POETICS

CoPackaging of Terabit direct-detection and coherent Optical Engines and switching circuits in mulTI-Chip moduleS for Datacenter networks and the 5G optical fronthaul

Information & Communication Technologies (ICT)
Research and Innovation Action (RIA)
G.A. no: 871769
Start Date: 01.01.2020 [M01]
Duration: 36 Months

Funded by the Horizon 2020
Framework Programme of the European Union

Deliverable D7.1

Announcement of POETICS

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Date due of deliverable	31.01.2020 [M01]
Actual submission date	31.01.2020 [M01]
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Participants	FhG-HHI, LioniX, IMEC, Optagon, PHIX, MLNX, TIM
Work-package	**WP7**
Dissemination level	Public
Type	DEC
Version	1.0
Total number of pages	32

Table of Contents

List of abbreviations

BiCMOS	Bipolar CMOS
CMOS	Complementary Metal-Oxide-Semiconductor
DC	Datacenters
EC	European Commission
EMLs	Electro-absorption Modulated Lasers
ICT	Information and Communication Technologies
RIA	Research and Innovation Action

Executive Summary

The following document reports on the preparation of basic material for the announcement of POETICS project through the official tools of the European Commission (EC) and through the dissemination channels of the consortium partners. More specifically, the document reports on the preparation of the project factsheet and the preparation of a short presentation of the project for the official website of the EC, the preparation of two press-releases (by Fraunhofer-Heinrich Hertz Institute and Institute of Communications & Computer Systems) a reposting of a press release as a news announcement by PHIX.

Keywords: Dissemination, Project presentation, Press release, Factsheet

Introduction

The rapid adoption of cloud computing in today's economies has fueled an explosive traffic growth in Datacenters (DC), estimated at >25% CAGR, that will result in global annual DC traffic greater than 20 ZB by 2021. To support the emerging workloads and cope with the bandwidth demand, DC operators have followed a combination of two approaches: i) upgrading existing network switches and optical interfaces inside the DC to increase capacity ("scale up") and ii) adding new network equipment and optical interfaces to the DC ("scale out"). Although, both approaches were successful in allowing the Cloud DC infrastructure to grow to hyperscale, it is certain that they will eventually become bound by power and real-estate constraints

POETICS comes as a Research and Innovation project aiming to develop novel Terabit optical engines and optical switching circuits and co-package them with digital switching chips to realize Multi-Chip Modules (MCM) for next generation switching equipment with Tb/s capacities and very high energy efficiency that fit into the roadmap of vendors. In order to do that, POETICS is relying on a photonic integration technology based on a silicon nitride platform, optical polymers, InP electro-absorption modulated lasers (EMLs) and external cavity lasers, and on high-speed electronics based on BiCMOS technology.

POETICS is a 3-year Research and Innovation Action project that brings together eight (8) leading research centers and companies from five (5) from European countries and one (1) associated country (Israel). The project was launched in January 2020 and is expected to finish in December 2022. POETICS project is funded by the European Commission through the Horizon 2020 programme under the Photonics Public Private Partnership (www.photonics21.org). The initial announcement of the project launch to the general public and the scientific and technical community is pursued through the publication of the project factsheet and the project presentation through the cordis website of the EC and through three press-releases from an industry-oriented research institute (FhG-HHI), an academic partner (ICCS) and an SME (PHIX) of the consortium. This dissemination material is presented below.

1 Project Factsheet

The 2-page long project factsheet provides standard information about the project (call identifier, consortium, time-line, budget, contact persons and project website), a short description about the motivation behind the project, a short description about the main technical concepts and the main objectives, and an overview about the expected impact. The factsheet will go public and will be made available through the project website (ict-poetics.eu), which is under development during the time of writing this deliverable and will be also available through the cordis website. The project factsheet is appended to the present report as Appendix I.

2 Project Presentation

The short presentation of the project includes fourteen (14) slides that provide the same information as the project factsheet with stronger emphasis on the technical scope and the technical concepts of the project. The short presentation of the project will be made available through the project website (ict-poetics.eu) and will be also available through the cordis website. This presentation is appended to the present report as Appendix II.

3 Press Releases

Within the first month of the project, two (2) press releases were prepared to announce POETICS to the general public and the scientific and technical community.

@ FhG-HHI official website

The first one was prepared and announced by the Fraunhofer Heinrich Hertz Institute and was wired through the Photonics Component department News/Projects section of the Institute's website (https://www.hhi.fraunhofer.de/en/departments/pc/projects/poetics.html) addressing the German and international general public and technical community (see Figure 1).

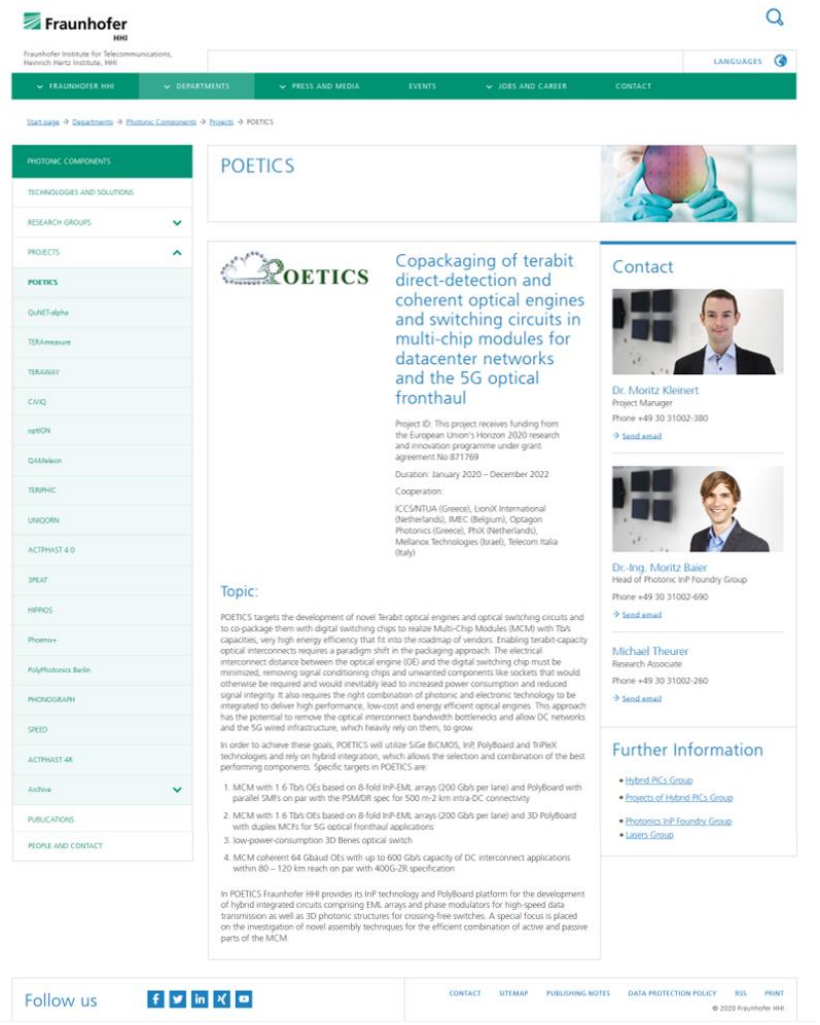

Figure 1. POETICS press release Press Release at FhG-HHI's official website

Project Announcement - KoM@ PCRL-ICCS official website and PHIX website

The POETICS project has been also announced by the Institute of Communications and Computers Science (ICCS) at the 'Projects' section of the Photonics Communication Research Laboratory official website and a second press release announcing the Project launch was wired through the 'News' section of PCRL website just after the official Kick-off meeting of the project (14-15 January 2020).

The content of the specific press release (appended to the present document as Appendix III) has been distributed to all partners of the project.

Link

https://www.photonics.ntua.gr/poetics-project-launch-kick-off-meeting/

PHIX has announced the project in the 'News' section of their official website by reposting the press release for the Project launch.

Link

https://www.phix.com/news/

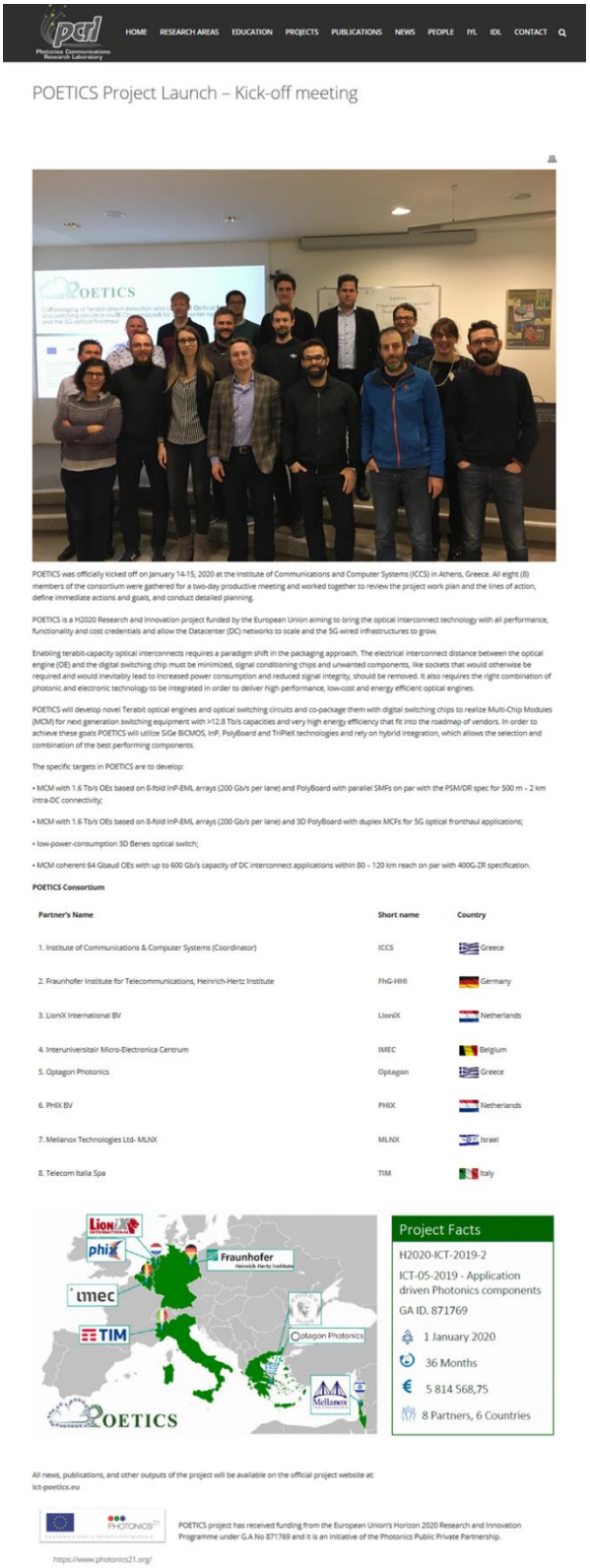

Figure 2. Project Announcement and Kick-off Press release at ICCS-PCRL website

4 Further dissemination channels

Further announcements of POETICS have been made through the accounts in social media e.g. LinkedIn, Facebook of the participant organizations. Some examples are listed in the figure(s) below.

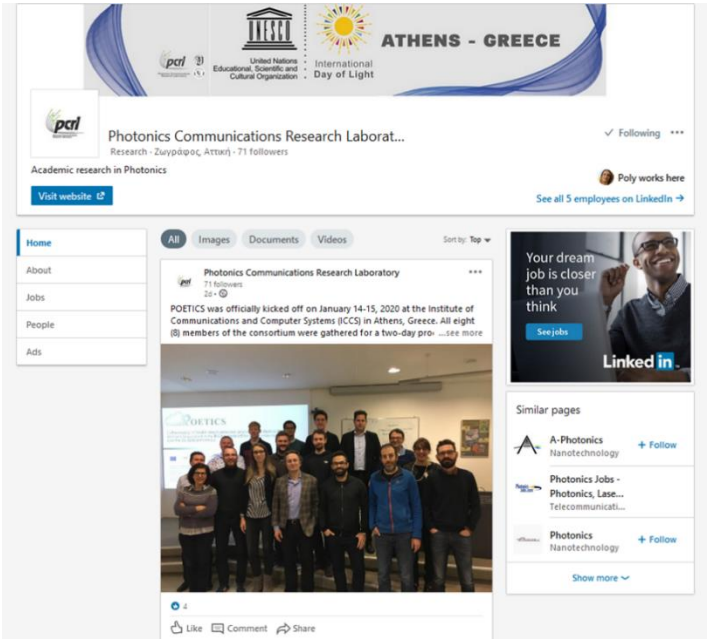

Figure 3. Screenshot for the PCRL-ICCS's LinkedIn page announcing POETICS

Figure 4. Screenshot from the PCRL-ICCS's Facebook announcing POETICS launch

5 Conclusions

Dissemination material for the project has been prepared. It is in the form of a 2-page factsheet that contains a brief overview of the motivation of project, its objectives, the exploitation strategy and the expected impact. The content of the factsheet has been elaborated in a short presentation, presenting also in more detail the role of the partners and the underlying technology. The project has been announced through the websites of the participating organizations and two press releases have be prepared and issued.

List of Figures

List of Tables

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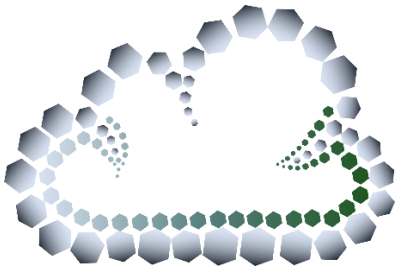

Appendix I. POETICS Factsheet

POETICS

CoPackaging of Terabit direct-detection and coherent Optical Engines and switching circuits in mulTI-Chip moduleS for Datacenter networks and the 5G optical fronthaul

OUR VISION

POETICS is a H2020 Research and Innovation project funded by the European Union aiming to bring the optical interconnect technology with all performance, functionality and cost credentials and allow the Datacenter (DC) networks to scale and the 5G wired infrastructures to grow.

Motivation

The rapid adoption of cloud computing in today's economies has fueled an explosive traffic growth in Datacenters (DC), estimated at >25% CAGR, that will result in global annual DC traffic greater than 20 ZB by 2021. To support the emerging workloads and cope with the bandwidth demand, DC operators have followed a combination of two approaches: i) upgrading existing network switches and optical interfaces inside the DC to increase capacity ("scale up") and ii) adding new network equipment and optical interfaces to the DC ("scale out"). Although, both approaches were successful in allowing the Cloud DC infrastructure to grow to hyperscale, it is certain that they will eventually become bound by power and real-estate constraints.

POETICS CONCEPT

Concept - Objectives

POETICS comes as a Research and Innovation project aiming to develop novel Terabit optical engines and optical switching circuits and co-package them with digital switching chips to realize Multi-Chip Modules (MCM) for next generation switching equipment with Tb/s capacities and very high energy efficiency that fit into the roadmap of vendors.

Enabling Terabit capacity optical interconnects requires a paradigm shift in the packaging approach. The electrical interconnect distance between the optical engine and the digital switching chip must be minimized and signal conditioning chips and unwanted components that are required and inevitably lead to increased power consumption and reduced signal integrity, should be removed. It also requires the right combination of photonic and electronic technology to be integrated in order to deliver high performance, low-cost and energy efficient optical engines. This approach has the potential to remove the optical interconnect bandwidth bottlenecks and allow DC networks and the 5G wired infrastructure to grow.

Factsheet

Call identifier: H2020-ICT-2019-2

Contract No: 871769

Timeline: 1 January 2020
31 December 2022

Overall budget: € 5 999 498,88

EU contribution: € 5.999.498,75

Project Website: ict-poetics.eu

Consortium: 8 Partners
(5 EU countries & 1 associated country)

https://www.photonics21.org/

POETICS project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under G.A No 871769 and it is an initiative of the Photonics Public Private Partnership

POETICS

Concept - Objectives (cont.)

In order to achieve this, POETICS is relying on a photonic integration technology based on a silicon nitride platform, optical polymers, InP electro-absorption modulated lasers (EMLs) and external cavity lasers, and on high-speed electronics based on BiCMOS technology.

Specific targets in POETICS are:

- MCM with 1.6 Tb/s OEs and PolyBoard with parallel SMFs on par with the PSM/DR spec for intra-DC connectivity
- MCM with 1.6 Tb/s OEs and 3D PolyBoard with duplex MCFs for 5G optical fronthaul applications
- Low-power-consumption 3D Benes Optical Switch
- MCM coherent 64 Gbaud OEs with up to 600 Gb/s capacity for DC interconnect applications

POETICS will develop for the first time in SiGe BiCMOS, monolithically integrated arrays of analog multiplexing and driving circuits for the transmitter and monolithically integrated arrays of TIA and analog demultiplexing circuits to deliver up to 100 Gbaud PAM-4 signals. 8-fold InP-EMLs arrays with very high bandwidth and ability to operate at elevated temperatures will be developed and combined with PolyBoard motherboard using automated processes to form the basis for direct-detection transceivers up to 200 Gb/s per lane for a total capacity of 1.6 Tb/s over parallel SMFs, for intra-DC connectivity of 500 m-2km. The same EML array will be coupled to a 3D PolyBoard motherboard for the first time to realize a forward looking 1.6Tb/s optical engine with the 3D PolyBoard acting as a MCF interposer, for increased bandwidth density in intra-DC links or delivering 8x200Gb/s in point-to-multipoint links in the 5G optical fronthaul.

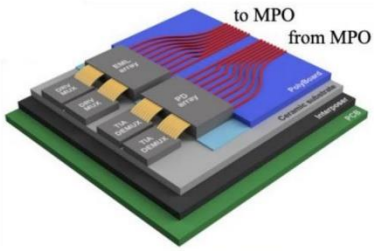

Figure 1. Artistic layout of the 1.6 Tb/s MCM optical engine with parallel single mode fibers

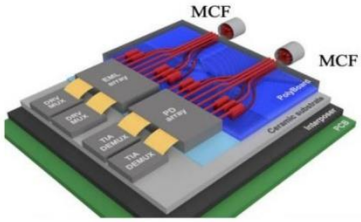

Figure 2. Artistic layout of the 1.6Tb/s MCM Optical Engine with MCFs using a 3D Polyboard motherboard.

POETICS will introduce for the first time a novel 32x32 3D Benes optical switch in 3D PolyBoard, offering a reconfigurable, non-blocking and low power optical switching device that eliminates waveguides crossings and can scale gracefully.

The project invests also on the complementarity of the TriPleX and PolyBoard platforms to realize for the first time a cost-efficient 64Gbaud coherent transceiver with up to 600Gb/s capacity for DCI links within 80-120km.

Impact

The project has been conceived with the strategic objective to develop the underlying technology in Europe for the development of MCMs comprising digital switch ASICs and optical interfaces. The competitive advantages in terms of performance, energy efficiency and reliability are based on the use of the multifunctional components and the hybrid electronic-photonic integration approach which allows for global optimization of the system. The advantages in terms of manufacturability and costs on the other hand are based on a straightforward plan for the development of advanced integration methods and automated assembly processes with simple and reliable steps, high fabrication yield and compatibility with high volume fabrication runs.

Contact

Institute of Communications & Computer Systems
Photonics Communication Research Lab
Prof. H. Avramopoulos
Lefteris Gounaridis
Dr. Maria Massaouti

Project Website: *ict-poetics.eu*

https://www.photonics21.org/

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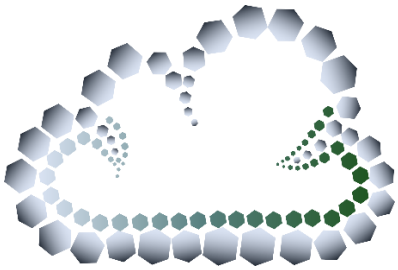
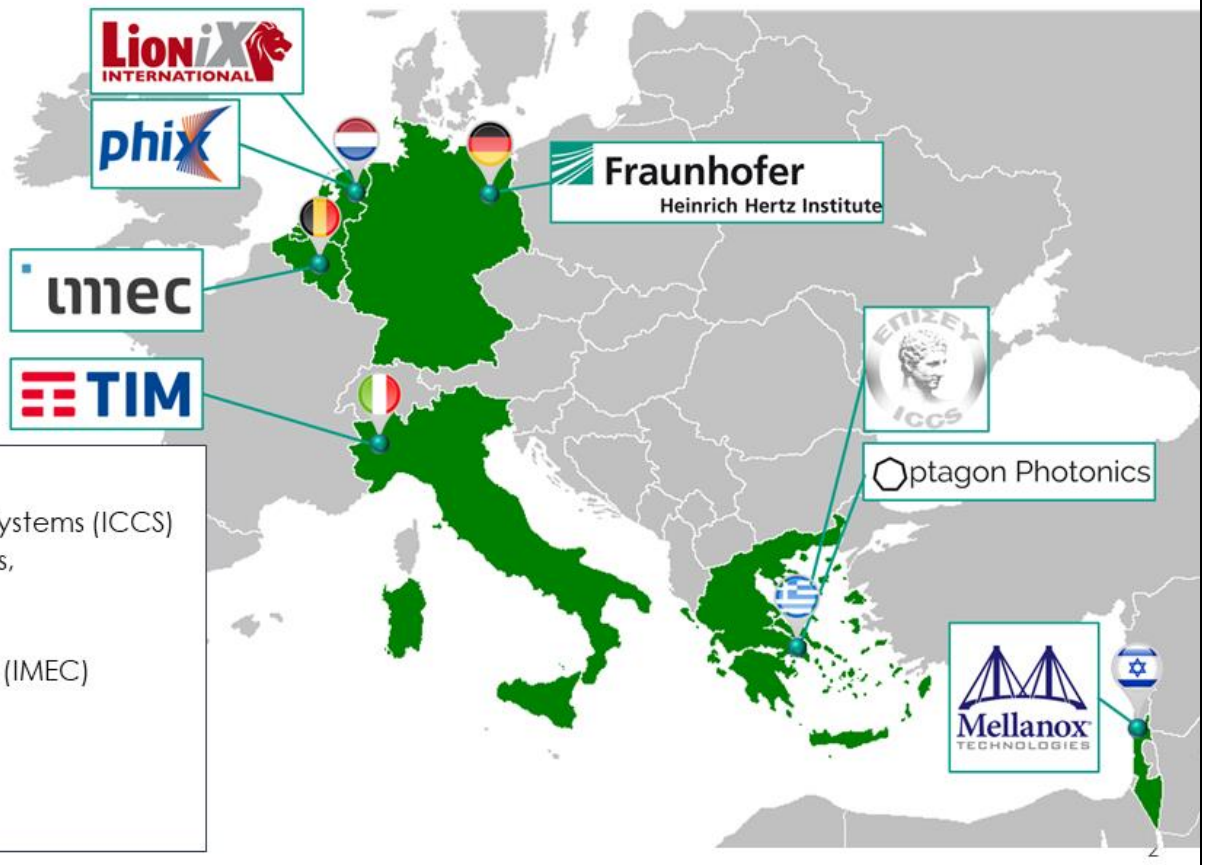


Appendix II. POETICS Project presentation


POETICS
CoPackaging of Terabit direct-detection and coherent Optical Engines and switching circuits in mulTI-Chip moduleS for Datacenter networks and the 5G optical fronthaul
POETICS EU Project
Call: H2020-ICT-2019-2
Topic: Application driven Photonics components
Type: RIA
Contract No: 871769
Start date: 1 January 2020
Duration: 36 Months
EC contribution: € 5.814.568,75
PHOTONICS21
PHOTONICS PUBLIC PRIVATE PARTNERSHIP
Funded by the Horizon 2020 Framework Programme of the European Union under the Photonics Public Private Partnership
ICCS
Fraunhofer
Heinrich Hertz Institute
LIONIX INTERNATIONAL
imec
Optagon Photonics
Mellanox TECHNOLOGIES
phix
TIM

POETICS Consortium



Partners' Name

1. Institute of Communications & Computer Systems (ICCS)
2. Fraunhofer Institute for Telecommunications, Heinrich-Hertz Institute (FhG-HHI)
3. LioniX International BV (LioniX)
4. Interuniversitair Micro-Electronica Centrum (IMEC)
5. Optagon Photonics (Optagon)
6. PHIX BV (PHIX)
7. Mellanox Technologies Ltd (MLNX)
8. Telecom Italia Spa (TIM)

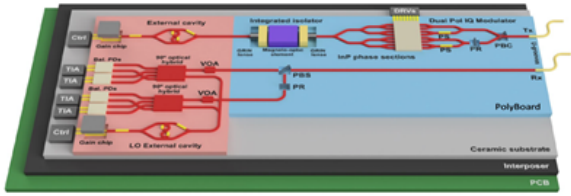
POETICS Project

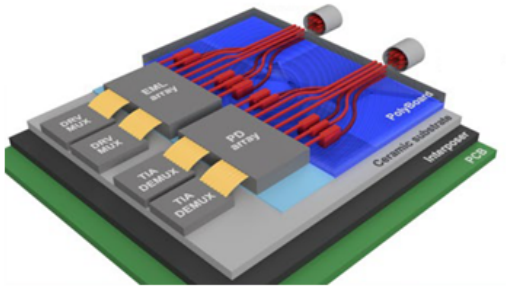
Driving Idea: Scaling "up" and "out" DC networks and increase 5G capacities

Development of Multi-Chip Modules (MCM) switching devices with novel Terabit Optical Engines (OE) and optical for the next generation switching equipment with Tb/s capacities and very high energy efficiency

POETICS Specific Targets

- MCM with 1.6 Tb/s OEs based on 8-fold InP-EML arrays (200 Gb/s per lane) and PolyBoard with parallel SMFs on par with the PSM/DR spec for 500 m - 2 km intra-DC connectivity
- MCM with 1.6 Tb/s OEs based on 8-fold InP-EML arrays (200 Gb/s per lane) and 3D PolyBoard with duplex MCFs for 5G optical fronthaul applications
- Low-power-consumption 3D Benes optical switch
- MCM coherent 64 Gbaud OEs with up to 600 Gb/s capacity of DC interconnect applications within 80 – 120 km reach on par with 400G-ZR specification





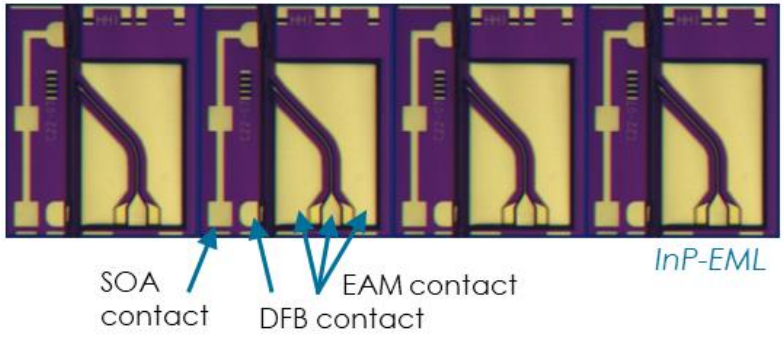
3

Objective - MCM Terabit transceivers (I)

High-speed InP-EML arrays supporting uncooled operation

EML technology for light generation, modulation and amplification in a single die

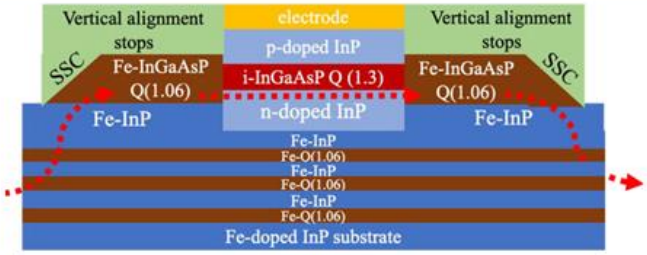
- High-speed (up to 200 Gb/s per lane in O-band with PAM-4)
- High temperature operation (up to 85°C)
- Low chirp (a-parameter: 0.3)
- Improved bandwidth (> 50 GHz)
- Low driving requirements (1.5 Vpp for > 4.5 dB ER)
- High output power (8 dBm for PAM-4)
- Low power consumption (150 mW per EML)



Flip-chipped high-bandwidth InP phase modulators for hybrid InP-polymer IQ modulators

8-fold arrays of phase modulators

- High-bandwidth (> 40 GHz)
- Low driving voltage (< 1.5 Vpi)
- Low insertion loss (< 1 dB)
- Low coupling loss (< 0.6 dB per waveguide interface)

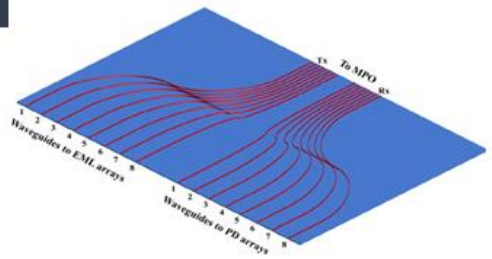


4

Objective - MCM Terabit transceivers (II)

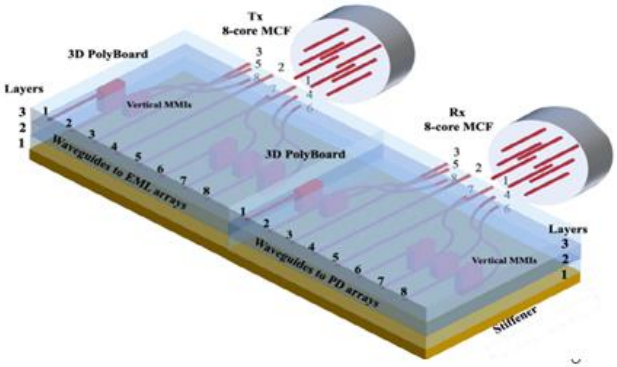
2D photonic motherboard (Polyboard) to host the EML/PD arrays

- Low coupling losses of the EML/PD array with the PIC waveguides (< 0.6 dB)
- Low coupling losses of the PIC with the SMFs (<0.5 dB)
- 8 parallel waveguides
- 8 parallel single mode fibers



3D photonics motherboard (Polyboard) to host the EML/PD arrays and for realizing a PIC MCF (de)mulltiplexer

- 3 waveguide layers
- Low coupling losses of the EML/PD array with the PIC waveguides (< 0.6 dB)
- Low loss 1x1 vertical MMIs for transition between the layers
- 8 parallel waveguides
- 8-core MCF



Objective - 3D Benes optical switch

3D PolyBoard optical switch
32x32 active optical switching prototype with low reconfiguration time

- Reconfiguration time <10 ms, in O-band
- 9 cascade stages of 16 elements each (144 crossbar switches)
- Low loss 2x2 MMI-MZI crossbar (< 0.25 dB)
- Low crosstalk between ports (<30 dB)
- Low switching power (<10 mW) – worst case path loss of less than 5 dB and total power consumption of less than 2 W
- Low loss 1x1 vertical MMIs (< 0.2 dB)

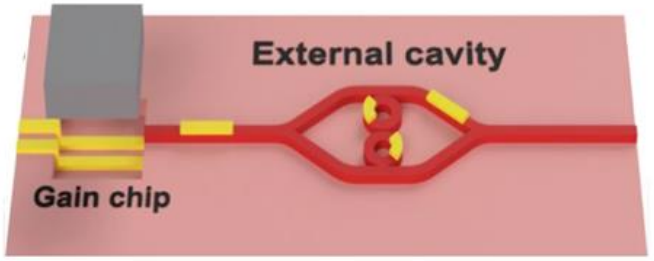
6

Objective – MCM Coherent transceiver

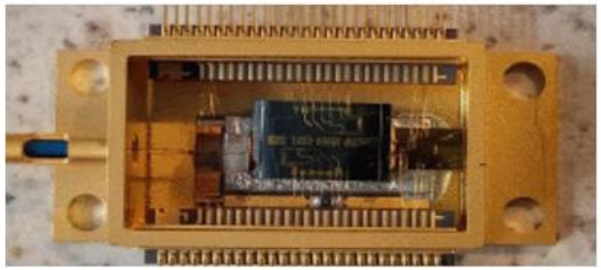
Cost effective, widely tunable, narrow linewidth **External Cavity Laser (ECL)**

ECL based on flip-chip bonding of InP gain chips on TriPleX platform

- Operation in the C-band
- Wide wavelength tuning (> 50 nm)
- Long effective path length (~ cm by having high Q-factor MRRs)
- Narrow linewidth (< 10 kHz)
- High Side Mode Suppression Ratio (SMSR > 60 dB)
- Low relative intensity noise (-160 dB/Hz)
- High output power (50 mW)
- Low power consumption (< 0.4 W)
- High stability by using polarization independent isolator



Artistic layout of InP flip-chip bonded gain chip in a recess formed in TriPleX



7

Sophisticated assembly methodologies and advance packaging process (I)

Develop monolithically integrated SiGe electronic circuits

- High-bandwidth transmitter and receiver electronics for 100 Gbaud with PAM-4 modulation format
- Quad linear driver arrays (with Continuous-Time Linear equalization, gain > 10 dB, high output power amplitude, 2v Vpp single ended, Signal to Noise and Distortion Ratio > 30 dB, high linearity-total harmonic distortion < 5% and power consumption 300 mW)
- Quad TIA arrays with adjustable linearity, gain values > 10 dB, and high output power

Develop high-performance PCB boards

- High-speed data generating digital chip with >160 pins (BGA, LGA etc.)
- Sophisticated design allowing the routing of high bandwidth signals through the multiple layers (>6)

8

Sophisticated assembly methodologies and advance packaging process (II)

InP flip-chip bonding process on TriPleX and PolyBoard for optical alignment and electrical connection in one step

Novel high-volume compatible integration method for forming a set of motherboards for low-cost coherent transceivers

Use FlexLines for Driver/TIA array connection with optical subassembly (InP EMLs-PDs)

- Develop high bandwidth Polymer FlexLines as flexible tapes
- Connect many driver/TIA interfaces and the optical subassembly in a single assembly step

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Prototypes – MCM Terabit transceivers

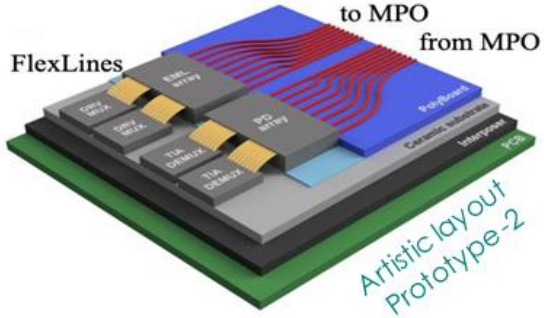
MCM for intra-DC network connectivity

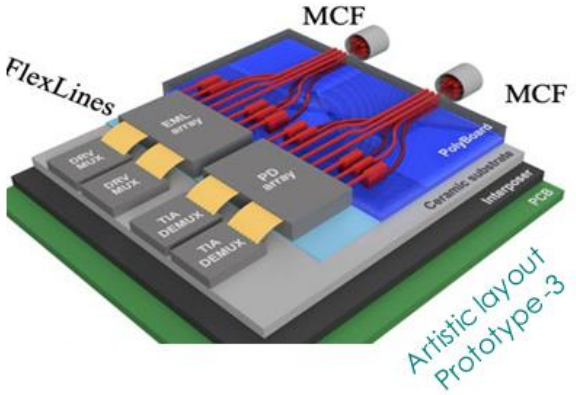
Prototype -1: 800 Gb/s transceiver (precursor)
Prototype -2: 1.6 Tb/s transceiver

MCM for intra-DC network connectivity & 5G fronthaul connectivity

Prototype -3: 1.6 Tb/s transceiver

- ✓ 8-fold InP-EML and PD array
- ✓ MUX-driver arrays
- ✓ FlexLines for electrical interconnection
- ✓ 2D (or 3D) coupling with the PolyBoard motherboard
- ✓ Connection with the ASIC switch (BGA, LGA connectors)
- ✓ Quad array (or 8-fold array) of linear TIAs and de-mux





System Evaluation: In laboratory settings and quasi-real settings at the testbeds of the system vendor MLNX and telecom provider TIM

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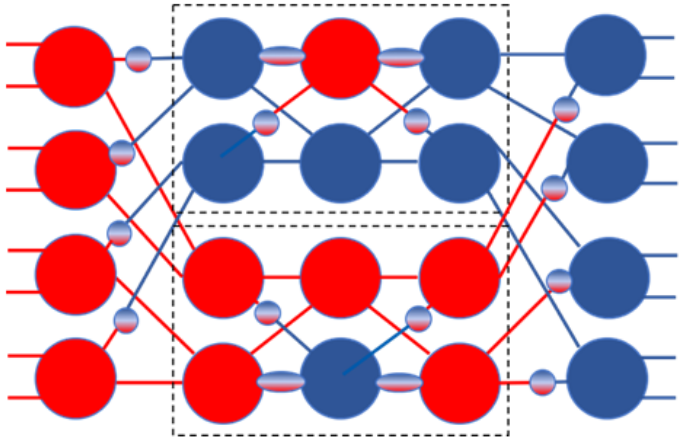
Prototypes – 32x32 Optical Switch

Package the active optical switching circuit with control electronics
Prototype -4

- ✓ 3D PolyBoard platform
- ✓ Placed on a low-speed LGA interposer for heat dissipation
- ✓ Both (optical switch and interposer) will be connected to a MCM PCB
- ✓ Reconfiguration time <10 ms



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Prototypes – MCM Coherent transceivers

MCM Coherent transceiver for low-cost and energy efficient high-capacity DCI interconnects

Prototypes -5, -6: Dual-pol 64Gbaud Coherent transceiver optical engines

Prototype -5 (Precursor)

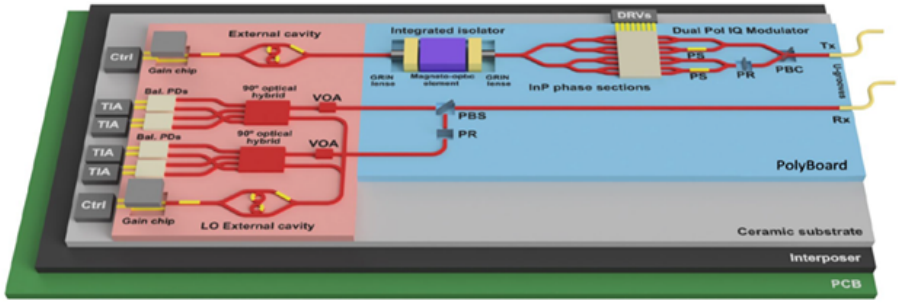
Narrow linewidth ECL on TriPleX platform

Optical isolator on PolyBoard

InP IQ modulators on PolyBoard

Dual polarization detection scheme:

- PBS, PR on PolyBoard
- Local oscillator and optical hybrids on TriPleX
- Balanced PDs



Block diagram of the coherent optical transceiver (Prototype 6)

Prototype -6 (Final)

Flip-chip bonding process:

- InP active components on TriPleX
- InP active components on PolyBoard

Alignment requirements: 2 PICs with two waveguide interfaces

5 times better energy efficiency compared to 400G-ER DD-QSFP modules

- <4 W to deliver up to 600 Gb/s on a single carrier

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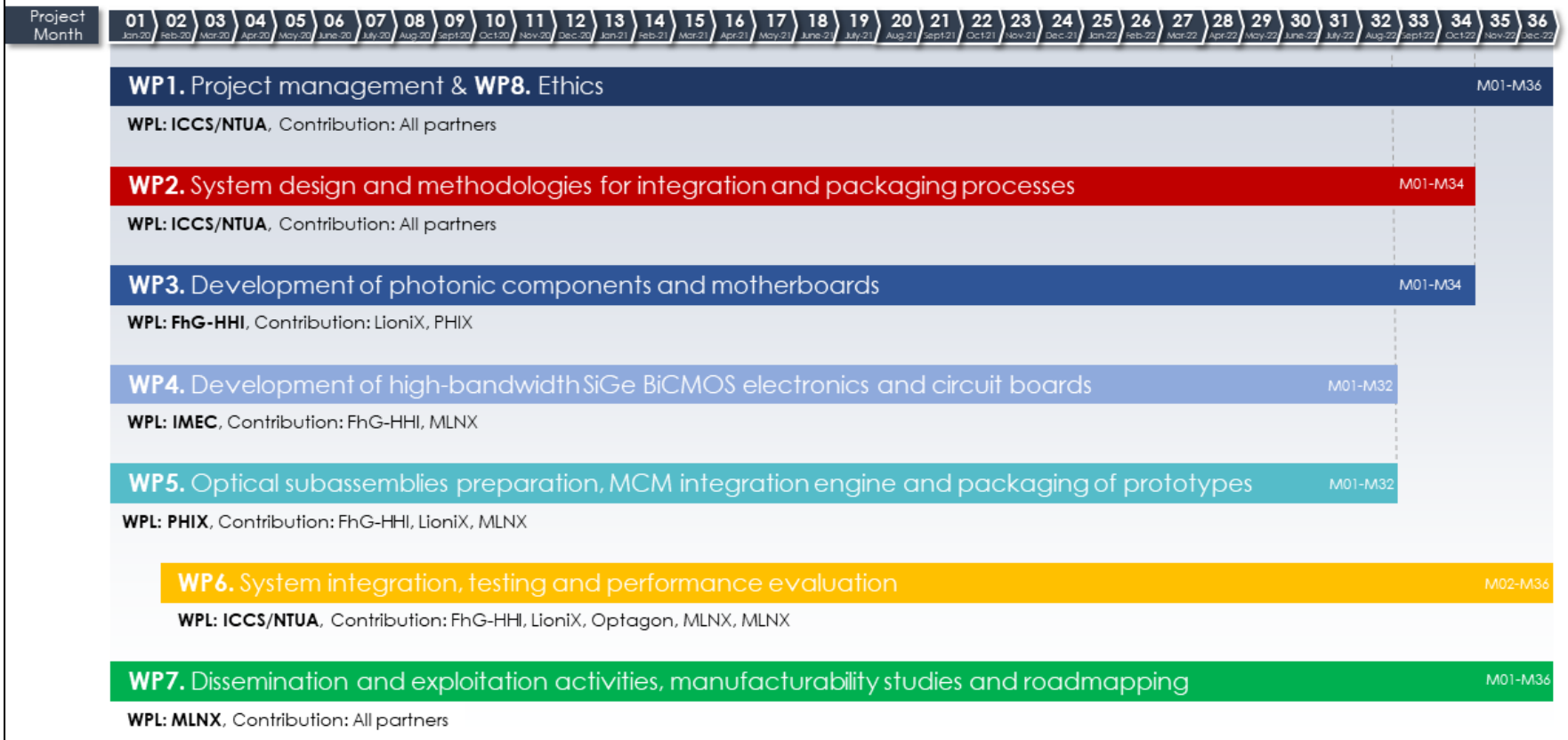
POETICS Work packages



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Contact

For more info, visit POETICS website

ict-poetics.eu

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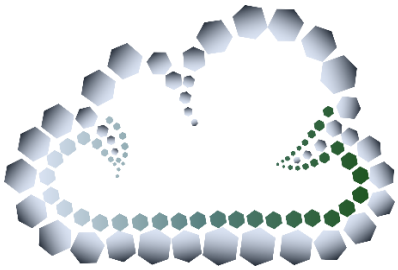

Appendix III. POETICS Press Release – Project Announcement

POETICS

CoPackaging of Terabit direct-detection and coherent Optical Engines and switching circuits in mulTI-Chip moduleS for Datacenter networks and the 5G optical fronthaul

Announcement of Project Launch

POETICS was officially kicked off on January 14-15, 2020 at the Institute of Communications and Computer Systems (ICCS) in Athens, Greece. All eight (8) members of the consortium were gathered for a two-day productive meeting and worked together to review the project work plan and the lines of action, define immediate actions and goals, and conduct detailed planning.

POETICS is a H2020 Research and Innovation project funded by the European Union aiming to bring the optical interconnect technology with all performance, functionality and cost credentials and allow the Datacenter (DC) networks to scale and the 5G wired infrastructures to grow.

Enabling terabit-capacity optical interconnects requires a paradigm shift in the packaging approach. The electrical interconnect distance between the optical engine (OE) and the digital switching chip must be minimized, signal conditioning chips and unwanted components, like sockets that would otherwise be required and would inevitably lead to increased power consumption and reduced signal integrity, should be removed. It also requires the right combination of photonic and electronic technology to be integrated in order to deliver high performance, low-cost and energy efficient optical engines.

POETICS will develop novel Terabit optical engines and optical switching circuits and co-package them with digital switching chips to realize Multi-Chip Modules (MCM) for next generation switching equipment with >12.8 Tb/s capacities and very high energy efficiency that fit into the roadmap of vendors. In order to achieve these goals POETICS will utilize SiGe BiCMOS, InP, PolyBoard and TriPleX technologies and rely on hybrid integration, which allows the selection and combination of the best performing components.

The specific targets in POETICS are to develop:

- MCM with 1.6 Tb/s OEs based on 8-fold InP-EML arrays (200 Gb/s per lane) and PolyBoard with parallel SMFs on par with the PSM/DR spec for 500 m - 2 km intra-DC connectivity;
- MCM with 1.6 Tb/s OEs based on 8-fold InP-EML arrays (200 Gb/s per lane) and 3D PolyBoard with duplex MCFs for 5G optical fronthaul applications;
- low-power-consumption 3D Benes optical switch;
- MCM coherent 64 Gbaud OEs with up to 600 Gb/s capacity of DC interconnect applications within 80 – 120 km reach on par with 400G-ZR specification.

All news, publications, and other outputs of the project will be available on the official project website at ict-poetics.eu.

https://www.photonics21.org/

POETICS project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under G.A No 871769 and it is an initiative of the Photonics Public Private Partnership.

POETICS Consortium

Partner's Name	Short name	Country
1. Institute of Communications & Computer Systems (Coordinator)	ICCS	Greece
2. Fraunhofer Institute for Telecommunications, Heinrich-Hertz Institute	FhG-HHI	Germany
3. LioniX International BV	LioniX	Netherlands
4. Interuniversitair Micro-Electronica Centrum	IMEC	Belgium
5. Optagon Photonics	Optagon	Greece
6. PHIX BV	PHIX	Netherlands
7. Mellanox Technologies Ltd- MLNX	MLNX	Israel
8. Telecom Italia Spa	TIM	Italy

Project Facts

H2020-ICT-2019-2

ICT-05-2019 - Application driven Photonics components

GA ID. 871769

1 January 2020

36 Months

5 814 568,75

8 Partners, 6 Countries

https://www.photonics21.org/

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