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REFINET
INFRASTRUCTURE MOBILITY

REthinking Future Infrastructure NETworks

REFINET

Project Duration: **2015.05.01 – 2017.04.30**
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WP4

D4.2 | D'Appolonia

REFINET SIP Roadmap

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Revision history

Date	Version	Author/Contributor	Revision By	Comments
07.03.2017	V00	D'Appolonia	All partners	ToC available and shared before the REFINET workshop in Bucarest
07.04.2017	V01	D'Appolonia	All partners	First version with section 1
21.04.2017	V02	D'Appolonia	CSTB	Additions of sections 2-3
28.04.2017	V03	D'Appolonia	CSTB	Additions of conclusions and refinement of the presented roadmaps
03.05.2017	V04	D'Appolonia	CSTB	Final refinement and addition of annexes
04.05.2017	V05	D'Appolonia	CSTB	Final review and submission by CSTB
30.06.2017	V06	D'Appolonia		Implementation of review meeting comments in Section 2.3 ("Aalignment with USE-it and FOX"); Implementation of changes linked to publication on CORDIS (EU emblem, disclaimer)

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List of Figures

Abbreviations

Acronym	Full name
ACARE	Advisory Council for Aviation Research
ALICE	Alliance for logistics Innovation through collaboration in Europe
BP	Best Practice
CSA	Coordination and Support Action
CEF	Connecting Europe Facility
DoA	Document of Action
EC	European Commission
ECTP	European Construction Technology Platform
ERDF	European Regional Development Funds
ERTRAC	European Road Transport Research Advisory Council
ERRAC	European Rail Research Advisory Council
ESIF	European Social and Innovation Fund
EU	European Union
FEHRL	Forum of European National Highway Research Laboratories
FP7	Framework Programme 7
H2020	Horizon 2020
HPT	High Potential Technologies
HLSI	High Level Service Infrastructure
IRL	Innovation Readiness Level
KPI	Key Performance Indicator
PCP	Pre-Commercial Procurement
RMMTI	Refinet Multimodal Model for Transport Infrastructure

S2R	Shift to Rail
SIP	Strategic Implementation Plan
TRL	Technology Readiness Level
TI	Transport Infrastructure

Definitions

Term	Definition
Multimodal transport	Multimodal transport: The carriage of freight or passengers or both, using two or more modes of transports.
Best Practice	Innovative solutions widely used and recognised as best practice by the industry.
High potential Technologies	Existing technologies that are not yet widely used but having high potential to become so.
R&I Project Innovations	Innovations coming out of recently closed R&I projects (mostly FP7 & H2020 projects) related to TI having generated interesting incoming technologies still in demonstration and validation phases.
TI-TechMapper	Transport Infrastructure (TI) Technology Mapping Platform

EXECUTIVE SUMMARY

The objective of Deliverable 4.2, in line with REFINET Description of Action (DoA) and its activities described in Task 4.2, is to map first and secure afterwards the deployment of the REFINET Strategic Implementation Plan (SIP). This has been done by means of various "actions", presented in the form of a roadmapping exercise, which purpose is to maximize and sustain the project achievements, after its end. As such the activities for the deployment of the SIP have a clear link with the project Exploitation Plan (see Deliverable D5.5) and with to the post-project communication and dissemination activities (see Deliverable D5.4).

The first section of the present document explains the rationale behind Deliverable D4.2 by briefly reviewing the context within which REFINET was implemented, the main outputs of the project and the strategy chosen for the deployment of these outputs. The deployment strategy, based on a two-fold deployment strategy following a short to medium-term and a medium-long term timeframes, was outlined as part of Deliverable 4.1.

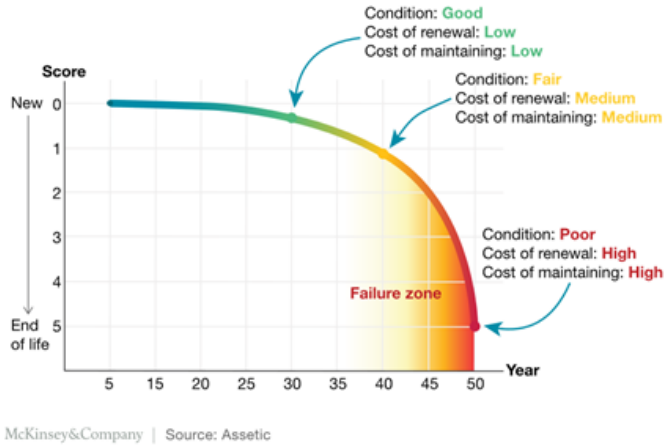
In the second section, D4.2 details how the deployment strategy was crafted in collaboration with a number of key stakeholders of the "Engage" member-level of the REFINET network and was finally officially presented at the final REFINET event held at FIRM17 on 5 April 2016. The process of collecting direct contributions from exchanges with two case study countries to feed into the short-term deployment strategy and that of the launch of strategic discussions first and foremost with the European Commission and the European Parliament as part of the medium to long-term deployment strategy are also explained in section 2. Other stakeholders targeted and engaged in the deployment strategy of REFINET included: the Member States (and their related transport ministries), the European Technology Platforms in Transport & Infrastructures (e.g. ACARE, ERRAC, ERTRAC, Waterborne, ALICE, ECTP) and the relevant associations (e.g. CEDR, etc.) and networks, the industry (e.g. TI Managers, Operators, General Contractors, etc.), etc.

As a result of the work done to define the deployment strategy, section 3 proposes two specific roadmaps – one for each timeframe - which will be taken forward as part of REFINET's exploitation activities (D5.5).

Finally, in the conclusion, the result of a joint effort by the 3 CSAs, funded within H2020-MG-2014 (MG-8.1b-2014), namely REFINET, Fox and Use-iT, to work towards the integration of their respective outputs is shown in a consolidated deployment roadmap.

1. INTRODUCTION: RATIONALE FOR D4.2

European Transport Infrastructure (TI) needs modernising[1]. As stated in the Transport European First Semester 2016 Thematic Fiche prepared by the Commission, "European transport network infrastructures, and in particular the trans-European transport network (TEN-T), require a proper level of investment (to support) new infrastructure, refurbishment and modernisation of the existing network, as well as an increased coordination between Member States affected by cross-border infrastructure projects[2]". Financially now is a good time for the EU TI to be brought up-to-date; as stated by Economic Science Nobel Prize recipient Paul Krugman[3] , European Member States should seize the current opportunity of low interest rate on bank loans to renew an old and quickly degrading transport infrastructure. Waiting too long will increase the price of renewal or maintenance as shown by the consultancy firm McKinsey in a recent article published on their website[4]:



Global challenges

However investments at public level across European Member States have been decreasing over the last ten years due to an unfavourable economic climate and a focus on other more urgent priorities. Indeed, challenges at global level are putting pressure on our societies and on the infrastructure of transportation of goods and people; they can be summed up and clustered as follows:

- **A paradigm shift towards increased environmental awareness**: Infrastructure networks must be designed, built, operated and maintained in a sustainable way, reducing resource and material consumption, with a reduced environmental impact and with increased level of safety;
- **Climate change**: infrastructure networks must be adapted to cope with new and increased risks from natural hazards, including extreme events such as floods, droughts and rising sea levels;

[1] See D3.4 for a detailed analysis of the state of European TI.
[2] Source: http://ec.europa.eu/europe2020/pdf/themes/2016/transport_201605.pdf
[3] Source: Internazionale, July 2016, http://www.internazionale.it/.
[4] Source: "Using 'asset genetics' to unlock hidden capital", http://www.mckinsey.com/industries/infrastructure/our-insights/using-asset-genetics-to-unlock-hidden-capital?cid=other-soc-lkn-mip-mck-oth-1607&kui=IDn5kwzg83LVR1keZHYk3Q

- **Concern about the availability and cost of energy**: new types of equipment will be developed, new uses of infrastructure will require new concepts, new products and new regulations to existing and new infrastructure;
- **An ageing society**: a new concern on the variety of users' needs will necessitate a new approach to the design of infrastructure;
- **Increasing economic constraints**: global competition obliges to optimise construction and maintenance costs and favours larger application of ICT solutions.

According to the Transport Research and Innovation Agenda of Horizon 2020, going forward therefore all transport infrastructure should be built with the following targets in mind:

- Resilience;
- Agility to respond to growing mobility needs of people and businesses;
- Low environment impact;
- High level of maintenance and quality;
- Innovation.

Barriers to the adoption of technologies and innovation

Specific barriers impede the adoption of the technologies and innovation which could enable the achievement of these targets and to build an integrated and optimised European transport system which would consist of safe, durable, connected, updated and innovative facilities with the capacity to satisfy the increasing freight and passengers transport demand.

Barriers
Funding Gap
Risk averse policies
Mainly national, public and price based market
Lack of long term vision and over cost perception
High risk perception: Long lifespan and high fixed costs of transport infrastructure innovations
Strict regulatory framework for infrastructure construction sector and lack of support to demonstration
Not integrated value/supply chain of transport infrastructure
Low motivation to innovate by the supply chain
Lack of Key Performance Indicators
Policies at national level lack transnational and network vision
Large number of agents implied with different priorities and visions
Specialisation of transport modes
Economic competition among transport modes
Difficult cross border collaboration
Information Gap and uncertainties on climate behaviour and its impact in the infrastructure
Over-cost perception of climate change impact
Lack of awareness
Lack of standards
Limited demand of new fuels and lack of innovative business models

In this context as underlined by Travis P. Dunn and Joseph M. Sussman, a **multimodal approach** to investment decisions can be very strategic: "the potential benefits include more effective, efficient investments characterised by a reduction in the level of public resources necessary for transportation infrastructure while maintaining or improving the level of service of the

transportation system as a whole[5]." In line with this idea, the overarching aim[6] of REFINET is to contribute to establishing a coherent Research and Innovation (R&I) programme for Transport Infrastructure at European level, promoting multimodality, and sustainable innovation in the whole value chain and demonstrating the relevance of the sector in public R&I programmes. This will contribute to the formation of a new European multimodal transport infrastructure network by 2050, which can ensure the efficient transport of goods and passengers through the High Level Service Infrastructure concept over urban networks, multimodal hubs and long-distance corridors responding to state of the art performance indicators – Green, Cost-Efficient, Social/Inclusive, Resilient and Safe/Secure – and taking into account a systemic perspective – for what regards Governance, Communication, Financial/Economic, Legal/Standards and Risks/Interdependency aspects.

1.1 REFINET OUTPUTS

The REFINET's **Vision** to achieving that overarching aim is to use REFINET's main output, the **RMMTI Model**, high-level non-transport-mode specific model as a living reference for objectives and sustained criteria for defining the design & operation specification of infrastructure projects in Europe, based on the High Level Service Infrastructure concept, for each transport mode. The model itself can be exploited in two main ways, as an infrastructure performance index and as guiding principle and strategy for the European multimodal transport infrastructure network for defining a long-term research and innovation programme for the European transport infrastructure.

Figure 1 – REFINET Multi-Modal Transport Infrastructure model

- *Level 1* aims to identify which key features should be considered to define the European Multi-modal Transport Infrastructure of the future. Which are the desired performance parameters for the RMMTI model of the future from the point of view of all stakeholders (end-users, operators/owners, construction companies, engineering firms, public administration)?

[5] Source: http://www.trforum.org/journal/downloads/2011v50n2_02_MultimodalInfrastructure.pdf
[6] see D3.1 and D3.4 for more details

- *Level 2* helps identify the key aspects to be considered when implementing a multimodal systemic approach, that is, from the perspective of the transport network as a whole. Which are the targets to focus on when implementing a systemic approach?
- *Level 3* aims to identify which key technologies/knowledge need to be developed in the short/medium/long term. Which projects are necessary to boost the sector?

In addition, built *upon* the RMMTI Model, other bespoke REFINET solutions have been generated to help achieve the project Vision. They are as follows and will be presented in detail in this document:

- A Framework for the Monitoring R&I projects
  - for all projects being developed in Europe (FP7 & H2020 Infrastructure calls, INFRAVATION, national R&I…).
- The Catalogue of Best Practice:
  - A taxonomy of circa 100 use-cases and reference practices in design, construction and maintenance of transport infrastructures that have already been deployed in practice
- The Catalogue of High Potential Technologies for infrastructures
  - 111 technologies reviewed using a framework and a taxonomy providing means for current and future technology capture and classification
- Identified future R&I priorities:
  - As part of REFINET, the RMMTI Model helped structure the priority areas and actions of the Strategic Implementation Plan around the five performance features of the High-Level Service Infrastructure[7]. The outcome of that exercise is a list of 50 future R&I priorities[8] for the European TI sector; two topics per performance and priority areas covering research oriented TRL levels (TRL<5) and innovation-oriented levels (5<TRL<8) and 10 Technology and Innovation Deployment topics (TRL>8).
- The TI-TechMapper Platform
  - A key enabler of the deployment strategy, the TI-TechMapper is tool for the analysis and mapping of technological demands (e.g. related projects, existing technologies, best practice, EU funding schemes, etc). It may also become a monitoring tool for policy makers to understand impact of funded innovation projects. The tool is the one central vehicle to ensure all REFINET outputs are accessible to all TI stakeholders - Public Bodies, Members States Ministry, The European Commission, Infrastructure Managers and Operators – to make better-informed decisions and identify the technologies they need to improve/update/upgrade the European TI.

The TI-TechMapper is available http://www.dappolonia-innovation.com/refinet/. The page can be reach also from the REFINET website at http://refinet.eu/ti-techmapper/.

[7] PRIORITY AREA A: URBAN MOBILITY; PRIORITY AREA B: MULTIMODAL HUBS; PRIORITY AREA C: LONG DISTANCE CORRIDORS and PRIORITY AREA D: SYSTEMIC APPROACH
[8] R&I priorities can be found in Annex I.

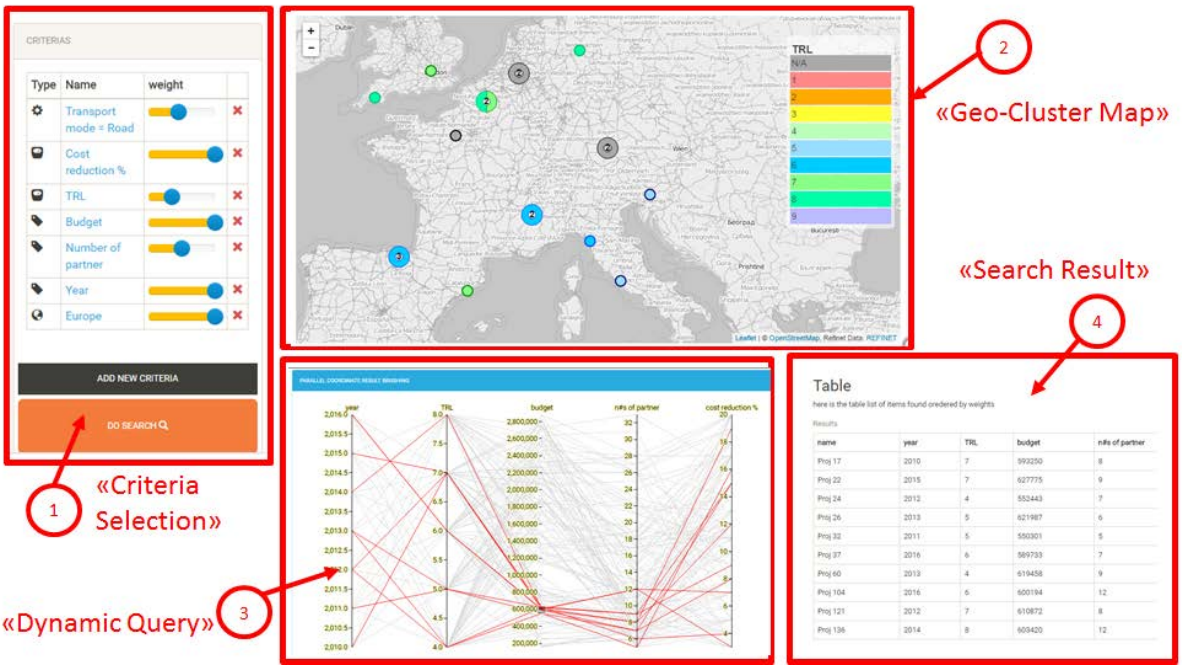


Figure 2 – REFINET TI-TechMapper : how it looks like

As proposed to and subsequently approved by the Innovation and Networks Executive Agency (INEA) as part of Deliverable 4.1, the deployment of the REFINET outcomes to these stakeholders is characterized by **two timeframes**, as described in what follows.

1.2 Short to Medium-term deployment of the REFINET outcomes

The aim is to support Stakeholders in Transport Infrastructure in identifying short-term (from now to 8 years) solutions to their immediate 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 and modernization. Priority for the deployment in the short to medium-term is in geographic areas needing most support, i.e. medium and low performers as far as quality of the TI is concerned, as REFINET aims at "reducing the current disparities among countries or in the worst case ensuring that the existing gaps will not be enlarged" [9]. On that basis, the two case study countries selected for the pilot deployment activities in REFINET are Italia and Romania, medium and low performers respectively.

The REFINET Multi-Modal Transport Infrastructure (RMMTI) model and the Strategic Implementation Plan (SIP) will help guide TI managers and operators, as well as contractors, in their investment decisions for what concerns i) the deployment or adaptation (before deployment) of available technologies and ii) the need for research and innovation in new technologies with the support of EU, national and regional funding. The TI-TechMapper platform will help them identify

[9] The full detail of this research on TI performance can be found in REFINET Deliverable 4.1; the prime source of knowledge used to generate the analysis is the Transport Scoreboard, an online platform which compares the performance of the EU Members States in 22 transport-related categories (http://ec.europa.eu/transport/facts-fundings/scoreboard/index_en.htm)

these innovations and understand how to access them, using the platform to enable a four-step process as follows:

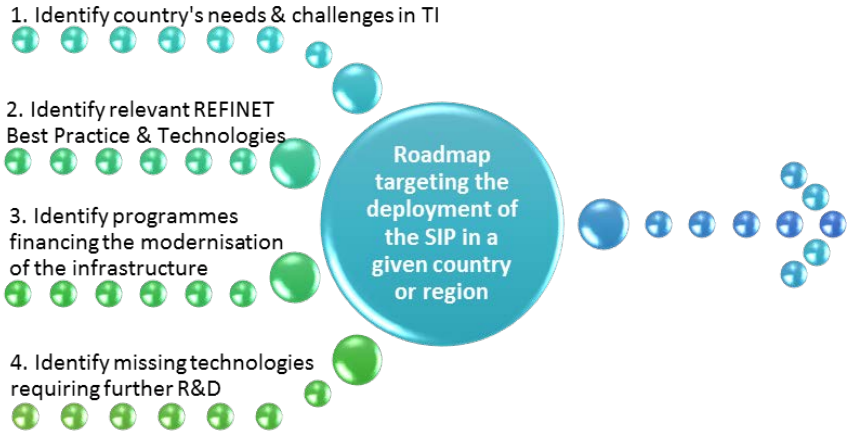


Figure 3 - REFINET mapping for a given country or region

Step #1: Identify country's needs and challenges in TI

- For each case study country, we have first browsed relevant documents to understand their Innovation Readiness Level (IRL) such as the RIO (Research and Innovation Observatory) country reports. Those reports, produced by JRC, monitors R&I policies and performances in all 28 EU Member States are available at https://rio.jrc.ec.europa.eu/en/country-analysis; they include references to Research and innovation strategies for smart specialisation -RIS3 (with further details available at http://s3platform.jrc.ec.europa.eu/home). Hereafter are key facts and figures on the two case study countries that will be useful and relevant to start building their roadmaps in Task 4.2. they give indication of their Innovation Readiness Levels (IRL) and TI status of development.

Step #2. Identify relevant REFINET Best Practice & Technologies (both High Potential & Incoming)

- For each case study country, the catalogues produced by REFINET are browsed to identify typologies of projects responding to the country needs and challenges. (template for collection of best practices and technologies below)

Field	Description
Title and Keywords.	Title of the best practice or technology and main keywords
Source of best practice	Organization providing the best practice or technology or other reference to the source (e.g. conference, etc.).
Lifecycle stage	Design, Construction or Maintenance.
Type of infrastructure	Road, Rail, Air, Water, Multi-modal.
Component of infrastructure	Bridge, tunnel, pavement, etc.
Element of the infrastructure	Specific element belonging to a component. For instance, in a bridge it could be a pier, segment of a deck, abutment, foundation, etc.
Short Description	Scenario for application, technology and how is applied, geographical coverage

Success factors	For example, what are the conditions for successful replication.
Constraints	Which are the factors restraining the application of the best practice (e.g. environmental or weather conditions).
Main impacts	For instance economic or environmental benefits, advantages to users, increased safety, reduction of disturbance, etc.
Maturity and degree of implementation	For example technically feasible, replicable, adaptable.
Key Performance Indicators (optional)	Indicators according to the definition of the RMMTI model that help to assess the efficiency of the described practice.
Further information	Links, references and / or contact details for further information.

Step #3. Identify programmes financing the modernisation of TI

- For each case study country, the programmes offering financing opportunities for modernisation of the TI are scouted to identify possible routes for financing the required technology adaptation projects that will respond to the country needs and challenges.

Step #4. Identify missing technologies requiring further R&D

- Finally, for each case study country, whenever the need or challenge require a brand-new approach to anything tried out before, recommendations for investment into further R&D is made.
- Step 4 leads directly to triggering or to contributing to the **medium to long-term approach of relaying information to Policy Makers** (including Transport Ministries, Authorities, Agencies, etc.) in identifying future research topics in TI based on an analysis of the current existing technology offer and the future demands. This process is described in the section below.

Actions which were taken to define the short to medium-term roadmap are detailed in section 2.1. The actual roadmap for the short to medium-term deployment of the REFINET SIP is presented in section 3.1.

1.3 Medium to long-term deployment of REFINET outcomes

This second timeframe aims at relaying information to Policy Makers at Member States and at EU Level (including Transport Authorities) to support the medium to long-term development (from 8 to 20 years) of Transport Infrastructure in the EU and at National level through Research, Development and Innovations plans, based on an analysis of the current existing technology offer and the future demands.

Ultimately REFINET aims at guiding the long-term evolution of the TI at European and National level. After the project end, the specific research priorities and actions identified through REFINET will be promoted at EU-wide level through recommendations as well as strategy and position papers to various key actors who will be able to use these results strategically to help them **contribute to shaping the European Multi-modal Transport Infrastructure** of the future. These actors include:

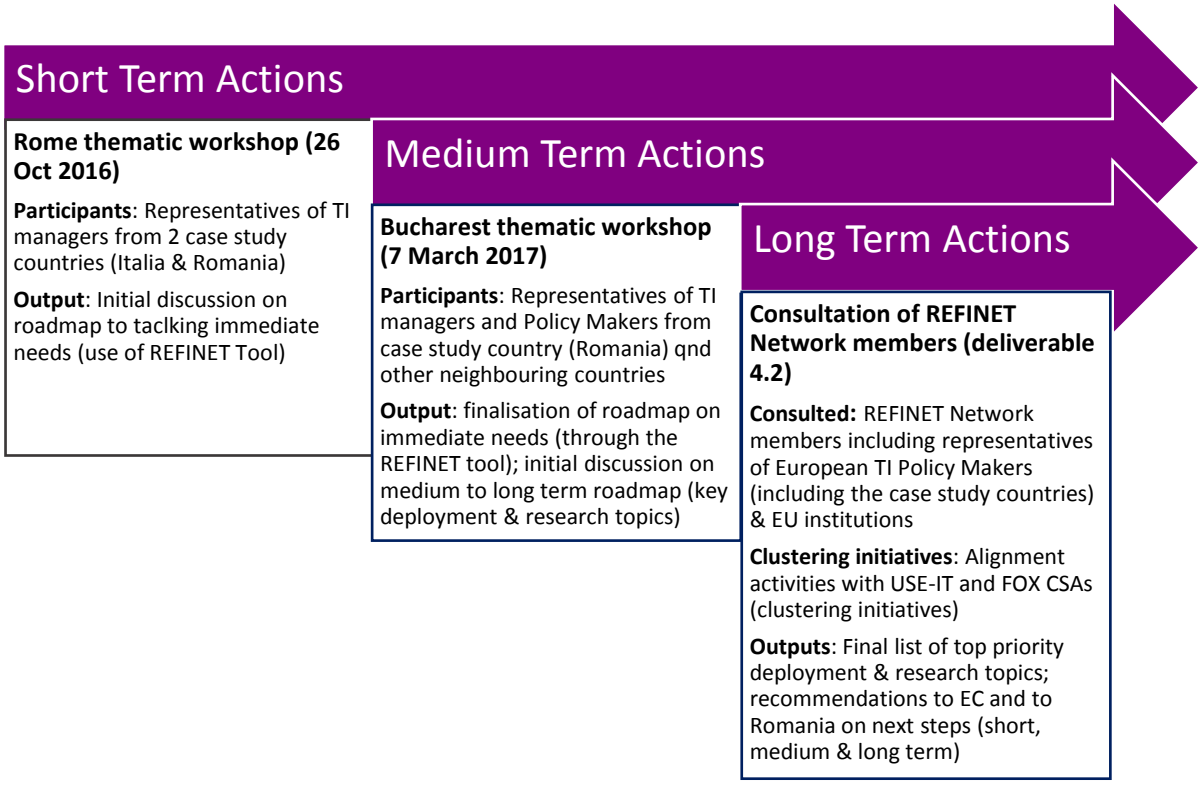
- The European Commission

- The European Parliament
- The 28 Member States (through their Ministry of Transport and Infrastructure)
- Public Authorities and Decision Bodies (e.g. authorities in charge of Transport Safety, in charge of transport policy for adaptation to climate changes, etc.)
- The European Technology Platforms in Transport & Infrastructures (ACARE, ERRAC, ERTRAC, Waterborne, ALICE, ECTP, etc.) and their related and relevant committee (e.g. the Infrastructure and Mobility (I&M) Committee of ECTP).
- Other Relevant Associations such as the European Network of Construction Companies for R&D (ENCORD), the European Infrastructure Managers (EIM), the Community of European Railway and Infrastructure companies (CER), the European Union Road Federation (ERF), International Road Federation (IRF), World Road Organization (PIARC), Airports Council International Europe (ACI EUROPE), European Sea Ports Organisation (ESPO), European Association for Battery, Hybrid and Fuel Cell Electric Vehicles (AVERE), European Federation of Inland Ports (EFIP), European Federation for Transport and Environment (T&E), UNIFE as the European rail manufacturing industry representing body, European Construction Industry Federation (FIEC) , European Network of Construction Companies for Research and Development (ENCORD), European Passengers Federation, among others.

Actions which were taken to define the long-term roadmap are detailed in section 2.2. The actual roadmap for the long-term deployment of the REFINET SIP is presented in section 3.2. It details how a dialogue has been launched to inform the above-mentioned stakeholders of the future priorities for funding R&D developments. The actual deployment of the SIP at political level will be implemented post-REFINET by a consensus among these actors.

2. FROM THE REFINET DEPLOYMENT STRATEGY TO THE ROADMAPS

The following section gives detail of the **actions** implemented as part of Task 4.2 of REFINET to get to the final roadmaps presented in section 3. Following the short to long-term perspective of the deployment of the SIP, activities enabled feedback to be collected from stakeholders targeted in both the short and long-term time plans foreseen by REFINET; the overview of the process is as follows:



2.1 Mapping REFINET's short to medium-term Deployment

2.1.1 Thematic workshops of Rome & Bucharest

Two thematic workshops were organised as part of Task 4.2 to collect feedback from selected stakeholders on the proposed deployment of the REFINET SIP including expectations concerning technological demands of the new and existing infrastructure. Target audience consisted primarily of representatives of **Transport Infrastructure managers and operators** from the two REFINET WP4 **case study countries** Italy and Romania.

The first **workshop**[10] was held on 26 October by D'Appolonia and aimed at presenting the proposed deployment strategy and discussing it with 24 invited experts. The theme of the workshop was

[10] See Annex 1 of D4.1 for additional details.

identifying solutions to managers and operators' current needs through the transfer of existing and incoming innovative technologies. Participants included **Transport Infrastructure managers** from Italy and Romania represented by Austostrade per l'Italia, AISCAT (The Italian Association of Toll Motorways and Tunnels Operators) and RFI (Italian Railway Infrastructure Manager) for Italy; CFR S.A. (Romanian Railway Infrastructure Manager) for Romania.

To continue collecting the feedback from the Romanian operators, and to start leveraging other stakeholders' feedback, a **second workshop**[11] was held in Bucharest on 7th and 8th March 2017 with a twofold aim (the proposed agenda of the workshop can be found below):

1. present the results of the collaboration with the two case study countries to date and finalise **the short-term roadmap** approach as illustrated by the Romanian case study
2. start exploring the **medium to long-term** roadmap timescale, starting from the Romanian case study, aiming at feeding information to Policy Makers, Public Bodies and Members States Authorities on future research topics.

Thirty participants from 20 organisations attended the workshop, most of them from Romanian Infrastructure Management authorities and ministries. Representatives of European associations and of other national organisations involved with TI from Slovenia, Italy and Spain were also present. The two days were structured as follows:

- *Morning of day#1*:
  - Update on the Deployment Strategy for the SIP through Romanian Railway case study and presentation of progress on the REFINET TI-TechMapper (Geo-Clustering) Platform;
  - Discussions on the roadmap for deployment of the SIP in Romania – short term perspective: Deploying the SIP to other modes and multimodal TI at a regional, Eastern European dimension and later on at a European dimension.
- *Afternoon of day#1*:
  - Workshop session: Deployment Strategy Discussion – Identification of Research, Development and Innovation Priorities and Topics in the medium to long term, identifying and analysing technological demands of the new and existing transport infrastructure.
  - Debrief and Wrap-up; Information about the REFINET final event at FIRM17
- *Morning of day#2*:
  - Discuss tangible opportunities for collaboration in the scope of REFINET. A round table of two-hours was organised to continue discussing with representatives of the REFINET network members and end-user community (e.g. stakeholders in the transport sector including Infrastructure Managers, Operators, Transport Solutions Supplier, Local and National Organizations, etc.). Discussions targeted how to better exploit the outcomes of the project and to identity opportunities for collaboration in joint initiatives in the form of Public Private Partnership, European Innovation Partnerships or any other Joint Undertaking (e.g. Structural Funds, CEF, etc.) or

[11] See Annex II for additional details.

H2020 tool to be later proposed to deciding bodies (EC, member states, industry, etc.).

The proceedings of the workshop have been directly leveraged into the overall roadmap of deployment for the REFINET solutions in the context of European Transport Infrastructure and into the more specific roadmap focusing on Romania.

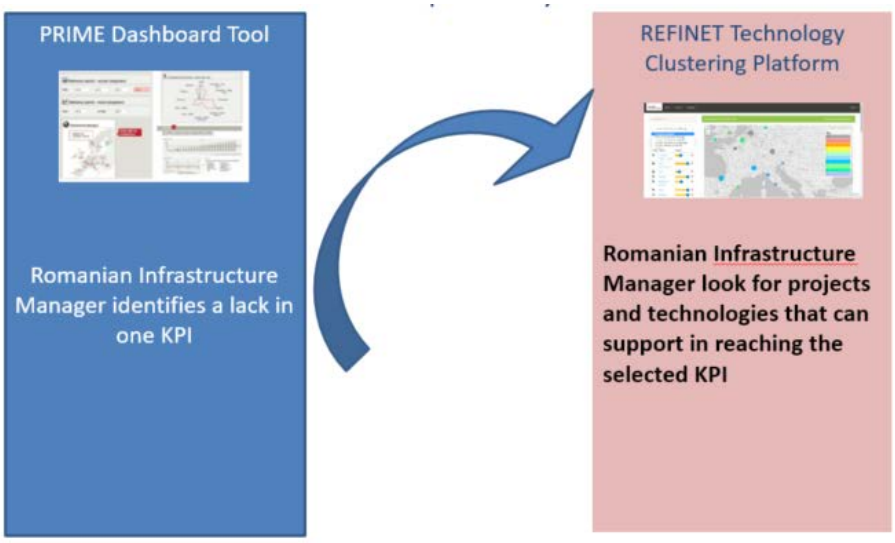
2.1.2 Further Dialogue on the Deployment Strategy with Case Study Partners

Feedback received from participants to both workshop was very useful and encouraging. During workshop#1, representatives of both case study countries confirmed their interest in being actively involved in the next steps of the short-term deployment strategy as well as in providing data and information for the validation of the REFINET TI-TechMapper Platform. With the Romanian Operators on the one hand, it was agreed that the dialogue would continue at both strategic – for the co-creation of a short-term SIP deployment roadmap - and at operational levels – for the REFINET platform requirements definition and validation. A plan for collection of input was defined[12], which aimed at collating contributions and feeding them into the platform so as to prepare a user scenario[13] focusing on the Romanian Railway Infrastructure Manager – CFR CFR Căile Ferate Române – as representative of the rail community, in time for workshop#2. On the other hand, it was agreed with the Italian Operators that they would resume active involvement in the creation of a user scenario for Italian Road TI once the Romanian case would have been completed. A similar dialogue will take place; it is likely to happen post-REFINET.

The specific issue of Key Performance Indicators (KPIs)

As part of the dialogue with the Romanian case study stakeholders, the identification of KPIs for the railway infrastructure sector were discussed. As with any KPIs for TI, they are difficult to be collected on proper and homogenous bases. Besides the work done by REFINET on the topic, another valuable source of KPIs for Transport & Infrastructure has been identified. The PRIME high-level Platform of Rail Infrastructure Managers in Europe[14] enables benchmarking and exchange of best practices between Infrastructure Managers on the topic of KPIs[15]. PRIME has defined a KPI system to enhance the performance and the business development of each IM; the KPIs are a common set of indicators which allow good and clear comparison between Infrastructure Managers. The potential interoperability between REFINET and PRIME has been investigated. Indeed, looking forward, in the framework of the Romanian case study, REFINET Platform can support the railway infrastructure manager with complementary instruments and concepts but starting from a similar KPIs based approach. Moreover, PRIME has created a Dashboard Tool which enables analysis of KPIs and comparison/benchmarking with the Infrastructure Managers for each KPI. REFINET Platform could become interoperable with PRIME Dashboard Tool, as shown below.

[12] See Annex III.
[13] The actual scenario is available at Annex V of this document.
[14] CFR Căile Ferate Române (Romania) joined PRIME in 2016.
[15] Source: https://webgate.ec.europa.eu/multisite/primeinfrastructure/en



Further actions, in the framework of the Romanian case study, as part of the short to medium-term deployment strategy, will be carried out to explore the relevance and potential for interoperability between REFINET and PRIME. Among the others potential actions include:

- Better understand the PRIME Dashboard Tool
- Verify if the PRIME Dashboard Tool can export KPIs related data in a format that can be imported in REFINET Platform
- Investigate the mapping between PRIME KPIs and REFINET KPIs and concepts
- Integrate the mapping between PRIME and REFINET KPIs inside the REFINET Platform.

2.2Mapping REFINET's medium to long-term deployment

2.2.1 Identification of R&I Priorities

The medium to long-term approach (from 8 to 20 years) is being developed to relay information to Policy Makers and Public Bodies (including Transport Authorities) about future strategic research topics in TI based on an analysis of the current existing technology offer and the future demands. To achieve this result, the REFINET "research needs" matrix has been developed to collect information in order to help prioritise investments in R&D in 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 matrix 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.

2.2.2 Review of R&I Priorities with key stakeholders

To prepare for the workshop the matrix was circulated to all participants a week ahead. At the workshop itself participants were split into two groups; each group worked on two of these pillars to discuss the proposed topics, identify any missing topics in an effort to help refine the final short list

which is to be used as part of the long-term roadmap for the deployment of the REFINET SIP. Participants were also asked to select their top three priority topics for immediate lobbying with the relevant institutions to ensure these topics are integrated into either the final H2020 research & development work programme or in the first work programme of FP9. A list of refined topics was produced and presented at the final REFINET conference as part of FIRM event on 5th April. Actions implemented during the framework of task 4.2 also included a dialogue with key stakeholders such as the European Commission. A dedicated meeting was held on 9 March to present the REFINET platform as a tool for the Commission to track projects and their results in the area of TI to understand gaps and overlaps. The REFINET TI-TechMapper could be a good complement to the current EC project database TRIP. The April 2017 FIRM2017 event (http://new.fehrl.org/knowledge-transfer/workshop-and-seminars/firm2017) was an opportunity to interact with the REFINET Network members. Many key stakeholders of the Network attended this event which if primarily focussing on road infrastructure developments also dedicated a large proportion of its programme content to multimodal TI issues with sessions entitled "Strategy view - the need to go beyond the borders of the transport modes". In additions, further actions have been carried out (or are planned to be) to raise awareness and discuss how REFINET R&I priorities might fit into long-term Transport & Infrastructures agenda. Among the other, the following two are worth mentioning:

- April 20, 2017, D'Appolonia, together with SEA – Milan Airport (being a member of the REFINET network and having participated at the REFINET Bucarest Workshop), presented REFINET (and in particular the Transport Infrastructure (TI) TechMapper) to an Italian member of the **European Parliament** involved in the Transport Commission of the Parliament. The aim was to raise awareness on REFINET and to rely, in line with the Long-Term REFINET Roadmap aim, information to Policy Makers so that to define precise and pragmatic next steps. A follow-up is foreseen after REFINET ends.
- May 17, 2017, D'Appolonia will present REFINET at the **ETNA2020** (http://www.transport-ncps.net) **EUROPEAN MARITIME DAY** to be held in Poole (UK), in the occasion of a workshop/forum to rely information to all SC4 National Contact Points (NCP) (http://www.transport-ncps.net/wp-content/uploads/2017/04/European-Maritime-Day-2017-Flyer-1.pdf). In addition, at the event, the last newsletter of ETNA2020 will be distributed containing an article on REFINET with details on the TI TechMapper. - The newsletter will be available at ETNA2020 project website (http://www.transport-ncps.net) here.

2.3Alignment with USE-it and Fox

Another aspect of the medium to long-term REFINET deployment strategy concerns the integration of REFINET's outputs with that of sister projects Fox and USE-IT. The collaboration was foreseen in all three projects' grant agreements and was officially shaped and launched with the issuing of the Scoping Paper to foster synergy between FOX, USE-IT and REFINET on December 17, 2015[16]. Further discussions were held all through the projects and common workshops were held (e.g. Brussels, 15 Sept 2016) until a final cooperation meeting at ECTP in Sophia-Antipolis on 26 April 2017.

[16] Bourdeau L., Goger T., Zarli A.

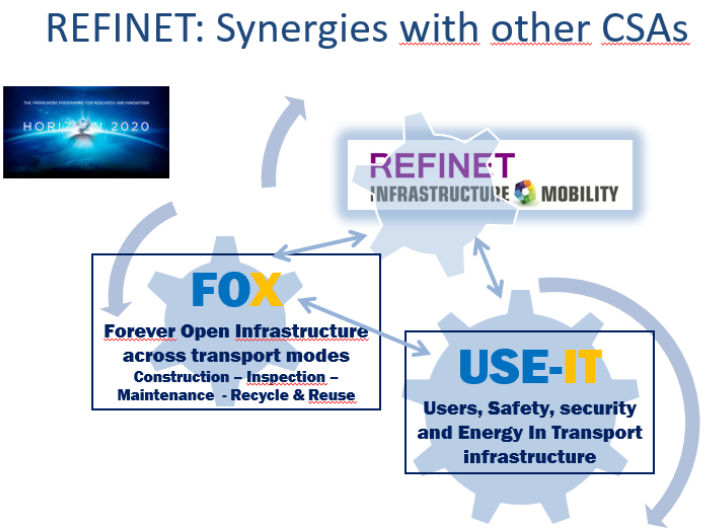


Figure 4 - Overview of the 3 H2020 CSAs funded in MG8.1b-2014

At that meeting, CSTB (as REFINET coordinator), FEHRL (as FOX and USE-iT coordinator), D'Appolonia as TI-TechMapper implementer and Maple Consulting, as one of the main contributors to both FOX and USE-iT, discussed the way forward for what concerns deployment of integrated results for the three projects and shaped a roadmap for future cooperation and integration plans, as presented in the conclusion of this document. One key aspect of integration of outputs relates to the effort of each project to classify innovations (as those emerging from R&D projects, but not only) from different perspectives during their work programme lifespan which will now be unified into an integrated taxonomy by the end of FOX in October 2017. The taxonomy will take into accounts elements which are proper of FOX and USE-iT (e.g. the identification of innovations gaps in the following categories: Infrastructure, Technology, Governance, Customers) combined with a detailed level of classification (Life Cycle Stage, Infrastructure type, component, element, etc.) proposed by REFINET. This ensure that proper information is released to proper user, according to their profiles, needs and requirements. For instance, and in accordance to the REFINET two categories of target audience and stream of work, information at the level of Infrastructure, Technology, Governance, Customer will be released to R&D&I Funders and Policy Makers; whilst information at the level of Life Cycle Stage, Infrastructure type, component, etc. will be released to TI Managers and contractors whose interested is more in digging up in a specific innovation, responding to a specific and detailed needs, rather than to look at innovations from a more systemic perspective which is, on the contrary, the interest of a policy maker. As outcomes of this work, together the three projects and identified group of interests, mong the partners involved in them, will aim at strengthening the position of TI in future R&D&I financing programme, such as FP9.

The good corporation between three CSAs (REFINET, FOX and USE-IT) was achieved because each of the three projects has contracted a grant with the EC based on a specific DoA, and each of them has limited resources dedicated to primarily fulfil its own objectives. Therefore, FOX and USE-iT projects had scopes which were directed by specific fields of application, specific primary stakeholders/users of results and specific primary results, whereas REFINET scope considers all fields of application, all stakeholders, and all kinds of innovation development and implementation.

In addition, FOX and USE-iT had mainly a short term (1-3 years) target, whereas REFINET had a short (1-3), medium (3-5) and long (5-10) term targets. Through this cooperative approach based on complementarities, the 3 CSAs achieved producing more integrated and validated results with higher value than the foreseen individual projects' results.

3. FINAL REFINET ROADMAPS

Before detailing the REFINET roadmaps, it is useful to remind what is meant in project management by a "roadmap". As per project management best practice[17], a roadmap is graphical, high level overview of a project's goals and deliverables presented on a timeline. Unlike the project plan where details are fleshed out, the roadmap should be simple and free of minutiae. This makes the project roadmap a useful tool for managing stakeholder expectations, as well as for communicating plans and coordinating resources with other teams. As such REFINET proposes two main roadmaps, one for the short-term timeframe of the deployment of the REFINET outputs and one for the medium to long-term one; both contain goals and objectives, a timeline indicating the schedule with key milestones and deliverables, possible risks and dependencies. They are presented in the following sections.

3.1 Supporting TI Stakeholders - The short to medium-term approach

A concrete goal for the deployment of the REFINET outcomes would be to see, within 3 year from the end of the project, a technology transfer taking place through the use of the REFINET "TI-TechMapper" Platform. To achieve this goal, REFINET proposes the following roadmap with a detailed strategy for the first critical 12 months after the end of the project:

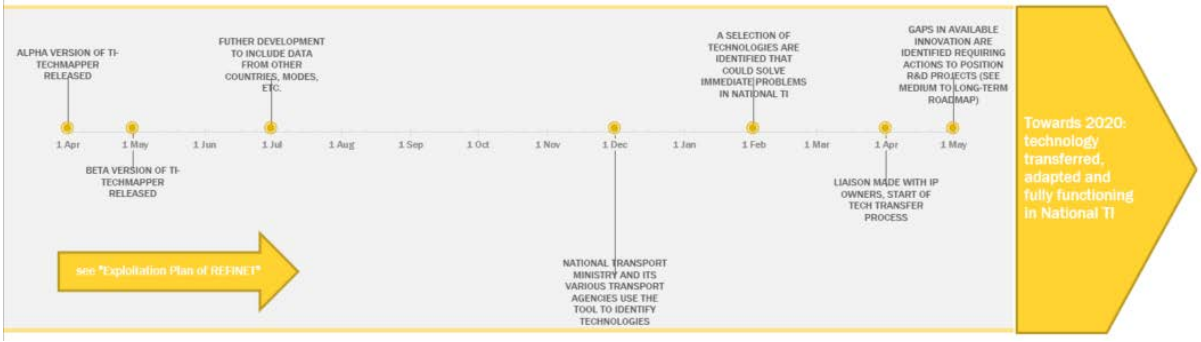


Figure 5 - REFINET Short to Medium-Term Roadmap

The TI-TechMapper is a central element of the deployment of the REFINET outcomes in the short to medium-term. However, it is still under development. To reach its full capacity as analysis and mapping tool, it will require being uploaded with additional data covering more transport modes and more geographic areas. Two main routes may enable the further development, population and maintenance of the tool:

- Through the 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)

[17] Source : https://www.projectmanagement.com/blog-post/22017/Visual-Project-Management---Road-Maps

- Through relevant TI associations at EU and national levels, led by ECTP and its I&C Committee, but also possibly including FEHRL, and other Transport Technology Platforms, etc. and networks. ECTP I&M Committee has committed to lead the effort of updating various of the REFINET outputs such as the catalogue of Best Practice and High Potential Technologies, to keep these alive and turn them into valuable references for the future of construction. The task of updating the TRL for each high potential technology will help continuously monitor their maturity and market readiness. The additional task of defining KPIs for TI will also be very relevant as well, and will require proper actions and funding support to be properly taken.

These two routes are not exclusive and can be taken in parallel. Each of the above-mentioned routes have been explored individually as part of D5.5 of REFINET[18].

Explanation of key steps, deliverables and milestones using the Romanian case study

The roadmap starts with an alpha version of the tool released by 1st April 2017. A short video using the Romanian Railway case study was developed to give a first demonstration of what the REFINET TI-TechMapper – can be used; it is currently available from the REFINET website at http://refinet.eu/ti-techmapper/ once credentials (username and password) have been issued to registered users. 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 types of search: a fast, unstructured textual search to directly access identified item information and a structured, weighted search based on predefined search profiles and search criteria.

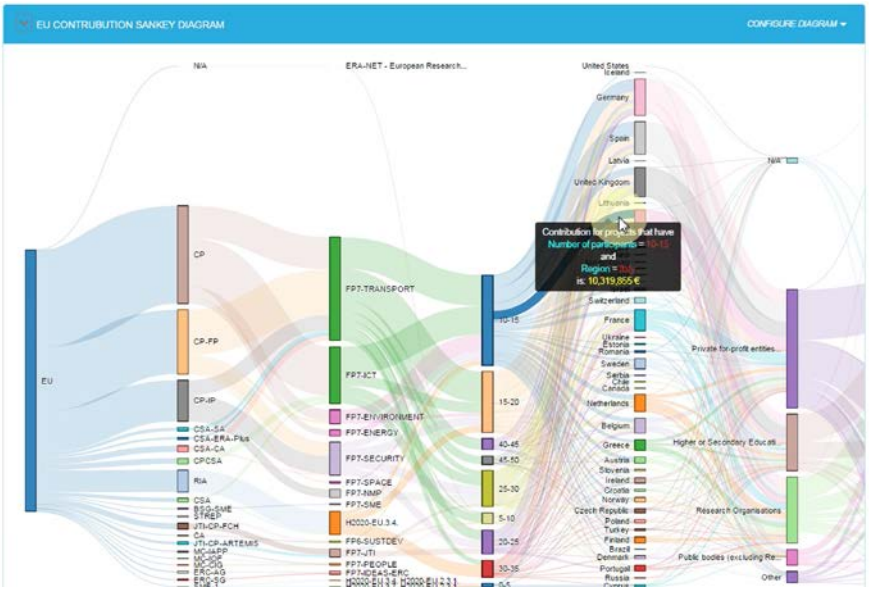


Figure 6 - Example of a search for specific EU funding scheme, projects, funding entities, etc.

[18] Confidential to EC and project partners.

The next step of development is a beta version by 1st May 2017. This is part of the exploitation plan of REFINET which lays out commitments of partners and other relevant stakeholders to the continuous exploitation of the project results after the end of the EC's financial support. The exploitation plan will detail how the next step – further development to include data from other countries, other transport modes and relevant elements – will be implemented. The role of the Infrastructure and Mobility (I&M) Committee of the ECTP will be central in making this step happen. By the end of 2017, we expect TI operating agencies to be able to use the tool to help with planning and decision-making regarding TI. We expect they will use it to identify existing technologies that could solve current TI issues in the country, either through browsing previously funded projects (figure above) or existing technologies and best practice (figures below).

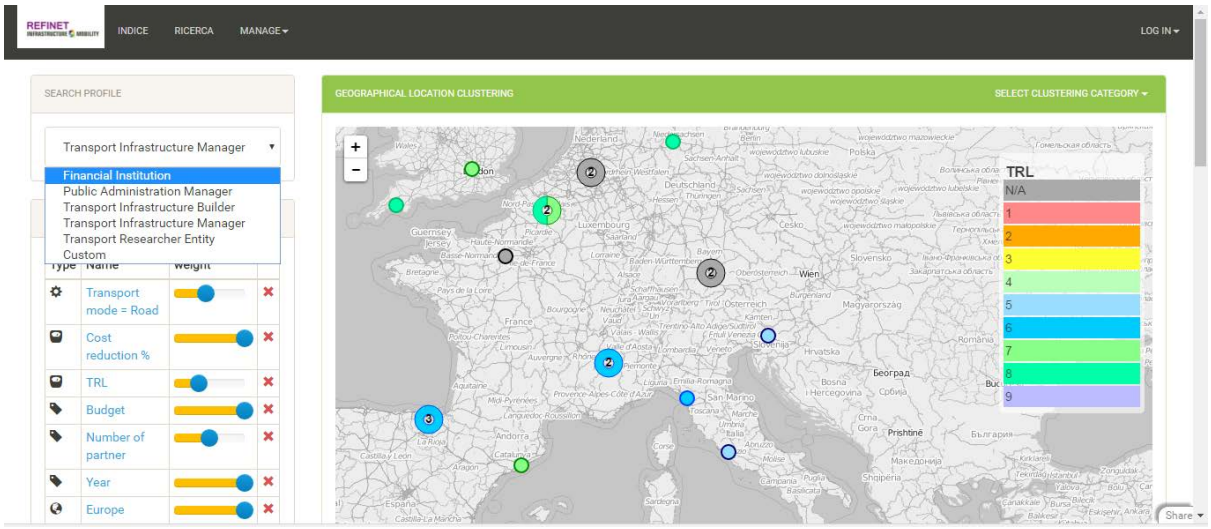


Figure 7 - Example of technology search (user profile on the left; mapping visualization by classification criteria on the right)

From that stage on, actual discussions around technology transfer will start between the tool users and the owners of the intellectual property at stake. A milestone will be reached when an actual technology transfer take place. For areas where no existing or incoming innovations exist, the tool users will be able to liaise with the ECTP I&M Committee (http://infrastructure.ectp.org/) to relay that information. The ECTP I&M Committee will ensure this information is passed onto relevant authorities (European Commission) as part of the long-term roadmap. In addition and conjunction to this, the option to integrate the TI-TechMapper Platform into the FEHRL Knowledge Centre will be explored. In both cases, the data from the stakeholders will be crucial to be acquired and the information provided will be valuable for them in return.

3.2Supporting Policy Makers - The medium to long-term approach

A concrete goal for the medium to long-term deployment of the REFINET outcomes would be to see, within 4 years, included as topics of the first calls and work programmes of FP9 (follow-on programme to H2020 for R&I) some of the priorities identified and promoted through the SIP common vision. This would lead by 2023-2025 (maximum 8 years from the end of REFINET) to the

first projects having worked on priorities set through REFINET being complete and working towards commercial application and exploitation and by 2028-2030 the first new technologies reaching the market to solve gaps in the current TI technology offer.

The actions in the roadmap below are all linked to promoting R&I priorities to relevant decision-makers and primarily the European Commission and the European Parliament, through relevant intermediaries, first and foremost ECTP and its I&M Committee, and others such as the National Technology Platforms, networks, associations and platforms (e.g. FEHRL) to help them analyse current existing technology offering, incoming innovations (Monitoring R&I projects) and future demands (Challenges & Trends).

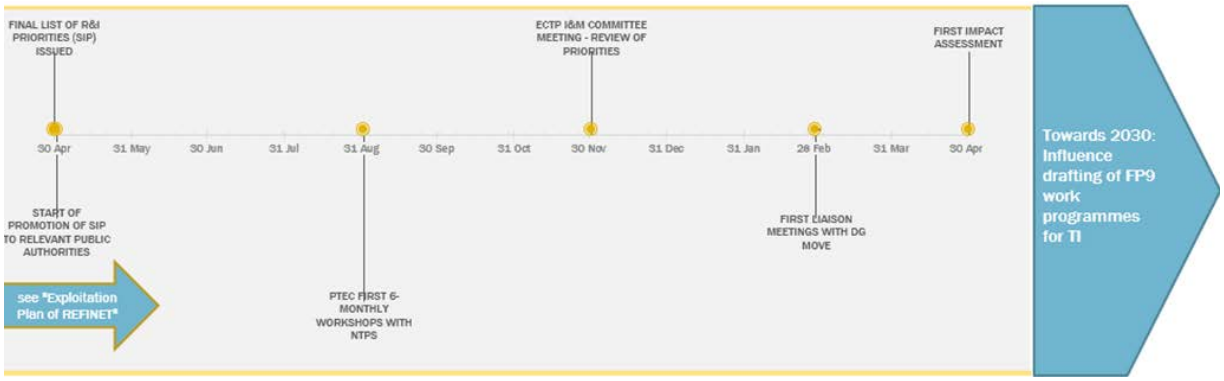


Figure 8 - REFINET SIP Medium to Long-Term Deployment Roadmap

Explanation of key steps, deliverables and milestones

The final list of 50 R&I topics identified through REFINET will be published in the final project report. It is that list that will be the central REFINET output to be disseminated and used as part of the medium to long-term REFINET deployment roadmap. Leading the effort in promoting that list to relevant decision-makers of the policy and programme supporting the development of European TI, will be the ECTP I&M Committee. The members of the Committee will all be asked to commit to a number of tangible promotion and dialogue actions, such as PTEC which will be leading an action involving other European TI technology platforms to gather their feedback on promotion actions towards their ministries or FEHRL which will update the vision and SIP throughout its think-tank activities, or D'Appolonia which will promote the REFINET SIP to Italian policy-makers through the National Contact Points (NCPs) network[19]. The ECTP I&M Committee will be in charge of the direct dialogue with DG Move and other relevant stakeholders (e.g. transport platform, relevant associations, etc.) and will be expected to organize regular liaison meeting with the Commission to promote and share the REFINET R&I priorities. A first milestone associated to this medium to long-term roadmap will be an impact assessment performed by ETCP's I&M Committee by the end of

[19] An article on REFINET outcomes including the SIP will be published in the upcoming issue of the ETNA2020, the newsletter of the NCPs on transport (http://www.transport-ncps.net) and D'Appolonia will speak on behalf of REFINET at the 17 May Poole (UK) EUROPEAN MARITIME DAY.

April 2018 (a year after the end of REFINET), to check on progress in promoting the REFINET R&I topics. The second milestone is for some of the 50 topics identified by REFINET to be called in the first FP9 work programme around 2020/2021.

To secure the wider impact and the successful implementation of the aforementioned actions, the involvement of the REFINET Sustainable Network will be crucial. In this sense it is foreseen that 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 an Expert Group. This group will be in charged to develop a strategic programme (linked to the FEHR 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, will eventually lead 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”).

4. CONCLUSION AND IMMEDIATE NEXT STEPS

This deliverable had for main scope to clarify how the outputs of the REFINET project will be deployed to relevant stakeholders; as presented throughout the document. Two main vehicles will be critical to ensure the success of the deployment: first of all, the TI-TechMapper as a central, interactive repository of all of the essential REFINET outputs; second of all, the I&M Committee of ECTP which will effectively take the leadership and full responsibility for taking the REFINET deployment (D4.2), dissemination and exploitation (D5.5) effort forward, once the project is completed (end of April 2017).

However, progressively this responsibility will be transferred to a dedicated group newly formed[20], an Expert Group, constituted by member from the REFINET Group of Experts and the FOX & USE-iT Stakeholders reference group. Indeed, as briefly presented at the end of section 2, the three H2020 Transport Infrastructure CSAs (funded under MG-8.1b-2014), REFINET, Fox and Use-iT, have collaborated all through the projects' lifespans, and they are now actively planning the consolidation of their work and the complete integration of their respective outputs. To do lead the process, the aforementioned Expert Group is being set-up which will work on developing a strategy paper to be potentially presented at the next General Assembly of FEHRL and the ECTP I&M Committee meeting, to be held end of November 2017. In the coming weeks and months, the expert group it will be open to include representatives of the TI industry, as well as key stakeholders from the most active part of the REFINET Sustainable Network. A preliminary roadmap has been agreed among four partners, D'Appolonia, CSTB (as ECTP General Secretary), FEHRL and Maple Consulting in April 2017, as follows:

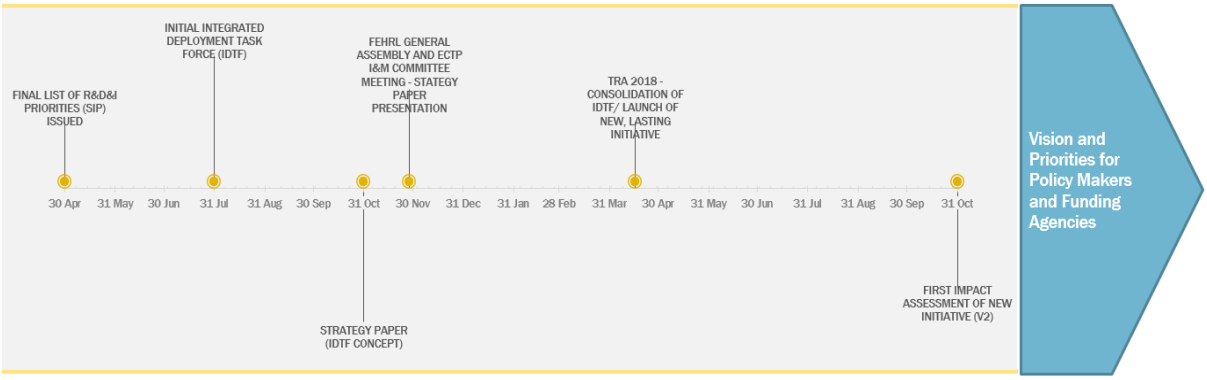


Figure 9 - Integrated Deployment Task Force (REFINET, Fox, USE-IT)

Together, the Expert Group will work towards the full integration of the various results from the three CSAs. By October 2018 the group will review the work done to that date against the strategy paper and will propose the final actions towards reinforcing the presence of TI in future FP9 Work Programmes and other relevant R&I initiatives, eventually leading to a PPP initiative.

[20] As part of the 26th April 2017 joint workshop, at CSTB, in Sophia-Antipolis.

5. ANNEXES

5.1Annex I – R&I Priorities

		Connection to the RMMTI model	REFINET priority on transport infrastructures	PRIORITY LEVEL		
			PRIORITY AREA A: Urban mobility	SHORT-TERM	MEDIUM-TERM	LONG-TERM
A	**1**	**G**	Advanced technologies and materials to improve air quality, noise and vibration in cities through smart infrastructure - Integration of nature-based solutions (both GREEN & SOCIAL / INCLUSIVE) - Superabsorbing surface materials (CO2, NOx)			
A	**2**	**G**	Adaptation technologies for sustainable energy harvesting and recovery for future sustainable urban transport infrastructure - Heat removal - solar road -inductive technology - electrification			
A	**3**	**G**	Flexible and adaptable transport infrastructure to favour sustainable transport mobility - increasing soft transport modes, such as biking, electric vehicles - automated mobility- underground mobility and parking - integration of charging infrastructures for Electrical vehicles in urban regeneration- electric buses - movement energy harvesting - inductive technology electrification - rapid-charging of vehicles			
A	**4**	**G**	Optimization of construction materials for prefabrication and development of advance production techniques, including additive manufacturing, improving recycling and reuse.			
A	**5**	**C**	New construction processes and techniques for low intrusive, fast and cost-efficient infrastructure adaptation to the new demands and needs of the operation and maintenance stage in the large city environment.			
A	**6**	**C**	Advanced materials and technologies for urban infrastructure looking for increased durability, resilience and increased performance levels in order to reduce the whole life-cycle costs of infrastructures. Self-healing materials. - Addictive manufacturing (3D printing) - Design for upgradebility, retrofiting.			
A	**7**	**S/I**	Accessibility for All citizens to all transport modes, taking into account ageing society challenge and the increasing urban demography trend for the daily operation and emergency situations.			

A	**8**	**S/I**	Adaptation of a Smart Urban infrastructure to ensure inclusiveness of all citizens to all transport modes based on ICT and Construction aspects. - safe and friendly routes for vulnerable population (children, ageing...) - Informing customer - providing choice-traveler needs - Wide spread technology APP - Transport links info on delays across modes.			
A	**9**	**R**	Increasing the resilience and adapting urban infrastructure to the impacts of environmental and man-made hazards, including: - Self-sufficient technologies to ensure day-to-day activities under exceptional circumstances - Understanding the impacts of severe weather events on infrastructure networks - Adaptation to both incremental and abrupt increases of weather and longer-term climate change -Terrorist attacks (explosions, cyberphysics) - Understanding the impacts of floods, earthquakes, landslides, volcanoes (could incorporate real time response, recovery technologies etc.) - Use of real-time info to forecast environmental hazards and Expected Impact based on simulations/modelling			
A	**10**	**S/S**	Safe and Secure Urban Infrastructure: safety in relation to the incorporation of new vehicles and autonomous driving concepts and security with regard to man-made hazards, especially terrorist attacks and ciber-security.			

G: GREEN; C: COST-EFFICIENT; S/I: SOCIAL & INCLUSIVE; R: RESILIENT; S/S: SAFE & SECURE

		Connecti on to the	**REFINET priority on transport infrastructures**	**PRIORITY LEVEL**		
			PRIORITY AREA B: Multimodal hubs	**SHORT-TERM**	**MEDIUM-TERM**	**LONG-TERM**
B	**1**	**G**	Application of new technologies, new materials to the design of multimodal hubs enabling low-carbon and resource efficient green hubs.			
B	**2**	**G**	Development of tools to analyse whole-life whole-system energy and carbon impacts, considering multimodal hubs as energy producer centers.			
B	**3**	**C**	New designs and construction techniques for multimodal hubs in order to optimise the structure repair, maintenance and life extension processes -prefabrication and automatisation processes -use of the underground - vertical designs specially in urban environment			

B	**4**	**S/I**	Friendly environments for inclusive mobility and accessibility for persons whatever their social category, age and life characteristics and their possible impairment. (People with reduced mobility).			
B	**5**	**R**	Adaptive design. Increase flexibility to interchange route or transport mode adaptable for increasing demand of future population adaptable for climate change events link with other hubs (network of hubs)			
B	**6**	**R**	Modelling of consequences via different scenarios assessment and management to preparedness to disruptive events, study of interdependencies, cascade effects and other consequences. -Real-time data acquisition tool to prepare for disruption (SHM, …)			
B	**7**	**S/S**	Security against man-made extreme events in transit environments (preparedness, prevention, robustness and recovery)			
B	**8**	**S/S**	Security by design: including proven and effective measures to prevent mitigate or detect man-made extreme events.			
B	**9**	**S/S**	Minimise Security Barriers to mobility without decreasing the overall system security level (security controls, ...) -fast & non intrusive safety controls in accordance with ethics, health and privacy requirements : biometric identification, non radioactive scanning and detection and identification of dangerous material			

G: GREEN; C: COST-EFFICIENT; S/I: SOCIAL & INCLUSIVE; R: RESILIENT; S/S: SAFE & SECURE

		Connection	**REFINET priority on transport infrastructures**	**PRIORITY LEVEL**		
			PRIORITY AREA C: Long distance corridors	**SHORT-TERM**	**MEDIUM-TERM**	**LONG-TERM**
C	**1**	**G**	**Adaptation of road infrastructure to new sustainable energy sources**: Rapid electric charging infrastructure linked to renewable energy sources. Low energy bound materials (LEBM) for pavements. New efficient technologies and systems are required to increase the energy efficiency, harvest energy from vehicles, and reduce the carbon intensity of the infrastructure as a whole, while maintaining levels of safety, security and resilience. Energy generating road surfaces. The use of Piezoelectric devices within the road infrastructure will lead to the harvesting of vibrational energy from vehicle movement.			

C	**2**	**G**	**Innovative solutions and concepts for resource harvesting**, such as integrated energy harvesting, heat recovery or rain collection systems should be explored in order to take advantages of surface transport infrastructures. Diverse technologies are currently used and developed for city buildings, but rarely applied to insfrastructure facilities and networks. Surface infrastructures are covering large areas and connecting cities and industries, therefore infrastructure with the ability of ressource harvesting could profit to the infrastructure system and nearby residential or industrial areas.			
C	**3**	**G**	**New transport infrastructure with low environmental impact.** New improved design of corridors, such as vertical or/and underground corridors or multi-utility routes, should be considered to include the increasing future demands on autonomous and electric vehicles with the minimum environmental impact. New and recycled materials and improved construction techniques should be included in these new designs to minimise acoustic, water, soil and air contamination. Not only in design and construction stages, the environment should be taken into account, but also modelling tools to analyse whole-life system energy and carbon impacts are crucial in order to ensure the environment is always taken in to account. Traceability of materials & products - to ensure the performance and durability of materials and hence, the user´s safety in new design approach. Durable and energy-efficient materials - increasing the lifetime of assets. Recycling and reuse by design - to ensure R&R aspects in designing new products.			
C	**4**	**C**	**Performance based approach for maintenance of transport infrastructure**: New methods and tools for monitoring and assessing (the status of) existing structures, relatively to structural loading and deterioration potential. New (non-destructive) testing methods (radar, ultrasound, optical fibre, wireless smart sensors, Inspection robots/self-repairing robots in maintenance....) for diagnostic, early damage detection and maintenance of the infrastructures. Smart inspection and robotics for maintenance. Integration of terrestrial and satellite systems for the structural health monitoring of key infrastructures located in a natural risk prone area (earthquakes, landslides, floods). Such parameters may therefore be called indicators and associated threshold values can be established on a risk basis, as well as admissible average frequencies for outcrossing.			
C	**5**	**C**	**Extending the life time of existing infrastructure.** New methods and tools for monitoring and assessing (the status of) existing structures, relatively to structural loading and deterioration potential. * New (non-destructive) testing methods (radar, ultrasound, optical fibre, wireless smart sensors...) for diagnostic, early damage detection and maintenance of the infrastructures; * Smart inspection and robotics for maintenance * Integration of terrestrial and satellite systems for the structural health monitoring of key infrastructures located in a natural risk prone area (earthquakes, landslides, floods). Developing alternative structural models for deteriorating structures * The resistance of an ageing structure is dependent on the condition of the materials of which it is composed, for example the level of degradation of reinforcement bars. Precast elements for quick and efficient maintenance measures. This also will include new track forms, switches and crossings, and their potential for commercial development.			

C	**6**	**C**	**Smart Infrastructures enabling condition based Maintenance.** It is important that the sensing and inspection technology as well as the models for degradation and structural integrity are developed in projects combining the two elements. The output of sensing and inspection is input for modelling. Hence, the input data that models require and the information that sensing and inspection can produce must fit. This program will have wide application for maintenance of large structures. - fewer maintenance operations mean fewer interruptions of the infrastructure network			
C	**7**	**C**	Seamless cross borders transport operations, Freight Competitiveness via co-operation and co-ordination across Europe with technology and innovation, including: cross-European means of coordinating, managing and exploiting freight operations; Focus on corridors and create network dedicated to rail freight and strengthen the international corridors (TEN-T freight network), cross border ticketing-> faster, better quality, - Using sensor-based technology to monitor transport fleets.			
C	**8**	**S/I**	Ensuring new LD corridors has minimal impact on Accessibility (e.g. cycling and walking routes), minimising disruption to travel whilst ensuring that vulnerable users can safely cross the network.			
C	**9**	**R**	Innovative solutions for preparedness, prevention, robustness and recovery from the occurrence of emergency situation based on disruptive events (natural and man-made hazards)			
C	**10**	**R**	Infrastructure adaptation to climate change increasing the resilience against natural hazards considering service performance and related costs balance.			
C	**11**	**R**	**Resilient transport and logistics networks by design** Real Time Traffic Management enable control, command and communication systems runs across the whole European Rail network; Infrastructure resilience via technology innovation and governance, management and finance of the infrastructure; Transport chain design and operation for synchro modality			
C	**12**	**S/S**	**Future infrastructure for all users' safety: Road infrastructure**, both in urban and in rural areas, needs to be adapted to the requirements of new vehicle technologies, in particular automated driving functions, and its performance needs to be guaranteed by intelligent maintenance and monitoring. Also for pedestrians and cyclists a focus should be on their dedicated infrastructure to avoid amongst others single vehicle / road user accidents. Infrastructure design should take into account the need for interactions with all kinds of road users (human factors).			
C	**13**	**S/S**	Improved management of critical interfaces with others modes and smart methods for monitoring road-rail intersections with the use of advanced solutions (GNSS systems, advanced CCTV tools, etc.) and analysis (collaborative tools) integrated by new human centred safety measures . eg Level crossing for rail/road with the aim to minimize risks at and around level crossings by developing a fully integrated cross-modal set of innovative solutions and tools for the proactive management and new design of level-crossing infrastructure.Properly adapted technical solutions deployed within an appropriate human, legal and organisational framework are necessary.			

G: GREEN; C: COST-EFFICIENT; S/I: SOCIAL & INCLUSIVE; R: RESILIENT; S/S: SAFE & SECURE

		Connection	REFINET priority on transport infrastructures	PRIORITY LEVEL		
			PRIORITY AREA D: Systemic approach	SHORT-TERM	M-	LONG-TERM
D	1	G	Integrated information system for asset management to ensure the proper decision-making process on prioritisation of asset maintenance and investment, based on sensing, measuring, imaging, simulation and computing tools through the whole life cycle of the transport infrastructure.			
D	2	G	Transport infrastructure Network assessment through asset management including BIM for monitoring and assessing the existing structures in order to prioritize the maintenance actions.			
D	3	C	Coordinated Travel Process - Multimodal Information Platforms, developing accurate information systems and integrating predictive urban and long distance traffic models with real-time information and mobility services.			
D	4	C	Active Integrated Transport Infrastructure: Data /Information systems to inform different stakeholders, as a Service supply model to be included in Transport industry, e.g. procuring for traffic information instead of traffic Sensors: to end-users on traffic conditions, to infrastructure managers on maintenance needs, to community to look for public acceptance of major infrastructure works, …			
D	5	F/E	Supply and demand - to make an overview of the streams of reuse and recycling materials and products, adding GREEN and COST-EFFICIENT aspects and to support company investments and the development of the regulation on the use of waste materials in the infrastructure construction/upgrading.			
D	6	L/S	Codes: lack of multimodal standards and tools related to multihazard resilience, considering the government and private organisation collaboration, in order to achieve a seamless transport.			
D	7	L/S	Standards for multimodal transport data aggregation in a common format for the development of multitude potential services from multimodal approach.			
D	8	R/I	Advanced traveler information - cross modal emergency evacuation/events/weather user information - integration, aggregation and dissemination of data across sectors (Transport operators, weather information providers, emergency sercives, public and authorities)			
D	9	R/I	Systemic multi-scale approach for assessment of the performance of transport infrastructure against multi-hazard risk within transport sector and from or to other sectors (intradependencies and interdependencies, such as cascade effects - in this sense cybersecurity as security of the data is so relevant)			
D	1	G	Inclusion of carbon in procurement decisions. That is why, lack of data on carbon emitted by different methods and materials			

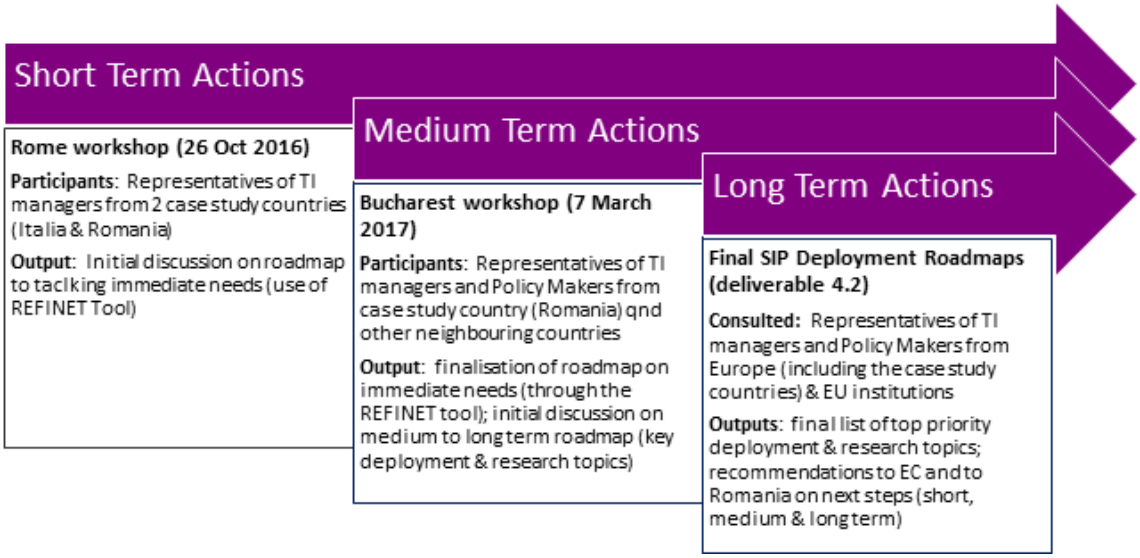
	0		should be known and the regulation should be developed.			
D	**11**	**G**	**Identification of Operational, Tactical and Strategy Key Performance Indicators for securing the uptake of transport infrastructures innovation in TEN-T projects/networks**: *Ensure efficient transport of goods and passengers using the High Level Service Infrastructure concept throughout needs relating to urban mobility, multimodal hubs and long-distance corridors. *Emphasizing characteristics such as GREEN, COST-EFFICIENT, SOCIAL/INCLUSIVE, RESILIENT and SAFE/SECURE, OPEN, ACTIVE and QUALITY as a reference framework for any new multimodal transport infrastructure. *Identification of Key Performance Indicators for securing the uptake of transport infrastructures innovation in TEN-T projects/networks			
D	**12**	**C**	**Increasing awareness of transport (multi-modal) operators on high-potential technologies and future trends in design, construction, operation and maintenance of the future (after 2020) European infrastructure network**: Widespread, shared and agreed roadmap on high-potential technologies and future trends for an European infrastructure network, taking into account of key partnership roles from sectors such as energy and ICT.			
D	**13**	**C**	Transport user Expectations and Acceptance factors (age, sex, background, cultural aspects) across modes and according to new technologies in order to encourage the use of more sustainable behaviors of transport.			
D	**14**	**F/E**	**Better funding and financing methods**: ***Innovative funding methods:** innovative approaches are required to draw upon tax revenues; there is a need to consider innovative user engagement methods. Improved social and environmental impact assessment methodologies are required in order to improve existing financial assessments. ***Innovative financing methods:** to involve institutional investors more directly and actively. Application and testing of the suitability of different emerging common performance metrics and key performance indicators is required, through collaboration with the financial sector. New approaches are also required to the assessment and management of risk and resilience, through collaboration with the insurance industry.			
D	**15**	**L/S**	Standards and service quality assurance - interoperability: legislation and standards.			
D	**16**	**L/S**	Rules and Regulations - to facilitate and stimulate recycling and re-use in the field of infrastructure			
D	**17**	**R/I**	Undesired travelers behavior to response emergency situations			
D	**18**	**-**	**Spreading innovation and research in smart high-level service infrastructure**: Leveraging on the continuous development of a multi-modal infrastructures European stakeholders network for dialog and consultation between all actors, and to update and enhance a pan-European vision and approach towards the needs for collaborative R&D covering products, systems & services for			

			HLSI development, operation & management.			

G: GOVERNANCE; C: COMMUNICATION; F/E: FINANCING & ECONOMICS; L/S: LEGAL & STANDARDS; R/I: RISKS & INTERDEPENDENCIES

5.2Annex II - Bucharest workshop

On 7th and 8th March 2017 in Bucharest, Romania, REFINET held its second STRATEGIC IMPLEMENTATION PLAN (SIP) & DEPLOYMENT OF THE SIP WORKSHOP to continue discussing the future of Transport Infrastructure over a day and a half of high-level exchanges between experts in the field. The workshop was entitled: *From short to long-term research & deployment priorities, leveraging the REFINET SIP in Romania and extending it to Eastern Europe.* This stemmed from the fact that a first workshop had been held in October 2016 to open the dialogue with key REFINET stakeholders on the deployment of the project results including the SIP itself. The deployment strategy continues; hereafter is an overview of its major steps:



Deployment Strategy of REFINET solutions

A **first workshop** was held in October 2016 in Rome to present a proposed deployment strategy and discuss it with 24 invited experts. By the end of the discussions, the representatives of the Transport Infrastructure managing authorities of two REFINET case study countries, Italy and Romania; Austostrade per l'Italia, AISCAT (Italian Association of Toll Motorways and Tunnels Operators) and RFI (Italian Railway Infrastructure Manager) for Italy; CFR S.A. (Romanian Railway Infrastructure Manager) for Romania both confirmed their interest in being actively involved in the next steps of the short-term deployment strategy as well as in providing data and information for the validation of the REFINET Platform. A dialogue between these organisations and REFINET was therefore initiated and a plan for collection of input defined.

A **second workshop** was then held in Bucharest on 7th and 8th March 2017 with a twofold aim (the proposed agenda of the workshop can be found below):

3. present the results of the collaboration with the two case study countries to date and finalise **the short-term roadmap** approach as illustrated by the Romanian case study
4. start exploring the **medium to long-term** roadmap timescale, starting from the Romanian case study, aiming at feeding information to Policy Makers, Public Bodies and Members States Authorities on future research topics.

30 participants from 20 organisations attended the workshop, most of them from Romanian Infrastructure Management authorities and ministries. In advance of the workshop, participants were sent a briefing document including the latest list of R&I topics to be discussed and analysed at

the workshop (afternoon of Day#1 session). Representatives of European associations and of other national organisations involved with TI from Slovenia, Italy and Spain were also present. The two days were structured as follows:

- *Morning of day#1*:
  - Update on the Deployment Strategy for the SIP through Romanian Railway case study and presentation of progress on the REFINET TI-TechMapper (Geo-Clustering) Platform;
  - Discussions on the roadmap for deployment of the SIP in Romania – short to medium term perspective: questions asked to the Romanian CFR stakeholders included: what could be the next steps for the collaboration? What could be CFR's use of REFINET in the short to medium-term? What are their expectations? The debate was then extended to how to deploy the SIP to other modes and to multimodal TI at a regional, Eastern European dimension and later on at a European dimension. Questions asked to the audience included: As far as you can imagine, how could the REFINET Geo-Clustering tool be used in your case? For which purpose (e.g. planning, identification of promising innovations, identification of relevant R&D projects in the field, etc.)? In that case what data would you want included? How do you see its extension from rail to other transport modes (e.g. road, maritime, etc.)? How do you see its extension from Romania to other neighbouring countries?
- *Afternoon of day#1*:
  - Workshop session: Deployment Strategy Discussion – Identification of Research, Development and Innovation Priorities and Topics in the medium to long term, identifying and analysing technological demands of the new and existing transport infrastructure.
  - Debrief and Wrap-up; Information about the REFINET final event at FIRM17
- *Morning of day#2*: Discuss tangible opportunities for collaboration in the scope of REFINET. A round table of two-hours was organised to continue discussing with representatives of the REFINET network members and end-user community (e.g. stakeholders in the transport sector including Infrastructure Managers, Operators, Transport Solutions Supplier, Local and National Organizations, etc.). Discussions targeted how to better exploit the outcomes of the project and to identity opportunities for collaboration in joint initiatives in the form of Public Private Partnership, European Innovation Partnerships or any other Joint Undertaking (e.g. Structural Funds, CEF, etc.) or H2020 tool to be later proposed to deciding bodies (EC, member states, industry, etc.).

From the proceeding of the workshop, an overall roadmap of deployment for the REFINET solutions in the context of European Transport Infrastructure and a more specific roadmap focusing on Romania is being prepared. It will be finalised in a public deliverable at the end of REFINET (April 2017). In parallel, a wider consultation of selected members of the REFINET community is taking place to produce a final list of topics which will be recommended as high priority research and deployment actions to key stakeholders, including the European Transport Technology Platforms, Innovation and Networks Executive Agency (INEA) in charge of the CEF agenda and the European Commission (DG-MOVE primarily).

Highlights of the discussions held in Bucharest

1. *REFINET Romanian CFR case study*

Since the October 2016 Rome workshop the Căile Ferate Române (CFR[21]), the national train operator in Romania serving the 22,247km of track, has become a central partner for the development of the short-term deployment roadmap of REFINET, consequently setting railway as the first of the four transport modes to be explored as part of the work on the deployment roadmap. D'Appolonia, leader of the activity related to the deployment, has since collected input from CFR which directly fed into the TI-TechMapper Platform of REFINET, thus enabling the development of scenarios to help understand how the Platform can be leveraged by its users. At the Bucharest workshop, CFR represented, continued sharing contributions regarding their expectations of the use of the tool (e.g. priority needs to projects and programmes targeted at European corridors (CEF), the collection of data needs to be extended to other EU countries or neighbouring countries such as Ukraine and Moldova, etc.). During the workshop it was also discussed that AFER, the specialized technical body of the Romanian Ministry of Transports, could be the next Romanian stakeholder involved in sharing information also on the railway case study but from the standard and regulation angle.

2. *Opening the REFINET Deployment Case study to other modes:*

As explained above, the first transport mode specifically studied as part of the REFINET deployment strategy is rail in the Romania context. At the Bucharest workshop participants, coming from all transport modes, discussed the rationale behind opening the study to other modes of transport or to multimodal TI, first at a regional, Eastern European dimension and later on to a European dimension. In that context, the Representative of the Ministry of Transport expressed his interest in promoting the tool at events organised by the Ministry to the various operators to showcase the REFINET Platform. Participants from Bucharest airport on the other hand explained that they are involved in discussion regarding multimodal access to the airport which has already lasted for many years due to change in political support, lack of authorisation and difficulties with expropriation issues. Their input into the Platform could be very relevant but may be given at a later stage. On behalf of Romanian Waterways BCPC explained that for it to be useful to them the tool must include past projects and information about future calls to enable improvements of navigation on the Danube and the missing link between Bucharest and the Danube. The benefits of using waterways versus other modes should also be emphasised. Finally, participants floated the idea that joint procurement as way to structure R&I activities could be included to the Platform to enable transnational collaboration between TI policy makers or managers. An example of joint procurement between Slovenia and other South Eastern European partners was given by the participant from Slovenia, Prometni Institute[22]. Participants suggested that information regarding the current pre-commercial procurement programme of the European Commission – which supports the transfer and adaptation of innovative solutions – could be added to the Platform.

3. *Workshop session: Deployment Strategy Discussion – Identification of Research, Development and Innovation Priorities and Topics in the medium to long term*

In parallel to the short-term roadmap for the deployment of the REFINET SIP, a medium to long-term approach (from 8 to 20 years) is being developed to relay information to Policy Makers and Public Bodies (including Transport Authorities) about future strategic research topics in TI based on an analysis of the current existing technology offer and the future demands. To achieve this result, the

[21] http://www.cfrcalatori.ro/
[22] http://www.prometni-institut.si/

REFINET "research needs" matrix has been developed to collect information in order to help prioritise investments in R&D in 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 matrix 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.

To prepare for the workshop the matrix was circulated to all participants a week ahead. At the workshop itself participants were split into two groups; each group worked on two of these pillars to discuss the proposed topics, identify any missing topics in an effort to help refine the final short list which is to be used as part of the long-term roadmap for the deployment of the REFINET SIP. Participants were also asked to select their top three priority topics for immediate lobbying with the relevant institutions to ensure these topics are integrated into either the final H2020 research & development work programme or in the first work programme of FP9. The list of refined topics is being produced right now and will be presented at the final REFINET conference as part of FIRM event on 5th April.

Participants list

No	Organisation	Country
1	Ministry of Transport	Romania
2	CNAB, Bucharest Airport	Romania
3	CFR, Railways	Romania
4	AFER, Railways	Romania
5	CNAIR, Roads	Romania
6	BCPC consulting, representing Romanian waterways	Romania
7	UTCB, Technical University Bucharest	Romania
8	PROMETNI-INSTITUT	Slovenia
9	S&T ROMANIA	Romania
10	D'Appolonia	Italy
11	FEHRL	Europe
12	VALAHIA University of Targoviste	Romania
13	PTEC	Spain
14	UIC	EU
15	TECNALIA	Spain
16	GSGROUP	Romania
17	SEAMILANO, Milan airports	Italy
18	ARUP	UK
19	EURNEX	Europe
20	CONFIMA Consulting (expert in ERDF)	Romania

Figure 10 - Introduction to the Bucharest workshop by FEHRL

Figure 11 - PTEC calls for partners contributions to the newsletter at the REFINET Bucharest workshop

Figure 12 - Participants debrief after the afternoon workshop in Bucharest - 1

Figure 13- Participants debrief after the afternoon workshop in Bucharest - 2

5.3Annex III - Romanian case study

The following reports on the content collated through direct dialogue with the Romanian case study partners over the duration of Task 4.2 on the short-term deployment timeframe of REFINET outputs.

The information was collated through the following timetable of exchanges:

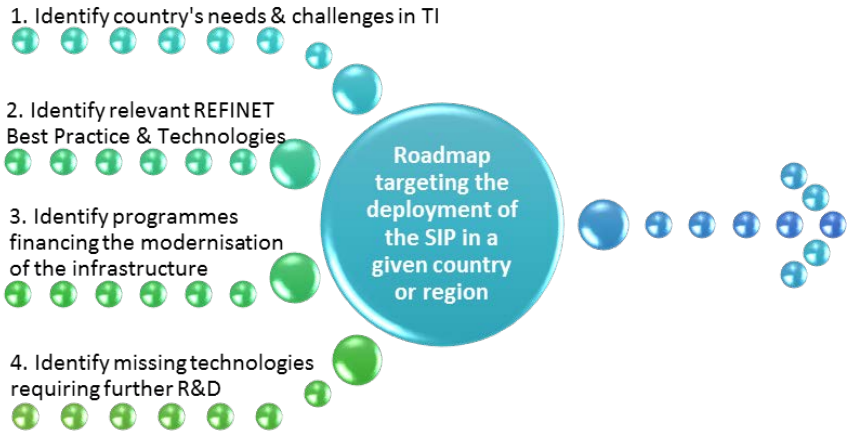
When	What	Who
February 2017	• Organise 2 Video Conference sessions (1 briefing and 1 info collection) • Email exchanges of information to collect the necessary data to create the Romanian case study (incl. feedback on present document see sections 1.1.2 & 1.1.3[23])	• DAPP to lead and organise the two sessions • CFR to contribute through two video conference and one remote document commenting: o Comment (add information, review existing info) the present document; • Other local actors to be approached (road, water and air)
By early March 2017	• Development of Romanian case study in REFINET Platform • First test of platform in real case scenario	• DAPP to lead all IT development work • Tool testing during the workshop (7-8 March, 2017)
7th March 2017	Bucharest Workshop (venue: D'Appolonia Romania) • Detailed presentation of the Romanian case study and roadmap	• DAPP to lead and organise the workshop • CFR and other local actors to attend (road, water and air)
5-7 April 2017	Final REFINET conference with WP4 results presentation, of which Romanian case detailed presentation	• DAPP to present main results • CFR and other local operators to present their roadmap

The information collated will eventually be added to the TI-TechMapper platform to help build a detailed user profile for Romanian operators. Information includes a top-level analysis of the Romanian TI.

Background research on Romania & TI

The following table presents the background research on Romania as a case study country for the REFINET short-term deployment strategy. A similar process has been initiated with Italian case study partners (see Annex IV). The process follows the 4-step approach to the REFINET SIP deployment, as follows:

[23] It includes information provided by CFR to REFINET for the REFINET newsletter #4. In blue in the text.



Step #1: *The Romanian needs and challenges – overview*

Innovation Readiness Level - Romania

Research and Innovation Observatory – Romania Country Report (2015)[24]

Compared to 2007, when Romania joined the EU, the R&I system performance has improved to a certain extent in several departments, but it still lags behind the EU average and similar countries.

- One of the lowest GDPs per capita in Europe (2014, 54% of the EU28 average)
- Large discrepancies the eight regions: Bucharest registers more than double of the GDP per capita compared with the second-best region (West Region) and close to four times compared with the region with the lowest level (North East).
- Deprioritising funding to carry on R&I activities
  - The economic crisis hit severely the country in 2009 and 2010
  - The rising trend of R&I investments from previous years was halted
  - And R&I investments were cut or delayed at both public and private levels
- Economic growth increased again to around 3% of GDP in 2013,
- But the cuts in public R&D expenditures have not been scaled back
- Structural Funds (SF) for R&I did not fill the gap: Romania allocated one of the
- Lowest shares in the EU of total ESIF funding to R&I activities.
- The adoption of the National RDI Strategy 2014-2020 in October 2014
- But the commitment for public resources has been already broken.
- One of the most important policies introduced in the last 5 years concerns the 50% tax deduction for R&D expenditures
- The National RDI Plan, which should warrant the implementation of this strategy, has just been adopted, after an extended delay.
- The National RDI Strategy 2014-2020 which includes an important component of smart specialisation identifies a set of four priorities: Bioeconomy; ICT, Space and Security; Energy, Environment and Climate Change; Eco-nano Technologies and Advanced Materials.

The Innovation Union Scoreboard 2016 defines Romania as modest innovator, ranking last among the EU Member States.

Transport Score Board Factsheet - Romania

- Overall country rank: 28 Area (1000km2): 238
- Nominal GDP 2015 (million €): 160 353
- Population 2015 (million): 19.871

[24] https://rio.jrc.ec.europa.eu/en/country-analysis/Romania/country-report

- Expenditure per head on transport-related items 2014 (€): 536
- Planned Allocation of Community funding for transport 2014-2020 (million €): 7 771.45
- Number of proposals selected for CEF Transport (2015 call only): 7
- Number of innovation/new technologies proposals selected for CEF Transport (2015): 2
- Global Expenditure on TEN-T - 2007-2013 (million €): 6 166

As far as the quality of Romania's transport infrastructure is concerned, ratings of respondents to a survey by the World Economic Forum are low, with a small improvement only as regards the air transport infrastructure. The development of the TEN-T Core Network is in its first stages for all but the Inland Waterways Network, which is 91% completed.

Territoriality

Romania's is endowed with a distinctive geography and many of the country's development challenges and opportunities have a profound spatial character. Only one of Romania's eight regions is highly developed and dynamic.

With some variation, the remaining seven regions have larger rural populations and agriculturally based activities, lack modernisation and fully functioning markets. Social and economic inclusion varies across space, with rural areas significantly disadvantaged in their access to opportunities and to public services. Geographical position and features influence development pattern and opportunities.

The infrastructure challenge

Romania is hampered in pursuing growth by underdeveloped and outdated infrastructure. Although Romania sits on important routes connecting Central Europe with the Black Sea and the Caucasus, its transport infrastructure is under developed relative to the volume of goods and passengers that transit Romanian territory, and accessibility remains a major barrier to regional growth. Connectivity via all transport modes is suboptimal due to the backlog of investments, as well as administrative deficiencies in the maintenance and operation of the infrastructure.

Case study Rail System[25] *(input from web – see source below and from contribution to WP4 Task 4.2 workshop in Rome on 26 October 2016)*

The Romanian network of rail lines open to commercial traffic is about 11,000 km long (the eighth largest in the EU). It comprises more than 1,000 stations, almost 200 tunnels and around 6,800 bridges. At present, the rail transport is facing major challenges – an inter-modal competition with the road transport, an intra-modal competition at the level of the national and international routes, a loss of traffic that has occurred over the last 20 years. The amounts allocated from the State Budget are used to cover the public railway infrastructure investments, repairs, modernization and developments necessary for the performance of the projects of national importance ensuring Romania's integration in the European transport system. Railway TI is in an advanced state of disrepair due to a chronic lack of maintenance: most of the track-related assets are on their last legs. As a consequence, the rail system is inefficient and it continues to deteriorate. The speed is limited to 50 km/h on almost a third of the network and to 80 km/h on another 40% (not to mention the numerous temporary speed restrictions). Moreover, a lot of lines (72% of which are single track) are closed for maintenance during the morning. This results in low commercial speeds and poor frequencies. According to the Romanian Ministry of Transport this deterioration is due to the lack of money, which is partly true: the poor situation is also due to poor management and operating practices affecting the infrastructure manager as well as railways. Moreover, endemic corruption is undermining the development and modernisation of the rail sector as a whole. Consequently, even when significant funds have been invested to upgrade segments of the network, the journey times have had little or no impact. For instance travel times after rehabilitation work on the Bucharest-Constanta corridor (one of the parts of the network permanently affected by theft of cables and other equipment) are longer than before rehabilitation. It follows that the traffic volume collapses. Despite a fully open market, the volume of passengers dropped by 85%9 between 1990 and 2012, the volume of freight by 71%.

[25] http://www.europarl.europa.eu/RegData/etudes/IDAN/2015/540376/IPOL_IDA(2015)540376_EN.pdf

Impact of climate change - Romania

Vulnerabilities of transport system due to climate change - Romania[26]

The following vulnerabilities with respect to infrastructure and buildings have been identified:

- Increase of the risk of earth slides;
- Modification of the characteristics of building materials and of the building foundations (e.g. setting time of concrete);
- Damage to buildings, infrastructure and transport conditions due to increased storm intensity, earth slides and coastal erosion;
- Damage of the localities and infrastructure due to more frequent floods;
- Loss of the existing construction stability in uneven areas, on fields sensitive to humidity or in flooded areas;
- Increased costs of material and thermal isolation of building;
- Damage of harbour infrastructure and river-borne transportation conditions as a result of the Danube flowing conditions;
- Reduction of protection level of dams and quay walls due to sea level rise;
- Increase of costs to build and maintain the transport infrastructure.

Infrastructure

Small increases in climate extremes above thresholds or regional infrastructure 'tipping points' have the potential to result in large increases in damages to all forms of existing infrastructure nationally and to increase disaster risks. Since infrastructure systems, such as buildings, water supply, flood control, and transportation networks often function as a whole or not at all, an extreme event that exceeds an infrastructure design or 'tipping point' can sometimes result in widespread failure and a potential disaster.

Adaptation strategies

A selection of adaptation strategies that have been proposed:

- revision of infrastructure such as drainage of rainwater, earth moving, roads, railways, bridges, tunnels;
- identification of alternative transportation routes;
- protection of railway infrastructure against erosion;
- reinforcement of harbour structure to face heavier storms;
- replacement of surface cables by underground cables;
- promotion of new technologies for street carpet and runway, based on modified asphalt to prevent the permanent deformations (because of high temperature) and to provide resistance to cracking (because of low temperature);
- promotion of different transport modes (railway, marine, river-borne transportation);
- afforestation of the areas affected by floods and earth slides close to the communication lines;
- promotion of prevention systems and fast efficient intervention in case of extreme weather phenomena;
- increase urban storm water drainage capacity;
- development of pavements that provide infiltration of rainwater;
- extent green areas and water supply to reduce excessive heat in cities;
- development of construction standards for green buildings (storage and cycling of rainwater, water saving by efficient installations, thermal isolation);
- use of renewable energy sources, and promotion of materials and constructive solutions suitable for the potential effects of climate change.

Priorities according to ESIF/ERDF

Large Infrastructure Operational Programme (LIOP)

- Removing the main transport bottlenecks and developing sustainable, efficient and green transport

[26] http://www.climatechangepost.com/romania/transport-infrastructure-and-building/

modes in the country.
- Improving mobility through the development of the TEN-T and the metro network
- Development of a multimodal, high-quality, sustainable and efficient transport system:
    - Travel time on the road TEN-T core network reduced to 74,1 Min/100km
    - Travel time on the rail TEN-T network reduced to 79,2 Min/100km
    - Quantity of goods carried by inland waterways will increase to 32,2 tonnes/year
    - Number of road fatalities per million inhabitants will decrease to 73
    - Number of passengers embarked and disembarked in airport transport will increase to 20 million/year
    - Increase in the containerised cargo volume handled in intermodal terminals to 70.000
    - Halve the waiting time in customs at exit points in agglomerated periods (carriers)

Regional Operational Programme (ROP): Improving regional connectivity.

- Improving urban public transport attracting 140 million additional passengers per year in less developed regions
- Rehabilitation and modernisation of more than 2,000 km of roads improving regional connectivity to the TEN-T network

Step #2. Identify relevant REFINET Best Practice (BP) & Technologies (HPT & IC)

Romania needs readily available technologies and incoming technologies TRL6 to 8 at least.

Key challenges:

Remove transport bottlenecks

- IC/FP7 – "ICSI - Intelligent Cooperative Sensing for Improved traffic efficiency", TRL6

Sustainable, Efficient and green

- HPT – "Efficient Urban Interchangers – The City-Hub Model" (Design) Technical University of Madrid (S)
- HPT – "Energy Management Control Systems for Rail" (Operation) Bombardier (DE)
- HPT – "Design for Manufacture Assembly (DfMA) for efficient on-site construction and reduction in wastes and risks to the environment" (Design / Construction), Highways England, White Young Green, Laing O'Rourke (UK)
- HPT – "Carbon reduction through use of environmentally-friendly material for filler in backfill for culvert refurbishment", (Construction / Renovation), Trafikverket, Sweden
- BP71 – "Sustainable use of construction materials for transport infrastructure" (Planning and construction – road/rail)

Railway & Road Rehabilitation and modernisation

- HPT – "Self-healing concrete surfaces for highway pavement refurbishment", (Design) Cardiff University project (UK)
- HPT – "Birmingham Highways Maintenance and Management Service upgrading traffic signals and traffic management systems" (Operation), Siemens, Amey, Birmingham City Council Birmingham City (UK)
- HPT – "LOCORPS: Lowering the Costs of Railways using Preformed Systems" (Design / Construction) Heriot-Watt University (UK)
- BP21 – "Asphalt mixture incorporating RAP (reclaimed asphalt pavement)", (construction/maintenance - road/railway)
- BP22 – "Recycled asphalt mixture with foamed bitumen" (design - road)
- BP61 – "Infrastructure Life Cycle Management" (design/construction/maintenance – road/railway)
- BP63 – "Performance-based design" (design/construction/maintenance – road/railway)
- IC/FP7 "HERMES - Innovative, Highly Efficient Road Surface Measurement and Control System" TRL8

Increase safety

- HPT – "Sensors for track-side safety and lone works" (Maintenance / Operation), Digital Barriers (UK)

- IC/FP7 – "MAXBE - interoperable monitoring, diagnosis and maintenance strategies for axle bearings" rail – TRL7
- IC/H2020 – "GREENRAIL : sustainability, safety and saving in the railroad sleeper of tomorrow" rail – TRL8
- IC/FP7 - "SMARTRAIL - Smart Maintenance and Analysis of Transport Infrastructure" rail – TRL6

Step #3. Identify programmes financing the modernisation of TI

Connecting Europe Facility (CEF)

The Regulation 1316 of the Connecting Europe Facility (CEF) aims to accelerate the investments in the trans-European networks, and to attract funding from both the public sector and the private one. The concept of corridors of the core network is a tool facilitating the coordinated implementation of the core network, and defines the modernization priorities.

Keywords Romania: remove transport bottlenecks, sustainable, efficient and green; Railway & Road Rehabilitation and modernisation; increase volume of air and urban transport; increase safety

CEF proposes opportunities to do:

- Railways:
  - Works or studies aiming at accelerating the removal of bottlenecks (in terms of capacity and service quality) which hinder the traffic flows on Core Network.
  - Studies that shall contribute to the start-up of the implementation of works on sections or parts which are most critical to the "success" of the completion of the Core Network, i.e. which are of vital importance for smooth traffic flows along the entire axis and would, if not completed within the agreed period, reduce the benefits
- Roads:
  - Removal of bottlenecks;
  - Coordinated development and management of road networks.

Large Infrastructure Operational Programme (LIOP) - to remove the main transport bottlenecks and developing sustainable, efficient and green transport modes in the country; to improve mobility through the development of the TEN-T and the metro network and develop a multimodal, high-quality, sustainable and efficient transport system and the ***Regional Operational Programme (ROP): Improving regional connectivity,*** to improve urban public transport attracting 140 million additional passengers per year in less developed regions, to rehabilitate and modernise more than 2,000 km of roads improving regional connectivity to the TEN-T network.

Railway corridors in Romania:

Romania is crossed by 2 railway corridors belonging to the core network, i.e. the Orient/East Med Corridor and the Rhine – Danube Corridor. The railway infrastructure modernization projects are carried out on the northern branch of Corridor IV, part of the TEN-T core network and of the Rhine-Danube corridor, along the seven sections. The stage of completion varies by date of contract signing and commencement of works. The most completed section is that on the Western border, whereas the last section on which the works began is Simeria - Vintu de Jos. The works comprise the modernization and construction of new embankments and railway superstructure, the construction of new tunnels, bridges and culverts, the modernization of platforms, canopies, the provision of uneven pedestrian access to the platforms, the modernization of the electrification systems, the provision of electronic signalling systems, the implementation of ERTMS Level 2 and GSM-R communication system.

At present, CFR-SA's infrastructure development projects also focus on three main areas, namely:

A. Modernization of railway stations, which currently focuses on the completion of 15 stations situated in main cities.

B. Railway bridges, culverts and tunnels rehabilitation works …

C. Traffic safety projects.

In A area, the objective is represented by the rehabilitation and modernization of 15 railway stations: Giurgiu, Slatina, Piteşti, Râmnicu Vâlcea, Reşiţa Sud, Sfântu Gheorghe, Târgu Mureş, Vaslui, Botoşani, Piatra Neamţ, Bistriţa, Zalău, Brăila, Călăraşi, Slobozia

In C area, the projects aiming to increase the traffic safety are:

- Modernization of the electromechanic interlocking systems.
- Modernization of the level-crossings
- System for detecting hot axle boxes and blocked brakes

Over the last years, CFR-SA has proposed for PPP financing a Projects portfolio related, in general, to the intermodal transport. This Project Portfolio includes the following List of Projects:

- Modernization of the Gara de Nord railway station
- Connecting Gara de Nord Railway station with the main airport in Romania and the
- largest in Bucharest, the Henri Coanda Bucharest Airport
- Modernization of the Bucharest belt railway line;
- Construction of intermodal terminals in the locations set down in the new Intermodal Transport Strategy prepared by the Ministry of Transport.

Step #4. Identify missing technologies requiring further R&D

Safety

- *Modelling of consequences via different scenarios assessment and preparedness to disruptive events, study of interdependencies, cascade effects and other consequences*: More and more man-made events occurs in our society. Resilience is the goal of all transport infrastructure taking into account business continuity approach and people safety. Thus, it is needed more effective strategies to: 1) prevent the occurrence of this dramatic events; 2)mitigate the effect both in the risk scenario as well as the repercussion in the net; 3)better response the crisis taking into account mobility of both people and goods and 4)better recovery strategies taking into account both redesign, reconstruction approaches.
- *Performance based approach for maintenance of transport infrastructure*: New methods and tools for monitoring and assessing (the status of) existing structures, relatively to structural loading and deterioration potential. New (non-destructive) testing methods (radar, ultrasound, optical fibre, wireless smart sensors...) for diagnostic, early damage detection and maintenance of the infrastructures; Smart inspection and robotics for maintenance. Integration of terrestrial and satellite systems for the structural health monitoring of key infrastructures located in a natural risk prone area (earthquakes, landslides, floods). Risk control by means of monitoring. Indicators may be monitored and the measured values can continuously be compared to the threshold values previously established. Alarm systems may be installed which are activated in the event of outcrossing. Safety measures can therefore be adopted depending on the consequences of the observed non-compliance. Based on such an approach, and by using modern information technology, inspections of large infrastructures may be automated and optimized. Cost effective maintenance process, based on infrastructure performance assessment and risk control/ New methods for infrastructure performance monitoring and assessing."
- *Responsive infrastructure* - lights that came on when you walk past - Management of people/public during upgrade of infrastructure - Roadway lighting systems
- *Traceability of materials & products to ensure the performance and durability of materials and hence, the user´s safety*: An important issue limiting the uptake of using recycled materials nowadays is the uncertainty about the exact composition and quality of the recycled material. For instance it could contain contaminations or undesired materials, or even dangerous substances such as asbestos. Development of systems to trace the materials and products to where they come from could help to provide the trust needed for construction companies to use recycled materials. Additionally, development of the proper risk methods, test protocols and measurement equipment could help to reduce the probability of using contaminated or bad quality materials.

Horizon 2020 – the involvement of the railway operators CFR-SA

Regarding the innovation and research in railway infrastructure sector and its European financing instruments for the current programming period 2014-2020, CFR-SA has been evaluating its capacity for entering in projects with roles such as an end-user for testing various solutions in Consortia of multi-national private and public partners especially focused on aspects of safety and security. CFR-SA would also be interested in pilot projects with new solutions which, if successful, could be applied by CFR-SA at a large scale. CFR-SA has

currently in implementation various technical assistance projects and has also daily collaborations with advisory services such as BEI / JASPERS and with technical assistance such as BEI/PASSA for the preparatory and implementation project management.
CFR-SA has been deemed eligible on various Horizon 2020 Axes on innovation and research such as: a/ MG-9.1. Transport societal drivers1; b/ MG-8.4 a. Smart governance, Network resilience and Streamlined delivery of infrastructure Innovation; c/ MG-6.3. Common communication and navigation platforms for pan-European logistics applications and others. CFR-SA found it challenging to comply with all the eligibility criteria especially difficult being guaranteeing the number of partner countries and sectors involved in creating the capacity for such large-scale collaborations for project preparation and implementation.
Since the launch of the Horizon 2020 Program, CFR-SA services have consistently increased their database with national, European and international stakeholders interested in collaborating with CFR-SA on research and innovation projects.
Concomitantly, CFR- SA has been following the Call for proposals for CEF Innovation and for the Junker Plan/ EFSI 1.0 and 2.0 Funding to verify their capacity for multi-funding projects combining innovative solutions as project sub-actions (ERTMS).

Acquisition of additional, specific data

To ensure an accurate, detailed user profile on the TI-TechMapper, additional data, specific to each transport mode and each country where the TI is concerned, is needed, as follows:

- KPIs for the parameters of the RMTTI model - Green, Cost-Efficient, Social/Inclusive, Resilient and Safe/Secure (i.e. share a set of indicators/targets that local partners are after for their TI)
- Directory of stakeholders
- Best practices in design, operation and maintenance at local/national levels
- High-Potential Technologies at local/national levels
- R&I project innovations at local/national levels
- Recent R&D projects at local/national levels
- National funding priorities and schemes
- And all data which are not available at the EU Transport Scoreboard : http://ec.europa.eu/transport/facts-fundings/scoreboard/compare/investments-infrastructure/quality-rail-infrastructure/2013_2014/index_en.htm such as:

Data collation will continue after the end of the REFINET project in priority with the two case study countries (Romania and Italy) but will be open to other interested EU member states on a voluntary basis.

5.4Annex IV - Italian Case Study

On the model of the Romanian data collation exercise, Italian case study partners have expressed interest to create a detailed user profile in the TI-TechMapper platform and therefore to continue the dialogue with REFINET post-project to enable data collation. To kick-start the process, during Task 4.2, initial information has been gathered for each of the 4 steps of the REFINET SIP Deployment process.

Background research on Italy & TI

The following table presents the results of initial background research on Italy as case study country.

Step #1: ***The Italian needs and challenges – overview***

IRL: Research and Innovation Observatory – Italy Country Report (2015)[27]

- Italy's GDP is still far below pre-2008 levels
- The Italian economy is showing signs of recovery after the years of recession that followed the financial crisis in 2008 and the euro area sovereign debts crunch of 2011.
- For the first time in years, gross domestic product (GDP) is forecast to grow by 1.4% in 2016.
- The debt/GDP ratio is one of the highest in the euro area, at 132.3% (2014).
- The unemployment rate is 12.7%, with a very alarming 42.7% rate of unemployment among young people (less than 25 years old).
- Both labour utilisation and labour productivity are low.
- Unfavourable innovation and business environment (OECD, 2015).
    - Italy put in place a set of strong fiscal consolidation measures
    - But in doing so it did not preserve its public support for R&D
    - As a consequence, Italy did not implement a smart fiscal consolidation strategy.
- The Ministry for Education, Research and Universities (MIUR) is the main player in research and innovation (R&I), in charge of coordinating national and international scientific activities, supervising the academic system, funding universities and research agencies, and supporting public and private research and technological development.
- The Ministry for Economic Development (MISE) manages industrial innovation.
- The national research programme 'PNR 2014-2020', delayed since early 2014, has been finally approved.
- Italy's R&D intensity is 1.29%, still far from the Europe2020 national target of 1.53%, which will not be reached if the current trend persists.
- To reach the Europe2020 target the yearly R&D investments should increase – assuming a constant GDP – by €4b, a much greater amount than the resources made available by present policies.
- Moreover, the share of gross domestic expenditure on R&D (GERD) performed by the business sector (54%) is low for industrialised economies (OECD, 2014) and much lower than the EU-28 average of 63.67%.

The Innovation Union Scoreboard 2016 defines Italy as a moderate innovator, performing below the EU average in most dimensions, in particular in Finance and support and in Firm investments. Nonetheless Italy has been increasing its innovation performance relative to the EU from 78% in 2008 to almost 83% in 2015.

Italian Transport Infrastructure Overview

Transport Score Board Factsheet:

- Overall country rank: 17 Area (1000km2): 301.3
- Nominal GDP 2015 (million €): 1 636 372
- Population 2015 (million): 60.796
- Expenditure per head on transport-related items 2014 (€): 2 000
- Planned Allocation of Community funding for transport 2014-2020 (million €): 3 820.35

[27] https://rio.jrc.ec.europa.eu/en/country-analysis/Italy/country-report

- Number of proposals selected for CEF Transport (2015 call only): 4 Global Expenditure on TEN-T – 2007-2013 (million €): 58 956

According to the World Bank Logistics Performance Index, Italy's transport infrastructure receives ratings slightly below the EU average, with however a positive tendency across all modes. The completion rate of the TEN-T Core Network is close to the EU average, with most development needed in high speed rail.

Case study (data collected at WP4 Task 4.2 workshop in Rome on 26 October 2016 – source: AISCAT):

The Italian Motorway Network - Motorways represent about 3% of the National road network, or 5,980 km in operation of which: 1,800 km with three lanes per way, 115 km with four lanes per way, more than 25 km of International Tunnel, 1,608 bridges and viaducts which length is above100 m and 686 tunnels which length is above 100 m. in the last 2 years, 180 km of new sections have come into operation and 40 km of new sections are under construction. The main challenge is managing traffic growth: over the last 30 years, the tolled motorway network extent has been increasing of only 15%, to be compared with a 118% traffic growth (Light Vehicles +117% and Heavy Vehicles +121%). However despite this major challenge, fatalities have decreased by 63% between 1990 and 2015, making toll motorways the safest road infrastructure in the country. To enable this result, a lot of innovation is constantly needed and Italy has adopted amongst other innovative solutions Traffic Control Centres, SOS Posts, Weather Stations, Ice and Fog Detectors, Tutor, dynamic lane, and big data central system.

Possible impact of climate change Italy

Main effects of climate change on transport system may include the following:

- changes in stability and resistance of the transport system and infrastructures, as well as in the choice of transport modality directly dependent on temperature rise that thus indirectly affects the overall quality of transport;
- possible inaccessibility or disruption of the transport network due to SLR and more frequent and intense precipitation, mainly in relation to floods;
- indirect negative effects of changing precipitation patterns on air transport timeliness as well as fuel supply;
- maritime and riverine navigation paths and conditions affected by ice melting.

Infrastructure

Small increases in climate extremes above thresholds or regional infrastructure 'tipping points' have the potential to result in large increases in damages to all forms of existing infrastructure nationally and to increase disaster risks. Since infrastructure systems as a whole or not at all, an extreme event that exceeds an infrastructure design or 'tipping point' can sometimes result in widespread failure and a potential disaster.

Adaptation strategies

Climate change will require changes in building codes and standards where they exist.

Priorities according to ESIF/ERDF
OP on "Infrastructures and Networks" (PON Infrastrutture e Reti 2014-2020):

To re-balance the Italian transport system, currently characterised by a predominance of road traffic, by modernising and extending sustainable transport modes for passengers and freight, along the Trans-European core transport network TEN-T in less developed regions. The programme focuses on actions in three sectors: railways, port infrastructure and intelligent transport systems.

Developing and improving environmentally-friendly (including low-noise) and low-carbon transport systems, including inland waterways and maritime transport, ports, multimodal links and airport infrastructure, in order to promote sustainable regional and local mobility (total funding EUR 684.2 million, 38%)

Step #2. Identify relevant REFINET Best Practice (BP) & Technologies (HPT & IC)

Italy needs readily available solutions and incoming technologies too.
Example of relevant technologies:

Railways

Low-noise:

- BP27 – "Reducing noise from rail transport" (maintenance)
- HPT – "Generator Set Enclosure acoustic barrier for rail generators" (Construction), Echo Barrier (UK)
- IC/FP7-TRANSPORT "QUIET-TRACK - Quiet Tracks for Sustainable Railway Infrastructures".

Low-carbon:

- IC/FP7 "OSIRIS - Optimal Strategy to Innovate and Reduce energy consumption In urban rail Systems"

Port infrastructure

- IC/FP7 "NEWS - Development of a Next generation European Inland Waterway Ship and logistics system"
- HPT – "Modular manufacturing for construction of new container port and logistics terminal" (Design / Construction) World London Gateway (UK)

Intelligent transport systems

Low-noise

- HPT – "Temporary Sound Control solutions on transport construction projects", (Construction), SOUNDEX Solutions, Network Rail, Copenhagen Metro Underground

Low-carbon:

- IC/FP7 "COLOMBO - Cooperative Self-Organizing System for low Carbon Mobility at low Penetration Rates"
- IC/FP7 "e-SAVE - Energy Efficiency in the Supply Chain through Collaboration, Advanced Decision Support and Automatic Sensing"
- IC/FP7 "IMPACTS - The impact of the quality of CO2 on transport and storage behaviour"
- IC/FP7 "COMPASS - optimised co-modal passenger transport for reducing carbon emissions"

Other ITS

- IC/FP7 "OPTIRAIL - development of a smart framework based on knowledge to support infrastructure maintenance decisions in railway corridors"
- IC/FP7 "FAULT-ADAPTIVE - Fault-Adaptive Monitoring and Control of Complex Distributed Dynamical Systems"
- IC/FP7 "SECCRIT - SEcure Cloud computing for CRitical infrastructure IT"

Airport infrastructure

- HPT – "Asset management tools enable increase in proactive maintenance of airports" (Maintenance / Operation), IBM, Dubai (UAE)
- HPT – "Smart baggage handling at airports" (Design / Operation), IBM, Schipol Airport (NL)

Step #3. Identify programmes financing the modernisation of TI

Relevant programmes for the transfer of existing technologies:

- H2020 Pre-Commercial Procurement to adapt and adopt existing technologies
- ERDF OP on "Infrastructures and Networks

Step #4. Identify missing technologies requiring further R&D

Keywords Italy: railways, port infrastructure and intelligent transport systems; environmentally-friendly (including low-noise) and low-carbon transport systems, including inland waterways and maritime transport, ports, multimodal links and airport infrastructure

Relevant REFINET Priority actions:

- *New rail infrastructure technologies*. This will include new track forms, switches and crossings, and their potential for commercial development. Development of intelligent infrastructure maintenance and inspection and defect detection technologies carried out at commercial speeds.
- *Infrastructure adaptation to climate change*: Adverse weather conditions have a negative impact on transport service performance and related costs. These costs are expected to increase because of changing climate patterns resulting in an increase in the intensity and frequency of extreme weather events. Weather conditions also affect the ageing of railway infrastructure. In order to mitigate the impact of climate change on transport systems there is a need for infrastructure resilient to climate change.
- *Improved management of critical interfaces with others modes and smart methods for monitoring road-rail intersections* with the use of advanced solutions (GNSS systems, advanced CCTV tools, etc.) and analysis (collaborative tools) integrated by new human centred safety measures, e.g. Level crossing for

rail/road with the aim to minimize risks at and around level crossings by developing a fully integrated cross-modal set of innovative solutions and tools for the proactive management and new design of level-crossing infrastructure. Properly adapted technical solutions deployed within an appropriate human, legal and organisational framework are necessary.

- *Security against terrorism attacks in transit environments (preparedness, prevention, robustness and recovery)*: Security in transit environments refers to the security of airport terminals, buses stops, stations and interchanges, to the immediate vicinity of transport stops and stations and to the 'en route' travel (on board of different modes). Criminal acts are a result of 1) the environment of the transport node itself (e.g., design of platforms, CCTVs, dark corners, hiding places) and, 2) the social interaction within those environments (e.g., poor guardianship, crowdedness). A multi- and interdisciplinary approach is required to tackle transit security and demands more integrated, holistic and cross-disciplinary approach. Also, the identification and assessment of transport infrastructure vulnerabilities regarding man-made threats can contribute to the strengthening of the resilience of the European Transport Network against various man-made hazards, by providing road owners and operators with an easy to manage, practice-oriented tool for the assessment of the infrastructure.
- *Security by design*: There is a considerable scope in the design and planning of station infrastructure to include proven and effective security measures to prevent, mitigate or deter attacks from terrorists. Multi modal hub infrastructure should be designed to ensure the control of flow of persons or goods in any circumstances but without jeopardizing the performances of activities. The measures to improve security include the implementation of appropriate physical secure stations/terminals against bomb blast, CBRN (Chemical, Biological, Radiological and Nuclear) attacks involving particle dispersion and fire events); security procedures (screening, materials detection, intrusion detection systems, and tracking applications) should be considered at all stages of station development. The containment (where possible) of building services and power supplies, locating public car parks as far away from station buildings, creating a distinct separation with other 'crowded places' are examples of possible measures.

Acquisition of additional, specific data

To ensure an accurate, detailed user profile on the TI-TechMapper, additional data, specific to each transport mode and each country where the TI is concerned, is needed, as follows:

- KPIs for the parameters of the RMTTI model - Green, Cost-Efficient, Social/Inclusive, Resilient and Safe/Secure (i.e. share a set of indicators/targets that local partners are after for their TI)
- Directory of stakeholders
- Best practices in design, operation and maintenance at local/national levels
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- Recent R&D projects at local/national levels
- National funding priorities and schemes
- And all data which are not available at the EU Transport Scoreboard : http://ec.europa.eu/transport/facts-fundings/scoreboard/compare/investments-infrastructure/quality-rail-infrastructure/2013_2014/index_en.htm such as:

5.5 Annex V - TI-TechMapper: USAGE SCENARIO #1

Based on the data collated during task 4.2 (see Annex III), a usage scenario for Romanian users of the platform has been created to illustrate how the TI-TechMapper could be leveraged by a stakeholder of the TI sector.

- **Profile: Stakeholder (e.g. Infrastructure Manager) in the Transport Infrastructure sector**[28]
- **Purpose:** The aim of the stakeholder is to identify highly potential technologies developed in European Project dealing with multi-modality, with particular focus on specific topics

Background:

In the framework of REFINET Platform development and Proof of Concept, **Romania T&I network** (and especially the railway network) has been selected as Case Study. Although Romania sits on important routes connecting Central Europe with the Black Sea and the Caucasus, its transport infrastructure is under developed relative to the volume of goods and passengers that transit Romanian territory, and accessibility remains a major barrier to regional growth. Connectivity via all transport modes is suboptimal due to the backlog of investments, as well as deficiencies in the maintenance and operation of the infrastructure.

Group	Case study country
Group#3: Low performers (below low threshold)	Romania: As far as the quality of transport infrastructure is concerned, ratings for all modes of transport in Romania are quite low.

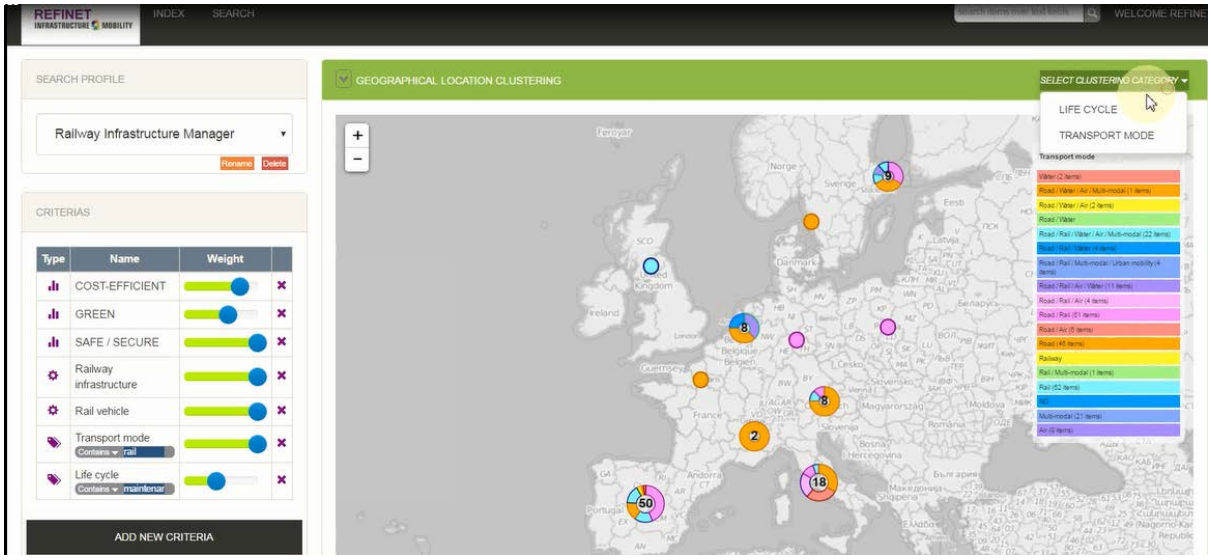
Case in point:

In 2016, Romanian Compania Naţională de Căi Ferate was funded by Connecting Europe Facility (CEF) to upgrade the Braşov–Sighişoara railway section, Apaţa–Caţa sub-section, to be fully compliant with EU Regulations 1315/2013 and 1299/2014 and the interoperability Directive 2008/57/EC.

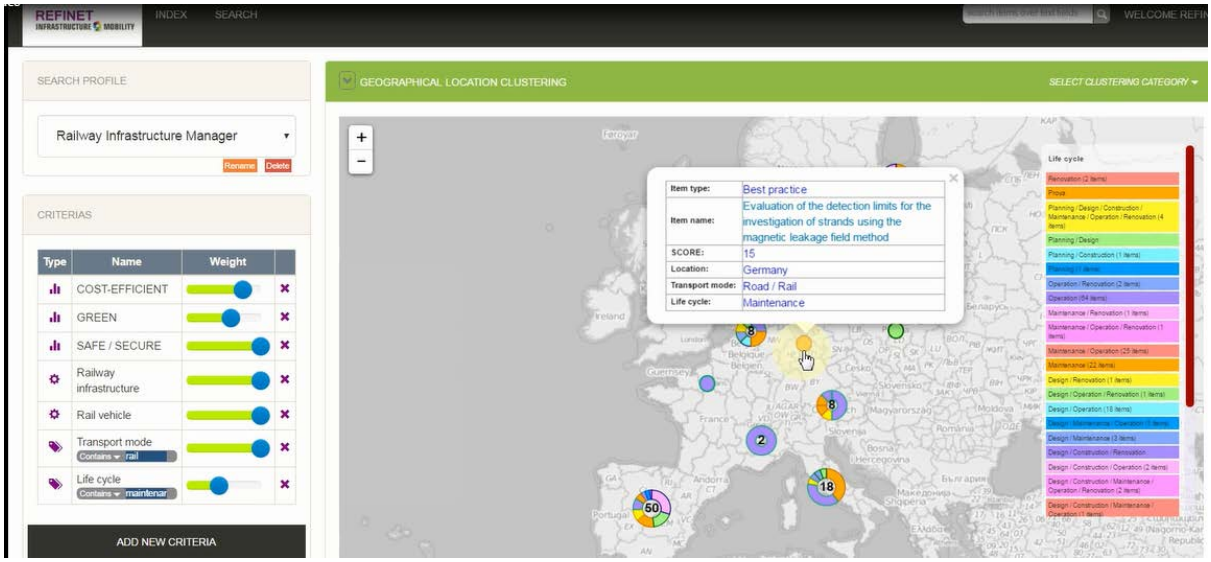
[28] Further user profile data will continue being uploaded into the Platform post-project to enable ever more accurate searches (See Annex III).

In this framework, The Romanian Railway Infrastructure Manager is looking for the most cost effective maintenance methods on railway system, coming from best practices, high-promising solutions/technologies, R&I projects, on the basis of its specific needs. Hereafter is the process he or she will follow to identify relevant results.

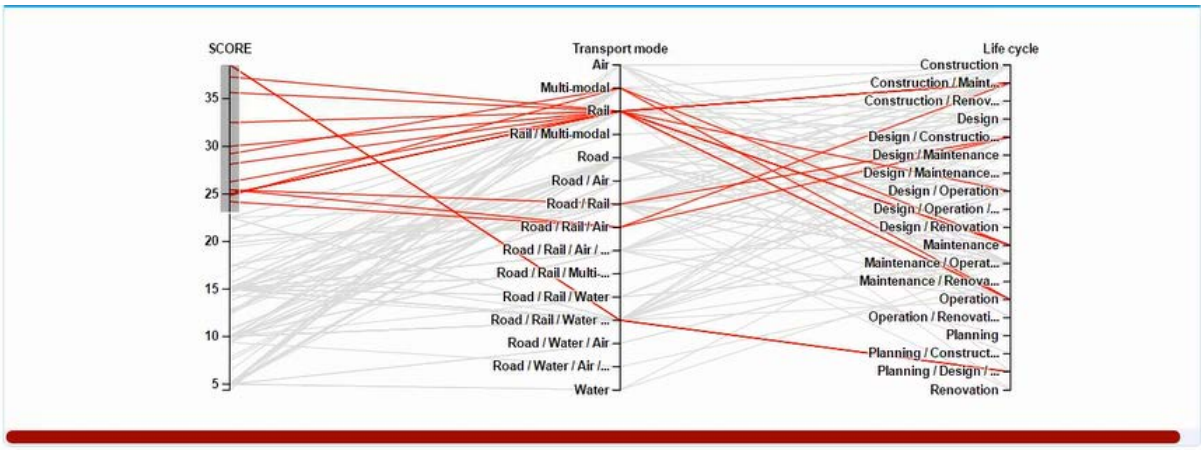
The Romanian Railway Infrastructure Manager first create the profile “Railway Infrastructure Manager”, by adding to a predefined profile “Infrastructure Manager”, a focus on “railway” as well as specific KPIs of interest (GREEN, SAFE e COST-EFFICIENT) and the focus on “maintenance” phase of the Life-cycle of a Transport Infrastructure.



Afterwards he looks for specific project, by clinking on a specific “dot” in the map.



He then refine the search by selecting projects, technologies, and best practices which score is higher than an identified average value. The latter is calculated on the basis of the "weights" attributed by him to the profile criteria.

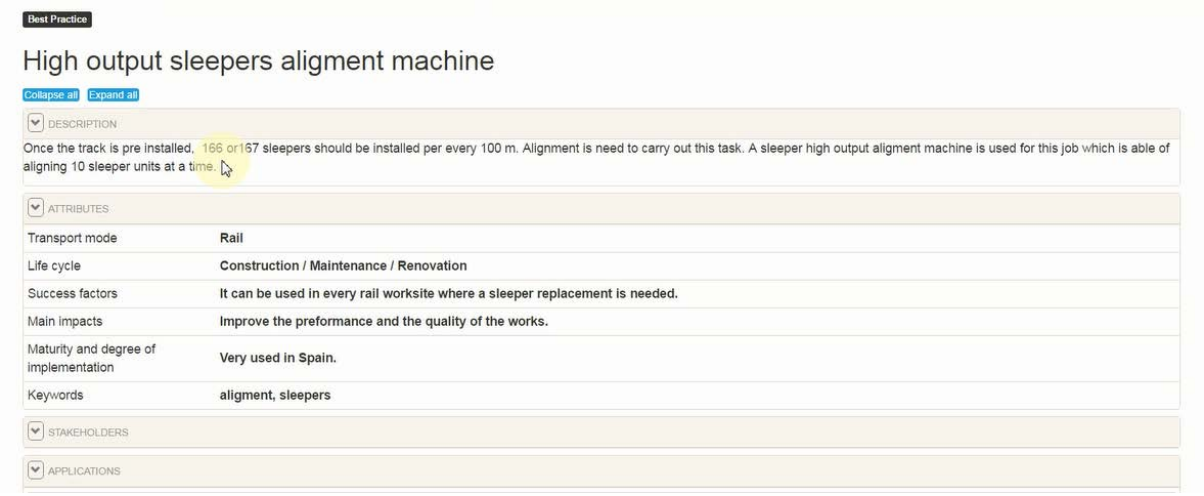


The obtained result are listed in a tabular form, so that to enable further details search by means of enabling external links.

RESULTS TABLE (SELECTED 18 OVER 258 ITEMS FOUND)

Item type	Item name	SCORE	Location	Transport mode	Life cycle	GREEN	COST-EFFICIENT	SAFE / SECURE
Research Project	Risk based approaches for Asset inteGrity multimodal Transport Infrastructure ManagEment	38.575	United Kingdom	Road / Rail / Water / Air / Multi-modal	Planning / Design / Construction / Maintenance / Operation / Renovation			
Research Project	Risk based approaches for Asset inteGrity multimodal Transport Infrastructure ManagEment	38.575	Slovenia	Road / Rail / Water / Air / Multi-modal	Planning / Design / Construction / Maintenance / Operation / Renovation			
Research Project	Risk based approaches for Asset inteGrity multimodal Transport Infrastructure ManagEment	38.575	Italy	Road / Rail / Water / Air / Multi-modal	Planning / Design / Construction / Maintenance / Operation / Renovation			
Best Practice	Reducing noise from the rail	37.3	Sweden	Rail	Maintenance			

Among the others best practices (high TRL level) are identified that might be of interest to the Railway Infrastructure Manager to look for available solutions that can improve the cost-effectiveness of maintenance. He can have more details by clicking on the corresponding best practice to open an additional link as shown below.


Best Practice

High output sleepers aligment machine

Collapse all Expand all

DESCRIPTION

Once the track is pre installed, 166 or167 sleepers should be installed per every 100 m. Alignment is need to carry out this task. A sleeper high output aligment machine is used for this job which is able of aligning 10 sleeper units at a time.

ATTRIBUTES

Transport mode	**Rail**
Life cycle	**Construction / Maintenance / Renovation**
Success factors	**It can be used in every rail worksite where a sleeper replacement is needed.**
Main impacts	**Improve the preformance and the quality of the works.**
Maturity and degree of implementation	**Very used in Spain.**
Keywords	**aligment, sleepers**

STAKEHOLDERS

APPLICATIONS

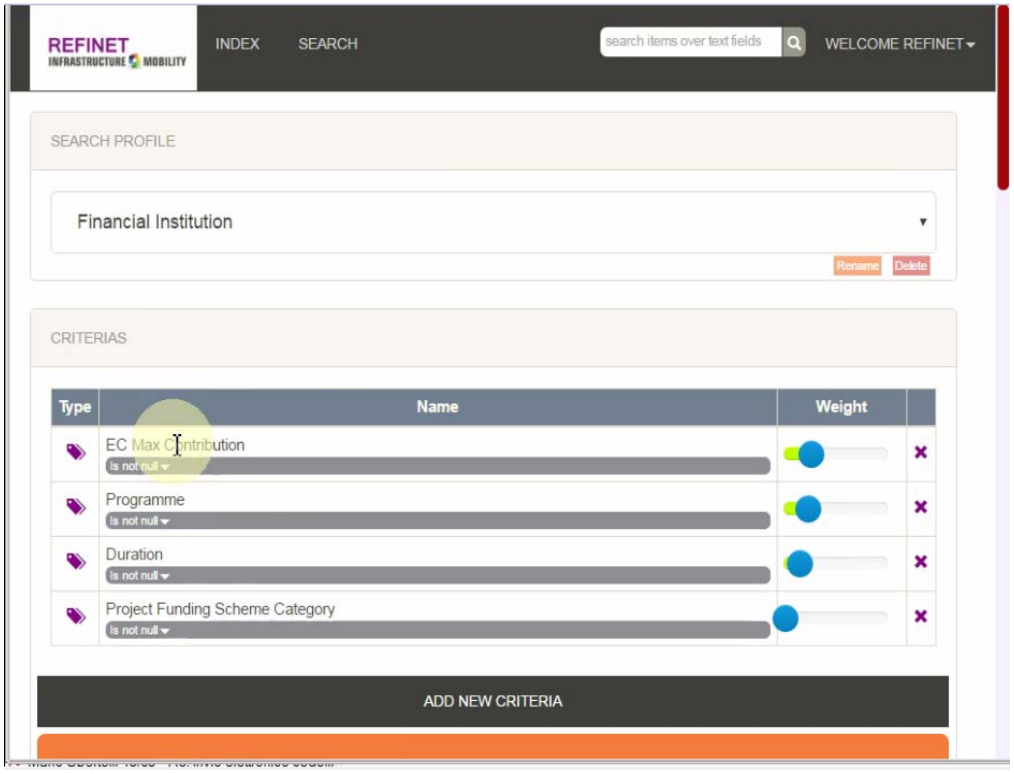
If they results of the analysis correspond to realistic options for the infrastructure manager, he will then be able to contact the IP owner and explore the possibility of transferring these methods.

5.6Annex VI - TI-TechMapper USAGE SCENARIO #2

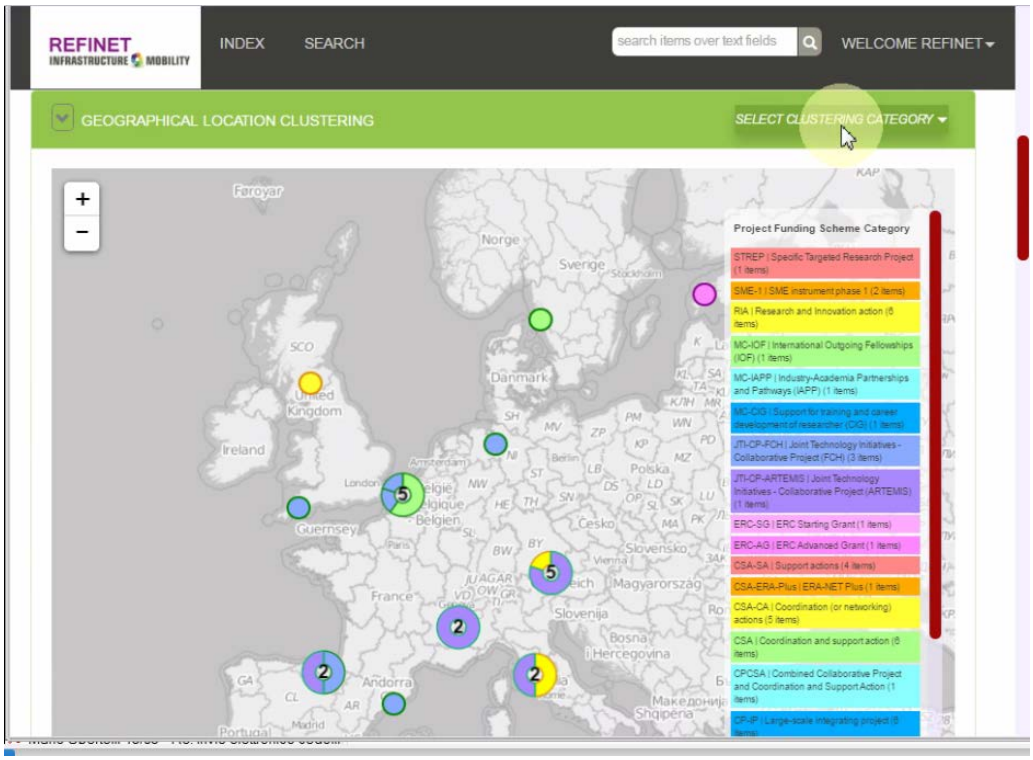
- **Profile: Policy Officer**
- **Purpose:** Policy Officer is interested in analyzing the funding for specific mode, life-cycle place, demonstrator, in specific countries (related to TI), matching them with structural funds

Process:

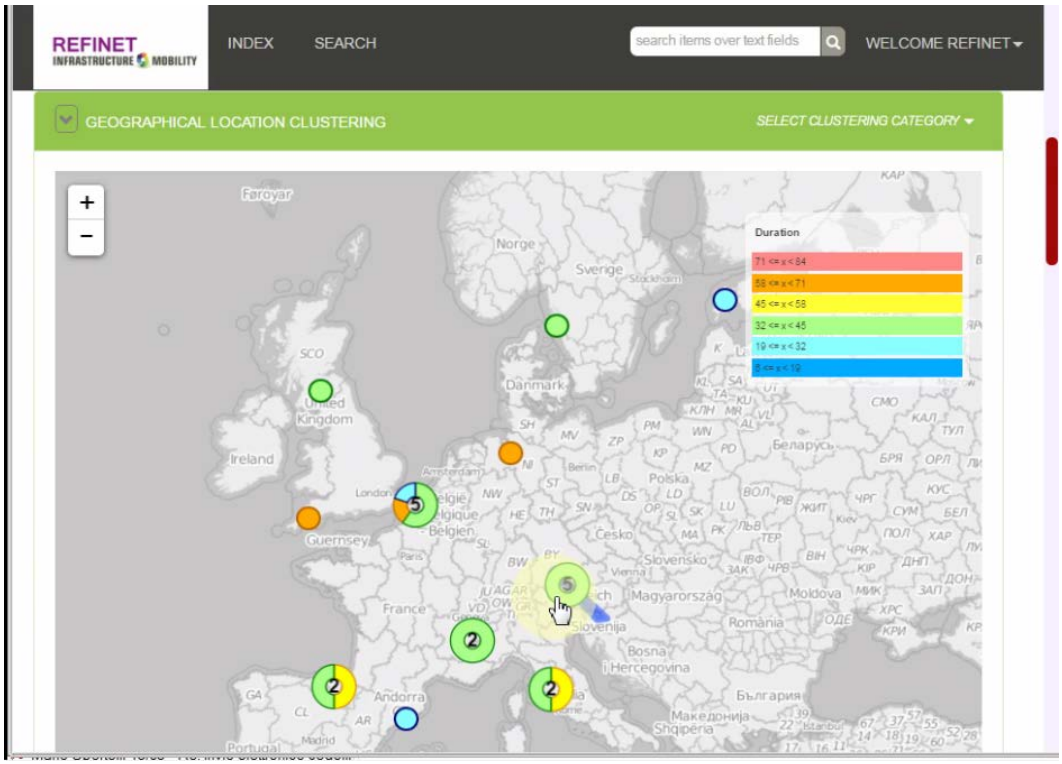
An Officer of the European Union is interested in analysing the different funding schemes in the framework of FP7 and H2020 and associates them with closed and ongoing projects considering the budget distribution across EU Countries. After the login, EU Officer selects the Profile " Financial Institution" having a set of predefined selection criteria: EC Max Contribution, Programme, Duration and Project Funding Scheme Category. Using the predefined criteria weighted in term of relevance, the EU Officer starts the search using the "Do Search" button.



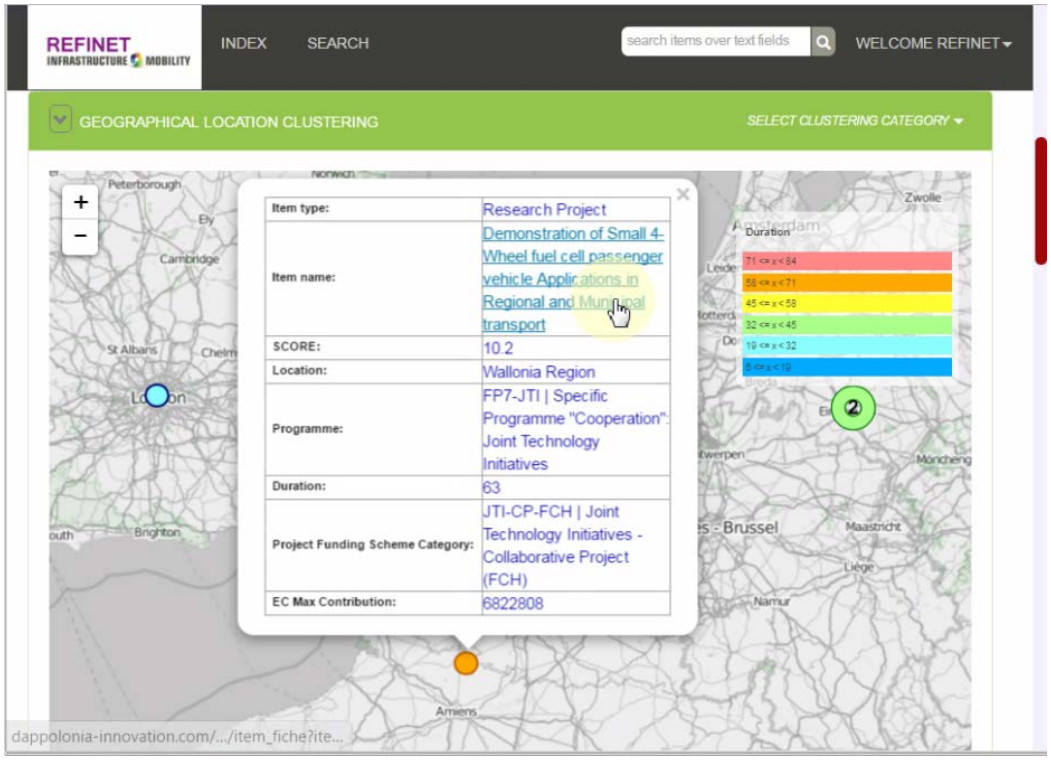
The Geographical map view shows to the EU Officer the geographical distribution of European Projects funded in different years clustered by means of "Project Funding Scheme Category" criteria.



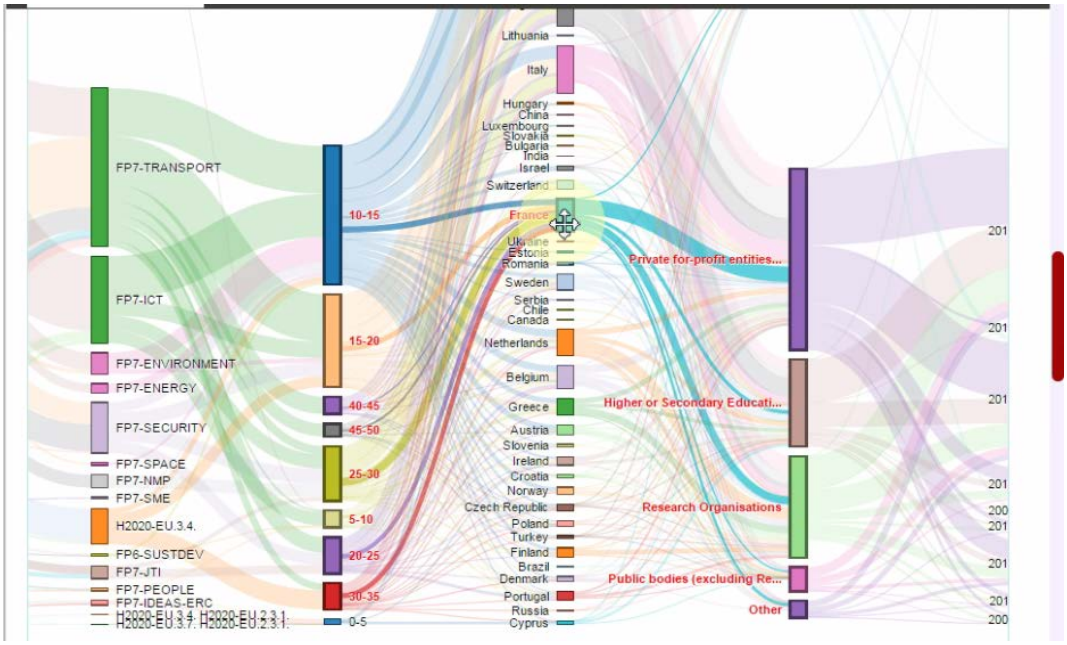
The EU Officers selects the duration criteria and the REFINET platform adapt the geographical view by clustering the projects on the basis of “duration”.



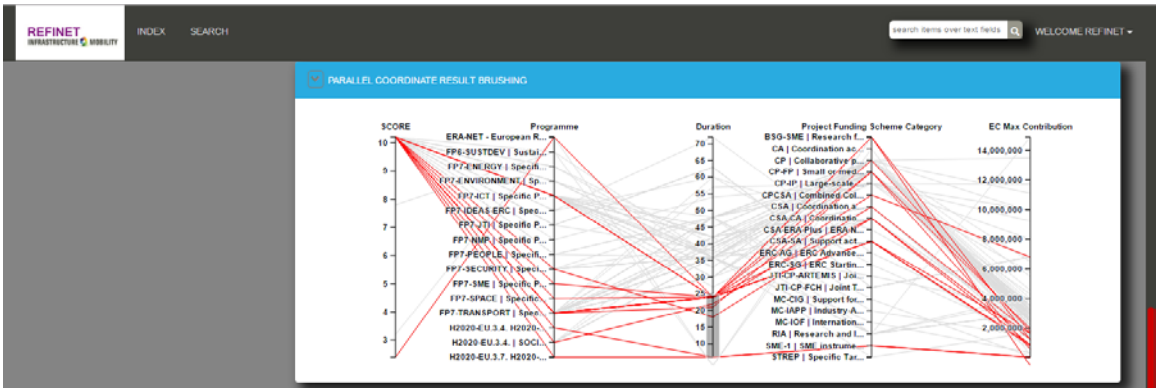
Hooking a single project on the geographical view, the EU Officer can see details about the project



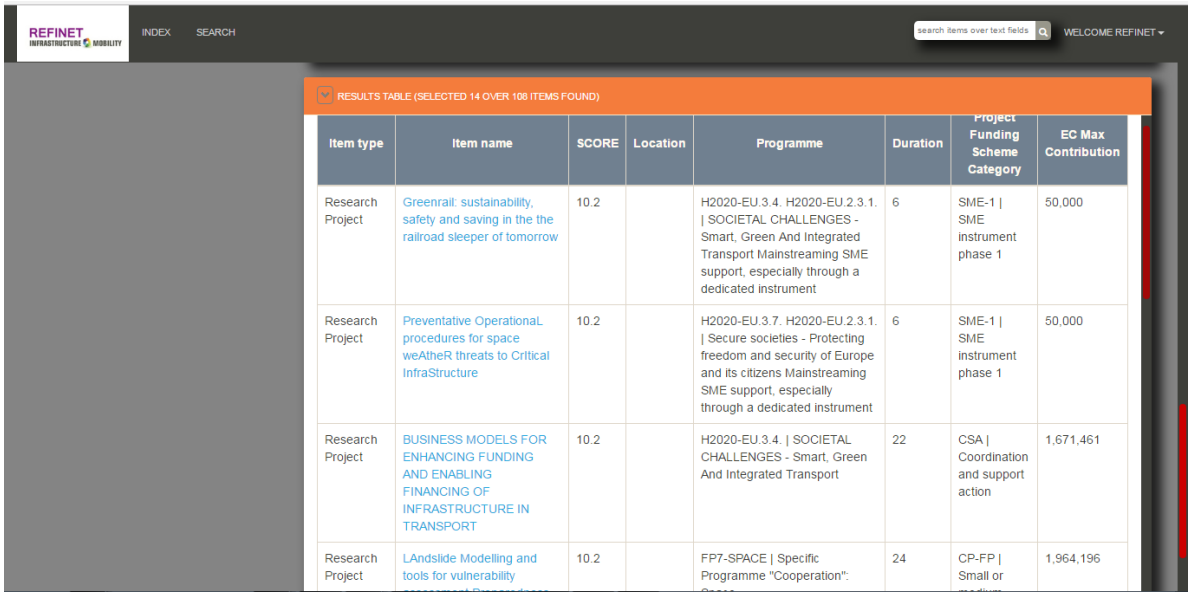
Another powerful representation of the REFINET platform is the **Eu contribution sankey diagram** in which the width of the arrows is shown proportionally to the flow quantity. This view allows the EU Officer to understand in an effective way the different budget distribution among Funding schemes, EU Countries and consortium of different dimensions, distinguishing the various contributions.



Then the EU Officer refines the search with the "dynamic query view" filtering the projects with a duration less of 24 months.



The results of the query is presented in a tabular form.



Item type	Item name	SCORE	Location	Programme	Duration	Project Funding Scheme Category	EC Max Contribution
Research Project	Greenrail: sustainability, safety and saving in the the railroad sleeper of tomorrow	10.2		H2020-EU.3.4. H2020-EU.2.3.1. | SOCIETAL CHALLENGES - Smart, Green And Integrated Transport Mainstreaming SME support, especially through a dedicated instrument	6	SME-1 | SME instrument phase 1	50,000
Research Project	Preventative OperationaL procedures for space weAtheR threats to Critical InfraStructure	10.2		H2020-EU.3.7. H2020-EU.2.3.1. | Secure societies - Protecting freedom and security of Europe and its citizens Mainstreaming SME support, especially through a dedicated instrument	6	SME-1 | SME instrument phase 1	50,000
Research Project	BUSINESS MODELS FOR ENHANCING FUNDING AND ENABLING FINANCING OF INFRASTRUCTURE IN TRANSPORT	10.2		H2020-EU.3.4. | SOCIETAL CHALLENGES - Smart, Green And Integrated Transport	22	CSA | Coordination and support action	1,671,461
Research Project	LAndslide Modelling and tools for vulnerability	10.2		FP7-SPACE | Specific Programme "Cooperation":	24	CP-FP | Small or	1,964,196