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Abstract

This deliverable presents the detailed plan for standardization activities of the H2020 RISE-6G project. Hereafter we provide the list of activities, and we introduce an initial standardization roadmap that will include the identification of relevant standardization development organizations and open-source projects. We finally provide a preliminary list of achievements.

Keywords

Beyond-5G, 6G, Standard, 3GPP, ETSI, O-RAN, RIS, Rel-18

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List of Acronyms

5G-NR	5th Generation - New Radio
BS	Base Station
CSI	Channel State Information
DL	Downlink
gNB	gNodeB
ISG	Industry Specification Group
KPI	Key-Performance Indicator
MANO	NFV management and network orchestration
mmWave	Millimiter-wave
NFV	Network Function Virtualization
PoC	Proof-of-Concept
RACH	Random Access Channel
RIS	Reconfigurable Intelligent Surface
SDO	Standard Developing Organization
SI	Study Item
UE	User
WI	Work Item
WP	Work Package

1 Introduction

International standardization contributions represent one of the major dissemination activities of the RISE-6G project. Specifically, we pioneer a novel technology exploitation, namely RIS, for upcoming commercial wireless systems that will be developed in the near future. Therefore, the impact on current and future standardization organizations might be relevant for the accomplishment of all project objectives and, in general, for the overall project success.
The standardization exploitation of project results will be performed based on two different main operations:

- Direct contribution: industrial project partners directly involved in the main standardization bodies, such as 3GPP, ITU, ETSI and O-RAN, will discuss and actively contribute to the relevant study items/work items pushing for the RISE-6G outstanding results.
- Active monitoring: industrial or academic partners being part of standardization meetings will directly report about main discussions on the relevant topics. This would help to quickly identify areas of interest, check whether the project roadmap is aligned with concurrent standardization activities and provide a feedback on preliminary results.

An example of such activities is depicted in Figure 1-1.

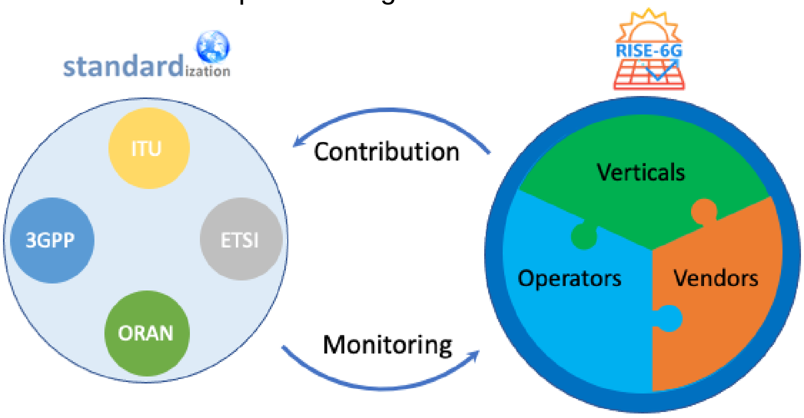

Figure 1-1 – Exploitation through standardization.

Verticals, vendors and operators will cooperate within project technical work packages to bring the innovation introduced by the usage of RIS into the main standardization bodies. Detailed activities per each relevant standard are hereafter provided.

2 Standardization activities

RISE-6G project will address standardisation activities across relevant standards bodies and fora based on specific standard involvement of key-partners of the project. A specific focus will be on 3GPP and ETSI related standards activities, as the most relevant on the definition of upcoming network generation designs. In general, standardisation activities are identified to be key to push for the novel technology, such as RIS, adopted and broadly deployed by the relevant core industrial stakeholders, such as vendors and operators. We list in Table 2-1 the standard groups where RISE-6G is expected to provide contributions while leaving additional standardization fora for upcoming deliverables.

Table 2-1: Expected impact on main standardization bodies

Bodies or fora	Groups	RISE-6G Contribution	Partners
3GPP		3GPP will be the key-standards body for Beyond-5G and 6G system definition. This will be included in Release 18 and 19.	NEC, TIM, ORA, CEA
	SA1, SA2, SA3, SA5	Reference architecture for integrating innovative and novel services that might comprise RIS-enable networks.	
	RAN1	Advanced localisation techniques that might require timing, synchronisation and novel signals, such as Demodulation Reference Signal (DMRS), Channel Modelling Sounding Reference Signal (SRS) and Orthogonal Time-Frequency Space (OTFS)-related modulation for RIS environments.	
	RAN2	Monitoring of 5G NR guidelines for advanced solutions that might include RIS specifications	
	RAN3	Handover mechanisms in a cell-less deployment where RISs might be in place to provide service continuity.	
ETSI	RIS	RIS-related interfaces and protocols. Integration with other existing ETSI ISG.	NEC, NKUA, CEA, CNRS
	NFV	NFV-MANO administrative domains, Management and connectivity of multi-site network services, Network slicing in NFV), Reconfigurable Radio Systems (RRS) (Cognitive Radio (CR), Software Reconfiguration through Radio Applications)	
	MEC	RIS-aware applications that require pre/post-processing on edge data centres	
	NTECH	Enablers and associated APIs to access network resources, such as network-based authentication, location information, content caching. Service and Network interconnection and interworking with RISs.	
	ENI	AI-based solution supporting RIS activation and operations.	
O-RAN	WG1, WG2, WG3, WG4, WG6	Open fronthaul contribution to have RIS-based deployments. Interface between RISE-6G controller and Near-real-time RIC.	NEC, ORA, TIM

Following the main standard bodies, the RISE-6G project will define a clear standardization activity roadmap to be in line with ongoing and upcoming activities. This would automatically capture updates that might influence industrial choices while keeping RISE-6G output still up-to-date. In addition, RISE-6G will also contribute by means of each involved partner to the main discussions to disseminate project technological innovations giving more visibility to our technical achievements. A project timeline matching the major SDOs is depicted in Figure 2-1. However, the overall standardization activity roadmap will be updated accordingly after the first year based on the standard bodies progresses.

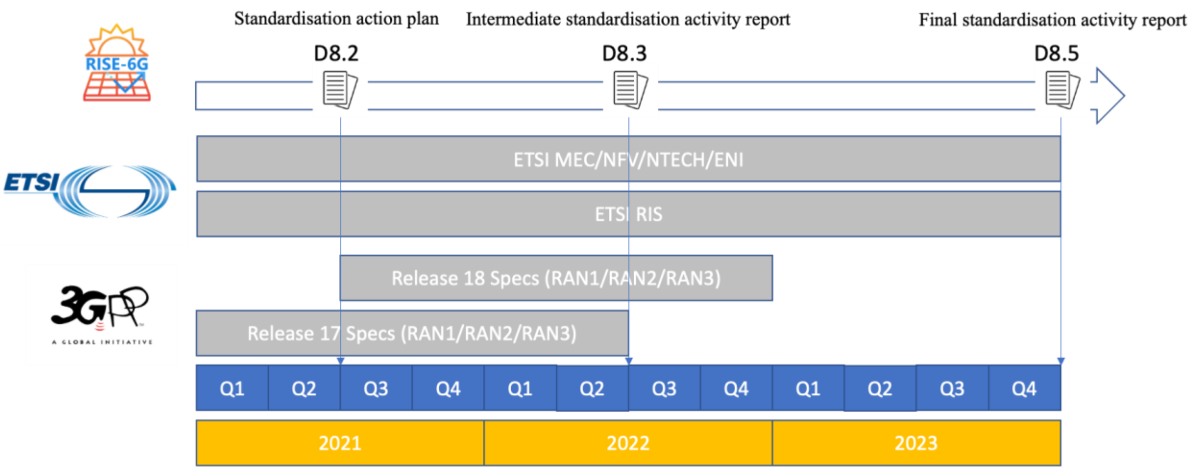

Figure 2-1 – RISE-6G timeline over major SDOs.

3 3GPP

The 3rd Generation Partnership Project (3GPP) aims at covering cellular telecommunications technologies that will include radio access network (RAN), core network (CN) and service capabilities. This automatically provides the means for creating a complete architecture mobile telecommunication system. In general, specifications from the 3GPP standardization group are proposed by each member company within specific Working Groups (WGs) and at the Technical Specification Group (TSG) level. We can identify three different TSGs, such as Radio Access Networks (RAN), Services & Systems Aspects (SA), Core Network & Terminals (CT) with their last release (17) of specifications ready and public within Q2 of 2021. Novel and innovative concepts to be included in 5G-and-beyond (B5G) and 6G network design will be part of the discussion for upcoming 3GPP release 18.

RISE-6G project will mostly focus on contributions related to radio access network (RAN). However, future standard contributions may also include core networks-related topic to support seamless RIS integration into the existing system. Monitoring activities will be performed to be aligned with the relevant ongoing discussions.

3.1 Relevant working groups: RAN1/RAN2/RAN3

Physical layer specifications, protocols and architectural contributions are currently discussed within 3GPP RAN1, RAN2 and RAN3 WGs. In particular, the novel RIS devices will be part of the radio access network focusing on the recently-defined 5G New-Radio (NR) guidelines. This would make room for discussions on advanced localisation techniques that will require timing, synchronisation and novel signals as per upcoming definitions. Specifically, the RISE-6G project will make use of Demodulation Reference Signal (DMRS), Channel Modelling Sounding Reference Signal (SRS) and Orthogonal Time-Frequency Space (OTFS)-related modulation within its technical work packages. In addition, handover mechanisms in a fully cell-less deployment will be further analyzed and discussed to provide service continuity while being integrated with current standard specifications.

3.2 RAN Release-18 and expected contributions

3GPP MRP workshop on industry verticals and Rel-18 RAN was organized in preparation of the RAN Release-18 workshop. During the MRP workshop, interests and priorities of the main involved verticals were discussed. The workshop covered satellite, public safety, maritime, broadcast/media, automotive, industrial, utilities and railways application scenarios. Therefore, covering requirements across multiple verticals became the priority while defining the next RAN release. In this context, RIS definition will play a relevant role as the technological means to achieve unprecedented key-performance indicators.

As part of preliminary monitoring activities, RISE-6G project partners joined the RAN Release-18 workshop where diverse industrial partners contributed on the RIS technology. Hereafter, we summarize detailed contributions, as per Table 3-1.

Table 3-1 - RIS-related contributions

Description of contribution	ID	Partner
Ubiquitous antennas	RWS-210465	ZTE, NEC
mmWave-related scenarios	RWS-210390	China Unicom, ZTE
Channel modelling	RWS-210247	Rakuten
Physical and upper layer impacts	RWS-210306	Sony
Smart repeater evaluation	RWS-210300	KDDI

3.2.1 Ubiquitous antennas

Ubiquitous scenarios where RISs can be easily and cheaply deployed were proposed. In particular, limited power consumption, contiguous surface properties and signal quality improvement make the selected technology as the right candidate for the 3GPP Release-18 specifications as per Figure 3-1.

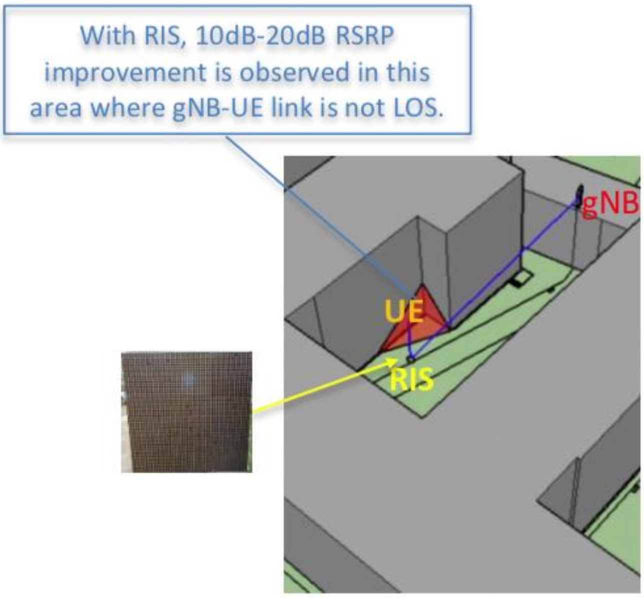

Figure 3-1 – Improvement of coverage with field-measurements at 28GHz [c.f. RWS-210465[1]]

Some technical enhancements were discussed to enable UE-specific optimization. This would have a direct impact on the beam management by performing Training mechanism for RIS-gNB and RIS-UE links. In addition, it would require a control interface between the RIS-gNB that might include synchronization mechanisms with accuracy up to symbol level. Also, a RACH enhancement would be required to cope with the extended coverage issue. Finally, when RIS deployment will be dense, an interference coordination mechanism is also needed.

3.2.2 MmWave-related scenarios

While considering mmWave communications, for e.g., at 28GHz, the overall system efficiency may involve several technical challenges due to a stronger pathloss, including transmission blocks due to tree, body, glasses. In specific scenarios, RISs can be used to extend the coverage of already-deployed mmWave points-of-access as per Figure 3-2.

[1] The contribution is available at the following URL: https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Docs/RWS-210465.zip

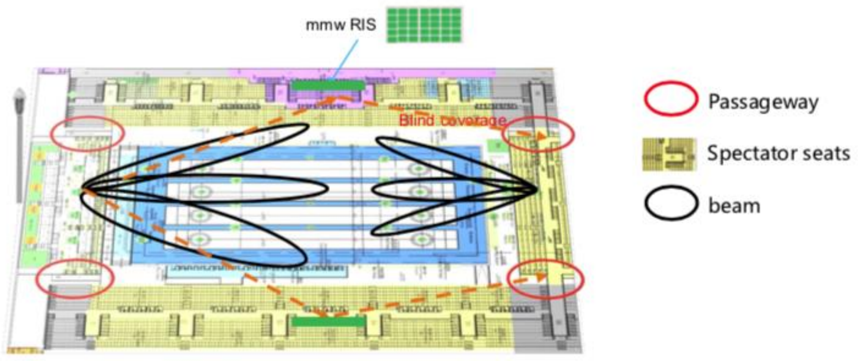

Figure 3-2 - mmWave-based trail scenario integrated with RISs (c.f. RWS-210390[2]).

3.2.3 Channel modelling

A new RAN1 study item was proposed to cover novel channel modelling issues including interference suppression mechanisms that might be caused by introducing RIS devices within the existing network deployments. A new generation of ray tracers, for example based on Eulerian schemes and computed by solving energy flow equations on meshes (e.g., Dynamical Energy Analysis) will incorporate multiple RISs and will help deciding how many and how large RIS devices should be deployed given a specific scenario, even in presence of structural uncertainties, in both indoor and outdoor scenarios. In addition, RIS-related beam management mechanisms will also be discussed with CSI-feedbacks, based on the type of RIS that is considered. Finally, use cases and deployments scenarios will be further investigated and discussed by the study item.

3.2.4 Physical and upper layer impacts

RIS physical layer-related aspects shall be discussed and considered into release-18 items. Channel estimation procedures for RIS-UE and BS-RIS links shall be investigated with a corresponding CSI feedback reporting. This would require a dedicated signalling between the BS and RIS device that must be standardized. In addition, mobility management protocols shall be improved to consider RIS selection while steering the signal beam toward specific areas/UEs. This calls for more sophisticated channel models to be included in the RAN1 item on channel modelling.

3.2.5 Smart repeater evaluation

New-radio repeaters were introduced and discussed in release 17 with an adaptive control of beamforming to UEs. This has improved the coverage (in outdoor) and the overall signal penetration. However, RISs can provide measures to combat the dead-spot problem. Therefore, a study item would be beneficial to evaluate the performance gain and involved cost of both technologies, such as smart repeater and RISs. In addition, there is an impelling need to identify enhancements on the interface between gNBs and smart repeaters or RISs while realizing adaptive control of beamforming or ad-hoc RIS reflection direction configuration.

[2] Contribution is available at the following URL: https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Docs/RWS-210390.zip

4 ETSI

In Europe, ETSI is the European Telecommunication Institute, a recognized European Standards Organization that deals with telecommunications, broadcasting and other electronic communication networks and services. The standardization work is carried out by means of different Industry Specification Groups (ISGs), which focus on specific activities and standardization guidelines. The RISE-6G project will mostly focus on four existing ISGs, such as ETSI MEC, ETSI NFV, ETSI ENI and ETSI NTECH. A **new ISG has been recently approved** to focus on the **novel RIS concept,** namely ETSI RIS.

4.1 Relevant ISGs: NFV/MEC/ENI/NTECH

Running applications and services at the edge of the network is of paramount importance for the next-generation network design. ETSI Multi-access Edge Computing, namely MEC, takes care of architectural definition, functional building blocks identification and corresponding protocols to expose applications and services running close to the end-users. In particular, this would reduce the end-to-end latency to control and run network applications.

In this context, RIS-related interfaces will have a direct impact on the edge computing as specific algorithms and procedures might be deployed close to the end-users to reduce latency of the control channel. RIS-related APIs will be discussed and analyzed within the ETSI MEC ISG in order to integrate existing interfaces with novel RIS capabilities.

Network function virtualization also represents a key-enabler for the upcoming network generation. ETSI NFV has been established in 2012 thereby providing the management and orchestration framework that has been exhaustively used by different vendors and network operators. RIS control algorithms can also be part of the orchestration layer, as long-term RIS configurations might be directly issued through an improved version of existing interfaces.

Machine learning and Artificial Intelligence will help on orchestration and management operations. In particular, ETSI ENI focuses on AI-enabled network management. The ISG built an Experiential Network Intelligent that implements flexibility and agility in network operations by making network configurations and monitoring processes automatic. RISE-6G will make use of AI-enabled management techniques to autonomously and quickly reconfigure RIS devices keeping complexity and cost affordable.

Finally, ETSI NTECH focuses activities on enablers and open APIs to directly access network resources based on network-based authentication, location information or content caching. Such information might be exploited by RIS configuration algorithms to deliver ad-hoc services and automatically configure RIS to achieve expected KPIs.

4.2 ETSI RIS ISG

While RIS-based contributions will be discussed and included in different ETSI ISGs, the huge impact of such a novel technology has triggered discussion on whether to get a novel ETSI ISG focusing directly on RIS. This has been exhaustively discussed among academic and industrial partners to give birth to a new powerful ISG that will cover different RIS aspects.

In particular, the new ISG is expected to provide an opportunity for all ETSI members to coordinate their pre-standards research efforts on RIS technology across various EU/UK collaborative projects, extended with relevant global initiatives, towards paving the way for future standardization of the technology. The main mission of this ISG is to finally explore RIS technology and all its applications across the wide spectrum of use cases and deployments, and identify any specification needs that may be required.

The scope of the ISG will include the definition of use cases, expected KPIs and deployment and operational scenarios relevant for the RIS technology. In addition, it will focus on Radiofrequency aspects including surface models, channel characterization, radiation characterization, and radiation exposure limits for RIS, as already considered within the RISE-5G project. Also, RIS-aided air-interface technologies mechanics, and requirements will be considered as important topic of the ISG. System and network level control signaling aspects as well as network architecture framework considerations will be investigated within the new ISG activities thereby providing a baseline evaluation methodology and performance analysis for RIS. Finally, a proof-of-concepts with enabling technologies with a verification and validation plan (e.g., Hackathons) will also be part of the discussion.

The newly-approved ETSI ISG will follow the roadmap as per Figure 4-1.

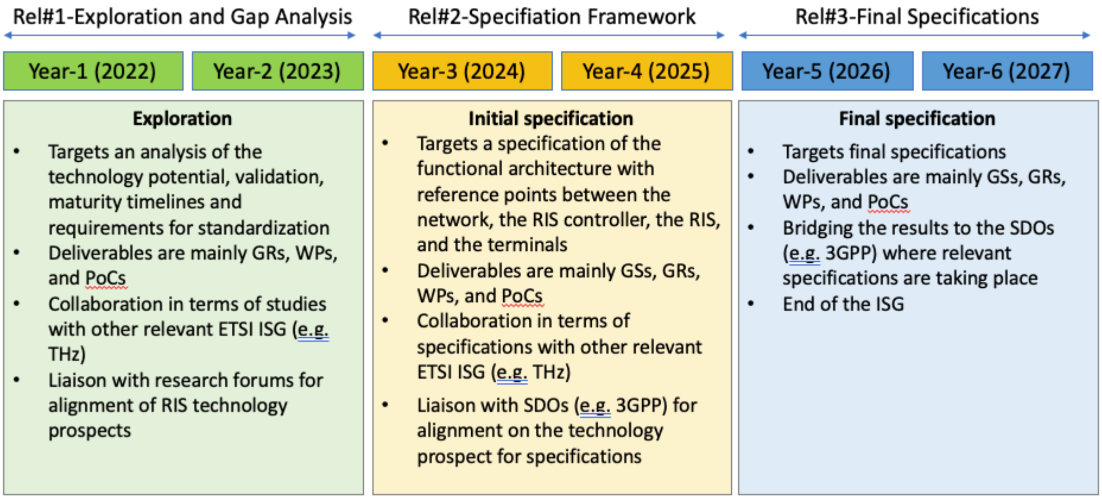

Figure 4-1 – Expected ISG Roadmap

Specifically, the kickoff of the first 2-years round is expected on September 2021. Within the first phase, an exploration and gap analysis will be carried out so as an initial specification will be defined in the next second phase. By the end of 2027 the final specifications will be released trying to make a clear link with other SDOs, such as 3GPP.

Many relevant partners are funding the initiative. Most of them are also part of the RISE-6G consortium, as reported in Table 4-1.

Table 4-1: Co-founding members of ETSI RIS

Organization	Country	Type	ETSI Member	ETSI Board Member
British Telecommunications plc	UK	Operator	Yes	Yes
CEA-LETI	France	Research Institute	Yes	No
CNIT	Italy	Research Institute	Yes	No
CNRS	France	Research Institute	Yes	No
IMDEA Networks	Spain	Research Institute	Yes	No
InterDigital Europe Ltd	UK	Vendor	Yes	No
National Physical Laboratory	UK	Research Institute	Yes	No
NEC Europe Ltd	Germany/UK	Vendor	Yes	Yes

UK DCMS	UK	Government	Yes	Yes
University of Oulu	Finland	Academia	Yes	No
University of Surrey	UK	Academia	Yes	No
ZTE	China	Vendor	Yes	Yes

This would give more visibility to the project activities while create a reserved path to disseminate technical solutions and project results directly into the ETSI ISG. Future activities will align expected RISE-6G field-trial demonstrations with current version of ISG specifications.

5 O-RAN

The transformation of the classical radio access network takes place with the new O-RAN Alliance, initially founded by mobile operators and now counting major industrial partners. Virtualized network elements, white-box hardware and standardized interfaces will empower two major key-concepts, such as Openness and Intelligence. The O-RAN Alliance has already coined the first version of the O-RAN architecture to build the virtualized RAN on open hardware and cloud, with embedded AI-powered radio control. Specifications defined by O-RAN are fully supporting and complimentary to other standards promoted by 3GPP and other industry standards organizations. On the one hand, with open interfaces, it might build agile and cost-effective future RAN designs to open opportunities to small vendors and business players. On the other hand, the intelligence brings an added-value to quickly coordinate and manage complex-network deployments. This would result in automating operational network functions and, in turn, minimizing network operational costs.

RISE-6G aims at being aligned with the O-RAN vision so that project results and advanced solutions might eventually influence the design of standard interfaces, such as the coordination between radio and computing resources and the coordination between near-real and non-real-time data collection. The relevant working groups of O-RAN are the following: WG1: Use Cases and Overall Architecture Workgroup, WG2: The Non-real-time RAN Intelligent Controller and A1 Interface Workgroup, WG3: Near-Real-time RIC and E2 Interface Workgroup, WG4: The Open Fronthaul Interfaces Workgroup ad WG6: Cloudification and Orchestration Workgroup.

RISE-6G will directly contribute to O-RAN discussions and activities by means of O-RAN Alliance members (both operators and vendors, such as ORA, NEC, TIM). The contributions will gather the main project outputs and functional building blocks that might be relevant in the O-RAN architectural picture. RISE-6G partners have been actively following the activities in O-RAN, which is quite relevant for RISE-6G. In this line, NEC and ORA are the members of O-RAN and also participating in regular meetings. This would give RISE-6G a high chance of impacting on this SDO while issuing new interfaces between the Near-Real-Time RIC and the RIS Controller, that would also be aligned with the scopes of the O-RAN WG1, WG2, WG3 and WG4. Finally, expected RISE-6G field-trials will try to address standardized interfaces to improve reusability of obtained results.