JERICO-DS DELIVERABLE

Joint European Research Infrastructure of Coastal Observatories - Design Study

DELIVERABLE #, WP# and full title	JERICO-DS D6/D2.3 – WP2 "**Roadmap for technical implementation of the JERICO-RI**"
5 Key words	coastal – technology – observations - roadmap
Lead beneficiary	SYKE
Lead Author	Jukka Seppälä (SYKE)
Co-authors	Katri Kuuppo (SYKE), Helene Frigstad and Andrew King (NIVA), Anouk Blauw, Lorinc Meszaros (DELTARES)
Contributors	National representatives in JERICO Design Study (J-DS)
Submission date (dd/mm/yyyy)	31.1.2024

Nature

X R = Report, □ P = Prototype, □ D= Demonstrator, □ O = Other

Dissemination level :

X PU □ PP □ RE □ CO

PU = Public, PP = Restricted to other programme participants (including the Commission Services), RE = Restricted to a group specified by the consortium (including the Commission Services), CO = Confidential, only for members of the consortium (including the Commission Services)

GRANT N°: 951799
PROJECT ACRONYME : JERICO-DS
PROJECT NAME : Joint European Research Infrastructure network of Coastal Observatories - Design Study
COORDINATOR : Laurent DELAUNEY - Ifremer, France - design.jerico@ifremer.fr

DOCUMENT TECHNICAL DESCRIPTION

Document ID	JERICO-DS-WP2-D6/D2.3-310124-V1.0

REVISION HISTORY

Revision	Date	Modification	Author
V1.0	31/01/2024	Final version submitted	Jukka Seppälä

APPROVALS

	Name	Organisation	Date	Visa
Coordinator	Laurent Delauney	Ifremer	31/01/2024	X
WP Leaders	Jukka Seppälä	SYKE	31/01/2024	X

Diffusion list

Consortium beneficiaries	Third parties	Associated Partners	other
X	X		

According to the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) and the 78-17 modified law of 6 January 1978, you have a right of access, rectification, erasure of your personal data and a right of restriction to the data processing. You can exercise your rights before the Ifremer data protection officer by mail at the following address: IFREMER – Délégué à la protection des données- Centre Bretagne – ZI de la Pointe du Diable – 29280 Plouzané - FRANCE or by email: dpo@ifremer.fr + design.jerico@ifremer.fr
Ifremer shall not hold your personal data for longer than necessary with regard to the purpose of the data processing and shall destroy it thereafter.

Table of Content

EXECUTIVE SUMMARY

This deliverable is a "Technology Roadmap" for the JERICO-Design Study (J-DS) Task 2.3 developed in collaboration with the scientific vision created in WP1. It follows the Technology Outlook (JERICO-DS D2.1) and Technology Gap Analysis (JERICO-DS D2.2).

The document reviews JERICO-RI Mission and Vision statements as a starting point of Technical Design. The main outcomes of Technology Outlook and Gap Analysis are reviewed, followed by a description of methodologies used in data collection. A key element for Technology Design has been interaction with JERICO-RI Nation Representatives (NRs) who have provided vast amounts of background information from their nations through questionnaires, participation in workshops and other discussions.

The Technology Roadmap was constructed first by identifying key technology needs and development proposals identified by NRs. These were balanced with essential elements of JERICO-RI technologies when building a Pan-European coastal marine Research Infrastructure. The long list of development Proposals and related practical Activities were exposed for evaluation and ranking by NRs. Based on NRs evaluations of Roadmap Proposals and Activities, the first shortlist was formulated and some borderline cases were again discussed among NRs.

The final list of Roadmap items included 44 Activities distributed for the timelines "Now" (11 Activities to be done prior ESFRI application, expected in 2025 - i.e. in 1-1.5 years from now), "Short" (10 Activities for JERICO-RI Preparatory Phase) and "Long" (23 Activities during JERICO-RI Implementation Phase). The list of Activities to be performed prior ESFRI application included:

- Create a clear understanding of JERICO-RI, nationally, regionally and pan-Europeanly, indicating which parts of the national observing capacities and which services are part of JERICO-RI
- Map the national state-of-art in coastal observations, including various RIs and other initiatives, and find out what is (and what should be) the JERICO-RI's position in this national landscape
- Demonstrate the added value of transnational observations in regional seas
- Identify the key thematic areas (incl. Blue Growth -topics) where pan-European technology coordination is a necessity, acknowledging different needs of various Key Scientific Challenges
- Clarify the role of JERICO-RI in using those platforms and technologies, which are also used by other RIs
- Make the catalogue of SOPs and Best Practices easily available
- Perform an in depth analysis of PSS and IRS work done, in terms of transnational technology collaborations
- Participate in marine industry events for promotion of JERICO-RI technologies and opportunities
- Agreement which are the core JERICO-RI variables and how they are measured
- Agree which platforms are supported by JERICO-RI
- Provide a high-level illustration of JERICO-RI variables and platforms, for dissemination purposes

Monitoring of the realisation of Roadmap must be conducted in concert with JERICO-RI Nation Committee, JERICO-S3 project, ESFRI proposal writing team, dedicated teams for certain Activities and, after all, JERICO-RI as structured after JERICO-DS and JERICO-S3 projects.

1. Introduction

This deliverable presents the JERICO-RI Technology Roadmap, produced in JERICO-DS Work Package 2 "Technical Design for an Operational JERICO-RI (physical part of the RI)". It is a continuation of JERICO-RI Technology Outlook and Gap Analysis, which are largely based on the information provided by Nation Representatives of JERICO-RI.

JERICO-RI Technology Roadmap has a time period of 10 years, assuming that JERICO-RI is moving towards ERIC and therefore covering three phases; 1) items to be done prior ESFRI application (expected in 2025 - i.e. in 1-1.5 years from now), 2) activities during JERICO-RI Preparatory Phase and 3) activities during JERICO-RI Implementation Phase. Roadmap covers the requirements for coastal observations as given by background documents (various deliverables from JERICO-DS), answering the needs of various identified Key Scientific Challenges, covering regions JERICO-RI has now, users as identified so far and including the platforms and variables described in Outlook and Gap analysis.

Technology Roadmap will focus on selected key areas of development needs and covers not only technology per se, but also related strategies, structures and human capacities, as one cannot plan technological advance in isolation from those.

Finally, it is expected that Technology Roadmap will feed in other strategic plans of JERICO-RI, including plans for e-infrastructure, governance, sustainability and scientific topics to be covered.

2. Background for JERICO-RI technology roadmap

2.1. Summary of JERICO-RI Mission and Vision

A Technology Roadmap is a planning tool that provides information on the most recommended and selected technological improvements that an organisation (in this case a Research Infrastructure) is seeking to implement. Such planning must be strongly aligned with what the organisation aims to overall achieve (Mission) and what its desired state is in the future (Vision).

For this JERICO-RI Technology Roadmap, we align with Mission and Vision statements elaborated in JERICO-DS WP1, and reported in D1.3.

- Mission statement: *"The JERICO mission is to enable a sound understanding of the responses of coastal marine systems to natural and anthropogenic stressors. To do so, JERICO adopts a systematic approach to monitor, observe, explore and analyse coastal marine systems in order to reach reliable information of their structure and functioning in the context of global change. JERICO encompasses the whole range of environmental sciences, technologies and data sciences. It achieves observations at global, regional and local scales, through the implementation and the harmonisation of a set of complementary platforms and multidisciplinary observation systems. JERICO enables open-access to state-of-the-art and innovative facilities, resources, FAIR data and fit-for-purpose services, fostering international science collaboration."*

- Vision statement: *"JERICO will be the pan-European integrated gateway to long-term scientific and harmonised observations and related services for coastal marine systems."*

2.2. Summary of JERICO-RI Technology Outlook

JERICO-RI Technology Outlook, reported in JERICO-DS D2.1, was developed in collaboration with the scientific vision created in JERICO-DS WP1.

Input from JERICO-RI Nation Representatives (NRs) were received through a questionnaire, elaborated with relevant J-DS and JERICO-S3 (J-S3) work packages, and filled out by NRs over a 3-month period in 2022. It provided an overview of the current status of JERICO-RI infrastructures from a national perspective and national requirements on the technology design for the future JERICO-RI. The compilation of national inputs focused on the technical aspects of the infrastructure (systems/platforms/sensors), and on questions that dealt with how the JERICO-RI infrastructure should look and function in the future (5-10 years).

Based on the information from the questionnaire, the underlying key scientific challenges (KSCs) and ongoing work within the WPs of JERICO-RI (both J-S3/J-DS), the Technology Outlook provided a synthesis of requirements for the future operational JERICO-RI. This synthesis introduced a set of "core variables" considered to be essential to observe for the future operational JERICO-RI and the main platforms for (semi-)continuous sensors and observations that will be involved, well aligned with the GOOS EOVs framework. It underlined the need for a multiplatform approach to study coastal areas at optimal spatial and temporal scales. It also described how the partners in JERICO-RI collaborate to provide high quality scientific coastal data and support coastal research and policy. The Technology Outlook provided the basis for the JERICO-RI Technology Gap Analysis performed and the Technology Roadmap for the future JERICO-RI.

2.3. Summary of JERICO-RI Technology Gap Analysis

In the Technology Gap Analysis study (JERICO-DS D2.2) the desired state of the future JERICO-RI, as described in the Technology Outlook, was compared to the current situation as reported by JERICO-RI NRs through a questionnaire. Furthermore, relevant results from earlier JERICO-RI projects were summarised: on the current spatial and temporal resolution of JERICO-RI observations and on the current TRL-level of observation methods for key JERICO variables that were defined in the Technology Outlook. Relevant results on gaps from the on-going JERICO-S3 project and other gap analysis reports were reviewed.

The information on current gaps in observation capacity from these different sources agreed on many overarching issues. The questionnaire results from NRs gave further insight into the reasons why current gaps in observation capacity and international harmonisation still exist.

While sensor observations of relevant physical and some chemical variables are operational at high TRL-level in most countries associated with JERICO, observations of many biological, chemical and benthic variables are still in testing phase or developing phase. Partly this is due to observation methods that are still being developed. A major reason why many variables are still observed at a low TRL-level is the lack of sustained funding for these observations. The funding is currently nation-based or by European research projects. These scattered funding sources hamper the prioritisation of international harmonisation efforts and the required maintenance, quality control and data management efforts to make

observation data suitable and available for stakeholders in a FAIR way. Stakeholders, such as the EEA, Regional Sea Conventions and COPERNICUS have a high demand for such high-quality FAIR observation data, but they don't fund the required efforts for data collection and data management.

These results indicated that there is a need for a mature JERICO-RI, as described in the Technology Outlook, based on international coordination and sustained funding.

2.4. Methods of collecting information for Technology Roadmap

The key elements of Technology Roadmap, Development-Proposals and related list of Activities, were in main part extracted from the questionnaire filled by NRs, and which was already used as an input for Technology Outlook and Technology Gap Analyses.

The preliminary list of Technology Roadmap Development Proposals was presented to the JERICO-RI community during a JERICO-week in Rovinj 18.-20 April 2023 in a session "*How will JERICO-RI look like, from technology perspective (multi-platforms, variables, integration, user needs) when we present it in ESFRI. Based on PSS results and JDS-WP2 technological design*". In full form, a list of Development Proposals was discussed during a JERICO-DS Steering Committee meeting in La Spezia, 13.-15. June 2023, in a session "*WP2 Technology Roadmap*".

The detailed list of Development-Proposals and Activities were submitted to NRs on 15th November 2023 for their evaluation. The instructions, how to provide feedback, were demonstrated in practice and discussed during the JERICO-DS General Assembly in Tallinn 21.-23 November 2023 during a session "*Technical Design for an Operational JERICO-RI*". Details of ranking Development-Proposals and Activities by NRs will be given in Section 4.

Once the Roadmap Proposals and Activities were written out, they were opened to JERICO-RI NRs for their evaluation (described in Section 4). The final content of the Roadmap was approved unanimously in JERICO-RI Nation Committee meeting on 12 January 2024.

2.5. Overview of McKinsey 7S method

Selection of McKinsey 7S as a framework for Technology Outlook, Gap Analyses and Roadmap has been detailed in JERICO-DS D2.1. The key elements included in the framework, that seemed also appropriate for our purpose, are recognition of multiplicity of interconnected factors that influence the organisation, and that there is no a priori hierarchy among the factors. The framework of McKinsey 7S's - *Shared values, Structure, Systems, Strategy, Skills, Staff and Style* - represents the complexity of organisations and interdependency of factors (Figure 1).

Briefly, to describe the meaning of various S's in JERICO-RI

- *Shared values* are the key objectives agreed within JERICO partnership, so that JERICO-RI will be the future gateway for European coastal long-term observations and related services (and this "S" is not considered in Technology Roadmap, as we consider that Shared values come from overall strategy of JERICO-RI).
- *Style* represents how leadership and organisation structures are designed and how they are affecting technology implementation of coastal observations. As well, Style

is not an "S" to be considered in Technology Roadmap, as it is more related to Governance

- The *Strategy*, in developing JERICO-RI technologies to meet the Vision, builds upon the existing coordination and integration of observations and takes into account the additional needs and possible synergies for integration.
- *Structure* stands for understanding what are the key scientific focus areas among different nations and regions, how different actors share the work and collaborate, and how all these are coordinated, and which might be the benefits from transnational and pan-European structures.
- *Systems* refer to the current and desired use of technology and the key future technologies. This part of analysis checks the needs for multiplatform observations, mechanisms for transfer of knowledge and barriers for optimal use. Briefly, our aim is to analyse how the use of technology (platforms, sensors) is organised and implemented and if it meets the JERICO-RI science strategy.
- In our analysis we do not clearly separate *Staff and Skills*, mainly because it may be hard at this phase of JERICO-RI technology planning to make an in-depth analysis of the actual technology related personnel. With the two S's we refer here to overall availability of human resources for coastal observations, future needs in improving their competences, and needs for training, transnational support and specialisation.

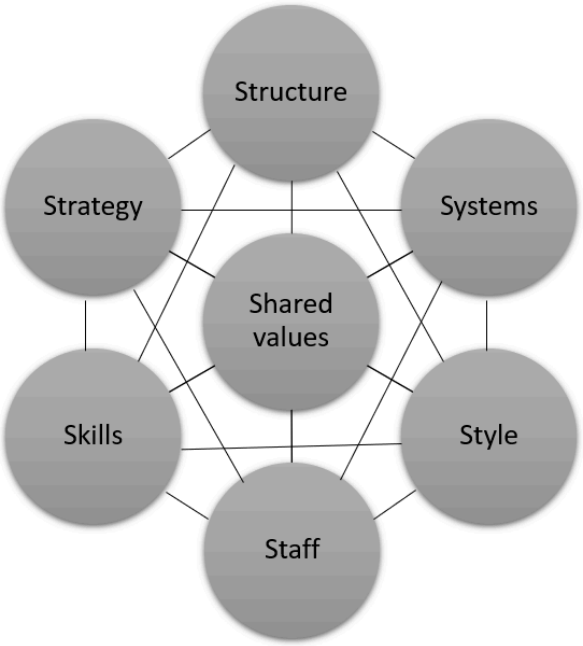

Figure 1. Graphical representation of McKinsey 7S Framework, with 7 elements of organisational framework, redrawn from Waterman et al. (1980).

2.6. Objectives of the Roadmap

The JERICO-RI technology Roadmap provides a plan to implement JERICO-RI Vision, from the technology point of view. It provides insight to following key objectives:

- how regional observation systems should be technically organised,
- which types of sensors and technologies should be implemented for various tasks,

- how the operational activities should be optimally designed among various platforms,
- which are the most efficient networking schemes between expert communities and technology groups,
- how to optimally support the sustainable operational JERICO-RI through technical expert centres i.e. organisational nodes for specific operations (link to WP5)
- what are the needs and means for technology knowledge transfer
- how the JERICO-label may be implemented to evaluate different technology solutions and practices and to provide a tool to answer which observatories are part of operational
- how the technical structures selected may affect data flows and use of e-infrastructures
- how the technical solutions may affect the physical and open access to infrastructures

Aim of the Roadmap is not to go into very details of technology solutions, like brand of sensors to be used, or technical specifications of platforms. Such details would limit finding optimal technology solutions as technologies are constantly evolving. Rather, key aim of this technology Roadmap is defining a commonly accepted technology development framework for developing JERICO-RI as leading coastal RI. It sets a range of development Proposals, under each a variety of Activities are formulated for different time-spans. These time-spans are set for practical reasons, to define which action need to be taken prior the ESFRI application submission (assumed in 2025), during the preparatory phase or during the implementation phase. Activities are in most cases measurable and their implementation must be monitored. The Roadmap needs to be also adjusted to match the changes in the landscape.

3. Essential elements of JERICO-RI technologies

JERICO-RI is being built to provide consistent pan-European coastal marine observations for diverse needs. Processing data into high-value data products requires making observations in accordance with jointly agreed Best Practices. The interoperability of systems and data must be ensured. To provide long-term services, observations must be long-term and their availability must be ensured.

Observation technologies (platforms, sensors, accuracy of measurements, their spatiotemporal coverage, interoperability, data FAIRness) must be fit-for-purpose to collect data for the needs of different Key Scientific Challenges (KSC). A feedback mechanism is needed from science and user needs to technology design. The design of the technology must be flexible, so that new observations can be included or existing observations can be adapted to meet the requirements of new user groups. One new user group already identified is the emerging Blue Economy applications such as wind parks, and co-design of observations must be the focus of JERICO-RI in the next phase. Another new core user of JERICO-RI observations is the Digital Twin of the Ocean applications.

Due to the complexity and nested spatiotemporal scales of coastal seas, observations must be collected using various technologies, so a multiplatform approach is needed. In order to enable multidisciplinary studies, observations must be structured in such a way that several key variables are measured together. This structure can be accomplished using a

hierarchical coastal observations model that includes three levels of observatories. The mission of Standard observatories is to provide continuous measurements of some key parameters, often for local or regional needs. The list of variables measured from them is typically low and they can be logistical constraints that do not allow new types of observation. Advanced observatories offer comprehensive and state-of-the-art measurements in specific fields of science or services. Supersites aims to integrate top-level high-frequency measurements in all required scientific fields using an integrated multiplatform strategy for long-term observations. If necessary, Supersites are transnational. They are also the key platforms when connecting with other RIs.

Although the main goal of JERICO-RI is to build a pan-European coastal observation system, national and regional aspects and resources must be taken into account. First of all, most observation capacities are maintained with national funding and must provide services for national needs, in addition to pan-European needs. Second, the specificities of regional coastal marine ecosystems must be considered when designing regional sampling strategies (vs. sampling strategies for pan-European needs). Third, user communities can vary widely across regions, and observations must be tailored also to their needs. Fourth, at least in the beginning, we have to accept the slow adoption of some emerging technologies in some areas because it takes time to build the required capabilities.

One key aspect of JERICO-RI technologies is their inclusiveness. The purpose, by definition, is to provide fit-for-purpose observations for diverse needs of complex coastal systems, not to promote or develop some technologies over others. This can lead to great diversity in observing technologies, as the needs, starting points, traditions and capabilities vary from region to region. Different coastal systems also have their own special features and observation needs, so different technologies may be best suited in different regions. However, this diversity in technologies should not lead to unstructured and incoherent data and related products, and therefore the core variables and environments of JERICO-RI may need to be defined and then supplemented with regional and thematic specificities in observing technologies.

JERICO-RI Technology Roadmap aims to balance these essential elements and take them all into account. As technology develops, new needs for marine data and products emerge, and the landscape of European Marine Research Infrastructures may change, the JERICO-RI roadmap must also be dynamic and adapt to these changes.

4. JERICO-RI Technology Roadmap

4.1. Roadmap questionnaire

As described in Section 2, JERICO-RI Roadmap is structured along 4S's of McKinsey 7s framework: Strategy, Structure, Systems and Staff&Skills. For each S, using the work done during Technology Outlook and Gap analysis, we have identified 3-7 key areas of development related to technologies, called **Roadmap Proposals (n=19)**. Next, for each Proposal we define the objectives and detail the work to be done, dividing it into 4-7 **Activities (altogether n=104)**.

All JERICO-RI Nation Representatives (altogether 15 NRs) evaluated Roadmap Proposals and Roadmap Activities.

First, NRs provided information if the description and objectives of Roadmap Proposals are acceptable or not (by answering "Yes" or "No"). This was followed by a question to prioritise the Proposals (with a scale "High", Medium" and "Low").

- The Proposal was considered generally acceptable, if >80% of NRs answered "Yes" (i.e. at least 12 out 15).
- Answers for prioritisation were scaled (High=1, Middle=0, Low=-1) and Proposals having a mean value of scaled prioritisation less than 0 (overall Priority level from Low to Middle) were considered as Low Priority ones, those with a mean 0-0,5 as Middle Priority ones and those with mean >0.5 as High Priority Proposals.
- In the case the answer for acceptability of Proposal has been "No", then the priority of Proposal is set to "Low" for that NR, even if the answer was not provided.

Second, NRs made a similar analysis for Activities.

- Activity was considered generally acceptable, if at least 80% of NRs answered "Yes" (i.e. at least 12 out 15).
- Answers for prioritisation were scaled (High=1, Middle=0, Low=-1) and Activities having a mean value of scaled prioritisation less than 0 (overall Priority level from Low to Middle) were considered as Low Priority ones, those with a mean 0-0,5 as Middle Priority ones and those with mean >0.5 as High Priority Activities.
- In the case the answer for acceptability of Activity has been "No", then the priority of Activity is set to "Low" for that NR, even if the answer was not provided. For Timeline, a similar correction was not done.
- Answers for Activity timeline of implementation (see below) were scaled (Now=1, Short=0, Long=-1) and Activities having a mean value of scaled timeline less than 0 (overall Timeline level from Low to Middle) were considered as having Long timeline, those with a mean 0-0,5 as having Short timeline and those with mean >0.5 as having timeline of implementation as Now.

Regarding the timeline of Activities, the three scales are interpreted as

  - "Now" = needs to be done prior ESFRI application in 2025 (within 1 year),
  - "Short", i.e. 1-5 years = needs to be done in preparation phase
  - "Long", i.e. 5-10 years = may wait until implementation/operational phase

If the answer was not clearly articulated (e.g. given as intermediate, like "S/L") we selected the more conservative alternative (decreasing the priority or timeline of the Activity). Such answers constituted less than 1.5 % of the total amount of answers, so the possible overall bias introduced is not very significant.

As follows, all original Roadmap Proposals, their objectives and Activities are listed in Section 4.2. For each of them, we provide results from NRs evaluation. For each Proposal and Activity, we consider if they are valuable contributions to the Roadmap, based on their rankings.

In Section 4.3 the results of Nation Representative evaluation are analysed and the reasoning behind which Activities are selected for the roadmap are given. Thereafter the roadmap will be visualised in Section 4.5.

4.2. Roadmap Proposals, objectives and Activities

While the actual description of the Roadmap Proposals and Activities, and their evaluation results, are provided below, first we provide an overview of the results of Nation Representative evaluation. Against the background of such an overview, the analysis of individual Proposals and Actions is easier.

All of the 19 Roadmap Proposals were found acceptable by NRs (Figure 1), using 80% acceptance threshold. In three cases one of the NRs considered Proposal as not acceptable (#7, #10, #19). But even in those three cases, that NR found most of the related Activities (under those Proposals) as acceptable and mostly with high or middle level of priority.

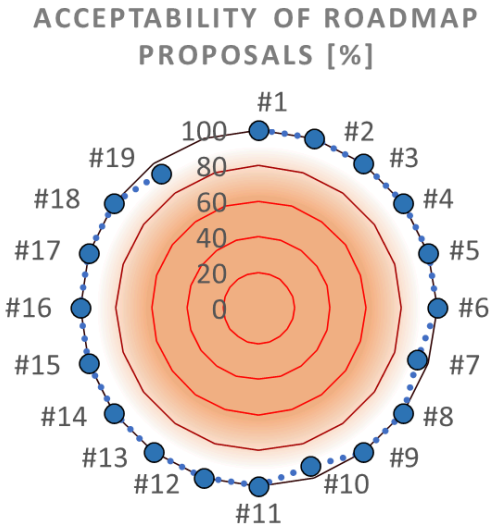

Figure 2. Acceptability of JERICO-RI Roadmap Proposals as evaluated by Nation Representatives (NRs). The scale (0-100%) indicates the fraction of NRs accepting the Proposal and its objectives. Most of the Proposals were acceptable to all NRs (n=15), while three Proposals were acceptable for 14 NRs. For actual description of Proposals and their objectives, see below.

Thereafter, NRs evaluated the priority levels of Roadmap Proposals (FIgure 3). One of the Proposals (Strategy-Proposal #3 Implement regional technology coordination) did not get a single "High" priority flag, and averaged between Middle and Low priorities. We are not completely ignoring this Proposal for further analysis, however, as its Activities were mostly found to be acceptable, with some having a medium or even high priority level. Priority level of six Proposals were evaluated as medium (#2, #9, #10, #11, #18 and #19), while the rest were high.

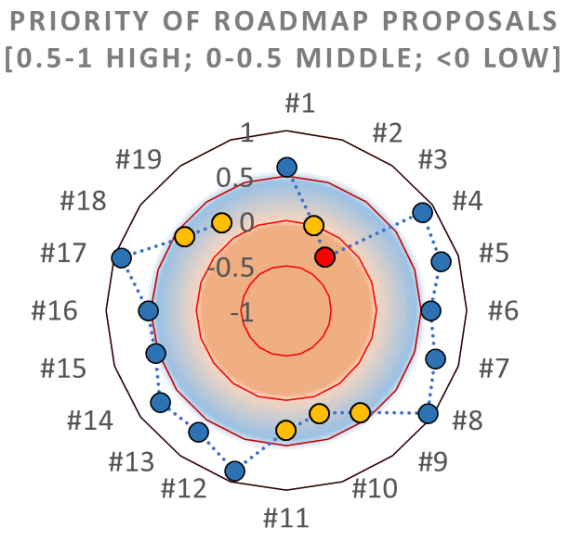

Figure 3. Priority levels of JERICO-RI Roadmap Proposals as evaluated by Nation Representatives (NRs). The scale (-1 – 1) indicates the priority level (0.5-1 High; 0-0.5 Medium; <0 Low), calculated as given in Section 4.1. 13 of the proposals were at high priority level (Blue circles), 5 at middle level (yellow circles) and 1 at low level (red circle). For actual description of Proposals and their objectives, see below.

Next, NRs evaluated altogether 104 Activities under Roadmap Proposals. The following figures are provided for illustration purposes only, to provide an overview of results, and details will be discussed later and can be found in Annex 1. Overall acceptability of Activities were good, as 70 out of 104 Activities were acceptable for all NRs (Figure 4). 98 Activities exceeded the 80% acceptability threshold (i.e. were accepted at least by 12 out of 15 NRs), leaving 6 of the Activities to be not acceptable (Activities #2-5, #3-5, #9-2, #9-3, # 10-5 and #12-2)

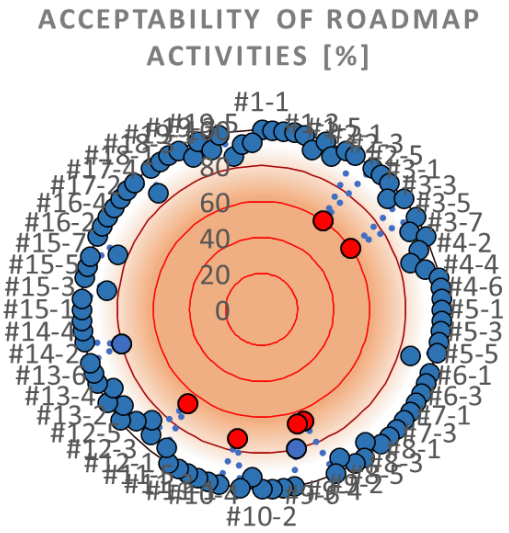

Figure 4. Acceptability of JERICO-RI Roadmap Proposals Activities as evaluated by Nation Representatives (NRs). The scale (0-100%) indicates the fraction of NRs accepting the Activity. Most of the Activities were acceptable to all NRs (n=70), and 98 Activities exceeded the threshold of 80% acceptability, leaving 6 Activities as not acceptable (red circles). For actual description of Activities, see below.

When analyzing the priority levels of different Activities (FIgure 5), the result was large differences between them. 36 Activities received high priority, while 45 had medium priority and 23 had low priority. Notably there was one Activities which al NRs indicated as high priority ones (#8-2 Plan, as necessary, the required JERICO-RI technology centres for centralised supporting actions and identify core groups capable and willing for their coordination).

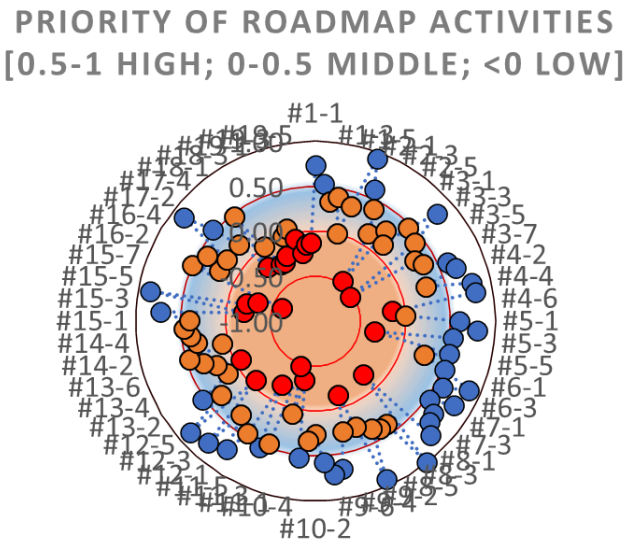

Figure 5. Priority levels of JERICO-RI Roadmap Proposal Activities as evaluated by Nation Representatives (NRs). The scale (-1 – 1) indicates the priority level (0.5-1 High; 0-0.5 Medium; <0 Low), calculated as given in Section 4.1. 35 of the proposals were at high priority level (Blue circles), 46 at middle level (yellow circles) and 23 at low level (red circles). For actual description of Proposals and their objectives, see below.

Finally, NRs evaluated the approximate timeline of Activities (Figure 6). For some Activities, they stated that the task was challenging because the described Activities can have several timelines, for example, part of the description of the Activity should be done right away and some can wait for a later moment. Based on the results, tImeline "Now" was found for 8 Activities (referring that they should be completed within approx. 1 year, prior the ESFRI application is submitted), timeline "Short" for 25 Activities (referring that they should be completed within approx 1-5 years, i.e. during Preparatory Phase) and timeline "Long" for 71 Activities (referring that they should be completed within approx 5-10 years, i.e. during the implementation phase, or later),

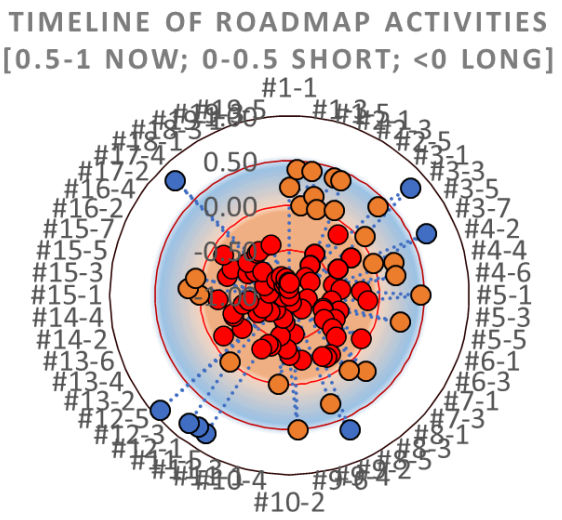

Figure 6. Timelines for JERICO-RI Roadmap Proposal Activities as evaluated by Nation Representatives (NRs). The scale (-1 – 1) indicates the timelines (0.5-1 Now, within approx. 1 year, prior ESFRI application is submitted; 0-0.5 Short, within 1-5 years, i.e. during Preparatory Phase; <0 Long, within 5-10 years, i.e. during the implementation phase, or later), calculated as given in Section 4.1. 8 of the proposals were at "Now" timeline, (Blue circles), 25 at "Short" timeline (yellow circles) and 71 at "Long" timeline (red circles). For actual description of Proposals and their objectives, see below.

In the following, we provide the details of the Proposals, their objectives and related Activities. To assist interpreting the results of NRs evaluation, overviewed in this section, we have the following colour coding highlighting the results.

- **Proposals found Acceptable and with high priority are written in blue bold text**
- **Proposals found Acceptable and with medium priority are written in orange bold text**
- **Proposals found Acceptable, but with low priority are written in red bold text**

- ***Activities found Acceptable, with high priority and with timeline now are written in blue bold, underlined and italicized text***
- **Activities found Acceptable, with high priority and with timeline "Short" are written in blue bold text**
- Activities found Acceptable, with high priority and with timeline "Long" are written in normal blue text
- Activities found Acceptable and with medium priority are written in orange text
- Activities found not Acceptable and/or with low priority are written in red text

After each Proposal and Activity, the evaluation results are given in parenthesis (A=acceptability with a scale 0-100%, P=priority with a scale from -1 to 1, and T=timeline with a scale from -1 to 1).

4.2.1. Strategy Proposals

The Strategy of JERICO-RI technology design needs to reflect and align with existing (or work-in-progress) national and regional strategies and Pan-European needs for developments in coastal observations. We need to build upon the existing coordination and integration of observations (technology-wise, in the context of this work), as well as take into account the needs and possible synergies for integration.

Strategy-Proposal #1 Incorporate JERICO-RI observations in national/regional strategies and technology roadmaps (A=100%, P=0.60)

Objective:

- It was identified during the survey to nation representatives that JERICO-RI partners are well positioned in the design of national observing (technology) strategies for coastal waters. However, more work needs to be done so that JERICO-RI observations are considered as a core component of national and regional strategies. Having JERICO-RI high in the national agenda is the key to securing more sustained funding for long-term and strategic observations, which was the main concern raised by NRs and by EU Agencies such as EEA for example.

Activities:

- **#1-1. Create a clear understanding of JERICO-RI, nationally, regionally and pan-Europeanly, indicating which parts of the national observing capacities and which services are part of JERICO-RI (A=100%, P=0.73, T=0.20)**
- **#1-2. Demonstrate the added value of JERICO-RI observation technologies, as complementary methods to traditional research vessel-based monitoring, in creation of high quality data products and services (A=100%, P=0.53, T=0.40)**
- #1-3. .Demonstrate the added value of harmonised transnational and pan-European observations (in terms of sharing technology resources and transferring knowledge in technologies, and in making more valuable observations for various needs) and incorporate them as a component of national and regional strategies and technology roadmaps. (A=100%, P=0.33, T=0.00)
- #1-4. Document the state-of-art how JERICO-RI observations are included in various national and regional strategies and technology roadmaps (A=100%, P=0.40, T=0.40)
- #1-5. Create (national & regional) Action plans, based on above mentioned analysis, how to include JERICO-RI stronger in the national and regional observing technology strategy landscape (A=100%, P=0.00, T=0.13)
- #1-6. Start a dialogue with involved nations and regions on JERICO-RI structuration of observations and their technology needs, guided by experiences from IRSs and PSSs (A=93%, P=0.33, T=0.00)

Strategy-Proposal #2 Build-up (or maintain) national technology coordination (A=100%, P=0.00)

Objective:

- Several nations pointed out the need for improving national collaboration and interactions (technical centers, communications, joint implementation of work). As nations differ a lot in their observing efforts, funding, amount of collaborators, and positioning of JERICO-RI in the national landscape, generic methods for national technology coordination may not be feasible and various alternatives need to be utilised while building up national technology coordination as part of JERICO-RI.

Activities:

- **#2-1. Map the national state-of-art in coastal observations, including various RIs and other initiatives, and find out what is (and what should be) the JERICO-RI's position in this national landscape (A=100%, P=0.93, T=0.40)**
- **#2-2. Ensure a dialogue between different national parties making observations, if needed, using formal agreements (A=93%, P= 0.60, T=0.40)**
- #2-3. Demonstrate the benefits of coordination in various technological steps of data value chain (involving managers, scientists, technicians) (A=100%, P= 0.40, T=0.07)
- #2-4. Create a link between national and regional technology coordination, thematic coordination and with overall JERICO-RI technology coordination with clear division of tasks (A=100%, P=0.13 ,T=-0.47)
- #2-5. Create a national forum, linked to JERICO-RI, to exchange and transfer technology knowledge among those making observations (A=60%, P= -0.47, T=-0.60)
- #2-6. Promote joint national projects and pilot studies, linked to JERICO-RI aims, which foster technology cooperation and uptake of new technologies (A=100%, P=0.27, T= -0.13)

Strategy-Proposal #3 Implement regional technology coordination (A=100%, P=-0.27)

Objective:

- In addition to national and overall JERICO-RI technology coordination, consideration of regional aspects is needed. Regional technology coordination within JERICO-RI needs to be balanced with other regional initiatives.

Activities:

- #3-1. Establish a dialogue between JERICO-RI technology coordination and ROOSes, Regional Sea Conventions and other established regional initiatives (A=100%, P=0.13, T=-0.73)
- #3-2. Map the existing and potential transnational observations and joint use of facilities/resources within regions, including their strengths and weaknesses (A=100%, P=0.47, T=0.40)
- ***#3-3. Demonstrate the added value of transnational observations in regional seas (A=93%, P=0.80, T=0.80)***
- #3-4. Build up transnational pilot studies, if not already existing, using jointly agreed and harmonised technologies (A=100%, P=0.40, T=0.07)
- #3-5 Foster the creation of several regional JERICO-RI fora to exchange and transfer knowledge in technologies (A=60%, P=-0.53, T=-0.73)
- #3-6. Promote regional joint projects and pilot studies to facilitate technology cooperation and uptake of new technologies (A=100%, P=0.29, T=-0.20)
- #3-7. Create a pan-European JERICO-RI framework to guide the regional technology coordination (A=93%, P=0.36, T=-0.38)

Strategy-Proposal # 4 Implement thematic technology coordination (A=100%, P=0.87)

Objective:

- To create consistent pan-European data and products for various Key Scientific Challenges, and to act as a key European hub for new research topics and developments, overall JERICO-RI thematic technology coordination is required. This needs to be balanced with national and regional coordination activities.

Activities:

- ***#4-1. Identify the key thematic areas (incl. Blue Growth -topics) where pan-European technology coordination is a necessity, acknowledging different needs of various Key Scientific Challenges (A=100%, P=0.60, T=0.67)***
- #4-2. Create a framework for JERICO-RI technology centres and working groups and in early phase identify core groups capable and willing for thematic coordination (A=93%, P=0.67, T=0.00)
- #4-3. Convince nations and regions that for some KSCs pan-European technology coordination may be necessity (A=87%, P=0.29, T=0.21)
- #4-4. Provide a technology forum and tools, including e-infrastructure, to exchange, share knowledge and distribute best practices, software etc. for different thematics (A=93%, P=0.79, T=-0.50)
- **#4-5. Demonstrate the added value of making pan-European consistent observations, with coordinated technologies, for various KSCs in creation of high-quality data products and services (A=100%, P=0.80, T=0.20)**
- #4-6. Promote the collaboration of technology experts within JERICO-RI and outside, also coordinate the JERICO-RI participation in already established thematic networks, followed by efficient dissemination of the knowledge obtained within JERICO-RI community (A=100%, P=-0.13, T=-0.43)
- #4-7. Promote joint thematic projects, with elements of technology harmonisation and transfer of knowledge (A=100%, P=0.00, T=-0.20)

Strategy-Proposal #5 Secure technology synergies with other RIs and initiatives (A=100%, P=0.80)

Objective:

- JERICO-RI partners have a lot of cooperation and synergies with other research infrastructures and initiatives that make observations of the European coastal seas. JERICO-RIs role in making these observations, using various platforms and developing technologies needs to be clarified.

Activities:

- **#5-1. Clarify the role of JERICO-RI in using those platforms and technologies, which are also used by other RIs (A=100%, P=0.60, T=0.47)**
- #5-2.Map and build up national, regional and pan-European synergies with other RIs in using and developing technologies (A=100%, P=0.80, T=-0.13)
- #5-3.Plan strategically how JERICO-RI will participate in various joint technology initiatives and working groups (between RIs), and secure bottom-up and top-down transfer of knowledge (A=100%, P=0.53, T=-0.53)
- #5-4.Search actively for new RI-RI technology partnerships, also outside environmental and aquatic domains when promising synergies are to be expected (A=100%, P=-0.33, T=-0.80)
- **#5-5.Make sure that JERICO-RI gets visibility of the things that belong to it, e.g., by labelling its data, platforms, sensors and workshops (A=100%, P=0.53, T=0.27)**
- #5-6. Establish a process to ensure consideration of and synergy with the needs and goals of other RIs and initiatives, particularly when making long-term decisions about sampling strategies or technology choices (A=86.66666667%, P=0.27, T=-0.43)

Strategy-Proposal #6 Expand interactions with modelling and remote sensing (A=100%, P=0.60)

Objective:

- Usability of JERICO-RI data and products for different user groups, especially for modellers and remote sensing, is essential. To ensure usability, the technology used for observations must be discussed and, if needed, co-designed together with these stakeholders.

Activities:

- #6-1. Connect more strongly to Copernicus Marine Services to understand their needs and requirements, and identify and solve technological barriers for key data gaps and data inconsistencies (A=100%, P=0.53, T=-0.60)
- #6-2. Improve usability of multiplatform and transnational datasets by securing their interoperability and improve technological prerequisites to advance their collection (A=100%, P=0.87, T=-0.60)
- #6-3. Create a dialog in various levels (national, regional, pan-European), to identify data gaps and look for possibilities in adjusting JERICO-RI observations (sampling strategy, technologies, platforms) to fill these gaps (A=100%, P=0.60, T=-0.43)
- #6-4. Promote joint projects where JERICO-RI partners collaborate with modellers and remote sensing, in improving use of new technologies and platforms, and increasing data coverage and availability (A=100%, P=0.80, T=-0.07)

4.2.2. Structure Proposals

Structure in our interpretation of McKinsey 7S stands for understanding what are the key scientific focus areas among different nations and regions, how different actors share the work and collaborate, and how all these are coordinated, and which might be the benefits from transnational and pan-European structures.

Structure-Proposal #7 Clarify which are the core Key Scientific Challenges for JERICO-RI and their requirements for technologies (A=93%, P=0.73)

Objective:

- While challenges the coastal areas face are complex, their prioritisation is needed to be able to focus. This prioritisation process needs to take into account current user needs and emerging challenges, and existing, mostly nationally driven, observing capacities, resulting in what is the added value of jointly steered observations and which are the required future technology developments.

Activities:

- #7-1. Create a mechanism for joint evaluation of emerging coastal challenges and required observing technologies, to steer the future developments in observations (A=100%, P=0.53, T=-0.53)
- #7-2. Identify national and regional priorities in KSCs and their subsequent needs for developing technologies and observations (A=100%, P=0.67, T=-0.40)
- #7-3. Recognise pan-European added value, per various KSCs, for joint harmonised observations, and balance these with national and regional observation priorities (A=100%, P=0.69, T=-0.31)
- **#7-4. Demonstrate, towards stakeholders at nations and regions, the added value of transnational and multiplatform approach, and technology requirements of it (A=100%, P=0.80, T=0.20)**

Structure-Proposal #8 Plan the supporting actions to maintain and develop observing technologies (A=100%, P=0.93)

Objective:

- JERICO-RI needs to include and support various joint activities to keep the observations at a high level and promote uptake of new technologies. These actions, like calibration, validation and intercomparison of sensors, need to be done in partnership with various other actors.

Activities:

- #8-1. Create partnership with other RIs, private companies and academia to share the work. (A=100%, P=-0.20, T=-0.80)
- **#8-2. Plan, as necessary, the required JERICO-RI technology centres for centralised supporting actions and identify core groups capable and willing for their coordination (A=93%, P=1.00, T=0.07)**
- #8-3. Identify which type of observations require pan-European support actions, and which ones are best dealt with within each region or nation.(A=100%, P=0.40, T=-0.20)
- #8-4. Promote the use of JERICO-RI platforms as test-beds and sites for pan-European intercomparisons and sensors tests (A=100%, P=0.40, T=-0.20)
- #8-5. In planning of JERICO-RI support actions, include estimation of cost-efficiency (A=93%, P=0.36, T=-0.23)

Structure-Proposal #9 Promote adopting common SOPs and Best Practices (A=100%, P=0.40)

Objective:

- Despite long-term cooperation with Best Practices and the sharing of SOP instructions, their implementation has been partially delayed. In order to promote their introduction, some kind of incentives must be planned.

Activities:

- ***#9-1. Make the catalogue of SOPs and Best Practices easily available (A=100%, P=0.93, T=0.64)***
- #9-2. Create a system to follow up the uptake of common SOPs and Best Practices (A=67%, P=0.27, T=0.30)
- #9-3. Plan how the follow-up system may be linked with JERICO-label (A=67%, P=-0.13, T=-1.00)
- #9-4. Assign teams in charge of approving joint SOPs and Best Practices, and following their consistency with similar products from other RIs and initiatives (A=80%, P=0.27, T=-0.92)
- #9-5. Reinforce training for methods and use of SOPs and Best Practices (A=100%, P=0.67, T=-0.27)
- #9-6. Secure seamless integration of technology Best Practices and SOPs with those for data management (A=100%, P=0.71, T=-0.57)

Structure-Proposal #10 Take the benefits from transnational technology collaborations (A=93%, P=0.20)

Objective:

- To efficiently tackle Key Scientific Challenges, transnational and multiplatform sampling strategy is required. The effective implementation of this requires that we develop new forms of cooperation in the use of observation technologies, and this transition may partly require a redefinition of national monitoring strategies.

Activities:

- **#10-1. Perform an in depth analysis of PSS and IRS work done, in terms of transnational technology collaborations (A=100%, P=0.57, T=0.50)**
- #10-2. Make Best Practices, where missing, for joint use of platforms and sensors to facilitate of transnational observations (A=100%, P=0.27, T=-0.33)
- #10-3. Organise joint campaigns and workshops, to create feeling of communality, to create connections between technical people and to transfer knowledge (A=93%, P=0.33, T=-0.40)
- **#10-4. Build-up transnational demonstrations of technology collaboration, with follow-up documentation of issues faced (A=100%, P=0.53, T=0.00)**
- #10-5. Create a forum for transnational technology communication (A=73%, P=-0.33, T=-0.69)

Structure-Proposal #11 Increase the dialogue with private sector (A=100%, P=0.33)

Objective:

- Private sector is already largely collaborating with JERICO-RI partners, supporting observations and creation of data products in various ways. However, much more could be done jointly, and new strategic cooperation partnerships could be opened.

Activities:

- #11-1. Share the lessons learned from the technology cooperation with the private sector to others in the JERICO-RI partnership, and create collaboration models (A=100%, P=0.07, T=-0.53)
- #11-2. Provide support for contractual matters when collaborating with private sector (A=100%, P=-0.47, T=-0.73)
- #11-3. Plan strategic projects with private sector to improve TRL-level of key enabling technologies (A=100%, P=0.47, T=-0.40)
- #11-4. Promote the JERICO-RI platforms, especially new technologies used, multiplatform approach, and pan-European sites, as key sites for industry in their product development (A=100%, P=0.53, T=-0.40)
- #11-5. Promote new partnerships with industry, especially those that promote the sustainable use of marine resources (A=100%, P=-0.20, T=-0.33)
- #11-6. Participate in marine industry events for promotion of JERICO-RI technologies and opportunities (A=100%, P=0.47, T=0.80)

4.2.3. Systems Proposals

Systems refer to the current and desired use of technology and the key future technologies. This part of analysis checks the needs for multiplatform observations, mechanisms for transfer of knowledge and barriers for optimal use. Briefly, our aim is to analyse how the use of technology (platforms, sensors) is organised and implemented and if it meets the JERICO-RI science strategy.

Systems-Proposal #12 Agree what are the core JERICO-RI variables and platforms (A=100%, P=0.87)

Objective:

- As a prerequisite for creating interoperable data and joint products JERICO-RI needs to come into the agreement which are its core components. This should not, however, lead to exclusion of some thematically or regionally required observations, which are not among the core ones.

Activities:

- ***#12-1. Agreement which are the core JERICO-RI variables and how they are measured (A=93%, P=0.73, T=0.79)***
- #12-2. Agree which platforms are supported by JERICO-RI (A=67%, P=0.33, T=0.82)
- **#12-3. Define quality criteria for JERICO-RI observations, linking to JERICO-label (A=93%, P=0.80, T=0.00)**
- #12-4. Negotiate the share-of-work and synergies in technology use and development with adjacent RIs using similar platforms or observing the same variables (A=87%, P=-0.07, T=-0.77)
- ***#12-5. Provide a high-level illustration of JERICO-RI variables and platforms, for dissemination purposes (A=93%, P=0.87, T=0.93)***

Systems-Proposal #13 Improve sharing the knowledge on technologies, including regional specificities (A=100%, P=0.67)

Objective:

- For interoperability and cost-efficiency, and to be able to provide joint services and know-how, sharing of common technologies is needed. This goal requires that technology information is efficiently distributed and shared within partnership.

Activities:

- #13-1. Include both top-down and bottom-up approach, with appropriate communication tools, for efficient technology knowledge sharing, including wide range of experts and stakeholders (A=100%, P=0.33, T=-0.71)
- #13-2. Establish technology guidelines, to be communicated and followed, for the key variables and platforms contributing to joint products (A=93%, P=0.53, T=-0.36)
- #13-3. Promote uptake of shared technologies and jointly agreed solutions/components (A=100%, P=0.13, T=-0.13)
- #13-4. Investigate which are the regionally important variables/technologies but which have not been widely adopted and how they may be supported by JERICO-RI (A=93%, P=-0.07, T=-0.60)
- #13-5. Create a mechanism to support selection of appropriate technologies for different KSCs and for various regions, where knowledge is not directly available (A=100%, P=0.20, T=-0.67)
- #13-6. Make sure the JERICO-RI technology choices are consistent with adjacent RIs and with national/regional requirements (A=100%, P=0.33, T=-0.33)

Systems-Proposal #14 Facilitate multiplatform and transnational approach (A=100%, P=0.73)

Objective:

- Multi-platform and transnational observations are the core concepts in JERICO-RI, but their implementation is technically demanding. The required harmonisation, intercomparison, coordination and sharing of work is challenging and requires top-level guidance.

Activities:

- #14-1. Demonstrate and discuss institutional and logistic challenges of the multiplatform and transnational missions, in addition to scientific results and products (A=100%, P=0.47, T=-0.33)
- #14-2. Establish collaboration schemes for the division of work within transnational observations, especially as not all partners need to invest in all technologies (A=80%, P=0.07, T=-0.92)
- #14-3. Organise transnational intercomparisons between platforms and technologies, also including the needs of modelling and ocean colour (A=100%, P=0.33, T=-0.47)
- #14-4. Facilitate multiplatform measurements especially for biogeochemical and biological variables, which often require data fusion from different methods applied (A=100%, P=0.40, T=-0.53)
- #14-5. Demonstrate the value of multiplatform observations, with different sampling strategies, for both long-term trend measurements and for short term events (A=100%, P=0.47, T=-0.20)

Systems-Proposal #15 Promote development and validation of emerging technologies (A=100%, P=0.53)

Objective:

- Besides maintaining the high quality of contemporary JERICO-RI observations, uptake of emerging technologies needs to be supported. Such support needs to include the whole data value chain, from sensor development to data delivery and product creation.

Activities:

- #15-1. Make frequent inventories of emerging observing technologies, platforms, and novel data needs for existing or new KSCs (A=100%, P=0.40, T=0.00)
- **#15-2. Promote use of JERICO-RI platforms as testbed for new technologies (A=100%, P=0.73, T=0.13)**
- #15-3. Define expert groups to prepare and realise targeted action plans, improving TRL for selected emerging technologies (A=87%, P=-0.20, T=-0.77)
- **#15-4. Promote inclusion of especially biogeochemical and biological sensors in JERICO-RI platforms (A=100%, P=0.87, T=0.07)**
- #15-5. Support technology uptake during critical phases prior operationality, typically occurring during integration and validation of new technologies (A=100%, P=-0.21, T=-1.00)
- #15-6. Seek possibilities for funding the sensor developments, by pooling the expertise in the JERICO-RI partnership and using connections to private sector and academia (A=100%, P=-0.33, T=-0.27)
- #15-7. Provide communication tools for peer support in uptake of new methods and technologies (A=86%, P=-0.60, T=-0.69)

Systems-Proposal #16 Secure links to various types of making observations and promote the use of new ways of making them (A=100%, P=0.53)

Objective:

- While JERICO-RI's objective is to cover a wide range of variables and measuring platforms, its capacity of making observations is still limited. JERICO-RI needs to connect seamlessly to other observation systems, including (but not limited to) statutory monitoring using research vessels and boats, citizen science observations, commercial observations, and experimental studies.

Activities:

- #16-1. Establish JERICO-RI positioning towards other key national, regional and Pan-European observation and monitoring technologies and efforts, allowing their interoperability and integration (A=100%, P=0.50, T=-0.29)
- #16-2. JERICO-RI needs to have an active role in the transfer of technological knowledge between initiatives (A=100%, P=0.20, T=-0.47)
- #16-3. Connect to selected citizen science programmes, as user of data, point of reference, and as co-developer (A=100%, P=0.40, T=-0.13)
- #16-4. Map novel marine operations and structures, for their needs of data and products and for the possibilities they offer for new observations (A=100%, P=0.20, T=-0.53)

4.2.4. Staff and skills Proposals

In our analysis we do not clearly separate Staff and Skills, mainly because it may be hard at this phase of JERICO-RI technology planning to make an in-depth analysis of the actual technology related personnel. With the two S's we refer here to overall availability of human resources for coastal observations, future needs in improving their competences, and needs for training, transnational support and specialisation.

Staff&Skills-Proposal #17 Secure and improve technical competence of staff (A=100%, P=0.93)

Objective:

- Technical competence of staff in charge of various phases of observations is the key factor for the quality of observations. Emerging complexity of platforms and sensors requires life-long training of staff and recruitments of people with complementary skills.

Activities:

- #17-1. Create pan-European training system and materials for technical staff, as typically the national needs and resources are not large enough (also for non-partners as profit mechanism) (A=100%, P=0.87, T=-0.40)
- #17-2. Collaborate with universities and technology schools to create educational programs, projects and materials for coastal observations (A=100%, P=0.53, T=-0.60)
- #17-3. Share information on the job opportunities (A=100%, P=0.20, T=0.80)
- #17-4. Promote career roadmaps for technical staff with various phases and possibility for advancement (A=87%, P=-0.20, T=-0.77)
- #17-5. Improve the pan-European cohesion and cooperation of the technical staff, (A=100%, P=0.47, T=-0.40)

Staff&Skills-Proposal #18 Create mechanisms for transnational mobility, secondment and sharing of technical staff (A=100%, P=0.40)

Objective:

- Mobility of the technical staff, with complementary skills, will improve cost-efficiency of JERICO-RI observations. JERICO-RI partnership needs to invest in finding working solutions for such activities.

Activities:

- #18-1. Identify key technology areas where transnational sharing of technical staff is most beneficial(A=100%, P=0.00, T=-0.40)
- #18-2. Create a cost-efficient mechanism for sharing of technical staff within JERICO-RI (A=100%, P=-0.27, T=-0.87)
- #18-3. Apply funding for projects where technical staff secondment is possible. (A=100%, P=-0.27, T=-0.87)
- #18-4. Create a transnational mentoring program for technical staff (A=93%, P=-0.21, T=-0.77)

Staff&Skills-Proposal #19 Plans for centralised technology services (A=93%, P=0.21)

Objective:

- Cost-efficient operation of JERICO-RI may include some institutes/nations/regions specialising in some technological activities and providing related internal services within the consortium. Such activities must be jointly planned, with consensus and to avoid competition within partnership.

Activities:

- #19-1. Identify key technology activities benefitting from centralised internal services (A=100%, P=0.00, T=-0.40)
- #19-2. Agree the terms of providing internal services (A=93%, P=0.07, T=-0.86)
- #19-3. Secure within consortium that the critical resources and assets are at place for centralised technology services, including their documentation and a follow-up mechanism (A=100%, P=-0.07, T=-0.80)
- #19-4. Set long term commitments within partnership for the use of internal technology services (A=87%, P=-0.23, T=-0.92)
- #19-5. Create a mechanism where partnership in large may participate in the innovation and renewal of internal technology services(A=93%, P=-0.14, T=-0.85)
- #19-6. Plan profit mechanisms for external services, to support centralised technology services (A=93%, P=-0.13, T=-0.86)

4.3 Selection of Activities for JERICO-RI Technology Roadmap

The ranking provided by NRs and summarised in the previous section is the starting point for the process of selecting Activities for JERICO-RI Technology Roadmap. However, such a process cannot be a simple mathematical one and the ranking needs to be considered as the initial stage. For example, some of the Proposals and Activities have been understood slightly differently by NRs which makes the answers inconsistent. Sometimes the descriptions have been vague, for example some Activities have clearly included a sequence of actions that likely will take place at several phases of timeline. However, going through all of them in a large group in detail and finding a consensus on wording would also be a cumbersome task.

To proceed, we have following steps:

- Evaluate NRs answers and have the ranking as starting point for Roadmap
- Analyse the borderline results for each S, to move some Activities forward or backward in their priorities or timeline, to balance the number of items for each to be included in the Roadmap.
- Estimate if the high priority Activities with timeline "Now" can be realistically completed prior ESFRI application deadline, balancing the availability of resources and the actual need of such information for ESFRI application
- After the selection of items for Roadmap by WP2 group, we need to open a follow-up discussion with NRs, to modify the outcome as needed. This discussion may also take place during the remaining months of the JERICO-S3 project.

Table 1 summarises the starting point based on NRs responses, how the acceptable and highly prioritised Activities are distributed across the timeline and between various S's. Thereafter we continue analysing each S separately, especially analysing which are the key Activities for the shortest timeline of the Roadmap, which need to be completed prior to ESFRI application.

Table 1. The initial Number of Activities selected for the JERICO-RI Technology Roadmap. The Activities are selected based on their acceptability and given high priority.

	Now (1 year)	Short (1-5 years)	Long (5-10 years)
Strategy	2	7	8
Structure	1	4	6
Systems	2	3	1
Staff & Skills	0	0	2
Total	5	14	17

4.3.1. Analysis of Strategy Activities for Roadmap

Overall, most of the Strategy Activities were found acceptable and 17 out of them had high priority (Figure 7). Two Activities out of them had timeline "Now"; ***#3-3. Demonstrate the added value of transnational observations in regional seas*** and ***#4-1. Identify the key thematic areas (incl. Blue Growth -topics) where pan-European technology coordination is a necessity, acknowledging different needs of various Key Scientific Challenges.*** Both are clearly important aspects to be considered when defining a niche for the JERICO-RI in the ESFRI roadmap.

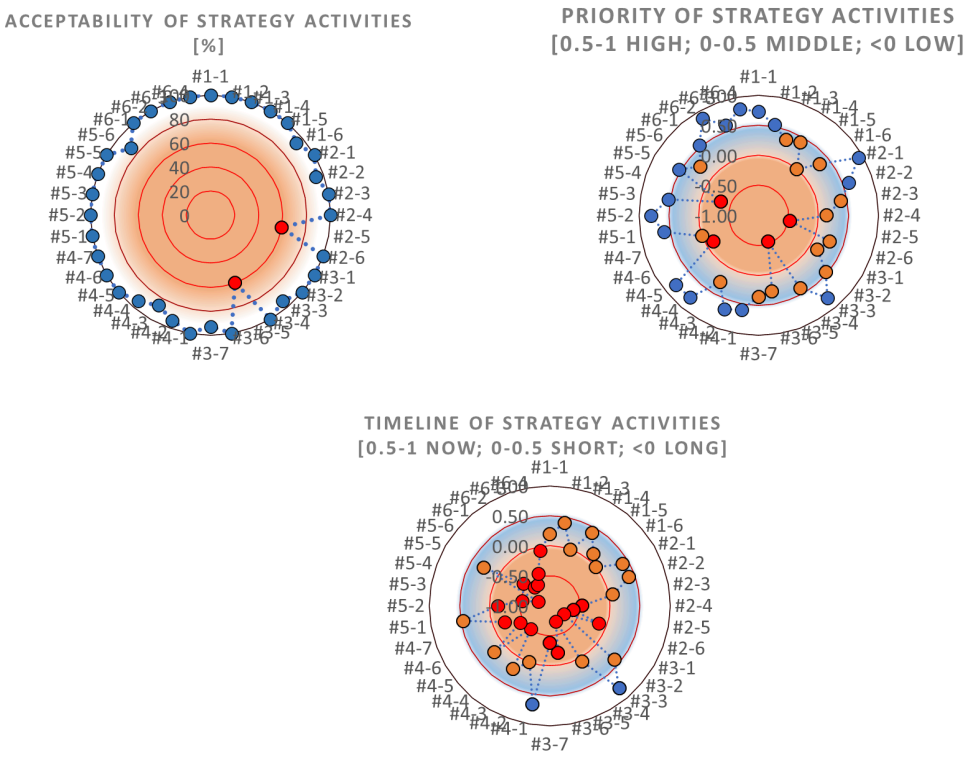

Figure 7. Acceptability, priority and timeline of Strategy Activities. Explanations for figures are given in Figures 4-6.

The #3-3 emphasises the regionalization of JERICO-RI and the fact that being an RI, not a network, requires a transnational approach at different levels of operational activity, and coordination thereof. To advance this Activity in the short term requires that the transnationality aspects experimented so far, e.g. as obtained during Pilot Supersite and Integrated Regional Sites during JERICO-S3 project, are processed and reported purposefully. Such demonstrations should also include elements, where possible, how to balance transnational activities with national ones.

The #4-1 links to the implementation of thematic technology coordination. This is a time-consuming process, but it is very central to JERICO-RI's overall goals of being a key data provider for pan-European Key Scientific Challenges. While several of the Activities in #4 were found with high priority, most of them are clearly expected to take place during later development stages of JERICO-RI. The #4-1 is clearly developing along the strategy work of JERICO-S3 and JERICO-DS. However, it is important to keep in mind what the core strengths of the JERICO-RI community are and not to aim for an immediate solution to everything.

Maybe as a surprise, **#1-1. Create a clear understanding of JERICO-RI, nationally, regionally and pan-Europeanly, indicating which parts of the national observing capacities and which services are part of JERICO-RI** was not considered to have an immediate need, but it was ranked for "Short" timeline. The discussions thereof indicated that since creating such understanding (or "identity" as used in original formulation of Activity) is dynamic, and formally to be part of JERICO-RI will not happen "Now" but step-wise as ESFRI process is ongoing, it may be difficult to place it in the timeline. We may state that such understanding is already in place, but it needs continuous update during RI-process. This Activity was discussed among NRs how it will be placed in the Roadmap timeline, and it was agreed to lift it up for "Now" timeline, to illustrate continuity of the process. When the Roadmap will be executed, further discussions are needed for this Activity to especially clarify if we need to list the key technology components and services of JERICO-RI already in the ESFRI proposal phase.

Activity **#2-1. Map the national state-of-art in coastal observations, including various RIs and other initiatives, and find out what is (and what should be) the JERICO-RI's position in this national landscape** obtained a very high priority, only one NR indicating a "Medium" priority. In the timeline it was in the high end of the "Short" timeline. As discussed with NRs the rank was upgraded to "Now", as it sounds quite logical to know the national positioning of RI once national commitments for ESFRI application will be asked for. Similar decision was made for another, very much related Activity close to the target of "Now" timeline, **#5-1. Clarify the role of JERICO-RI in using those platforms and technologies, which are also used by other RIs.** Both of these Activities are strongly supported by ongoing activities of JERICO-S3 project.

The other Activities placed in the timeline "Short" (#1-2, #2-2, #4-5 and #5-5) seem to fit well in the Preparatory Phase, aiming to demonstrate the relevance of JERICO-RI observations in national, regional and pan-European landscapes, and to clarify the identity of JERICO-RI components. Such targets and definitions are clearly needed to consolidate JERICO-RI leadership in coastal observations and positioning in RI landscape.

In principle, the Activities placed in the timeline "Long" in the Roadmap should wait their turn at the Implementation or Operation phases of JERICO, 5-10 years from now. Of course, their positioning in the timeline needs to be critically evaluated, but at first glance they seem to include operations that can be started only once JERICO-RI is closer to operationality. All Activities for **Strategy-Proposal #6 Expand interactions with modelling and remote sensing** (#6-1,2,3,4) were noted as fully acceptable, having a high priority and all of them were placed in "Long" in the timeline. For simplicity, instead of specifying all of them in the final Technology Roadmap, we pool them together under the title of the Proposal #6. Having these Activities at the late phase of Technology Roadmap does not, however, mean that collaboration with modelling and Ocean Colour communities should wait several years, rather it means that to fully exploit synergies and collaborations need to wait until JERICO-RI is close to operationality. To foster collaboration with these communities, maybe moving the Activity #6-4. Promote joint projects where JERICO-RI partners collaborate with modellers and remote sensing, in improving use of new technologies and platforms, and increasing data coverage and availability to "Now" or "Short" timeline could be considered in later phase.

4.3.2. Analysis of Structure Activities for Roadmap

23 out of 26 Structure Activities were found acceptable, 11 of which had a high priority (Figure 8) and one of them with timeline "Now"; ***#9-1. Make the catalogue of SOPs and Best Practices easily available*****.** This Activity is the starting point for wide-spread use of SOPs and Best Practices, i.e. harmonisation process. It is also a long term objective of JERICO-CORE, as noted in the NRs comments for this point, and thus a good connection point between JERICO-CORE and Technology design. As adopting new Best Practices is often a time consuming process, including streamlining with institutional and/or national instructions, it may be a good kickstart for JERICO-RI technology harmonisation to have this Activity in the Roadmap agenda. And need to mention, that a lot of work has already been done towards this objective during the past and ongoing JERICO projects. This Activity may not be a key for ESFRI proposal, but we feel however, that the community may benefit from stronger agreements which are the JERICO SOPs and Best Practices to start with, and on their clear visibility and easy access.

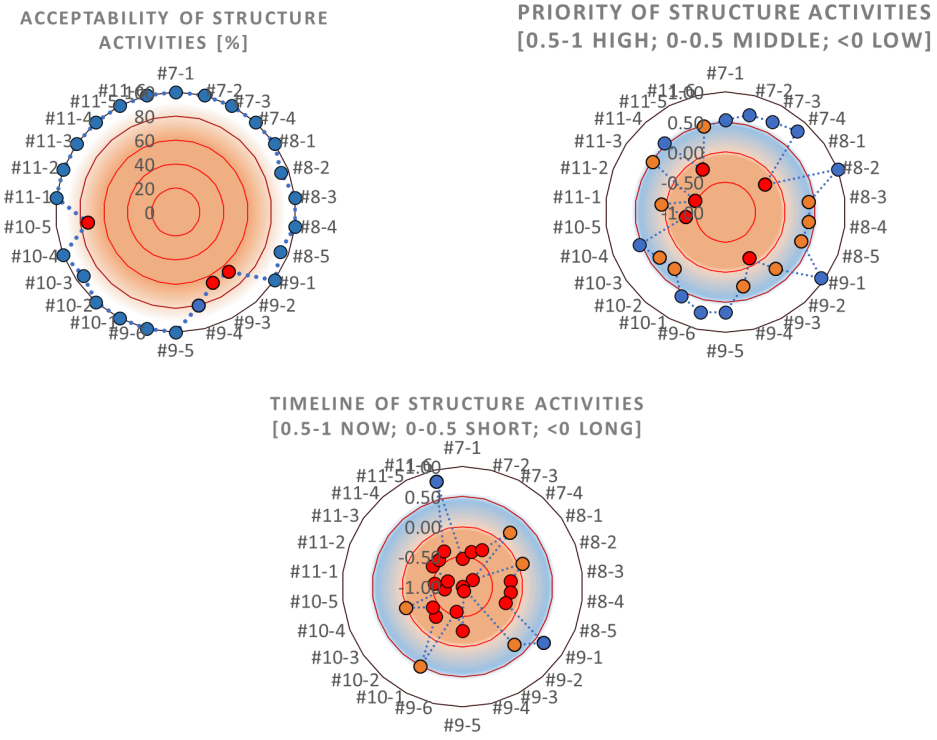

Figure 8. Acceptability, priority and timeline of Structure Activities. Explanations for figures are given in Figures 4-6.

There was yet another Activity with timeline "Now", "#11-6. Participate in marine industry events for promotion of JERICO-RI technologies and opportunities". It was actually noted as "Medium" priority, but very close to the threshold to be "High". This may be another low hanging fruit for the early phase of Technology Roadmap, not maybe directly advancing the ESFRI application, but needed to build up a long term dialogue with the private sector and therefore it is suggested for the Roadmap. This was also accepted by NRs.

Activity **#10-1. Perform an in depth analysis of PSS and IRS work done, in terms of transnational technology collaborations** was highly prioritised and exactly at the edge

between "Now" and "Short". It is clear that we need to untap the experiences from PSS and IRS soonest, demonstrate them in the ESFRI application and consequently it would be natural to lift this Activity among the first tasks to be conducted during the Roadmap implementation. Again, this was agreed by NRs. It needs to be noted, that activity #3-3 is closely linked to #10-1 (see section 4.3.1), but while #3-3 is related to the need for alignment with regional technology strategies and their coordination, #10-1 will examine more on a practical level and analyse which have been good examples in concrete transnational technical cooperation, and which should be adopted more widely.

The Activities placed in the timeline "Short", are, as with Strategy Activities with the same phase, clearly actions that may wait until Preparatory Phase has started. They include connecting with stakeholders to demonstrate JERICO-RI transnational capacities (#7-4), concrete planning of JERICO-RI technology centres (#8-2) and transnational demonstration studies of technology collaboration (#10-4, which actually may suit better for the Implementation phase, to be discussed later).

Six Activities were included in the timeline "Long", again to be again critically evaluated at later check-points of Technology Roadmap.

4.3.3. Analysis of Systems Activities for Roadmap

All but one Systems Activities were acceptable, while only 6 were of high priority (Figure 9). Out of them, two Activities were included in the timeline "Now"; ***#12-1. Agreement which are the core JERICO-RI variables and how they are measured*** and ***#12-5 Provide a high-level illustration of JERICO-RI variables and platforms, for dissemination purposes.***

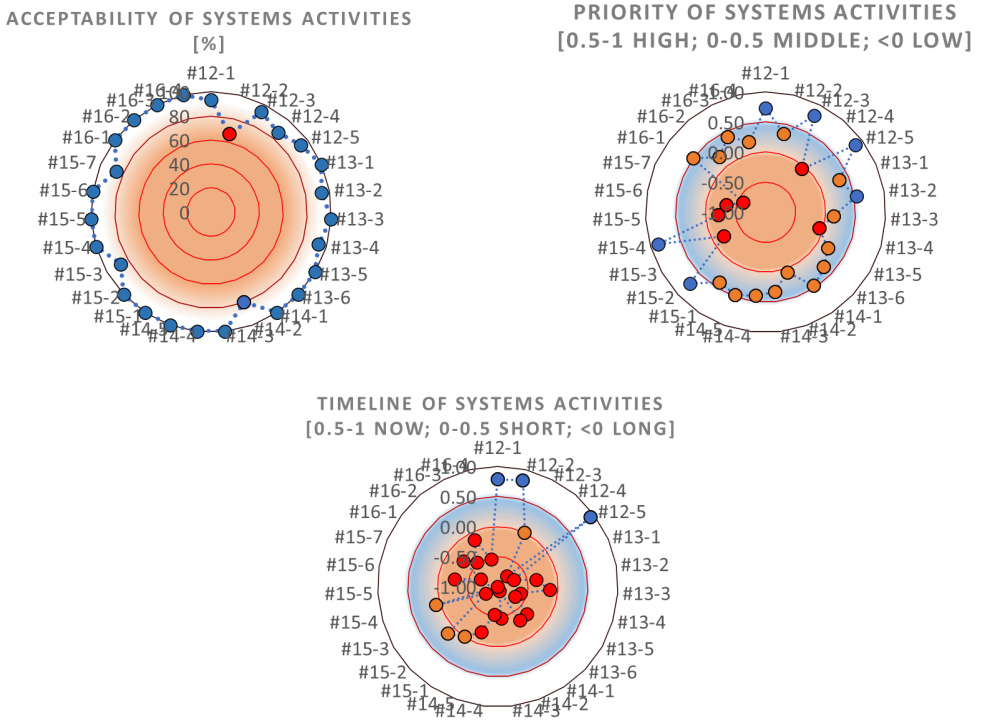

Figure 9. Acceptability, priority and timeline of Systems Activities. Explanations for figures are given in Figures 4-6.

Activity #12-1 is well aligned with the work already done in the Technology Outlook and Gap analysis (JERICO-DS D2.1 and D2.2) and the discussion thereof needs to be continued among NRs prior submission of ESFRI proposal. The variables and their measurement methods, which of course support different needs and objectives, are the core of what JERICO-RI is what it looks like from the outside. This does not diminish the value of e-infrastructure and services created by JERICO-RI, and their impact on JERICO-RI's identity, but without defining the core variables, the meaning of JERICO-RI remains unclear.

Activity #12-5 is, needless to say, an important part of JERICO-RI's marketing. The created material must be able to be used when applying for national commitments, promoting Jerico's cooperation with other RIs etc, and of course it must be fully usable for an ESFR application. Thus, this Activity must have a timeline "Now", building on the large amount of materials that already exist, but fine tuning it towards the needs of different nations towards the next ESFRI application.

Activity #12-2 Agree which platforms are supported by JERICO-RI received controversial answers which called for further discussions. 5 of the NRs considered this Activity as not acceptable, while all those who considered it important indicated high priority and the immediate timeline. It was clarified with NRs that the purpose of this Activity was to agree which platforms will at least receive JERICO-RI support, but not to exclude others. This is in analogy with Activity #12-1 on variables to be endorsed. After presenting this to NRs, it was considered as an Activity for the Roadmap with timeline "Now".

There were three Activities that qualified for the "Short" timeline. #12-3 is about defining the criteria for JERICO-RI observation, clearly an Activity for later parts of the Technology Roadmap. #15-2, promotion of JERICO-RI platforms (which should be clarified before, thus pointing to #12-2) as testbeds is also a task for when the operational phase is more in sight. Promotion of biogeochemical and biological sensors to be included in JERICO-RI platforms should officially wait until operationality is planned, but in reality the initial elements of this Activity are already in place.

According to results of NRs answers, there was only one Activity to be placed in the "Long" timeline, (#13-2) on technology guidelines. However there were quite many runner-ups, with high priority levels. Especially the Proposal #14, **Facilitate multiplatform and transnational approach** had most of its Activities at close-to high level, though all located at "Long" in the timeline. To compromise, we wish to lift the #14 to the Roadmap, multiplatform and transnational issues being elemental to JERICO-RI and as it has a strong impact on selected technology solutions. Similarly #16-1. "Establish JERICO-RI positioning towards other key national, regional and Pan-European observation and monitoring technologies and efforts, allowing their interoperability and integration" is a borderline case to be promoted, and is likely a core Activity in the operational phase.

4.3.4. Analysis of Staff and Skills Activities

While all Activities of Staff and Skills were acceptable, only 2 of them were considered at high priority (Figure 10); #17-1. "Create pan-European training system and materials for technical staff, as typically the national needs and resources are not large enough (also for non-partners as profit mechanism)" and #17-2. "Collaborate with universities and technology schools to create educational programs, projects and materials for coastal observations"

Both of the high priority Activities were considered to be placed in "Long" timeline, thus to be fully activated in the implementation or operational phase. The result is pretty straightforward, prior to an operational RI, or at least it is in sight, there is no way of starting staff training activities for real. However, that does not mean that training is generally looked down upon; the JERICO-RI community already maintains various training workshops, but goal-oriented training for RI can only begin when steps have been taken on the ESFRI roadmap.

In the timeline there is one outlier with timeline "Now", #17-3. Share information on the job opportunities and it had a priority close to the threshold of being "high". In principle, a mechanism for such activity is in place and occasionally used, as such positions may be distributed and announced within JERICO-RI newsletters and news.

As the results from Staff and Skills did not bring any other immediate needs for short timescales, we opt leaving these results out from JERICO-RI Technology Roadmap.

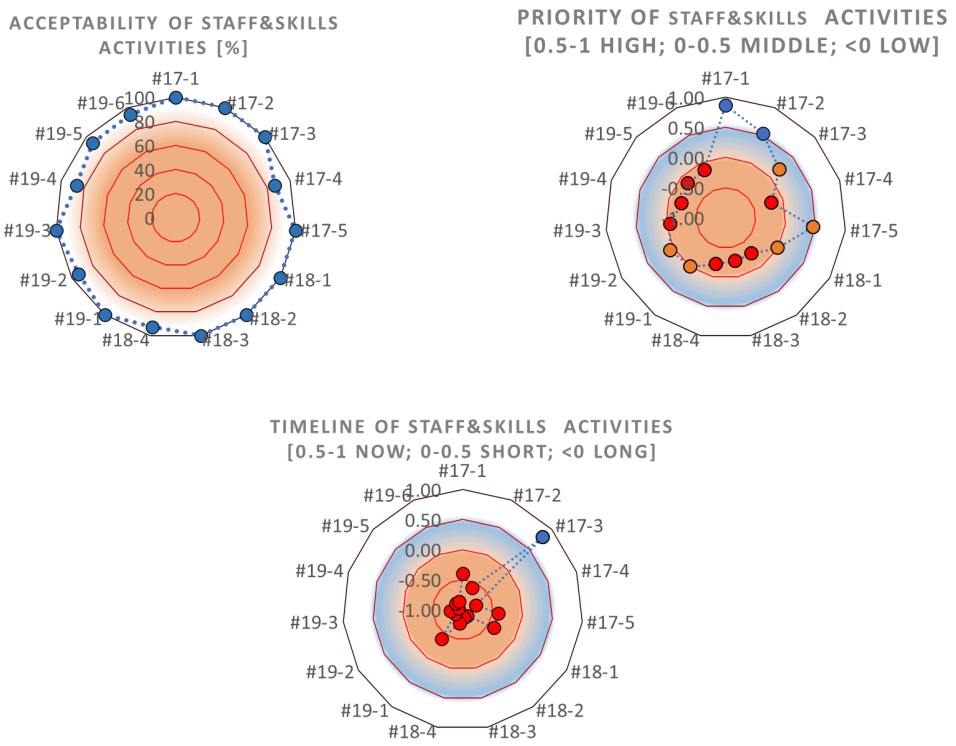

Figure 10. Acceptability, priority and timeline of Staff ad Skills Activities. Explanations for figures are given in Figures 4-6.

4.4. Visualisation of JERICO-RI Technology Roadmap

Based on the evaluation of Roadmap elements by NRs, as detailed in sections 4.2 and 4.3, and on the follow-up discussions with NRs, the list of Activities in JERICO-RI Technology was adjusted. Table 2 provides the amount of Activities selected in the Technology Roadmap, and how they are distributed across the timeline and between various S's. In Figures 11-13 these Roadmap Activities are illustrated.

Table 2. The final Number of Activities selected for the JERICO-RI Technology Roadmap. The Activities are selected based on their acceptability and given high priority, and after follow-up discussions with Nation Representatives.

.

	Now (1 year)	Short (1-5 years)	Long (5-10 years)
Strategy	5	4	8
Structure	3	3	6
Systems	3	3	7
Staff & Skills	0	0	(2)
Total	11	10	21 (23)

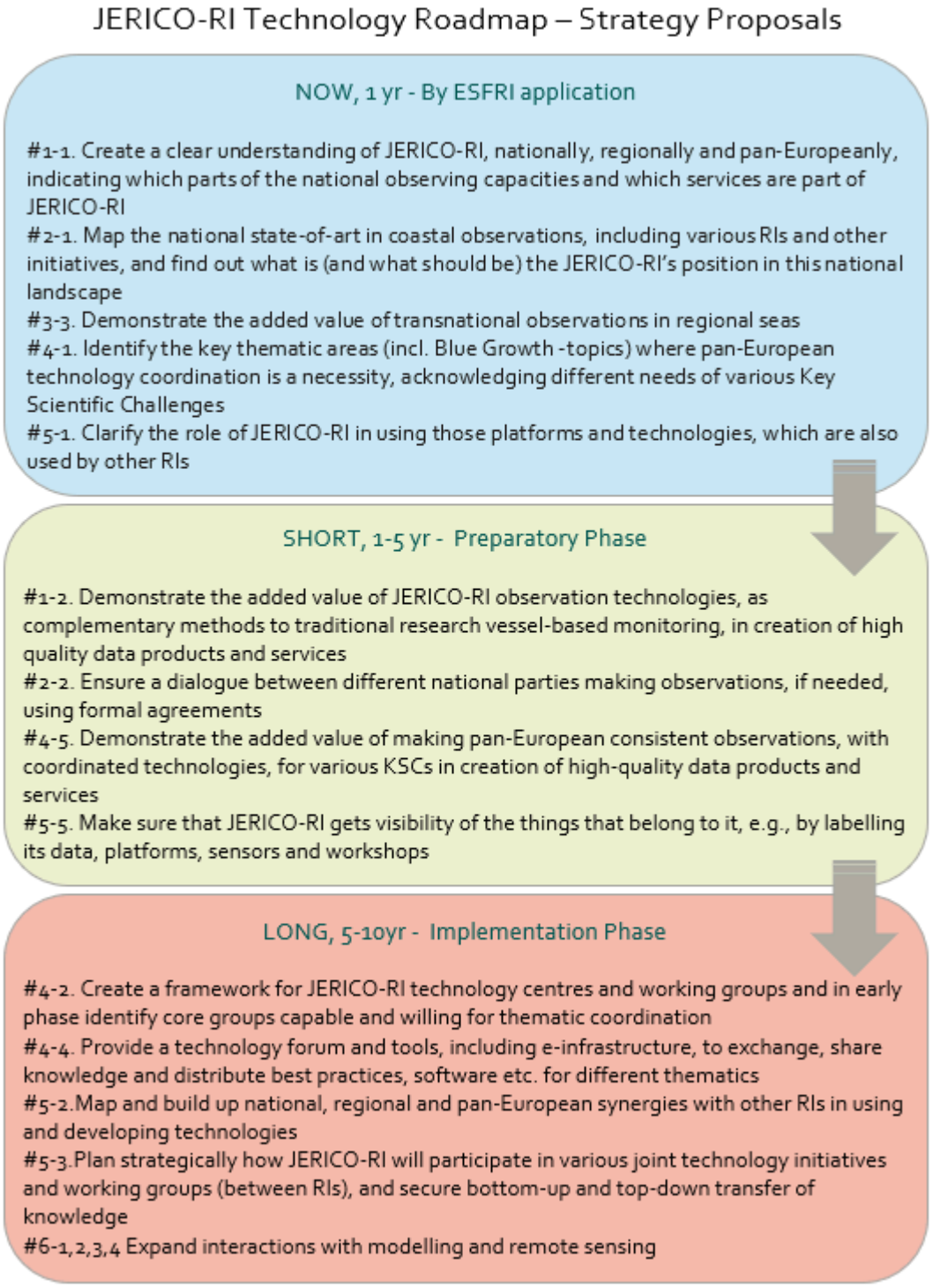

Figure 11. JERICO-RI Technology Roadmap Activities for Strategy Proposals

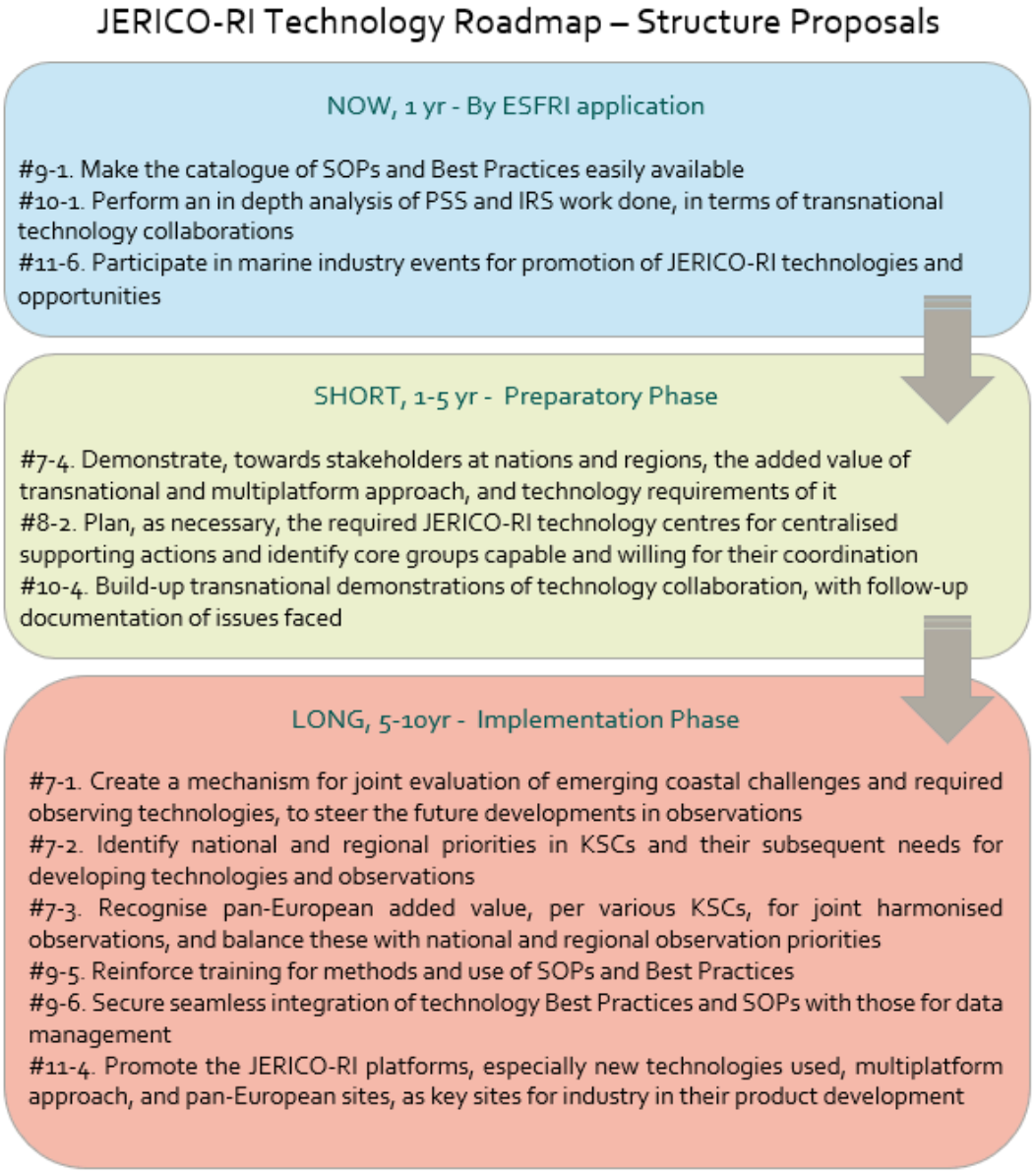

Figure 12. JERICO-RI Technology Roadmap Activities for Structure Proposals

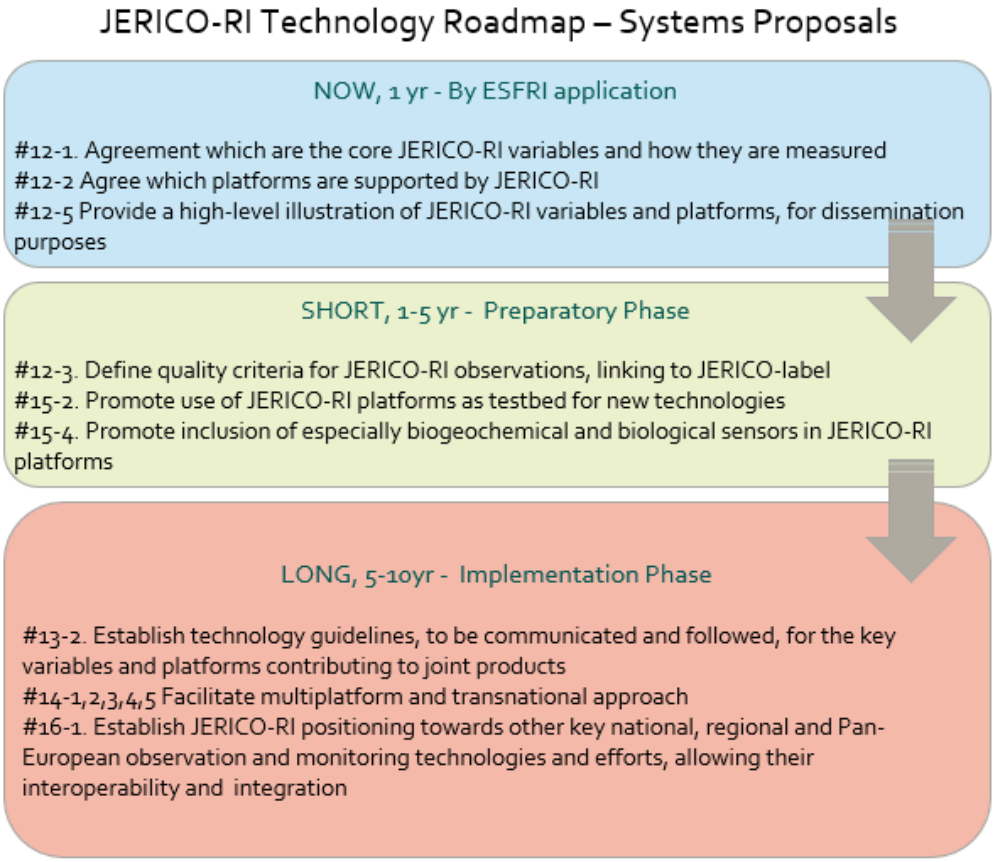

Figure 13. JERICO-RI Technology Roadmap Activities for Systems Proposals

5. Roadmap monitoring plan and next steps

JERICO-DS WP4 identified Key Performance Indicators (KPI) for technological impact, which are used to assess the implementation of JERICO-RI (Table 3). Among these, a KPI was identified to follow JERICO-RI Technology development, i.e. progress and success of Technology Roadmap execution.

Table 3. Preliminary definition of Key Performance Indicators for technological impact of JERICO-RI.

Selected Key Performance Indicators	Related to JERICO-RI criteria
Number of publications	scientific excellence
Number of projects granted	considers various stakeholders amount and type of RI users scientific excellence
Number of users	amount and type of RI users, considers various stakeholders
Structuring effects of the RI on the scientific community	progress and success of technology roadmap execution
Collaboration with other RIs and industry	technology collaboration with other RIs and industry, innovations developed
KPI to be defined once the Technology roadmap is in place	
JERICO RI Technology development	Progress and success of technology roadmap execution, technical integration and harmonization

The three timelines of Technology Roadmap execution calls for different strategies for their monitoring. Some of the Activities need to be accomplished prior to the ESFRI application being submitted. For some of the Activities, main elements are available and they can be consolidated during the ongoing series of JERICO Nation Committee meetings. As well, the remaining time of JERICO-S3 project (until July 2024), and meetings organised, can be used to execute some of the Activities. Part of the work requires smaller teams working with the topics (e.g. the ones analysing results from PSSs and IRSs), and these need to be formalised and nominated during Nation Committee meetings. Finally, during the ESFRI application writing sessions the team needs to be nominated to complete the required actions.

For "Short" and "Long" timelines the monitoring strategy needs to be build when we know more on the possible structuration of JERICO-RI community after JERICO-DS and JERICO-S3 projects.

As well, analysing the technology roadmaps, development plans and needs of other initiatives needs to be done and to streamline JERICO-RI Technology Roadmap with them.