The 5G Infrastructure
Public-Private Partnership

The European strategic initiative to have 5G operational by 2020

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Coordinator, 5G PPP mmMAGIC Project & Steering Board 5G PPP Initiative

www.5g-ppp.eu
The European 5G PPP/Initiative

- 5G and where Europe stands today
- Our EU 5G (-PPP) vision
- The 5G PPP projects and ambitions
- Next steps, (Events, Phase 2, etc.,)
5G PPP has evolved over the years and has shared some major milestones @ the MWC

- European ICT Industry called for concerted action on 5G in Europe in 2012
- Commissioner Kroes invited the ICT Industry in Europe to cooperate on 5G PPP at **MWC 2013**
- 5G PPP Contractual Arrangement was signed between the EU Commission and the 5G Infrastructure Association in December 2013
- 5G PPP held a Industry Launch event at **MWC 2014**
- 5G-PPP Project Proposals were submitted November 2014
- 5G Infrastructure Association vision paper was published @ the 5G Vision EU – CTO Press Event at **MWC 2015**
- 19 Phase 1 projects were selected and started in July 2015
- 5G Infrastructure Association white paper on how **5G will empower the vertical sectors** is being presented at an EU-CTO Press Event at this **MWC 2016**
International activities on 5G also gaining momentum & The European 5G-PPP is signing MoUs with other regions

ITU-R Visions Group

EU
- Framework Program 7, e.g. METIS and 5GNow projects
- 5G PPP in Horizon 2020

Germany – 5G Lab Germany at TU Dresden

UK – 5G Innovation Centre (5GIC) at University of Surrey

US
- Intel Strategic Research Alliance (ISRA)
- NYU Wireless Research Center
- 5G Americas, MoU signed

China
- 863 Research Program
- Future Forum
- IMT-2020 (5G) Promotion Group, MoU signed

Japan – The 5G Mobile Communications Promotion Forum, MoU signed

Korea – 5G Forum, MoU signed

Taiwan – TAICS, Ministry of Science and Technology, Ministry of Economic Affairs

Russia – 5GRUS by Russia’s Icom-Invest

CJK White Paper

NGMN – White paper on future requirements

Source: 5G Infrastructure Association.
Europe on the road to 5G

5G Infrastructure PPP was launched

19 5G PPP Projects were launched

We are now here!

First results from Phase 1 available & Phase 2 proposals in preparation

Source: The European Commission.
Key challenges being addressed by the 5G-PPP

• The 5G PPP program will deliver solutions, architectures, technologies and standards for the ubiquitous 5G communication infrastructures of the next decade

• Program Ambitions: Key Challenges / High level KPIs

- Increasing wireless capacity 1,000 times
- Connecting 7 billion people
- Connecting 7 trillion things
- Saving 90% energy
- Perceiving zero downtime

• These challenges are being refined and quantified through liaison with the Vertical sectors and the evolution of the use cases

Source: 5G Infrastructure Association.
5G PPP Vision and Requirements: 5G key drivers

- The start of full commercial deployment of 5G systems is expected in years 2020+
- 5G is an **opportunity for the European ICT sector** which is already well positioned in the global R&D race
- 5G will bring **new unique network and service capabilities**
  - user experience continuity
  - Internet of Things
  - mission critical services (low latency, high reliability)
- 5G targets a **unified and programmable infrastructure**
- 5G will support **multi tenancy models**
- 5G will be designed to be a **sustainable and scalable technology**
- 5G will create an **ecosystem for technical and business innovation**

5G PPP Vision and Requirements:
5G new service capabilities

- 5G needs to support efficiently three different types of traffic profiles
  - high throughput for e.g. video services
  - low energy for e.g. long–living sensors
  - low latency for mission critical services

- 5G covers network needs and contributes to digitalization of vertical markets
  - automotive, transportation, manufacturing, banking, finance, insurance, food and agriculture
  - education, media
  - city management, energy, utilities, real estate, retail
  - government
  - healthcare

- Sustainable and scalable technology to handle
  - anticipated dramatic growth in number of terminal devices
  - continuous growth of traffic (at a 50-60% CAGR)
  - heterogeneous network layouts
  - without causing dramatic increase of power consumption and management complexity within networks

Listening to the Vertical sectors

• White papers on
  – 5G and Factories of the Future
  – 5G and Healthcare
  – 5G and Energy
  – 5G and Media
  – 5G and Automotive

• Identification of
  – main use cases
  – requirements and
  – areas for research and innovation

• Vertical workshops
  – June 18, 2015
  – November 9, 2015

• White Paper will be published at Mobile World Congress 2016

Source: 5G Infrastructure Association.
Vertical sectors: capturing their technical requirements

5G – A driver for industrial and societal changes

Integrated 5G architecture for mobile broadband and vertical services

5G PPP Vision and Requirements

5G roadmap

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<td>RI5</td>
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<td>EC 5G PPP</td>
<td>5G PPP set-up</td>
<td>5G PPP Phase 1</td>
<td>5G PPP Phase 2</td>
<td>5G PPP Phase 3</td>
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<td>ONF, Open Daylight, OPNFV, Open Stack...</td>
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</table>

The 5G PPP projects and programme ambitions

• The Phase 1 Projects,
  o 19 projects selected in phase 1
  o Operational since July 2015

• The operating structure
  o The 5G Infrastructure Association
  o Partnership board
  o Steering board
  o Technology Board
  o Working groups
Horizon 2020 5G PPP: Call 1 projects

5G Ensure
- Security
  (Will be added later)

CHARISMA
- Converged Heterogeneous Advanced 5G Cloud-RAN Architecture for Intelligent and Secure Media Access

CogNet
- Building an Intelligent System of Insights and Action for 5G Network Management

SELFNET
- Framework for SELF-organized network management in virtualized and software defined NETworks

VirtuWind
- Virtual and programmable industrial network prototype deployed in operational Wind park

FANTASTIC-5G
- Flexible Air iNTerFACE for Scalable service delivery wiThin wireless Communication networks of the 5th Generation

Flex5Gware
- Flexible and efficient hardware/software platforms for 5G network elements and devices

SUPERFLUIDITY
- Superfluidity: a super-fluid, cloud-native, converged edge system

5G-Xhaul
- Dynamically Reconfigurable Optical-Wireless Backhaul/Fronthaul with Cognitive Control Plane for Small Cells and Cloud-RANs

COHERENT
- Coordinated control and spectrum management for 5G heterogeneous radio access networks

SPEED-5G
- quality of Service Provision and capacity Expansion through Extended-DSA for 5G

SESAME
- Small cEIIIS co ordinAtion for Multi-tenancy and Edge services

Crosshaul
- The 5G Integrated fronthaul/backhaul

5G-Norma
- 5G NOvel Radio Multiservice adaptive network Architecture

SPEED
- 5G quality of Service Provision and capacity Expansion through Extended-DSA for 5G

Metis-II
- Mobile and wireless communications Enablers for Twenty-twenty (2020) Information Society-II

SUPERFLUIDITY
- Superfluidity: a super-fluid, cloud-native, converged edge system

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mmMAGIC
- Millimetre-Wave Based Mobile Radio Access Network for Fifth Generation Integrated Communications

Source: 5G PPP, [https://5g-ppp.eu/5g-ppp-phase-1-projects/](https://5g-ppp.eu/5g-ppp-phase-1-projects/).
## 5G PPP Vision and Requirements

### 5G roadmap

<table>
<thead>
<tr>
<th>Year</th>
<th>ITU</th>
<th>5G PPP</th>
<th>3GPP</th>
<th>ETSI</th>
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<tr>
<td>2016</td>
<td>IMT-2020 requirements</td>
<td>5G PPP Phase 1 projects</td>
<td>SI: CM &gt; 6 GHz</td>
<td>NFV Phase 2</td>
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<td>2017</td>
<td>IMT-2020 proposals</td>
<td>5G PPP Phase 2 projects</td>
<td>SI: 5G enhancements</td>
<td>NFV Phase 3</td>
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<tr>
<td>2018</td>
<td>IMT-2020 spec</td>
<td>5G PPP Phase 3 projects</td>
<td>SI: self-evaluation</td>
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<tr>
<td>2019</td>
<td>WRC 19</td>
<td></td>
<td>WI: 5G Phase 1</td>
<td></td>
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<tr>
<td>2020</td>
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<td>WI: 5G Phase 2</td>
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**Source:** 5G Infrastructure Association: 5G Empowering vertical industries White Paper, February 2016.
Next steps: Phase 2 Calls for projects

• 5G-PPP Phase 2 Call for projects opens on May 10, 2016,
  – ICT-07-2017:5G PPP Research and Validation of critical technologies and systems
  – ICT-08-2017:5G PPP Convergent Technologies

• New proposals need to be submitted by November 8, 2016

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Horizon 2020 5G PPP Call 2 objectives
148 million € Funding

- ICT-07-2017: 5G PPP Research and Validation of critical technologies and systems
- ICT-08-2017: 5G PPP Convergent Technologies

Wireless access and radio network architecture/technologies
- Novel air interface technologies, heterogeneous set of requirements (low rate sensors including mission critical M2M to very high rate HD/3D TV and immersive services, supporting local and wide area systems), enabling usage of frequency bands above 6 GHz
- Hardware architectures and building blocks
- (Radio) Network functional architectures and interfaces leading to vision / reference architecture for 5G
- Co-operative operation of heterogeneous access networks, including broadcast/multicast (terrestrial and satellite based) and supporting SDN and virtualization
- Multi-tenancy for Radio Access Network (RAN) sharing
- Integration of Satellite Networks to support ubiquitous coverage, resilience, specific markets

High capacity elastic - optical networks
- Support very high traffic and capacity increase originating from an (5G) heterogeneous access networks with matching capabilities from the core and metro environments, at ever increasing speeds and in more flexible and adaptive form
- New spectrally efficient, adaptive transmission, networking, control and management approaches to increase network capacity by a factor of >100 while at the same time providing high service granularity, guarantees for end-to-end optimization and QoS - reducing power consumption, footprint and cost per bit and maintaining reach
- Integration of new optical transport and transmission designs with novel network control and management paradigms (e.g., SDN) are expected to enable programmability

Software Networks
- Software network architecture to support access agnostic converged core network and control framework enabling next generation services
- Architecture leverages SDN/NFV paradigm to integrate/manage next generation transport and optical technologies
- Unified management of connectivity, with end to end security mobility and routing for flexible introduction of new services
- Scalability and efficiency related to increasing deployment of software-based network equipment and functions as well as corresponding more diverse services and usages
- Ease of deployment of multitenant networks, cost and energy efficiency, "five 9" reliability, flexibility and perceived "zero latency" where relevant
- Target is for a Network Operating System (NOS) with hardware and user interfaces to manage and orchestrate unified access to computing, storage, memory and networking resources
- Management and security for virtualised networks and services
- Network analytics tools, knowledge reasoning and cognition, may be extended towards network operations
- Management of security across multiple virtualised domains

Ubiquitous 5G access leveraging optical technologies
- 5G access networks have to dramatically grow in user capacity, quality of service, responsiveness, energy efficiency and number of connected devices while keeping a sustainable cost
- To develop and assess new optical access network solutions based on integrated optical device prototypes
- Co-operative radio-optical approaches are seen as very promising, also to cover intelligent interference cancellation
- Techniques to map 5G channels to optical transport and a co-design of the optical and wireless interfaces and protocols
- Scalable demonstrators validated through typical usage scenario

Flexible network applications
- Leveraging current intense research activities in relation to Virtualised Network Functions (VNF) and targeting development of a multiplicity of VNF's useful to operators, service providers and users
- Service providers or third party providers should be able to assemble virtualised 5G functions as "network apps" from NFV hosting infrastructure, to deploy them in the relevant network nodes, to orchestrate and customise resources to provision user services
- Target is for a cloud like 5G infrastructures, supporting network services, resource and service orchestration
- This environment also provides an open source development framework for control functionalities and application developments
- It also provides the link between the network -terminal functions and the app/content providers towards standards developments

H2020 5G Infrastructure PPP
Phase 2 Pre-structuring Model – TAs Portfolio

**Application Layers**

**TA1**
5G Wireless System Design

**TA2**
5G Low Band AI

**TA3**
5G mmWave AI

**TA4**
Subsystems for 5G Platforms

**TA5**
Novel Radio System Architecture

**TA6**
Seamless Integration of Satellite and Air Platforms

**TA7**
5G for Future MTC Solutions

**TA8**
Cognitive Network Mgmt

**TA9**
Cost Efficient Optical Metro

**TA10**
High Capacity Optical Core

**TA11**
Converged 5G FlexHaul Network

**TA12**
Foundations for SW Networks

**TA13**
Security, Privacy, Resilience, and High Availability

**TA14**
Multi-Tenant / Domain Plug & Play Control Plane

**TA15**
Open “Blue” TA (ICT 7)

**TA16**
Open “Blue” TA (ICT 7)

**TA17**
UCR 5G Access

**TA18**
NetApps Development and Verification Platform

**TA19**
E2E NFV and SDN Holistic Operational Model

**TA20**
Open “Blue” TA (ICT 8)

**TA21**
Open “Blue” TA (ICT 8)

**TA22**
Access Convergence 1

**TA23**
Access Convergence 2

**TA24**
EUJ-01 1

**TA25**
EUJ-01 2

**TA26**
EUK-01

Note: The size and the orientation of the TAs boxes do not indicate the potential size or manpower of future Projects

Source: 5G Infrastructure Association.
Next steps: Events for Networking

• 2\textsuperscript{nd} Info day to network and find partners/proposals:
  – March 17\textsuperscript{th}, Bologna, Italy
• Networld20202 General Assembly, 19\textsuperscript{th} April Brussels
  – www.networld2020.org
• 3\textsuperscript{rd} Info day to network and find partners/proposals:
  – Warsaw, Poland – May (date to be confirmed)
• 4\textsuperscript{th} Info day to network and find partners/proposals is planned:
  – Alongside EuCNC 2016, Athens – June 27-30, (Maybe 1\textsuperscript{st} July?)
• A 5G-PPP Call 2 brokerage service will be implemented on the 5G-ppp website
• All news on these events and services will be posted on the 5G-ppp website as soon as it is available

www.5G-ppp.eu
Next steps: Publications:

- The new white paper on “empowering the Verticals” is available now on the 5G-PPP Website

- Other Papers available from the 5G-PPP include:
  - 5G-PPP Pre-standards-WG Issues Paper – October 2015
  - 5G-PPP White Paper on eHealth Vertical Sector – October 2015
  - 5G-PPP White Paper on Automotive Vertical Sector – October 2015
  - Specialized Services, Network Management and 5G – May 2015

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