HE RI WP 2021- 2022 Outline

Destination #1: A well-functioning European Research Infrastructure landscape

Over recent years, the European Commission and Member States have been closely collaborating, in particular within the European Strategy Forum on Research Infrastructures (ESFRI), to develop an integrated and efficient ecosystem of research infrastructures (RIs) in Europe, which encompasses single-sited facilities, distributed facilities integrating resources across the European Research Area, as well as networks of national facilities and which serves researchers and engineers in all S&T fields. To facilitate integration and pooling of resources for the development of new capacities, a legal instrument has also been developed at European level, the European Research Infrastructure Consortium (ERIC) that provides favourable conditions for the establishment and operation of large European infrastructures among several MSs and ACs as well as third countries. While Member States remain central in the development and financing of public RIs, the Union plays a catalysing and leveraging role in this field.

The challenges for the near future are to consolidate and optimise the European Research Infrastructure landscape and enhance its capacity to support frontier research and address the emerging and new scientific and societal objectives associated with the transition towards a sustainable and resilient Europe. In addition there is the need to define an effective and sound RI strategy in Europe, which is complemented by and interlocks with the long-term ambition of creating an integrated Technology Infrastructure (TI) landscape, the latter is supported in Pillar II of HE.

Destination 1 aims to create a coherent, agile and attractive RI landscape in Europe, by reducing its fragmentation at European, national and regional level, ensuring coordination of efforts and alignment of priorities among MSs, federating and connecting RIs to the EOSC, and which is able to support national and regional R&I ecosystems. The support to a European strategy for Research Infrastructures as well as activities to enhance the role of RIs for international cooperation and science diplomacy will also be covered under this Destination.

Possible topics

1.1 A well functioning European RI landscape

- **RI concept development:** to support the development of new concepts for the next generation of European research infrastructures, single/multi sited, distributed or virtual, that none or few Member States might individually be able to afford. Major upgrades of existing infrastructures may also be considered if the end result is significantly transformative and equivalent to a new infrastructure concept. The development of new Global Research Infrastructure concepts, to address global challenges such as those linked to climate change and environment, in line with the needs and gaps identified by the GSO (Group of Senior Officials of G8) on Global RI, can also be covered under this topic

  Main features: General bottom up approach, with possible targeted actions to address very specific and well identified policy needs (e.g.: Population Health Information RI). Main deliverables: clear science cases including gap analysis and feasibility/design studies; European relevance; plans for the provision of research services; strategy for institutional/stakeholder commitment and long-term sustainability options.

- **Preparatory phase of new RIs :** to support the implementation of the ESFRI roadmaps, by addressing legal, financial and technical issues leading to the establishment of a new RI and ensuring commitment of MSs/ACs to their long-term operation and use in all fields of science

  Main features: targeted approach based on the new projects in the ESFRI roadmaps; Main deliverables: formal agreement(s) among MS/ACs for establishing new RIs, including plans

for the governance structure and legal entity (e.g.: ERIC), for future sustainability, for service provision and arrangements for the implementation;

- **A well-integrated European RI ecosystem**: to consolidate and enhance coherence and cost-effectiveness of the landscape of pan-European RIs and their higher levels of integration through e.g.: merging and service level agreements between operational RIs, development of new RI components, broadening the partnership and user base as well as reorientation of the science agenda and fostering the international dimension of individual ESFRI/ERICs or other world-class research facilities.

  Main features: A targeted approach, identifying specific RIs and based on science cases and/or governance options, will be co-developed with the MSs/ACs in line with the ESFRI strategy and the RI life-cycle approach. Main deliverables: new settings and arrangements for the concerned RIs;

1.2 European RIs, policy activities, international cooperation and outreach

Specific actions to reinforce European RIs strategy and to strengthen the knowledge base for policy making will be carried out as well as outreach actions and training/skill development for RI staff. Similarly, international cooperation to develop global RIs and/or address global health, environmental and socio-economic challenges will be promoted for mutual benefits.

- **European Strategy Forum on Research Infrastructures (ESFRI):** to support cooperation between policy makers, funding bodies and the scientific community in the context of the European Strategy Forum on Research Infrastructures (ESFRI) in relation to priority setting and to the implementation of pan-European research infrastructures leading to a well-functioning and consolidated European research infrastructure ecosystem.

  Main features: Targeted approach to support the coordination of activities for the development and publication of the ESFRI Roadmap, the implementation of ESFRI activities and an effective monitoring of research infrastructures on the ESFRI Roadmap as well as to develop an effective ESFRI communication and outreach strategy.

- **Strengthen the bilateral cooperation on research infrastructures with Africa:** *to be developed*

- **International Conference on Research Infrastructures:** Following the International Conference on Research Infrastructures (ICRI 2021), that will be held in Ottawa, Canada, in June 2021, the Research Infrastructure action would support in the second semester 2022 one major International Conference on Research Infrastructures jointly organised by the European Commission and the Czech Republic, under the Czech Presidency. The objectives of the conference are (1) to provide an international forum for the discussion on the development of global research infrastructures as well as on issues of common interest such as the long-term sustainability of Research Infrastructures and their innovation potential; (2) to facilitate strategic international cooperation between European Research Infrastructures and their International counterparts; (3) to address the role of RIs to tackle global challenges and to contribute to the SDGs; (4) to analyse the resilience and adaptability of RIs in times of crisis.

  Main features: Grant to identified beneficiary to support the organisation of the main Conference for Research Infrastructures at global level, a high-level, invitation-only event gathering 500 to 600 participants, which has always been supported by the EC.

- **Transition to digital/remote RI service provision: lessons learnt, needs and best practises:** The provision of digital and remote RI services has proved its effectiveness during the COVID-19 emergency/lockdown. Such an approach would contribute to a sustainable and effective ecosystem of RIs, and, more in general, to a more sustainable society. Building on the resilience strategies and approaches developed during the COVID-19 emergency by RIs in Europe, this topic will investigate good practices and lessons learned as well as needs and further technological developments to support the transition to digital/remote RI service provision.

  Main features: Supporting action addressing RIs in many different fields. Main deliverable: Analysis of recent experiences, bottlenecks, good practices and possible improvements to foster the transition to digital/remote RI services.

Destination #2: Enabling an operational, open and FAIR EOSC ecosystem

Remark: Destination #2 shall take into consideration the R&I priorities arising from the Strategic Research and Innovation Agenda (SRIA) that is now under preparation by the research stakeholders as part of the candidate EOSC Partnership. The topics listed below represent a preliminary list of possible topics that will be reviewed as the SRIA will be taking shape in the coming months.

The European Open Science Cloud (EOSC) is an ecosystem of research data and related services. It encompasses standards, common rules of engagement, technologies, and services, which will enable and enhance seamless access to and reliable re-use of FAIR[1] research outputs (i.e. data and other digital objects), including those generated or collected by other research infrastructures, and covering the whole research data life cycle from discovery and mining to storage, management, analysis, and re-use.

EOSC development has been supported through a series of Horizon 2020 projects and an interim EOSC governance structure preparing the next stage of EOSC development for the period after 2020. These projects have contributed to the creation of a pan-European access mechanism; coordination of national activities for EOSC on-boarding; connection of European Research Infrastructures (ESFRI and other world-class RIs); initial setting and operationalisation of the FAIR principles and a FAIR-compliant certification scheme for research data infrastructures; EOSC portal providing access to a range of services, guidelines and training; and the development and provision of a number of research enabling and value-added services (both public and commercial). From 2021, the EOSC partnership will help ensuring directionality (common vision and objectives) and additionality (complementary commitments and contributions) of the stakeholders involved.

Building on this progress, Destination 2 aims to continue to develop the European Open Science Cloud (EOSC) to become a fully operational enabling ecosystem for FAIR research data commons (a.o. data, services, tools), based on key horizontal core functions and service layers accessible to researchers across disciplines throughout Europe, leading to a "**Web of FAIR Data and Services**" for Science.

Possible topics:

- **Supporting Open Science practices and a digitally-skilled workforce:** help shifting research in Europe towards an Open Science model by developing and connecting to the EOSC ecosystem the infrastructure and frameworks necessary to enable monitoring and reward of Open Science practices as well as the development of a large digital talent pool equipped with adequate digital skills in Europe.

[1] Findable, Accessible, Interoperable, Reusable

Main features: Support relevant activities that would aim at (i) developing EOSC-federated services and tools supporting the gathering of usage data, and best Open Science practices across borders and disciplines; and (ii) the training and deployment of professional data stewards, among other relevant data professionals, by launching a number of pilot activities in close collaboration with the Member States and in synergy with possible activities under the European Structural Funds and other funding programmes.

- **EOSC-Core: Development of** key functions of EOSC federated core to provide a fully operational environment to discover, access, share, and re-use data and services covering the full cycle of research. These functions will include aspects like resolution of different identifier types, metadata and ontology schemes, APIs for machine-actionable and interoperable data, service management and on-boarding, advanced discoverability features for all types of resources, further extension of the Authorisation, Authentication and Identification (AAI) framework, mechanisms to monitor service uptake and to provide feedback, and privacy and security aspects. The core enabling infrastructure will include development and access to added value services, applications and tools supporting the full cycle of scientific workflows. Use cases of researchers engaging with stakeholders from the public and private sector to identify societal challenges and use EOSC resources to address them will be promoted.

  Main features: The core enabling infrastructure builds on the outcomes of the projects funded under Horizon 2020. Main deliverable: fully functional and operational EOSC enabling core providing access to a Web of FAIR data and services.

- **Disciplinary/Multidisciplinary/Horizontal use cases and services for FAIR:** This can include supporting research communities and scientific disciplines to define and address FAIR requirements, testing the FAIR data maturity model in a wide range of communities and support its uptake, consolidate and promote the use of common technical specifications, etc.

  Main features: Actions to address specific and well-identified policy needs. Main deliverable: increasing levels of FAIRness and FAIR-by-design data and any other digital research objects.

- **Support to specific entities**:
  - **Support to the new EOSC legal entity during its start-up phase:** to engage, and align EOSC-relevant resources in Europe, monitor its implementation and enable the Web of FAIR data and services,
  - **Support to the Research Data Alliance** for the development, adoption and implementation of generic and/or domain specific research data solutions suited to the EOSC context and facilitate and promote the participation of European stakeholders into the RDA processes and structures.

  Main features: Support the EOSC legal entity to bring a minimum number of members together and support its activities in the first years of its activity, complementing the membership fees. Support RDA in in its international data interoperability activities.

Destination #3: RI services to support health research, accelerate the green and digital transformation, and advance frontier knowledge

Access to the services provided by research infrastructures in the European Research Area is essential both for the quality of the research produced and for the training of researchers. Easy access to high-quality resources, based on clear conditions and with appropriate funding, is an important feature of the attractiveness of the research and innovation system, encouraging researchers to move within or from outside Europe to perform their research. An open landscape of RIs in Europe contributes to the

circulation of skills and talents and promotes European cohesion.

The support under past Framework Programmes of trans-national and virtual access to RI has opened to research communities across Europe state-of-the-art services and resources for their scientific activities. RIs are key players in the generation of knowledge and drivers of scientific excellence in Europe. In conjunction with the European Science Cloud and Technology Infrastructures they are crucial enablers of research and innovation. The provision of services at EU level has been so far mainly organised per types of infrastructures or disciplines. The complexity and urgency of the socio-economic and environmental transition that Europe is facing, requires interdisciplinary approaches and a new challenge-driven provision of customised services able to accelerate the pace of the research cycle and the delivery of solutions.

Actions under Destination 3 will provide efficient and customised research infrastructure services to drive and enable the transition toward a sustainable Europe and a prosperous economy. RI services (e.g. access to unique scientific tools, samples provision, processing and analysis, data services) will be directed to support an effective and responsive health system and to accelerate the transition towards a green and digital future. Specific alignments and synergies with priorities in Pillar 2 will be developed and research infrastructure support will duly contribute to the identified missions and partnerships under Horizon Europe. At the same time, Research Infrastructures, which are key players in the generation of fundamental knowledge and drivers of scientific excellence in Europe, will also continue enabling the advancement of frontier knowledge.

Possible topics

3.1 Research Infrastructures services to address European and Global challenge(s): these topics bring together several complementary and interdisciplinary RIs to provide transnational access (on-site work at specialised facilities or remote services) to integrated and customised RI services for challenge-driven research and innovation. Access also includes ad hoc users' training and scientific and technical support. Harmonisation, customisation and virtualisation of RI services will also be supported.

Main features: Targeted approach based on EU policy priorities; Main deliverables: effective and customised RI services and access provision to the scientific community and industrial researchers by national and multinational RI (e.g. ESFRI/ERIC).

- **Research Infrastructures' services for rapid research responses to infectious disease epidemics:** two different topical areas will be addressed (i) to integrate complementary research infrastructure services to provide evidence for the development of new prevention and intervention tools, methods or measures, ranging from biomedical and disease vector control tools to psycho-societal and behavioural aspects, for fast responses to emergencies and decision-making and (ii) to facilitate and accelerate the access to, and the linking of, data and metadata on SARS-CoV-2 and COVID-19, on other related viruses and diseases, and on socio-economic consequences, across research fields, from omics, clinical, and epidemiological research, to Social Sciences and Humanities. Relevant authorities should be involved and links with the implementation of the European Open Science Cloud (EOSC) should be ensured. One-Health approach covering epidemics and epizootics is encouraged. Activities should build on the experience of the COVID-19 epidemics and, in particular, on the existing SARS-CoV-2 Data Hubs and COVID-19 Data Portal and should ensure mid- to long-term epidemics preparedness.

- **Biomedical Research Infrastructures' services to support research addressing cancer and major chronic diseases**: to integrate at EU level and provide access to complementary research infrastructure services and customised workflows supporting various steps of the bio-medical research lifecycle. In order to facilitate user access, a different interface should be developed for each disease, offering all the relevant resources and services. Appropriate links and complementarities will be ensured with the relevant HE Missions.

- **Research Infrastructures services for a sustainable and resilient agriculture and agro-ecological transitions:** to provide inter- and cross-disciplinary research services for agricultural research and innovation, its interconnections with food security and health, climate change and environmental factors, in line with One-Health approach. Access should be provided to transdisciplinary RIs platforms, including long-term data and models, and agro-ecological Living Labs/experimental facilities to support research enabling an agro-ecological transitions. RI services should enable the assessment of main threats (i.e. emerging pests, climate change, including drought, pollution and contaminants, etc.) on agriculture and of the societal benefits (e.g. high quality and safe food, improved health and wellbeing, etc.) of the agro-ecological transitions as well as support the development of mitigation and adaptation strategies and socio-economic and policy frameworks for a more resilient and sustainable agriculture. Customisation of RI services in relation to new or ongoing initiatives are encouraged as well as pilots and/or use cases in specific areas/environments. Appropriate links and complementarities will be ensured with the relevant data spaces.

- **Research Infrastructures services for adaptation to climate-related risks on the environment:** to integrate RIs providing access to observations, models and experimental facilities to support research addressing mitigation strategies and adaption to new/increased environmental risks caused by climate change such as flood, landslides, fires, extreme weather events and to provide evidence for risk assessment and civil protection. Appropriate links and complementarities will be ensured with the relevant activities under HE Pillar II.

- **Research Infrastructures services enabling the development of materials for a circular economy:** to integrate complementary services across different types of RIs and provide access to customised workflows, for the development of innovative materials for a circular economy. The services should address needs that arise at the different stages of materials development, ranging from first concepts to up-scaling, validation, and demonstration, and that serve the specific requirements of the actors in the materials development value chain.

- **Research Infrastructures services supporting research on recovery from socio-economic crises:** to integrate complementary RIs providing access to information and data services for research on employment, work and living conditions. Services should enable the development of evidence based strategies and solutions for recovery from major crises, for enhancing social cohesion and for a sustainable socio-economic development. Services for research on labour market and employment, including the identification of needs for new skills to support Europe's Green and Digital Transformation, should also be considered.

3.2 Research Infrastructures services advancing frontier knowledge

- **Research Infrastructure services for fundamental science:** this topic promotes transnational and virtual access to services provided by a wide community of research facilities to enable advancements at the frontier of knowledge and breakthrough discoveries in large domains of fundamental science. Access also includes ad hoc users' training and scientific and technical support to users. Harmonisation and virtualisation of RI services will also be supported.

  Main features: Targeted approach addressing specific large scientific domains on the basis of a multi-annual planning; Main deliverables: effective RI services and access provision to the scientific community.

- **EBRAINS - Empowering neuroscience for health and brain inspired technology**: EBRAINS is an integrative digital research infrastructure for Europe initiated as part of the Human Brain Project to cross-fertilise progress in neuroscience and advanced computing. Under this topic, proposals should develop comprehensive use-cases, provide an effective and comprehensive Europe-wide service to users, identify new user needs, provide training for developers of new EBRAINS services and support for networking with the HBP Facility Hubs and with other brain initiatives. This will allow maintaining the scientific leadership of

European brain researchers (academic and applied research), supporting the development and tuning of individualised brain medical treatments and facilitating the design and test of the most advanced brain-inspired technologies. Connecting of EBRAINS into the EOSC ecosystem is also foreseen.

Destination #4: Next generation of scientific instrumentation, tools and methods and advanced digital solutions

Scientific communities cannot adequately respond to current research challenges without having access to state-of-the-art scientific instruments and tools. Their constant adaptation, upgrading and innovation, as the underlying technologies develop at a very rapid pace, is critical for providing the optimal conditions for scientific advancements and discoveries in Europe.

The aim of Destination 4 is the development of ground-breaking RI technologies, including scientific instruments, tools, methods, and advanced digital solutions, to enable new discoveries and keep Europe's RIs at the highest level of excellence in science, while paving the way to innovative solutions to societal challenges and new industrial applications, products and services. New instruments and tools (such as advanced sensors, imaging devices, light source detectors) and advanced digital solutions (e.g. digital twins, data analytics and AI tools, etc.) for RI upgrade, will enable solutions to be found even for the most demanding scientific and societal challenges.

Use of artificial intelligence as enabler for better exploitation of data sets for research queries will be an important contribution from research infrastructures to the Commission's AI strategy proposed in the Commission's White Paper On Artificial Intelligence - A European approach to excellence and trust (COM(2020) 65 final).

Possible topics

- **R&D for the next generation of scientific instruments, tools and methods:** To deliver innovative scientific instrumentation, tools and methods, which advance the state-of-art of European RIs, and show transformative potential across scientific domains, serving a wide community of users and/or new areas of research and underpinning the provision of improved and advanced services. Their development should take into due account resource efficiency and environmental (including climate-related) impacts. Co-development with industry, including SMEs, as well as training of RI staff for the operation and use of new solutions are important aspects. Consideration should be given to the potential exploitation of the innovative solutions at industrial level. Cutting-edge technologies will also enhance the potential of RIs to contribute addressing EU policy objectives and socio-economic challenges.

  Main features: Bottom-up approach or targeted approach based; Main deliverables: new types of scientific instrumentation, tools, methods that will be widely used by RIs, complemented by the related necessary training for RI staff. Actions should involve a wide set of RIs and other technological partners, including industry. Consortia must be built around a leading core of ESFRI, ERIC and/or other world-class Research Infrastructures in Europe and beyond.

- **Interdisciplinary Digital Twins:** Building prototypes of new interdisciplinary Digital Twins[2] that permit to model and simulate ultra-complex phenomena and advance scientific discovery, as well as deliver socio-economically beneficial technical and software solutions and services to interdisciplinary research communities. Activities will include the development and deployment of common methods and tools to support interoperability, integration and collaboration across different scientific domains, disciplines, or missions of Horizon Europe and across the different RIs involved, to establish a robust framework to ensure the quality,

[2] A Digital Twin is defined as a digital replica of a living or a non-living physical entity.

reliability, verifiability of the data, information and outputs of such Digital Twins.

Main features: The areas of development can include those related to Horizon Europe missions, European partnerships and other current trends in the ERA communities. As they require major development effort, large-scale interventions across scientific communities are foreseen. The new developments would include service provision through the Digital Twins back to the involved scientific communities.

- **AI based pilot solutions to improve data acquisition and quality of data sets for research:** to develop innovative AI-based solutions for the acquisition of data from natural language or other unstructured and not harmonized data sets responding to specific needs of RIs. AI-based solutions are expected to enhance data quality and completeness (curation, plausibility); enhance data management (storage, transferability, handling of very large data volumes), data analysis and interpretation (inverse techniques, image analysis, social sciences, behavioural research, physics). Appropriate links and complementarities will be ensured with the relevant activities under HE Pillar II.

  Main feature: Bottom-up approach. Main deliverables: pilot(s) of AI-based solutions for applications in thematic areas (e.g. environmental monitoring; behavioural aspects), and/or data type (e.g. imaging, medical records) to be defined in advance.

Destination #5: Network connectivity - enabler for collaboration without boundaries

The way scientific research is conducted has dramatically changed over the last years. Today the data for research is generated from countless sources and large instruments across the globe (e.g. SKA[3]/Copernicus) and stored in largely distributed data repositories across Europe or even the globe. Access and processing of this data requires ultra-fast, high-bandwidth networks and network services to interconnect researchers, data and computing resources.

This destination aims at providing faster, resilient, agile and secure **connectivity services** for enabling scientists, researchers and students access to near real-time applications that support evidence-based decision-making in society and world-wide effective collaboration of virtual research communities

Possible topics:

- **Excellence in connectivity and collaboration services for the European Research Area (ERA):** The network infrastructure must offer state-of-the-art services for extracting the full potential and maximise value from the investments in data sources, research infrastructures and computing resources. The network service offering has to cater for virtual research teams from different domains and affiliations, providing access to heterogeneous digital resources and allowing collaboration with the private sector and SME's, when necessary. The provision will cover overall connectivity within the ERA, including HPC connectivity. Cooperation, community building and knowledge transfer through events, training and task forces is fundamental to maximise the impact of the service offering.

  Main features: Deliver operational excellence in connectivity and collaboration services, (including prototyping of new services when required to meet users' needs). Standardise performance across the board, consolidate backbone speeds in multiples of 100Gbps, and pave the way for Terabit connectivity where required. Stimulate use of cross-border network links between NRENs to the benefit of the pan-European infrastructure. Activities will also consolidate investments and aggregate demand for GÉANT and the extended NREN community including but not limited to: network capacity, networks services, cloud services, hardware & software.

[3] Square Kilometer Array

- **International connectivity & cooperation.** Conducting excellent research requires access to world-class RI resources and access to data sources beyond EU boundaries. Access to EU resources and data also attracts external talent and fosters international collaboration.

  Main features: Invest in strategic network capacity for science and research in international links that enables bilateral or multilateral collaboration in research and education with 3rd countries and secure suitable access for European based scientists to the major Research Infrastructures worldwide (like the SKA, ESO, CTA among many others).

- **Network / Connectivity enabling services**

  Trust & Identity. Authentication and authorisation Infrastructures (AAI) enable secured and authorised access to resources within research and scientific institutions, having cross-cutting relevance. The ongoing alignment with other EU policies beyond research and academia (such as e-IDAS or the forthcoming European identity management system) will enable to extend the access to Research Infrastructures (RIs) to a wider user base and facilitate seamless experience for those users in the digital realm.

  Main features: Maintain and evolve the core operations on identity federations, such as eduroam & eduGAIN, ensuring support of more complex services.