EVOLVED-5G Network Applications workspace.
	5GTANGO	CI/CD and SDK developments as inputs for the EVOLVED-5G Network Applications workspace.
	5GENESIS	Open5GENESIS suite and validation methodologies for the definition and implementation of the EVOLVED-5G Network Applications validation framework. Also, the two (out of 5) 5G testing infrastructures of 5GENESIS, namely the Athens platform and the Malaga platform.
	5G!Drones	Vertical-specific developments for the agility in the production line through automation and control of robotic parts.
Smart5Grid	5G ESSENCE	Included the 5G ESSENCE architecture and findings of the highly flexible and scalable platform, able to support new business models and revenue streams by means of a neutral host market.
	5GTANGO	Utilised the knowledge gained from the developed open source cloud-native platform of 5GTANGO for development, validation and verification of the Smart5Grid platform.
	NRG-5	Used NRG-5 outcome on integrating analytics in the ETSI-MANO processes as the baseline for addressing various types of 5G applications'. Moreover, the extended MEC open-source software stack facilitating automated analytics-based deployment was exploited in order to strengthen the multi-vendor interoperability and avoid lock-ins on the Smart5Grid platform.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-41 5G innovations for verticals with third party services		
Smart5Grid	5GENESIS	Used the capabilities to deploy and test applications, and to provide support for the operation and optimisation of the NFV infrastructure of the 5GENESIS, in order to enhance the MANO capabilities. Special focus will be given in evaluating the potential of novel elements, such as the Network Applications Controller, as well as the 5G RAN Controller.
	5G-VICTORI	Leveraged 5G-VICTORI enhancements of the existing distribution grid infrastructures towards the integration of the vertical and cross-vertical use-cases.
VITAL-5G	5G-EVE	Up-graded OTE and NSA 5G testbed to support 3GPP R.16 SA. Reuse 5G-EVE Portal dashboard, the Experiment Lifecycle Manager and the Experiment Execution Manager as a base for VITAL-5G Service Portal and extended it to support Network Applications and intelligent VxF placement. Customise the Experiment Execution Manager to support T&L validation process.
	5G-SOLUTIONS	Extended the functionality of the KPI visualisation system to cover the GUI of the VITAL-5G Open Platform and additional KPIs. Reuse of Customer, discovery templates for value assessment in T&L operational roadmaps for Financial, People, Product, Marketing and Sales. Reuse of innovative IPR.
	5G-EVE	Extended the functionality of the WINGS big data analytics platform to accommodate the unique semantics of logistics environments and to control/cooperate with AGVs and warehouse automation. Update robotics/AGV autonomous functionality.
	5G-MOBIX	Extended the functionality of the WINGS big data analytics platform to accommodate the unique semantics of logistics environments and to control/cooperate with AGVs and warehouse automation. Update robotics/AGV autonomous functionality.
	5G-TOURS	Extended the functionality of the WINGS big data analytics platform to accommodate the unique semantics of logistics environments and to control/cooperate with AGVs and warehouse automation. Update robotics/AGV autonomous functionality.

Phase 3 Projects	Phase 2,1,3 Projects	Components Use / Re-use
ICT-41 5G innovations for verticals with third party services		
VITAL-5G	5G-HEART	Extended the functionality of the WINGS big data analytics platform to accommodate the unique semantics of logistics environments and to control/cooperate with AGVs and warehouse automation. Update robotics/AGV autonomous functionality.
	5G-EVE	Transformed Nextworks 5G-catalogue to implement the core engine of the VITAL-5G Open Online Repository for Network Applications. Implemented the new functionalities for selective onboarding of Network Applications and VxF/VNF in NFV infrastructures and MANO and integrated eLicensing mechanisms to manage license schemes.
	5G-MEDIA	Transformed Nextworks 5G-catalogue to implement the core engine of the VITAL-5G Open Online Repository for Network Applications. Implemented the new functionalities for selective onboarding of Network Applications and VxF/VNF in NFV infrastructures and MANO and integrated eLicensing mechanisms to manage license schemes.
	5G-City	Transformed Nextworks 5G-catalogue to implement the core engine of the VITAL-5G Open Online Repository for Network Applications. Implemented the new functionalities for selective onboarding of Network Applications and VxF/VNF in NFV infrastructures and MANO and integrated eLicensing mechanisms to manage license schemes.
	MATILDA	Extended microservice based capabilities to allow for the implementation of the appropriate fusion techniques and the development of advanced AI mechanisms for the optimization of logistic & inspection operations.
	5G-CARMEN	Reused CCAM platform that provided a two-tiered orchestration capability for vertical, vertical-agnostic, and 5G network applications. The platform provided the means for orchestrating various Network Applications in diversified domains. Life Cycle Management operations performed by two-tier SDN & NFV MANO orchestrators customized to specific Network Applications.

PROJECTS PLATFORMS USE

The following Table summarizes the PPP ICT-19 Verticals Pilots -> ICT-17 Platforms use.

	5G-EVE	5G-VINNI	5GENESIS
5G!Drones	✓		✓
5G HEART	✓	✓	✓
5Growth	✓	✓	
5G-SMART	✓		
5G-SOLUTIONS	✓	✓	
5G-TOURS	✓		
5G-VICTORI	✓	✓	✓

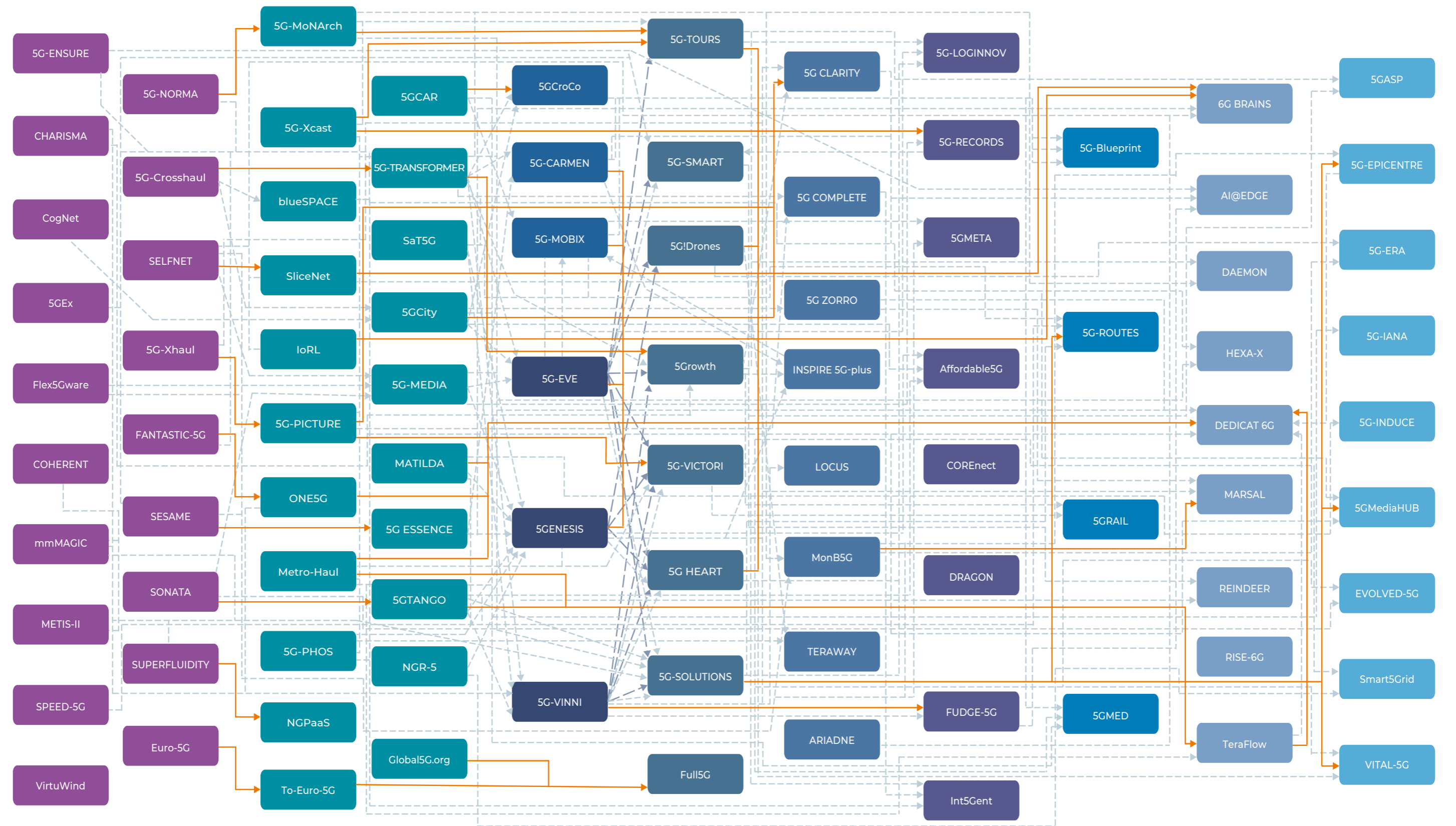
PROJECTS HERITAGE FIGURE

The PPP Projects Heritage Figure is summarizing the interconnections between projects under three specific categories:

1. Projects follow-up (captured in orange solid lines in the figure),
2. Components use/re-use (captured in light blue dashed lines in the figure) and
3. ICT-19 Verticals Pilots / ICT-17 Platforms use (captured in dark blue dashed lines in the figure).

The PPP Projects Projects Heritage Figure is deployed on the next pages.

PROJECTS HERITAGE AND CONNECTIONS



PHASE 1

PHASE 2

PHASE 3

→ Projects Follow-up

- - - Components Use/Re-use

- - - Platforms use

■ ICT-17 ■ ICT-18 ■ ICT-19 ■ ICT-20 ■ ICT-42 ■ ICT-53 ■ ICT-52 ■ ICT-41

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5G-VINNI	Diego Lopez and Kashif Mahmood
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ICT-18 Automotive Projects	
5G-CARMEN	Andreas Heider-Aviet
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5G-MOBIX	Kostas Trichias and François Fischer

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ICT-19 Advanced 5G validation trials across multiple vertical industries	
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5Growth	Xi Li and Manuel Lorenzo
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