REthinking Future Infrastructure NETworks

REFINET

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31.10.2016	V1	CSTB	Alain ZARLI	Draft structure + identification of results/outcomes for draft development of exploitation by partners.
10.01.2017	V1	ALL partners in charge of outcomes exploitation (FEHRL, DRA, TEC, DAPP, ARUP, CSTB/ECTP)	*ALL*	Provide preliminary hints/views on how exploit each individual outcomes.
18.01.2017	V1.1	CSTB	Alain ZARLI	Integration + extended draft (with AZ comments) to be discussed @ REFINET GM#6.
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21.04.2017	V1.2	ALL partners in charge of outcomes exploitation (FEHRL, DRA, TEC, DAPP, ARUP, CSTB/ECTP)	*ALL*	Provide with (pre-)final inputs for exploitation of the REFINET outcomes. CSTB to aggregate all inputs by 31.03.2017 for completed draft.
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Abbreviations

Acronym	Full name
CSA	Coordination and Support Action
CEF	Connecting Europe Facility
EU	European Union
ERTRAC	European Road Transport Research Advisory Council
ERRAC	European Rail Research Advisory Council
ACARE	Advisory Council for Aviation Research
ECTP	European Construction Technology Platform
ALICE	Alliance for logistics Innovation through collaboration in Europe
HLSI	High Level Service Infrastructure
RMMTI	Refinet Multimodal Model for Transport Infrastructure
STA	Smart Transportation Alliance
S2R	Shift to Rail
LDT	Long distance transport
GHG	Greenhouse gas
CEDR	Conference of European Directors of Roads
FEHRL	Forum of European National Highway Research Laboratories
ITS	Intelligent Transport System
BIM	Building Information Modeling
BOT	Build-Operate-Transfer
PPP	Public Private Partnership
LOS	Level of service
KPI	Key Performance Indicator
TI TechMapper	Transport Infrastructure Technology Mapping Platform

Definitions

Term	Full name
Multimodal transport	Multimodal transport: The carriage of freight or passengers or both, using two or more modes of transports.

1. INTRODUCTION

The overarching aim of the REFINET project is to create a sustainable network that integrates relevant stakeholder's representatives of all transport modes and infrastructure sectors in order to nurture a unique and shared European vision of how should be specified, designed, built or renovated, and maintained the multimodal European transport infrastructure network of the future: this vision aims at integrating and prioritizing short-, medium- & long-term research and innovation targets, with a focus on the entrepreneurial consideration of infrastructures that targets the architectural, engineering and contracting eco-system, including socio-economic aspects of the development and the management of infrastructures. The European transport infrastructure network is considered as the lifeblood of European trade and society, and is commonly regarded as a shared heritage of great economic value. But it is also recognised today that this network is composed of many existing infrastructures that no longer fulfill the current functional requirements and today's safety and quality standards, and requires refurbishment and increased capacities, potentially relying on innovative technologies, components and systems. The REFINET European Coordination action (*http://www.refinet.eu/*), funded by the European Commission (GA 653789) under its H2020 framework programme and under the auspices of the ECTP (*European Construction Technology Platform* – www.ectp.org), is an instrument having initiated the organization of the future development and delivery of innovative design, construction, maintenance and upgrading concepts and solutions that promote and strengthen seamless transport links for passenger and freight - relying on a sustainable research network that integrates relevant stakeholders' representatives of all transport modes (road, railway, maritime, fluvial…) and transport infrastructure sectors. The primary and key objective has been to initiate a shared European vision of how the multimodal European transport infrastructure network of the future should be specified, designed, built, renovated, and maintained, and elaborate a SIP (Strategic Implementation Plan) defining the innovation activities required to make this shared vision a reality, along with an approach towards deployment of this so-called SIP.

This deliverable D5.5 defines an exploitation plan that identifies possible actions to exploit the REFINET outcomes. The main outcomes and deliverables of REFINET are:

1. A growing and **sustainable network of 838 stakeholders** in Europe and beyond (especially from the US), from all transport modes and the infrastructure industry;

2. A **multi-modal transport infrastructure model** - offering a generic simple vision that can be shared by all transport stakeholders and research related organisations, since being a high-level non transport-mode specific model that should be a living reference for the establishment of objectives and sustained criteria for defining the design and operation specification of infrastructure projects in Europe;

3. A **Collection of Best Practices** relying on a taxonomy of such use-cases and reference practices in design, construction and maintenance of transport infrastructures that have already been deployed in practice;

4. A **Catalogue of technologies** for transport infrastructure, relying on a taxonomy framework that provides a mean to capture, classify and monitor currently available and emerging technologies;

5. A **Vision** for the European transport infrastructure network - so as to create a common understanding among the REFINET network members about the blueprint and characteristics of the multimodal European transport infrastructure network of the future - and the consequent R&I demands to evolve the current European transport networks according to this vision;

6. A **Strategic Implementation Plan** (SIP) with prioritised R&I (Research & Innovation) actions, recommendations and guidelines - containing specific actions and initiatives at different levels which must be taken to design, maintain and operate European transport infrastructures according to the REFINET multi-modal transport infrastructure model, and cooperation between all stakeholders (transport modes & infrastructures);

7. A **framework for monitoring R&I projects** – all projects being developed in Europe (H2020 MOBILITY FOR GROWTH – Infrastructure calls, INFRAVATION, national R&I…) being analysed in order to assess their alignment with the REFINET Vision, identify their main results and support them in the dissemination and exploitation of these results;

8. A **TI-TechMapper** (formerly Geo-clustering platform) **for technological demands**, as a backbone of geographical nodes grouping both interested stakeholders and appropriate solutions targeting local or regional characteristics and needs from several points of view (technological, geographical, socio-economical, regulatory, political);

9. A **set of Recommendations for mobilizing R&I programs and ESIF** (European Structural and Investment Fund2014-2020 (ESIF)[1]): REFINET has analysed the different European, national and regional initiatives that could support the deployment of the SIP.

2. APPROACH

The overall exploitation of the REFINET results as introduced above can be foreseen by four main entities: first and foremost, the REFINET Core partners (through the direct exploitation of the REFINET results , but also indirectly through new research projects and consultancy services) as well as the ECTP as a whole (and more precisely the Infrastructure and Mobility - I&M - Committee), considering that the project's origin is within the reFINE initiative of the I&M Committee to get support to the work that was being carried out, then the REFINET network members themselves – both Consortium and REFINET network members may influence the national funding institutes and potential new technology programmes - and all the relevant stakeholders (with launch of new strategic projects, inter-enterprise collaboration, etc.). The knowledge generated in the project is indeed to support also the development of future research projects in Horizon 2020 in a more structured way (between the various key stakeholder from the construction and contractor side, and the Transport side), as well as in other European research programmes and in National research programmes, helping in the establishment of a more global RTD coherency in which all partners can benefit from the identification and implementation of the key RTD priorities for implementation of the REFINET vision at the crossing of transport and infrastructures expectations. Starting from the outputs of the REFINET project, as regards already reached results and identified needs to reach wider impacts at European and National levels, advantages and disadvantages of the various existing approaches are to be explored and the best strategy identified.

The REFINET partners' intention is to achieve the necessary steps in order to be able to propose to deciding bodies (European Commission, Member States, platforms, Industry initiatives or networks…) one or several initiatives which would take the form e.g. of a Public Private Partnership (preparing impact assessment and strategic roadmap documents), a European Innovation Partnership or any other Joint Undertaking or Horizon 2020 tool. The exploitation activity has been launched as soon as possible in the 2nd half of the project, first to start establishing the way each and every REFINET result could be better exploited (i.e. according to which

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[1] Enabling synergies between European Structural and Investment Funds, Horizon 2020 and other research, innovation and competitiveness-related Union programmes. http://ec.europa.eu/digital-agenda/en/news/enabling-synergies-between-european-structural-and-investment-funds-horizon-2020-and-other.

strategy and development), and secondly so that relevant contacts with the EC (DG MOVE, DG RTD, the executive agencies, CEF,…), EU Member States, and the Transport platforms [ERRAC, ERTRAC, Waterborne, ACARE, ALICE], initiatives like the ERA-NET+ Infravation [*http://www.infravation.net/*] or the JTI Shift2Rail [*http://shift2rail.org/*], the stakeholders representatives (e.g. CEDR, STA,…) etc., are made at the right level to promote the REFINET outcomes and launch the appropriate actions in agreement with the relevant deciding bodies. This is why the REFINET Consortium, and its partners (beyond the completion of the project) will regularly communicate about the project outcomes, exploitation and transfer to:

o the European Commission;
o the European Parliament;
o the ECTP, and especially *its Infrastructure & Mobility* Committee - indeed represented in the REFINET project by CSTB;
o Member States and (the representatives of) the Network of National Liaison Points - NTPS are linked to about 25 European countries and National Technology Platforms, especially addressable through PTEC) – as well as through the activities carried out at local (e.g. national) level;
- the representatives of the numerous European Associations and Federations dealing with the infrastructures sector, such as ECCREDI, FEHRL, IRF, FHWA, Shift2Rail, ERTRAC, ERRAC, Waterborne, ALICE, ACARE, ENCORD, CEDR, the UIC members, European Union Road Federation, FIEC and including the Infrastructure Managers and operators at national level; Considering that one of the priority area is urban mobility, representatives from cities live Eurocities or the Covenant of Mayors may be included; eventually, other initiatives or networks active in dissemination, exploitation or marketing activities, such as the European Mobility and Transport Portal[2] or the Enterprise Europe Network (EEN) at European level, or European technology platforms in the related R&D fields, the construction NTPs in the Rail Research Portal (http://www.railway-research.org/), etc..

The table below synthesizes the set of REFINET outcomes, and for each of these outcomes, the targeted stakeholders. The description of the outcomes and corresponding actions towards stakeholders is provided in section 3.

REFINET outcomes	Stakeholders
(REFINET) Sustainable stakeholders Network	This REFINET network is exploitable by the network itself as it is providing a forum (ECTP), the I&M Committee have an interest in maintaining the network) where discussion and consultation will take place openly, usually upon request for instance from the I&M committee searching for consolidating positions on given issues. The network is open and not just for ECTP members only.
Multi-Modal Transport Infrastructure model (REFINET MMTI)	The MMTI model is open for future continuous and incremental improvement to: • REFINET network; • Transport infrastructure owners and operators; • Policy makers.
Collection of Best Practices	The catalogue is a public document to be exploited by practitioners. It is an initial work that was developed within REFINET. Further exploitation will be carried out by the I&M Committee of the ECTP. It sets up the starting point for innovation and technology transfer.
Catalogue of technologies	As in the item before but in the case of emerging technologies.
(REFINET) Vision	Transport infrastructure owners and operators (typically Railway infrastructure managers as UIC members).

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[2] http://ec.europa.eu/transport/index_en.htm

	Infrastructure and mobility policy makers and innovation programmes managers, in particular the EC and Member States. ECTP and others if the vision is shared.
Strategic Implementation Plan (REFINET SIP)	Transport infrastructure owners and operators (typically Railway infrastructure managers as UIC members). Infrastructure and mobility policy makers and innovation programmes managers, in particular the EC and Member States. Infrastructure managers and operators. Industry and SMEs of the whole infrastructure value chain. Research centres, Universities, researchers and innovators from the public and private domain. ECTP: this is basic information useful to identify common ground with other R&I priorities-mapping organisations. It should help to achieve a common vision on R&D topics relevant for the coming years.
Framework for monitoring R&I projects	The European Commission, through Directorate-General for Mobility and Transport (DG-MOVE), and The Innovation and Networks Executive Agency (INEA) in charge of managing the Mobility for Growth Programme. Any other Agency (e.g. National one) in charge of Transport Infrastructure related programmes/projects (e.g. ERANET, Infravation, etc.) needing to structure information to generate analysis/statistics/mapping
TI-TechMapper - Transport Infrastructure (TI) Technology Analysis and Mapping Platform	The prime users of the platform are on the one side, the Policy Makers - Public Bodies and Agencies (at Regional, National, EU level) and on the other side Asset (Infrastructure) owners and operators including companies contracted to design, built, operate and maintain the network. They will use the platform in two main ways: • For users belonging to Public Entities, Agencies, Authorities as well as for any stakeholders in the sector (including Associations and Technology Platform in the Transport & Infrastructure domain): they may be interested in using the tool for making advanced analysis of technologies and correlations among technologies, at different level of development (according to the TRL) or use. Only public information will be used and released. • For private sector companies and/or customers of public sector (Infrastructure Managers and Operators, design, construction, maintenance companies, technology suppliers and providers, etc.) they may want to use the tool as ad advanced analysis tool to support their planning and decisions making in terms of investments, adoption of one technology, etc. In this sense the tool can be seen as a sort of market place where demand and offer is combined.
Recommendations for mobilizing R&I programs and ESIF (*European structural and investment*)	Transport infrastructure owners and operators (typically Railway infrastructure managers as UIC members). As above – this information is accessible through the TechMapper Platform and in the public version of Deliverable 4.1.

Table 1: REFINET outcomes and identified stakeholders.

3. EXPLOITABLE RESULTS

The aforementioned solutions, the identified financial mechanisms, etc. will be key elements of the deployment of the REFINET SIP, characterized by **two time-scales**:

- **A short-term approach to support TI** (Transport Infrastructures) stakeholders in the transport sector, in particular TI **Managers and Operators** , in identifying solutions to their current needs by enabling the transfer of existing and incoming innovative technologies, such as materials, components, IT systems and processes, etc. to support Transport Infrastructure (TI) update, modernization, etc.
- **A medium to long-term approach to relay information to Policy Makers** (including Transport Authorities) in identifying future research topics in TI based on an analysis of the current existing technology offer and the future demands.

3.1 The REFINET stakeholders network

One of the main tasks of REFINET project was to create a sustainable network of European and international stakeholder representatives of all transport modes and transport infrastructure sectors. It was achieved succesfully setting up the mechanism to renforce networking among stakeholders in all modes in order to enhance the effectiveness of the transport sector. First of all, the REFINET stakeholder community was created and later was called REFINET Network. REFINET network is about gathering together various stakeholders from quite different profiles and expertise involved in increasing complex infrastructures and services – sustaining the improvement and effectiveness of the sector.

The current REFINET community is very strong. Around 838 stakeholders are already part of the REFINET community or network (see Figure 1). The statistics also shows that the current distribution of stakeholders is well balanced in term of geographical distribution, types of stakeholders, modal and cross-modal distribution and international dimension. This good achievement comes from the successful cooperation between the three CSAs projects REFINET, FOX and USE-iT, which have joined forces in order to establish a representative REFINET Network of multi-modal transport infrastructure stakeholders. Such cooperation between the three CSAs gives in disseminating project results to a wide community of stakeholders.

The REFINET network helped to deliver a shared European vision of how to specify, design, build or renovate, and maintain the multimodal European transport infrastructure network of the future along with innovative processes so as to enhance the effectiveness of the transport sector.
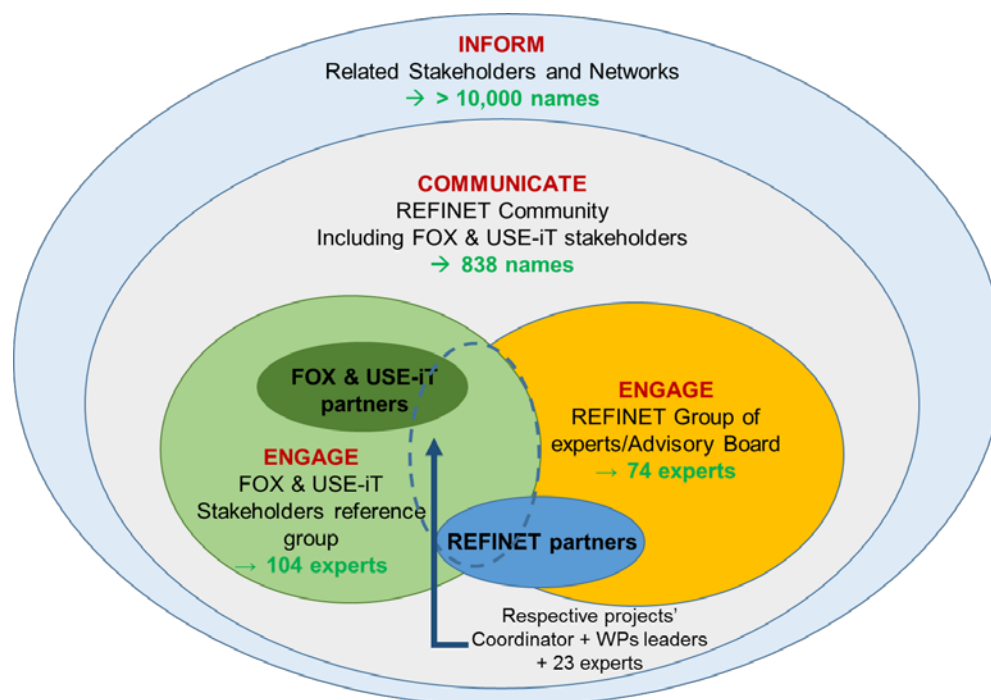
Figure 1: REFINET Network

Embedded within the REFINET Network, two smaller groups of experts have been established: one for REFINET; one for FOX and USE-iT projects. These two groups represents experts who have a greater interested and influence in the cross-modal issues.

The REFINET Network has been established with a medium to long-term perspective. As a matter of fact, the ECTP will continue to keep alive the data-basis and the community beyond the end of the projects. It is also expected that further activities managed by the ECTP (under the Infrastructure &Mobility Committee) as well as other platforms such as FEHRL and PTEC will carry on updating the vision and SIP throughout their respective think-tank activities. To that purpose, it is expected that the members of the experts group will keep being highly active beyond the end of the projects.

It is also worth mentioning that a few members of the REFINET community as well as partners (FEHRL and ARUP) have been involved in the Strategic Transport Research and Innovation Agenda (STRIA) and it is expected that a few will be involved in the update of this initiative at a later stage.

The REFINET network will continue to enable stakeholders to network with each other's, and to contribute developing the shared vision on the future of the European transport infrastructure.
More precisely, the most active part of the REFINET Network, namely the REFINET Group of Experts and the FOX & USE-iT Stakeholders reference group would form the basis for the establishment of the FEHRL FORx4 Group. This group will be in charged to develop the FORx4 programme which should integrate the output from the 3 CSAs (REFINET, FOX and USE-iT), and enhance the work achieved within the 3 projects.
Besides, the work undertaken within REFINET, FOX and USE-iT with the support of the REFINET Network is currently leading to some high-level discussions with the EC about the possible establishment of "Platform for Transport Infrastructure" which could eventually lead to a PPP initiative (like the Green Vehicle initiative for instance").

REFINET network will be linked and managed at level of the ECTP Website. CSTB (on behalf of ECTP I&M will share information to all ECTP members who have raised interest in Infrastructure &Mobility WG.
PTEC will share also information to National Technology Platforms (NTPs) members who raised interest in I&M
ARUP has planned an event (internal &external) to disseminate the REFINET outcomes – UK stakeholders
UIC will carry on the discussion within ERRAC plenary meetings and send information to the UIC infrastructure managers group.

In addition, further discussion will be held between FEHRL and D'Appolonia in order to possibly integrate the TI-TechMapper Platform into the FEHRL Knowledge Centre. This Platform being mostly empty, the data from the stakeholders will be crucial to be acquired and the information provided will be valuable for them in return.

3.2 The REFINET Multi Modal Transport Infrastructure Model (RMMTI)

The REFINET Multi-Modal Transport Infrastructure model (RMMTI) offers a generic and simple vision that can be shared by all transport stakeholders and research related organisations. It is a high-level non transport-mode specific model that should be a living reference for the establishment of objectives and sustained criteria for defining the design and operation specification of infrastructure projects in Europe.

The model itself can be exploited in two main ways:

A) As an infrastructure performance index:

A potential and future main outcome will be the "*REFINET index*" that could be applied to different infrastructure types. This index would evaluate the performance of an infrastructure and network against the five performance criteria identified in the REFINET MMTI model. It could also contribute to benchmarking best practices among infrastructure managers and operators.

It could be used at EU, Member State or regional level. Individual infrastructure owners / managers should establish their individual targets but it could be a EU wide tool to evaluate and improve the European Transport Network with a common perspective and it would be a coherent way to identify the areas of investment and evaluate the impacts.

This model should be tailored to each case and further research is needed to identify and select appropriated KPIs, weights and measures. In this sense, new projects such as CityKeys, in smart cities, or PRIME, the platform of rail infrastructure managers in Europe, should be necessary to follow with the KPIs development below the defined REFINET MMTI framework in order to cover the needed research.

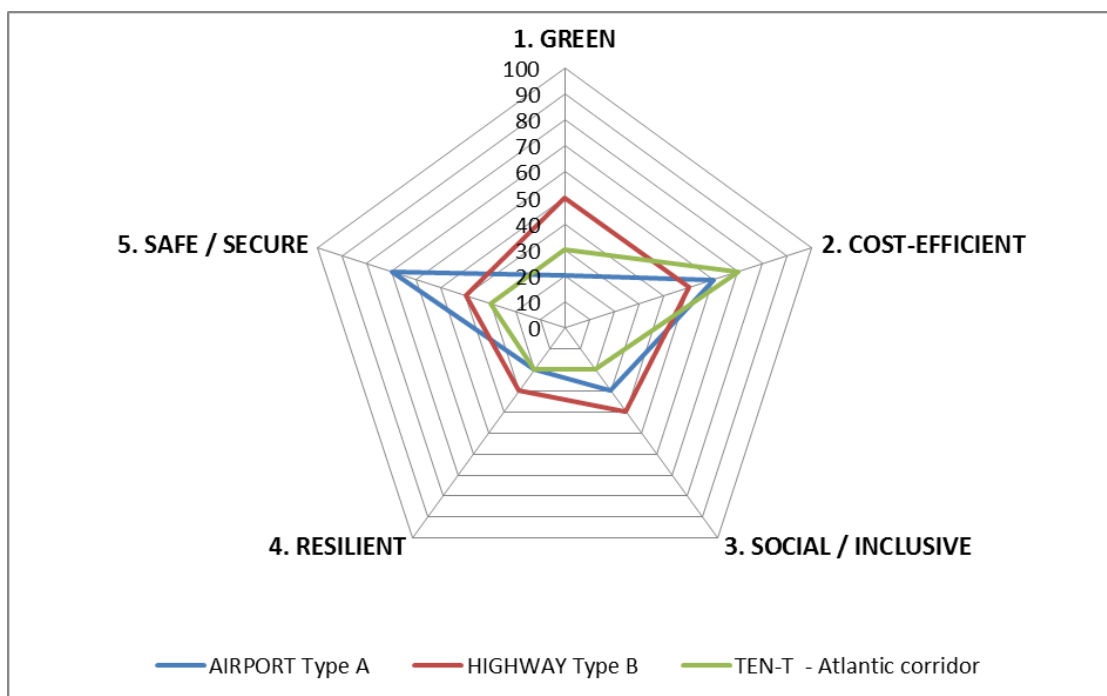The following figure is an example of a potential use of the REFINET MMTI:

Figure 2: Illustrative example of an evaluation based on the REFINET MMTI

Ideally, the exploitation of this outcome should be through consultancy services provided by the consortia members. The strategy to implement the model in a real case would be:
- Identification of the strategic vision and targets of the infrastructure owner / operator;
- Definition of the time line;
- Identification of KPIs to measure the performance;
- Establishing links and weights;
- Identification of the current scenario;
- Definition of actions, projects and initiatives to accomplish the vision;
- Monitoring the performance, evolution towards the ambition.

Furthermore, this outcome is public, therefore the community can make use and create a leverage effect on it both at EU level or at Member State level. In fact, the European Commission itself would be a strong promoter of the model if it is further developed and adopted by the European Commission to monitor de evolution and benchmark the transport infrastructure network as well as a monitoring tool for research and innovation projects.

B) The REFINET MMTI model as the guidance for the European multimodal transport infrastructure network:

In this case, the model serves as the guiding principle and strategy for defining a long-term research and innovation programme for the European transport infrastructure. The model serves as guidance and structure of the programme. Defining challenges, actions and impacts for the five elements of the model (Green, Cost Efficient, Social / Inclusive, Resilient and Safe / Secure). This approach is applied to the three applications: urban mobility, multimodal hubs and long distance corridors.

It is expected that ECTP and ENCORD will trigger the discussion and collaborations with relevant stakeholders for the evolution of the RMMTI model and in particular with the European Commission, considering that this model could be implemented by the European Commission to define and monitor the future research programmes in infrastructures. Potential future use of the REFINET MMTI if further developed is:

Stakeholder	*Potential use*
European Commission and Member States	- Monitoring and benchmarking of EU transport infrastructure network. It could evolve towards a Quality label. - Monitoring of research projects and evaluating their impact against strategic objectives.
Researchers	Starting point for future research activities related to KPIs, monitoring technics, data acquisition and treatment, analytics,…
Infrastructure managers and operators	Methodology and decision support system to establish strategic objectives.
ECTP and other European Technology platforms	Definition of research and innovation programmes oriented to a coherent and sustained vision.
Industrial Association and initiatives such as ENCORD	Promote the development of technologies and solutions that improve the implementation of the model and the strategic challenges.

3.3 The REFINET Collection of BEST PRACTICES

The objective of the REFINET collection of best practices was on the one hand to provide a taxonomic scheme for best practices in design, construction and maintenance of transport infrastructures that **have already been applied in practice**, and on the other hand, to select and compile a collection of best practices to learn from these real-world experiences. The source organizations for the best practices in REFINET covered several of the most important infrastructure designers, constructors and operators in the World as well as renowned academia and research centres.

As explained in D3.2, the collection was just the commencement of a task of best practice compilation to be continued by the *Infrastructure and Mobility* Committee of ECTP and the ENCORD Working Group on Infrastructures in the next years. The idea is to grow the catalogue in the coming years by areas of expertise, as the work to carry out is huge and to integrate it as explained below within the TI-TechMapper tool. Therefore, the main exploitation means for the collection of best practices are through these two organisations, as envisioned since the project inception. Notice however that the spirit of the project is that of the public use of its findings and thus the practices can be used by the network of REFINET stakeholders or any other interested parties. In this direction, care was taken that the best practices descriptions included information regarding the success factors and constraints for their application. This means public entities and providers of services or products can rely in these descriptions for applying the different techniques throughout Europe. This is another form of exploitation of the results of REFINET that the project is granting for free. In addition, it should be possible to integrate the best practices catalogue within the REFINET TI-TechMapper tool, resulting in a much more efficient search for results given a geographical area or any other type of constraints or advantages being searched for: this can be done either by collecting the practices "on paper" then being uploaded to the TI-

TechMapper tool, or with stakeholders having the opportunity to directly write the best practice into the TI-TechMapper tool, with a process of reviewing / curating by a team of I&M experts before going live online: these options will be assessed in the future development and exploitation of the TI-TechMapper tool, considering it is definitely one of the main ways to ensure the BPs are accessible to the public

It must be noticed that the collection of practices sets the status quo of current technology practice. Everything else falls in the Technology Readiness Levels below market application. This is also why the collection of best practices is interesting. The exploitable result in this case is that these techniques cannot be considered as candidates for R&D agendas (although advancements of these techniques could).

Finally, the catalogue of technologies is also indirectly exploited using other project tools such as the REFINET geo-clustering / exploitable resources brushing platform.

3.4 The REFINET catalogues of technologies

As part of the REFINET project a catalogue of transport infrastructures technologies was created. Currently, many of the technologies that are needed to allow the European transport infrastructures to move toward the REFINET multi-modal transport infrastructure (RMMTI) model are **already available in the market or will be available in the next few years, but the industry sector is not necessarily using them nor is aware of their availability and potential**. In order to overcome the gap between "common practices" in design, construction and maintenance of transport infrastructures and the "most sustainable practices" that could be deployed, examples of different technologies being developed and trialled by transport infrastructure clients, and the main engineering companies, contractors and maintenance services providers were collected and categorised.

Over one hundred technologies have been catalogued from a wide range of sources: the REFINET partners themselves, members of the different networks of organisations represented by the partners and by other organizations external to the project partners or their networks (such as National Technologies Platforms), proceedings of industry conferences etc. In practice, several of the most innovative transport infrastructure clients, infrastructure designers, constructors, operators, manufacturers and suppliers globally as well as notable academia and research centers in the fields of expertise have contributed to the development of this catalogue of technologies. This meant that very high quality content could be developed.

For each technology, the following information was collected and presented in the report following the same taxonomy used for the collection of best practices (see section 3.3). In particular the information collated includes : a short description of the technology, the main advantages in relation to competitor technologies, examples of application of this technology, indication of its maturity through the well known Technology Readiness Levels (TRLs) framework, as well as links to further reading.

However, it must be understood that the compilation of technologies cannot be comprehensive given the wide scope of transport infrastructure systems covered in the REFINET project and the wide array of technologies available on the market. However it provides a fantastic resource on technologies that are available but not yet widely used and that have a potential to increase performance and sustainability.

It is envisaged tha the ECTP I&M Committee will continue to update the catalogue and contribute content on a regular basis to keep it alive and turn it into a valuable reference for the future of construction. Moreover, by regularly updating the TRL for each technology, there is scope for continuosly monitor it maturity and market readiness.

The catalogue of technologies is further used in the REFINET project to provide valuable input into the TI-TechMapper Platform tool.

By making use of the REFINET framework for monitoring R&D projects (WP4 – Task 4.1 – see below), REFINET mapped around hundred innovations coming out of recently closed FP7/H2020 projects related to Transport Infrastructure having generated interesting incoming technologies that are still in demonstration and validation phases. The majority of the projects studied have a multimodal approach; their technologies can be used mainly for Design and Operation stages.

3.5   The REFINET Vision and SIP

The REFINET Multi-Modal Transport Infrastructure (RMMTI) model and framework, which is a key ambition of the H2020 REFINET Coordinated and Support Action, aims to create a shared European vision and strategic implementation plan about how the multimodal European transport infrastructure network of the future should be specified, designed, built or renovated, upgraded and maintained.

The vision of REFINET is the following:

> *By 2050, a new **European multimodal transport infrastructure network** will ensure efficient transport of goods and passengers through the **High Level Service Infrastructure** concept spread out by **urban mobility, multimodal hubs and long-distance corridors** with the performances of **GREEN, COST-EFFICIENT, SOCIAL/INCLUSIVE, RESILIENT and SAFE/SECURE**, based on advanced and development of technologies and by means of **systemic approach perspective**, considering **GOVERNANCE, COMMUNICATION, FINANCIAL/ECONOMIC, LEGAL/STANDARDS and RISKS/INTERDEPENDENCY aspects**.*

This vision should be promoted at all levels, public, private and the society, in order to increase the awareness for the relevance of the transport infrastructure and the needs for research and innovation.

One of the major outcomes, is the definition of the SIP (Strategic Implementation Plan) that contains for each of the priority areas (Long Distance Corridors; Multimodal Hubs; Urban Mobility) a set of research and innovations actions that answer to the five performance criteria identified in the model (GREEN, COST-EFFICIENT, SOCIAL/INCLUSIVE, RESILIENT and SAFE/SECURE) identifying over 80 specific research and innovation actions to address specific challenges and showing the expected impact.

THE SIP will be exploited in the following ways:
- Promoting investment in transport infrastructure research and innovation by public stakeholders at EU (H2020 and other instruments), Member State and Regional level. In particular, DG MOVE and DG Research & Innovation (Transport unit) can benefit from the SIP to define future research and innovation actions. REFINET aims to promote REFINET through the following means:
    - European Commission through the European Construction Technology Platform represented by CSTB and Dragados as chairman of the Infrastructure and Mobility Committee.
    - Member States and their national contact points through the network of National Technology Platforms (NTPs).
    - Regions and their smart specialization strategy through the NTPs, the TI-TechMapper tool and the partners of Refinet (For example, Tecnalia linked to the Basque Country).
- PTEC will organize next meetings and events where SIP will be exploited:

- o PTEC working Group on Transport Infrastructure meetings (June and October 2017, other)
- o NTPs meetings (June and October 2107, other)
- o PTEC conference (November 2017, other)
- Increasing the awareness for research and innovation by Member States and in transport infrastructure owners and operators. The can adopt and make use of the SIP to improve the quality of the infrastructure in its whole life cycle.
- Promoting the long term strategic vision for infrastructure owners and operators while increasing the acceptance for innovation.
    - o A key target is "reducing the costs" + other obligations (including regulations?) – but there may be some difference between private and public (authorities) ones.
    - o DAPP – with Italy and Romania --> see afternoon session of the Ws in Bucharest + interactions thru the network + potential WS beyond the end of the project.
    - o ARUP: dissemination WS (internal + external).
- Promoting investment through the value chain and industrial stakeholders.
    - o Thru ECTP I&M Committee;
    - o Thru ENCORD;
    - o Owners;
    - o Funding organisations.
- Establishing concrete actions for improving and upgrading European infrastructure to new and future standards based on the strategic orientations of the MMTI model.
    - o potential application of the model – according to strategic targets.
    - o Link with the ECTP, with concrete action towards the EC to invest more in priorities as identified in the SIP.

The deployment of the REFINET SIP and the is characterized by **two time-scales**:

- **A short-term approach to support TI Managers and Operators** in identifying solutions to their current needs by enabling the transfer of existing and incoming innovative technologies, such as materials, components, IT systems and processes, etc. to support Transport Infrastructure (TI) update, modernization, etc.
- **A medium to long-term approach to relay information to Policy Makers and Public Bodies** (including Transport Authorities) in identifying future research topics in TI based on an analysis of the current existing technology offer and the future demands.

3.6 The REFINET framework for monitoring Research & Innovation projects

The framework to monitor R&I projects and their outcomes has been created as part of REFINET to provide a template for collecting and analysing essential pieces of information regarding an existing or an incoming technology, helping potential users better understand the parameters of that technology. The framework has been developed based on the taxonomy as adopted by REFINET and depicted below
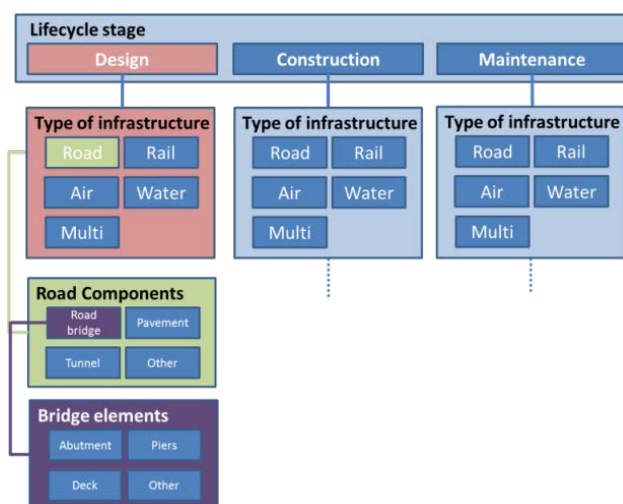
An essential element of the Framework resides in the presence of a "*Key Performance Indicator*" field, which is underpinned by the RMMTI model. These KPIs – when available – are a very powerful decision point at the time of TI investment (either in further research or in technology transfer or adaptation).

The framework was used to collect information from circa one hundred Best Practice and promising technologies (see REFINET D4.1). The framework was also tested in REFINET WP4 on recently closed projects across FP7/H2020, collating enough information to fill in the aforementioned template for each project. These tests helped verify the acceptability and usefulness of the framework.

To increase pertinence for the users, additional elements such as KPIs (e.g. besides the green/cost effective ones and performance measures mentioned in section 3.5), but also deliverables, leverage factor from industry and RTO, number of patents, number of products, etc. need to be added to the Framework in collaboration with key actors of the TI in a second stage of development of the framework, beyond REFINET. Stakeholders could take on this task, such as the ECTP and its Infrastructure and Mobility Committee which is currently including this task in their discussions to define the most efficient way to leverage the knowledge gained in REFINET. On that basis, the Framework could become a standard tool for the Commission and the various Technology Platforms to ensure the collect of consistent data sets.

3.7 The REFINET TI-TechMapper Platform: Technology Analysis and Mapping tool

To automatize the RMMTI model (see above) and all data collected by REFINET (e.g. best practices, technologies and innovations from projects) as well as to maximise the use and the potential interest on it, a Transport Infrastructure (TI) Technology Analysis and Mapping Platform, **TI-TechMapper** Platform, is being created as part WP4, Task 4.1.
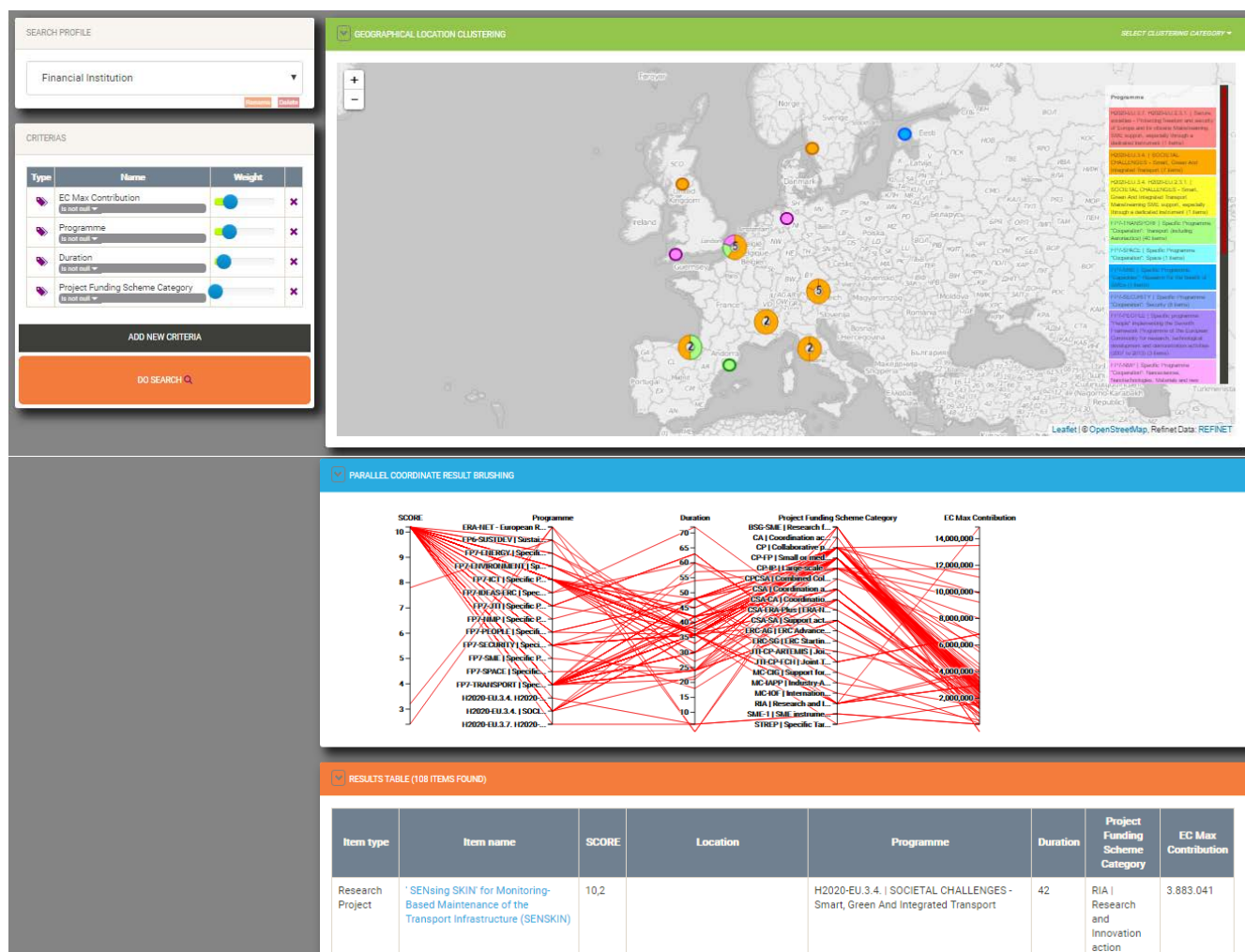
Figure 3 – REFINET TI-TechMapper Platform: profile management and geo-clustering (top); query, analysis and statistics (bottom)

Within the scope of REFINET, the TI-TechMapper Platform makes use of all the data identified by project (e.g. Best Practices, Technologies, Innovations from projects, etc.) and presents them in a format that can be used as a decision-support tool for stakeholders active in European Transport Infrastructure, with the aim of:

- Providing an **easy-to-use** tool to different stakeholders in accessing to a set of technologies, best practices, innovations, projects outcomes, etc. which can be applied to European Transport infrastructures
- Allowing the **visualization of data on an interactive maps/layers**, featuring the possibility to combine different information related to different aspects (e.g. technological, regulatory, maturity, indicators, etc.)
- Identifying **best practices/technologies**, etc. for specific assets, in a specific environment, with specific boundaries (as sets by the KPIs, standard, etc.)

In this sense the Platform can be seen as a tool, that digitalize all the information collected in the project, and make the available for visualization, search, query, analysis etc.

More specifically, two categories of stakeholders may use the platform in two main ways:

- For users belonging to Public Entities, Agencies, Authorities as well as for any stakeholders in the sector (including Associations and Technology Platform in the Transport & Infrastructure domain): they may be interested in using the tool for making advanced analysis of technologies and correlations among technologies, at different level of development (according to the TRL) or use. Only public information will be used and released.
- For private sector companies and/or customers of public sector (Infrastructure Managers and Operators, design, construction, maintenance companies, technology suppliers and providers, etc.) they may want to use the tool as an advanced analysis tool to support their planning and decisions making in terms of investments, adoption of one technology, etc. In this sense the tool can be seen as a sort of market place where demand and offer is combined.

The TI-TechMapper Platform is currently available online on the REFINET Web site (http://refinet.eu/ti-techmapper/) where a link is provided for accessing the Platform at *www.dappolonia-innovation.com/refinet*. A user can access the platform upon registrations. Credentials (username + password) are provided once registered. The tool enables registered users to search, browse and map in a structured way, research project, best practices and technology related to Transport Infrastructures as identified and classified in the REFINET project, supporting the REFINET Strategic Implementation Plan. The tool offers two type of search:
- A fast, unstructured textual search to directly access identified item information;
- A structured, weighted search based on predefined search profiles and search criteria.

As said, it is currently necessary to sign-up and log-in in the site to use the tool. New registration will require verification and in future may require approval by the Platform Administrator. The intention is for the platform to be kept up and running after the project ends and to continue stimulating a collaborative feeding of data/information so as to expand the mapping to additional countries, to dig deeper at the level of data quality, accessibility, etc. The taxonomy and characterization ("data model") used by REFINET (see section 3.6) ensures that although additional information will be included or updated, the same quality and granularity of information can be kept. For the time being, the access to the platform is ensured at the level of the REFINET Web site (http://refinet.eu/ti-techmapper/), and will be further moved to the ECTP I&M Committee Web page (on the ECTP Web site). Further projects (e.g. new CSAs) may insert additional KPIs, demonstrating the benefits of the tool (platform)

Commercial Exploitation of the TI-TechMapper Platform
Two main routes may enable the further development, population and maintenance of the Platform:
- Through ongoing and future funded H2020 Research and Innovations projects, in agreement with the European Commission, DG MOVE and the Innovation and Networks Executive Agency (INEA);
- Through relevant TI associations at EU and national levels (e.g. ECTP and its I&M Committee, FEHRL, national Transport Technology Platforms, etc.).

These two routes are not exclusive and can be taken in parallel. The background of the TI-TechMapper Platform and the idea being that of D'Appolonia's but the development of the platform having been done through the REFINET project, project partners have all a free licence to use the TI-TechMapper Platform during and after the project for a duration of 12 months (beyond REFINET formal ends – end of April 2017),to be re-negotiated, after the end of this period,at fair and reasonable conditions. However they are not authorised to sub-licenced the tool for commercial purposes.

Through ongoing and future funded H2020, in agreement with the European Commission, DG Move and the Innovation and Networks Executive Agency (INEA)

A visit to the European Commission was held on 9th March 2017 with the participation of Ms Cristina Marolda of DG Move, Alain Zarli of CSTB and Clemente Fuggini and Simone Genta of D'Appolonia to present the REFINET TI-TechMapper Platform to the Commission. The Commission expressed interest in the REFINET Platform as a tool to "integrate" and "correlate" results from R&D projects when it comes to the issue of clustering them, as it is on-going with the Cloud Infrastructure initiative. The Commission invited REFINET to a presentation of the platform at the final session of the Innovation Day (http://www.datainnovationday.org/, March 28th) focusing on Construction & Maintenance. An outcome of the event may be to insert the data of invited projects to the event into the Platform using the REFINET Template. The Commission also asked that REFINET gets in contact with the network of NCPs for H2020/Transport and that for CEF (as a 1st step, with the Italian NCPs) in order to organize a dedicated webinar at which the platform could be presented as a tool to support technology searches (and transfer of innovations from H2020 to CEF). Similar contacts should be made towards CEDR Working Group Innovation (e.g. to organize a webinar). Further exploration of collaborations with existing databases of the Commission such as TRIP should be explored.

➢ Eventually, the Commission, in agreement and conjunction with the INEA,could request all projects having a link to Transport Infrastructure to share specific project data at the start, during review periods and at the end of the project with the Platform and to ring-fence a small amount of budget to contribute to the operation and maintenance of the TI-TechMapper Platform by which they would get a free access to the database.

Through relevant TI associations at EU and national levels (e.g. ECTP and its I&M Committee, National Transport Technology Platforms, etc.).

The Infrastructure & Mobility (I&M) Committee is a networking forum within ECTP for all stakeholders seeing the need to comprehensively tackle the challenges infrastructures are facing. ECTP provides the grounds to facilitate innovative approaches for the needs of European society and as such, the TI-TechMapper Platform is of high interest to ECTP as an initiative aiming to support technology transfer and RDI dedicated to infrastructure topics (http://infrastructure.ectp.org/). Therefore ECTP is considering taking over the Platform (after an agreement on use of background with D'Appolonia) to continue developing, operating and maintaining it, e.g. using a small share of the fees paid by its members. The Platform would not only be open to ECTP members but to any stakeholders interested in using it. However, ECTP members would have a privileged access to the Platform. A three-tier pricing approach could be envisaged for access to the Platform, as follows:

➔ Gold Members, i.e. ECTP members could access the TI-TechMapper Platform upon the payment of a small share of their ECTP membership fees to be negotiated and agreed at ECTP level – *considering that they explicitly declare their interest in the Platform*;

➔ Silver Members, i.e. all other interested users, not member of ECTP, but members of relevant Transport Technology Platform (e.g. ERTRAC, ERRAC, etc.) and associations (e.g. CEDR, etc.), making agreement with ECTP, could access the TI-TechMapper Platform upon payment of a fee to be defined and negotiated among the Transport Technology Platform and ECTP;

➔ Bronze Members, remaining users, for which the access to the platform will be provided upon the payment of service fees.

ECTP would be responsible for collecting all relevant data and adding it to the Platform trhough survey and enquiries (via the Commission or directly with project coordinators).

An alternative option concerns FEHRL (http://www.fehrl.org/) which is currently building a Knowledge Centre which collects information on Transport projects and technologies and for which the TI-TechMapper Platform

could be relevant. The Platform could be integrated in the Knowledge Centre on behalf of ECTP. *FEHRL is to be invited as an observer to the next ECTP I&M Committee plenary to discuss this issue.*

3.8 The REFINET Recommendations for mobilizing R&I programs and ESIF

A key output of REFINET is a list of upcoming R&D priorities that the project has identified as being critical trends for the TI research effort of the future. To achieve this result, the REFINET Strategic Implmentation Plan (SIP) which includes a collection of research needs and priorities (integrated in the RMMTI model) has been used to prioritise investments in R&D in the three Transport Network Pillars – i.e. urban mobility, multimodal hubs and long-distance corridors – and in a fourth systemic dimension transversal to the whole TI sector. The SIP filters priorities by TRL levels and gives for each of them critical information on scope, impact, costs, timeline, scale and any further comments which can help a user in prioritising.

In addition to the identification of R&D priorities and in compliance with them, the following financial instruments have been identified.

- The European Structural and Innovation Fund (**ESIF**) being one main financing instrument exist at European level to support infrastructure projects of high economic importance and relevance for the EU single market and compensate budgetary deficiencies at national level. Within ESIF the European Regional Development Funds (**ERDF**) and the Cohesion Funds (with its dedicated "Connecting Europe Facility, **CEF**[3]") can be leveraged in order to support the modernisation of the European;
- The **H2020** programme support the development of innovative solutions which may underpin infrastructure projects. It is important to note that, if infrastructure has been an element of the EC Framework Programmes for Research and Development for many decades, it is only since 2014 that a specific item of the Transport Work Programme in Horizon 2020 has been dedicated to the topic. "INFRASTRUCTURE".

Projects funded by these financial instruments should at a later stage be added to the TI-TechMapper Platform to enable users to get a complete picture of any innovation funded in the field of Transport Infrastructure. For TI managers and operators this would mean being able to detect innovation to transfer it where it is needed; for policy makers and innovation financers this would mean having a comprehensive map of research, development and demonstration topics funded and therefore understanding which ones are being underfunded and need further support. It is anticipated the need of a coordinated scheme to promote research and innovation in infrastructures: one could mention existing instruments like PPP, JTI, etc., showing that there is a need for a coordinated approach with sustained investment over a significant period.

4. SYNTHETIC EXPLOITATION BY REFINET PARTNER

The table below introduces to the main actions planned by each partner in REFINET after completion of the project:

Partner	Foreseen exploitation of REFINET outcomes
ARUP	Arup will promote REFINET outputs and outcomes both internally and externally, raising the profile of this work with representative of infrastructure sector, research institutions and academia through e.g. publications, workshop events,

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[3] Multi-Annual Work Programmes available at http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/project-funding/work-programmes_en.htm

	social media. The work done within this project will inform further research activities around multimodal transport infrastructure and support real-life project work, particularly by using the knowledge base of available technologies and construction best practices, see sections 3.3 and 3.4 of this report. Arup will continue to engage with the REFINET network through ECTP I&M Committee.
CSTB	CSTB, as REFINET coordinator and representing ECTP in the project, is to help in the promotion of the REFINET outcomes through the activities of the ECTP I&M Committee, including participation to the organization and coordination of TRA2018 as well as presentations to the conference, but also in supporting dissemination with the ECTP network and participating to the deployment of the TI-TechMapper platform, in particular in its role of managing the ECTP General Secretariat.
DRAGADOS	- Best practice catalogue: contains a wealth of information interesting from the engineering practice point of view. Extending it in the future though the ECTP I&M Committee would be of interest as well. This could be consulted in different ways, be it as a document or with the use of advanced tools such as the TI-TechMapper tool. - The reminder results of the project will be exploited by DRAGADOS through the work it is carrying out at the ECTP I&M Committee as explained in all the previous sections.
D'Appolonia	D'Appolonia intends exploiting the REFINET outcomes and in particular the TI-TechMapper as explained and detailed above. This will done in liaison with the ECTP I&M Committee, as well as with the other consortium partners for what concerned joint outcomes. In this sense further discussions are foreseen with FEHRL in order to possibly integrate the TI-TechMapper Platform into the FEHRL Knowledge Centre. In addition to this D'Appolonia has the intention and commitment to further develops the TI-TechMapper functionalities and data coverage (as well as to keep the platform up and running after REFINET ends) so that to promote and showcase the use of the tool among interested and relevant stakeholders (e.g. TI managers, general contractors, etc.) and attract them as users and in the future customers. Finally a technology transfer of the platform concept is foreseen in other applications, for both research and consultancy activities.
FEHRL	It is also expected that further activities managed by the ECTP (under the Infrastructure &Mobility Committee) as well as other platforms such as FEHRL and PTEC will carry on updating the vision and SIP throughout their respective think-tank activities. To that purpose, it is expected that the members of the experts group will keep being highly active beyond the end of the projects. It is also worth mentioning that a few members of the REFINET community as well as partners (FEHRL and ARUP) have been involved in the Strategic Transport Research and Innovation Agenda (STRIA) and it is expected that a few will be involved in the update of this initiative at a later stage. The most active part of the REFINET Network, namely the REFINET Group of Experts and the FOX & USE-iT Stakeholders reference group would form the basis for the establishment of the FEHRL FORx4 Group. This group will be in charged to develop the FORx4 programme which should integrate the output from the 3 CSAs

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	(REFINET, FOX and USE-iT), and enhance the work achieved within the 3 projects. Besides, the work undertaken within REFINET, FOX and USE-iT with the support of the REFINET Network is currently leading to some high-level discussions with the EC about the possible establishment of a "Platform for Transport Infrastructure" which could eventually lead to a PPP initiative (like the Green Vehicle initiative for instance"). In addition, further discussion will be held between FEHRL and D'Appolonia in order to possibly integrate the TI-TechMapper Platform into the FEHRL Knowledge Centre. This Platform being mostly empty, the data from the stakeholders will be crucial to be acquired and the information provided will be valuable for them in return.
PTEC	- Analysis of R&D priorities for the definition of PTEC Research Strategic Agenda - Presentation of REFINET results at PTEC Conferences (November 2017, other) - Dissemination through PTEC working Group on Transport Infrastructure meetings (June and October 2017, other) - Dissemination through NTPs meetings (June and October 2107, other) - REFINET contributions in NTPs newsletters (May and November 2017, others)
TECNALIA	As a technology and knowledge centre Tecnalia expects to exploit the results of REFINET through services provided to infrastructure managers and public authorities as a tool to establish strategic objectives and monitor the impact of projects implemented to reach the established targets. Furthermore, Tecnalia expects to internally exploit the knowledge generated through research projects that give continuity to this action in the areas of KPIs, decision support systems, monitoring and data management.
UIC	UIC being an international trade association with the vocation amongst other things, to promote and disseminate best practices, will use its platforms to continue to disseminate the outcomes of REFINET to railway infrastructure managers (UIC infrastructure group, UIC Research & Innovation Coordination Group, ERRAC, SEE-SARI). In addition, UIC has and will encourage its members to join the REFINET network of stakeholders.

5. CONCLUSION

This deliverable (D5.5) has described the potential exploitation of the REFINET outcomes beyond the project, analysing the different mechanisms and instruments that could allow exploiting the project results after the end of the project, including the continuity of the REFINET community network. Whilst the REFINET project is a CSA, and therefore there is no (scientific and technical) research undertaken which would be likely to generate new commercially exploitable knowledge, the nature of the REFINET approach (along with the similar approach by the other sister CSAs FOX and USE-iT) has led to the identification of a number of potential activities for follow-up and exploitation of the outcomes of the project, as described in this document.

What is especially under current consideration as a joint follow-up effort of REFINET, FOX and USE-iT is the potential creation (by July 2017) of an initiative and working group to be entitled FORx4[4] – *Forever Open Road, Rail, River and Runaway* – that indeed encompass the 4 transport modes as well as the Multi-modal transport aspects and all infratructures-related challenges. It should take into considerations outcomes from the 3 CSAs and pave the way to an "integration" at the level of models/framework so as to set the grounding for the next steps/actions, and keep on explaining the rationale and the value proposition of it, especially considering stakeholders like R&D&I funders and Policy Makers, the EC and the Member States, as well as TI managers and Contractors. It should incrementally refine the REFINET outcomes (Vision, RMMTI model, etc.), taking into account the 9 drivers identified in FOX and USE-iT that will impact on "the mobility of the future" and the infrastructures of the future with sustainable characteristics (such as green, cost-effective, etc.).

The TI-TechMapper is another outcome from REFINET to be exploited and further developed in this context, potentially integrating taxonomy(ies) to organize the data and explain how they can be used, how we have classified/identified solutions (e.g. technologies, tools, methods, etc.), and allowing the future integration of the R&D&I topics FOX, USE-iT and REFINET (summary) have collected and synthesised.

The schema below is a first tentative (*valid at the time of submission of this deliverable, but subject to evolution*) that exhibits a possible timeline for the FORx4 initiative: it is expected that this timeline will be refined by the end of this year, and especially in the context of the FOX CSA ending on the 31st of October.
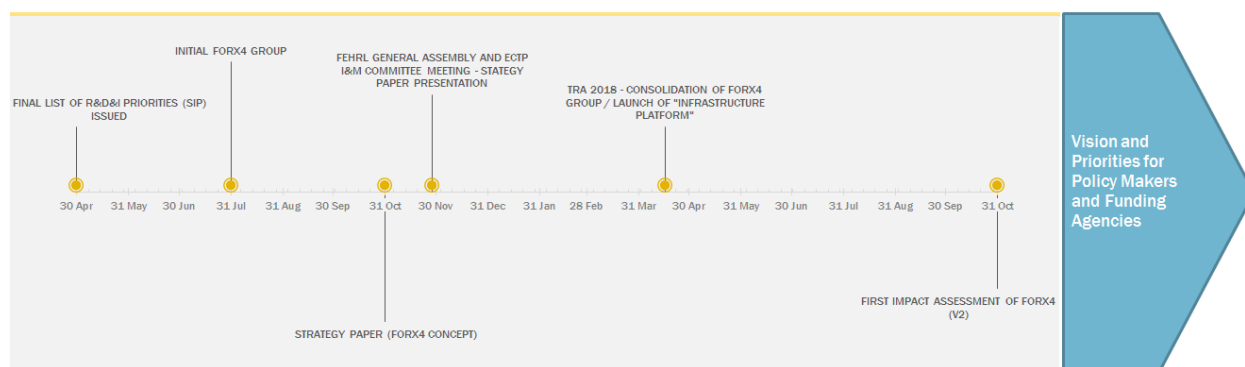
PROJECT DETAILS

DATE	MILESTONE	POSITION
30-Apr-17	Final list of R&D&I priorities (SIP) issue	10
31-Jul-17	Initial FORx4 group	20
31-Oct-17	Strategy Paper (FORx4 concept)	-20
28-Nov-17	FEHRL General Assembly and ECTP I&M Committee meeting - Stategy Paper presentation	15
16-Apr-18	TRA 2018 - Consolidation of FORx4 grou	10
31-Oct-18	First impact assessment of FORx4 (v2)	-15

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[4] The title of the initiative may have to be confirmed and in case adapted in a near future.

REFERENCES

1. REFINET (2015): *Rethinking Future Infrastructure Networks Coordination and Support Action – GA 653789* : http:/www.refinet.eu