D 1.1 PROJECT PRESENTATION

PASSION fact sheet and power point presentation

Project title	**Photonics technologies for ProgrAmmable transmission and switching modular systems based on Scalable Spectrum/space aggregation for future aglle high capacity metrO Networks**
Project acronym	**PASSION**
Grant number	**780326**
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TABLE OF CONTENTS

Executive summary 4
1 Introduction 5
2 Consortium 6
3 Project objectives 10
4 Technical approach 11
5 Project management 13
6 Planned achievements and impact 14
Annex 1 – Project fact sheet 15
Annex 2 – Project presentation - slides 16

EXECUTIVE SUMMARY

This document is the deliverable D1.1 of PASSION Project.

It is a document produced within Work Package 1 “Project management and coordination” and it gives an overview of the project.

The reader will be provided with the most relevant information regarding the project objectives, expected results, vision and approaches. In particular, it will be underlined how the project activities will bring the consortium to reach the main project objectives. This presentation as well as the project fact sheet and the project presentation slides (Annexes) will be used as dissemination material.

1 INTRODUCTION

PASSION is a RIA Project funded under Horizon 2020, Call ICT-30-2017.

In the last decade, we assisted to a continuous development of the fibre optic networks for metropolitan applications, but we are now facing a bottleneck in transmission and routing of the huge amount of data due to the dramatic increase in the user's number, in the content size, and to the convergence with mobile and datacom networks. Photonics is a key enabling technology for the evolution of the entire telecommunication infrastructure, but the technologies used so far for the metro network directly derive from the long-distance transport and they are too expensive and power hungry.

Alternatively, PASSION will develop an innovative technological platform based on directly-modulated vertically emitting laser sources (VCSEL) and on multi-channel coherent receivers integrated on Silicon-Photonics technology, providing high modularity and aggregating signal flows with a capacity of 16 Tb/s per spatial channel and 112 Tb/s per link exploiting a 7-core fibre.

PASSION technologies will achieve a 10-fold power-consumption reduction with respect to commercially available modules based on externally modulated traditional sources. The dimensions of the PASSION modules will be even 3 orders lower than the current WDM solutions.

Thanks to these innovative transmitters and receivers, PASSION will design a flexible network architecture, optimized for metro applications, based on aggregated signal flows, exploiting the full wavelength spectrum and the "space" dimension in a multi-core fibre. Photonic devices capable of aggregating/disaggregating and/or routing data flows in spectrum and/or in space will allow a switching capacity of 1 Pb/s node. The metro network architecture developed in PASSION will thus provide a full programmability to match the traffic evolution.

PASSION will contribute to reinforce European industrial technological leadership in high-capacity photonic devices and sub-systems, addressing the growing market of metro networks, improving business opportunities in Europe. Therefore, it addresses the objective of ICT-30-2017 i).

Project acronym	PASSION
Project title	Photonic technologies for a programmable transmission and switching modular systems based on Scalable Spectrum/ space aggregation for future high capacity metrO Networks
Grant agreement no.	780326
Theme	ICT
Project and Scientific Coordinator	Prof. Pierpaolo Boffi, *Associate Professor at Politecnico di Milano*
Participating Countries	Finland, France, Germany, Israel, Italy, Spain, The Netherland, Japan, Korea
Project total costs	8.393.076,25 €
EU Funding	7.535.747,50 €
Duration	December 2017 – November 2020
Website	http://www.passion-project.eu
Keywords	Next-generation metro network, VCSEL, Silicon Photonics, S-BVT, WSS, optical switch, SDN

2 CONSORTIUM

Thirteen participants, coming from seven different EU countries (Finland, France, Germany, Israel, Italy, Spain and The Netherlands) and from two non-European countries (Japan and Korea) compose the Consortium in order to achieve all of **PASSION** goals.

Participant no. *	Participant organisation name	Part. short name	Country
1 (Coordinator)	Politecnico di Milano	POLIMI	Italy
2	Centre Tecnològic Telecomunicacions Catalunya	CTTC	Spain
3	Technische Universiteit Eindhoven	TUE	Netherlands
4	VTT Technical Research Centre of Finland Ltd	VTT	Finland
5	Vertilas GmbH	VERT	Germany
6	VLC Photonics S.L.	VLC	Spain
7	OpSys Technologies	OPSYS	Israel
8	Effect Photonics BV	EFP	Netherlands
9	SM Optics S.r.l.	SMO	Italy
10	Telefónica Investigación y Desarrollo SA	TID	Spain
11	European Photonics Industry Consortium	EPIC	France
12	National Institute of Information and Communications Technology	NICT	Japan
13	Electronic and Telecommunications Research Institute	ETRI	Korea

The PASSION Consortium collects all the skills needed to fulfil project tasks as the different Partners have complementary expertise. The PASSION consortium includes universities, research centres, small medium-size enterprises (SMEs) for devices manufacturing, an industrial consortium, a supplier of communication equipment, and a network operator in order to address the entire supply chain:

- **Politecnico di Milano (POLIMI)** is the first Italian university both in general and in the Engineering & Technology category, according to the 2015 QS World University Ranking. Today POLIMI is the largest school of architecture, design and engineering in Italy. In particular, the *Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB)* is one of the

largest European ICT departments, with a strong reputation in attracting projects and investments, from both public institutions and private companies, at a national and international level. Within PASSION, the POLIMI Team is constituted by the Optical Communications Group (now called PoliCom Group) at DEIB, representing a mix of interdisciplinary competences and experiences in optical fibre communications. PoliCom expertise include also specific aspects of optical communication systems at high bit rate for short, medium and long-haul distances; fibre-optic and related optical technologies; exploitation of multicarrier modulation formats, spatial division multiplexing (SDM) propagation and management; energy-efficient and cost-effective solutions for metro/access domain, WDM and TWDM PON and client optics applications. POLIMI will coordinate PASSION and will support the VCSEL characterization and the exploitation of high spectral efficiency modulation formats in the experimental demonstrator.

- **The Centre Tecnològic de Telecomunicacions de Catalunya (CTTC)** is a non-profit research institution based in Castelldefels (Barcelona), resulting from a public initiative of the Regional Government of Catalonia (Generalitat de Catalunya). Research activities, both fundamental and applied, are organized onto four research divisions: Communication Networks, Communication Systems, Communication Technologies and Geomatics. Within the Communication Networks Division, the Optical Networks and Systems (ONS) department of CTTC has broad experience in research programs due to its participation in several Spanish and European public-funded R&D projects, closely collaborating with leading research institutions in Europe or Japan. CTTC will be involved in the analysis of the capabilities of the radically new scalable and modular metro systems architecture, including SDN-enabled adaptive transmission systems and the suitable control and management infrastructure.
- **Technische Universiteit Eindhoven (TUE)** in the Netherlands offers (pre)graduate engineering programmes (BSc and MSc) and post-graduate technological design (MTD), PhD and teacher training programmes (MSc) and post-academic continuing education. The courses are research-driven and design-oriented. In particular, TUE hosts the Dutch national centre on III-V-semiconductors and opto-electronics and with these facilities, COBRA belongs to the world's best equipped academic research centres in the field of Photonics. As an expert of node/switch technologies and of integration on silicon, in PASSION TUE will provide the design and the fabrication of integrated switching circuits and the support in Tx and Rx modules.
- **VTT Technical Research Centre** of Finland is a non-profit government organization established by law and operating under the auspices of the Finnish Ministry of Employment and the Economy. VTT is a multi-technological research organization providing high-end technology solutions and innovation services. From its wide knowledge base, VTT can combine different technologies, create innovations and a wide range of world-class technologies and applied research services, thus improving its clients' competitiveness and competence. Within PASSION, VTT will support the passive silicon on insulator (SOI) design, fabrication and testing of the Tx and Rx devices.
- **VERTILAS GmbH (VERT)**, founded in 2001, is a spin-off from the Technical University of Munich (TUM). The founders and research team of VERT have pioneered the work of Indium-Phosphide based long-wavelength VCSELs. They developed a unique laser design around a Buried Tunnel Junction (BTJ) concept and internationally launched single mode InP VCSEL products with more than 15 different wavelengths for various applications. VERT VCSELs are specifically designed and manufactured to offer excellent single mode behavior and excellent performance over a wide temperature range. They can be directly modulated at

10.3 Gbps and 25.8 Gbps, with the fastest data rate measured at 50 Gbps. In general, this VCSEL technology shows very low power consumption and enables system designers to reduce power consumption by 50% and more compared with other lasers technologies. Within PASSION, VERT will design, process and characterize the high-performance single-mode WDM VCSELs.

- **VLC Photonics** is a spanish SME devoted to providing all kind of services related to the development of photonic integrated circuits (PICs). VLC is a spin-off company from Universitat Politecnica de Valencia (UPV, Spain), specifically from the Optical and Quantum Communications Group, worldwide reputed in the fields of Optical Communications, Quantum optics and Microwave Photonics. VLC, as a pure-play fabless design house, works with multiple foundries embracing the generic integration model, and makes use of these fabrication platforms to always chose the most suited substrate material (Silicon-on-insulator, Silica/PLC, SiN/TripleX, InP/GaAs) for the application at hand. Within PASSION, VLC will support on specification, design and characterization activities of photonic circuits, and will serve as a platform to commercially exploit design libraries from VLC and any other partner too.
- **OPSYS Technologies** is a spin-off company of Finisar corporation Israel based R&D center, located in Israel. OPSYS core technology is different type of electro-optical devices development and integration. By using this technology OPSYS provides electro-optic based solutions for various markets and applications, with strong expertise in optics, RF design, transceiver, wavelength selective switch (WSS) and advance transceiver based line cards for data and telecommunication. OPSYS has in house production capability with the most advanced test and measurement equipment. OPSYS will design and manufacture high density and high baud rate transceivers and high port count WSS based line cards.
- **Effect Photonics B.V. (EFP)** is a research-performing SME based in Eindhoven. It was founded in 2010 and was spun out of the prestigious Eindhoven University of Technology (TUE) in 2013. EFP develops and delivers optical communication products based on InP (Indium Phosphide) photonics integration using a fabless business model. The PIC design expertise is combined with a unique low-cost packaging technology, developed in-house specially for highly integrated system-on-chip products. Within PASSION, EFP will develop the multichannel coherent receivers.
- **SM Optics (SMO)** is a young Company, part of SIAE Microelectronics Group, funded from a spinoff of Alcatel-Lucent Italia. It has been built over the core R&D team of about 270 people, who since 1990 develop a piece of history of Italian telecommunication sector deeply influencing the worldwide market with innovative products. Besides to continue to support Alcatel-Lucent product development as consultant, SMO is working on new products addressing both Telecom and Datacom market, introducing strong differentiators both in photonics and in network management domains. SMO will support the system subsystem integration and the experimental demonstration in a suitable field-trial, considering also the standardization aspects.
- **Telefónica Investigación y Desarrollo (TID)** is the innovation company of the Telefónica Group. Owned 100% by Telefónica, this subsidiary was formed in 1988, with the aim of strengthening the Group's competitiveness through technological innovation. Within PASSION, the TID Team is constituted by the Core and Transport group, which will support the network architecture design and identify the metro user requirements. Universidad Carlos III de Madrid (UC3M) will participate to PASSION as a third party of TID. Therefore, UC3M will work on the techno-economic analysis of PASSION deployment scenarios and the scientific dissemination of the results.

- **The European Photonics Industry Consortium (EPIC)** is an association with more than 300 leading industry members from the photonics value chain. It is a non-profit, industry driven, small enterprise registered in France and operating from offices in Brussels and Eindhoven, where it can leverage its close ties to other connected organizations such as SEMI and Digital Europe. EPIC works closely with related industries, universities, and public authorities to build a more competitive photonics industrial sector, capable of both economic and technological growth in a highly competitive world-wide marketplace. Within PASSION, EPIC will support all the activities regarding the exploitation and the dissemination of the results.
- **The National Institute of Information and Communications Technology (NICT**) is Japan's sole National Research and Development Agency specializing in the field of information and communications technology. NICT is charged with promoting ICT sector as well as research and development in ICT, which drives economic growth and creates an affluent, safe and secure society. NICT promotes the full spectrum of research and development in ICT from basic to applied research with an integrated perspective, and thus promotes the advancement of Japan as an intellectual nation that leads the international community. Within PASSION, NICT is present with the Photonic Network System Laboratory (PNSL), one of the world's leading research laboratories specializing in advanced SDM transmission fibres, dynamic networks and optical access technology. NICT will support the project with multicore fibres and device testing in its suitable test bed.
- **Electronic and Telecommunications Research Institute (ETRI)** is the biggest government-funded research institute in Korea and has led to the successful development of Korea in the area of information and telecommunication technologies since its foundation in 1976. In addition, to create the synergy between photonic and wireless semiconductor components, ETRI performs researches on compound semiconductor materials (e.g. InP, GaAs, GaN etc.) to develop ultra-high speed photonic/wireless components, such as high-speed optical network components, 3D packaging technology for optical and wireless convergence devices. ETRI will support PASSION with space switch devices and components.

3 PROJECT OBJECTIVES

The main goal of PASSION project is the development of application driven photonic technologies supporting an innovative transceiver and node featuring different levels of aggregation (in spectrum, polarization and space) for an envisaged network architecture able to match the growing traffic demand in metro connections.

The proposed approach is capable to establish high capacity connection for metro network distances (a few hundreds of km) with high-throughput, low-cost, energy-efficient, reduced-footprint devices for massive deployment. End-to-end metro transport for novel services and business is achieved with dynamic SDN control of the different systems and subsystems to ensure metro connectivity and deployment of services.

In order to pursue its ambitious goal, PASSION is based on the design and feasibility demonstration of photonic components and sub-systems, targeting **five main science and technology (S&T) Objectives**:

Objective 1: Design and development of photonic technologies for the realization of a new generation of energy-efficient and compact transmitter (Tx) modules for the metro network enabling up to Tb/s capacity per PIC.

Objective 2: Design and development of photonic technologies for the realization of a new generation of compact, flexible receiver (Rx) modules for the metro network, able to sustain the PASSION sliceable-bandwidth/bitrate approach.

Objective 3: Development of energy-efficient and small-footprint switching technologies for a node featuring functional aggregation/disaggregation, together with switching in the space and wavelength domain in order to handle 1-Pb/s capacity.

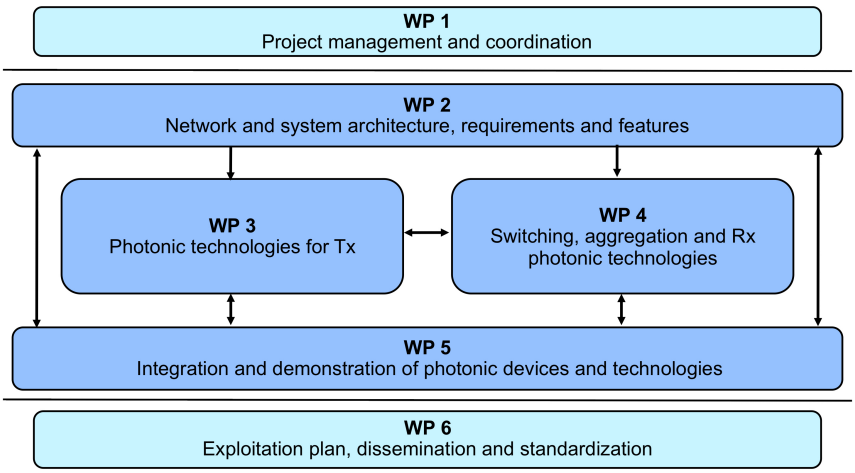
Objective 4: Design and development of scalable and modular S-BVT architectures, allowing to adaptively generate multiple flows of Tb/s capacity and enabling up to 100 Tb/s aggregated capacity per link.

Objective 5: Development of scalable and modular metro network architectures for subsystem sharing and functional reuse to support flexible agile spectrum/spatial switching addressing capacities of Pb/s per node.

The PASSION project team aims at upgrading the present metro network targeting **1 Tb/s per channel** and enabling up to **100 Tb/s per link** thanks to flexible agile spectrum/spatial aggregation. Moreover, with respect to the present solutions based on external modulation, PASSION will demonstrate the development of suitable optical modules achieving at least a **10-fold energy reduction** in consumed Joule/bit and equipment **footprint reduction by more than 10**. The agile generation and routing of optical channels with high-capacity will be enabled by scalable, modular, sliceable bandwidth/bitrate variable transport, enhancing system capacity and reach, also exploiting the space dimension (SDM is approached either considering different fibre cores or different fibres in a bundle).

4 TECHNICAL APPROACH

PASSION is organized in four technical WPs plus two additional WPs, WP6 devoted to the exploitation plan, dissemination, standardization, and technology transfer and WP1 devoted to the project coordination. The technical WPs focus on the central S&T Objectives (Objective 1 to Objective 5), described in the previous paragraph, with a straightforward relationship between Objectives and work-packages. PASSION aims at developing radically new scalable and modular photonic technologies and devices to support future metro transmission, switching and interconnection. WP2 defines network, systems and subsystems requirements and use cases for the designed metro network and node architectures featuring different levels of aggregation to match the traffic demand. Specifically, the network relies on programmable (SDN-enabled) scalable and modular systems including S-BVT and node architectures. The S-BVT is based on directly modulated VCSELs and coherent receiver to enable up to Tb/s capacity per channel. Exploiting the polarization and spectral dimension over the whole C-band and the spatial dimension (multi-core fiber or fibre bundle) up to 100 Tb/s aggregated capacity per link will be enabled. The PASSION node architecture is based on flexible optical switching supporting modular on-chip functionalities and agile Pb/s spectrum and space aggregation. To pursue this ambitious network approach, PASSION develops and deploys fundamental photonic technologies in WP3, and WP4. Specifically, in WP3 the WDM VCSELs are produced and aggregated by the development of compact SiPh integration solutions with dual side SOI wafer processing for the co-integration of thermo-optic tuning layer and high-speed interconnects. In WP4 a flexible switching node providing agile spectrum switching and aggregation is achieved thanks to the exploitation of monolithic and hybrid integrated active (gain and tuneable) devices with passive circuitry on InP an SiPh, respectively, in order to support SDM routing. Suitable space switches and wavelength routing for spectrum slicing, switching and aggregation functionalities will be developed. PASSION receiver module will be developed in WP4 integrating few coherent PDM receivers to obtain footprint reduction with respect to the commercial modules, useful for the development both of the transceiver and the node. WP5 will support all the other R&D WPs integrating, testing and demonstrating the PASSION design and the developed technologies/solutions. WP5 includes a network-wide proof-of-concept demonstration, exploiting the developed devices and technologies, and supported by multi-core fibres and SDM technology provided by NICT. The work plan is complemented by the project management tasks in WP1 and by the definition of the exploitation plan, of dissemination, technology-transfer and standardization activities in WP6.



The description and the objectives of the six WPs are reported in details below.

WP-1: Project management and coordination
WP-1 provides PASSION management, aiming at carrying out an adequate administration of the project, a good partners coordination, control and care of project schedule. Moreover, risk management strategies and contingency plans are properly developed. Special attention is given to the communication tools in order to give appropriate visibility to the project through an up-to-date project web site, a detailed calendar of events and clear project presentations.

WP-2: Network and system architecture, requirements and features
The objectives of WP-2 are the definition of network, systems and subsystems use cases and requirements according to operator roadmaps; the design of the metro network and node architectures featuring different levels of aggregation to match the traffic demand, including control aspects; the design of programmable scalable and modular S-BVT architectures targeting high capacity and increased transport distances; the techno-economic studies and analysis to evaluate the proposed technical solutions.

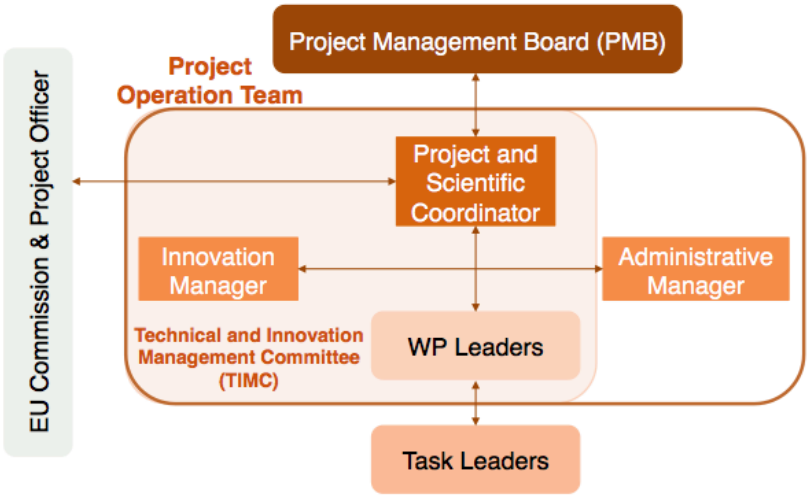
WP-3: Photonic technologies for Tx
The objectives of WP-3 are to create a compact transmitter module (with capacity higher than 1 Tb/s) which can be aggregated with similar such modules to create a 16 Tb/s transmitter sub-system; to develop high bandwidth and large tuning range C band VCSELs for use in the transmitter module; to develop a low-cost packaging concept based on dual side processing of SiPh wafers to allow for tight integration of optical and electronic components with a SiPh optical planar circuit.

WP-4: Switching, aggregation and Rx photonic technologies
The objectives of WP-4 are to deliver the optical switching node with flexible and aggregation functionalities to improve effective and agile usage in a statistical multiplexing fashion of data traffic by bundle of fibre pipes; to handle the add/drop traffic and aggregation/disaggregation functionalities in a modular fashion based on the use of three core devices like space switch, multicast switching and the wavelength selecting switching; the design and fabrication of high-port count photonic space switch which allows high port count with low-cost and low-power consumption; the design of compact and lossless add/drop switches for connectivity to all the add/drop channels, the design of compact and lossless aggregator switches allowing full usage of the data links, as well as to add the data from the transmitter side; the design and realization of a multichannel coherent receiver; the development of the photonic technology for the integration of the multichannel coherent receiver.

WP-5: System Integration and Field Trial
The objectives of WP-5 are the design a continuous integration process of the project outcome in an evolving test bed(s), enabling the monitoring and the verification of the Project results; the design and development of an SDN control platform; the integration and assessment of SDN-enabled S-BVTs based on the proposed photonic devices and technologies.

WP-6: Dissemination technological transfer and standardization
The objectives of WP-6 are to provide recommendations on migration and roadmap for industrialization; coordinate and perform project results dissemination; to promote the technical results of PASSION to the European and global research community; the coordination of dissemination activities; the exchange with other projects active in neighbouring fields with similar focus; to generate a SW tool for metro network design for operators willing to exploit PASSION technologies; to participate to international standardization bodies.

5 PROJECT MANAGEMENT



PASSION exploits a light project management structure to allow the degree of flexibility necessary for the efficient management of a complex multi-national, multi-stakeholder and multi-cultural Research and Innovation project with strong research, innovative and industry led content, over a time period of 3 years.
The **Project and Scientific Coordinator (PC)** serves as the single point of contact with the EC for all the matters and is assisted by the:
- **Project Manager** for the day-by-day coordination activities
- **Administrative Manager** for the administrative tasks and financial matters
- **Innovation Manager (IM)** for innovation management.

The **Project Management Board (PMB)** chaired by the PC includes one member per partner - makes decisions on contractual matters, such as the budget, timeline, deliverables, PM shifts, adding/deleting partners. The PMB is in charge of risk management. Decision is made by simple majority. PMB meets at least every six months.
The **Technical and Innovation Management Committee (TIMC)** - coordinated by the PC and including each WP leader - ensures that the technical developments and general progress are well coordinated. The TIMC in sessions chaired by the IM will analyse and review promising ideas. TIMC meets at least every six months.

The PC, IM and WP Leaders constitute the **Project Operation Team (POT)** which is responsible for the planning, execution and control of the project.

The PC is responsible for:
- Fulfilment of the **contractual obligation** on schedule and within budget
- The achievement of the project's **technical progress** and the recommendation of corrective actions when needed
- Organization and chairing of the PMB and the TIMC meetings
- Final approval of deliverables
- Adding a level of **quality assurance** validating the visible outputs (deliverables, presentations, papers, website) and suggesting improvements
- **Dissemination** about the Project conferences, cluster meetings

The **WP Leader** is responsible for the production and the timing of the relevant deliverables and ensures that the activities proceed according to the project work plan.

6 PLANNED ACHIEVEMENTS AND IMPACT

The rapid evolution of the ICT infrastructure is progressively enabling new opportunities to implement innovative services for people. Among the key ingredients of such evolution, it is worth to highlight the capability to manage mission-critical communication services: autonomous driving, remote surgery, security monitoring, are examples of application than cannot be supported by today networks. Bandwidth, quality of service (QoS), and flexibility are part of the PASSION goals and will greatly contribute to this evolution. In fact, optical metro network constitutes the fundamental infrastructure driving the future communicating society and providing virtually ubiquitous, ultra-high bandwidth "connectivity", not only to individual users, but also to connected objects. PASSION metro network approach can support future connected society thanks to the development of novel enabling photonic technologies and devices. In fact, these technology developments will be the key to the envisioned high-capacity, scalable, modular, SDM sliceable bandwidth/bitrate variable transport, which will enhance system capacity and reach. Furthermore, space and spectrum aggregation and switching, enabling the agile generation and routing of high-capacity channels with different levels of aggregation, will be the basis for an autonomous and agile optical network, capable to dynamically deliver services with a guaranteed QoS. Thus, an important part is the SDN-based network control to ensure high-capacity and dynamic connectivity and smooth deployment of the services.

The PASSION objectives are perfectly in line with the expected impact related to the next generation of optical network, guaranteeing a sustainable evolution. In fact, PASSION offers a modular, compact, low-cost and low-power solution for the metro network thanks to the exploitation of VCSELs as light sources and a 3D stacking approach for co-integration of VCSELs and SiPh circuits. In addition, the transmitter/receiver modules concept means that regardless of the number of modules required (or capacity needed) only a single module has to be created. The eventual desired choice of wavelength channels to be deployed can be programmed into the standard module, greatly simplifying the supply chain. The use of single VCSELs for the assembly, will result in higher utilization of fabricated VCSELs as the yield of the components will not be compounded by the exponential drop in yield due to the use of larger arrays. The population of the high capacity switching node with space and wavelength domain switches, where the co-integration of amplifiers is the key feature, will provide at once 1000 times reduction in form-factor for reduced OPEX, as well as more than 1 order improvement in power consumption per fully loaded module. When relating the power to the energy consumption per bit/s, that goes down to an impressive value of order tens of fJ/bit/s due to the high capacity links.

ANNEX 1 – PROJECT FACT SHEET

PASSION

Photonic technologies for a programmable transmission and switching modular systems based on Scalable Spectrum/ space aggregation for future high capacity metrO Networks

Project reference: GA 780326
Instrument: RIA

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Web site:
http://www.passion-project.eu

Timeline:
Start Date: 01/12/2017
End Date: 30/11/2020

Budget:
Overall Cost: 8.393.076,25 EUR
Funding: 7.535.747,50 EUR

Project Partners:
Politecnico di Milano (POLIMI), IT (Coordinator)
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Technische Universiteit Eindhoven (TUE), NL
VTT Technical Research Centre of Finland Ltd, FIN
Vertilas GmbH (VERT), D
VLC Photonics S.L., ES
OpSys Technologies, IL
Effect Photonics BV (EFP), NL
SM Optics S.r.l. (SMO), IT
Telefónica Investigación y Desarrollo SA (TID), ES
European Photonics Industry Consortium (EPIC), FR
National Institute of Information and Communications Technology (NICT), J
Electronic and Telecommunications Research Institute (ETRI), KR

Vision & Aim

In the last decade we have observed a continuous development of the fibre optic networks for metropolitan applications. However, we are now facing a bottleneck in the transmission and the routing of data due to the dramatic increase in the users' number, in the content size, and caused by the convergence of mobile and datacom networks. Photonics is a key enabling technology for the evolution of the entire telecommunications infrastructure, but the technologies used so far for the metro network directly derive from the long-distance transport and they proved to be too expensive and power hungry.

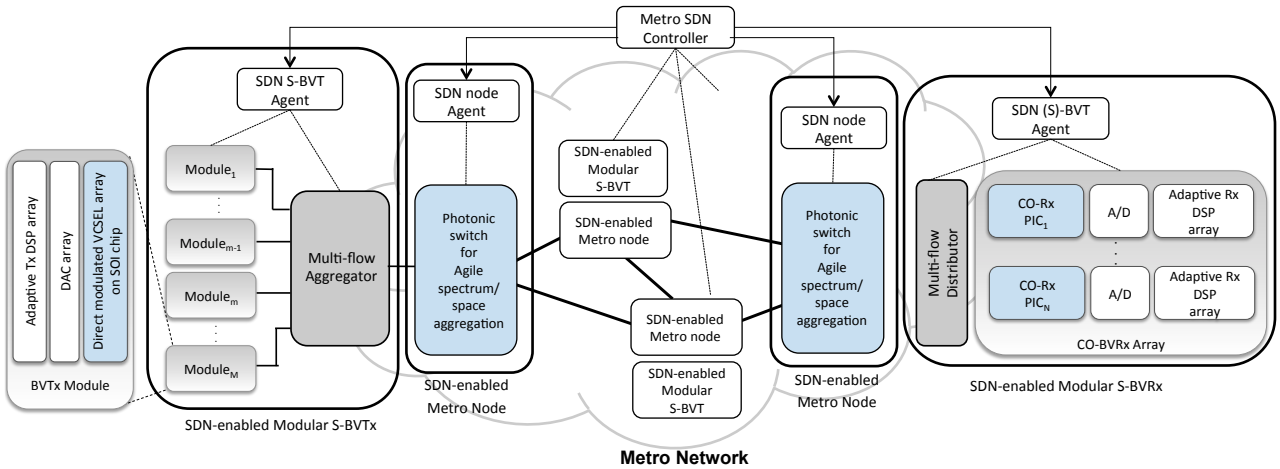
Alternatively, PASSION will develop an innovative technological platform based on directly-modulated vertically emitting laser sources (VCSEL) and on multi-channel coherent receivers integrated on Silicon-Photonics technology, providing high modularity and aggregating signal flows with a capacity of 16 Tb/s per spatial channel and 112 Tb/s per link exploiting a 7-core fiber. PASSION technologies will achieve a 10-fold power-consumption reduction with respect to commercially available modules based on externally modulated traditional sources. The dimensions of the PASSION modules will be even 3 orders lower than the current WDM solutions.

Thanks to these innovative transmitters and receivers PASSION will design a flexible network architecture, optimized for metro applications, based on aggregated signal flows, exploiting the full wavelength spectrum and the "space" dimension in a multi-core fibre.

Photonic devices capable of aggregating/disaggregating and/or routing data flows in spectrum and/or in space will allow a switching capacity of 1 Pb/s node. The metro network architecture that will be developed in PASSION will thus provide a full programmability to match the traffic evolution.

The exploitation of PASSION expected results represents a step forward compared to the existing technological solutions employed for metro network architectures, paving the way for the future metropolitan infrastructure of European high-bitrate communications that will connect people, content, clouds and things. PASSION will contribute to reinforce the European industrial technological leadership in high-capacity photonic devices and sub-systems, addressing the growing market of metro network scenarios, and improving business opportunities in Europe.

The PASSION project aims at sustaining bandwidth requirements in metro networks supporting a highly connected and communicating society by developing a photonic platform based on the integration of VCSELs and Silicon Photonics (SiPh) and of highly functional multichannel coherent receivers for the high bandwidth, low cost, reduced footprint and low power consumption.



In order to pursue its ambitious goal, PASSION is organized in **four technical WPs** plus **two additional WPs**, **WP6** devoted to the exploitation plan, dissemination, standardization, and technology transfer and **WP1** devoted to the project coordination. The technical WPs focus on **five Objectives**. The first one is the design and development of photonic technologies for the realization of a new generation of energy-efficient and compact transmitter modules for the metro network enabling up to **Tb/s capacity per PIC**. Specifically, in **WP3** the WDM VCSELs are produced and aggregated by the development of compact SiPh integration solutions. The second objective is the design and development of photonic technologies for the realization of a new generation of compact, flexible receiver modules able to sustain the PASSION sliceable-bandwidth/bitrate approach. In **WP4** few coherent polarization-division multiplexed receivers are integrated to obtain footprint reduction with respect to the commercial modules. The third objective is the development of energy-efficient and small-footprint switching technologies for a node featuring functional aggregation/ disaggregation, together with switching in the space and wavelength domain in order to handle **1-Pb/s capacity**. In particular, in **WP4** a flexible switching node is achieved thanks to the exploitation of monolithic and hybrid integrated active (gain and tuneable) devices with passive circuitry on InP and SiPh, respectively. The fourth objective is the design and development of scalable and modular sliceable variable bandwidth/bitrate transceiver (S-BVT) architectures, allowing to adaptively generate multiple flows of Tb/s capacity and enabling up to **100 Tb/s aggregated capacity per link**. The last objective is the development of scalable and modular metro network architectures for subsystem sharing and functional reuse to support flexible agile spectrum/spatial switching addressing capacities of Pb/s per node. Regarding the last two objectives, **WP2** defines network, systems and subsystems requirements and use cases for the designed metro network and node architectures featuring different levels of aggregation to match the traffic demand. The network relies on programmable (SDN-enabled) **scalable and modular systems** including S-BVT and node architectures. Exploiting the polarization and spectral dimension over the whole C-band and the spatial dimension (multi-core fiber or fibre bundle) up to 100 Tb/s aggregated capacity per link are enabled. Moreover, **WP5** supports all the other R&D WPs integrating, testing and demonstrating the PASSION design and the developed technologies/solutions. WP5 includes a network-wide proof-of-concept demonstration, exploiting the developed devices and technologies.

The PASSION consortium collects all the skills needed to fulfill the tasks of the project as the different Partners have **complementary expertise and are capable of addressing the entire supply chain**. The PASSION consortium includes universities (*POLIMI*, *TUE*), research centres (*CTTC, VTT, NICT, ETRI*), small medium-size enterprises (*VERT, VLC, OPSYS, EFP*) for devices manufacturing, an industrial consortium (*EPIC*), a supplier of communication equipment (*SMO*), and a network operator (*TID*). The strong industrial commitment is reflected in the composition of the consortium and in the 50% portion of the budget dedicated to industry (32% to SMEs).

ANNEX 2 – PROJECT PRESENTATION - SLIDES

PASSION project

H2020 Call ICT30-2017 Photonics KET

PASSION

Photonic technologies for progrAmmable transmission and switching modular systems based on Scalable Spectrum/space aggregation for future agIle high capacity metrO Networks

ABSTRACT:

The PASSION project aims at sustaining bandwidth requirements in metro networks supporting a highly connected and communication society by developing a photonic platform based on the integration of vertical cavity surface emitting lasers (VCSELs) and Silicon Photonics (SiPh) and of highly functional multichannel coherent receivers for the high bandwidth, low cost, reduced footprint and low power consumption.
PASSION will develop transmitter/receiver (TX/RX) and switch modules for 100 Tb/s capacity per link and a metro network architecture handling Pb/s per node.

- **PASSION date of start** December, 1st 2017

Project budget

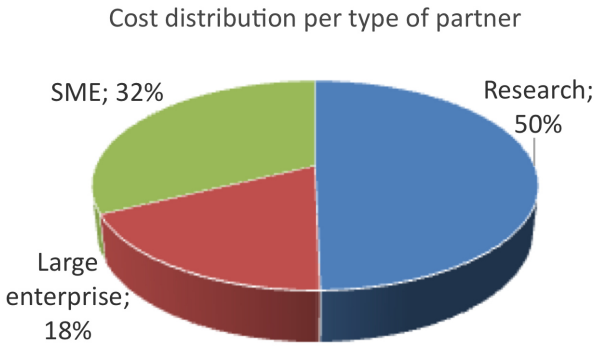
PASSION

Photonic technologies for progrAmmable transmission and switching modular systems based on Scalable Spectrum/space aggregation for future agIle high capacity metrO Networks

Total budget: ***8.393.076,25 €***

Requested contribution: ***7.535.747,50 €***

(the two non-EU partners participate through their own funds)



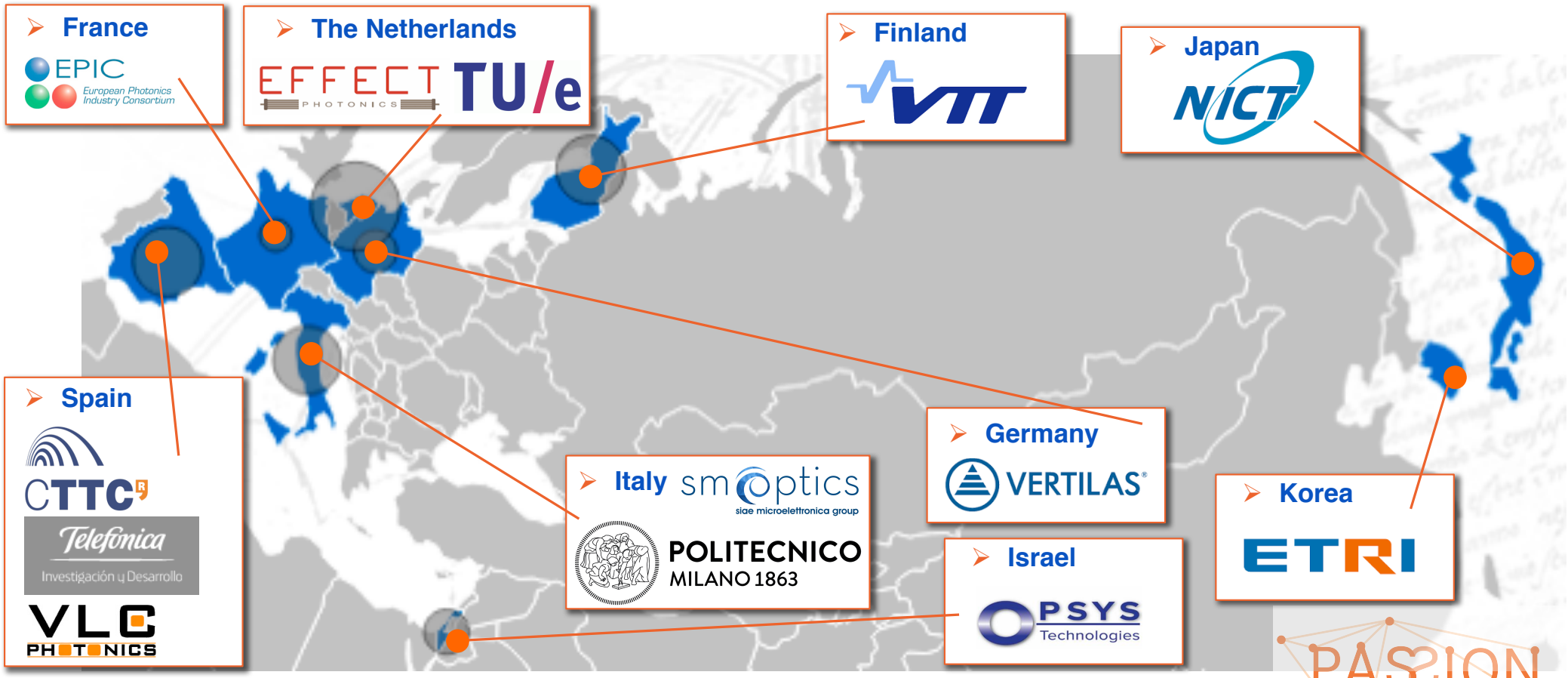
50.3% of the project budget for industrial companies (***32%*** for SMEs)

Total staff effort: ***702.2 person months*** ***(≅ 58.5 years)***

PASSION partners

Participant no. *	Participant organisation name	Part. short name	Country
1 (Coordinator)	Politecnico di Milano	POLIMI	Italy
2	Centre Tecnològic Telecomunicacions Catalunya	CTTC	Spain
3	Technische Universiteit Eindhoven	TUE	Netherlands
4	VTT Technical Research Centre of Finland Ltd	VTT	Finland
5	Vertilas GmbH	VERT	Germany
6	VLC Photonics S.L.	VLC	Spain
7	OpSys Technologies	OPSYS	Israel
8	Effect Photonics BV	EFP	Netherlands
9	SM Optics S.r.l.	SMO	Italy
10	Telefónica Investigación y Desarrollo SA	TID	Spain
11	European Photonics Industry Consortium	EPIC	France
12	National Institute of Information and Communications Technology	NICT	Japan
13	Electronic and Telecommunications Research Institute	ETRI	Korea

PASSION partners



PHOTONICS21
PHOTONICS PUBLIC PRIVATE PARTNERSHIP

PASSION

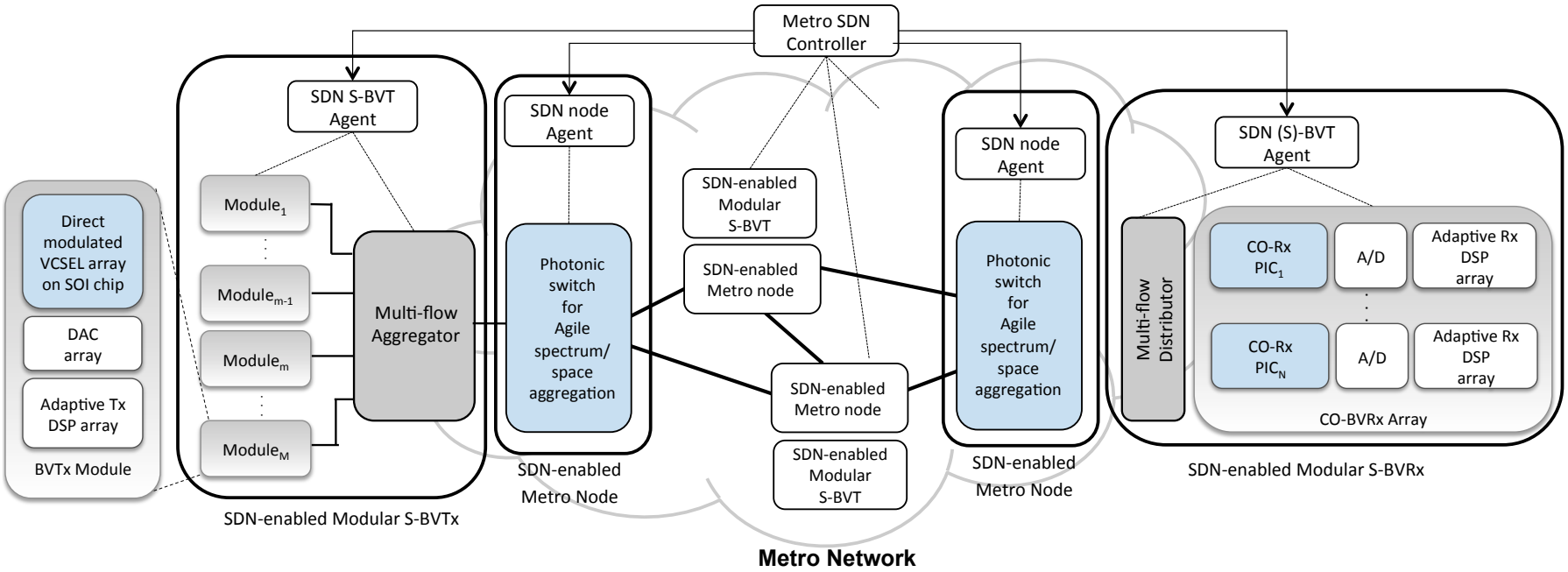
PASSION partners and logo

PASSION logo design

- the ***network*** embracing the project name symbolises the aim of the project, finalized to support the future connected and communicating society;
- the ***nodes*** of the network represent the innovative technologies developed in the project. They are 13, as the ***13 partners*** of the project, connected to work together and to share their experience and research;
- the ***heart*** (shaped by the two S) is at the center of the project name and of the network, representing the passion followed in the challenging approach to the project research;
- the ***orange colour*** used for the logo is creative, youthful, and enthusiastic, as the PASSION project team is.

PASSION GOAL

PASSION GOAL: the development of application driven photonic technologies supporting an innovative transceiver and node featuring different levels of aggregation (in spectrum, polarization, space) for the future metro network



PASSION GOAL

TECHNOLOGICAL TX/RX CONCEPTS:

- InP directly-modulated WDM VCSEL sources emitting in the whole C band
- coherent detection
- SiPh platform for dense integration to achieve modular design with more than **1 Tb/s capacity per channel**

➢ *Low power consumption:*
10-fold reduction with respect to 100-Tb/s solution implemented aggregating present commercial transceivers based on externally-modulated WDM sources

➢ *Reduced footprint*:
3 orders of magnitude improvement compared to currently available WDM solutions

PASSION GOAL

TECHNOLOGICAL SWITCHING CONCEPTS:

- suitable compact WSSs and WDM multicast switches (MCSs) adopting monolithic integration on InP platform and hybrid integration on SiPh circuits
- functional aggregation/disaggregation and switching at different levels, as in spectrum and in space, in order to improve effective and agile usage of the traffic pipes

➢ *Node full flexibility*

network node flexible in terms of spectrum slicing, selecting, broadcasting, shuffling and aggregating, in order to add-drop channels when requested and handle up to **1-Pb/s capacity**

PASSION GOAL

NETWORK CONCEPTS:

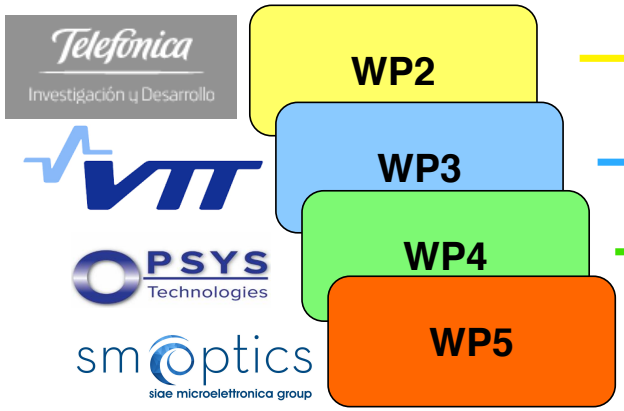
- sliceable bandwidth/bitrate variable transceiver (S-BVT) architecture for the metro network
- aggregation of multiple flows with subwavelength granularity, enabling up to more than **100 Tb/s per link** exploiting multicarrier modulation, and multiple dimensions including the spectrum (the whole C band), the polarization and the space (by means of multi-core fibers or fiber bundles).

➢ *Network programmability*

SDN-enabled platform ensuring metro programmability and connectivity, subsystems sharing and functional reuse, fitting network operator requirements and roadmaps.

Work packages

4 Technical Work Packages



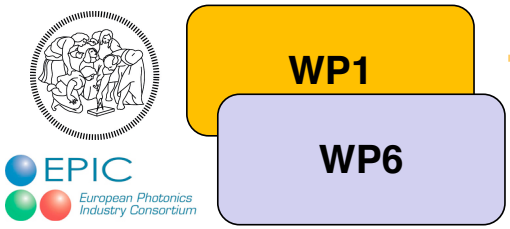
Network and system architecture, requirements and features

Photonic technologies for Tx

Switching, aggregation and Rx photonic technologies

Integration and demonstration of photonic devices and technologies

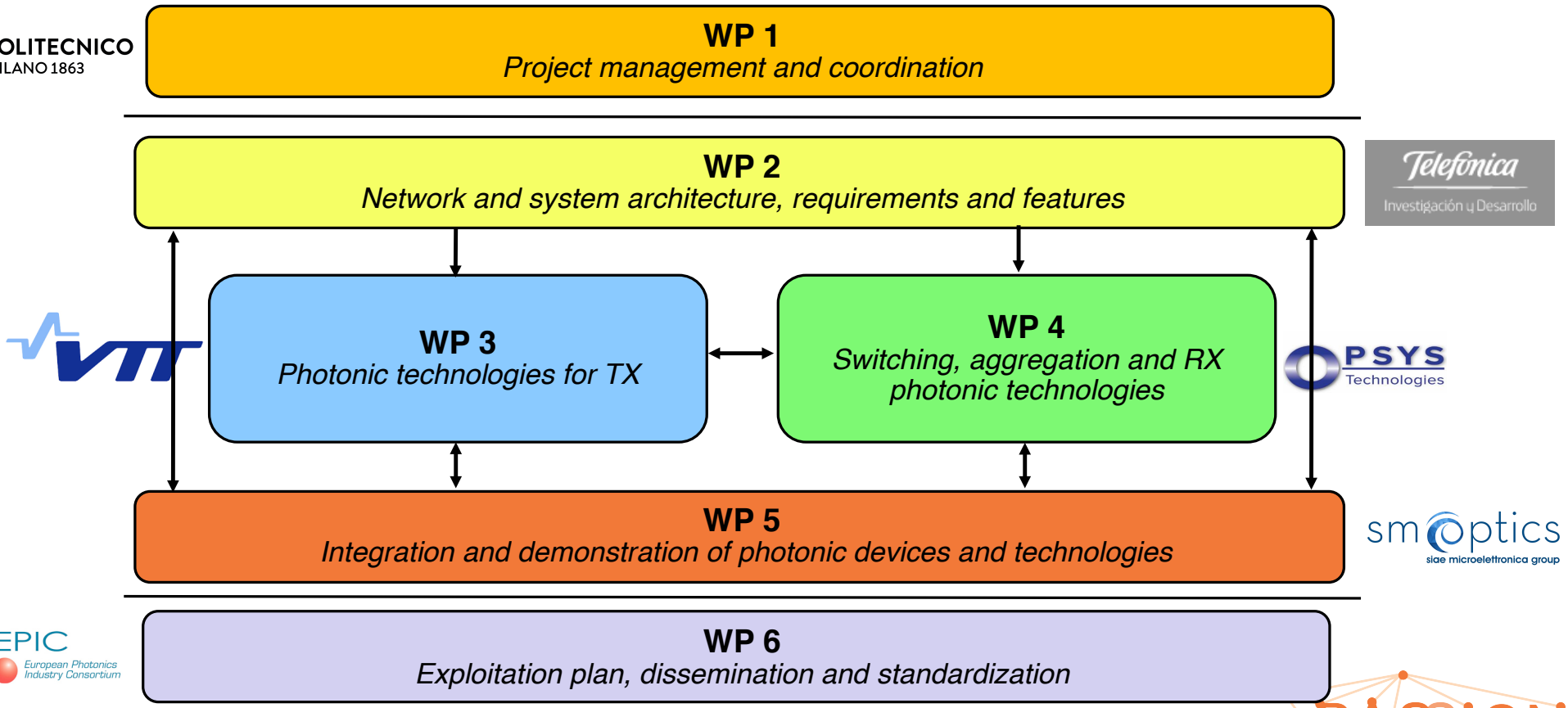
2 Organizative-Dissemination Work Packages



Project management and coordination

Exploitation plan, dissemination, and standardization

Work packages



Objectives

Objective 1

Design and development of photonic technologies for a new generation of **energy-efficient and compact Tx modules** for the metro network @ **Tb/s capacity per PIC**

Objective 2

Design and development of photonic technologies for a new generation of **compact, flexible Rx modules** for the metro network, able to sustain the PASSION **sliceable-bandwidth/bitrate approach**

Objective 3

Development of **energy-efficient and small-footprint switching technologies** for a aggregation/ disaggregation node, w **space/ wavelength switching domain for 1-Pb/s capacity**

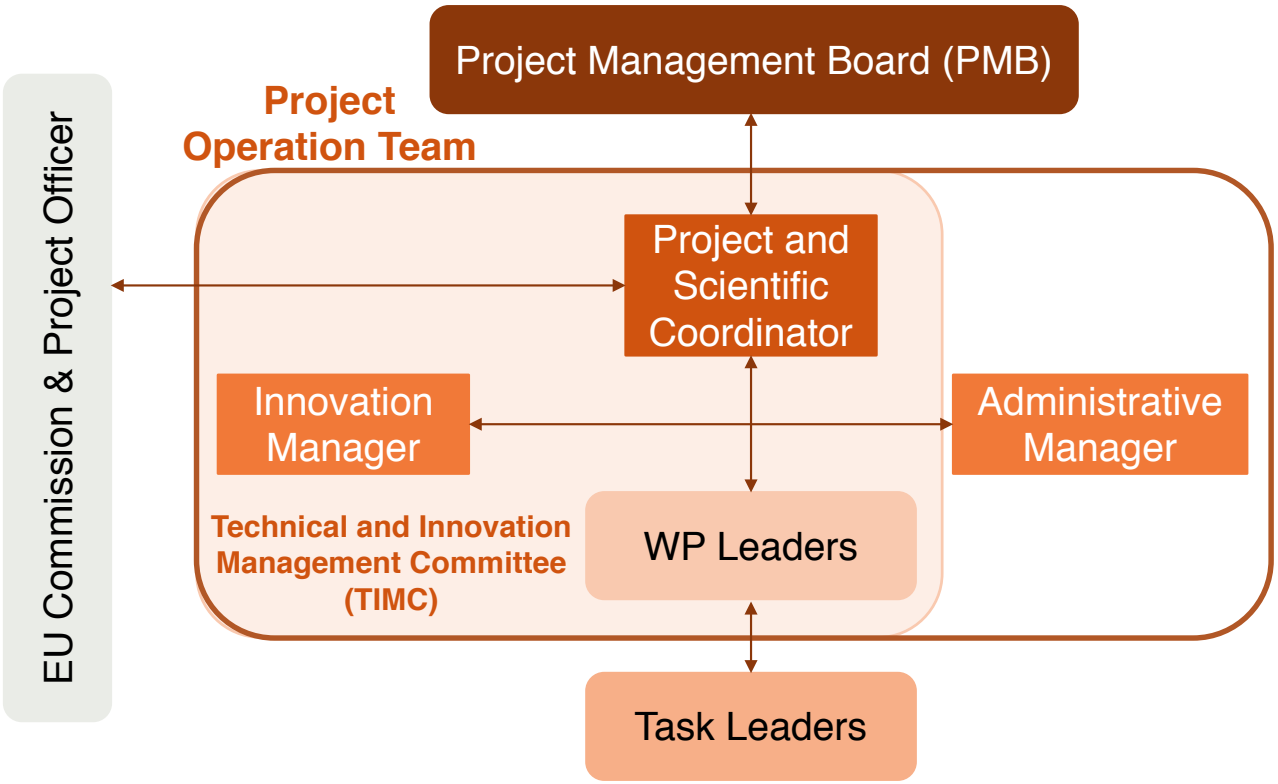
Objective 4

Design and development of **scalable and modular S-BVT architectures**, allowing to adaptively generate multiple flows of **Tb/s capacity** and enabling up to **100 Tb/s aggregated capacity per link**

Objective 5

Development of **scalable and modular metro network architectures** for subsystem sharing and functional reuse to support **flexible agile spectrum/spatial switching** addressing capacities of **Pb/s per node**

Management structure



Management structure: PC, PMB, TIMC, POT

The **Project and Scientific Coordinator** **(PC)** serves as the single point of contact with the EC for all the matters and is assisted by the:

- **Project Manager** for the day-by-day coordination activities
- **Administrative Manager** for the administrative tasks and financial matters
- **Innovation Manager** **(IM)** for innovation management.

The **Project Management Board** **(PMB)** chaired by the PC includes one member per partner - makes decisions on contractual matters, such as the budget, timeline, deliverables, PM shifts, adding/deleting partners.
The PMB is in charge of risk management.

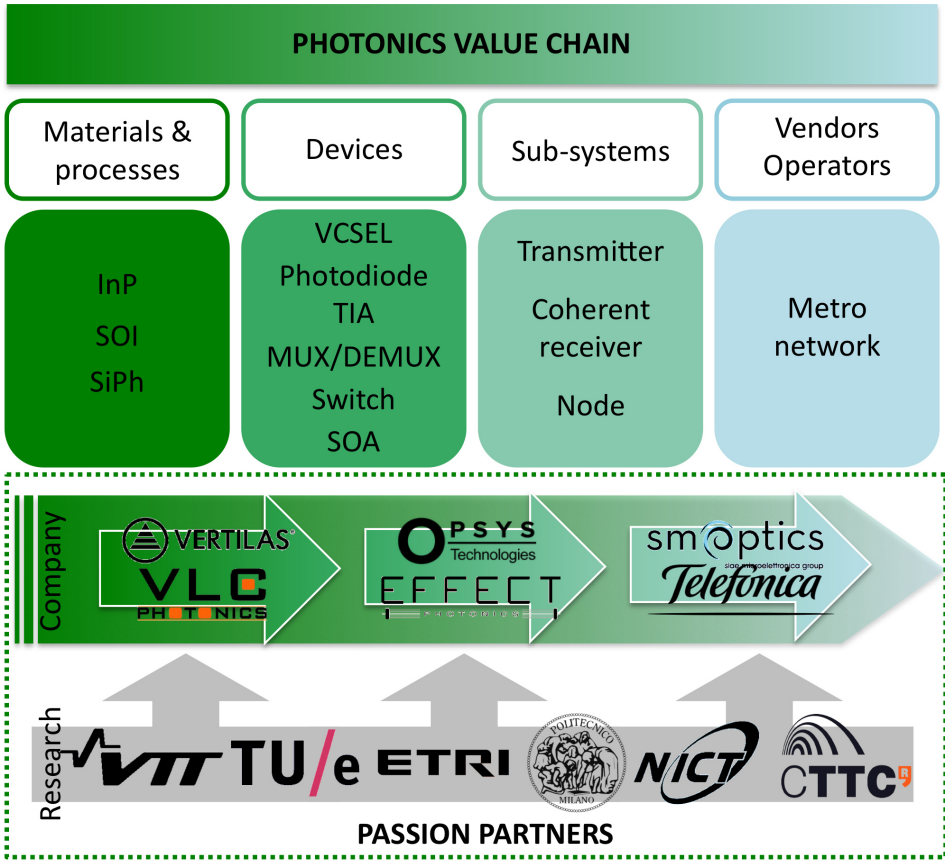
- Decision is made by simple majority.
- PMB meets at least every six months.

The **Technical and Innovation Management Committe** **(TIMC)** - coordinated by the PC and including each WP leader - ensures that the technical developments and general progress are well coordinated.
The TIMC in sessions chaired by the IM will analyze and review promising ideas collected through the Idea section (in the private area) of the Website.

- TIMC meets at least every six months

The **PC, IM and WP Leaders** constitute the **Project Operation Team** **(POT)** which is responsible for the planning, execution and control of the project.

Photonics value chain



PASSION consortium covers the entire photonics value chain and offers to industrial partners and in particular to the SMEs the opportunity to benefit of advance research by top European Universities and Research Centres through technology transfer processes and to have access to shares in the metro market through collaboration with EU vendors and network operators.

PASSION IMPACT

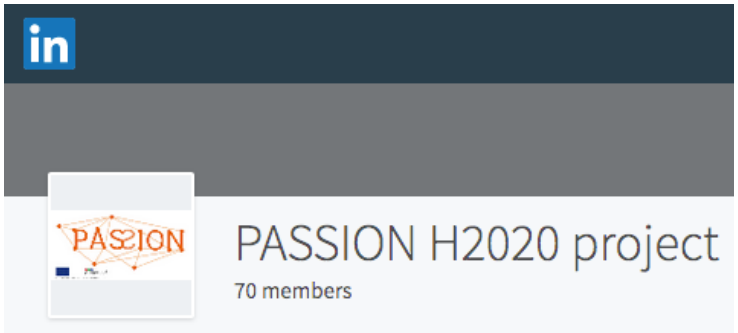
- The rapid evolution of the ICT infrastructure is progressively **enabling new opportunity** to implement **innovative services** for people. Among the key ingredients of such evolution, it is worth to highlight the capability to manage **mission critical services**. Autonomous driving, remote surgery, security monitoring, are examples of application than cannot be supported by today networks.
- **Bandwidth, QoS,** and **flexibility** are part of the PASSION goals and will greatly contribute to this evolution. In fact, optical metro network constitutes the fundamental infrastructure driving the future communicating society and providing virtually ubiquitous, ultra-high bandwidth "**connectivity**", not only to individual users, but also to connected objects.
- PASSION metro network approach can support future connected society thanks the development of novel **enabling photonic technologies** and **devices**. In fact, these technology developments will be the key to the envisioned **high-capacity, scalable, modular, SDM sliceable bandwidth/bitrate variable transport**; which will enhance system capacity and reach
- Space and spectrum aggregation and switching, enabling the **agile generation and routing of high-capacity channels** with different levels of aggregation, will be the basis for an autonomous and agile optical network, capable to dynamically deliver services with a guaranteed QoS. Thus, an important part is the SDN-based network control to ensure high-capacity and dynamic connectivity and smooth deployment of the services.

Social media and web accounts

LinkedIn group PASSION H2020 project

PASSION website
http://www.passion-project.eu

facebook
https://www.facebook.com/H2020PASSION/
PASSION project



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@PASSIONeuH2020
PASSION project