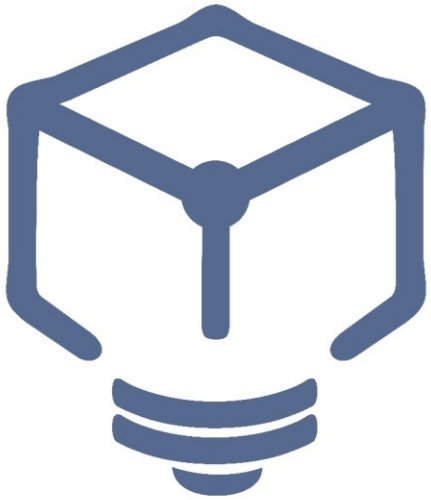

INCUBANDO

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ABSTRACT

The chief goal of INCUBANDO is to develop a ***technological Incubator*** providing a unique infrastructure in the field of optical communications in the era of Internet of Things (IoT) and 5G. Specific *objectives* are:

- provide a **favorable environment** for the implementation of ideas related to fiber communications technologies supporting the continuous growth of internet-based applications (IoT, cloud computing, real-time audio/video applications);
- stimulate **innovative research** in the field of high-speed communications, large traffic demanding applications, and encourage the conception of ideas that are suitable for commercialization.
- enhance the **cooperation** between the Italian and Israeli researchers and entrepreneurs through collaboration, visits, and joint events.

The development of the Incubator will go through the following major steps:

- comprehensive definition of the available infrastructures and services;
- training of personnel dedicated to enable the incubation from a technical standpoint;
- recruit/develop personnel with the skills which are required for the purpose of enabling the incubation process from the financial/administrative standpoint, and provide help in attracting seed-funding for the individual startups.

On the other hand, main actions towards startups will be:

- define the **place** (Incubator will provide specific spaces to startups where they can have full access to the infrastructures and available services)
- set the **way** (how startups will take benefit inside the Incubator)
- set the **time** (call will be launched yearly for startups funding together with open access to the infrastructures and services)

The Incubator will be located in the city of L'Aquila where participants will enjoy full access to the infrastructure of the ongoing "INCIPICT" project (http://incipict.univaq.it/), which includes:

- a Smart-City-oriented test-bed, designed to provide an 'International Service' to the research and technology communities;
- a flexible fiber-optic infrastructure with reconfigurable capabilities, and supporting integration with state-of-the-art wireless technologies targeting a broad variety of communications, sensing, and multimedia applications;
- the first space-division multiplexed (SDM) infrastructure based on Multicore/Multimode fiber technologies.

At the same time startups will have access to unique experimental facilities of CNIT Photonic Networks National Laboratory (PNNL) and Photonic Integrated Circuits design and fabrication (InPhoTec) co-located in Pisa.

The proposed research activity is expected to have a considerable impact through the advancement of the state-of-the-art in multiple directions including:

- cost-effective solutions for short-reach applications;
- 5G fronthauling solutions based on single and multi-mode fiber structures;
- networking approaches in the SDM environment
- high-speed transmission schemes for long-haul applications;
- models for linear and nonlinear SDM transmission, and their experimental validation.

The achievement of the above stated objectives relies on the expertise of the participants in both countries, and requires their active collaboration.
The cooperation between the Incubator participants will imply:

- periodic meetings in L'Aquila and Israel for discussions and brain storming;
- visits in L'Aquila for joint activities in the Incubator infrastructure;
- teleconferences;
- organization of joint events in order to disseminate the Incubator mission within the Italian and Israeli potential investors.

A major advantage of the proposed collaboration is in the exposure of the Incubator plan to a broad community of entrepreneurs, by exploiting the well-established entrepreneurial tradition on the Israeli side.

SCIENTIFIC JUSTIFICATION AND WORKPLAN

1. State of the art

In recent decades, the world has been experiencing a steady exponential increase in the demand for transmitted data. This trend has accelerated in the past few years in order to support the increasing data traffic produced by machine-to-machine communications and cloud computing. Current growth-rates are of the order of 60% of growth per year [1], which implies a doubling of the demand every year and a half. The situation with short optical links (such as the metro segment or intra/inter data centers) is even more critical, where an enormous demand for bandwidth has been introduced by multiple global players (Microsoft, Google, Alibaba, Facebook, and others) [2]. The optical communications community is now scrambling for new disruptive technologies that would take the world of internet applications further into the future. Considering the framework where the Incubator will be established (more details will be given in the following sections) and in accordance to the optical network infrastructure available from the project INnovative City Planning Through Information & Communications Technologies (INCPICT), three main research topics are considered as basis for the Incubator research activities. These are: i) Cost-effective short reach transmission; ii) Space-Division Multiplexed (SDM) transmission; iii) Software-Defined Flexible Networking.

i) The need for low-cost solutions has led to a number of direct-detection (DD) based transmission schemes, whose optical hardware is considerably simpler than that of coherent receivers [3]. Currently, pulse amplitude modulation (PAM) [4] seems to be leading the race for low-cost transmission systems. One popular alternative approach is that of DD orthogonal frequency-division multiplexing (OFDM) [5]. A shortcoming of PAM and DD-OFDM is that they are not tolerant to linear propagation effects, primarily chromatic dispersion. In order to resolve this issue, self-coherent heterodyne scheme was proposed in [6]. More recently, in [7] a new receiver scheme that allows the reconstruction of complex optical signal from an intensity measurement requiring only a single-photo-diode has been proposed. Another technique, still adopting simple DD and avoiding DSP, named combined amplitude-phase shift (CAPS), has been proposed in [8] and experimentally demonstrated [9]. Order-3 CAPS increases the achievable transmission distance compared to a PAM-4 format, while keeping the same simple receiver configuration adopted for OOK. This comes at the expense of a slightly higher transmitter complexity, as it requires modulation of both the in-phase and quadrature components.

ii) Satisfying the demand by means of increasing the number of installed systems is economically unviable, as it would imply an exponential increase in the costs encountered by the end user. The most promising alternative that is currently being explored is SDM transmission, where multiple channels are simultaneously transmitted over the spatial modes of a multi-mode fiber or different cores of multi-core fibers. Currently, major players in the fiber-communications market are examining the viability of employing multi-mode and multi-core technologies as a possible approach to a cost-effective and energy efficient solution [10] to the imminent capacity crunch [1]. The sudden explosion of this field of research entails a number of complex and significant challenges ranging from fundamental issues related to light propagation in multiple modes of various fiber-optic structures to the technological issues arising from the upgrade of the system components.

Record experiments reported from around the world have shown the technical viability of SDM transmission, by demonstrating spectral efficiencies as high as 58 bits/second/Hertz [11] over fiber supporting up to 15 spatial and polarization modes [12]. Extensive research

conducted in the past few years has also demonstrated the feasibility of cost-effective inline optical components and sub-systems suitable for SDM communications. Works on the theoretical front have indicated that SDM systems operated in the regime of strong crosstalk between modes can in principle outperform parallel single-mode systems [13,14]. In spite of the numerous efforts that are being invested in this field of research, the understanding of the potential performance of an SDM link in a field environment is far from having been achieved.

iii) In the last years, because of the continuous increase of network traffic and the consequent development of transmission techniques allowing high spectral efficiency, flexibility and the possibility to manage services through abstraction of lower-level functionality became two main requirements for the next generation optical networks.

At the control plane layer, software defined networking (SDN) represents an innovative and attractive paradigm for the control of network infrastructures, decoupling data and control planes with the availability of a centralized controller [15]. Moreover, SDN may decrease lightpath set-up time being node configuration done in parallel instead of sequentially. The OpenFlow (OF) architecture represents one of the most considered solutions for SDN [16-18]. In [17], the OF control of a multi-domain optical network testbed employing packet, fixed and flexible grid technologies is demonstrated. In [16], monitoring functionalities are introduced in the OF architecture in flex-grid optical networks. More recently, networks have been evolving toward higher programmability and flexibility [19]. In this contest, NETCONF is emerging as a SDN protocol for the control and management of optical networks. NETCONF may exploit YANG data modeling to describe in a formalized and standardized way the network devices. In particular, YANG and NETCONF are suitable to describe data plane capabilities, such as the properties of a transponder (e.g., supported bit rate values), or, in general, the structure of an optical network in a vendor independent way [20].

2. Expected impact

The proposed technological Incubator will be established in a unique social, economic, and scientific scenario. The framework chosen for this new entrepreneurial project is the city of L'Aquila, in Italy, which in 2009 was hit by a high magnitude earthquake that heavily damaged the whole city. Since 2009, the rebirth of the city of L'Aquila has included a number of significant innovative and experimental projects, devoted not only to rebuild the city "as it was", but also aimed at promoting a renovated propulsive strength in the economic, social and scientific life. In this scenario, one of the major strengths of the proposed Incubator will be the deep bond with the project INCIPICT, which includes a Smart-City-oriented test-bed based on an innovative fiber-optic infrastructure supporting integration with state-of-the-art wireless technologies for communication, sensing, and multimedia applications (IoT technologies and the progress towards the 5G paradigm of wireless communications). INCIPICT also includes a SDM infrastructure based on Multicore/Multimode fiber technologies allowing the development of cost-effective ultra-high throughput communications and offer a rare and valuable opportunity for conducting filed trial experiments in an installed SDM network.

The Incubator will offer assistance and facilities to enable the birth and the growth of new startups focused on developing novel well-defined hi-tech products with strong commercial potential, targeting the international market, and carried out by highly motivated entrepreneurs. Through extensive mentoring and networking support, as well as sharing of expertise and collaborative initiatives among companies and shareholders, hosted companies will benefit of a favorable environment to reach significant milestones such as lab or field trials, product sales and strategic agreements for additional financing and/or

business partnership. Hosted companies will take advantage of technical and scientific support by professors, researchers, technicians, access to scientific libraries subscription, to scientific equipment and lab facilities. Furthermore, they will enter in contact with the CNIT network ecosystem, including the possibility to take part to national, European (Horizon 2020), and international research projects where SMEs play a fundamental role. On the other hand, scientific expertise as well as financial background make Israel a perfect partner for joint Incubator especially in the field of optical communications. As a prove of the matter Israeli ministry of economy funded the PetaCloud consortium with the goal of encouraging the collaboration of industrial companies and major academic institutions for the development of technologies designed to enhance the information handling capability of network data-centers. The consortium academic participants come from five major universities (Technion, Tel Aviv University, Bar Ilan University, The Hebrew University, and Ben Gurion University), and combines experts on optical transmission and experts on networks and network algorithms. The industrial partners are Melanox, Cello, Opsys, Effdon, ECI, Bezeq International, and TowerJazz, spanning the areas of optical interconnect devices, optical networks, systems, and deployment. The INCUBANDO project will directly expose startups to Petacloud consortium, private investors, and Israeli business angels.

3. Research program

The ambition of the INCUBANDO project is manifold; while the main goal of this proposal is the establishment of a technological Incubator to support the birth and growth of new startups, it appears essential to plan a detailed research activity, with the aim of consolidating the scientific and technological premises of the Incubator itself, and to be able to provide highly qualified services.

Main objectives can be summarized as:

- establish the joint technological Incubator infrastructure;
- carry out and stimulate innovative research in the field of optical communications and applications, and encourage the conception of ideas that are suitable for commercialization;
- provide highly qualified support and services to incubated startups, included but not limited to workplace, access to scientific subscriptions, advanced scientific equipment and Lab facilities, additional financing opportunities, workshops, courses, events;
- bilateral exchange of expertise in order to strength relationship and put the basis for appealing investments.

The INCUBANDO project is organized in four Work Packages (WPs) concerning the aspects of managing (WP1), the establishment and the maintenance of an Incubator (WP2), research activities (WP3), and the creation of an environment that allows the generation of highly qualified services available to the incubated companies (WP4).

WPs Detailed description

WP1. Management

WP1 concerns the project management and coordination and covers the whole duration of the project activity. It will care about all the management operations required for the Incubator establishment, including legal and administrative aspects. The project management will be carried out by CNIT including:

- Italia-Israel cooperation agreement (including Intellectual Property Right, techno-economic aspects, joint human and financial resources);
- organization of meetings in L'Aquila and Tel Aviv for discussions and brain storming;
- annual reporting of the Incubator activities;

- maintaining and managing contacts with all the staff involved in the project
- coordinating a joint working group dedicated to promotional events and funds attraction opportunities.

CNIT administration will contribute for carrying out the administrative and financial management of the project. A website of INCUBANDO project will be regularly updated. Promotional material (flyers, brochures, posters, videos, slide presentations, newsletters) will be also prepared and made available through the website and also distributed in the various dissemination and events.

WP2. Joint Incubator establishment, operation, and maintenance.

Within WP2 all aspects related to Incubator establishment and maintenance will be addressed. At the very beginning, the administrative and logistic aspects will be studied in depth by CNIT personnel in order to set the best conditions both for Incubator and even for startups. The Italian law (mainly n. 221, 17/12/2012) provides a number of possible fiscal benefit in order to help Incubators and startups. Once all the administrative aspects will be clarified, the first year will be dedicated to Incubator establishment including spaces, rules, agreement, services and startups admission definition.

At the beginning of the second year a dedicate committee will be settled with the aim of managing the first call including application and rating. The committee will include 1 administrative, 2 researcher, and 1 invited business angel from a Business Angel Network

A grant of € 15.000,00 will be given to a single selected startup that will reserve up to 10% participation to the INCUBANDO. All the other applicant will have free access to the infrastructure.

A dedicated study will be carried out during the third project year in order to find out all possible solutions for INCUBANDO continuation after the end of the project. From the financial point of view, INCUBANDO will take benefit from participation in startups generated within the Incubator as well as from patent and fund-raising activities. Some of the services provided for free to the startups during their first three years of activity will be gradually converted into revenues. Such revenues will be used for MAECI reimbursement in the form of royalties and INCUBANDO expenses. At the same time, new international public and private bodies will be considered for inclusion in the Incubator. On the other hand, INCUBANDO itself and INCUBANDO as a part of startups will participate to new call at local, regional, national, and European level. Regulation and administrative expertise will be transferred to dedicated personnel recruited by the Incubator. Moreover, a new call will be open for funding a new startup with a grant of € 20.000,00 with the same rules of the previous year, including INCUBANDO participation. Finally, academic and R&D participation in INCUBANDO will guarantee for scientific upgrade and extension especially towards novel applications and services capable of providing innovation for startups.

WP3. Incubator research activities.

This WP will be dedicated to define initial research lines and identify topics to be addressed within the Incubator in accordance to the installed infrastructure made available by the INCIPICT project. In this framework, the main goal of the WP is not only to consolidate the scientific and technological premises of the Incubator itself but also to create a favorable environment for the hosted companies to stimulate and encourage innovative research and the conception of new ideas, commercial products and services. Given the research-oriented nature of shareholders, the range of available expertise accessible by incubated partners will continuously broaden following most significant scientific and industrial research trends.

Novel energy- and cost-efficient transmission schemes as well as transceiver architectures will be explored to meet the optical reach requirements of the metro scenario, such as the infrastructure available in L'Aquila, while providing high throughput. Preferred target will be DD solutions based on low-complexity optoelectronic front-ends enabled by smart, cost-effective DSP. The chief idea is to approach the performance of a coherent transceiver with a much simpler receiver implementation that eliminates the need for balanced detection with a complex optical hybrid, with a minor compromise on the overall system throughput and spectral efficiency (the theoretical limit can be shown to be smaller than 1 bit in spectral efficiency below that of coherent systems). As currently known schemes are still far from achieving this limit, the potential impact of this line of research is very significant and appears as a promising topic to be explored within the Incubator for its industrial application.
Moreover, the installed infrastructure represents a valuable and unique opportunity to conduct research in a realistic SDM transmission environment, as SDM fiber properties are known to vary considerably in time when placed in a dynamic environment. All existing studies have been conducted on spooled fibers in the lab. The development of experimental capabilities with buried fibers in a realistic environment is an invaluable step when developing commercial solutions and this will make the Incubator an attractive site for investigations on this topic. As an example, efficient MIMO techniques suitable for large mode-count SDM systems will strongly benefit from characterization of the installed fiber infrastructure to optimize construction of statistical models. Also, development of numerical tool for the efficient evaluation of system performance (BER, Q-factor) as well as devising methods for reducing the impact of nonlinear interference effects have the potential of being marketed as a software product to system designers. The study will also include cost-effective SDM transmission solutions for short-reach applications, in the context of fiber-based front-hauling for the 5G network.
From the networking point of view, the project will be focused on the development and implementation of flexible SDN control and management functionalities for the installed network infrastructure available through the strong relation with INCIPICT project. The consolidated expertise of CNIT in control and management (CO&M) plane development will ensure valuable support and guidance to incubated companies operating on this subject. Targeted CO&M plane implementation should support programmability (e.g. through OpenFlow, NETCONF protocols and YANG data modeling) to ensure optimum configuration and monitoring of network nodes and devices. In particular, focus will be given to ensure the correct operation of the CO&M plane over the installed network infrastructure that, at the lowest level (data plane), includes advanced optical devices that perform data switching functions in optical spectrum and on space domains. YANG models will be developed for spectrum and space switching flexible networks. As an example, models will account for the (re-)configuration of switches supporting multi-core fibers.

WP4. Incubator services.

The Incubator will offer highly qualified support and facilities to promote the birth and the growth of new startups focused on developing novel well-defined hi-tech products. Typical startup project should be focused on developing novel well-defined hi-tech products with strong commercial potential, targeting the international market, carried out by highly motivated entrepreneurs. Through the sharing of expertise and collaborative initiatives among companies and shareholders, hosted companies will be able to reach significant milestones such as lab or field trials, product/service sales and strategic agreements. Hosted companies will benefit of:

- a favorable environment for implementation of ideas, workspace and meeting rooms;

- research specialist network (Italian/Israeli - within CNIT consortium);
- workshops and courses;
- open participation to conferences organized by CNIT;
- specific promotional joint Italy/Israel events organization;
- access to online scientific libraries subscription (IEEE, OSA…);
- access to scientific equipment and Lab facilities;
- access to CNIT network ecosystem, including the possibility to take part to international research projects, fostering worldwide interactions with international industrial and scientific community;
- privileged access to InPhoTec facilities in Pisa for Photonic Integrated Circuits design and fabrication;
- assistance in scouting additional financing and/or strategic partners;
- advice on business planning, financial and management expertise;
- administrative services;
- funding opportunities (two specific calls whose overall budget will be € 45.000,00);
- support to market fit and traction;
- direct exposure to national and EU calls (Horizon 2020) where SME are mandatory.

An important goal that will be pursued is to associate the Incubator to the FIRE program (FIRE – Future Internet Research and Experimentation, https://www.ict-fire.eu/#), so as to disseminate the mission of INCUBANDO in the broadest European testbeds platform.

4. Available research resources

Different resources will be part of INCUBANDO project. The scientific quality provided by Italian and Israeli researchers guarantee for an outstanding quality of innovation. At the same time, Laboratory as well as field trial expertise will be of great interest for any startup with the ambition of highly technological products and services. Equipment present at the PNNL of CNIT in Pisa will be available for any kind of test for innovative devices, subsystems, systems, network, and services grown within INCUBANDO. At the same time, expertise in startups, project management, and international collaborations are widely present within the INCUBANDO proposers. Hereafter, short CVs are summarized for proposers with the exclusion of Italian and Israeli principal investigators, whose CV are included as separate pdf files (see 1.4, 1.6).

- Elisa Razzoli is administrative at PNNL of CNIT in Pisa. She graduated in Doctor in Economics (1997) at University of Parma. She has strong experience in project management and personnel resources administration.

- Antonio Mecozzi is Professor and the Director of Department of Physical and Chemical Sciences of the University of L'Aquila (UNIVAQ), Italy. Previously, he worked for fifteen years at the Fondazione Ugo Bordoni in Rome. He holds numerous patents, and he is the author of over 170 publications in international journals and of numerous presentations, many invited, at international conferences. His areas of interest include studies on soliton transmission, laser mode-locking, nonlinear propagation in fiber, polarization mode dispersion, physics and applications of semiconductor optical amplifiers, optical amplification, noise, and optical and quantum cryptography. He is a Fellow of the Optical Society of America (1999) and of the IEEE (2003).

- **Enrico Forestieri** received the Dr. Ing. degree in Electronics Engineering from the University of Pisa in 1988. From 1989 to 1991 he has been a postdoctoral scholar at the University of Parma, working on optical communication systems. From 1991 to 2000 he was a Research Scientist and Faculty Member of the University of Parma. Since 2001 he has

been with Scuola Superiore Sant'Anna (SSSA), where he currently is Professor of Telecommunications. His research interests are in the general area of digital communication theory and optical communication systems, with special attention to adaptive optical and electronic equalization, channel coding, and advanced modulation formats for optical systems. Currently, he serves as director of the PNNL at CNIT.

- **Cristian Antonelli** is a tenure-track Assistant Professor at UNIVAQ. He received his MSc and PhD degrees in Electrical Engineering from UNIVAQ, Italy, in 2002 and 2006, respectively. Since 2007 he has been a senior research scientist first at CNISM, the Italian inter-university consortium for the physics of matter, and then at the UNIVAQ. He performs research in the area of fiber-optic communications, with focus on the analysis of various propagation-related aspect, and systems and sub-systems modeling. He co-authored more than 40 papers in international journals, and about 40 papers in leading international conferences. He is a co-inventor of 5 US patents. He is in charge of Optical Communications-related activities within the INCIPICT project.

- **Andrea Marotta** received the B.SC. and M.Sc. degrees in Computer Engineering from University of L'Aquila, Italy. He is currently working toward the Ph.D. degree with the Department of Information Engineering Computer Science and Mathematics at UNIVAQ. He is spending a one year period as visiting Ph.D. at SSSA in Pisa performing research on 5G Radio Access Network design. He performs research on 5G functional split, function placement optimisation, TDM-PON Dynamic Bandwidth Allocation schemes for 5G.

- **Francesco Fresi** received the Ph.D. Degree from SSSA in Pisa, Italy, in 2009. From 2010 to 2016 he was Assistant Professor at the SSSA Institute of Communication. He's currently research fellow at SSSA. He actively contributed in several European and National research projects on next generation optical networks, as well as technology transfer projects with industry. His research activity is focused on high capacity optical communications for next generation elastic networks, including direct and coherent detection, signal processing and data-plane support to network optimization. He is (co-)author of more than a hundred publications in international journals, conference proceedings and patents.

- **Gianluca Meloni**, received the master's degree in Telecommunication Engineering from the University of Pisa in 2003 and the Ph.D. degree from the SSSA of Pisa, Italy, in 2008. He is actually employed as research executive technician for the CNIT PNNL. He is co-author of 3 book chapters, more than 25 papers on international journals, 40 invited and regular talks at international conferences and 4 international patents. His main research activities include the area of fiber optic transmission with particular interest in coherent optical systems, photonic subsystem for next generation optical networks and all-optical technologies. He has been involved in research projects funded by the Italian Ministry of University and Research (MIUR) and by private companies (Marconi-Ericsson).

- **Muhammad Imran** received the B.Sc. Electrical Engineering in 2003 from University of Engineering & Technology Taxila, Pakistan. From 2004 to 2010, he served in Pakistan Telecommunication Company Limited (PTCL) as Senior Engineer in Optical Fiber Networks Department. In 2010, he was selected for Erasmus Mundus Scholarship for Masters on Photonic Network Engineering (MAPNET) and received his double degree from Aston University UK and SSSA Italy. In 2016 he received PhD degree at SSSA where he has currently a post-doc fellowship. His research interests include High capacity optical communications, optical frequency combs and SDM networks.

- Nicola Sambo received the Laurea degree in Telecommunications Engineering at Università degli Studi di Pisa, Italy and the Ph.D. degree at SSSA, Pisa. Currently, he is

Assistant Professor at SSSA, Pisa, Italy. His work is interdisciplinary, ranging from signal transmission to control plane for optical networking. He collaborated and collaborates with several industrial and academic partners such as Ericsson Research (Italy), France Télécom and Orange Lab (Lannion, France), Telefonica (Spain), Telecom Italia, Nokia Bell Labs (France), and Coriant (Germany). He took part to several international projects such as EU FP7 STRONGEST and IDEALIST, EU H2020 ORCHESTRA. He is author of about 80 publications including international journals, conference proceedings, and patents.

- Vito Sorianello received the PhD degree in Electronic Engineering in 2010 from University "Roma Tre" of Rome (Italy). He spent three years as postdoctoral research fellow at the Nonlinear Optics and OptoElectronics Lab of University "Roma Tre" of Rome (Italy) being involved as responsible for the fabrication and characterization processes of Germanium on Silicon photodetectors. He is currently researcher at the PNNL (CNIT) of Pisa since 2013. His main research interests are the modeling, design, and characterization of optoelectronic components and systems for the Silicon Photonics platform. He is currently involved in several application-oriented research project in collaboration with national and international research institutions and industries.

- Ori Golani is a Ph.D. student in the school of electrical engineering in Tel Aviv University. His expertise is in the fields of optics, optical communication, and digital signal processing. The present focus of his research is nonlinear effects in optical communication systems, and particularly statistical modeling and mitigation of nonlinear interference noise. Education: B.Sc. in computer engineering and applied physics, Hebrew University of Jerusalem, 2007-2011. M.Sc. in applied physics, Hebrew University of Jerusalem, 2011-2014. Ph.D. in electrical engineering, Tel Aviv University, 2014-present

- Dan M. Marom is an Associate Professor in the Applied Physics Department at Hebrew University, Israel, heading the Photonic Devices Group and currently serving as the Department Chair. He received the B.Sc. Degree in Mechanical Engineering and the M.Sc. Degree in Electrical Engineering, both from Tel-Aviv University, Israel, in 1989 and 1995, respectively, and was awarded a Ph.D. in Electrical Engineering from the University of California, San Diego (UCSD), in 2000. He is currently leading a research group pursuing his research interests in creating photonic devices and sub-systems for switching and manipulating optical signals, in guided-wave and free-space optics solutions using light modulating devices, nonlinear optics, and compound materials.

- Lior Blech has recently started his PhD in electrical engineering in Tel Aviv University. His research currently focuses on methods and applications of modern non-convex optimization methods in the field of fiber optics receivers. Previous education and occupation: 2007-2010: BSc in physics from Bar Ilan University with distinction. 2010-2013: Project management officer in the Israeli ministry of defense. 2014-2016: MSc in high energy physics from Tel Aviv University. Thesis on the subject of a string theoretic model of Hadrons.

5. Facilities

CNIT is a non-profit consortium among 37 Italian Universities, whose main purpose is to coordinate and foster basic and applied research activities also looking for cooperation with national and international bodies and industries and provide advanced education and training. The operating structure of CNIT is based on Research Units and National Laboratories operated directly by CNIT through its own research and administrative personnel. In this project, the PNNL is involved. The activity encompasses all research aspects related to optical transmission and networking. In particular, remarkable results have been achieved in field such as high capacity coherent optical transmission, field trials, network control and management and so on. The wide-range expertise available can be

fruitfully leveraged to carry out the INCUBANDO project. UNIVAQ is one of the Italian universities that are consortium members of CNIT. UNIVAQ will make freely available, for this project, the experimental network of project INCIPICT. The main goal of INCIPICT is the implementation of a metropolitan area network (MAN) for the city of L'Aquila, as a mean to stimulate and support smart-city-oriented applications. These range from building monitoring for early earthquake warning, to building automation and energy efficiency, and pervasive service provisioning through innovative networking technologies based on context-awareness. The decision to fund the project proposal dates back to December 21st, 2012, almost three years later than the earthquake that devastated the city of L'Aquila, with the aim of sustaining production and research activities. The project ends on December 31st 2018 (http://incipict.univaq.it/it/). The implementation of the MAN, which is expected to be finalized by the middle of 2017, aims to provide broad-band connectivity between the local governmental facilities (these include the municipality, the regional administration, the court, the prefecture, the police headquarter), schools of various types, the hospital, the Gran Sasso Science Institute, and the UNIVAQ, which is responsible for the network design and implementation. The MAN is based on a fiber-optic ring of about 20 km, consisting of at least six cables for standard single-mode fibers and two cables for multi-core and multi-mode fibers, with thirty one access points and various wireless local area network extensions. The fiber-optic ring and the connected facilities are shown in the figure. The MAN infrastructures accommodates an experimental independent network characterized by advanced information and communication technologies, including multi-mode fiber structures for space-division multiplexing, energy efficient cognitive wireless protocols for wireless sensors/actuator networks, besides state-of-the art fiber-optic cables and WDM components, as well as MIMO-based wireless network extensions. The experimental network is meant to serve as a testbed available to the national and the international research community for the investigation and the implementation of innovative communications-related technologies and services. This makes INCIPICT's experimental network a natural and ideal candidate for the establishment of a technological Incubator in the spirit of the present call.

The PNNL of CNIT in Pisa is an 800 m^2 laboratory including most of the advanced equipment for optical communication testing, ranging from the optical networks down to the physical layer and photonic devices. Moreover, in recent years, CNIT and SSSA have founded the InPhoTec. This facility was born as both a center for scientific technological development and, at the same time, it offers technology services not only for research purposes. Its mission is to provide fabrication facilities and technology platforms for research, prototyping and production of high added value components and circuits to academic and industrial SMEs. The major areas where InPhoTec can provide innovative front-end and back-end processes and technologies are: photonic integrated circuits and optoelectronics; bio photonics and medical applications; sensors and MEMS, MOEMS. The Incubator, thanks to the presence of InPhoTec, will guarantee high-level services in the field of integrated photonics including integrated circuit design support, prototypes production and advanced customizable packaging. Technological expertise and infrastructure provided within the CNIT-SSSA and InPhoTec institutions will be available for the incubated companies providing highly qualified support and services.

6. Compatibility of the proposed Joint Incubator with this call for proposals

The main target of the call is to put together Italian and Israeli entities in order to increase innovation and, at the same time, speed up technological transfer towards new startups fulfilling market demands in the ICT topic. INCUBANDO project takes benefit from already

existing infrastructures and collaborations thus generating the optimal environment for launching new ideas and startups without strong and unaffordable investment in testing infrastructures, equipment, and highly qualified research.

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