DELIVERABLE

D1.3. Strategic interaction of SERA activities with EPOS-IP

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Summary

This deliverable presents the strategy to ensure full alignment between the work being conducted in SERA and how SERA outputs are foreseen to be integrated in EPOS. At the time of submitting the SERA proposal, EPOS was in the implementation phase (H2020 EPOS-IP, ending in October 2019); Now, EPOS has been recognised as a landmark in the current ESFRI roadmap and the EC granted EPOS with the ERIC status on October 30th 2018. Sharing of strategy is ensured through the participation of the SERA Coordinator and Manager in the EPOS-IP Project Development Board, the participation of the EPOS-IP Coordinator and EPOS-IP Director in SERA WP1 and the Managing Board respectively, and the presence of key WP leaders in EPOS in SERA (TCS-ICS integration, seismology, anthropogenic hazards, near-fault observatories). At M18, the specific function of each SERA output in EPOS is identified (for service development, service validation, service provision). Also, the roadmap for interaction between SERA and the EPOS Project Development Board & EPOS Executive and Coordination office is presented.

1   Introduction

EPOS (*https://www.epos-ip.org*) is a long-term plan aimed at creating a Pan-European infrastructure for solid Earth science to support society. The EPOS scientific mission is to integrate the diverse and advanced European research infrastructure for solid Earth Science relying on new e-science opportunities to monitor and unravel the dynamic and complex Earth System. EPOS ultimate goal is to enable innovative multidisciplinary research for a better understanding of the Earth's physical processes that control earthquakes, volcanic eruptions, ground instability, tsunami, and tectonics. This goal will be achieved by implementing thematic services and by ensuring integration within the full EPOS framework, covering legal, governance and financial aspects, and interoperability through the novel e-science solution.

1.1   Current status of EPOS implementation

Integrated Core Services (ICS, Figure 1) has been designed and implemented to deliver tools to facilitate the discovery of data, data products, software and services and the integration of these resources to fulfil users requests. The key element of the ICS in EPOS will be a central hub (ICS-C), the EPOS web portal, where users can discover and access to services available in the Thematic Core Services and National Research Infrastructures. The ICS-C system design is based on the usage of a metadata catalogue, which maps and describes all the "assets" available from the EPOS community. The ICS-C system itself uses leading edge technologies and it is based on a micro-services approach, which makes the system scalable and the integration of new resources and services easy and fast. In particular, the ICS-C metadata catalogue utilises CERIF (Common European Research Information Format, a EU Recommendation to Member States) as its rich metadata format.

The **Thematic Core Services (TCS, Figure 1)** represent the community-specific framework in which to implement and operate the data and service provision offered by each community to users through EPOS. They act as transnational governance frameworks where data and services are provided to answer scientific questions and where each community discusses their specific implementation, best practices and sustainability strategies as well as legal and ethical issues. All TCS have been working for

the last years to design their own legal and governance structure, adapted to their services and specific needs and constraints. In particular, each TCS has established a legal and governance structure represented by a Consortium Agreement to ensure the engagement of the communities and national teams. Users and Data Providers will be engaged in the TCS Governance. Within each TCS, the identified Service Providers will sign Service Contracts with EPOS-ERIC, in order to guarantee the data and service provision. The envisaged financial framework for the delivery of EPOS-ERIC services is part of the EPOS Financial Plan. A list of potential TCS services, for which standards in terms of eligibility of types of services and costs were previously defined in a cost model applicable to all TCS, have been compiled and reported in the EPOS Cost-Book.
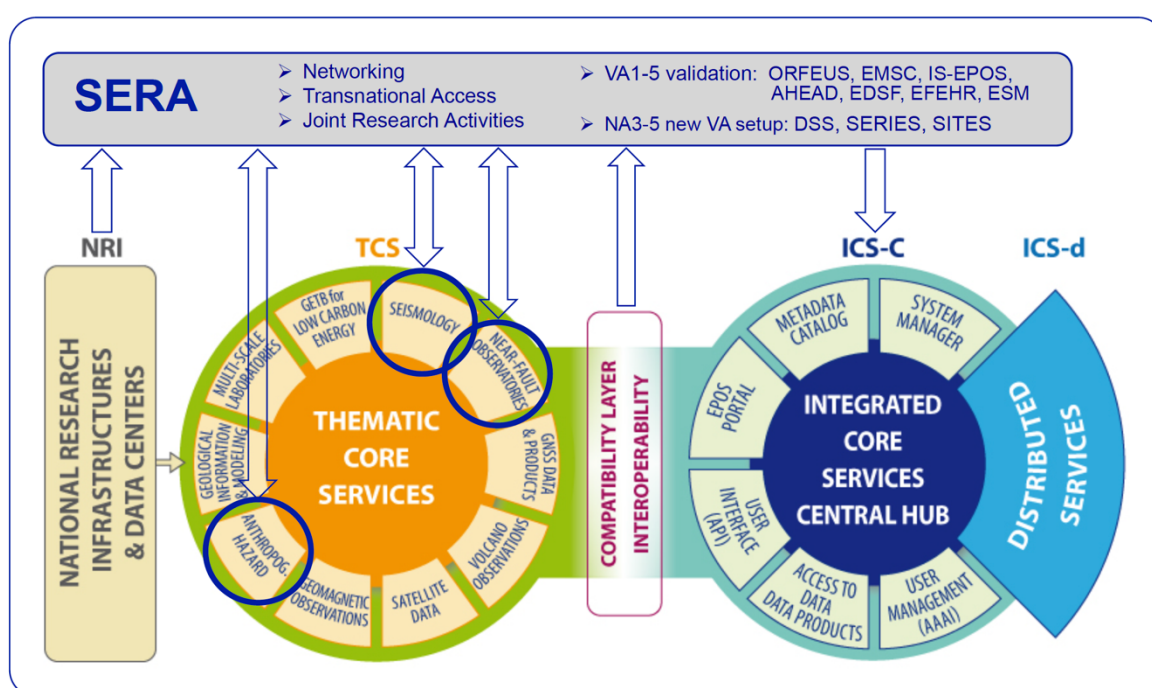

Figure 1. EPOS architecture and links to SERA activities.

1.2   Links between SERA & EPOS

The EPOS platform will provide visualization and discovery of data, data products, software and services across all main solid Earth science disciplines. This is possible thanks to the development of thematic services through time, funded through a variety of national and EC projects as well as national funds. In the last few years, the FP7 EPOS Preparatory Phase project (EPOS PP) and H2020 EPOS Implementation Phase project (EPOS IP), have focused on the development and implementation - according to the technical, legal, and governance requirements of EPOS - of TCS services across ten disciplines (see Section 3). In the future, EPOS will only provide partial financial support to the TCS, which will continue to rely on national support and competitive funding for developing new services and for supporting EPOS operations.

Figure 2 shows an overview of past and existing EC projects (from 2006 onwards), which illustrates the role of the different EC projects in supporting the consolidation of an advanced research community.

Through the various projects in **Figure 2**, it has been possible to advance in the understanding of specific scientific questions through Joint Research Activities, that have led (and will lead) to developing new components of services. Once coordinated with the support of Networking Activities, these components become individual operational services accessible to the community (Virtual Access). In this process, the strategy has also been to bring individual research groups into integrated advanced research communities, and to foster the exchange across related disciplines with the purpose of developing joint services (e.g. seismology and engineering communities). Some specific examples of this strategy are:

- The FP7-SERIES project (Seismic Engineering Research Infrastructures For European Synergies) conducted experimental research in earthquake engineering; the SERIES databases are now being updated in SERA through a Networking Activity involving the main earthquake engineering experimental facilities in Europe, so that access to earthquake engineering experimental data is archived and accessible. As a result, a new Virtual Access service provision for EPOS will be available at the end of SERA, that incorporates also the facilities and datasets generated by Transnational Access in SERA.

- The FP7-SHARE project (Seismic Hazard Harmonization in Europe) produced in 2013 the first seismic hazard model for the Euro-Mediterranean region (ESHM13); this model is now being updated in SERA (Joint Research Activities), and will lead to a new model of the European seismic hazard (ESHM20) on time for the revision of the European seismic norms (Eurocode 8), where it will be applied. At the same time, another Joint Research Activity in SERA will expand the exposure and vulnerability results of FP7-NERA (Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation) and FP7-SYNER-G (Systemic Seismic Vulnerability and Risk Analysis for Buildings, Lifeline Networks and Infrastructures Safety Gain), to develop a risk modeling framework for Europe. Then, EFEHR (European Facilities for Earthquake Hazard and Risk) will provide additional services through its earthquake hazard and risk tools and products platform (Virtual Access in SERA), and once validated, will deliver operational services in EPOS.

The specific areas where EPOS and SERA and linked are shown in Figure 1. More detailed objectives of the EPOS and SERA interaction strategy are to:

- Provide an important contribution to the construction and validation of EPOS, by developing major building blocks for the provision of key services in seismology, anthropogenic hazards and earthquake engineering.
- Validate in the pre-operational phase the most important pillars of virtual access to data and products from seismology and anthropogenic seismicity.
- Develop new service pillars in domains planned but not yet developed in EPOS, including active seismology data and products, site characterization and earthquake engineering experimental data.
- Offer the first large-scale transnational access to a coherent set of large research infrastructures, enabling to test one of the planned service modes of EPOS.
- Promote co-ordination and pooling of resources benefitting the EPOS operational phase.
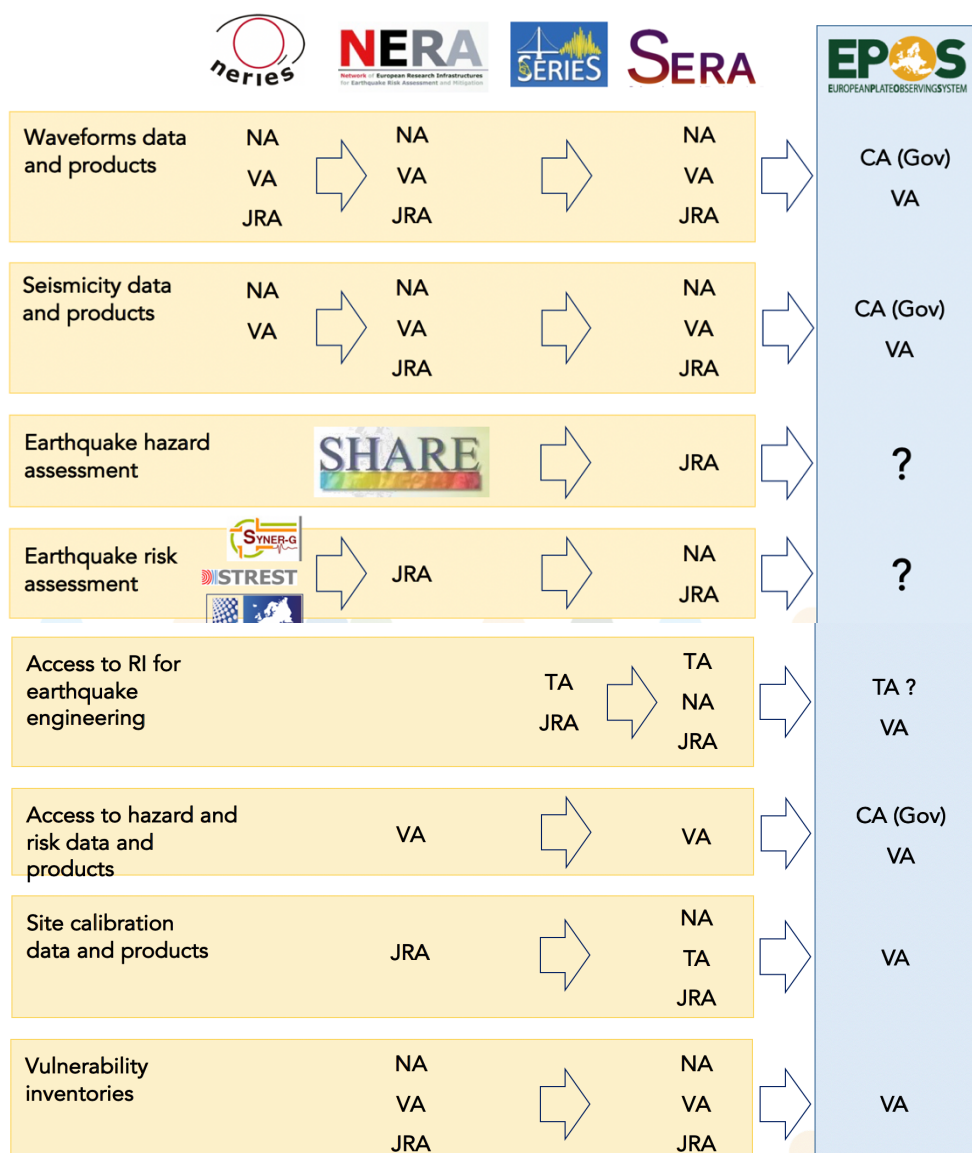
	neries	NERA	SERIES	SERA	EPOS
Waveforms data and products		NA VA JRA		NA VA JRA	NA VA JRA	CA (Gov) VA
Seismicity data and products		NA VA		NA VA JRA	NA VA JRA	CA (Gov) VA
Earthquake hazard assessment		SHARE			JRA	?
Earthquake risk assessment		SYNER-G STREST	JRA		NA JRA	?
Access to RI for earthquake engineering				TA JRA	TA NA JRA	TA ? VA
Access to hazard and risk data and products			VA		VA	CA (Gov) VA
Site calibration data and products			JRA		NA TA JRA	VA
Vulnerability inventories		NA VA JRA			NA VA JRA	VA

Figure 2. Precursor projects and relationship to SERA and EPOS.

In order to fulfil this strategy, the design of SERA incorporated the following specific measures:

- SERA is anchored in the structure of three EPOS TCS - Seismology, Near-Fault Observatories and Anthropogenic Hazards; in addition, SERA incorporates the TCS-ICS interoperability activities covered by WP6 in EPOS-IP (in charge of partner UiB in both EPOS and SERA), to ensure that the services developed or validated in SERA will be compatible for integration in the EPOS operational phase.
- The SERA TA and VA services offer access which will be included in the EPOS Operational Phase at the end of the EPOS IP implementation and once the ERIC is in force; these services are planned by EPOS but are not yet offered in EPOS IP; SERA will enable validating their operational level, costs and the return by the user and stakeholder community.
- The SERA NA and JRA develop the networking, knowledge and products, which will serve to improve the offered services and to build a further generation of service pillars for EPOS.

- Key EPOS people have important roles in SERA: the EPOS-IP leaders of TCS Seismology, TCS Near-Fault Observatories and TCS Anthropogenic Hazards are all involved in the SERA activities; the SERA Coordinator was head of strategy in EPOS-PP, leads the Financial Framework in EPOS-IP and is member of the EPOS-IP Project Development Board (PDB); the SERA Manager is working on the EPOS-IP Financial Framework and is member of the EPOS-IP PDB; the leader of the TCS-ICS integration in EPOS participates in SERA NA and JRA WPs to ensure interoperability with the EPOS ICS architecture; the EPOS Secretariat is represented in SERA WP1, with EPOS-IP Director being member of the SERA Management Board, and EPOS-IP Coordinator and EPOS Interim Director authoring this deliverable.
- SERA will report regularly to EPOS on progress of services, which will be later included in the EPOS operational phase.
- The SERA timeline has been aligned with the EPOS construction.

2   Contribution of SERA to existing and new EPOS services

This section provides details on the specific contributions of SERA to EPOS, which are summarised in Table 1 (following page). Items referred to in Table 1 are:

- **TCS in EPOS**: These are the ten Thematic Core Services (TCS) in EPOS:

  TCS SEIS (WP8 Seismology)

  TCS GNSS (WP10 GNSS Data and Products)

  TCS SATD (WP12 Satellite Data)

  TCS AHAZ (WP14 Anthropogenic Hazards)

  TCS LABS (WP16 Multi-scale Laboratories)

  TCS NFOS (WP9 Near-Fault Observatories)

  TCS VOLC (WP11 Volcano Observations)

  TCS GEOM (WP13 Geomagnetic Observations)

  TCS GEOL (WP15 Geological Information and Modelling)

  TCS GETB (WP17 Geo-energy testbeds for low carbon energy) – also connected to SERA through JRA1/JRA2.

- **List of WPs in SERA:**

  WP1   Management (ETH)
  WP2   Communication (ETH)
  WP3   NA1: Networking Seismo@school outreach programs (UKRI)
  WP4   NA2: Expanding access to the European seismic monitoring infrastructure (KNMI)
  WP5   NA3: Networking Deep Seismic Sounding data and products (UU)
  WP6   NA4: Networking experimental seismic engineering databases (SERIES) (JRC)
  WP7   NA5: Networking databases of site and station characterization (CNRS)
  WP8   WP17: Transnational Access to 10 infrastructures

WP18 VA1: Access to seismological products and information at EMSC
WP19 VA2: Access to seismic waveforms at ORFEUS/KNMI
WP20 VA3: Access to data and services for engineering seismology at INGV
WP21 VA4: Access to earthquake hazard and risk products at EFEHR/ETHZ
WP22 VA5: Access to data and products of anthropogenic seismicity at IGPAS
WP23 JRA1: Physics of the earthquake initiation
WP24 JRA2: Characterizing the activity rates of induced and natural earthquakes
WP25 JRA3: Updating and extending the European Seismic Hazard Model
WP26 JRA4: Risk Modelling Framework for Europe
WP27 JRA5: Innovative testing methodologies for component/system resilience
WP28 JRA6: Real-time earthquake shaking

- **EPOS Cost-book services**: As explained in Section 1, EPOS IP has produced a catalogue of potential EPOS services, with associated costs, contained in the so-called EPOS Cost-book. In this context, an EPOS *service* has to be understood as an element with a key purpose (for example the TCS Governance), or as a group of theme-related data or products (for example, earthquake parameter information provided by EMSC). Each service in the cost-book follows this nomenclature: WPNr-SP-ServiceNumber.
  The EPOS services listed in Table 1 can be identified in the Cost-book services of Table 2.

- **Role of SERA:** The types of SERA roles described in Table 1 correspond to either:

  o **Product development**: this means SERA contributes to develop new products and to make them interoperable with EPOS, before they can enter the EPOS catalogue of services ready for operations. E.g. new seismic risk products.

  o **Service development**: this means SERA contributes to develop new services (some aggregating various datasets/products), before they enter the EPOS catalogue of services ready for operations. E.g. new virtual access service to earthquake engineering databases.

  o **EU validation:** this means SERA serves to validate services (through the acceptance of project deliverables by the EC, assessment of costs, etc.), so they can be offered to enter the EPOS catalogue of operational services. E.g. Virtual access to seismic hazard products.

  o **Service Provision**: this means SERA supports during its lifetime services of the EPOS catalogue of services, whether in the area of Governance, Coordination, Outreach, Transnational Access or Data-related services. E.g. Transnational Access to earthquake engineering infrastructures.

	EPOS SERVICE	WP SERA	ROLE OF SERA	EPOS COST-BOOK SERVICE ID	TCS IN EPOS
1.	Coordination of seismology community	NA2, VA4	Service provision	WP08-SP-002 WP08-SP-021 WP08-SP-026	TCS SEIS - Coordination
2.	Virtual access to seismology data and products	VA1, VA2	Service provision & EU validation Product development	WP08-SP-005 to -020 WP08-SP-022 to -025 WP08-SP-034 to -035	TCS SEIS
3.	Virtual access to anthropogenic data and products	VA5	Service provision & EU validation	WP14-SP-006 to -008	TCS AHAZ
4.	Virtual access to seismic hazard products	VA4, VA3 JRA3	Service provision & EU validation Product development	WP08-SP-027 to -031 WP08-SP-027, -030	TCS SEIS - EFEHR
5.	Virtual access to seismic risk products	JRA4	Product & service development	WP08-SP-027 WP08-SP-037	TCS SEIS - EFEHR
6.	Active seismology services	NA3	Product & service development	Not included	TCS SEIS
7.	Databases of site and station characterisation (strong motion/seismic)	NA5	Product & service development	WP08-SP-025	TCS SEIS
8.	Virtual access to earthquake engineering DBs	NA4 + TA1-TA9	Product & service development	WP08-SP-038	TCS SEIS - EFEHR
9.	Transnational Access to earthquake engineering infrastructures	TA1-TA8	Service provision & EU validation	WP08-SP-032 WP08-SP-039	TCS SEIS - TA
10.	Transnational Access to array seismology infrastructures	TA10	Service provision & EU validation	WP08-SP-033 WP08-SP-040	TCS SEIS - TA
11.	Networking European Seismo@School programs	NA1	Service provision	Not included	-

Table 1. Overview of EPOS services related to SERA

ID		SERVICE NAME	SERVICE DESCRIPTION	SP	MS
				Service Provider	Member State
GOV	WP08-SP-001	TCS Governance,Coord.,Outreach	TCS Seismology Consortium Secretariat / Chair	*TBD*	*TBD*
SUBTOTAL					
Waveform Services					
GOV	WP08-SP-002	Governance & Outreach	Governance and outreach activities for ORFEUS	ORFEUS	NL
GOV	WP08-SP-003	Coordination	Computational waveform services coordination	KIT	DE
GOV	WP08-SP-004	Outreach & Training	Computational waveform services outreach & training	INGV	IT
SERVICE	WP08-SP-005	EIDA waveform access	EIDA node operations and service maintenance	KNMI/ORFEUS	NL
SERVICE	WP08-SP-006	EIDA waveform access	EIDA node operations and service maintenance	GFZ	DE
SERVICE	WP08-SP-007	EIDA waveform access	EIDA node operations	INGV	IT
SERVICE	WP08-SP-008	EIDA waveform access	EIDA node operations	CNRS-RESIF	FR
SERVICE	WP08-SP-009	EIDA waveform access	EIDA node operations	ETH	CH
SERVICE	WP08-SP-010	EIDA waveform access	EIDA node operations	NOA	GR
SERVICE	WP08-SP-011	EIDA waveform access	EIDA node operations	BOUN	TR
SERVICE	WP08-SP-012	EIDA waveform access	EIDA node operations	BGR	DE
SERVICE	WP08-SP-013	EIDA waveform access	EIDA node operations	INFP	RO
SERVICE	WP08-SP-014	ODC products and services	RRTSM data products, station info.; USGS shakemap input	KNMI/ORFEUS	NL
SERVICE	WP08-SP-015	European Strong Motion D&P	Data processing/revision; event access; USGS shakemap inputs	INGV	IT
SERVICE	WP08-SP-016	Waveform modelling portal	Portal maintenance / user support	KIT	DE
SERVICE	WP08-SP-017	Waveform modelling portal	Portal maintenance / user support	INGV	IT
SERVICE	WP08-SP-018	Waveform modelling portal	Portal maintenance / user support	KNMI	NL
SERVICE	WP08-SP-019	Waveform modelling portal	SPECFEM (3D/global) operat. and user support	CNRS-LMA	FR
SERVICE	WP08-SP-020	Waveform modelling portal	AXISEM operational and user support	U.OXFORD	UK
SUBTOTAL					
Seismological Products Services					
GOV	WP08-SP-021	Governance & Outreach	Seismological products Governance and Outreach	EMSC	FR
SERVICE	WP08-SP-022	EMSC Earthquake parameter info.	EMSC Earthquake parameter information	EMSC	FR
SERVICE	WP08-SP-023	EMSC Seismological Product Platform	EMSC Seismological Product Platform	EMSC	FR
SERVICE	WP08-SP-024	AHEAD historical earthquake data	AHEAD historical earthquake data	INGV	IT
SERVICE	WP08-SP-025	Site characterization and archive	Site characterization and archive	CNRS-ISTERRE	FR
SUBTOTAL					
Earthquake Facilities for Seismic Hazard and Risk Services					
GOV	WP08-SP-026	Governance & Outreach	EFEHR Governance and Outreach	ETH	CH
SERVICE	WP08-SP-027	EFEHR platform	EFEHR Platform operation	ETH	CH
SERVICE	WP08-SP-028	GMPE service	European Ground Motion Prediction Equation	GFZ	DE
SERVICE	WP08-SP-029	EDSF service	European Database of Seismogenic Faults	INGV	IT
SERVICE	WP08-SP-031	ESMB service	European Strong Motion data in buildings service	BOUN	TR

Table 2a. Cost-book sheet from EPOS-IP for TCS Seismology (proposed services for operations)

	ID	SERVICE NAME	SERVICE DESCRIPTION	SP	MS
				Service Provider	*Member State*
Transnational access					
TA	WP08-SP-040	Coordination of TA to Seismology RIs	Governance and coordination	*TBD*	*TBD*
TA	WP08-SP-033	TA support to Seismology RIs	Host institution and visiting scientist support	*Open call*	
TA	WP08-SP-039	Coordination of TA to Earthq. Eng. RIs	Governance and coordination	*TBD*	*TBD*
TA	WP08-SP-032	TA support to Earthquake Eng. RIs	Host institution and visiting scientist support	*Open call*	
TOTAL DIRECT COSTS					

FUTURE SERVICES IN PREPARATION

		SERVICE NAME	SERVICE DESCRIPTION	SP	MS
Waveform services				*Service Provider*	*Member State*
SERVICE	WP08-SP-034	Mobile Pools & temporary deployment	Mobile Pools & temporary deployment	CSIC	ES
SERVICE	WP08-SP-035	Ocean Bottom Seismometry D&P	Ocean Bottom Seismometry D&P	CNRS-IPGP	FR
SERVICE	WP08-SP-036	Operational contact for EGI	Operational contact for EGI	SCAI	DE
Earthquake Facilities for Seismic Hazard and Risk Services					
SERVICE	WP08-SP-030	EGD service	European Geotechnical Database	AUTH	GR
SERVICE	WP08-SP-037	Risk Assessment service	Access to vulnerability inventories and risk assessment codes	EUCENTRE	IT
SERVICE	WP08-SP-038	EETF service	Access to experimental data from EarthquakeEngineering Testing Facilities	JRC	EU

Table 2b. Cost-book sheet from EPOS-IP for TCS Seismology (TA, and services for future implementation)

	ID	SERVICE NAME	SERVICE DESCRIPTION	SP	MS
				Service Provider	Member State
GOV	WP14-SP-001	TCS Governance & Coordination	Coordination, Administration nd TCS Council (including innovation Advisory Committee)	IG-PAS	PL
GOV	WP14-SP-002	TCS Governance & Coordination	Section for projects and partnership	LTU	SE
GOV	WP14-SP-003	TCS promotion and dissemination	Promoting TCS in various environments: governmental, academia, industry, public;	EOST	FR
GOV	WP14-SP-004	Implementation of TCS services	Section for implementing TCS services	ACK CYFRONET	PL
GOV	WP14-SP-005	Episode integration and application implementation	Section for episode integration and application implementation	GFZ	DE
SUBTOTAL					
SERVICE	WP14-SP-006	IS-EPOS Platform	Virtual access through the IS-Platform to data, products and services (e.g. applications, user's workspace, vizualizations)	IG-PAS/ACK CYFRONET	PL
SERVICE	WP14-SP-007	VAeN1	Virtual access to EOST eNode	EOST	FR
SERVICE	WP14-SP-008	VAeN2	Virtual access to IG-PAS eNode	IG-PAS	PL

Table 2c. Cost-book sheet from EPOS-IP for TCS Anthropogenic Hazards

3   Decision and implementation roadmap

EPOS-IP is now starting its last year, where a number of validated services will enter the testing and pre-operational phase. The process of validation in EPOS-IP involved a thorough analysis of the technical, legal, governance and financial aspects of each TCS and service, and was conducted by the scientific advisory body (BNSR) of the EPOS Board of Governmental Representatives (BGR) with the support of an External Evaluation Panel. The BGR will receive in November 2018 feedback from the validation process, and emit a recommendation for services to enter the testing and pre-operational phase. Because EPOS will officially start its path as an ERIC in November 2018, the BGR will give way to the EPOS General Assembly, who will ultimately decide on the workplan for testing and pre-operations and determine the allocation of resources.

During the SERA project duration, the following actions with EPOS are foreseen:

- Interaction will focus first on the services validated by EPOS, either at the present validation round or in future validations run by EPOS. The role of SERA here will be to improve service

delivery and contribute with resources to the service during testing and pre-operations. Timeline: M18-M36.

- SERA and EPOS will work together to ensure that newly developed services and products in SERA are fully compatible with the requirements of EPOS, at the technical, legal, governance and financial levels. Timeline: M18-M36.
- SERA will also make use of the interaction with EPOS to share with SERA partners the strategy for the integration in EPOS of new services developed in SERA. Timeline: M18-M36.
- D1.3 will be discussed with the EPOS-PDB to agree on the priority of services to be proposed for integration in EPOS. Timeline: M18-M24.
- EPOS-IP has elaborated a preliminary financial plan for 2019 & 2020 that takes into account resources that could be contributed through SERA as well as through other projects and national funds. This mapping of resources will continue in the coming months, and will be shared with the EPOS-IP PDB. Timeline: M18-M20.

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