Time Machine: Big Data of the Past for the Future of Europe

Time Machine

Deliverable D8.1
TM Preparation Report 1

Abstract

The first Interim Progress Report presents the quality criteria and progress reporting system of the LSRI maturing process. The report then describes how the CSA project advanced in the first three months and presents planning for next steps concerning the development of the Time Machine Pillar roadmaps.

Project Identification

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History of Changes

Date	Version	Author	Comments
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Disclaimer

List of abbreviations

AI	Artificial Intelligence
CH	Cultural Heritage
CSA	Coordination and Support Action
GLAM	Galleries, Libraries, Archives and Museums
ICT	Information and Communication Technologies
LSRI	Large Scale Research Initiative
RFC	Requests for Comments
TM	Time Machine
WG	Working Group
WP	Work Package

Table of contents

1 Introduction

Time Machine (TM) is a Large-Scale Research Initiative (LRSI), built around the vision of creating the big data of the past, a distributed digital information system mapping the European social, cultural and geographical evolution. This huge digitisation and computing infrastructure will enable Europe to turn its long history, as well as its multilingualism and multiculturalism, into a living social and economic resource.

The TM CSA project will design the Time Machine LSRI. The final document will present solid evidence on the feasibility of detailed and fully costed research and innovation roadmaps, the efficiency of the proposed governance scheme, as well as the significant benefits and impact for European society, scientific and technological competitiveness, and economy.

Preparation of the proposal document requires close coordination and follow-up of work conducted in the different work streams of the CSA. These are tasks of WP8 that started on Month 3 and will run till the end of the CSA. Accordingly, work in WP8 involves:

- Designing the monitoring system to be used for following progress in the other WPs.
- Discussing and validating this monitoring system with the other WPs, including the information to be provided for following-up progress.
- Coordinating the preparation of the final TM document.

This document is the formal deliverable D8.1 Interim Progress Report 1, prepared under Task 8.1 of WP8. It specifies the quality criteria for the LSRI proposal, monitors progress in the different stages of the LSRI maturing process in the first quarter of the project and shows planning of next steps. The intended audience comprises all the members of the CSA project team.

Following this short introduction, the deliverable is organised in the following sections:

- Section 2 discusses the form of the LSRI and the corresponding quality criteria methodology for the development of the LSRI.
- Section 3 presents the quality criteria used for the elaboration of the pillar roadmaps.
- Section 4 describes progress achieved during the current reporting period: Months 1-3 of the project, covering the period from March to May 2019.
- Section 5 focuses on the next steps of developing the pillar roadmaps.

The document is supported by Annex A, where the proposed structure of the TM LSRI is described.

2 Methodology for developing the LSRI roadmap

2.1 Form of the Time Machine initiative

Time Machine is designed as a LSRI, understood to be a structured cooperation of an already broad network of stakeholders involved with developing/drawing value from the big data of the past, and, therefore, aiming to create substantial socio-economic impact, by implementing a strategic research and innovation agenda.

The initiative is based on a common understanding of the:

- Expected achievements in terms of science and technology that are ambitious, realistic and measurable
- Specific timeframes, where concrete intermediate results will be produced
- Substantial qualitative and quantitative effects for key existing and developing economic sectors
- Requirement to continuously interact with policy/decision makers in order to optimise the implementation process
- Necessity to combine different sources of funding, creating synergies across and promoting efficient utilisation of different funding instruments
- Need for an integrated and holistic approach to maximize impact.

The TM roadmap is the reference document that consolidates and describes this understanding and, therefore, providing the guidelines for all actors involved in the implementation of the TM LSRI. It should, therefore, outline the strategy, the organisation of work to achieve stated goals and outcomes over specified time frames, necessary resources and criteria of success.

2.2 Development of the Pillar roadmaps

The TM LSRI is structured along four pillars, serving the following objectives:

- Addressing the scientific and technological challenges in AI, Robotics and ICT for social interaction, for developing the Big Data of the Past, while boosting these key enabling technologies in Europe (Pillar 1).
- Building the TM infrastructure for digitisation, processing and simulation, in order to develop a sustainable management and operational model ("TM franchise"), as well as to create the basis for and engagement with the TM communities participating in the development and use of TM (Pillar 2).
- Creating innovation platforms in promising application areas, by bringing together developers and users for the exploitation of scientific and technological achievements, and therefore leveraging the cultural, societal and economic impact of TM (Pillar 3).
- Developing favourable framework conditions for the outreach to all critical target groups, and for guiding and facilitating the uptake of research results produced in the course of the LRSI (Pillar 4).

The TM reference document is produced following the TM structure in the above pillars and their corresponding thematic areas (shown in Annex A).

In the CSA project, the development of roadmaps is organised in work packages (WPs). The pillar roadmaps are elaborated from detailed plans at the level of each thematic area, undertaken by working groups (WGs) composed of subject matter experts from the TM consortium. Work in pillars 1-3 (WPs 2-4) has started in month 1 and will be concluded by Month 8 (October 2019), after the integration of feedback received from consultations with external stakeholders. Work for Pillar 4 (WP5) will start in Month 5 (July 2019), building on specific needs identified in pillars 1-3 and finish by Month 8 as well.

Taking into account the requirements for the final outcome (the TM reference document), the pillar roadmaps should have the following structure:

- Pillar Objective
- Research and Innovation Plans

- Funding sources
- Stakeholders to be involved
- Framework conditions
- Risk and barriers – measures to address them

The starting point in each WP is a background document for the pillar describing the objectives, the current situation, and the priorities to be addressed, as well as specifications in terms of required resources, timing and funding.

During roadmap development, the WGs describe and assess the state of the art, define priorities and examine alternative development routes for each thematic area, through internal workshops, own expert judgements, consultations with external experts as required, and document / data analysis.

Their conclusions, as initial (Month 4) and, then, final (Month 8) drafts, are checked for coherence and compliance with the TM objectives, and are integrated into the pillar roadmap.

During this stage, the roadmaps for the pillars 1-3 also identify and describe:

- The funding sources, as well as corresponding mechanisms and processes to be followed in the contractual relations with the different funders;
- The large variety of stakeholders to be involved, their corresponding roles and, therefore, the needs in terms of management and coordination for the programme;
- The framework conditions relating to policy, legal aspects and ethics that have to be taken into account;
- The approaches and measures that address any barriers to market entry and/or facilitate the commercial exploitation of research results.

These aspects form the basis for the second stage of the design: the first two are used to shape a robust governance scheme (WP 6), while the last two will enable us to design the accompanying actions (WP5 - Pillar 4) supporting the dissemination and outreach of TM in the EU and internationally, as well as creating the enabling environment to maximise the societal and economic outcomes of Pillar 3.

Coordination also involves using the main conclusions from the pillar roadmap drafts to organise:

- Stakeholder workshops with selected representatives of academia, business and policy making.
- Stakeholder online consultations.

These actions aim to receive comments, integrate views, build consensus and ensure commitment to TM objectives and endorsement from a wide range of TM stakeholders. This is an important interaction of the WPs that develop the Pillar roadmaps and the horizontal WP7 that deals with dissemination and promotion:

- The Pillar roadmaps define the stakeholders to be involved (actors and funders).
- WP7 defines the overall dissemination strategy, part of which is to approach the stakeholders identified in WPs 2-5 and undertakes the promotion actions to raise interest and incite participation in TM.
- So, among other things, WP7 creates the favourable conditions for all stakeholders to participate in the road-mapping events organised in WPs 2-5.

In the final stage of the CSA, the findings of the previous stages are put together in the TM reference document presenting the TM strategic objectives, along with detailed methodologies and required resources, as well as the management and operational scheme that will drive the programme through its 10-year span.

3 The Quality Criteria

Taking into account the nature of the LSRI (section 2.1) and design process presented (section 2.2), the development of the pillar roadmaps should be based on the quality criteria presented in Table 3-1.

Table 3-1: Quality criteria for the development of pillar roadmaps

Roadmap sections	Quality criteria
1. Pillar objective	A clear mission statement is developed for the pillar, describing how the pillar contributes to the Time Machine vision
2. Research and Innovation plans	A master plan is developed describing the baseline, the expected ambitious outcomes and the methods to achieve them
a. State of the art	A thorough review of relevant scientific, technological and business fields constitutes the pillar's baseline
b. Targeted achievements	Concrete targets are defined for addressing the relevant scientific, technological and innovation challenges
c. proposed methodologies	The path to the targeted achievements is elaborated to a sufficient level of detail, specifying the key actors to be involved. Interdependencies with other pillars are identified
d. milestones	Critical points to evaluate progress in the proposed developments are determined
e. Key performance indicators	A set of metrics is developed to assess progress made in the different WGs
3. Funding sources	Realistic options, including alternatives, are identified for the funding resources of the proposed R&I plans
4. Stakeholders to be involved	The key actors that will validate, contribute and/or support the proposed actions have been identified and are informed/involved in the elaboration of the R&I plans
5. Framework conditions	Policy measures, legal issues, broader socio-economic developments that may have a positive or negative effect on the proposed R&I plans are identified and discussed
6. Risks & barriers and ways to address them	Risk factors and barriers for obtaining the targeted achievements are identified and mitigation strategies are formulated

4 Progress achieved during the reporting period (Months 1-3)

4.1 Pillar 1 (WP2)

The objective of Pillar 1 is to develop cutting-edge computational methods, specially through AI, to access, organize, and understand large-scale cultural heritage collections. This technology will enable virtual time traveling by extracting knowledge and establishing links over space and time. The aim is to put together multidisciplinary work groups in Europe to radically transform large-scale humanities studies, data archives, user interfaces and the way the past is analysed, in order to understand our future.

Progress in Pillar 1 is discussed next for each roadmap area.

Research and Innovation plans

A taxonomy of technologies relevant for the Pillar was defined, divided in three main areas "Data", "Computing and AI" and "Humanities and Social Sciences". Each of these areas was further divided in subareas and individual topics. This is a modular structure that will allow to create independent but interrelated technological developments.

The experts to contribute with the development of the roadmap in the different areas were identified and a series of fact sheets to complete was created with information relevant for the roadmap. These fact sheets are currently being completed and sufficient information is expected to be available for the timely preparation of the draft pillar roadmap.

State of the art

Many technological developments in Computing and AI as well as Data Acquisition and Storage have been made in recent years and will continue in the future (scanning robots, cloud computing, automatic handwritten and printed character recognition, image understanding, indexing and retrieval, information extraction, etc.). Not all these developments have been made considering the uses for Cultural Heritage (CH).

In Humanities and Social Sciences, the past is still studied mostly with inference strategies from selective information and much of the relevant archives are still only partially available in a digital format. Digital Epistemology, Digital Hermeneutics, Digital Humanities are still emerging fields that need to frame the way to approach the big data of the past.

Targeted achievements

- Create guidelines for data acquisition, management and storage for CH.
- Create a Time Machine architecture with modular technologies and solutions for CH, from data acquisition technologies to data analysis and reconstruction tools based on AI.
- Setting the foundations of new interpretative methods for Humanities and Social Sciences.

Proposed methodologies

Partner Institutions will develop technologies in their expertise, using the Time Machine as a hub that can foster their collaboration. The local Time Machines will use their own institutional infrastructure and take advantage of the general Time Machine architecture when required.

The Time Machine will receive input and suggestions from the local Time Machine experiences, the users and the academic community, especially in history and social sciences in order to understand the necessities and demands of the public.

Milestones

Most important milestones under consideration:

- 2022: The basic guidelines for data and metadata formats need to be in place, including provenance metadata.

- 2024: Visual analytics and explanation for selected types of Machine Learning and applications. Approaches for estimating confidence under noisy data, and integrated mitigation approaches to noise.
- 2025: Improve supervised learning generalization capabilities on limited amounts of training data and on imbalanced data sets.
- 2026: Freely available Probabilistic Indexing tools for large stakeholders
- 2027: Visualisation/explanation and feedback methods that allow better Human-Machine Learning tool interaction. Prescribe non-discrimination requirements for building ethical, bias-free ML model.
- 2028: Freely available tools for Handwritten Text Recognition. Standards for processing pipeline for automatic derivation of historical land-use/land-cover information from maps.

Key performance indicators

- For data acquisition: number, diversity and types of objects digitised and quality of the digitisation.
- For Machine Learning and AI: speed and efficiency of technologies; avoidance of biases.
- For Natural Language Processing: error rate of methods and language and variants where they are effective.
- For interfaces and analysis: user studies.
- For Humanities and Social Sciences: engagement of academia and research with the Time Machine (use of data and citations in journals and books).

Funding sources

European Research grants will be needed particular developments.

The technological development in each area will depend in great part on the individual partners (universities, labs and private companies) own financing structure.

The long-term preservation will also depend on the local Time Machines, and the technologies developed should consider that fact.

Stakeholders to be involved

Current members of the TM ecosystem:

Ecole Polytechnique Federale De Lausanne (EPFL); Technische Universitaet Wien (TUW); International Centre For Archival Research (ICARUS); Koninklijke Nederlandse Akademie Van Wetenschappen - Knaw(Knaw); Naver France (NAVER); Universiteit Utrecht (UU); Friedrich-Alexander-Universitaet Erlangen Nuernberg (FAU); Ecole Nationale Des Chartes (ENC); Alma Mater Studiorum - Universita Di Bologna (UNIBO); Institut National De L'information Geographique Et Forestiere(Ign); Universiteit Van Amsterdam (UvA); Uniwersytet Warszawski (UW); Universite Du Luxembourg (UL); Bar Ilan University (BU); Universita Ca' Foscari Venezia (UNIVE); Universiteit Antwerpen (UA); Qidenus Group Gmbh (QG); Technische Universiteit Delft (TUD); Centre National De La Recherche Scientifique Cnrs (CNRS); Stichting Nederlands Instituut Voorbeeld En Geluid (NISV); Iz Karlsruhe - Leibniz-Institut Fur Informationsinfrastrukturgmbh (FIZ); Fraunhofer Gesellschaft Zur Foerderung Der Angewandtenforschung E.V. (FRG); Universiteit Gent (UGent); Technische Universitaet Dresden (TUDr); Technische Universitat Dortmund (TUDO); Osterreichische Nationalbibliothek (ONB); Iconem (ICO); Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (PSNC); Picturae Bv (PICT); Centre De Visio Per Computador (CVC); Stichting Europeana (EF); Indra Sistemas Sa (INDRA); Ubisoft Entertainment (UBI).

New Partners:

3Dkosmos; Angewandte Informationstechnik Forschungsgesellschaft mbH (AIT); Arcanum Ltd.; Austrian Centre for Digital Humanities (ACDH); ArchivInForm GmbH; Barcelona Supercomputing Center (BSC); Cambridge Digital Humanities; Center for Advanced Studies, Research and Development in Sardinia (CRS4); Center for Art and Media Karlsruhe (ZKM); Cologne Center for eHumanities; Complutense University of Madrid; Dutch knowledge centre for digital heritage and

culture (DEN); Digitalisierung Innsbruck; DiSSCo; Ecole des hautes études en sciences sociales (EHESS); Europeana; Gesellschaft für Medien in der Wissenschaft (GMW); Institut de Recherche et d'Histoire des Textes; Institut fur Angewandte Informatik; Istituto Italiano di Tecnologia; Intelligent Systems Lab; Kaunas University of Technology; Klokan Technologies GmbH; Knowledge Integration Ltd; Laboratorio de Innovacion en Humanidades Digitales (LINHD); Laboratory on Digital Libraries and Electronic Publishing, Department of Archives; Lexicographic Institute Miroslav Krleža; Picturae Technische Informationsbibliothek Hannover (TIB); Swiss Federal Institute of Technology (ETH Zürich); TU Darmstadt; TU Dortmund; Universitat Autònoma de Barcelona; University of Applied Sciences Western Switzerland (HES-SO); University of Applied Sciences in Dresden; University of Bamberg; University of Belgrade; University of Helsinki; University of Applied Sciences in Mainz (AI Mainz); University of Hradec Králové; University of Luxembourg; University of South Bohemia; Women in AI.

To be contacted:

Trivago; booking.com; Leica (DE); Zeiss (DE); Audi (DE); Continental; Drone Manufacturers Alliance Europe; ARRI (DE); KUKA (DE); DFKI - German Center for Artificial Intelligence; IBM; Oracle; SAP; DeepMind; Epic Games; Microsoft; Unity Media; Blender Foundation; ERC-Founded Humanities Researchers; ALLEA; HERA; AHA: American Historical Association; The World History Association.

Framework conditions

There are some European projects on Cultural Heritage and Data Infrastructure for GLAM and the Humanities and the Time Machine needs to be inserted in this context in order to be part of a bigger and coherent European infrastructure. Collaboration with these institutions (for example, Europeana) are already taking place.

Big developments in key areas of technology will be achieved in the next couple of years independent of the TM developments, especially in the fields of AI. The TM needs to capitalize those findings for its own goals directed at the big data of the past.

Risks & barriers and ways to address them

The development of some technologies in the private sector might reach breakthroughs that make the current developments in the TM slightly outdated. However, the wide network and strong links with experts and institutions throughout Europe guarantees that the TM will be up-to-date with the main technological developments at any time and will be able to adapt.

The funding from some institutions might be interrupted for reasons outside of the TM's control. The modular system of development and the planned Time Machine Organisation guarantee that the project is not dependent on one particular funding source.

4.2 Pillar 2 (WP3)

The objective of this pillar is to build the TM infrastructure for digitisation, processing and simulation, in order to develop a sustainable management and operational model, as well as to create the basis for and engagement with the TM communities participating in the development and use of TM. The network of TM initiatives will be created across the EU as "franchises", grouping scholars, CH organisations and government bodies around specific integrated projects. The TM franchise model will be shaped based on the experience of local TM projects already developed in different European cities by the TM partners.

Between April and May 2019, the team has started preparing a formal document on the Time Machine Network and Operation. The on-going state of the document is being followed in the Time Machine Network Preparatory Document. The Document introduces the main concepts of the Time Machine Operations (Value Charters, Technical Charters, Time Machine Standard Contracts, Time Machine Network, Time Machine Graph, Local Time Machine, etc.). The document states the role of the Time Machine Organisation. Current work in this area concentrates on the following topics:

- Stabilise the content of the Time Machine Network document and organise the milestones for its development.
- Finish the volume 1 of the Value Charter (End of May 2019)

- Finish the volume 1 of the Technical Charter. This includes agreeing on set of the technology (End of May 2019)
- Write the legal annexes (End of June 2019)
- Assessment of technology
- Assessment of legal contracts
- Putting in place a technical infrastructure committee.

An overview of progress made in each area is presented next.

Infrastructure (Task 3.1)

The aim of Task 3.1. was to prepare the methodology for the roadmap of the Time Machine infrastructure. This includes the Digitisation hubs that facilitate and standardise digitisation process at European Scale, the development of distributed super computing infrastructure for processing Big Data of the Past and the distributed storage system.

To ensure the open development and evaluation of the infrastructure, a process inspired by the Request for Comments (RFC) publication mechanism for negotiating the standards and protocols used by the development of Internet protocol is currently under development (https://en.wikipedia.org/wiki/Request_for_Comments). Time Machine Request for Comments will be under a freely accessible publication, identified with a unique ID. Like for the development of the Internet, the Request for Comments aims to be the main process for establishing rules, recommendations, core architectural choices for the Time Machine Infrastructure. An early version of the submission and publication process is under discussion.

The core concepts developed in the Time Machine CSA proposal will be collectively extended and interconnected using this approach. The preparation of the Request for Comments for document concerning the following part of the architecture are under discussion and will be detailed in the WP3 Roadmap (Box 4-1).

Box 4-1: TM Requests for Comments (RFC)
- For Digital Hubs:
    - TM RFC on Definition of typologies
    - TM RFC on standardisation and homologation
    - TM RFC on Open Hardware
    - TM RFC on Synergy and interaction in EU Research Infrastructure
    - TM RFC on on-demand digitisation
    - TM RFC on Global optimisation of digitisation process
- For Processing and Simulation
    - TM RFC on General Standards for the Super Computing Architecture
    - TM RFC on Digital Content Processor (DCP)
    - TM RFC on TM Data Graph
    - TM RFC on Large-Scale Inference Engine
    - TM RFC on 4D Simulator
    - TM RFC on Universal Representation Engine

The work concerning the distributed storage system is still on-going and is expected to be finalised on time and integrated in the WP3 roadmap.

Community Management (Task 3.2)

The aim of the Task 3.2 during the first reporting period was to lay the groundwork for the preparation of the Community Management for the Pillar Roadmap Draft. Starting with the first project meeting in Brussels, the task team including several volunteers from the Time Machine Consortium had as a first work assignment to create a comprehensive profiling scheme for the various types of communities the TM will be interacting with. The team has agreed on the following types:

- Civilian / Government Communities
- Developer Communities
- Non-Expert/Volunteer Communities

- Professional Communities
- Scholar Communities / Learned Societies
- Teacher/Pupil Communities
- Urban Communities

During the following weeks, the team was tasked with completing the profiles for according to the scheme in Box 4-2.

Box 4-2: Scheme for profiling the TM Communities

1. State of the Art now from the communities' point of view
   i.   What types of members does the community have?
   ii.   Who are the main players?
   iii. What interests have they now?
   iv.   How do they work together?
   v.   Are they aware of big data of the past/cultural heritage and so on?
   vi.   How are they organized locally?
   vii. How are they organized internationally / with neighbouring fields?
   viii. Do they use common tools for their work?
2. Potentials / Benefits
   i.   For the communities
         a. What motivation / interest has the community to be in the TM?
         b. What benefits can the TM offer them?
         c. How can they use the TM in their work?
   ii.   For the Time Machine
         a. What can they contribute to the TM?
3. Difficulties / Obstacles / Risks
4. Quantitative indicators
5. Management strategy
   i.   How can we gain new communities in this area?
   ii.   How can we keep them in the TM, how can we develop their relationship to the TM?
   iii. How can we organize the communication with them?
   iv.   How should collaboration processes be organized? Do we need access to specific tools or media? Do we need special things to provide them with if we want to organize their collaboration with each other in the time machine?
   v.   Activities to be organized by the TM
   vi.   Time schedule

The team has completed the profiling process during the first reporting period except for the quantitative indicators and the list of main players (external stakeholders). These match the points 2.5 and 4 of the planned road map items.

Currently the team works on completing these two points. Additionally, work has been started to convert these profiles into a first draft of the road map according to the items of the road map. This process will be finished until the end of May 2019.

Local Time Machines (Task 3.3)

The Local Time Machines are meant to be at the centre of the TM network, rallying different partners behind the TM objectives and helping the growth of the TM Graph. Shaped as independent project networks, they are still active within a common global TM network, and as such benefit from the TM infrastructure and contribute to its development. Finding the proper balance between TM network governance and the LTM activities is an important factor in the TM development.

Before defining what could be an operational model for a Local TM and its interaction within the TM network, a considerable effort of context clarification and definition has been made. This resulted in a scheme used by the working group to identify connections happening between a Local TM and the

central platform of the TM Infrastructure, under the supervision of the Time Machine Organisation (TMO).

The scheme also contributed to clarify action and routines undertaken by the previously identified TM partners, grouped by services and actions typologies (data providers, operators in digitisation processes, researchers etc.). It had no intention of being exhaustive and static, as much of its outcomes could be improved by others pillars, but contributed to guide earliest reflexion towards Local TM definition and objectives. The scheme also helped to introduce and specify the central position undertaken by the so-called Project with Time Machine Label (PWTML)

As one of the pillar objective is to provide as soon as possible a starter-kit for minimum Local TM functionality, draft versions of supporting documents, clarifying minimal technical, legal and values requirements have been created. Eventually, a formalisation of different concepts has been introduced, as shown in Table 4-1below. These definitions are now integrated in the current draft of the WP3 roadmap.

Table 4-1: Formal definitions of concepts associated with the TM operation

Values Charter	Conform to the principle of openness in EU law
Technical Charter	Should contain information about infrastructure standards required within any project with Time Machine label. The Technical Charter defines the Time Machines Rules, Recommendations, Metrics and Official software. The document is revised periodically.
Time Machine Standard Contracts	Set of standard contracts to facilitate the interaction between Time Machine partners.
Time Machine Organisation	Association regrouping the Time Machine Partners. Some maybe active and other not. Not all may have signed the Values and Technical Charters.
Time Machine Network	Set of all the partners actually interacting in the Time Machine. Each member of the Time Machine Network must have signed the Value and Technical Charter
Time Machine Operation Graph	Formal representation of the past, on-going and future operations of the partners in the Time Machine Network and the data pipelines.
Time Machine Data Graph	Formal representation of knowledge extracted by human or automatic process, represented with semantic web technology
Local Time Machine	Zone of higher "*rebuilding the past activities*" density. Constituted of a group of local members and communities bound by a common territorial focus and a declaration of intent, which respect both graphical and values charters. Any institution who meets eligible criteria can integrate a Local Time Machine. The declaration of intent is reviewed on an annually basis (time for new members to integrate the TM
Project with Time Machine label	Project respecting the technical charter, whose tasks are documented - modelled within the Time Machine graph. All the members of a PWTML must have signed the declaration of intent of the related Local Time Machine.
Communities	Group of users, self-organised by territorial or transversal interests, offering various voluntary works and favours (annotation, digitisation, bibliographic research, development), according to the standards in place, to the members. Those communities can elect a representative.
Time Machine Index	The TM index is a global system indexing different type of objects: e.g. documents; iconography; 3D nodes; cloud points. It gathers all information regarding documents and their contents. Could be used as a basis for other search engine infrastructures (allows backups).
Time Machine Box	Servers that allow members to store their documents and metadata and integrate easily the Time Machine Network and be appropriately

	documented in the Time Machine Graph. The Time Machine Box is part of the Time Machine Official Components.
TM Rules	Standard and rules that need to be followed to be acceptable in the Time Machine Network and become a Time Machine operators. Any entity not following these rules are out.
TM Recommendations	Recommendation on technology which are not obligatory at this stage for the development of the Time Machine (e.g. choice of a particular IIIF image server).
TM Standard Metrics	Measures helping partners of the Time Machine Network coordinate with one another to compare performance (for quotes of services, but not only, there are also use for research performances, etc.).
TM Official Components	Pieces of software (e.g. Time Machine Box) that help partners conforming to the Time Machine rules as they are directly embedded in the software.

4.3 Pillar 3 (WP4)

The objective of Pillar 3 is to develop a roadmap documenting the exploitation avenues of Time Machine. The roadmap seeks to demonstrate how the scientific and technological advances in Pillar 1 and the operational models in Pillar 2 could be used to produce immediately valuable outputs of societal and economic relevance.

The main focus is in three thematic areas:

- Scholarship & Education – in these two areas the aim is to demonstrate, with concrete developments, the disruptive effects of TM on scholarly methods and learning (task 4.1 and 4.2);
- The third thematic area groups economic sectors, for which TM is expected to introduce new approaches and transformative business and cultural models, delivering social and economic impact. These groups are: GLAM, Creative industries, Tourism, Smart cities, urban planning, land use and territorial policies (task 4.3).

Each of these areas is explored through its own collaboration platform, bringing together specialists from the fields involved in each case. The roadmap is being developed, based on a factsheet document prepared during the Amsterdam meeting (9 and 10 May 2019) that analyses:

- technological monitoring or state of the art
- roadmap topics for discussion, with potential connections with WP2 domain lists
- stakeholders' and end users' profiling
- suggestions for expert interviews or questionnaires

Initial versions of the roadmaps are being revised by the WP-leaders until the end of May, to be followed by the development of the draft pillar roadmap. An overview of progress made in each area is presented next.

Scholarship

The Time Machine platform provides facilities for innovative, multi-scale SSH research (e.g. search engines for sources, tools for digital art historians, historical geographical information systems) that supports advances foreseen in Pillar 1 – Theory.

Under this task, the WP has identified specific academic fields and communities that can directly benefit from these facilities and will develop action plans for the elaboration of specific methodologies and tools.

Education

TM will develop tools and mechanisms to allow highly immersive exploratory and connectivistic learning by multi-sensory experiences with revolutionary technologies. Under this task, the WP has examined different development options that incorporate these features in the education process.

Particular points of examination include:

- Conception, development and assessment of technologies to automate and validate the learning process by learner behaviour, feedback and mobile sensor data.
- Conception, development and assessment of tools for automated generation of learning content as needed for different learning situations.
- Conception, development and assessment of tools and mechanisms to author, distribute and share heritage-related trusted educational resources.
- Implement principles and workflows to enable a deliberate, pluralistic access to History education.
- Technological frameworks and best practices for multiple learning scenarios and multiple life-long learning audiences.

Platforms for other specific areas and uses.

Under this task, the WP has developed action plans for the following sectors:

- Galleries, libraries, archives and museums (GLAM)
- Creative, media and entertainment industries
- Smart tourism
- Smart Cities and urban planning
- Policy making, especially in land use and territorial policies

5 Forward planning

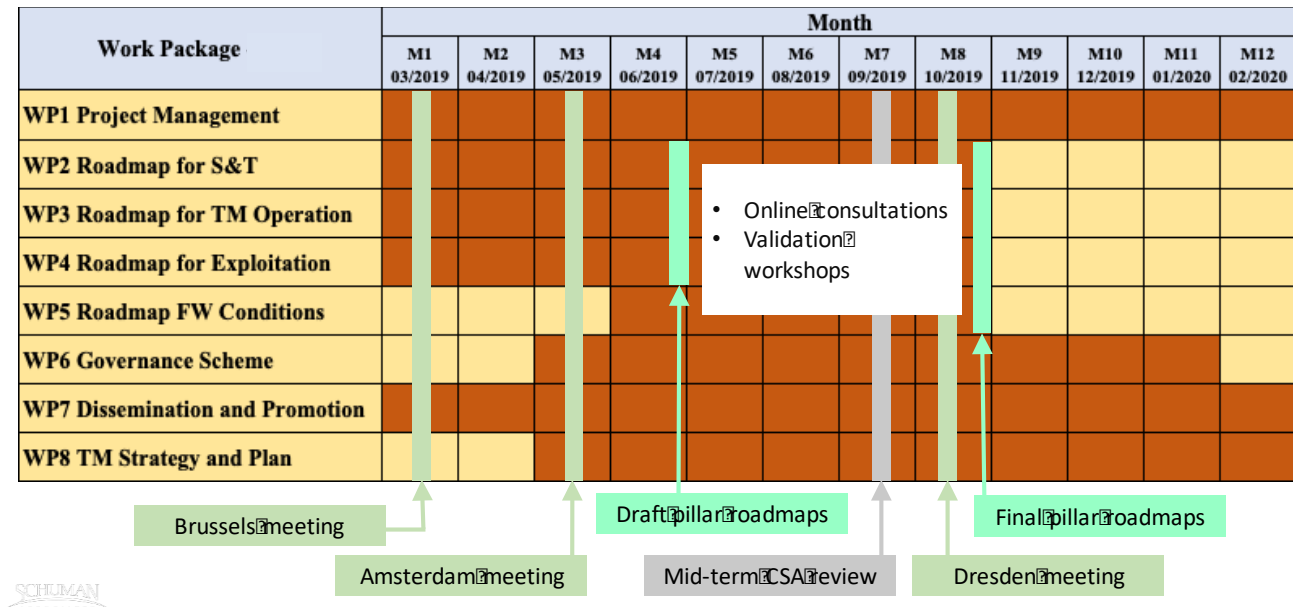The time plan for the TM CSA is shown in Figure 5-1.

Figure 5-1: TM CSA Time plan – reporting period: Months 1-3.

The reporting period was characterised by two main events, relating to the preparation of the roadmaps:

- During the project kick-off (Brussels meeting 19-20 March 2019), the working groups of Pillars 1, 2 and 3 were formed and their work plan was agreed.
- The Amsterdam meeting (9-10 May 2019) was the occasion for the Pillar 1, 2 and 3 working groups to validate intermediate results and plan remaining actions for the development of the draft roadmaps. The working group for Pillar 4 was also formed and its scope of work has been defined.

The wok in the next months will be organised around the following:

- The draft roadmaps for pillars 1-3 will be submitted by the end on Month 4 (June 2019).
- Online consultations and validation workshops will be organised in the period from end June to end September 2019.
- Feedback will be received by the European Commission in September 2019 during the CSA mid-term assessment.
- The working groups will use conclusions of the on-line consultation, validation workshops and mid-term assessment to prepare the final pillar roadmaps.
- The Dresden meeting, planned for 9 to 11 October 2019, will be used to validate progress in the final pillar roadmaps.
- The final pillar roadmaps will be submitted by the end of Month 8 (October 2019).

Annex A: The TM Structure
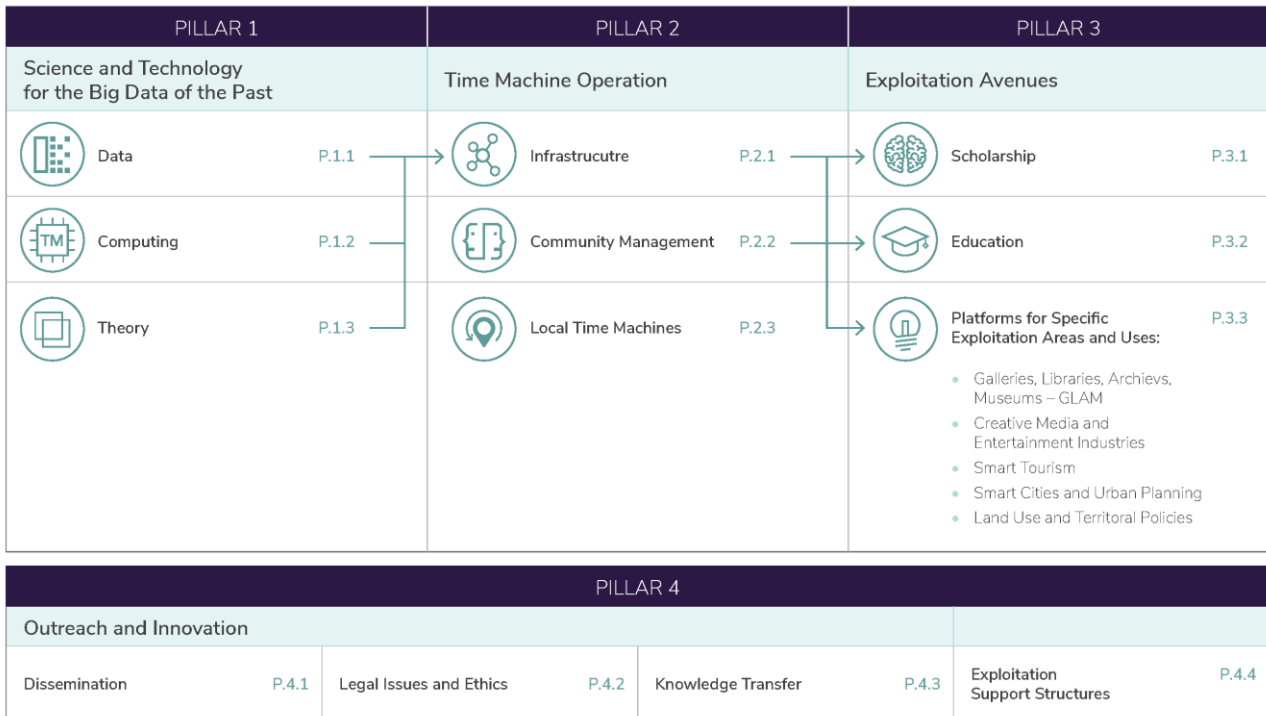
The structure of the Time Machine LSRI is shown in Figure A-1.

Figure A-1: The TM Pillars and Thematic Areas