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AFFORDABLE 5G

High-tech and affordable 5G network roll-out to every corner

D5.1: Dissemination and Communication Channels and Plan

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Abstract

This document defines Affordable5G's dissemination and communication channels and describes the activities Affordable5G will pursue to guarantee broad visibility, promotion and showcasing of the developed concepts, technologies, use cases, and results. This will include off-line and online communications, digital presence, participation in and organization of events, contributions to standardization, interaction with the 5G PPP projects, the 5G PPP working groups and the 5G IA, and liaisons with relevant national / local initiatives, as well as with other European research and innovation initiatives (such as NGI, IoT-LSP, Big Data, etc.) and global 5G organizations.

Keywords:

Communication, dissemination, stakeholders, website, social media, brand identity, liaisons

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Project co-funded by the European Commission in the H2020 Programme		
Nature of the deliverable:	to specify R, DEM, DEC, OTHER*	R
Dissemination Level		
PU	Public, fully open, e.g. web	√
CI	Classified, information as referred to in Commission Decision 2001/844/EC	
CO	Confidential to Affordable5G project and Commission Services	

** R: Document, report (excluding the periodic and final reports)*

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

OTHER: Software, technical diagram, etc

EXECUTIVE SUMMARY

This deliverable describes the Affordable5G's Dissemination Channels and Plan, as defined in Task 5.1 ("Dissemination and Communication activities") of Work Package 5 ("Dissemination, business modeling, opportunities for SMEs, standardization and 5G PPP collaboration"). It details the Affordable5G's outreach strategy and framework and outlines the envisaged dissemination and communication activities, as well as the impact measures.

It is aimed to be a guiding document for the projects' partners to align on main objectives and planned communication and dissemination activities, but also to define a common framework for coordination with other main parties such as the EC (in particular our Project Officer and other representatives) and other related H2020 projects within the overall 5G PPP context.

Affordable5G is embracing a large set of initiatives that aim to raise awareness on the benefits that target 5G technologies and architectures can bring to digitalise a broad range of advanced communication systems and solutions.

In this respect, the main objectives of the Affordable5G's Dissemination Channels and Plan are to:

- Ensure broad visibility and raise awareness about Affordable5G, spreading knowledge about the project and its results, establishing a distinctive and recognizable identity that will support marketing efforts.
- Reach, stimulate and engage a critical mass of relevant stakeholders to ensure that the results of the project are effectively showcased, leading to validation, improvement and possibly further adoption of the developed technologies and concepts, especially towards target vertical sectors.
- Facilitate exploitation of the project's outcomes and promote the development of innovative solutions based on the Affordable5G technologies and architectures.
- Foster impactful contribution to relevant standardization bodies as appropriate and relevant to planned exploitation plans and the project's outcomes.
- Ensure close coordination with relevant 5G PPP programme, working groups and bodies, while establishing liaisons with related initiatives in research and innovation domains such as NGI, BDVA, AIOTI, etc.

Affordable5G will engage in dissemination, communication and community building towards industry, including network operators and infrastructure providers, SMEs, standardization bodies, researchers, as well as citizens, public authorities and initiatives, policy makers and relevant 5G communities and projects as appropriate. To showcase the benefits of development of 5G services will be a core mission around which the Affordable5G promotional efforts will be organized, starting from the piloting communities in the smart cities and emergency communications.

A comprehensive set of dedicated dissemination, communication and community building activities will contribute to the overall success of Affordable5G, with the clear ambition to directly help the growth and consolidation of the 5G PPP programme as a crucial initiative for successful transformation of the European industry and services.

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ABBREVIATIONS

AI	Artificial Intelligence
CAM	Connected and Automated Mobility
CCAM	Cooperative, Connected and Automated Mobility
CNF	Containerized Network Functions
GPU	Graphics Processing Unit
IoT	Internet of Things
IP	Internet Protocol
KPI	Key Performance Indicator
MANO	Management and Orchestration
MEC	Multi-access Edge Computing
MNO	Mobile Network Operator
NOS	Networking Operating System
NR	New Radio
NFVI	Network Function Virtualization Infrastructure
OPEX	Operational Expenditures
RAN	Radio Access Network
RAT	Radio Access Technology
TCP	Transmission Control Protocol
VIM	Virtual Infrastructure Manager
VNF	Virtual Network Function
WG	Working Group
5G IA	5G Industrial Association
5G PPP	5G Infrastructure Public Private Partnership

1 INTRODUCTION

1.1 Purpose of the document

The present deliverable is prepared in the context of **Work Package 5 (WP5) "Dissemination, business modeling, opportunities for SMEs, standardization and 5GPPP collaboration"** and aims to develop an overall dissemination and communication strategy for Affordable5G for outreach and impact creation, taking into account the characteristics of the information that needs to be disseminated, the target audiences and groups and the impacts to achieve. The expected outcomes and impacts, assessment metrics and tools are defined. This strategy provides the framework within the different awareness-raising, and promotional and community building activities that will be carried out during the course of the project.

In this context, WP5 focuses on identifying the relevant stakeholders that have to be contacted in order to reach the right supporters at the right time. It also involves preparation of the promotional materials and organising dissemination activities to create an open, secured, decentralised, user-oriented and highly engaged Affordable5G community.

The purpose of this deliverable is therefore to outline an inclusive dissemination and communication plan for the realisation of the above stated goals and in particular to:

- Identify target audiences, including a broad range of stakeholders of the 5G community
- Present the strategy put in place for the dissemination and communication of knowledge and results
- Depict the methods, tools and promotional materials that will be used in the project's dissemination and communication
- Provide a complete overview of the planned activities, as well as list potential opportunities to be exploited in the project
- Define the rules and procedures that will be applied to implement, monitor and evaluate all the communication and engagement activities.

This is a 'living' document, able to accommodate any required customisation. The dissemination planning will thus be constantly evaluated and revised in the course of the project. Major updates will be included in the Periodic Reports.

1.2 Structure of the document

The sections of the deliverable at hand are organized in the following manner: After the introductory **Section 1, Section 2** depicts the mission of Affordable5G and the fundamental aspects of the dissemination and communication plan, including the main objectives, the description of the target audiences and the strategic planning of the envisioned activities. **Section 3** presents the various types of dissemination activities and tools that will be used in order to support the project's dissemination and communication activities. **Section 4** focuses on activities related to 5G PPP collaboration, standardization and open source communities. **Section 5** depicts the metrics for the evaluation of the dissemination and communication activities. **Section 6** concludes the document.

2 DISSEMINATION STRATEGY

Efficient dissemination and communication actions during the Affordable5G project ensure short and long-term success of the project. Therefore, promotion, dissemination, stakeholder engagement and impact creation activities are central to the whole Affordable5G effort and will be closely coordinated among the various WPs to create a cohesive plan of actions for the effective engagement of all target stakeholders in the 5G ecosystem.

One of the primary objectives of Affordable5G is to enable a high-tech but affordable roll out of 5G dense technologies every corner with especial emphasis on SMEs opportunities in niche market cases of neutral hosting, private networks and MVNOs. The consortium will therefore be targeting, among others, key initiatives in the vertical domains, and stakeholders of the 5G and emerging related technologies markets. This aims to raise awareness on the benefits that target 5G technologies and architectures can bring to digitalise a broad range of advanced communication systems and solutions.

Moreover, Affordable5G will engage in dissemination, communication and community building towards industry, including network operators and infrastructure providers, SMEs, standardization bodies, researchers, as well as citizens, public authorities and initiatives, policy makers and relevant 5G communities and projects as appropriate. To showcase the benefits of development of 5G services will be a core mission around which the Affordable5G promotional efforts will be organized, starting from the piloting communities in the smart cities and emergency communications.

A comprehensive and well-structured set of dissemination activities will ensure a broad promotion and effective showcasing of the developed concepts, technologies, use cases and results. This will include off-line and online communications, digital presence, participation in and organization of events, contributions to standardization, interaction with the 5G PPP projects, the 5G PPP WGs and the 5G IA, and liaisons with relevant national / local initiatives (especially around the trials), as well as with other European research and innovation initiatives (such as NGI, IoT-LSP, Big Data, etc.) and global 5G organizations.

The following sections describe Affordable5G's mission, overall communication and dissemination objectives, key stakeholders, communication phases and communication channels that will guide and streamline Affordable5G communication and dissemination activities.

2.1 Affordable5G mission

Affordable5G will deliver a complete and affordable 5G offering for private and enterprise networks, evaluated and validated in three vertical use cases, related to emergency communications, smart cities and manufacturing. Towards this end, the project's consortium brings together multiple (10) European SMEs working on 5G networks and equipment, envisioning this innovation initiative, as an opportunity to enhance their products according to each company's roadmap, while fostering collaboration among them, leveraging cell densification, RU/DU/CU split, edge computing and core network virtualisation, while adopting open solutions, such as O-RAN and open-source MANO frameworks for cloud native micro-service deployments.

Given that 5G enables a plethora of opportunities for new actors to offer their services via the high-throughput and low-latency infrastructure, Affordable5G project will support MVNOs to enter this new market and provide ubiquitous and high QoS 5G communication. For this purpose, special attention will be given to device hardware, network elements, topologies, neutral host and software licenses, thus allowing the reduction of costs, in terms of deployment, ownership and management.

Moreover, Affordable5G will be fully exploitable and open by adopting RAN functions on open interfaces and standard hardware platforms to bring a variety of affordable solutions to the market, capitalising on core network virtualisation for cost-efficient management of RRH/RUs and BBU/DU/CUs that will be flexibly deployed and shared among multiple MVNOs. At the same time, the support of innovative verticals will be achieved through cloud native orchestrators, managing the various IoT elements and customised devices, as well as the migration of Virtual Network Functions (VNFs) across different network nodes.

Affordable5G will provide real options for the required network densification by enabling the deployment of low-cost enterprise and private networks and the evolution of certain actors, such as MVNOs. This will allow novel, automated, faster-to-deploy and less expensive technology options, and new business models, moving away from traditional telecom equipment providers, thus escaping from vendor lock-in.

2.2 Dissemination and communication objectives

Affordable5G's dissemination and communication activities are overarching throughout the whole duration of the project and aim to ensure a broad promotion and effective showcasing of the developed concepts, technologies, use cases and results.

In terms of communication and marketing this ambition translates into the following main objectives.

- Ensure broad visibility and raise awareness about Affordable5G, spreading knowledge about the project and its results, establishing a distinctive and recognizable identity that will support marketing efforts.
- Reach, stimulate and engage a critical mass of relevant stakeholders to ensure that the results of the project are effectively showcased, leading to validation, improvement and possibly further adoption of the developed technologies and concepts, especially towards target vertical sectors.
- Facilitate exploitation of the project's outcomes and promote the development of innovative solutions based on the Affordable5G technologies and architectures.
- Foster impactful contribution to relevant standardization bodies as appropriate and relevant to planned exploitation plans and the project's outcomes.
- Ensure close coordination with relevant 5G PPP programmes, working groups and bodies, while establishing liaisons with related initiatives in research and innovation domains such as NGI, BDVA, AIOTI, etc.

2.3 Affordable5G stakeholder

The global demand for increased capacity and the 5G technology deployment bring several cost accelerators to MNOs, such as, RAN densification, backhaul capacity upgrade and mobile edge processing rollout, significantly increasing Total Cost of Ownership (TCO).

Under this context, Affordable5G aims to explore several cost optimizers, aiming to develop strategies for 5G to cope with this expected growth in network cost. This will enable traditional telecom stakeholders cope with the increased cost, as well as offer new market strategies, revenue models and novel business opportunities to new market players.

The innovation capacity and integration of new knowledge achieved by the proposition in Affordable5G, has the potential to impact the following stakeholders.

- 5G equipment and elements providers

The equipment & elements providers ecosystem consists of suppliers of Radio Access Network & Services, MNO Core Network, Private Network Core Network, Neutral Host infrastructure, Network Transport, Operations & Business Support Systems, Network Orchestrator, Management & Testing, Network Security, End User devices. The ecosystem is complemented by system integrators, consulting, and service providers.

The whitebox networking and the industry-standard open NOS concepts have the potential to change the entire networking industry in the near future. In order to avoid vendor lock-in, telecom providers and industrial network owners promote the installation of white box devices towards technically feasible, cost-effective vendor and hardware independent solutions. Therefore, 5G equipment and elements providers have to move from combination of proprietary software bounded with purpose-built hardware to a disaggregated model with software separated from underlying hardware. Affordable5G will help network vendors to adapt to the global demands of network operators for NOS, bringing their own solutions to the network market. Apart from whitebox servers deployment, additional revenues are expected from the configuration of open source solutions running on bare-metal servers.

- Infrastructure operators, tower companies, and neutral host providers

Tower Company means an entity engaged primarily in the business of constructing, owning and operating communications towers and leasing space thereon to tenants. The Neutral Host (the infrastructure owner) is the Operator who develops and manages the network and offers network capacity slices to the various 5G service providers.

With the adoption of 5G, infrastructure operators, tower companies and neutral host providers face a unique opportunity. Certainly, MNOs have to build the coming 5G networks, but holding the licenses to do so is not enough. The usage of higher frequencies from 5G platforms requires a denser network, to make up with the smaller coverage range and the weaker propagation. In other words, MNOs have to rent more space for cell towers, a fact that has a direct impact on their market competitiveness. Although some of the MNOs discuss about mergers and acquisitions in order to reach economies of scale, the majority of them will collaborate with infrastructure operators and tower companies. The Affordable5G added value in this direction is that the proposed multi-tenant network sharing in combination with the network slicing, as well as small-cell nodes, designed for short-range, high-frequency 5G signals, will make the role of infrastructure providers more crucial than ever.

- **MNOs, MVNOs, and spectrum owners**

Affordable5G, with its technology to offer flexible and cost-effective solutions, brings significant benefits to the network operators, both owners of network infrastructure (MNOs) or those not owning it (MVNOs).

It is envisaged to have private operators with license spectrum, shared with other or combination with unlicensed spectrum cases. The fully virtualized infrastructure with flexible network sharing capabilities, as described in Affordable5G, will significantly impact the network operators who aim for service and coverage expansion, while struggling with backhaul costs. Integration with the Affordable5G architecture will permit the telecom operators to define effective policies to improve the spectrum usage and will also provide them with flexibility concerning the network resilience. The validation of network sharing concepts in practical, real-world settings will reduce the CAPEX and OPEX for operators, especially at the initial roll-out stages of 5G. Additional services already specified in the scope of the Affordable5G anticipate that network operators will also benefit from smart city applications and emergency services.

- Private Network operators, and Industrial Network operators

Private and Industrial Network operators specialize in proving networks meeting evolving vertical requirements, either using unlicensed spectrum or dedicated spectrum awarded to specific vertical users.

Replacing professional radios and wired industrial Ethernet for reconfigurable factories with ultra-reliable, ultra-low latency 5G NR connections is a big and remaining challenge. At this point in time, the MCX (i.e. a term that collectively covers MCPTT, MCData, and MCVideo) specification work continues in Rel. 16 as it is neither fully completed nor mature. In 2019 some first pilot deployments started taking place with a limited number of users and not yet full capabilities. In parallel, a big driver behind the growth that has been seen to date in private 5G has been the release of unlicensed spectrum for industry verticals giving manufacturers the option to deploy their own private 5G, without having to work with an operator. Affordable5G use cases will open a new range of capabilities in both directions, the relevant concepts will be matured, and will likely require significant enhancements, before they are widely integrated in the mode of operation of professional organizations and distributed to European industry, but at this point in time we are still at the infancy of this process.

- Fixed Telecom Providers

The biggest cost involved with laying fibre optic cabling lies in the process, rather than in the actual fibre optic cable materials themselves. This means that Fixed Telecom Providers tend to lay more fibre optic cabling than is strictly necessary. This has resulted in a situation where there is a large amount of potential bandwidth, laying dormant in the form of dark fibre. Thankfully, 5G will make good use of this dark fibre, since higher-speed but shorter-range radios will demand more backhaul capacity, in more places, for network “densification”. Uncertainty about 5G deployment and usage patterns demands more flexibility about backhaul, that may become prohibitively costly without network sharing approaches, similar to those to be investigated by Affordable5G project.

- **IT Service Providers and Over-The-Top Players**

IT Service Providers and Over-The-Top Players get the maximum benefit and advantage out of the Affordable5G project by being able to closely work with leading mobile market vendors and ICT companies, and so they have the opportunity to position themselves strategically and gain an early-entrant advantage within the industry, also keeping in consideration the rapid evolution of the mobile edge computing market, expected to be a €14bn market by 2020. In particular, by contributing to the design and prototyping of the COTS and bare-metal servers, the IT industry will get a clear roadmap and exploitation opportunity to be placed as key proponents in the open source development communities, promoting the enhancement of solutions which can be developed further through collaboration with application and open programmable platforms developers. This will enable the IT suppliers to even directly approach equipment vendors, to offer competitive solutions at lower costs, enabling new business avenues and increased revenues. The virtualization and “cloudification” of the network architectures often result in transformation of the networks and increase the demand of a broad range of expertise of ICT.

- Vertical Industries

European vertical industries are seeking enhanced technical capacity in order to differentiate themselves at international level and to strengthen their brands. To this end, the availability of the Affordable5G achievements will allow vertical industries to set up and to validate different use cases. In this way, vertical industries can benefit from the enhancements and new capabilities provided by 5G technology, allowing them to incorporate new processes and/or enhance existing ones, thus gaining in efficiency and profitability. Although the Affordable5G architecture will be open and universal, and able to support use cases from different vertical industries, the project will perform validation in specific use cases associated with smart cities, emergency communications, and manufacturing.

Example industries that stand to benefit are Factories, Warehouses, Hospitals, Hotels, Stadiums, Campuses, Airports, Ports, Smart Buildings, Oil & Gas, Mining, Construction, First Responders, Municipalities, Smart Cities.

In the context of emergency communications, Affordable5G will demonstrate the robustness or “criticality” of the provided solution, that will leverage on cloud native monitoring functions, flexible deployment and scaling, and 3GPP-compliant mission critical services (MCS) stateful transition.

In the area of smart cities, Affordable5G will validate the 5G technology for efficient smart city monitoring, combining IoT data collection sensors integration and edge processing. This will allow deploying new applications for enhancing urban sustainability, mobility and safety and reducing deployment costs.

Within the scope of a manufacturing process, Affordable5G will deal with enhancing process automation and the benefits arising from the introduction of Time-Sensitive Networking (TSN) concept.

- Competitive Advantage for SMEs

The decoupling of software and hardware via SDN and NFV technologies, and the introduction of successful, open source software stacks for networks leads to open network ecosystems that are no longer limited to the large manufactures and their telecom customers. With the use of COTS instead of current proprietary technologies, as proposed by Affordable5G, network functionalities will not remain restricted in monolithic “boxes”, but will become totally virtualizable and thus easily reconfigurable. This will greatly influence SMEs that develop network services, since they will be able to innovate and launch new applications leveraging the new capabilities of 5G. In the new, unlocked ecosystem of Affordable5G, SMEs can take the role of the network application developers and maintainers. Lowering the barrier for new market entrants is a recognized benefit for software network technologies, and is of particular importance for the telecom market, which was traditionally dominated by a few ‘big’ players.

- Academia and the Research Community

Affordable5G will target high quality publications at top conferences and open access journals and will leverage greater collaboration between industry and academia around 5G multi-carrier network sharing, in combination with network slicing and mobile-edge computing services and deployments. Furthermore, the great emphasis of Affordable5G to contribute to new industry standards and open source communities’ initiatives, and the clear commitment to release specific solutions developed in the project as open source tools, will greatly benefit the scientific and research community in Europe. The acquired knowledge will enable the proposition and proper design of new courses related to 5G networking, as well as the update

of the existing. PhD and master theses will be supported aiming to introduce students to the new era of 5G networking.

2.4 Dissemination and communication phases

Affordable5G will follow a phased approach to defining, planning, organizing and exploiting a rich set of activities and instruments in the most effective way towards building a strong and vibrant Affordable5G community in the EU that will make a difference in the future development of the field and 5G scene at large. Accordingly, the project will follow a 3-stage approach to outreach and impact creation, as follows:

2.4.1 Stage 1 - Awareness creation and marketing foundation (M01-M04)

During this current phase, we have designed the dissemination and communication strategy, including target groups, planned activities and a selection of dedicated communication tools and community building activities. Moreover, we have started to inform all relevant stakeholders about the Affordable5G scope and objectives and to define the liaisons and interaction mechanisms with the rest of the 5G PPP entities and players, including ongoing 5G PPP phase 3 projects.

Outcomes/Measures: The Affordable5G website (www.affordable5g.eu) created and launched, including a calendar of relevant events. The dissemination and communication plan (D5.1). A project presentation (slides). Dedicated social media channels animated – Affordable5G on Twitter and LinkedIn. Participation in 5G PPP COMMS conf. calls. A first project flyer will be created and an Affordable5G e-newsletter circulated.

2.4.2 Stage 2 - Community outreach and engagement bootstrap (M05-M12)

Stage 2 of the Afforable5G dissemination and communication plan will actively reach out the main target stakeholders to generate interest in Affordable5G activities and outcomes and set a solid foundation for the planned dissemination and showcasing activities. Stakeholders will also be approached to provide support for the promotion of the project thanks to close collaboration of all WP 4 tasks. In this phase, the planning for first event participation and organization will commence.

Outcomes/Measures: Slide-based presentations of first project results. A first video to be used to raise awareness. Animation of social media channels. A number of news items published on the Affordable5G website and media, newsletters, and participation in selected events, to promote the project and its trials.

2.4.3 Stage 3 - Affordable5G showcasing and global outreach (M06-M24)

Stage 3 of the dissemination and communication plan will actively engage and support industry, SMEs and all target stakeholders in the adoption and deployment of the concepts, technologies and tools offered by Affordable5G through dedicated promotional activities. This includes scientific publications, development and distribution of promo materials, deliverables, participation in selected events, organization of dedicated workshops, demos, exhibitions, liaisons with relevant initiatives (e.g., AIOTI, NGI, etc.) and with verticals (e.g. Smart City Expo World Congress) and coordination with 5G PPP bodies and projects as relevant. It is expected that standardization efforts will intensify as the technologies developed and the trials will mature along the project's lifetime.

In addition, Affordable5G has a showcasing strategy. Besides identifying the potential results and outcomes of the project for showcasing, Affordable5G also identified some potential national and international events already. The main idea is to maximize the Europe 5G know

how outreach. Affordable5G will adopt an aggressive showcasing strategy, targeting early use case demonstrations.

Outcomes/Measures: Promotional material in various forms, publications, input to standardizations, established liaisons with 5G PPP projects, a number of news items published on the project's website and media channels, including papers, technical reports, additional editions of the e-newsletter, interviews, videoclips, dedicated webinars, participation in events, also in a vertically-oriented perspective, including support for WP4 for coordinated efforts in organization of dedicated showcasing events to engage target stakeholders.

Figure 1 gives an overview of these phases.

Figure 1: Affordable5G impact creation approach

2.5 Sustainable dissemination and communication approach

The Affordable5G dissemination and communication approach takes into account the sustainability principles for the organization of events and the production of communication materials. For this purpose, we will:

- Organize virtual meetings and workshops instead of face-to-face events
- Avoid using material resources where possible (avoiding printing flyers when unnecessary and promote the online download, producing promotional materials using recycled materials and avoiding single-use products, for example)
- Encourage the reduction of emissions through sustainable mobility practices (e.g., recommending bicycle use, public transport at Affordable5G events and rewarding these actions)
- Work with suppliers (printers, caterers, etc.) that use sustainable products and materials
- Try to measure the carbon footprint and compensation of emissions of partners' traveling to dissemination events.

3 MEANS AND ACTIVITIES

3.1 Project brand identity

As an EC co-funded Innovation Action project, a clear project brand identity needs to be implemented in order to have an impact with the dissemination of respective work and achievements.

The recognition and perception of a brand is highly influenced by its visual presentation. A project's visual identity is the overall look of its communications. Effective visual brand identity is achieved by the consistent use of particular visual elements to create distinction, such as specific fonts, colours, and graphic elements.

The visual identity and sets of guidelines have been finalised since the early stage of the project in order to secure a strong and unique brand. It will be incorporated in all promotional and dissemination materials produced during the project and will be used by all project partners in their communication activities.

Figure 2: Affordable5G logo

The main font families chosen are "Varela Round" (free and Open source) and "Arial": both suitable for print, screen, web, and titling usages. The "Varela Round" font, combined with "Arial" make a contemporary and neat font combination with detailed one-stroke forms. Clear letters with strong curved lines, elegance and an innovation touch. For deliverables, slides and reports the "Arial" font has been chosen, being a default font in most operative systems, to maximise compatibility.

The colour palette (figure below), is composed of 3 colours based on the logo colour scheme, inspiring innovation, technology and connection, to which 2 grey tones are added for variation and grayscale material necessities. This is intended as the primary colour palette of the all Affordable5G materials.

Affordable5G 5G-Blueprint is part of the 5G PPP projects cluster, therefore the colours are based on the 5G PPP brand guidelines[1] aligning to the two shades of blue characterizing that brand image: colours that represents, technology, seriousness, business and future.

[1] https://5g-ppp.eu/5g-ppp-brand-guide-logos/

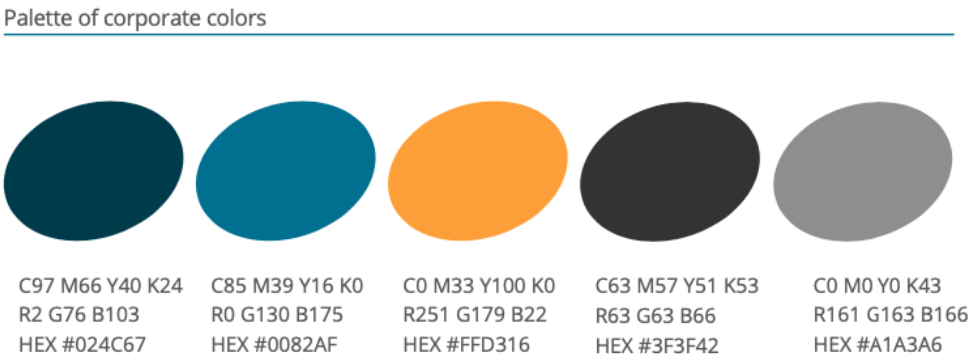


Figure 3: Affordable5G colour palette

Martel Innovate prepared a document which provides guidelines (see Annex A) to create a unique and easily recognizable image footprint. Such guidelines define all of the basic graphic characteristics of the Affordable5G project: from the logo to the colour palette and fonts used. The Affordable 5G logo is shown in several variations, to be used depending on the background, and in different sizes, to guarantee readability in different sources, e.g. reports, web, presentations. The range of colours to be used in the project are the ones adopted in the logo. Each colour is defined with precise printing characteristics (CMYK) and digital encoding (RGB and HEX).

A **PowerPoint presentation template** was created to be used by the partners to create their presentations for all external and internal events, meetings, etc., based on a common look and feel.

Figure 4: Affordable5G PowerPoint template

A Word document template was created to be used by the partners for deliverables (this document follows the defined template).

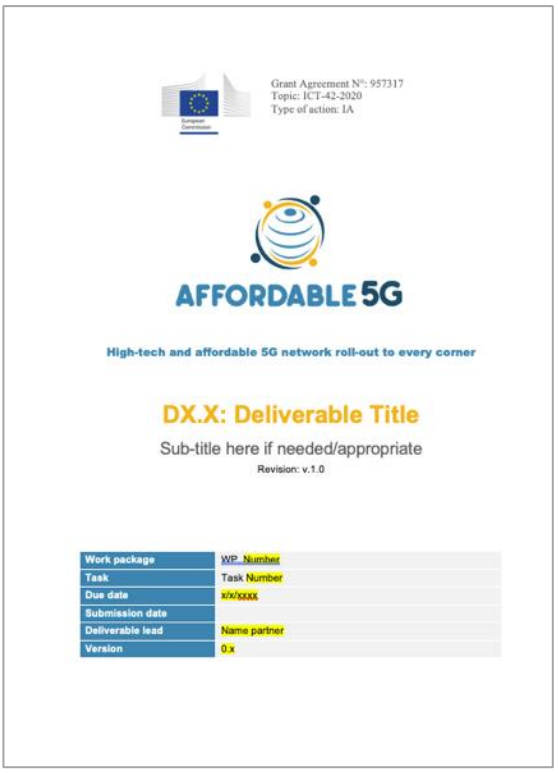


Figure 5: Affordable5G deliverable template

3.2 Online tools and channels

3.2.1 Project website

The Affordable5G project web portal (see Figure 7) is a fully functional web portal that contains comprehensive information on the Affordable5G aims and objectives with easy access and a friendly interface to retrieve information and any public material generated within the project, as well as materials gathered via the various work packages activities about ongoing projects and relevant initiatives. The Affordable5G web portal is the entrance point for all the 5G community players / stakeholders (existing and newcomers) to the activities, services, material and information that Affordable5G is planning to create, collect and share.

Web design experts within the project consortium conceived its design and structure to promote the outcomes to the relevant target groups.

A first release of the web portal was publicly accessible since the first month (on October 14, 2020) of the project at www.affordable5g.eu. Further updates will be promptly applied as necessary. At the time of writing, the website has already counted 34 unique visitors, who generated 230-page views, as shown in Figure 6.

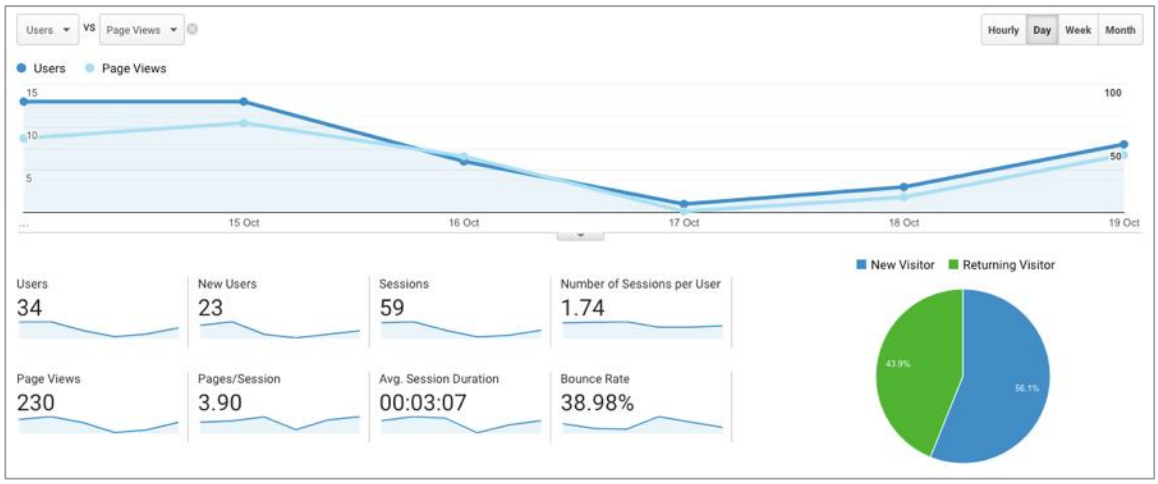


Figure 6: Affordable5G's website analytics

As shown in Figure 8, the **project website's home page** has evolved into a clear and clean communication interface that is easily navigable, containing all relevant project related public information. The site includes the Affordable5G logo and the EU flag with the respective message and is structured into the following sections:

About

This section contains the information about the project. In order to present it in a user-friendly way, three subsections have been created.

- Vision & Objectives: here is an overview on Affordable5G – the project's scope and main goals are stated in a brief text and broken down into a series of simple, captioned icons, for readability at a glance
- The consortium: presenting and linking all the partners
- Impact Creation Board: a section that elaborates on one of the project's main objectives

Technologies

This page describes the experimental platforms that will be advanced during project runtime.

Use cases:

This section gives an overview of Affordable5G three use cases on emergency communication, smart cities and manufacturing.

Community

Through two subsections, this area lists all "Liased projects" and other "relevant initiatives" that are part of Affordable5G's ecosystem. For all such project and initiatives, links and brief descriptions are provided.

News & Events

This section will cover news and press releases related to the project and will be updated often with new information in order to keep the audience aware of this project progress. Concerning the news: meetings execution, important milestones achieved and any other relevant information about project ongoing will be included here. Most of the news entries are spread through our Twitter/LinkedIn channels to increase their visibility and their promotion.

Future events related to the project such as meetings, workshops or conferences or those that could be interesting due to its relationship with project topic will be also gathered under this section.

Furthermore, visitors can subscribe to the newsletter from this section as well, and will be able to browser previous issues after publication, in the future.

Resources

We have also a “resources” section with all the dissemination materials to the users. In order to have the information categorized, four subsections will be included.

- Deliverables, currently presenting the list of public deliverables, which will be uploaded and made available along the project’s lifetime
- Scientific Publications: under this subsection all the publications related to the project will be gathered. When available, full paper and/or abstract download possibility will be set up as well.
- Videos: we will present here the project’s videos, linking to the YouTube channel as well
- Promotional Material: leaflets, brochures, logo and all the documents aimed to construct the corporative image of the project will be gathered under this subsection

Contact

This page allows visitors to directly contact the project through a dedicated form and it includes links to Affordable5G’s social media channels.

Messages sent via the contact form are forwarded to info@Affordable5G.eu, which is forwarded to the concerned project partners, who will receive the message and respond to it. It should be noted that all information and e-mails collected are protected under GDPR. Contacts will only be made to those who have submitted their inquiries and newsletters will only be sent out to those who have explicitly requested to receive them. Any person who has subscribed will be allowed to remove their e-mail upon request.

As one of the main dissemination channels and dynamic tools, the website will undergo a major streamlining, and it will be continuously updated throughout the lifetime of the project.

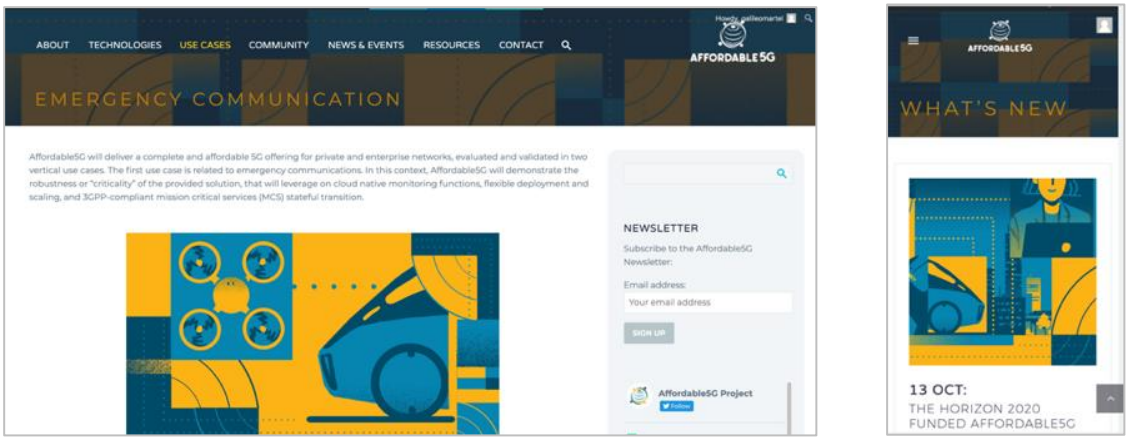


Figure 7: Affordable5G web portal responsive views

Figure 8: Affordable5G project portal homepage

The website provides also information on data kept and how they are used in alignment with the GDPR under the Privacy policy link (footer of the webpage).

Since its inception we are working on supporting the traffic to the website through:

- SEO (Search Engine Optimization): the traffic of visits to the project's website will increase progressively throughout the course of the project thanks to the implementation of strategies oriented to organic traffic, always considering the keywords identified for it.
- Link building: It will be able to create synergies between the project's website and the partners' websites as well as with other relevant agents of the sector (stakeholders), encouraging the exchange of links.

3.2.2 Affordable5G social media channels

Various social networks were established as **marketing tools** in order to promote activities and outputs of the project on a regular basis, while also encouraging a wider discussion on the topics related to 5G activities. Thus, Affordable5G created an active presence on the most popular social media channels, such as Twitter and LinkedIn, which are linked to the project's website.

Below we present a brief overview of the social media channels created for Affordable5G.

3.2.2.1 Twitter

Twitter is a very dynamic social network that covers the news in real-time at a global level. Affordable5G has established its Twitter account @affordable5g before the official start of the project (July 2020). At the time of writing it counts 40 followers, it has tweeted over 20 posts and has been already used to cover the project's own kick-off meeting and relevant initiatives and projects' activities. The Twitter account will be used for promoting and disseminating the development of Affordable5G, including news, events, outcomes, etc. Moreover, re-tweets are made of relevant and interesting content from disparate sources. Last but not least, by following relevant users, Affordable5G not only gains access to more relevant content and updates, but also acquires more followers.

Affordable5G uses Twitter to establish meaningful connections with an active and relevant audience (EC, policy makers, stakeholders of the industry, local authorities and general public). These connections can produce beneficial opportunities for the project across the

network of stakeholders. It serves as well to tell everybody in real time what is happening in the co-creation workshops and other activities of the project. The credentials for Twitter are the following:

- @Affordable5g - Twitter handle, mentions the project
- #Affordable5g – hashtag

Figure 9: Affordable5G Twitter channel

Examples of appropriate hashtags:

- 5G, #5GPPP
- #smartcities
- #emergencycommunication
- #IoT
- #H2020
- #connectivity
- #SMEs
- #internetofthings
- #EC
- #EASME

To maximize the impact of the project on social media channels, images and gifs will be created and shared with all the partners. Tweets can be directed to specific accounts by using: @TWITTER-HANDLE in tweets. Please find here below 3 lists for partners' handles and other relevant handles - To be mentioned in the Affordable5G's tweets to generate conversations and interactions. List of the European Union related Twitter accounts and hashtags:

- @EU_H2020
- @EUScienceInnov
- @EU_EASME
- @EU_Commission
- @EESC_PRESS
- @NetTechEU
- @DSMeu

List of Affordable5G's consortium Twitter accounts:

- @ADVAOpticalNews
- @cellnextelecom
- @IncitesCons
- @ubiwhere
- @Martel_innovate
- @Atos
- @nemergent1
- @accelleran
- @8Bells_research
- @ThinkSilicon
- @i2CAT
- @Athonet_PriMo
- @nbycomp
- @infoUMA
- @uoaofficial
- @EURECOM

List of twitter accounts of related initiatives relevant for Affordable5G:

- @5GPPP
- @3GPPLive
- @BDVA_PPP
- @ETSI_STANDARDS

3.2.2.2 LinkedIn

LinkedIn is currently the main business network in the world and has more than 150 million users in more than 200 countries and territories. Stakeholders, which Affordable5G needs to connect with, are on LinkedIn, so it is appropriate to implement some actions. Affordable 5G's LinkedIn company page has been established before the project officially started (July 2020) to provide a public image on a global scale as a reputable and trustworthy project. It counts, at the time of writing, 19 followers and 4 posts have been published.

By producing content about the project that our viewers want to see and share with others, our viewers become engaged advocates of Affordable5G and can expand our global influence. The content generated by Affordable5G project will be available in different formats such as project presentations, website blog posts, infographics and videos to suit the viewing preferences of our target audience. Affordable5G should post as many status updates as our content supports. We will reach more of our audience and extend our reach as we post more often. The Affordable5G LinkedIn profile is a supplement to the website, helps driving traffic to the site and offers a way out to promote the project. We will mention partners' LinkedIn pages when appropriate to create positive visibility exchanges. We intend to engage all the 5G PPP projects in the dialogue on this platform, while promoting the Affordable5G initiatives across LinkedIn relevant groups, with a direct link to the Affordable5G group, to further increase this social media audience and diversify the group's user base, engaging more vertical representatives/managers.

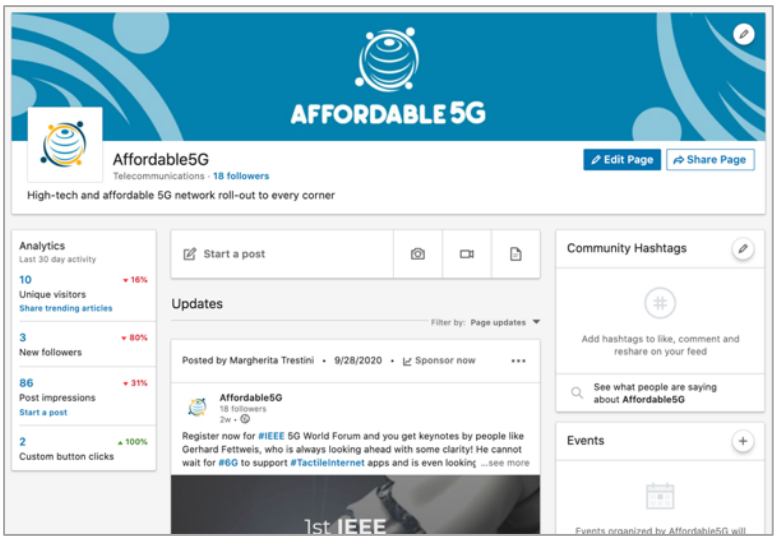


Figure 10: Affordable5G LinkedIn channel

3.2.2.3 YouTube

YouTube is one of the leading video-sharing platforms at a global level that allows to upload videos and create a community of subscribers. Affordable5G will maintain a YouTube channel that is used to disseminate the Affordable5G vision, concepts and objectives, but also to promote and ensure enhanced visibility of the experts and engaged stakeholders of the project that participate in the interviews and project events.

3.2.3 Affordable5G e-newsletter

An e-Newsletter will be produced by the Affordable5G consortium on a quarterly basis and will provide regular updates on trends of 5G innovation practices, project findings and results, news from industrial partners, among others. The newsletters will also contain information regarding the upcoming tasks and events in an attempt to inform the audience on how they can get in touch with the project and the connected initiatives. As such, a typical e-newsletter of the project will contain highlights (major outcomes, links, contacts, and dissemination activities), the most important news, announcements and a schedule of the major upcoming events. Mailings with invitations to relevant workshops and webinars, consultations and other information which cannot wait for the newsletter publication or that cannot appear only in the newsletter will be sent out regularly to the same database used for the newsletter. Project partners will provide information for the e-Newsletter and ensure that the content is accurate. The first issue of the newsletter will be published in November (M03). Newsletters will be uploaded on the website and an internal calendar will be shared with all project partners for receiving their contributions and the final approval about the content and appearance.

A mailing list has been created, based on subscription, giving the possibility to share the e-newsletter via mass mailing as well to inform interested users about project news, achievements and planning of events. A registration functionality allowing the interested visitors to subscribe to the newsletter is already available on the Affordable5G website. Through the Data Management Plan prepared by ATOS (D6.2), it will be ensured that all these actions comply with the requirements of the General Data Protection Regulation (GDPR). The design of the newsletter has already been developed (see Figure 11) and it provides a clear branding and content template, flexible enough for the communication needs.

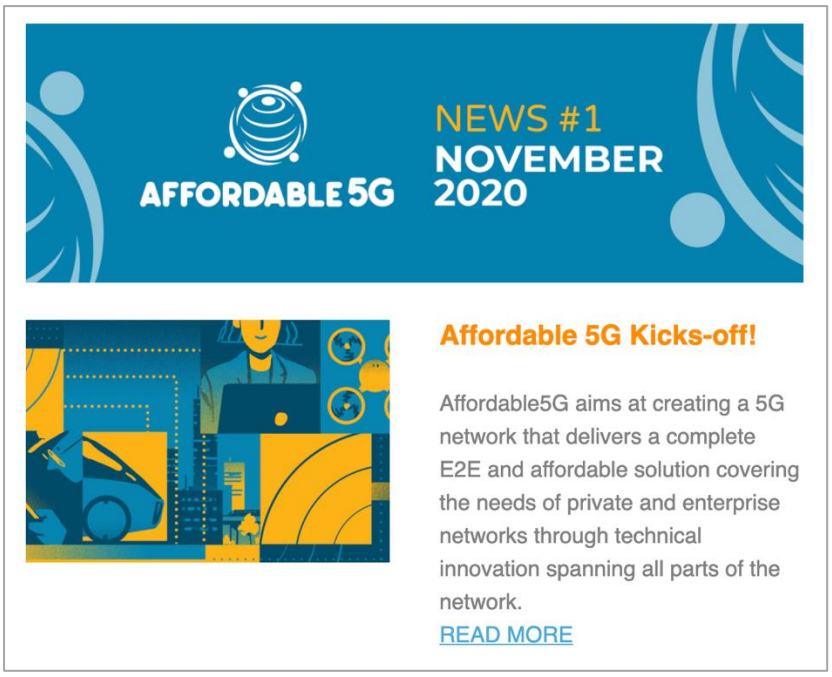


Figure 11: Affordable5G Newsletter preview

3.2.4 e-Publications and Scientific Publications

Significant project developments, news and announcements, white papers, but also articles introducing Affordable5G will be published on third-party portals, including professional and specialized platforms, Cordis, relevant thematic blogs and collaboration platforms, partners' web portals, as well as through several freely accessible tools.

A preliminary list of the freely accessible portals includes:

- Cordis projects & results: http://cordis.europa.eu/projects/homeen.html
- ELTIS: http://www.eltis.org/
- Horizon Magazine http://horizon-magazine.eu/
- Research*eu results magazine http://cordis.europa.eu/research-eu/homeen.html
- Headlines on the Commission's Research & Innovation website www.ec.europa.eu/research/infocentre/allheadlinesen.cfm
- CORDIS Wire http://cordis.europa.eu/wire/

Beyond these, other documents produced by the project will be properly presented through the Affordable5G website.

Affordable5G partners have set a target of publishing on average 3 peer-reviewed publications per year in journals, conferences and workshops. Table 1 below presents the relevant publications which will be considered for submission, along with the leading partners. We expect this list to be further reviewed and populated in the upcoming months as the academic and research partners take a deeper dive in Affordable5G results, methodologies and challenges, which may be relevant for the scientific community. All scientific publications issued by the Consortium will be made available through the project's website, where a specific section has already been created (Green Route).

Publication Type	Submission to
Journal scientific publication	IEEE Transactions on Network and Service Management
Journal scientific publication	IEEE Communications Magazine
Journal scientific publication	IEEE Transactions on Vehicular Technology
Journal scientific publication	IEEEXplore Journal of Communications and Networks
Journal scientific publication	IEEE Transactions on Wireless Communications
Journal scientific publication	ACM, Computer Networks: The International Journal of Computer and Telecommunications Networking
Journal scientific publication	Springer Wireless Personal Communications
Journal scientific publication	Springer Journal of Network and Systems Management
Journal scientific publication	MDPI, Future Internet
Journal scientific publication	IEEE Transactions on Control of Network Systems
Journal scientific publication	Wiley, International Journal of Communication Systems
Conference scientific publication	IEEE Global Communications Conference
Conference scientific publication	IEEE International Conference on Communications
Conference scientific publication	IEEE Vehicular Networking Conference
Conference scientific publication	IEEE Conference on Computer Communications
Conference scientific publication	Mobile World Congress (MWC)
Conference scientific publication	Connected Smart Cities Conference
Conference scientific publication	ITS World Congress
Conference scientific publication	IoT Week

Table 1: Relevant Journals and Conferences publications

3.2.5 Press releases

Press releases will be edited on a regular basis (approximately every six months) and coincide with key project achievements (e.g. organization of a large event, implementation of key activities within the project, etc.).

Press releases will be published in national and European media, thus contributing to the wider dissemination of the project. All partners will be responsible for engaging with their local media outlets to ensure a wider reach of the press release. All press releases will be published on the project's website.

3.2.6 Videos

Affordable5G will produce about 3 videos per year to present the project and its achievements.

3.2.7 Webinars

A series of webinars (at least 3 by the end of the project) will be organized for general audiences and will be available on the project website as well as on YouTube. After defining important 5G topics, selected experts (both internal and external) will prepare the material in the form of presentations. The topics of these webinars can include aspects relevant for WP1-4 to facilitate dialogue, involvement and the exchange of feedback and experiences with respect to the work of Affordable5G.

The topics can include:

- Time Sensitive Networking and 5G
- Network sharing strategies (e.g. neutral hosting)

3.3 Offline tools and channels

3.3.1 Affordable5G promotional materials

Three **project flyers** will be created and used for informing interested people about the project's objectives and activities. Upon completion, the flyers will be uploaded to the Affordable5G website and shared as printed versions during relevant events.

Moreover, **roll-ups** will be created, matching the look and feel of the website and the overall project design concept to meet the needs of the project.

Posters of a smaller size (A0) will be produced. Affordable5G will also consider producing event focused posters of smaller size, if considered necessary, where the content of the poster will be replaced to fit the needs (theme) of the event.

Both the roll-up and the posters will be prepared in English (local languages to be considered if appropriate or necessary) to raise awareness of the stakeholders and a variety of relevant audiences about the project with succinct textual and graphical information.

Printable versions of the posters will also be created and provided to partners to be printed and used at the events they participate in.

The design will be easily adjustable to the requirements individual partners have, in case an additional or a more specific version is required.

The project logo, the EU flag & acknowledgement along with the Affordable5G website and the social media links will be clearly displayed on all promotional materials.

3.3.2 Events

Events-based dissemination is a critical part of the Affordable5G strategy and activities. It targets liaison with 5G stakeholders via organization of dedicated events, as well as coordinating participation in major EC/Non-EC conferences and events.

The following sections give an overview of the events the Affordable5G consortium intends to organize and attend. Given the current COVID-19 containment measures, however, we expect that many of these events will be cancelled or turned into digital events.

3.3.2.1 Events organization and participation

Throughout the whole project's duration, participation and organization of events in the form of webinars, sessions, workshops, demos, trials, exhibitions, expert panel's discussions, etc., will play a crucial role. We envisage to **organize at least 2 workshops**, pursuing co-location

with major events and coordination on this with other 5G PPP / 5G projects and related national and international initiatives. Of major relevance, will be the annual Mobile World Congress, the annual EuCNC events, the annual Smart City Expo World Congress, the EC Info Days, the ICT Proposers' Days, the ITS World Congress, the Berlin 5G Week, the Connected Smart Cities Conference, the Future Internet Forum, the NGI Forum, the IoT Week, the 5G Global Event, the 5G PPP workshops, the EC relevant events, and any other scientific, technical and industrial venue of high relevance to showcase and promote the project's results. See Table 2 for an overview of relevant events the Consortium will evaluate for co-location and or projects' presentations (virtual editions in some cases due to the current epidemic).

Title of event	Type	Date	Location
EuCNC Summit	To attend – key event	8-11 June 2021	Porto, Portugal
IEEE Global Communications Conference	To attend	7-11 December 2020	Virtual
IEEE Vehicular Networking Conference	To attend	16-18 December 2020	Virtual
IEEE International Conference on Communications	To attend	14-18 June 2021	Montreal, Canada
IEEE Conference on Computer Communications	To attend	10-13 May 2021	Virtual
Mobile World Congress (MWC)	To attend – key event	28 June – 01 July 2021	Barcelona, Spain
Smart City Expo World Congress (SCEW)	To attend – key event	17-18 November 2020	Virtual
MPLS + SDN + NFV + MEC World Congress	To attend	28 September – 1 October 2021	Paris, France
ITS World Congress	To attend	11-15 October 2021	Hamburg, Germany
Connected Smart Cities Conference	To attend – key event	27-29 October 2020	Virtual
The European Big Data Value Forum	To attend	3-5 November 2020, 2020	Virtual
Digital Transport Days 2020	To attend	18 November 2020	Virtual
5G Expo	To attend	24-25 November 2020	Online
Horizon Cloud Summit 2020	To attend	25-26 November 2020	Virtual
CCW Critical Communications World	To attend	8-10 June 2021	Madrid, ES
Small Cells World Summit 2021	To attend	11-12 May 2021	London, United Kingdom

Title of event	Type	Date	Location
Layer123 World Congress: Service Beyond SDN and Network Virtualization	To attend	11-14 October 2021	Virtual
Key events with currently unknown date & location: ETSI 5G Summit European Week of Regions and Cities European Mobility Week EIP SCC events Global 5G events IoT Week NGI Forum ICT Proposers Day Future Internet Forum 5G Action plan events EC Info days Berlin 5G week 5G PPP workshops AWS ReInvent European Microwave Week	To attend	n/a	n/a
5GFORUM (Málaga)			

Table 2: Relevant events considered for wide dissemination

3.3.2.2 Events participation

Although event participation might be hindered due to the current COVID-19 emergency, Affordable5G will try to be presented at a number of events aiming to promote and communicate, by all relevant means and tools, all relevant information that will increase the project´s visibility in terms of the 5G aspects. Participation in events is also an opportunity to increase and strengthen the network of relevant parties interested in becoming part of the Affordable5G audience.

The Affordable5G representation at the events can take place in different ways, including paper or project presentations, poster presentations, simple participation for liaising or networking purposes, workshop organization or general support. Promotional materials such as brochures, a poster or a roll-up (where relevant) will be also used for dissemination purposes.

The consortium has identified a number of events highly relevant to Affordable5G that will be the target for organising workshop sessions, presenting in, or participating in (see Table 2).

3.4 Dissemination and communication recovery plan in times of COVID-19

The current COVID-19 outbreak brings about opportunities and challenges for the community building and communication activities of Affordable5G. To ensure that project outcomes will not be significantly affected by event cancellations due to COVID-19, we will carefully rethink our events. Face-to-face partners meetings and events might have to be organized as a virtual event. The Affordable5G consortium closely monitors the current COVID-19 situation, trying to anticipate early on the next steps that need to be taken.

4 5G PPP COLLABORATION, STANDARDIZATION AND OPEN SOURCE COMMUNITIES

4.1 Liaison with 5G PPP projects

Affordable5G will actively collaborate with other 5G PPP and non-5GPPP projects. Several Affordable5G partners have been or are actively involved in 5G PPP Phase 1, Phase 2, and Phase 3 projects, and have long track record in establishing fruitful liaisons with other projects. As a matter of fact, Affordable5G builds up on previous work that the consortium has performed as part of the aforementioned projects. Table 3 lists the liaisons that will be established, where the participation of several common partners will ensure a successful collaboration and a smoother integration of technologies and concepts. Moreover, the table also lists the participation to 5G PPP and 5G IA of such projects, therefore allowing Affordable5G to be aware of the ongoing and recently finished activities and strengthen the mutual developments within the 5G era.

Phase	Project	Participant WGs	Relation to Affordable5G	Partners Involved
H2020 5G-PPP Phase 2	5G XCAST	5G PPP (Architecture, Spectrum) 5G IA (SMEs)	5G-XCAST enables a dynamically adaptable 5G architecture that allows the interplay between unicast, multicast and broadcast modes by exploiting built-in caching capabilities. Affordable5G can leverage this flexible architecture to satisfy the requirements imposed by different traffic types (e.g., safety warnings together with multimedia content delivery).	-
	5GtangO	5G PPP (Software Networks, Architecture) 5G IA (Security)	5G-TANGO introduces an open-source cloud-native and edge-ready Management and Orchestration (MANO) platform. Affordable5G can take advantage of this orchestration platform for hybrid edge/cloud deployments and integrate it with the Kubernetes Virtual Infrastructure Manager.	ATOS
	5GCity	5G PPP (Steering Board, Technical Board, COMMS, Architecture, Network Management and QoS, Software Networks)	5GCity builds an open, multi-tenant, neutral host platform that extends the centralized clouds to the network's edge. It embeds a slice manager covering network, compute and storage resources spanning from the Radio Access Network (RAN) to the transport domain, thanks to the RAN	ACC, I2CAT, UBI, CEL, INC

Phase	Project	Participant WGs	Relation to Affordable5G	Partners Involved
		5G IA (Pre-standardization, Trials, Security, Vision and Societal Challenges)	Controller that interfaces LTE small cells and Wi-Fi access points. In Affordable5G, such a controller will be the basis for the O-RAN-compliant intelligent.	
	5G-PICTURE	5G PPP (Architecture, Spectrum, Software Networks) 5G IA (5G Pre-standardization, 5G Spectrum, Vision and Societal Challenges)	5G-PICTURE proposes a framework for disaggregated access and backhaul for outdoor Wi-Fi access points. This joint control plane will be enforced and leveraged in Affordable5G to provide a single integrated multi-access solution that can be easily deployed in locations where fibre connection is not available.	I2CAT, EURE
	NRG5	5G PPP (5G Architecture, Software Networks, Network Management and QoS) 5G IA (Security, Trials, SMEs)	NRG-5 provides a decentralized, secure, resilient, and highly available framework to model and virtualize multi-tenant, static and moving hardware-constrained devices, edge resources and services. Affordable5G will integrate in this framework the analytics in the ETSI-MANO processes for optimal Virtual Network Function (VNF) sizing and chaining, to enable a network management consisting of low cost and resource-constrained network devices. Moreover, the extended Multi-access Edge Computing (MEC) open-source software stack providing automated analytic-based VNF management will be exploited to strengthen multi-vendor interoperability.	UMA, NKUA
H2020 5G-PPP Phase 3.1	5Genesis	5G PPP (Steering Board, Technical Board, COMMS, 5G Architecture, Software Networks, Network Management and QoS)	5Genesis implements a 5G testbed to enable dedicated 5G use cases using an end-to-end approach for the experimentation and validation of 5G network Key Performance Indicators (KPIs) and technologies. This facility includes network elements from several	UMA, ATOS, EURE, REL, NEM, ATH

Phase	Project	Participant WGs	Relation to Affordable5G	Partners Involved
		5G IA (5G Pre-standardization, Spectrum, Vision and Societal Challenges, Security, SME, Trials, 5G Automotive)	Affordable5G partners, such as the RAN and core elements. Affordable5G will enhance the facility's components, and use this testbed to validate the MANO capabilities and enhanced services on top of the fully virtualized 5G New Radio (NR) and core network, giving special focus to novel elements such as the LAN over 5G for emergency communications.	
	5GCLARITY	Not publicly available.	5G-CLARITY focus on providing multi-technology access networks and addressing the related to the delivery of critical services, and autonomic network management. Relevant outputs from this project like multi-connectivity and Artificial Intelligence (AI) for network resource management will be considered for intelligence at the edge and the heterogeneous wireless backhaul.	I2CAT, ACC
-	VipGPU	-	VipGPU aims at developing new hardware and software technology to support cutting-edge vertical scenarios, such as robotic, computer vision, and medical virtual reality, leveraging low power Graphics Processing Units (GPUs), hardware accelerators and AI. These activities will be used in Affordable5G to develop an FPGA prototype based on the multicore, and heterogeneous GPUs to optimize edge functions.	THI

Table 3: Liaison of Affordable5G with 5G PPP and non 5G PPP projects

Affordable5G has been retained through the 5G-PPP ICT-42-2020 (5G PPP Phase 3, Part 5 – 5G Core Technologies innovation) call, together with seven more projects namely DRAGON, 5G-LOGINNOV, Int5Gent, 5GMETA, 5G-RECORDS, FUDGE-5G and COREnect. Moreover, 5G PPP Phase 3, Part 5 comprises also three projects in the ICT-53-2020 call – Connected and Automated Mobility (CAM) namely 5G-BLUEPRINT, 5GMED and 5G-ROUTES. In addition to the liaisons previously described with ongoing projects, Table 4 depicts the

descriptions and collaborations that can be found in the intersection of technologies and use cases of the projects accepted in the same call due to the sharing of common objectives.

Phase	Project	Description and possible synergies	Common Partners
5G Core Technologies innovation	DRAGON	DRAGON focuses on the exploitation of the radio spectrum in D-band with steering functionality to enable the wireless links on the same level of optical systems and provide cost efficient deployments. These concepts could be of interest for Affordable5G to strength the envisioned wireless backhaul.	TBD
	5GLOGINNOV	5G-LOGINNOV aims at designing a framework addressing integration and validation of CAM technologies in relation to the Industry 4.0, new types of Internet of Things (IoT) 5G devices, and data analytics for city ports. Despite ports being the main target of this project, common interest between 5G-LOGINNOV and Affordable5G is found in the objective of minimizing the disturbance to urban environments. Therefore, the integration of IoT devices, as well as the data-enabled traffic management could be a joint point for mutual collaboration.	TBD
	Int5Gent	In5Gent targets the integration of innovative technological solutions under a flexible 5G network resource, slice, and application orchestration framework. Including flexible multi Radio Access Technology (RAT), mmWave technology and hardware-based edge processor, it aims to promote edge processing and the overlay of vertical services applications. The low latency, slicing and edge self-management capabilities pursued in Affordable5G are fully in harmony with this project, where common use cases such as the smart IoT scenarios can be also found.	TBD
	5GMETA	5GMETA has as principal objective the creation of a flexible telematics platform leveraging car-captured data to facilitate and feed third-parties' products and services according to data licenses, where	TBD

Phase	Project	Description and possible synergies	Common Partners
		data liability and billing will be ensured. Given the secure and private pipeline that manages data computing and service/geo clustering, a fruitful interplay with Affordable5G could be found on the capture of smart cities images in a scenario of citizen security surveillance.	
	5G RECORDS	5G-RECORDS targets the development, integration, and validation of 5G components for end-to-end professional content production based on non-public networks. The expertise of the common partners in Affordable5G can bring valuable synergies for both projects in the prototyping of both private and non-public 5G networks together with the cooperation of cloud and edge technologies.	ACC, EURE
	FUDGE-5G	FUDGE-5G aims to take a step forward in realizing highly customized cloud-native 5G private networks by enhancing the 5G service-based architecture and offering a disintegrated, agnostic environment in the form of micro-services (edge, on premises and cloud). As FUDGE-5G, Affordable5G focuses on private 5G networks to validate the technology readiness, thus opening the door for defining new common use cases and extensions.	ATH
	COREnect	COREnects pursues a sustainable European technology sovereignty in 5G and beyond to lay a solid foundation between Smart Networks and Services, Key Digital Technologies, High-Performance Computing, Artificial Intelligence, IoT, etc. Since this project will cover the full 5G value chain including components and connectivity platforms, and will address vertical industry sectors like smart cities and automotive, it will be a beneficial collaboration in terms of technologies and use cases not only with Affordable5G but with all the projects in 5G PPP Phase 3.5.	TBD

Phase	Project	Description and possible synergies	Common Partners
5G for Connected and Automated Mobility	5GMED	5GMED focuses on demonstrating advanced Cooperative, Connected and Automated Mobility (CCAM) and Future Railway services on a self-sustainable 5G network enabled by a multi-stakeholder compute a network infrastructure building on neutral hosts and offering support for AI functions at the edge of the network. Affordable5G can identify symbiosis with this project in both technical aspects (execution of AI functions at the edge, and automated service orchestration) and common future use cases based on self-managed edge driving functions empowered by telemetry data.	CELL, I2CAT, 8BE, ATOS
	5G ROUTES	5G-ROUTES has as main objective the integration in cross-border CAM field trials of enabling technologies such as AI-based network slicing, AI-based distributed MEC, combined with commercial 5G base stations, on-board units, IEEE 802.11p connectivity, etc. The work of Affordable5G in automated slice management as well as the strong relationship with advanced service orchestration at a distributed MEC site enabled by AI could be prime collaboration points with this project.	ATOS
	5G BLUEPRINT	5GBLUEPRINT aims to design a 5G network for teleoperated transport services with stringent latency, reliability, and throughput requirements, investigating real-time data exchange between vehicles and infrastructure to reduce cost and increase the deployment speed. The service orchestration, migration and synchronization envisioned in Affordable5G as well as the involvement of AI not only for components automation but also in terms of edge video processing can compose a beneficial nexus of technological ideas with 5GBLUEPRINT.	MARTEL

Table 4: Relationship of Affordable5G with 5G PPP Phase 3 Part 5 projects

4.2 Interaction with 5G PPP working groups

Table 5 lists the principal participation of the Affordable5G's consortium to various 5G PPP and 5G IA Working Groups (WGs). Each entry contains the relevance for the projects, the objectives, and the main activities to be carried out, as well as the representatives responsible for following and contributing to each initiative.

WG	Relevance	Objective and main activities	Representative 1	Representative 2
5G PPP SME	High	Enhance, facilitate and promote the SME contribution to 5G infrastructure; Improve the visibility of SMEs in 5G PPP.	Israel Koffman (RunEL)	Eneko Atxutegi (NEM)
Software Networks	High	Contribute to the hybrid virtualized deployments encompassing Edge and Cloud infrastructures	Josep Martrat (Atos)	Sergio González (Atos)
Pre-Standardization	Low	Develop the B5G/6G standardisation roadmap to align H2020/HE projects with the releases of the relevant SDOs	Josep Martrat (Atos)	Aurora Ramos (Atos)
5G IA Vision and Societal Challenges	High	Definition of new business models; Contribution to white papers on the technologies developed in the project.	Ioannis Neokosmidis (INC)	Theodoros Rokkas (INC)
5G IA 5G Pre-standardization	Medium	Identify standardization and regulatory bodies to align with e.g. ETSI, 3GPP, IEEE and other relevant standards bodies, & ITU-R (incl. WPs) and WRC (including e.g. ECC PT1); Potentially propose where topics should be standardized; Influence timing on R&D work programs (e.g. EC WPs).	Giovanni Rigazzi (i2CAT)	

5G Automotive	Low	Applicability of 5G connectivity to Cooperative, Connected and Automated Mobility (CCAM), in the context of cross border trials along 5G corridors, in line with the cases described in 3GPP Release 16.	Elisa Jimeno (Atos)	TBD
5G Trials	Medium	To increase visibility of field trials in experimental 5G networks	Pedro Merino (UMA)	TBD
5G Architecture Working Group	Medium	To facilitate the discussion on the development of 5G architectural concepts and components.	NKUA	TBD

Table 5: Participation of the Affordable5G to the 5G PPP Working Groups

4.3 Standardization activity plan

4.3.1 Overview

In this section we present the standardization activity plan laid out in Affordable5G. First, we introduce each standardization body relevant to the project and identify the potential impact of this project. Next, we present a standardization roadmap and how it fits into the timeline of each standardization entity. As denoted in the project proposal, Affordable5G plans to make three contributions into any of the targeted standardization body.

4.3.2 3GPP

3GPP covers cellular telecommunications technologies, including radio access network (RAN), core network (CN) and service capabilities, which provide a complete system description for mobile telecommunications. The 3GPP specifications provides hooks for non-radio access to the core network, and for interworking with non-3GPP networks. 3GPP specifications and studies are contribution driven, by member companies, in Working Groups and at the Technical Specification Group level. The three Technical Specification Groups (TSG) in 3GPP are; Radio Access Networks (RAN), Services & Systems Aspects (SA), Core Network & Terminals (CT).

As shown in Figure 12, 3GPP connects seven standard development organizations (Association of Radio Industries and Businesses (ARIB), Alliance for Telecommunications Industry Solutions (ATIS), China Communications Standards Association (CCSA), ETSI, Telecommunications Standards Development Society of India (TSDSI), Telecommunications Technology Association (TTA), Telecommunication Technology Committee (TTC)), known as “Organizational Partners (OPs),”, which take part in the project coordination group, whose responsibility is to manage and coordinate activities inside the three technical specification groups. Furthermore, written contributions are submitted to 3GPP meetings by 3GPP member organizations. The meeting calendar describes the schedule of the meetings. 3GPP Release cycle is approximately 15 months. There are plenary sessions that approve the content of the release before the release cycle starts.

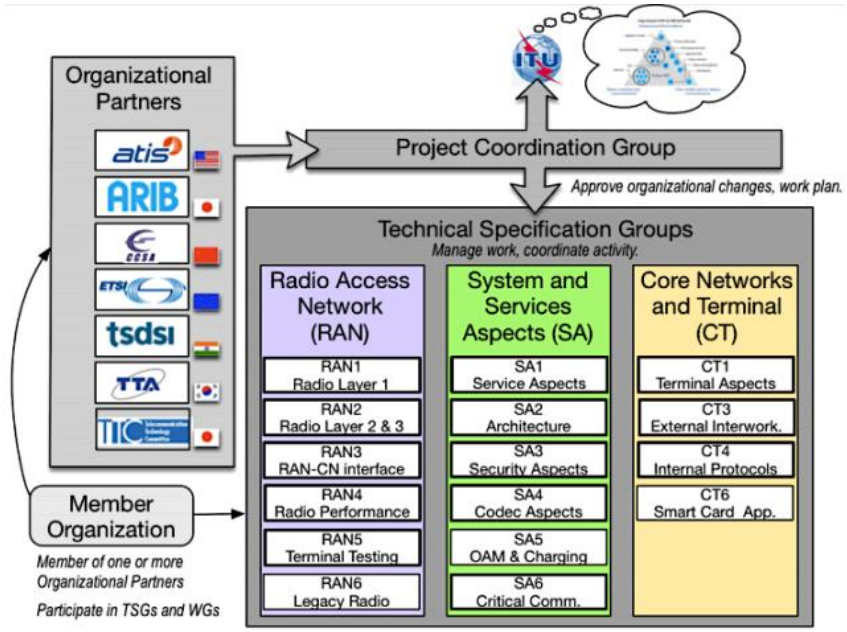


Figure 12: 3GPP organization and structure.

3GPP is the main SDO in the Affordable5G project targeting at specifications of radio access networks (RAN) and core networks (CN) of cellular communication systems. As shown in Figure 13, Release 17 is anticipated to be completed at the end of 2021 and Release 18 is expected to define its content between 2020 and 2021. As a result, Affordable5G is expected to be able to impact 3GPP activities in Release 17 and to set the stage for new study items that may be covered in Release 18. Several Study Items (SI) and Working Items (WI) relating to this project have been identified by 3GPP in SA and RAN working groups in release 17, addressing aspects such as Industrial IoT & Ultra-Reliable and Low Latency Communications (URLLC), Non-Public Networks, 5G-Local Area Network (LAN) type service, Edge Computing on 5G Core (5GC).

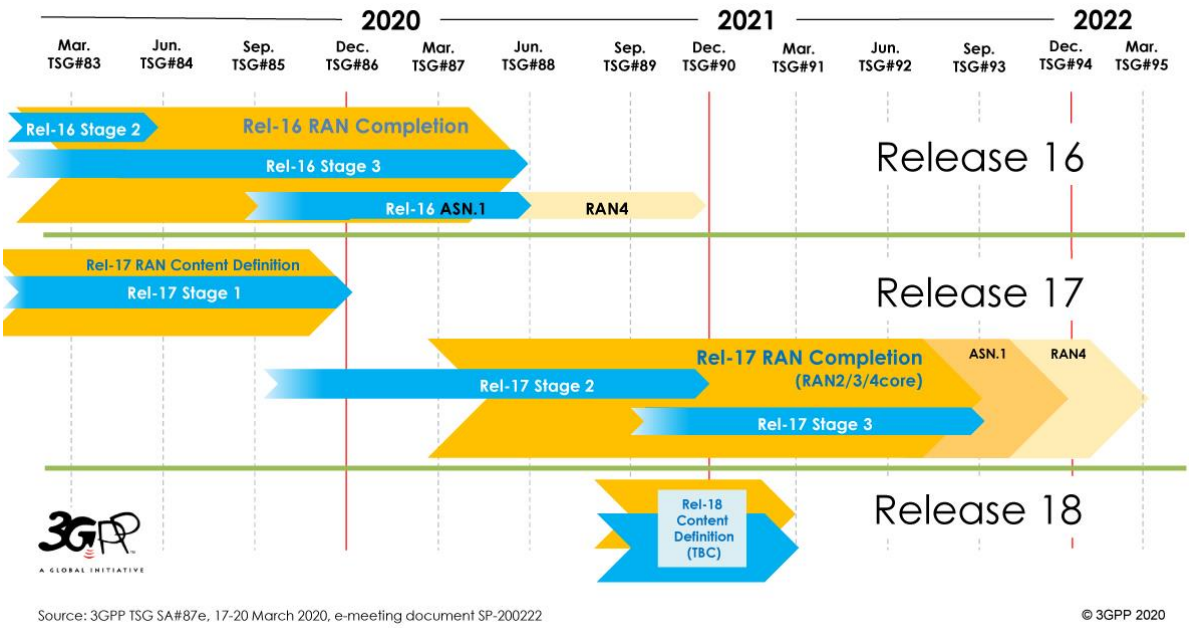


Figure 13: 3GPP standardization timeline.

4.3.3 ETSI

The European Telecommunication Standardization Institute (ETSI) is a non-for-profit SDO that produces globally applicable standards for the ICT industry. It scopes multiple technology areas, including fixed, mobile, radio, broadcast, multimedia, internet and aeronautical, among others. To ensure ETSI outcomes are of high quality and produced efficiently, ETSI standardization work follows a proven standards-making process based on consensus and openness. Most of this technical work is carried out by committees. These committees meet typically between two and six times and year, either on ETSI premises or elsewhere. There is a range of different types of committees for different tasks:

- Technical Committees – responsible for the definition of different work programmes, each addressing various standardization activities in a given technology area. To fulfil these activities, every work programme is made up of individual work items. Each technical committee establishes and maintains a different work programme. Collectively, the work programmes of all ETSI technical committees constitute the ETSI Work Programme.
- ETSI Projects – similar to technical committees, but with two main differences: o they are established to meet a particular market sector rather than centred around a basic technology; o they last for a fixed period, as they can be discontinued after the necessary work is done, i.e. when the market requirements cease to exist.
- ETSI Partnership Projects – set up when there is a need to cooperate with complementary organizations to achieve a standardization goal. Examples of these projects are 3GPP and oneM2M [3].
- Industry Specification Groups (ISG) – operate alongside the traditional standards-making mechanisms, focusing on a very specific activity. ISGs are self-contained, decide their own work programme and approve their own technical documents. These documents can be of two types: informative documents (Group Report, GR) and standards documents (Group Specifications, GS). Figure 14 shows the interactions of these groups with other bodies, including Special Committees, General Assembly and ETSI board.

Affordable5G will keep track of the standardization activities carried out in four ETSI ISGs:

1. NFV (Network Functions Virtualization),
2. MEC (Multi-access Edge Computing),
3. CIM (Context Information Management),
4. CDP (City Digital Profile).

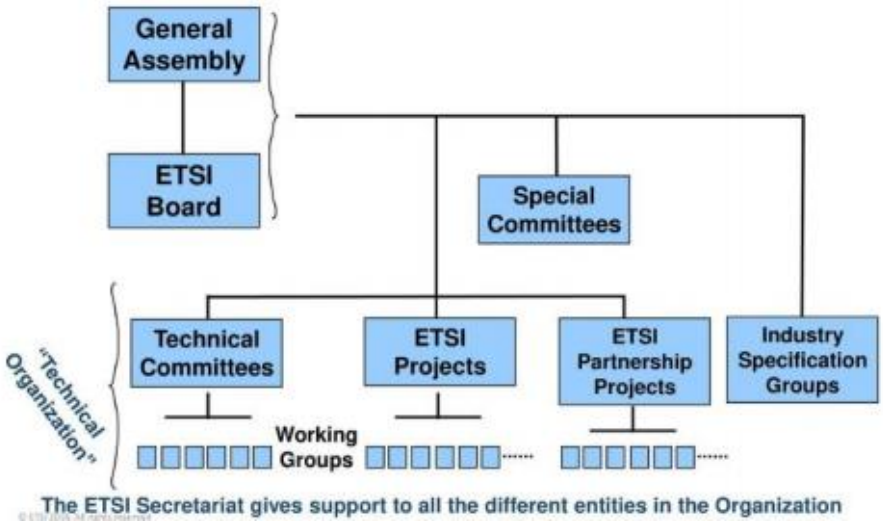


Figure 14: ETSI internal structure.

4.3.4 RISC-V

RISC-V is an open standard instruction set architecture (ISA) based on the reduced instruction set computer (RISC) principles and fostered by the RISC-V Foundation built in 2015. Differently from other ISA designs, the RISC-V ISA is provided under open source licenses not requiring fees to use. A number of companies are offering or have announced RISC-V hardware, open source operating systems with RISC-V support are available and the instruction set is supported in several popular software toolchains.

Fundamentally, RISC-V is a classic RISC architecture rebuilt for modern times and gets its name as the fifth major RISC architecture to come from University of California, Berkeley. It consists of an array of 32 registers containing the processor running state, the data being immediately operated on, and housekeeping information. This array is large enough to minimise the need to access external memory for a lot of basic CPU tasks, which reduces energy use and increases speed. RISC-V comes in 32-bit and 64-bit variants, with register size changing to match. A 128-bit version is also underway.

The core RISC-V specification is certified to be free of patent encumbrance and is licensed under Creative Commons CC BY 4.0. This does not require or mean that extensions have to be similarly free and open: designers can include licensed aspects in their additions if they wish. The key point is that the architecture is extensible without losing efficiency.

Figure 15: RISC-V foundation.

The RISC-V Foundation includes now more than 200 members, including Samsung, Google, Nvidia, Western Digital, NXP, Micron and Qualcomm, not to mention Raspberry Pi. The foundation also strongly encourages organizations, individuals, and enthusiasts to join the ecosystem and together enable a new era of processor innovation through open standard and open source collaboration.

4.3.5 CNCF

The Cloud Native Computing Foundation (CNCF) is a Linux Foundation project founded in 2015 to enhance container technology. Nowadays, CNCF is joined by over 450 members.

CNCF projects are classified with a maturity level of Sandbox, Incubated and Graduated, and the defined criteria include rate of adoption, longevity, and whether the project can be relied upon to build a production-grade product.

Graduated projects include Containerd, CoreDNS, Envoy, Fluentd, Helm, Jaeger, Kubernetes, Prometheus, the Update Framework and Vitess.

Incubated projects include Argo, CloudEvents, CNI, Contour, Cortex, CRI-O, etcs, Falco, gRPC, Harbor, Kong, Linkerd, Litmus, NATS, Notary, Open Policy Agent, OpenTelemetry, Rook, Thanos and TiKV.

Furthermore, CNCF is particularly active in setting up initiatives to support the cloud native community. For example, CNCF hosts events and conferences together with KubeCon and CloudNativeCon, and offers scholarships and travel grants. Finally, CNFS introduced the Kubernetes software conformance and training programme, where vendors can prove that their products are conformant with a set of core Kubernetes APIs and interoperable with other Kubernetes implementations.

Within Affordable5G, CNCF represents a key entity in terms of providing novel developments and enhancements in the MEC-oriented projects. As an example, KubeEdge [*https://kubeedge.io/*], an open-source project for extending native containerized application

orchestration capabilities to hosts at the Edge, will be a potential platform upon which developing and validating extensions and advancements.

4.3.6 O-RAN

The O-RAN Alliance is an initially operator-founded industry alliance later joined by vendors, system integrators, software component providers, hardware component providers which seeks to define Next Generation RAN Architecture and Interfaces leading the industry towards open, interoperable interfaces and RAN virtualization. O-RAN Alliance members and contributors have committed to evolving radio access networks towards a foundation of virtualized network elements, white-box hardware and standardized interfaces that fully embrace its core principles of intelligence and openness. The O-RAN Alliance's work will embody two core principles:

- Openness: bringing service agility and cloud scale economics to the RAN requires open interfaces to enable smaller vendors and operators to introduce their own services or customize the network to suit their own unique needs. Open interfaces also enable multi-vendor deployments, enabling a more competitive and vibrant supplier ecosystem. Similarly, open source software and hardware reference designs enable faster, more democratic and permission-less innovation
- Intelligence: networks are becoming increasingly complex with the advent of 5G, densification and richer and more demanding applications. To tame this complexity, the industry cannot use traditional human intensive means of deploying, optimizing and operating a network. Instead, networks must be self-driving, they should be able to leverage new learning-based technologies to automate operational network functions and reduce Operational Expenditure OPEX. The ORAN alliance strives to leverage emerging deep learning techniques to embed intelligence in every layer of the RAN architecture. Embedded intelligence, applied at both component and network levels, enables dynamic local radio resource allocation and optimizes network-wide efficiency. In combination with standardized southbound interfaces, AI-optimized closed-loop automation is achievable and will enable a new era for network operations.

The reference O-RAN Architecture leverages on the definition of 3GPP RAN split architecture (Centralized Unit [CU], Distributed Unit [DU], Radio Remote Unit [RRU]) and 3GPP interfaces enabling Control User Plane Separation (E1 interface between CU CP and CU UP), interoperability between CU and DU via F1 interface, etc). Furthermore, O-RAN defines further interfaces like O1 for the management/orchestration of RAN functions and the A1 for enabling the split of RAN network functions between Real Time and non-Real Time functionality in an interoperable manner. Figure 16 shows the O-RAN Reference Architecture.

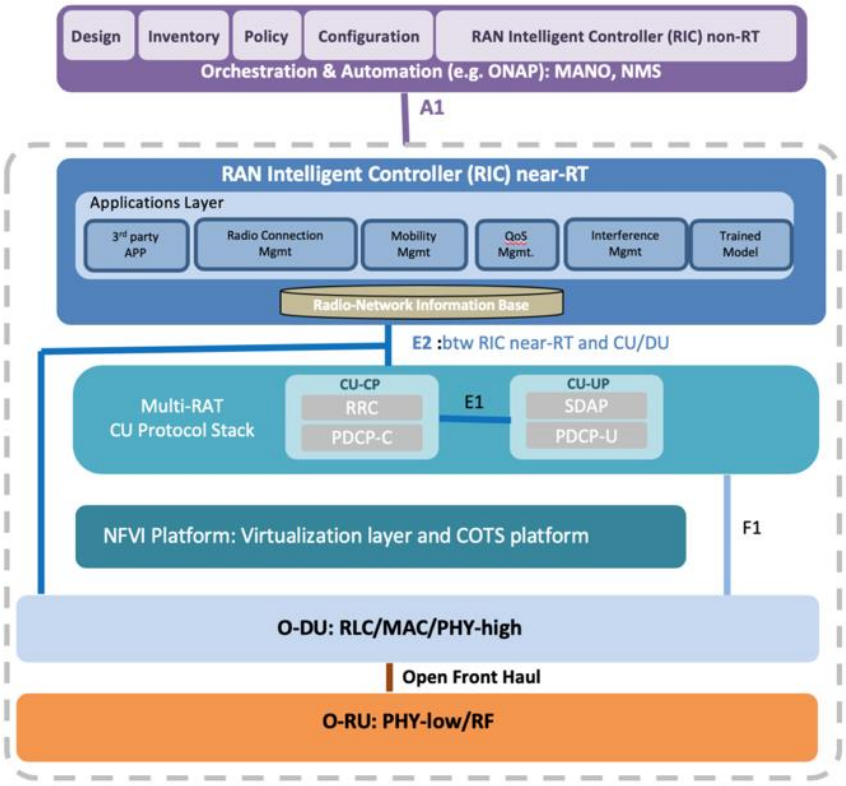


Figure 16: O-RAN reference architecture.

The O-RAN Alliance is composed of the following workgroups and committees.

- Operator Working Group
- Technical Steering Committee
- Technical Working Groups, including
    - **WG1 - Use Cases and Overall Architecture Workgroup.**
      It has overall responsibility for the O-RAN Architecture and Use Cases. It identifies tasks to be completed within the scope of the Architecture and Use Cases and assigns task group leads to drive these tasks to completion while working across other O-RAN work groups.
    - **WG2 - The Non-real-time RAN Intelligent Controller and A1 Interface Workgroup**
      The primary goal of Non-RT RIC is to support non-real-time intelligent radio resource management, higher layer procedure optimization, policy optimization in RAN, and providing AI/ML models to near-RT RIC
    - **WG3 - The Near-real-time RIC and E2 Interface Workgroup**
      The focus of this workgroup is to define an architecture based on Near-Real-Time Radio Intelligent Controller (RIC), which enables near-real-time control and optimization of RAN elements and resources via fine-grained data collection and actions over E2 interface.
    - **WG4 - The Open Fronthaul Interfaces Workgroup**
      The objective of this work is to deliver truly open fronthaul interfaces, in which multi-vendor DU-RRU interoperability can be realized.

- **WG5 - The Open F1/W1/E1/X2/Xn Interface Workgroup**
  The objective of this work is to provide fully operable multi-vendor profile specifications (which shall be compliant with 3GPP specification) for F1/W1/E1/X2/Xn interfaces and in some cases will propose 3GPP specification enhancements.
- **WG6 - The Cloudification and Orchestration Workgroup**
  The cloudification and orchestration workgroup seeks to drive the decoupling of RAN software from the underlying hardware platforms and to produce technology and reference designs that would allow commodity hardware platforms to be leveraged for all parts of a RAN deployment including the CU and the DU.
- **WG7 - The White-box Hardware Workgroup**
  The promotion of white box hardware is a potential way to reduce the cost of 5G deployment that will benefit both the operators and vendors. The objective of this working group is to specify and release a complete reference design to foster a decoupled software and hardware platform.
- **WG8 - Stack Reference Design Workgroup**
  The aim of this workgroup is to develop the software architecture, design, and release plan for the O-RAN Central Unit (O-CU) and O-RAN Distribute

- Focus Groups
  - **OSFG - Open Source Focus Group**
  - **SDFG - Standard Development Focus Group**
  - **TIFG - Test & Integration Focus Group**

Finally, Table 6 gives an overview of the partners involved in standardization activities and related topics of interest in Affordable5G.

Relevant SDO	Description of activities	Partners
3GPP	Potential contributions targeting the TSG RAN • RAN1(Physical layer) • RAN2 (Radio layer 2 and 3) Work related to mission critical services will be also monitored.	RunEL, NEM, EURE
ETSI	Affordable5G aims to contribute to ETSI NFV plugtests as well as to extend MANO functionalities through participation in OSM. Furthermore, contributions will be expected in the following areas: • MCPTT (Mission Critical Push-to-Talk) plugtests • ISG CIM (Context Information Management) • ISG MEC (Multi-Access Edge Computing) • CDP (City Digital Profile)	ATHONET, ADVA, ATOS, NEM, UBIWHERE
O-RAN	Many project assets are being developed according to O-RAN specifications. O-RAN	EURE, I2CAT, ACC, ADVA

Relevant SDO	Description of activities	Partners
	API specification will be extended through technical contribution throughout the project lifetime.	
RISC-V	The NNVM/TVM framework will be enhanced and customized to the RISC-V, GPU-based HW accelerators of THINKS.	THINKS
CNCF	Within the scope of Affordable5G, new extensions related to MEC projects, such as KubeEdge, will be provided.	MAR, ATOS

Table 6: Overview of the relevant SDO and partners involved

4.3.7 Standardization roadmap

Figure 17 presents the standardization activity roadmap expected until 2022. This is also aligned with the Affordable5G activities roadmap, which is anticipated to provide a standardization report each year.

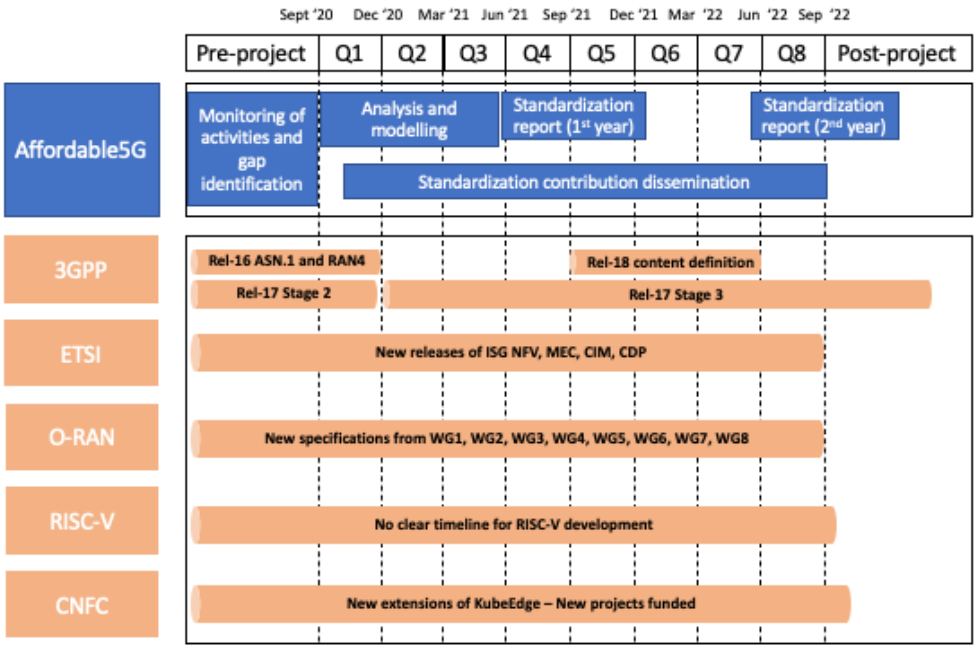


Figure 17: Affordable5G Initial standardization roadmap and alignment with the SDOs.

4.4 Open Source Communities

Nowadays there are several open-source initiatives and communities oriented to support the key radio, edge and software management and orchestration building blocks. In the following subsections the main projects are introduced and related to the impact and how they can be adopted in Affordable5G.

4.4.1 OpenAirInterface

The OpenAirInterface Software Alliance (OSA) is a non-profit consortium coordinating a community of industrial as well as research entities for open-source software and hardware development targeting core network (EPC), access network and user equipment (EUTRAN) of 3GPP cellular networks. The Alliance fosters the initial work of EURECOM to create OpenAirInterface towards development of 5G Cellular Stack on Commercial Off-The-Shelf (COTS) hardware.

OAI includes two key features:

- An open-source software implementation of the 4G mobile cellular system, fully compliant with the 3GPP LTE standards and suitable for real-time indoor/outdoor experimentation and demonstration.
- A built-in emulation capability that can be used in the same real execution environment to seamlessly transition between real experimentation and repeatable and scalable emulation.

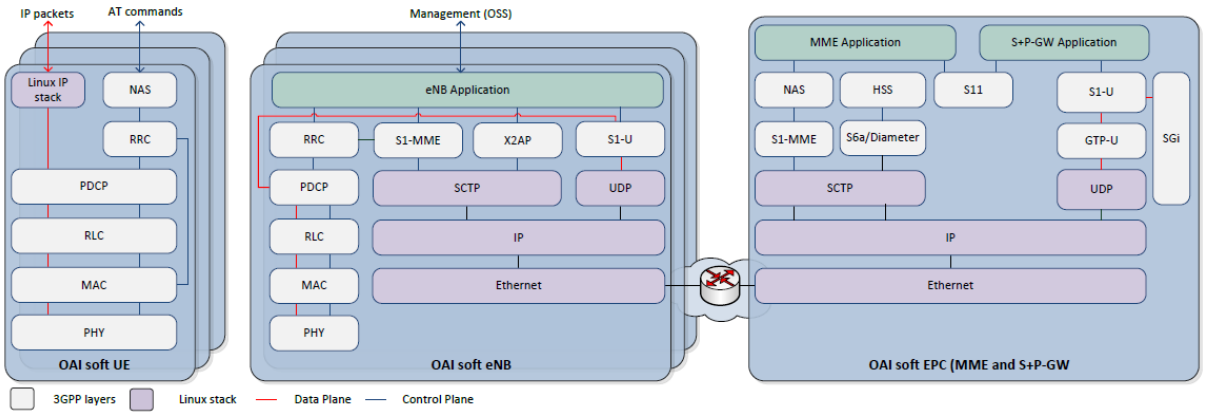


Figure 18: OAI software architecture for UE, eNB and EPC.

Figure 18 shows the software architecture for the UE, eNB and EPC, including the specific layers of the LTE protocol stack.

The OSA uses different licenses to distribute software and documentation and to accept contributions from individuals and corporations. Figure 18 illustrates the OAI software packages and the related licenses.

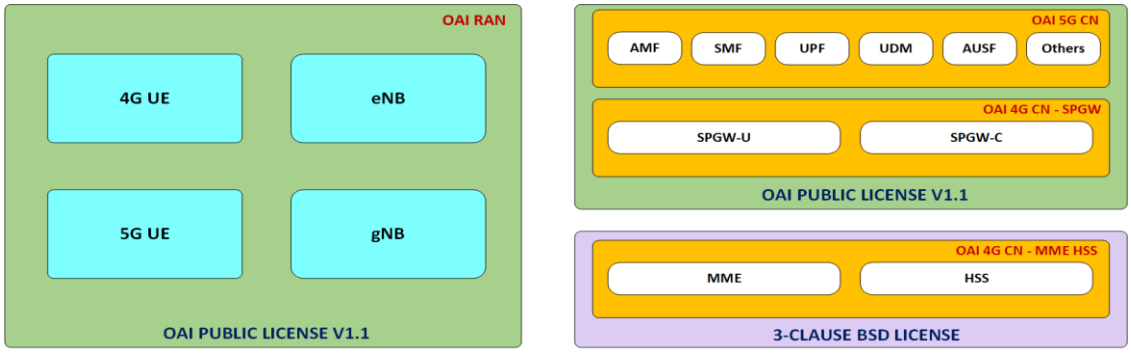


Figure 19: Licenses for the different OAI software packages.

The OAI Public License V1.1 is a modified version of Apache V2.0 License, with the modified patent clause that allows contributing parties to make patent license available to third parties under fair, reasonable and non-discriminatory (FRAND) terms for commercial exploitation. Moreover, the availability of OAI code is free for non-commercial/academic research purposes.

Currently, the OAI source code is split into:

1. OAI-RAN, implementing 4G LTE and 5G radio access network, and hosted on GITLAB.
2. OAI-CN, implementing the 4G LTE EPC and the 5G core network.

OSA has also recently announced the release of the 3GPP 5G Service-based architecture core network, with an initial set of features already available, such as AMF and SMF, while the UPF is still under development.

4.4.2 Free5GC

The free5GC is an open-source project for 5th generation (5G) mobile core networks led by the National Chiao Tung University (NCTU). The ultimate goal of this project is to implement the 5G core network (5GC) defined in 3GPP Release 15 (R15) and beyond. This is achieved by developing all the components in Go.

The current roadmap of the project is the following:

- Stage 1 – Released in January 2019 and with the object of migrating 4G EPC into 5GC Service-Based Architecture (SBA)
- Stage 2 – Released in October 2019 and with the goal of implementing the standalone 5GC features
- Stage 3 – Released in April 2020 and with the goal of delivering a fully operational 5GC

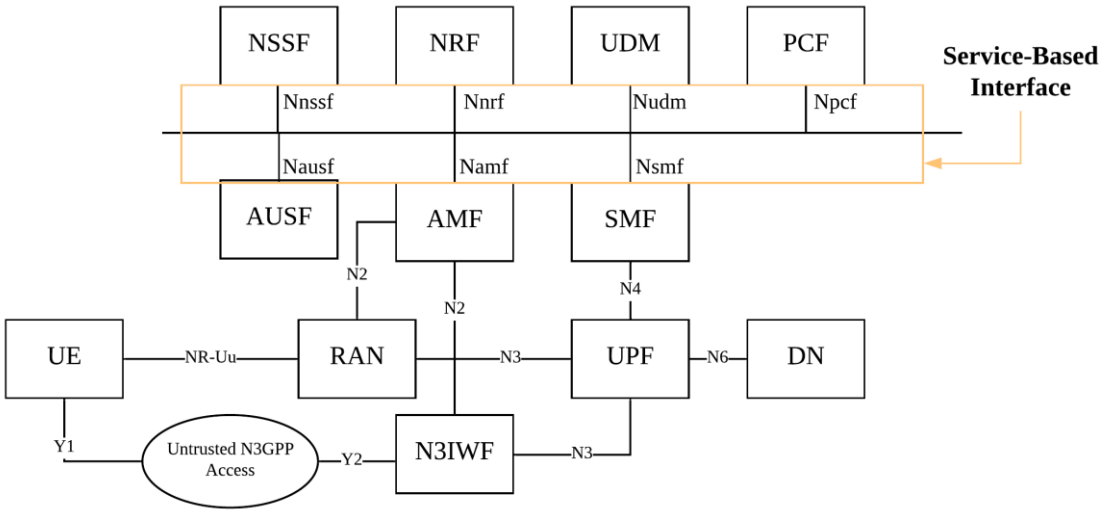


Figure 20: Stage 2 architecture of free5GC.

Except for stage 1, the license of free5GC follows Apache 2.0. As a result, anyone can use free5GC for commercial purposes for free. Furthermore, free5GC features a premium membership program where developers can ask technical questions and receive feedback from the project consortium.

4.4.3 OPNFV

OPNFV (Open Platform for NFV) is an open-source platform federated by the Linux Foundation for network function virtualization, whose components evolve in lockstep with upstream communities. The initial spotlight of OPNFV was mainly on the NFV infrastructure layer, comprising the Network Function Virtualization Infrastructure (NFVI) and the Virtualized Infrastructure Manager (VIM), and the alignment of the interfaces between such components with the aim of providing a modular framework for NFV deployment open to all industry participants. In the O-RAN architecture OPNFV is one of the communities supporting the NFVI function. OPNFV admits the adoption of external upstream open-source projects and provides integration resources and testing tools that become part of the initiative. OPNFV has a tight relationship with ETSI with the goal of promoting open NFV standards.

The strong relationship with O-RAN and ETSI makes this initiative key for Affordable5G. It will represent a natural component in the NFV infrastructure, as the cellular architecture will be aligned with the ongoing O-RAN standardization and interfaces. Therefore, it will facilitate an active participation and contribution in the community.

4.4.4 Kubernetes

Kubernetes in an open-source engine by Google that automates the deployment, scaling and orchestration of Linux containers. Since 2015, Kubernetes has attracted great attention from the NFV industry and Mobile Network Operators (MNOs), especially with respect to Containerized Network Functions (CNFs) due to the light weight, scalability and efficiency for service management and migration. Kubernetes abstracts and represents entities that describe the VNFs or applications running on the Kubernetes cluster, as well as their available resources, isolation and expected behaviour following a master-workers architecture.

In a path towards a service-based architecture converging automated network slicing, distributed micro-services, synchronization between MEC and cloud sites, and an edge AI platform within Affordable5G, Kubernetes provides an efficient, scalable, cloud-native approach to deploy the data analytics, AI services and MEC applications closer to the UE, and a common model to be deployed at the edge and at cloud sites in a distributed manner. At the same time, enhancements proposed on Kubernetes (especially in what concerns acceleration and automation) are envisioned to be presented during the life of the project in events of the community such as Kubecon and CloudNativeCon.

4.4.5 EdgeX

EdgeX (EdgeX Foundry) is an open-source project hosted by the Linux Foundation Edge**.** aiming at building a common micro-service (in the form of containers) platform for IoT edge. The Linux Foundation Edge is a specific umbrella covering an open and interoperable framework for edge computing that comprises several projects enabling low latency and fast processing at the network's edge. Initially, EdgeX was developed to standardize edge computing for Industrial Internet of Things. The platform is completely agnostic to the hardware and operating systems and enables a plug-and-play component ecosystem that simplifies the design, development, and deployment of services across industrial and enterprise applications. The southbound interface is the source of data from the IoT devices, while the northbound represents the nexus with the cloud computing site and it is used to store, analyse,

and integrate the data. This design enables edge analysis and intelligent services, as well as scheduling, alerting, and logging services.

EdgeX is currently being used by various industries including smart cities, manufacturing, energy, and transportation. This tightly relates with the necessities of the smart cities IoT deployment to be showcased in Affordable5G, where the output of various IoT devices must be explored at the edge for dangerous situation detection. Since some of this data could represent a considerable volume, the synchronization with IoT application devices and cloud sites offered by EdgeX can be of substantial benefit. Conversely, improvements to these synchronization mechanisms can be proposed by the technical work packages of Affordable5G to lower the latency induced in the backhaul.

4.4.6 OSM

The Open Source MANO (OSM) is an open-source project for the development of an End-to-End (E2E) network service orchestration framework aligned with ETSI NFV specifications. It is an ETSI-hosted initiative that aims to provide a software solution that facilitates the use of maturation of NFV technology, gives access to a huge ecosystem of VNF vendors, and allows testing and monitoring between the orchestrator and the rest of elements (Network Functions Virtualization Infrastructure [NFVI], VNFs and Physical Network Functions [PNFs], etc.). Although it was originally focused on NFV Management and Orchestration (MANO), the scope of OSM is currently more ambitious, with the definition of a micro-service architecture composed of fine-grained modules carrying out activities beyond NFV scope, including:

- **Network slicing management**, with the definition of an Information Model (IM) that support slicing through the definition of Network Slice Templates (NSTs), for the deployment and operation of instances from different network slices. OSM IM extends existing NFV information models, i.e. NSDs and VNFDs, with the incorporation of 3GPP-based slicing parameters (e.g. Single-Network Slice Selection Assistance Information [S-NSSAI], 5G Quality of Service Indicator [5QI]) and considering isolation settings across Network Slice Instances (NSIs) (e.g. VNF sharing).
- **NF application layer configuration and management**, over deployed VNFs, PNFs and Hybrid Network Functions (HNFs). This allows OSM to also take the role of Element Managers (Ems), today falling out of the scope of NFV.
- **Policy-based performance assurance and fault supervision**, with the definition of a monitoring module (MON) and a policy module (POL) that enables OSM to create, manage and trigger alarms based on NFVI and VNF metrics.

OSM is one of the first projects of the OSG (Open Source Group), an ETSI entity that allows opensource projects to be developed under ETSI, and that has strong connection with the European Commission to foster their use in European research projects. Similarly, to OpenStack, releases in OSM are based on six-month cycles. OSM releases are delivered biannually, and they are named with a number name in capital letters: (ZERO, ONE, TWO). Current software version is OSM Release SEVEN. The project developers agree on a blueprint for each coming release by deciding on priorities over different evolution proposals.

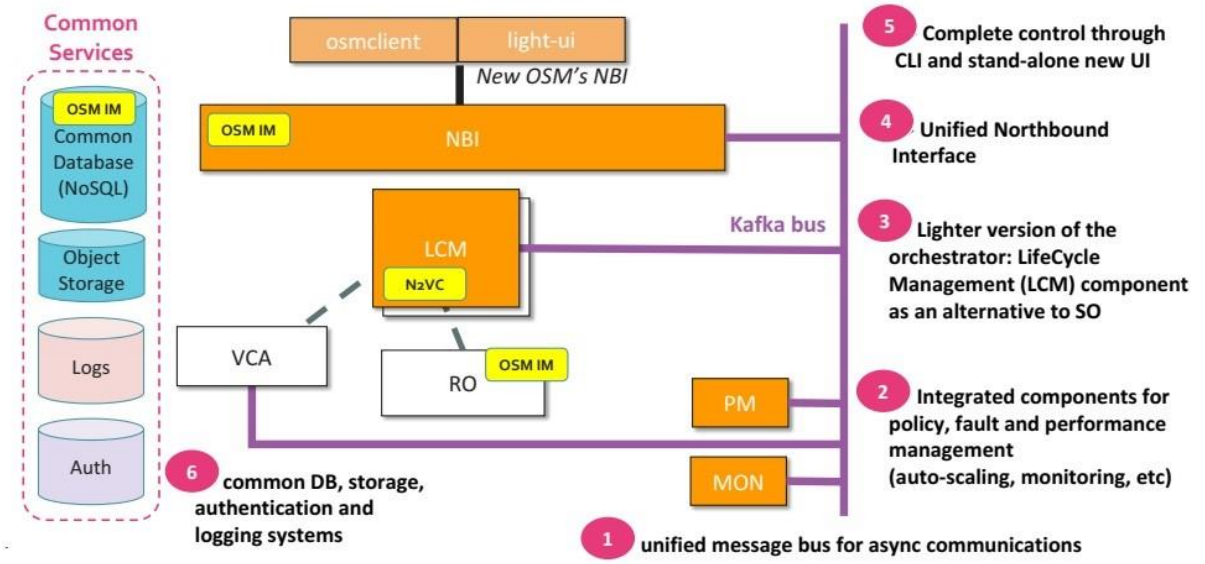


Figure 21: OSM architecture.

4.4.7 Akraino

Akraino Edge Stack provides a set of blueprints for MEC deployments leveraging the open-source community of the Linux Foundation Edge in conjunction with keystone projects such as OPNFV and EdgeX. In particular, Akraino is designed as a fully functional edge stack to support high-availability cloud services optimized for edge computing applications by relying on KubeEdge, a framework to extend Kubernetes with support for cloud-edge orchestration using low-cost devices and oriented to many costumers and small businesses. Akraino supports cloud-native VNFs and edge applications deployment in the form of VMs, containers, and micro-services to build an infrastructure that provides zero-touch provisioning, operations, and lifecycle, reducing Operational Expenditures (OPEX). It is expected that Akraino will support any type of access methodologies such as 4G/LTE, 5G, Wi-Fi, etc.

In Affordable5G Akraino will be used to deliver edge nodes and orchestrates edge services. Moreover, as Akraino seeks to introduce a new high-capacity service infrastructure for smart cities, and a network cloud to enable edge media AI analytics, the outputs of Affordable5G can be presented to the Akraino's community, as the use cases piloted within the project serve as a major test set for the new functionalities pursued by the open-source initiative.

4.4.8 NFV MANO

Network Function Virtualization Management and Orchestration (NFV MANO) is a software framework led by ETSI defining how VNFs are provisioned, their configuration and also the deployment of the infrastructure upon it will run. Figure 22 gives an overview of the NFV MANO architecture and its building blocks. NFV MANO is built around four main blocks:

- **Entities**

  These are the key elements of the ETSI MANO based environment and consists of

  - **Virtual Network Functions** (VNF), virtualized task formerly carried out by proprietary, dedicated hardware,
  - **Physical Network Function** (PNF), purpose-built hardware that provides a specific networking function, i.e. firewall.,

- **Virtual Deployment Unit** (VDU), Represents the VM that will host your virtual function,
- **Virtual Link** (VL), provides connectivity between VNFs,
- **Connection Point** (CP), the corresponding connection points for the virtual links,
- **Network Service** (NS), a set of VNFs, VNF Forwarding Graphs, VLs, and CPs that together form a 'network service',
- **VNF Forwarding Graph** (VNFFG), one or more forwarding paths across VNFs via either a single or set of VLs/CPs.

- **Descriptor files**

  For each element there is a descriptor file and each of them describes the configuration parameters for the given entity.

- **Repositories**

  Repositories hold information in ETSI MANO. There are four main repository types:

  - **NS catalogue** – a repository of all usable Network Service Descriptors (NSD)
  - **VNF catalogue** - a repository of all usable VNF Descriptors (VNFD).
  - **NFV instances** - holds information of all VNF instances and NS instances.
  - **NFVI resources** - a repository of utilized NFVI resources for running Entities.

- **Functional blocks**

  These are elements needed to orchestrate all the components:

  1. **NFV orchestrator (NFVO**)
     It onboards new NFs, VNFFGs and VNF packages, it authorizes and validates NFVI resource requests, it manages the NS lifecycle and performs validation/authorization of NFVI requests.
  2. **VNF manager (VNFM)**
     It is responsible for the lifecycle of VNFs, including the creation and termination, and the FCAPS (Fault, Configuration, Accounting, Performance and Security Management)
  3. **Virtualized Infrastructure Manager (VIM**)
     It controls and manages the NFVI, such as the virtual/physical compute, storage, and networking resources, along with collecting events and performance metrics

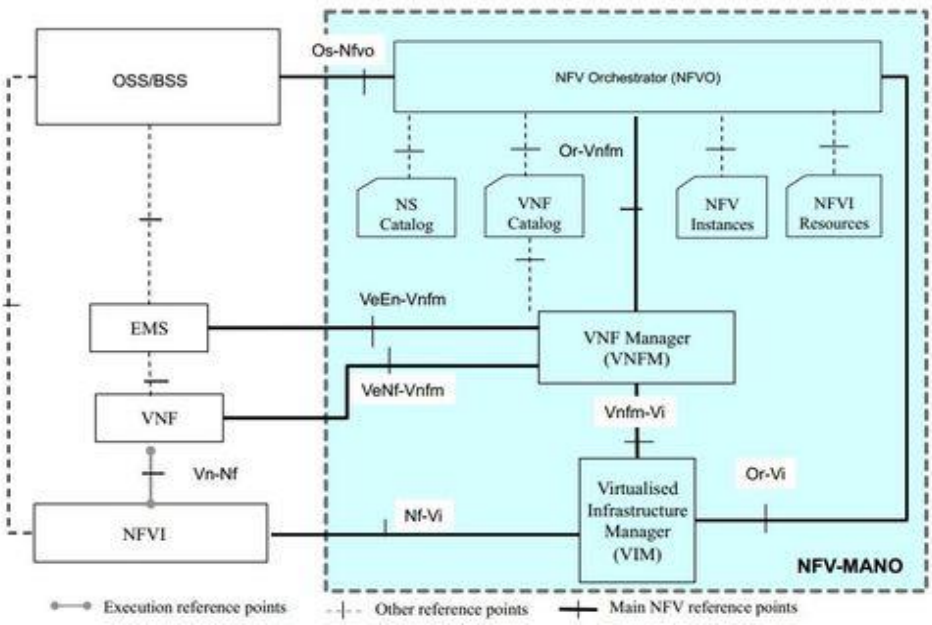


Figure 22: ETSI MANO model.

4.4.9 O-RAN Software Community

The O-RAN Software Community (SC) is a joint initiative between the O-RAN Alliance and the Linux Foundation driving the development of RAN software. The major focus of this community is to align O-RAN Alliance's open architecture and specifications to deliver a solution that can be utilized for industry deployment. Furthermore, it aims to address two main challenges: 1) building commercially viable solutions that meet high performance KPI requirements that support real-time system needs; 2) leveraging adjacent software communities and open approaches to utilize existing solutions to speed time to market.

As a new open source community under the Linux Foundation, the O-RAN SC is supported by the O-RAN Alliance, and will enable the development of open source software enabling modular, open, intelligent, efficient, and agile disaggregated radio access networks.

The initial set of software projects under discussion include:

- Near-real time RAN intelligent controller (nRT RIC)
- Non-real time RAN intelligent controller (NRT RIC)
- Cloudification and virtualization platforms
- Open central unit (O-CU)
- Open distributed unit (O-DU)
- Test and integration effort to provide a working reference implementation

These efforts will be looking to work with other adjacent open source networking communities. As a result, the O-RAN Software Community can enable collaborative development across the full operator network stack with strong community alignment.

Open Source software contributions are distributed according to the standard Apache 2 licence.

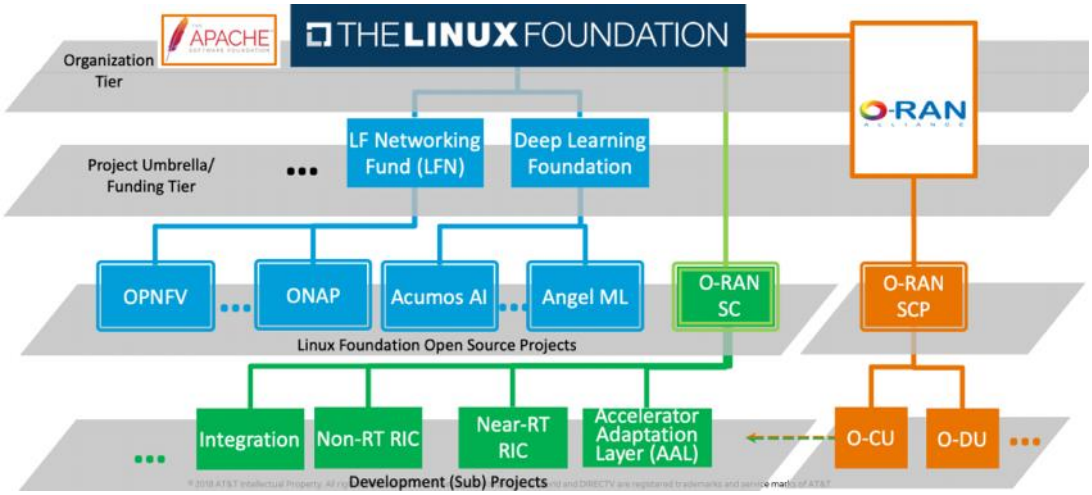


Figure 23: O-RAN SC structure and position in the Linux Foundation.

5 AFFORDABLE5G IMPACT ASSESSMENT

By implementing the Affordable5G Dissemination Plan we expect to communicate relevant outcomes to each of the target groups, as well as to attract their interest and generate engagement that will influence the overall impact of the project. The complete set of communication and dissemination activities will be closely monitored and evaluated in order to keep track of all ongoing activities. The deliverable "Dissemination, Communication and Standardization Report" will document all the related conducted activities in two versions: D5.2 (M12 & M24).

The evaluation of the Dissemination Strategy concerns both qualitative and quantitative indicators. Once measurable objectives are defined, we will then evaluate to what degree the project has achieved the objectives set. Process evaluation will involve examining the progress of the strategy's implementation and will refer to an outreach activity that is quantifiable through the attendance of persons present from the audiences, quantity of material distributed, number of events participated in, the development and dissemination of messages and materials, media presence and traffic created in social media.

There are various key issues associated with measuring and controlling the outreach and impact creation strategy and plan. Achievement is often more difficult to measure and compare, and thus needs to be carefully quantified and measured according to the specific type of action involved. The objectives chosen must be realistic, clearly defined, relevant, and coherent; the means of measurement must be objective, clearly defined and quantified, and the measurement process must not involve significant levels of cost relative to the objectives themselves. The evaluation needs to be continuous or incremental as much as possible, in particular for non-repetitive actions. Finally, the measurement of different actions must allow some degree of comparison with other actions and/or alternatives.

The proposed **analysis framework** will aim to measure various quantitative figures, as well as the impact of promotional efforts on the attitude of the receivers of the communications messages. This will be feasible through the combination of a set of measurement procedures, which will provide a clear view of the promotional activity outcomes in terms of behavioural trends. In full accordance with the Affordable5G needs, we take on **a five-step measurement cycle model**, spanning from objective identification to data driven optimization:

- We identify our core objectives (e.g. raise awareness, increase engagement – i.e. acquire more contacts, acquire more participants for our events).
- We set goals for our promotional tactics. We concentrate on how to accomplish our objectives (e.g. inform visitors through the content of our website, intensify events promotion, etc.).
- We identify our Key Performance Indicators (KPIs) – the metrics that play a crucial role to the success of the aforementioned utilized tactics and set the expected achievable qualitative and quantitative targets.
- We measure the progress and impact of the conducted activities based on these metrics on a regular basis. Such metrics will allow us to have a constant view of the amount and the effectiveness of the dissemination activities conducted.
- We adjust and optimize the dissemination strategy towards achieving the expected outcomes and maximising visibility.

The tools, products and activities outlined in this strategy will be monitored, measured, evaluated and realigned on an ongoing basis.

Table 7 below presents the Key Performance Indicators (KPIs) and the achievable targets set for each type of the dissemination activities, while Table 8 lists the project's dissemination deliverables and milestones.

Measure	Indicators	Target (M24)	Source and methodology
Flyers Posters/roll-ups	N. of flyers N. of posters/roll-ups (by the end of the project)	> 3 > 5	Distribution via participation to and organisation of dedicated events. Electronic distribution via the project web site
Project Website	N. of unique visitors to the website (average per year)	> 1500	News, Publications, Videos, Newsletters, Deliverables
Social Networks	Twitter, LinkedIn, YouTube (average new followers per year)	> 300	Keeping Affordable5G profiles on such networks active via regular posting and monitoring
Press Releases / publication in press (by the end of the project)	N. of press releases issued to specialised and general media channels at key project milestones	> 4	A press/media kit will be developed containing detailed press releases, videos, publishable images, flyers
Publications	N. of peer-reviewed publications in journals, conferences and workshops	≥ 3 per year on average	Articles and papers presented and published in high-quality venues
e-Newsletter (published every 3 months)	N. of subscribers (by the end of the project)	> 300	Recording of subscribers to the electronic newsletter
Videos	N. of videos published on the Affordable5G YouTube channel and average number of views	3 videos per year and 200 views per video	Introduction, informative and educational videos to support awareness creation and stakeholders' engagement
Promotional Workshops - at least 5 by the end of the project	Average number of participants per workshop	50 to 80 participants per event depending	Attendance proof, presented material, photos, animation of social media channels, events' reports

Measure	Indicators	Target (M24)	Source and methodology
		on scope and co-location	
Participation in events and presentations	Number of external events partners attended to promote the project, including industrial, scientific conferences, and number of demos and or presentations given	At least 5 events per year, with at least 6 presentation	Attendance proof, presented material, photos, animation of social media channels, events' reports
Webinars (at least 3 by the end of the project)	Average number of participants	At least 35 participants	Attendance proof, video-streaming, presented material, photos, animation of social media channels, events' reports
Standardization	Contributions to standardization fora	≥ 3 per year	Attendance proof, presented material

Table 7: Affordable5G communication KPIs

No.	Name	Lead	Type	Diss level	Due	Status
MS1	Affordable5G branding. Project guidelines established.	Martel	OTHER	NA	M2	Achieved
D5.1	Dissemination and Communication channels and plan	Martel	R	PU	M2	Current document
D5.2	Dissemination, collaboration and standardization report	Martel	R	PU	M12, M24	

Table 8: Affordable5G dissemination deliverables and milestones

6 CONCLUSIONS

This deliverable presents the Affordable5G Dissemination Strategy providing guidelines and a consistent framework for all planned activities to disseminate and sustain the concepts, achievements, as well as knowledge results developed within the project.

Dissemination, communication and engagement activities are essential to the achievement of the Affordable5G mission and objectives, having possibly an impact on 5G policy making, as well as planned research and innovations priorities and investments. It will be a coordinated and cooperative effort throughout the project's lifetime and integrated within all its work packages. The present plan illustrates in clear terms the rationale behind the strategy and clarifies all dimensions and tools necessary to communicate the core messages of the project in a very effective and comprehensive way.

Various activities will be realized throughout the project's lifetime in order to help Affordable5G achieve its purpose. Promotion of the project online and via participation in events (possibly online), organization of webinars, writing of news, producing high-quality promotional material as well as collaboration with other projects and relevant initiatives are essential planned activities.

The current report will act as a handbook for every project partner in order to perform their dissemination activities, as it lists all stakeholders, communication channels, dissemination activities and corresponding key performance indicators. It also addresses the European Commission that will be an essential partner in the realisation of this plan.

In order to measure the achieved progress and impacts of the proposed strategy and plan, a monitoring and evaluation framework has been defined and a number of indicators have been recognized and reported. Knowing that some activities might be impacted by the COVID-19 crisis even further, close coordination with the EC will be pursued so as any corrective measure might agilely be put in place.

ANNEX A

WHAT IS A BRAND IDENTITY?

A brand identity allows you to recognize a strong, consistent look and feel across all outlets (electronic and printed visual media). It defines how those who come into contact with the brand should perceive it and influences their opinion of the brand.

Examples of Affordable 5G's brand identity across different outlets (Twitter and LinkedIn accounts, website)

LOGO

Presented here is an overview on the versions available for Affordable 5G's logo, their designated use and some basic recommendations for use.

Main version

Icon version (for social media outlets)

Clear zone

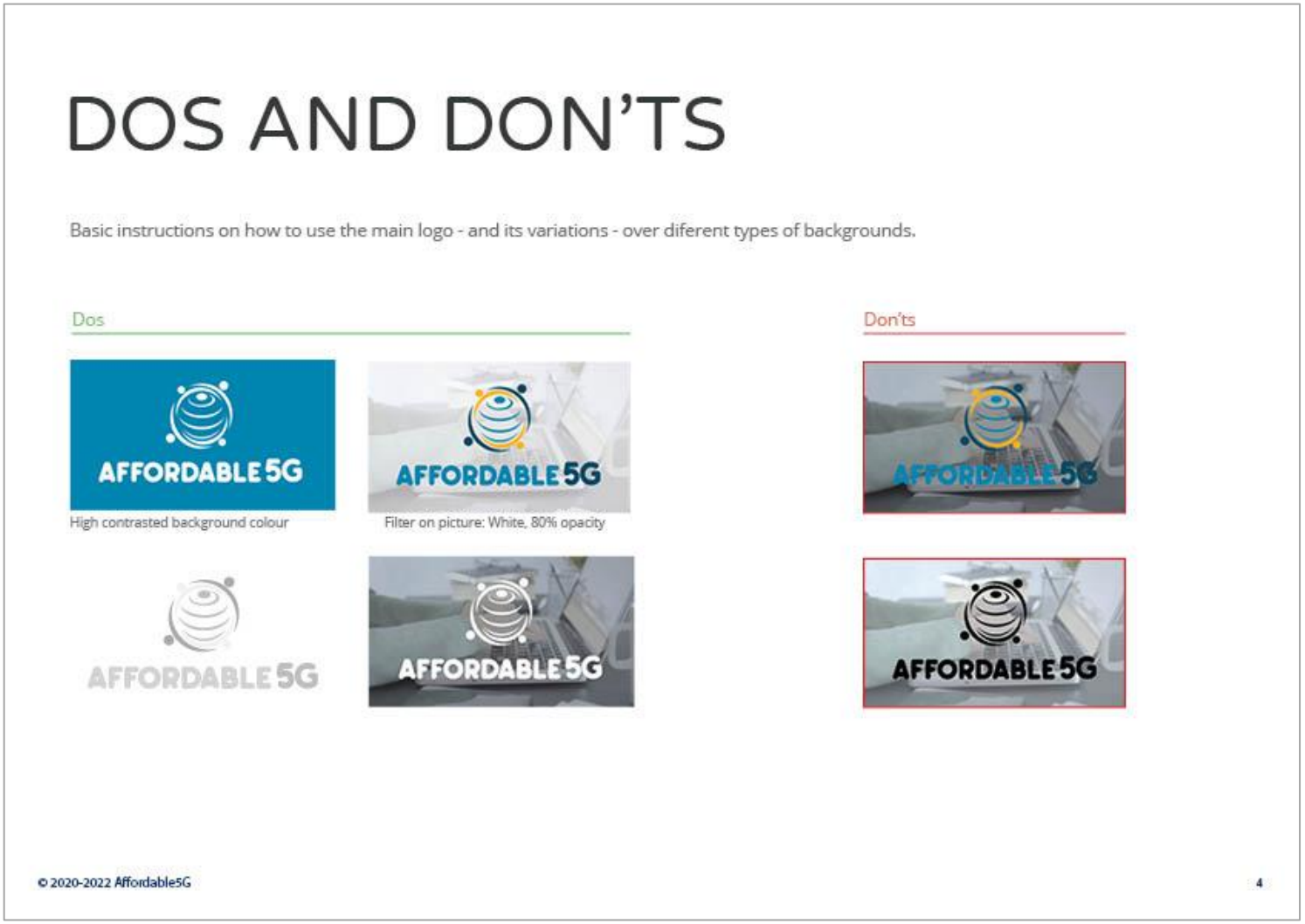
Minimum size

2

LOGO VARIATIONS

The main logo is also provided in the variations depicted here below, to allow readability over dark backgrounds or for black and white printing purposes.

3


DOS AND DON'TS
Basic instructions on how to use the main logo - and its variations - over diferent types of backgrounds.
Dos
Don'ts
AFFORDABLE 5G
High contrasted background colour
Filter on picture: White, 80% opacity
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CORPORATE COLOURS

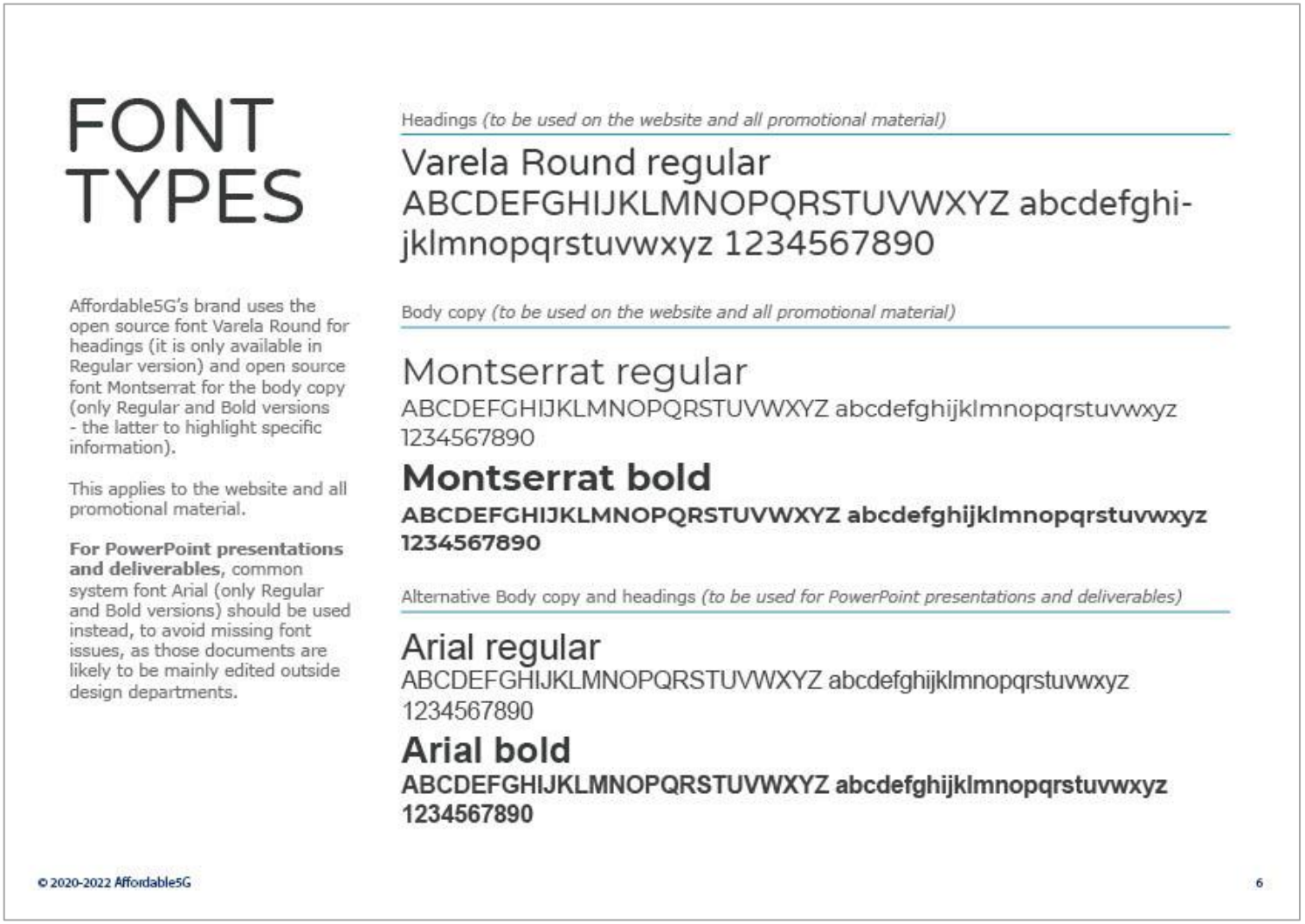
A main palette of 3 colors based on the logo colour scheme, and 2 complementary greyscale colours.

For PowerPoint presentations and deliverables: the color of standard elements has been defined and locked in the respective templates, as those documents are likely to be mainly edited outside design departments. To change colors of elements added during editing (icons or additional text), editors will find the corporate color palette in the templates.

Palette of corporate colors

C97 M66 Y40 K24	C85 M39 Y16 K0	C0 M33 Y100 K0	C63 M57 Y51 K53	C0 M0 Y0 K43
R2 G76 B103	R0 G130 B175	R251 G179 B22	R63 G63 B66	R161 G163 B166
HEX #024C67	HEX #0082AF	HEX #FFD316	HEX #3F3F42	HEX #A1A3A6

5


FONT TYPES
Affordable5G's brand uses the open source font Varela Round for headings (it is only available in Regular version) and open source font Montserrat for the body copy (only Regular and Bold versions - the latter to highlight specific information).
This applies to the website and all promotional material.
For PowerPoint presentations and deliverables, common system font Arial (only Regular and Bold versions) should be used instead, to avoid missing font issues, as those documents are likely to be mainly edited outside design departments.
Headings (to be used on the website and all promotional material)
Varela Round regular
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghi-jklmnopqrstuvwxyz 1234567890
Body copy (to be used on the website and all promotional material)
Montserrat regular
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890
Montserrat bold
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890
Alternative Body copy and headings (to be used for PowerPoint presentations and deliverables)
Arial regular
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890
Arial bold
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 1234567890
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5G PPP ACKNOWLEDGEMENT

All the 5G PPP projects should clearly show the 5G PPP logo in all Dissemination & Communication materials (e.g. flyers, posters, brochures, video, webiste, etc). Below you'll find the "stickers" you should use either on light or dark background as well as horizontal and compact versions. The files are available in different formats on the repository of the project.

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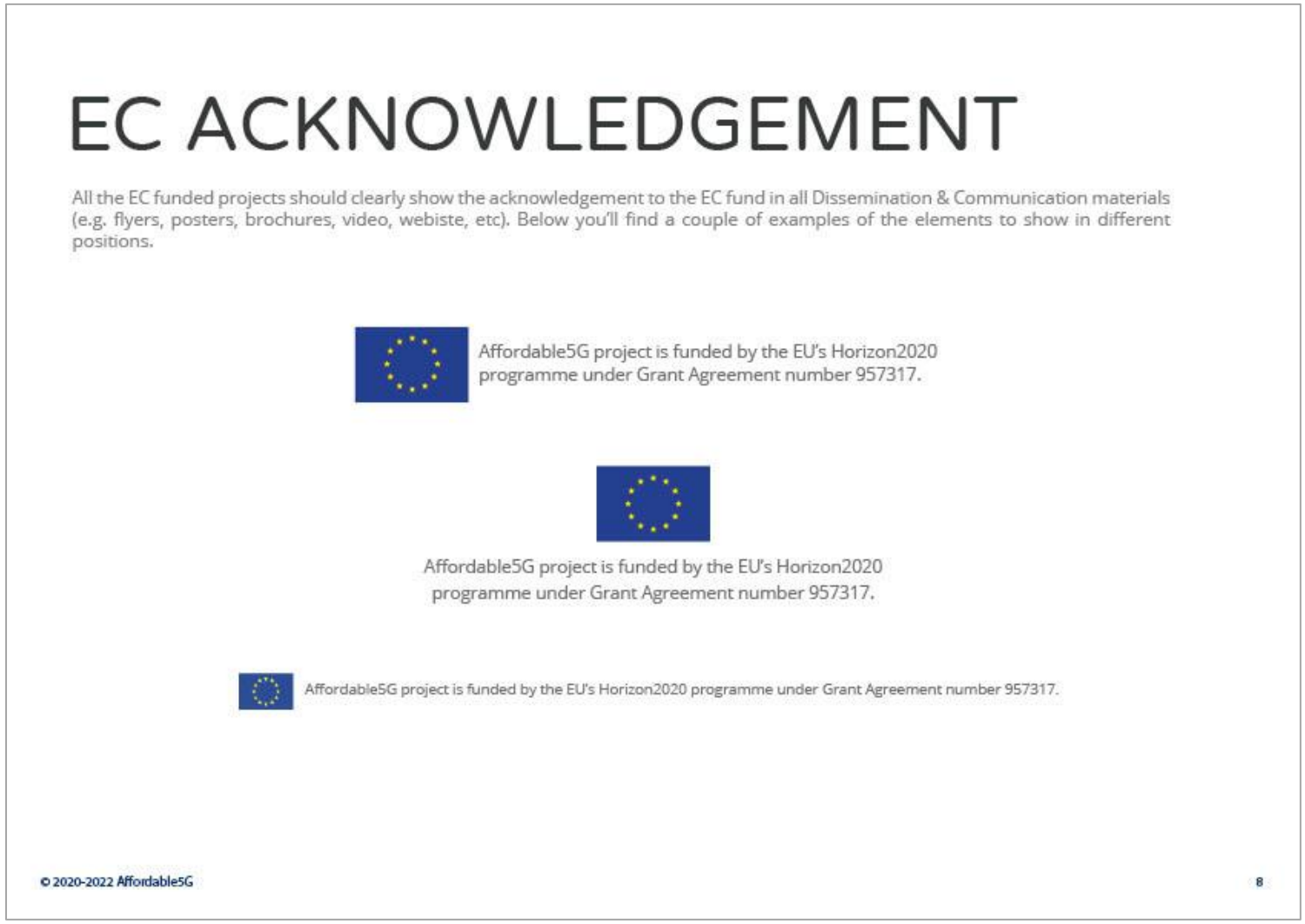
EC ACKNOWLEDGEMENT
All the EC funded projects should clearly show the acknowledgement to the EC fund in all Dissemination & Communication materials (e.g. flyers, posters, brochures, video, webiste, etc). Below you'll find a couple of examples of the elements to show in different positions.
Affordable5G project is funded by the EU's Horizon2020 programme under Grant Agreement number 957317.
Affordable5G project is funded by the EU's Horizon2020 programme under Grant Agreement number 957317.
Affordable5G project is funded by the EU's Horizon2020 programme under Grant Agreement number 957317.
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