IoRL Deliverable D7.3

Report on Standardisation and Regulation Activities

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Abstract

This deliverable summarises the first year activities within the H2020 IoRL project concerning standardization and regulation, which focused on establishing a strategy for influencing standardization through identifying the most promising activities where the project sees a chance for successfully contributing and helping to maximize its impact.

Our starting point was the architecture of the Internet of Radio-Light proposed solution, and its key components. As a next step the Key Performance Indicators (KPIs) were identified and the experiments required to measure each of them are also described briefly. Next the 3GPP and IMT-2020 standardisation activities were surveyed and the relevant IoRL architectural components and KPI experiments were mapped to those standardization activities. Finally, we selected the standardisation activities where the project team assessed to have a chance to successfully contributing with its architectural and KPI contributions.

Disclaimer

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Impressum

Internet of Radio Light

IoRL

WP7 Dissemination and Exploitation

Task 7.2 Liaison to Standardisation Bodies and Regulatory Bodies

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Executive summary

This deliverable summarises the first year activities within the H2020 IoRL project concerning standardization and regulation, which focused on establishing a strategy for influencing standardization through identifying the most promising activities where the project sees a chance for successfully contributing and helping to maximize its impact.

Our starting point was the architecture of the Internet of Radio-Light proposed solution, and its key components. As a next step the Key Performance Indicators (KPIs) were identified and the experiments required to measure each of them are also described briefly. Next the 3GPP, IMT-2020 and other relevant standardisation activities were surveyed and the IoRL architectural components and KPI experiments were mapped to those standardization activities. Finally, we selected the standardisation activities where the project team assessed to have a chance to successfully contributing with its architectural and KPI insight.

As such, this deliverable has drawn inspiration from the 5G PPP Pre-Standardisation Workgroup that compiled a list of all the activities in 3GPP and the work within the 5G PPP Infrastructure Association where a comprehensive list of Key Performance Indicators were compiled from inputs provided by all 5G PPP projects.

List of authors

Company	Author	Contribution
Brunel University	John Cosmas	The Complete deliverable except chapter 6
Building Research Establishment	Atanas Savov James Gbadamosi	Chapter 6
Tsinghua University Brunel University	Jian Song John Cosmas	Chapter 8 on ITU activities
Brunel University	John Cosmas	Chapter 9 on IEEE802.15.13 activities
Brunel University	John Cosmas	Chapter 10 on IEEE802.11ad activities
Brunel University	John Cosmas	Chapter 11 update on conclusions
Eurescom GmbH	Adam Kapovits	Regarding general aspects of standardization in research projects

Version History

This is the second version of this deliverable, which was extensively re-worked and extended considering reviewers comments. Most notably, expanding the standardization bodies considered by including IEEE as well.

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Abbreviations

3GPP	Third Generation Partnership Project
5G	Fifth Generation (mobile/cellular networks)
5G PPP	5G Infrastructure Public Private Partnership
AAS	Active Antenna System
API	Application Programmer's Interface
BER	Bit Error Ratio
CAPEX	Capital Expenditure
CAPIF	Common API Framework
CN	Core Network
CP	Control Plane
CU-DU	Central Unit - Distributed Unit
DC	Direct Current
DCAE	Data Collection, Analytics and Events
DC-OFDM	DC offset Orthogonal Frequency Division Multiplexing
DoS	Denial of Service
DRAN	Distributed Radio Access Network
EM	Electro Magnetic
EMF	Electro Magnetic Field
eNB	Evolved Node B
EPC	Evolved Packet Core
E-UTRAN	Enhanced Universal Terrestrial Radio Access Network
EVS	Enhanced Voice Services

FEC	Forward Error Correction
gNB	Next Generation Node B
HDTV	High Definition Television
IEEE	Institute of Electrical and Electronics Engineers (a professional association also setting standards)
IMT	International Mobile Telecommunications
IoT	Internet of Things
IoRL	Internet of Radio Light (project)
IP	Internet Protocol
IHIPG	Intelligent Home Internet Packet Gateway
IMT	International Mobile Telecommunication
IoT	Internet of Things
Itf-N	Type 2 Interface
ITU	International Telecommunications Union
KPI	Key Performance Indicator
LAN	Local Area Network
LTE	Long Term Evolution
MAC	Medium Access Control
MBMS	Multimedia Broadcast Multicast Service
MC	Mission Critical
MCPTT	Mission-Critical Push-To-Talk
MIoT	Massive Internet of Things
MISO	Multiple Input Single Output
MNO	Mobile Network Operator

MPS	Multimedia Priority Service
MSS	Multi Source Streaming
MTC	Machine Type Communications
NA	Not Applicable
NB-IoT	Narrow Band Internet of Things
NFV	Network Function Virtualization
NOMA	Non-Orthogonal Multiple Access
NR	New Radio
OAM	Operation, Administration and Management.
OFDM	Orthogonal Frequency Division Multiplexing
ONAP	Open Network Automation Platform
OPEX	Operational Expenditure
PC	Personal Computer
PEE	Power, Energy and Environmental
PPP	Public Private Partnership
PS	Public Safety
QoE	Quality of Experience
RAN	Radio Access Network
RRLH	Remote Radio Light Head
SCEF	Service Capability Exposure Function
SCS-AS	Service Capability Server – Application Server
SDN	Software Defined Networks
SIMO	Single Input Multiple Output
SMF	Session Management Function

SNR	Signal to Noise Ratio
SON	Self-Organizing Networks
TCP	Transmission Control Protocol
TTI	Transmission Time Interval
UE	User Equipment
uMMTC	ultra-Massive Machine Type Communications
uRLLC	ultra-Reliable Low-Latency Communications
UP	User Plane
UPF	User Plane Function
V2X	Vehicle to Infrastructure
VLC	Visible Light Communications
VR	Virtual Reality
WLAN	Wireless Local Area Network
xMBB	Extreme Massive BroadBand

1 Introduction Overview

1.1 Objective of this document

Standardisation is one important area for research projects to create a lasting impact, in addition to scientific dissemination and (industrial) exploitation. This document presents the strategy adopted by the H2020 IoRL project to impact standardization and reports initial activities in this direction.

First, we would like to state that in our assessment the most relevant standardization bodies concerning the research work under H2020 IoRL are

- The 3rd Generation Partnership Project (3GPP) – providing the mobile broadband standard [1];
- IEEE [2];
- ITU and ITU-R [3], and more specifically
- IMT-2020.

Before presenting our adopted approach and methodology to identify the standardisiation groups and activities to be targeted, we wish to present some general considerations regarding standardization, and influencing standardization.

1.1.1 General considerations regarding standardization and influencing standardisation

Standards developing and setting organisations are by nature international. They have their rules and working structure set. We would like to note that the most relevant standardization bodies concerning the work performed under the IoRL project are all well established, and the International Telecommunications Union in particular looks back on a very long history. Now in order to be able to successfully influence standardization in any well-established standards organization any contribution fed into the standardization process should consider the agenda and timeline as a basic rule. Outside of the timeline set by the standards organization contributions will not be considered. This often means that research projects can easily miss important deadlines, unless they really operate in sync with the standardization process.

It also has to be noted that standards bodies do not recognize research projects, which do not have a legal standing and identity. Instead, standards organisations operate on the basis of membership, and only members can present contributions. (IETF is somewhat an exception to this rather general rule to the extent that individual experts can make contributions.) Therefore, to be able to contribute at least one partner from the consortium undertaking the research project needs to be, or become a member.

However, to be successful and really influence standardization and create an impact – as opposed to making a contribution that does not have any impact –, experience shows that it is still not sufficient if one partner is a member. To create the necessary momentum within the standardization body and be able to pursue a set agenda, the member organization should be well accepted, preferably leading some activities or work items. Even then, we notice that in many instances business interests rule, and very forward looking approaches and propositions get turned down if they do not fit into the plans of dominant players.

1.1.2 Methodology adopted

Our adopted methodology is to start from the main IoRL architectural components as defined in the IoRL Deliverables D2.2 [4] and D2.3 [5] and the associated key performance indicators and map them onto the known 3GPP, IMT-2020, ITU-T, etc. standardisation groups with a view to potential promotion of the identified IoRL architectural components in that standardisation activity.

The steps towards achieving this goal are:

- Consult the 5G PPP Pre-standardisation Group
- Establish a list of 3GPP, IMT-2020, ITU-T, etc. standardisation groups
- Identify the standardisation groups relevant to the project
- Identify key standardisation we want to target and their subgroup
- Establish Timelines and checking if we can make relevant contributions
- Identify 5G PPP White Papers that could lead to standardisation

1.2 Structure of this document

This document is organized as follows:

- Section 1: Introduction
- Section 2: Summary of First Year's Main Achievements in the IoRL Project
- Section 3: Key Performance Indicators and Experiments to Measure them
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    - Section 5.1 Mapping of Architectural Components and KPIs
    - Section 5.2 Summary of Potential Contributions
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- Section 7: IETF
- Section 8: ITU-T and ITU-R
- Section 9: IEEE
- Section 10: Conclusions,

1.3 Evolutionary Strategy for Contributing to Standardisation and Regulation

This deliverable assesses the opportunities for contributing to standardization and establishes the strategy to be pursued, essentially selecting the groups to be targeted. A further deliverable, D7.7 is scheduled for M24 (May 2019) reporting on the actual contributions and achievements during the second year of the IoRL project. By the end of the second year of the project the laboratory test-bench systems will be nearing completion and first KPI test performance results obtained. The objective of D7.7 is therefore to describe the experiment procedures, identify the teams performing the experiments and provide a summary of the measured KPI results of each lab test-bench experiment to be reported in target standardisation activities. Last but not least there is a deliverable D7.8

scheduled for the end of the project in May 2020 as a final report on standardization. By that stage the field test of the IoRL system will have been completed and KPI test performance results obtained. The purpose of this deliverable is to describe the experiment procedures, identify the teams that performed the experiments and provide a summary of the measured KPI results of each experiment in the field to be reported in target standardisation activities.

2 Summary of First Year's Main Achievements in IoRL Project

The major achievements in the first year of the project are the elaboration of the use case scenarios and the extraction of the user and technical requirements, the development of the system architecture as shown in Figure 1, the implementation plan for the benchtop demonstrators and the first steps towards their implementation. Use case scenarios were developed for private homes, public buildings including a museum and a transportation hub and buildings hosting commercial operations.

2.1 Overall Architecture

IoRL devised a layered architecture consisting of three layers: Service, Network Function Virtualisation (NFV) / Software Defined Network (SDN) and Access; and as such our architecture is well aligned to the overall 5G architecture.

The next generation 5G Home eNB architecture was developed, which we are calling Home gNB (HgNB). It introduces the concept of indoor room/floor cellular coverage areas, which is suitable to the bimodal nature of visible light and mmWave channels depending on the presence or absence of line-of-sight. Furthermore, it introduces the concept of intra-handover between indoor coverage areas within the same building and inter-handover between building HgNB and outside gNB. This is a totally new concept, which increases the total bit rate that can be delivered to a building network.

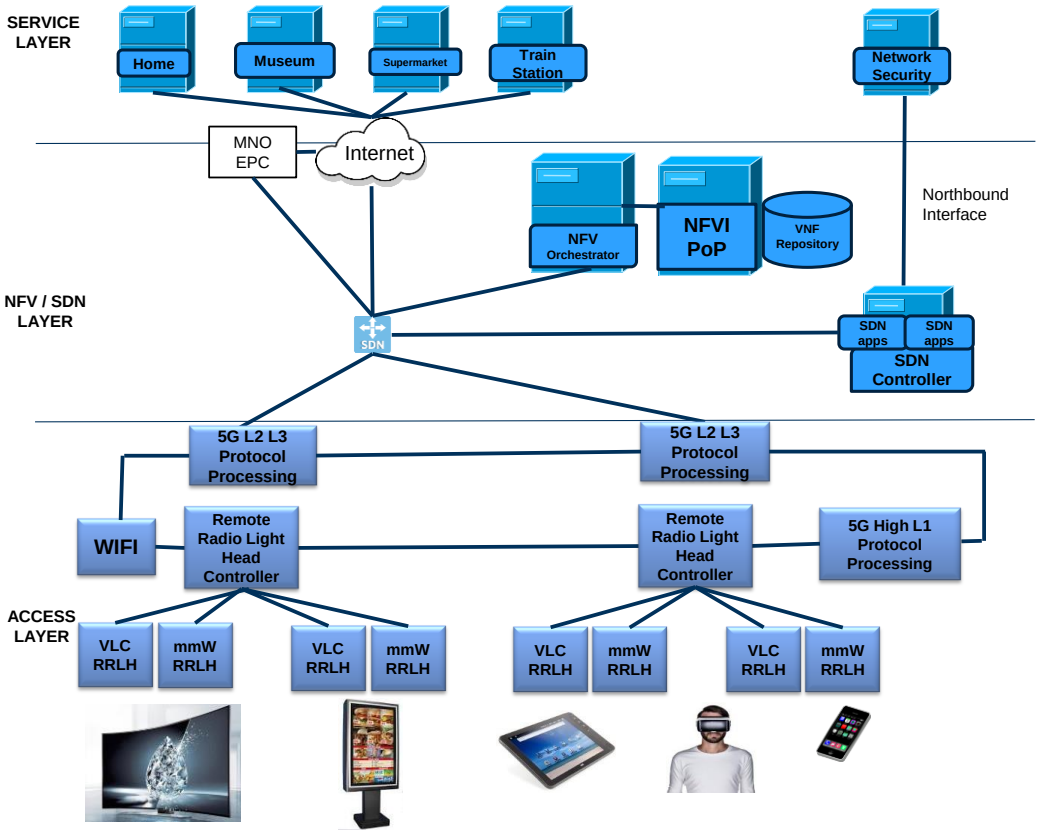

Figure 2-1: IoRL Layered Architecture

The 5G Home gNB can act both as an extension to the outside cellular network or as a standalone WLAN network operating independently from the 5G outside network. The

impact of this is that ultra-low latency communications can be obtained by selecting the appropriate path through the network.

2.2 Remote Radio-Light Head Architecture

Improvements to the 5G remote radio head architecture were made by including a VLC module, which we a calling Remote Radio-Light Head (RRLH), as shown in Figure 2. It uses the multi-component carrier feature of 5G architecture to transmit at these two different parts of the EM spectrum. The impact of this is that the total throughput to a building can potentially be dramatically increased.

The RRLH architecture uses DC offset Orthogonal Frequency Division Multiplexing (DC-OFDM) as VLC modulation, which combines modulation efficiency and compatibility with existing 3GPP's 5G OFDM modulation. The impact of this is that it can readily integrated into a future 5G standard.

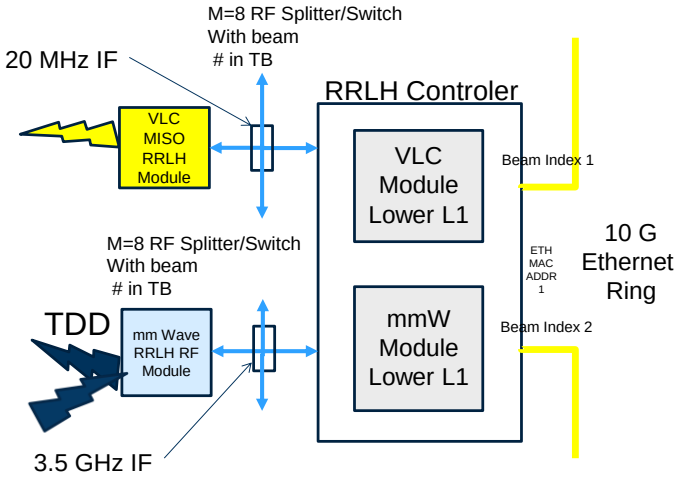

Figure 2-2: RRLH Architecture

2.3 Radio Access Network Architecture

A Distributed Radio Access Network (DRAN) architecture was developed that processes the 5G Lower Layer 1, Upper Layer 1, Layer 2 and 3 protocol stack in a parallel pipeline interconnected by a 10Gbit/s Ethernet ring. The impact of this is a reduction in processing delay and building network latency.

Algorithms estimating the location of User Equipment (UE) were developed using a combination of the Received Signal Strength of VLC OFDM reference symbols and using Round Trip Times of mmWave OFDM reference symbols. We expect to contribute with this to the development and improvement of indoor location based services.

2.4 NFV / SDN Architecture

A NFV - SDN architecture was developed that routes IP packets to different building room/floor coverage areas and performs intra building room/floor coverage area handover. The impact of this is the total bitrate that can be delivered to a building is increased by the number of coverage areas within the building. Since VLC and mmWave frequencies in adjacent room/floor coverage areas do not interfere with each other, the frequency reuse factor is always 1.

The NFV-SDN architecture can also increase the connection reliability of video services by Multi Source Streaming (MSS) offering different quality versions of the same content through RRLH and WLAN. The impact of this is that it overcomes the bimodal nature of visible light and mmWave channels by always ensuring a low quality – low bit rate video by WLAN. This principle can also be extended to multipath TCP protocols. The impact of this is reliable mmWave and VLC communications in buildings with a Quality of Service feedback to users on whether there is line of sight connectivity to the RRLH access points.

The envisaged Intelligent Home IP Gateway (IHIPG) provides the NFV/SDN functionality, which can be located within the building premises, but also in the Cloud. The impact of this is flexible OPEX/ CAPEX trade-off choices for Mobile Network Operators (MNO) depending on type of customer building network being provisioned.

2.5 User Equipment Architecture

5G User Equipment architectures were developed for HDTV, Tablet PC, Smart Phone and VR Headsets.

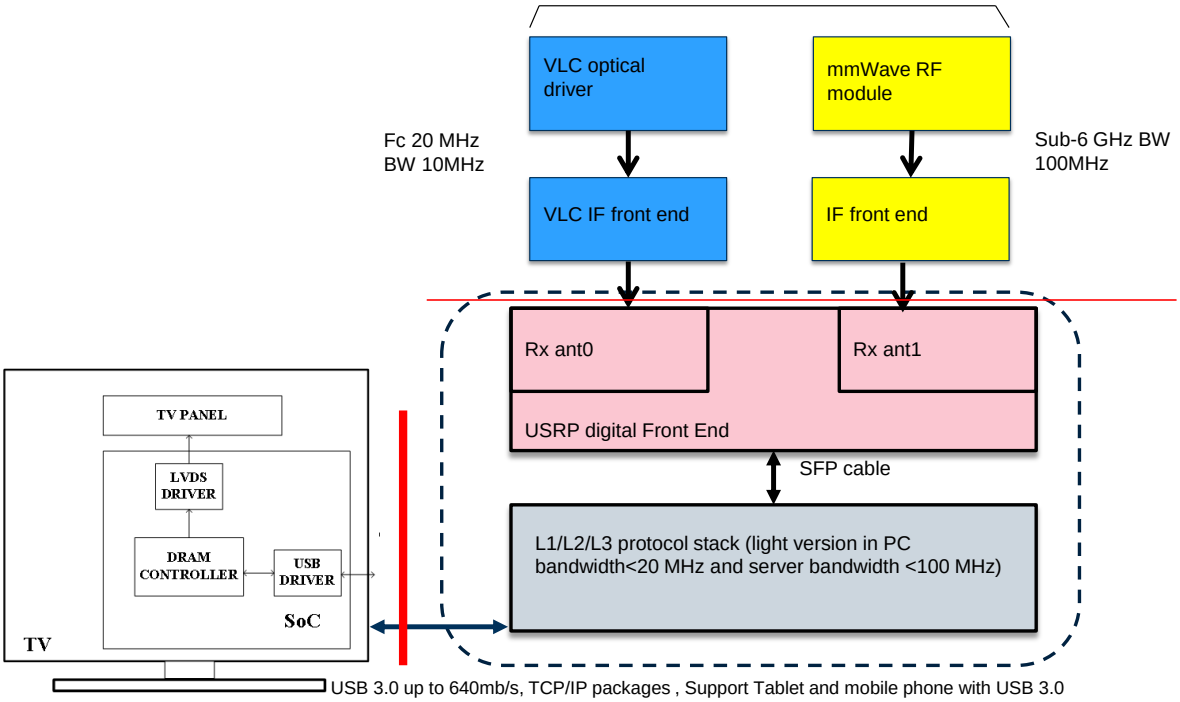

Figure 2-3: IoRL UE Architecture

2.6 Lighting System Architecture

The concept of light systems acting as an Electromagnetic access points in a room was introduced through the adaptation of the physical architecture of spot (as shown in Figure 2-4), pendant, strip, giotto visible light systems to include both a VLC transmitter and a mmWave transceiver torch. The impact of this is that a completely new disruptive market of radio-light EM access systems might complement the WLAN market.

Figure 2-4: Spot Light with External mmWave Torch

3 Key Performance Indicators and Experiments to Measure them

A series of experiments will be conducted in the IoRL project demonstrators to measure the performance of the system through the measurement of Key Performance Indicators as indicated in Table 3-1. The results of these experiments will allow the project to assess the performance of the IoRL network and compare it with existing systems.

Table 3-1: Table of Potential Experiments to Measure Key Performance Indicators (KPIs) [6]

KPI No	Title of KPI	Description of KPI	Experiment to Measure KPI
KPI-01	User data rate	Peak data rate of 732.16Mbit/s per room/floor with a potential of increasing up to 3.4Gbit/s per room/floor (for 6 rooms/floors)	Experiment that measures BER against SNR from VLC and mmWave Transmitters Experiment that measures BER against SNR for different numbers of MISO / SIMO VLC / mmWave Diversity Transmitters
KPI-02	Mobility (speed)	Confined to the building premises: from 0 to 5 km/hour	Experiment that measures of BER against SNR from VLC and mmWave Transmitter at different speeds
KPI-03	End to End Latency	Time taken for signal to get from input of IHIPG to User Equipment and vice versa < 1ms	Experiment that measures the end to end latency and latencies through individual NFV/SDN, Layer2/3 Processing, Upper Layer 1 (DRAN) processing, RRLH Controller, VLC and mmWave parts of RRLH and UE components of system.
KPI-04	Density	Number of Devices deployed in building	Depends on the services that are being used
KPI-05	Reliability	Reliability is the ability of a network to carry out communication through Improvement of the reliability of the individual components of the network; Increasing the number of alternative paths available to origin-destination (OD) pairs; Decreasing the number of intermediate links between the origin and the destination nodes.	Experiment that removes individual components of the IoRL system such as RRLH, RRLH Controller, Upper Layer (DRAN) Processor, Layer 2 / 3 Processor, WLAN and NFV/SDN network to determine the continued operation of the system for example through MISO / SIMO redundancy and Multi Source Streaming within room/floor

KPI-06	Position Accuracy (Location)	Position Accuracy is defined as the degree or closeness to which the estimation of UE location indoors matches the values in the real world. - < 10cm	Experiment that measures accuracy for different locations within a room relative to VLC and mmWave transmitters
KPI-07	Coverage	Coverage within boundaries of property – Potentially 100% indoors	Experiment that measures connectivity of User Equipment on a grid within a room coverage area
KPI-08	Communication range	Distance at which the UE can still receive VLC and mmWave signals	Experiment that measures the communication range of VLC and mmWave components of system, For mmWave at 60 GHZ based on attenuation of 12dB/Km – 250m with 3dB attenuation For mmWave at 40 GHZ based on attenuation of 0.12dB/Km – 25000m with 3dB attenuation
KPI-09	Service Deployment Time	Time it takes to configure SDN and apply VNFs say 10 minutes	Experiment that measures time required to deploy a location based service from scratch
KPI-10	Data Volume	Number of bits/second that can be provided per km^2 This depends on the size of property being provisioned for example US = 3.641T bits/second/km^2, UK = 9.632T bits/second/km^2, Canadian = 4.044T bits/second/km^2, China = 12.2T bits/second/km^2 with a potential of increasing up to US = 16.911T bits/second/km^2, UK = 44.739T bits/second/km^2, Canadian = 18.784T bits/second/km^2,	Estimation of Data Volume From experiments that measure KPI-01 and KPI-02 and KPI-07.

		China = 56.67T bits/second/km^2 (Based on US Average House Size 201x10^{-6} Km^2, UK at 76 x10^{-6} Km^2, Canadian at 181 x10^{-6} Km^2, China at 60 x10^{-6} Km^2)	
KPI-11	Autonomy	Autonomous network runs with minimal to no human intervention—able to configure, monitor, and maintain itself independently.	Experiment that measures the degree to which IoRL network is able to configure, monitor, and maintain itself independently
KPI-12	Security	Detection of traffic eavesdropping, DoS attacks and rogue VLC Transmitter Placement.	Experiment that launches a DoS attack and measures how long it takes for the SDN DoS attack monitor to detect and disarm it. Experiment that launches a rogue VLC/mmWave Transmitter attack and measures how long it takes for the SDN DoS attack monitor to detect and disarm it. Experiment that measures of locations outside of the building property in which an eavesdropping UE (i.e. one that cannot be identified) can be located i.e. a UE that has not been registered in a home network.
KPI-13	Identity	Identity applies network controls to network device access based on the identity of an individual or group of individuals responsible to or operating the device. Individuals are identified, and the network is tuned to respond to their presence by context.	Experiment that measures locations of UE inside and outside of the building property in which an eavesdropping UE (i.e. one that cannot be identified) can be located i.e. a UE that has not been registered in a home network by its IP protocol and MAC and IP source/destination addresses
KPI-14	Service continuity	Service Continuity is the ability of the network to continue connectivity (i.e. not lose connectivity) when performing handovers between rooms/floors indoors and also between outdoor to indoor and vice versa to avoid packet loss and latency during handover.	Experiment that measures the connectivity, packet loss and latency experienced during intra and inter HgNB/gNB handover.
KPI-15	Energy Consumption	Home gNBs and Radio-Light Head – Less than	Experiment that measures energy consumed by individual NFV/SDN,

	(HgNB)	that of an outside gNB	Layer2/3 Processing, Upper Layer 1 (DRAN) processing, RRLH Controller, VLC and mmWave parts of RRLH and UE components of system It is expected that his will be lower than that for access to an outside gNB from inside a building (difficult to measure as we are not using 5G Chip set it)
KPI-16	Energy Consumption (UE)	Energy expended by the UE to communicate with IoRL HeNB (Note that as the IoRL UE does not have a 5G UE chipset the only meaningful comparison that can be made is the energy expended by the physical layer processing required by the IoRL system and existing 4G/5G systems)	Experiment that measures the energy required to access VLC and mmWave Transport Blocks for audio, video and Internet access and comparison of this with the energy required to access Transport Block from outside eNB/gNB networks.
KPI-17	Battery Lifetime	Defined as the length of time it takes a battery changed to 100% to completely expend all its energy when continuously accessing audio, video and Internet data	This can be calculated from experiments to measure KPI-15 that takes into account that we are not using 5G Chip set. Lower than that for access to a outside gNB from inside a building.
KPI-18	Energy Savings (for MNO)	This is the amount of energy that the MNO requires to expend to operate the HgNB.	This can be calculated from experiments to measure KPI-14 Energy Consumption (HgNB) based on CAPEX/OPEX model adopted in project. This could be as high as 100% if Home owner is paying for the electricity cost for operating HgNB
KPI-19	Network Management OPEX / CAPEX options	Architectural options to locate various parts of the system architecture on Cloud	Experiment to test that Intelligent Home IP Gateway can be located at Home premises or in Cloud to provide different Energy Savings / Latency trade-offs.
KPI-20	EMF levels	Electromagnetic Field (EMF) level in milliGauss or microTesla	Experiment that uses an EMF meter to measure the EMF from VLC and mmWave RRLHs and compare this with the EMFs measured when accessing an outside eNB It is expected that it should be lower than that for access to an outside gNB from inside a building

4 3GPP Standardisation Groups relevant to the project

4.1 3GPP Standardisation Groups and Mapping of IoRL Architectural Components and KPIs

Table 4-1: Mapping of Architectural Components and KPIs to 3GPP Standardisation Activities

ID number	Release	Name	Group	Planned end date	Completion	WI/SI Description	IoRL Architectural Component	KPI Experiment
0	Rel-16	**Release 16 Features**		Mar-16	0%	-		
760054	Rel-16	**Mobile Communication System for Railways 2**	SA1	Jun-18	10%	SP-170451	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture Section 2.5 User Equipment Section 2.6 Lighting System Architecture	KPI 1 – KPI 20
770024	Rel-16	**EVS Codec Extension for Immersive Voice and Audio Services**	SA4	Dec-19	0%	SP-170611	NA	NA
780003	Rel-16	**Enhancements of Public Warning System**	SA1	Dec-18	0%	SP-170998	NA	NA
780055	Rel-16	**5G Voice Service Continuity**	SA1	Mar-18	0%	SP-171077	NA	NA
0	Rel-16	**Release 16 Studies**		Mar-16	0%	-		
770002	Rel-16	**Study on using Satellite Access in 5G**	SA1	Jun-18	0%	SP-170702	NA	NA
770004	Rel-16	**Study on 5G message service for MIoT**	SA1	Sep-18	0%	SP-170704	NA	NA

770038	Rel-16	**Study on Cellular IoT support and evolution for the 5G System**	SA2	Sep-18	0%	SP-170801	NA	NA
770005	Rel-16	**Study on Business Role Models for Network Slicing**	SA1	Sep-18	0%	SP-170705	NA	NA
760007	Rel-16	**Study on LAN Support in 5G**	SA1	Mar-18	35%	SP-170456	NA	NA
750004	Rel-16	**Study on Communication for Automation in Vertical Domains**	SA1	Mar-18	65%	SP-170169	NA	NA
730007	Rel-16	**Study on Maritime Communication Services over 3GPP system**	SA1	Jun-18	35%	SP-170453	NA	NA
780004	Rel-16	**Study on a Layer for User Centric Identifiers and Authentication**	SA1	Jun-18	0%	SP-170995	NA	NA
780005	Rel-16	**Study on Multimedia Priority Service (MPS) Phase 2**	SA1	Mar-19	0%	SP-170996	NA	NA
780025	Rel-16	**Study on application layer support for V2X services**	SA6	Sep-18	0%	SP-171071	NA	NA
780028	Rel-16	**Study on Enhancement to the 5GC Location Services**	SA2	Dec-18	0%	SP-170937	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture Section 2.5 User Equipment	KPI-06 Position Accuracy KPI-07 Coverage
780031	Rel-16	**Study on integration of ONAP DCAE and 3GPP management architecture**	SA5	Sep-18	0%	SP-170948	NA	NA
780022	Rel-16	**Study on Media Handling Aspects of RAN Delay Budget Reporting in MTSI**	SA4	Sep-18	0%	SP-170837	NA	NA
780030	Rel-16	**Study on EPC support for Mobility with Low Latency Communication**	SA2	Sep-18	0%	SP-171069	NA	NA
780001	Rel-16	**Study on User Plane Protocol in 5GC**	CT4	Sep-18	0%	CP-173160	NA	NA

0	Rel-15	**Release 15 Features on 5G**		Jun-16	0%	-		
750067	Rel-15	**New Radio Access Technology**	RAN1	Dec-18	21%	RP-171485	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture Section 2.5 User Equipment Section 2.6 Lighting System Architecture	KPI 1 – KPI 20
750167	Rel-15	**Core part: New Radio Access Technology**	RAN1	Jun-18	50%	RP-172115	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture Section 2.5 User Equipment Section 2.6 Lighting System Architecture	KPI 1 – KPI 20
750072	Rel-15	**LTE connectivity to 5G-CN**	RAN2	Jun-18	10%	RP-171432	Section 2.4 NFV/SDN Architecture	KPI-14 Service Continuity
0	Rel-15	**Release 15 Features on V2X**		Jun-16	0%	-		
750062	Rel-15	**Enhancements on LTE-based V2X Services**	RAN1	Dec-18	13%	RP-171069	NA	NA
750162	Rel-15	**Core part: V2X phase 2 based on LTE**	RAN1	Jun-18	30%	RP-171740	NA	NA
760043	Rel-15	**Study on architecture enhancements for 3GPP support of advanced V2X services**	SA2	Sep-18	20%	SP-170379	NA	NA

770029	Rel-15	**Study on V2X Media Handling and Interaction**	SA4	Sep-18	0%	SP-170799	NA	NA
770037	Rel-15	**EPC support for E-UTRAN Ultra Reliable Low Latency Communication**	SA2	Mar-18	0%	SP-170797	NA	NA
750061	Rel-15	**Highly Reliable Low Latency Communication for LTE**	RAN1	Dec-18	0%	RP-171489	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture	KPI-03 End to End Latency KPI-05 Reliability
750161	Rel-15	**Core part: Highly Reliable Low Latency Communication for LTE**	RAN1	Jun-18	0%	RP-171489	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture	KPI-03 End to End Latency KPI-05 Reliability
0	Rel-15	**Release 15 Features on improvements of Mission Critical (MC)**		Jun-16	0%	-		
760067	Rel-15	**MC Security Enhancements**	SA3	Dec-17	0%	SP-170415	Section 2.4 NFV/SDN Architecture	KPI-12 Security
750021	Rel-15	**Enhancements to MCPTT functional architecture and information flows**	SA6	Jun-18	23%	SP-170248	NA	NA
750022	Rel-15	**Enhancements to MC Data Functional architecture and information flows**	SA6	Jun-18	8%	SP-170462	NA	NA
760048	Rel-15	**Enhancements to MC Video Functional architecture and information flows**	SA6	Jun-18	15%	SP-170401	NA	NA
760051	Rel-15	**Study on MBMS APIs for Mission**	SA6	Mar-18	10%	SP-170598	NA	NA

		Critical Services						
760049	Rel-15	**MC system migration and interconnection**	SA6	Dec-17	20%	SP-170577	NA	NA
760050	Rel-15	**MC Communication Interworking between LTE and non-LTE Systems**	SA6	Dec-17	40%	SP-170578	NA	NA
770007	Rel-15	**Protocol enhancements for Mission Critical Services**	CT1	Jun-18	15%	CP-172145	NA	NA
0	Rel-15	**Release 15 Features on MTC-IoT**		Jun-16	0%	-		
750059	Rel-15	**Even further enhanced MTC for LTE**	RAN1	Dec-18	7%	RP-171427	NA	NA
750159	Rel-15	**Core part: Even further enhanced MTC for LTE**	RAN1	Jun-18	20%	RP-171427	NA	NA
750066	Rel-15	**Further NB-IoT enhancements**	RAN1	Dec-18	6%	RP-171428	NA	NA
750166	Rel-15	**Core part: Further NB-IoT enhancements**	RAN1	Jun-18	15%	RP-172063	NA	NA
0	Rel-15	**Release 15 Features on Virtual Reality (VR)**		Mar-16	0%	-		
770027	Rel-15	**Study on QoE metrics for VR**	SA4	Jun-18	0%	SP-170614	Section 2.5 User Equipment	KPI-01 User Data Rate KPI-02 Mobility KPI-03 End to End Latency
770030	Rel-15	**Study on 3GPP codecs for VR audio**	SA4	Sep-17	0%	SP-170617	NA	NA
770022	Rel-15	**Test Methodologies for the Evaluation of Perceived Listening Quality in Immersive Audio Systems**	SA4	Jun-18	0%	SP-170609	NA	NA
770023	Rel-15	**Addition of HDR to TV Video Profiles**	SA4	Dec-17	0%	SP-170610	Section 2.5 User Equipment	KPI-01 User Data Rate
770025	Rel-15	**Virtual Reality Profiles for Streaming Media**	SA4	Jun-18	0%	SP-170612	NA	NA
0	Rel-15	**Release 15 other Features**		Jun-16	0%	-		
710006	Rel-15	**Unlicensed Spectrum Offloading System**	SA1	Mar-18	44%	SP-160117	Section 2.4 NFV/SDN Architecture	KPI-14 Service Continuity

760030	Rel-15	**PS Data Off Phase 2**		Jun-18	13%	SP-170246	NA	NA
760035	Rel-15	**Northbound APIs for SCEF – SCS/AS Interworking**		Jun-18	59%	SP-170240	NA	NA
770049	Rel-15	**Common API Framework for 3GPP Northbound APIs**	SA6	Dec-17	46%	SP-170798	NA	NA
770041	Rel-15	**Stage 2 of CAPIF**	SA6	Dec-17	0%	SP-170798	Section 2.4 NFV/SDN Architecture	KPI-19 Network Management OPEX / CAPEX options
760066	Rel-15	**Management of Network Slicing in Mobile Networks, Concepts, Use cases and Requirements**	SA5	Jun-18	42%	SP-170586	Section 2.4 NFV/SDN Architecture	KPI-14 Service Continuity
770033	Rel-15	**Study on security aspect of 5G Network Slicing Provisioning**	SA3	Jun-18	5%	SP-170636	Section 2.4 NFV/SDN Architecture	KPI-12 Security KPI-13 Identity KPI-14 Service Continuity
760065	Rel-15	**Provisioning of network slicing for 5G networks and services**	SA5	Jun-18	0%	SP-170580	Section 2.4 NFV/SDN Architecture	KPI-12 Security KPI-13 Identity KPI-14 Service Continuity
770034	Rel-15	**Self-Organizing Networks (SON) for Active Antenna System (AAS) deployment management**	SA5	Jun-18	0%	SP-170658	NA	NA
770020	Rel-15	**Service Interactivity**	SA4	Jun-18	0%	SP-170796	NA	NA
620062	Rel-15	**Security Assurance Specification for 3GPP network products**	SA3	Jun-17	95%	SP-150292	Section 2.4 NFV/SDN Architecture	KPI-12 Security KPI-13 Identity
750014	Rel-15	**Lawful Interception Rel-15**		Dec-18	7%	SP-170039	NA	NA
760055	Rel-15	**Control and monitoring of Power, Energy and Environmental (PEE) parameters in Radio Access Networks (RAN)**	SA5	Mar-18	20%	SP-170479	Section 2.4 NFV/SDN Architecture	KPI-25 Energy Consumption (HgNB) KPI-18 Energy Saving(for MNO) KPI-20 EMF Levels

760058	Rel-15	**Management of QoE measurement collection**	SA5	Jun-18	5%	SP-170483	NA	NA
0	Rel-15	**Release 15 Features on LTE improvements**		Jan-00	0%	-		
720091	Rel-15	**Shortened TTI and processing time for LTE**		Jun-18	35%	RP-161299	NA	NA
750065	Rel-15	**Enhancements to LTE operation in unlicensed spectrum**	RAN1	Dec-18	17%	RP-170848	Section 2.4 NFV/SDN Architecture	KPI-14 Service Continuity
750069	Rel-15	**Further video enhancements for LTE**	RAN2	Dec-17	35%	RP-170781	NA	NA
0	Rel-15	**Release 15 Studies on 5G**		Jun-16	0%	-		
740005	Rel-15	**5G System - Phase 1**		Jun-18	47%	SP-160958	Section 2.1 Overall Architecture	KPI 1 – KPI 20
730056	Rel-15	**Study on management aspects of virtualized network functions that are part of the NR**	SA5	Sep-17	70%	SP-160703	Section 2.4 NFV/SDN Architecture	KPI-06 Position Accuracy KPI-9 Service Deployment Time KPI-11 Autonomy KPI-12 Security KPI-13 Identity KPI-14 Service Continuity KPI-15 Network Management
760039	Rel-15	**Study on 5G enhanced Mobile Broadband Media Distribution**	SA4	Mar-18	10%	SP-170334	Section 2.4 NFV/SDN Architecture	KPI-05 Reliability
760041	Rel-15	**Study on Media Handling Aspects of Conversational Services in 5G Systems**	SA4	Mar-18	5%	SP-170336	NA	NA
760044	Rel-15	**Study on the Wireless and Wireline Convergence for the 5G system architecture**	SA2	Jun-18	15%	SP-170380	NA	NA
760047	Rel-15	**Study of enablers for Network**	SA2	Sep-18	0%	SP-170383	NA	NA

		Automation for 5G						
760052	Rel-15	**Study on Access Traffic Steering, Switch and Splitting support in the 5G system architecture**	SA2	Sep-18	10%	SP-170411	Section 2.4 NFV/SDN Architecture	KPI-14 Service Continuity
750043	Rel-15	**Study on CU-DU lower layer split for New Radio**	RAN3	Dec-17	30%	RP-171717	Section 2.3 RAN Architecture	KPI-03 End to End Latency
750044	Rel-15	**Study of test methods for New Radio**	RAN4	Mar-18	15%	RP-171828	Section 2.2 RRLH Architecture Section 2.5 User Equipment	KPI 1 – KPI 20
750045	Rel-15	**Study on NR-based access to unlicensed spectrum**	RAN1	Jun-18	0%	RP-172021	Section 2.2 RRLH Architecture Section 2.5 User Equipment	KPI 1 – KPI 20
750046	Rel-15	**Study on Non-Orthogonal Multiple Access (NOMA) for NR**	RAN1	Jun-18	0%	RP-171043	NA	NA
750047	Rel-15	**Study on integrated access and backhaul for NR**	RAN2	Jun-18	0%	RP-171880	NA	NA
750040	Rel-15	**Study on NR to support non-terrestrial networks**	RAN1	Mar-18	40%	RP-171450	NA	NA
760080	Rel-15	**Study on separation of CP and UP for split option 2 of NR**	RAN3	Dec-17	45%	RP-171905	Section 2.3 RAN Architecture	KPI-03 End to End Latency
0	Rel-15	**Other Release 15 Studies**		Mar-18	0%	-		
770039	Rel-15	**Study on Enhancing Topology of SMF and UPF in 5G Networks**	SA2	Sep-18	0%	SP-170743	NA	NA
770031	Rel-15	**Study on EVS Float Conformance Non Bit-Exact**	SA4	Mar-18	0%	SP-170618	NA	NA
770026	Rel-15	**Study on Update to fixed-point basic operators**	SA4	Mar-18	0%	SP-170613	NA	NA
760064	Rel-15	**Study on system and functional aspects of Energy Efficiency in 5G networks**	SA5	Jun-18	5%	SP-170489	Section 2.1 Overall Architecture Section 2.2 RRLH	KPI-15 Energy Consumption (HgNB) KPI-16 Energy

							Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture	Consumption (UE) KPI-18 Energy Savings (for MNO)
760053	Rel-15	**Study on Long Term Key Update Procedures**	SA3	Dec-17	10%	SP-170413	NA	NA
760045	Rel-15	**Study on encrypted traffic detection and verification**	SA2	Sep-18	0%	SP-170381	NA	NA
750049	Rel-15	**Study on evaluation methodology of new V2X use cases for LTE and NR**	RAN1	Dec-17	5%	RP-171093	NA	NA
760040	Rel-15	**Study on MBMS User Services for IoT**	SA4	Mar-18	10%	SP-170592	NA	NA
760042	Rel-15	**Study on FEC for MC Services**	SA4	Dec-17	15%	SP-170337	NA	NA
740057	Rel-15	**Study on Policy and Charging for Volume Based Charging**	CT3	Dec-17	60%	CP-172135	NA	NA
720041	Rel-15	**Study on Technical Requirements for a new secure platform for 3GPP applications**	CT6	Sep-17	70%	CP-160371	Section 2.4 NFV/SDN Architecture	KPI-12 Security KPI-13 Identity
750030	Rel-15	**Study on technical requirements for a new secure platform for 3GPP applications**	CT6	Sep-17	70%	CP-170183	Section 2.4 NFV/SDN Architecture	KPI-12 Security KPI-13 Identity
750042	Rel-15	**Study on enhanced LTE Support for Aerial Vehicles**	RAN2	Dec-17	30%	RP-171050	NA	NA
750050	Rel-15	**Study on Architecture Evolution for E-UTRAN**	RAN3	Dec-17	40%	RP-172090	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture Section 2.5 User Equipment	KPI 1 – KPI 20

							Section 2.6 Lighting System Architecture	
730055	Rel-15	**Study on Management aspects of selected IoT-related features**	SA5	Dec-17	30%	SP-160611	NA	NA
680054	Rel-15	**Study on Overload Control for Diameter Charging Applications**	SA5	Dec-17	30%	SP-170481	NA	NA
710007	Rel-15	**Study on Implementation for the Partitioning of Itf-N**	SA5	Mar-18	80%	SP-160020	NA	NA
720046	Rel-15	**Study on Management Aspects of Next Generation Network architecture and features**	SA5	Dec-17	70%	SP-160399	Section 2.4 NFV/SDN Architecture	KPI-11 Autonomy KPI-12 Security KPI-13 Identity KPI-14 Service Continuity KPI-15 Network Management
720047	Rel-15	**Study on Management and Orchestration Architecture of Next Generation Network and Service**	SA5	Dec-17	30%	SP-160400	Section 2.4 NFV/SDN Architecture	KPI-15 Network Management
760056	Rel-15	**Study on OAM aspects of LTE and WLAN integration**	SA5	Mar-18	10%	SP-170480	Section 2.4 NFV/SDN Architecture	KPI-14 Service Continuity
760059	Rel-15	**Study on network policy management for mobile networks based on NFV scenarios**	SA5	Jun-18	20%	SP-170593	Section 2.4 NFV/SDN Architecture	KPI-14 Service Continuity
750048	Rel-15	**Study on self-evaluation towards IMT-2020 submission**	ITU-R AH	Jun-18	0%	RP-171451	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture Section 2.5 User Equipment	KPI 1 – KPI 20

							Section 2.6 Lighting System Architecture	

4.2 Summary of Potential Contributions

Table 4-2 lists a summary of all the potential contributions most of whom the project is too late to make a contribution. The only two contributions, which have not already made significant progress and with sufficient time for IoRL project to make a meaningful contribution, are:

- 780028 Rel-16 Study on Enhancement to the 5GC Location Services (SA1) – planned end date Dec 2018
- 750061 Rel-15 Highly Reliable Low Latency Communication for LTE (RAN1) – planned end date Dec 2018

Table 4-2: Table of Potential Contributions

ID number	Release	Name	Group	Planned end date	Completion	WI/SI Description	IoRL Architectural Component	KPI Experiment
780028	**Rel-16**	**Study on Enhancement to the 5GC Location Services**	**SA2**	**Dec-18**	**0%**	**SP-170937**	**Section 2.1 Overall Architecture** **Section 2.2 RRLH Architecture** **Section 2.3 RAN Architecture** **Section 2.4 NFV/SDN Architecture** **Section 2.5 User Equipment**	**KPI-06 Position Accuracy** **KPI-07 Coverage**
750067	**Rel-15**	**New Radio Access Technology**	**RAN1**	**Dec-18**	**21%**	**RP-171485**	**Section 2.1 Overall Architecture** **Section 2.2 RRLH Architecture** **Section 2.3 RAN Architecture** **Section 2.4 NFV/SDN Architecture** **Section 2.5 User Equipment** **Section 2.6 Lighting System**	**KPI 1 – KPI 20**

							Architecture	
750061	**Rel-15**	**Highly Reliable Low Latency Communication for LTE**	**RAN1**	**Dec-18**	**0%**	**RP-171489**	**Section 2.1 Overall Architecture** **Section 2.2 RRLH Architecture** **Section 2.3 RAN Architecture** **Section 2.4 NFV/SDN Architecture**	**KPI-03 End to End Latency** **KPI-05 Reliability**
770033	**Rel-15**	**Study on security aspect of 5G Network Slicing Provisioning**	**SA3**	**Jun-18**	**5%**	**SP-170636**	**Section 2.4 NFV/SDN Architecture**	**KPI-12 Security** **KPI-13 Identity** **KPI-14 Service Continuity**
760055	**Rel-15**	**Control and monitoring of Power, Energy and Environmental (PEE) parameters in Radio Access Networks (RAN)**	**SA5**	**Mar-18**	**20%**	**SP-170479**	**Section 2.4 NFV/SDN Architecture**	**KPI-25 Energy Consumption (HgNB)** **KPI-18 Energy Saving(for MNO)** **KPI-20 EMF Levels**
730056	**Rel-15**	**Study on management aspects of virtualized network functions that are part of the NR**	**SA5**	**Sep-17**	**70%**	**SP-160703**	**Section 2.4 NFV/SDN Architecture**	**KPI-06 Position Accuracy** **KPI-9 Service Deployment Time** **KPI-11 Autonomy** **KPI-12 Security** **KPI-13 Identity** **KPI-14 Service Continuity** **KPI-15 Network Management**
760052	**Rel-15**	**Study on Access Traffic Steering, Switch and Splitting support in the 5G system architecture**	**SA2**	**Sep-18**	**10%**	**SP-170411**	**Section 2.4 NFV/SDN Architecture**	**KPI-14 Service Continuity**

760064	**Rel-15**	**Study on system and functional aspects of Energy Efficiency in 5G networks**	**SA5**	**Jun-18**	**5%**	**SP-170489**	**Section 2.1 Overall Architecture** **Section 2.2 RRLH Architecture** **Section 2.3 RAN Architecture** **Section 2.4 NFV/SDN Architecture**	**KPI-15 Energy Consumption (HgNB)** **KPI-16 Energy Consumption (UE)** **KPI-18 Energy Savings (for MNO)**
750050	**Rel-15**	**Study on Architecture Evolution for E-UTRAN**	**RAN3**	**Dec-17**	**40%**	**RP-172090**	**Section 2.1 Overall Architecture** **Section 2.2 RRLH Architecture** **Section 2.3 RAN Architecture** **Section 2.4 NFV/SDN Architecture** **Section 2.5 User Equipment** **Section 2.6 Lighting System Architecture**	**KPI 1 – KPI 20**

5 IMT-2020 Standardisation Groups relevant to the project

5.1 IMT-2020 Standardisation Groups and Mapping of Architectural Components and KPIs

Table 5-1: Anticipated IMT-2020 related deliverables

Item	Proposed IMT-2020 related deliverable	Aspect to be addressed in proposed deliverable	Work start timing	Document completion in WP 5D	IMT-Advanced model document	Responsible WG (and SWG)	IoRL Architectural Component	KPI Experiment
1	**Doc. IMT-2020/001 IMT-2020 Background"**	Background on IMT-2020	Meeting #22 (June 2015)	Meeting #24 (June 2016)	Document IMT-ADV/1 *"Background on IMT-Advanced"*	WG GEN (SWG CL)		
2	**Doc. IMT-2020/002 IMT-2020 Process"**	The Submission and evaluation process and consensus building for IMT-2020 as well as the "timeline" for IMT-2020	Meeting #22 (June 2015)	Meeting #24 (June 2016)	Document IMT-ADV/2 "*Submission and evaluation process and consensus building"*	WG TECH (SWG COORD)		
3	**Draft new Report ITU-R M.[IMT-2020. TECH PERF REQ]**	General Technical Performance Requirements expected of a technology to satisfy IMT-2020	Meeting #23 (February 2016)	Meeting #26 (February 2017)	Report ITU-R M.2134 *"Requirements related to technical performance for IMT-Advanced radio interface(s)"*	WG TECH (SWG RADIO)		
4	**Draft new Report ITU-R M.[IMT-2020. EVAL]**	Evaluation Criteria and Evaluation Methods for IMT-2020 technologies	Meeting #23 (February 2016)	Meeting #27 (June 2017)	Report ITU-R M.2135 *"Guidelines for evaluation of radio interface technologies for IMT-Advanced"*	WG TECH (SWG EVAL)		

5	**Draft new Report ITU-R M.[IMT-2020. SUBMISSION]**	Specific Requirements of the candidate technology related to submissions, the evaluation criteria and submission templates	Meeting #23 (February 2016	Meeting #27 (June 2017)	Report ITU-R M.2133 *"Requirements, evaluation criteria and submission templates for the development of IMT-Advanced"*	WG TECH (SWG COORD)		
6	**Circular Letter IMT-2020**	The official ITU-R announcement of the IMT-2020 process and the invitation for candidate technology submissions	Meeting #23 (February 2016)	Meeting #36 (October 2020)	Circular Letter 5/LCCE/2 and Addenda *"Invitation for submission of proposals for candidate radio interface technologies for the terrestrial components of the radio interface(s) for IMT-Advanced and invitation to participate in their subsequent evaluation"*	WG GEN (SWG CL)		
7	**Doc. IMT-2020/YYY** **Input Submissions Summary**	Capturing in ITU-R documentation the inputs documents and the initial view of suitability as a valid submission	Meeting #28 (October 2017)	Meeting #32 (July 2019)	For example, Documents IMT-ADV/4 thru IMT-ADV/9 "*Acknowledgement of candidate submission from ……under step 3 of the IMT-Advanced process (….. technology)"*	WG TECH (SWG COORD)	Section 2.1 Overall Architecture Section 2.2 RRLH Architecture Section 2.3 RAN Architecture Section 2.4 NFV/SDN Architecture Section 2.5 User Equipment Section 2.6 Lighting System Architecture	

8	**Doc. IMT-2020/ZZZ** **Evaluation Reports Summary**	As the evaluation of each candidate technology proceeds the results of each evaluation of each technology by the different evaluation groups must be documented and analysed by WP 5D towards the final evaluation assessment	Meeting #30 (June 2018)	Meeting #34 (February 2020)	For example, Documents IMT-ADV/10 thru IMT-ADV/23 "Evaluation IMT-Advanced candidate technology submissions in documents IMT-ADV/xyz by XYZ Evaluation Group"	WG TECH (SWG EVAL)		KPI 1 – KPI 20
9	**Draft new Report ITU-R M.[IMT-2020. OUTCOME]**	The outcome of the evaluation and assessment and the statement on those candidate technologies suitable to move to the specification phase in ITU-R	Meeting #33 ([December] 2019)	Meeting #35 (June 2020)	Report ITU-R M.2198 "The outcome of the evaluation, consensus building and decision of the IMT-Advanced process (Steps 4 to 7), including characteristics of IMT-Advanced radio interface"	WG TECH (SWG EVAL)		
10	**Doc. IMT-2020/VVV** **Process and use of GCS**	Information on the process and use of the GCS, references, and certifications	Meeting #31 (October 2018)	Meeting #34 (February 2020)	For example, Document IMT-ADV/24 Rev.3 "Process and the use of Global Core Specification (GCS), references and related certifications in conjunction with Recommendation ITU-R M.2012"	WG TECH (SWG IMT SPECS)		

11	**Draft new Recommendation ITU-R M.[IMT-2020.SPECS]**	The detailed specification of each of IMT-2020 technology	Meeting #33 ([December] 2019)	Meeting #36 (October 2020)	Recommendation ITU-R M.2012 "Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT-Advanced)"	WG TECH (SWG IMT SPECS)		
12	**Doc. IMT-2020/WWW** **Update procedure for Rec. ITU-R M.[IMT-2020.SPECS]**	Procedure for the development of draft revisions	Meeting #36 (October 2020)	Meeting #37 (February 2021)	For example, Document IMT-ADV/25 Rev.2 "Procedure for the development of draft revisions of Recommendation ITU-R M.2012 Detailed specifications of the terrestrial radio interfaces of IMT-Advanced"	WG TECH (SWG IMT SPECS)		

5.2 Summary of Potential Contributions

The time line and process for IMT-2020 is shown in Figure 5-1. Table 5-1 shows the anticipated related deliverables and Table 5-2 the meeting schedule.

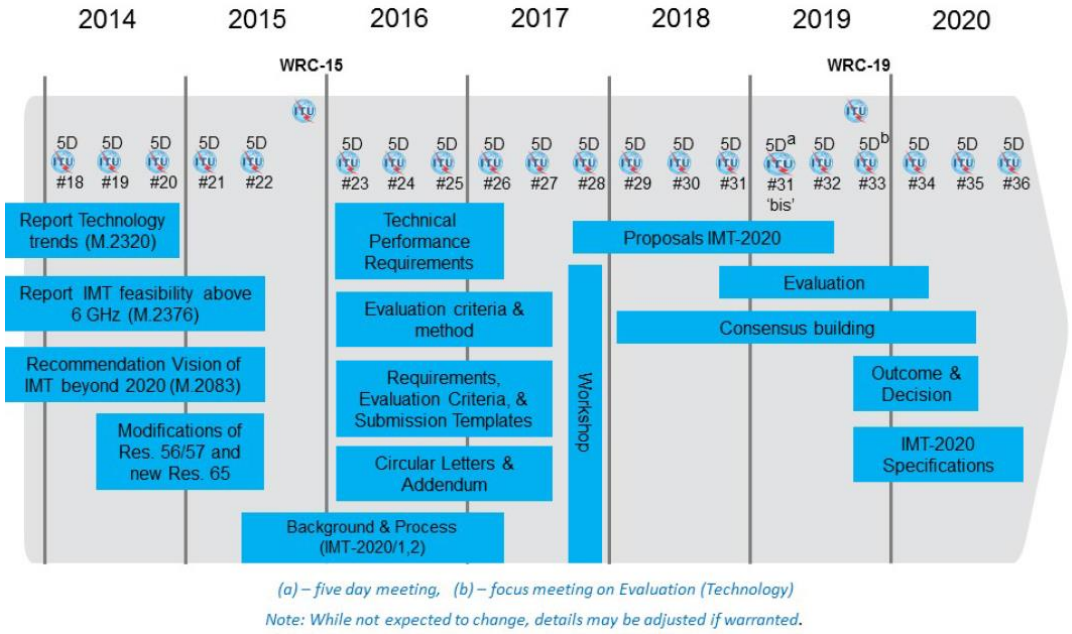

Figure 5-1: Timeline and Process for IMT-2020 in ITU-R

Proposals can be submitted by July-2019 where Doc. IMT-2020/YYY will provide an Input Submissions Summary that captures in ITU-R documentation the inputs documents and the initial view of suitability as a valid submission. By Feb 2020 the IoRL project would require to contribute towards Doc. IMT-2020/ZZZ Evaluation Reports Summary to provide KPI results for the evaluation of evaluation IoRL technology by the different evaluation groups that will be documented and analysed by WP 5D towards the final evaluation assessment. By June 2020, the Draft new Report ITU-R M.[IMT-2020. OUTCOME] will present the outcome of the evaluation and assessment and the statement on those candidate technologies suitable to move to the specification phase in ITU-R. This is much more in line with IoRL time schedule.

Table 5-2: Meeting Schedule

GROUP	No.	FROM	TO	PLACE	COMMENTS
WP 5D	30	13 June 18	20 June 18	Mexico	
WP 5D	31	9 October 18	16 October 18	[Japan]	(Tuesday to Tuesday)
WP 5D	31bis	11 February 19	15 February 19	Geneva	5 working day meeting
CPM19-2	–	18 February 19	28 February 19	Geneva	
WP 5D	32	9 July 19	17 July 19	[Geneva]	7 working day meeting
RA-19	–	21 October 19	25 October 19	[Egypt]	
WRC-19	–	28 October 19	22 November 19	[Egypt]	
WP 5D	33	[9 December] 19	[13 December] 19	[Geneva]	Focus meeting on evaluation (WG Technology Aspects)

WP 5D	34	19 February 20	26 February 20	[TBD]	
WP 5D	35	24 June 20	1 July 20	[TBD]	
WP 5D	36	7 October 20	14 October 20	[TBD]	

6 EM Exposure Groups relevant to the project

6.1 EM Exposure Groups and Mapping of Architectural Components and KPIs

Recommendation	Title	Description	KPI Experiment
ITU-T K.52	Guidance on complying with limits for human exposure to electromagnetic fields	Recommendation ITU-T K.52 aims to help with compliance of telecommunication installations and mobile handsets or other radiating devices used against the head with safety limits for human exposure to electromagnetic fields (EMFs).	KPI-20: EMF levels
ITU-T K.61	Guidance on measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations	Recommendation ITU-T K.61 helps telecommunication operators to verify compliance with exposure standards promulgated by local or national authorities. This Recommendation gives guidance on measurement methods that can be used to achieve a compliance assessment. It also provides guidance on the selection of numerical methods suitable for exposure prediction in various situations.	KPI-20: EMF levels
ITU-T K.62	System level radiated emissions compliance using mathematical modelling	This Recommendation supports telecommunication operators in demonstrating the compliance of the radiated emissions generated by telecommunication systems.	KPI-20: EMF levels
ITU-T K.83	Monitoring of electromagnetic field levels	Recommendation ITU-T K.83 gives guidance on how to make long-term measurements for the monitoring of electromagnetic fields (EMF) in the selected areas that are under public concern, in order to show that EMFs are under control and under the limits.	KPI-20: EMF levels

Supplement 1 to ITU-T K-series Recommendations ITU-T K.91	Guide on electromagnetic fields and health	The objective of Supplement 1 to the ITU-T K-series Recommendations, Guide on electromagnetic fields and health, is to answer questions commonly posed by the public on EMF and to address related concerns.	KPI-20: EMF levels
ITU-T K.91	Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields.	Guidance on how to assess and monitor human exposure to radio frequency (RF) electromagnetic fields (EMF) in areas with surrounding radio communication installations based on existing exposure and compliance standards in the frequency range of 9 kHz to 300 GHz. This includes procedures of evaluating exposure and how to show compliance with exposure limits with reference to existing standards.	KPI-20: EMF levels
ITU-T K.92	Conducted and radiated electromagnetic environment in home networking	Recommendation ITU-T K.92 describes the home networking electromagnetic environment.	KPI-20: EMF levels
ITU-T K.100	Measurement of radio frequency electromagnetic fields to determine compliance with human exposure limits when a base station is put into service	Recommendation ITU-T K.100 provides information on measurement techniques and procedures for assessing compliance with the general public electromagnetic fields (EMFs) exposure limits.	KPI-7: Coverage, KPI-8: Communication Range, KPI-12: Security, KPI-20: EMF levels
ITU-T K.122	Exposure levels in close proximity of radio communication antennas	The guidance concerning the exposure levels in close proximity to transmitting antennas is important for safety of the radio communication staff operating in such areas.	KPI-20: EMF levels
Supplement 9 to ITU-T K-series Recommendations	5G technology and human exposure to RF EMF	Supplement 9 to the ITU-T K-series Recommendations contains an analysis of the impact of the implementation of 5G mobile systems with respect to the exposure level	KPI-20: EMF levels

		of electromagnetic fields (EMF) around radio communication infrastructure.	

6.2 Summary of Potential Contributions

There does not seem to be a time schedule for defining EM exposure related to 5G by ITU. However [IEC 62232] and [ITU-T K.100] has defined base station installation classes that are applicable to small cells deployed in countries with exposure limits based on international guidelines (ICNIRP) [7]. Each installation class is including simple criteria such as the equivalent isotropic radiated power (EIRP) of all equipment at the site or installation height. The IoRL project could report to this group the EMF levels required to cover a property from radio-light access points.

7 Internet Engineering Task Force (IETF) Work Relevant to 5G

7.1 Introduction

The IETF works on Internet technologies which may or may not get used in different networks, whereas 3GPP puts together systems, architectures, and designs protocols specific to their networks and layers. The IETF is not in charge of making system level or requirement decisions for the 3GPP. Similarly, 3GPP leaves the evolution of Internet protocols to the IETF. As the IoRL project does not propose to make any modifications to Internet protocols then it may not be appropriate to make any submissions to the IETF. Nevertheless the work of some IETF work groups may have direct impact on our IoRL architecture.

7.2 Potentially relevant IETF work

New technology currently under development in IETF [8]

- Routing-related work
- Traffic engineering, abstractions, and network management
- Deterministic networking
- New transport protocol: QUIC

7.2.1 Routing Related Work

Table 7-1: Routing related work groups

Work Groups	**Work Item**
Relevant IETF working groups: Traffic Engineering Architecture and Signalling (TEAS), Interface to Routing System (I2RS)	Data models as abstractions for consuming topology, proximity, etc., plus APIs/bindings to program the network
Path Computation Element (PCE) working group	Path computation to meet constraints of 5G radio
BGP, OSPF/ISIS TE metric extensions, PCEP/RSVP	Routing protocols for distributed networking, transport of objective functions and metrics
MPLS, Network Virtualization Overlays (NVO3), Deterministic Networking (DETNET) working groups	Encapsulations to provide abstractions and metadata
Source Packet Routing in Networking (SPRING) working group	Segment routing as means to provide transport slice
Service Function Chaining (SFC) working group	Service chaining to transport traffic across virtualized functions

7.2.2 Traffic engineering, abstractions, and network management

Table 7-2: Traffic engineering, abstractions and network management related working groups

Work Groups	Work Item
Layer 2 Service Model (L2SM) and Layer 3 Service Model (L3SM)	Data models for service delivery
Network Configuration (NETCONF) and NETCONF Data Modelling Language (NETMOD) working groups	Data models for network management
Traffic Engineering Architecture and Signalling (TEAS) working group	Traffic engineering tools, including interfaces between service orchestration, SDN controllers, access network, core network

7.2.3 Deterministic networking (DETNET)

Table 7-3: Deterministic networking related working groups

Work Groups	Work Item
DetNet Working Group	Support for applications requiring controlled latency, loss, jitter, and high reliability within an administrative domain
DetNet Working Group	Deterministic delivery achieved through: Reserving data plane resources on path for individual flows Explicit routes that do not rapidly change Distribution of packets over time/space for redundancy

7.2.4 New transport protocol: Quick UDP Internet Connection (QUIC)

Table 7-4: Quick UDP Internet Connection related working groups

Work Groups	Work Item
QUIC Working Group	UDP-based, stream-multiplexing, always-encrypted transport protocol focused on minimizing application latency Work may include considerations for manageability, path MTU discovery, tuning

8 ITU-T and ITU-R

8.1 VLC Standardisation Groups

SG1B of ITU-R the next meeting will be in Geneva mid/late May 2019. They are preparing a report on Visible Light Communications [9], and the possible locations to add IoRL aspects are in Part 5 (specifically in 5.4 and 5.5).

In 5.4, IoRL will add EU-China collaboration instead of an individual country contribution to explain IoRL project perspective. In 5.5, we will add IoRL system description and this can be provided with certain measurement results (particularly location estimation), confirming it is a practical system (even for demo purposes).

Part 6, we will provide contributions to Smart Home and Smart City (Museums, Trains Stations and Supermarkets).

SG15 of ITU-T the next meeting will be in early July and IoRL project will seek to obtain and invitation to attend since attendance is only by invitation. They are preparing a report on Visible Light Communications [10] whose aim is to develop a “High speed indoor visible light communication transceiver – System architecture, physical layer and data link layer specification”. IoRL project will seek to point out that its 5G Home network architecture does comply with configurations identified in Section 6: System architecture and reference models; with the main difference being that IoRL system is largely 5G compatible. The ITU-T contact person is: Mr. Hiroshi OTA (Advisor) hiroshi.ota@itu.int.

8.2 Summary of Potential Contributions

IoRL project will make a contribution to Report ITU-R SM.2422-0 (06/2018) and will seek to obtain an invitation to ITU-T meeting to make a contribution to ITU-T G.9991.

9 IEEE

9.1 VLC Standardisation

Concerning IEEE802.15 the draft proposal for IEEE P802.15.13 [11] proposes an Optical Wireless Personal Area Networks (OWPAN). A wireless personal area network (WPAN) is a personal, short distance area wireless network for interconnecting devices centered on an individual person's workspace. WPANs address wireless networking and mobile computing devices such as PCs, PDAs, peripherals, cell phones, pagers and consumer electronics. WPANs are also called short wireless distance networks. This proposal defines the physical, MAC and Management protocols required for an OWPAN but do not address the same level of overall system architecture aspects that is required for a home network and that has been defined by IoRL project and ITU-T/R.

The majority of the contributions to this standardization effort are made by Fraunhofer Heinrich Hertz Institute as it is shown in Table 5 (see also [12]).

The Chairman of the group is: Eun Tae Won from Samsung (etwon@samsung.com) who we can approach to enquire if IoRL project can make a contribution towards 5G based Optical Wireless Personal Area Networks.

Table 5: Recent Contributions to IEEE802.15.13

IEEE 802.15

Documents

Everything | All Years | TG13 | DCN, Title, Author or Affiliation

Created (ET) ▼	Year	DCN	Rev	Group	Title	Author (Affiliation)	Uploaded (ET)
15-Feb-2019 ET	2019	80	0	TG13	Further text for TG13	Kai Lennert Bober (Fraunhofer HHI)	15-Feb-2019 07:51:06 ET
17-Jan-2019 ET	2019	67	1	TG13	TG13 Closing Plenary Slides for St. Louis	Volker Jungnickel (Fraunhofer HHI)	17-Jan-2019 19:56:45 ET
17-Jan-2019 ET	2019	68	0	TG13	TG13 Draft Agenda for March 2019 in Vancouver	Volker Jungnickel (Fraunhofer HHI)	17-Jan-2019 19:40:53 ET
17-Jan-2019 ET	2019	67	0	TG13	TG13 Closing Plenary Slides for St. Louis	Volker Jungnickel (Fraunhofer HHI)	17-Jan-2019 18:39:19 ET
17-Jan-2019 ET	2019	13	3	TG13	TG 13 agenda for St. Louis Jan 2019	Volker Jungnickel (Fraunhofer HHI)	17-Jan-2019 18:17:27 ET
17-Jan-2019 ET	2017	288	8	TG13	Suggested Timelines for TG13	Volker Jungnickel (Fraunhofer HHI)	17-Jan-2019 17:59:43 ET
17-Jan-2019 ET	2019	52	1	TG13	additional comments against D3.1	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI), Nikola Serafimofski (pureLiFi)	17-Jan-2019 17:23:23 ET
15-Jan-2019 ET	2019	13	2	TG13	TG 13 agenda for St. Louis Jan 2019	Volker Jungnickel (Fraunhofer HHI)	15-Jan-2019 19:06:14 ET
15-Jan-2019 ET	2019	52	0	TG13	additional comments against D3.1	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI), Nikola Serafimofski (pureLiFi)	15-Jan-2019 19:04:16 ET
15-Jan-2019 ET	2019	17	2	TG13	comments against D3.1	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI)	15-Jan-2019 10:36:01 ET
15-Jan-2019 ET	2019	13	1	TG13	TG 13 agenda for St. Louis Jan 2019	Volker Jungnickel (Fraunhofer HHI)	15-Jan-2019 07:39:27 ET
14-Jan-2019 ET	2019	17	1	TG13	comments against D3.1	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI)	14-Jan-2019 18:53:11 ET
14-Jan-2019 ET	2018	616	3	TG13	Text proposal for beacon enabled medium access	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI), Xu Wang (VLNComm Inc)	14-Jan-2019 14:49:08 ET
14-Jan-2019 ET	2018	617	2	TG13	TG13 telco Minutes for December and January	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI)	14-Jan-2019 10:50:20 ET
13-Jan-2019 ET	2018	273	4	TG13	Text proposal for High Bandwidth PHY	Volker Jungnickel (Fraunhofer HHI)	13-Jan-2019 17:59:28 ET
13-Jan-2019 ET	2019	17	0	TG13	comments against D3.1	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI)	13-Jan-2019 12:27:54 ET
12-Jan-2019 ET	2019	13	0	TG13	TG 13 agenda for St. Louis Jan 2019	Volker Jungnickel (Fraunhofer HHI)	12-Jan-2019 15:25:55 ET
12-Jan-2019 ET	2018	564	3	TG13	Minutes for November meeting in Bangkok	Chong Han (pureLiFi) Volker Jungnickel (HHI)	12-Jan-2019 15:17:27 ET
12-Dec-2018 ET	2018	617	1	TG13	TG13 telco Minutes for December and January	Kai Lennert Bober, Volker Jungnickel (Fraunhofer HHI)	12-Dec-2018 11:57:57 ET

Further to the above, IEEE 802.11bb™ defines a medium access control (MAC) and several physical layer (PHY) specifications for light-based wireless connectivity for fixed, portable, and moving stations within a local area network.

9.1.1 Summary of Potential Contributions

IoRL project will not seek to obtain an invitation to IEEE 802.15.13 meetings to make a contribution to IEEE 802.15 WPAN Task Group 13 (TG13) Multi-Gigabit/s Optical Wireless Communications, since this activity is focused on Personal Area Networks which does not take a system level view of the whole home network as is the case in IoRL architecture.

IoRL project will not seek to obtain an invitation to make a contribution to IEEE 802.11 bb meetings as this activity is not networked with 5G networks.

9.2 mmWave Standardisation

IEEE802.11ad also known as WiGig or 60GHz WiFi is a microwave form of Wi-Fi that can provide data transfer of up to 7 Gbps at frequencies around 60GHz.

As signals at this frequency do not travel over great distances and are absorbed by walls, etc, high levels of re-use can be obtained without users on the same channel experiencing interference.

Interworking between WiGig and LTE/LTE-A systems is not supported.

Solution to manage handovers between mobile network and the WiGig Home Network and between the different rooms within the WiGig Home Network is not supported.

It uses a MAC layer standard that is shared with current 802.11 standards to enable session switching between 802.11 Wi-Fi networks operating in the 2.4 GHz, and 5 GHz bands with those using the 60 GHz WiGig bands. In this way, seamless transition can occur between the systems. Conversely the architecture has not been enhanced to combat the nearly bimodal channel depending on the presence or absence of line-of-sight. A main difference between microwave and mmWave frequencies is the sensitivity to blockages: for instance because of the sensitivity to blockages, a given link can rapidly transition from usable to unusable and, unlike small-scale fading, large-scale obstructions cannot be circumvented with standard small-scale diversity countermeasures.

IEEE 802.11ay is the follow-up of 802.11ad that adds four times the bandwidth and MIMO up to 4 streams to support transmission rates of up to 8 Gb/s using single-input-single-output (SISO) wireless transmissions over a single 2.16 GHz channel. Multiple antenna elements used by Directional Multi-Gigabit (DMG) stations (STAs) only provide beamforming gain but not multiplexing gain. To achieve both beamforming and multiplexing gain both Single-User MIMO (SU-MIMO) and downlink Multi-User MIMO (MU-MIMO) is employed. The maximum number of spatial streams per station is eight, and downlink MU-MIMO transmission can be made to up to eight stations [13].

As the antenna solution tends to use beamforming from a single access point for both systems they are thus susceptible to path blockages and is not networked with other access points.

9.2.1 Summary of Potential Contributions

IoRL project will not seek to obtain an invitation to IEEE 802.11ad meetings to make a contribution as it seeks to promote a 5G cellular architecture within buildings from multiple access isotropic antenna access points providing a man-made multipath environment to overcome the bimodal nature of 60GHz channel.

10 Conclusions

IoRL develops a unique innovative architecture for 5G in-doors and plans twenty experiments to measure Key Performance Indicators of the results first by the laboratory demonstrators in June 2019 and then in the field test sites by June 2020.

An analysis of the 3GPP timetable indicates that the results of the project's experiments may arrive too late to make an impact.

A study of the IMT-2020 timetables indicates that the results of the project's experiments are closely aligned to support two key outputs, namely:

- Doc. IMT-2020/YYY: Input Submissions Summary (completion date June 2019)
- Doc. IMT-2020/ZZZ: Evaluation Reports Summary (completion date February 2020)

A study of the ITU-T k series timetables indicates that there is no timetable for producing results so the results of the IoRL project's EMF measurement results can be submitted at any time.

A study of relevant IETF study groups indicates that the following working groups have direct relevance to IoRL project:

- Traffic Engineering Architecture and Signalling (TEAS) working group
- DetNet Working Group
- QUIC Working Group

A study of ITU-R SG1B reveals that in the first instance it is timely to prepare and submit a contribution to a document that is being prepared on Visible Light Communications specifically addressing Smart Homes and Smart Cities with a particular emphasis on location estimation. This may be extended to an additional contribution to SG15 of ITU-T whose aim is similar to IoRL project's aim which is to develop a "High speed indoor visible light communication transceiver – System architecture, physical layer and data link layer specification".

The IEEE IEEE802.15 draft proposal for IEEE P802.15.13 proposes an Optical Wireless Personal Area Networks (OWPAN), which is out of scope of the IoRL project.

IEEE 802.11bb™ defines one medium access control (MAC) and several physical layer (PHY) specifications for light-based wireless connectivity for fixed, portable, and moving stations within a local area network but is not networked with 5G networks.

On the other hand the IEEE 802.11ad uses a MAC layer that is compatible with IEEE 802.11 Wi-Fi networks operating and more suited to transmission over 2.4GHz and 5GHz lower frequencies.

IEEE 802.11ay is the follow-up of 802.11ad uses beamforming from a single access point for both systems they are thus susceptible to path blockages and is not networked with other access points.

Therefore, it is recommended that the in the first instance the IoRL project prepares one document to ITU-R:

- IoRL Architecture and Location Measurement Results

Furthermore, we will keep a track of the results of the relevant TEAS, DETNET, 3GPP, ITU-T, IEEE and QUIC IETF working groups to see if the results of their work has an impact on the architecture devised by IoRL.

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