COCONUT

Exploitation and Dissemination Plans and 1st year activities

D7.2

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Partner Name	Short name	Country
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UNIVERSITAT POLITECNICA DE CATALUNYA	UPC	Spain
RESEARCH AND EDUCATION LABORATORY IN INFORMATION TECHNOLOGIES	AIT	Greece
ERICSSON AB	EAB	Sweden
PROMAX ELECTRONICA S.A.	PRO	Spain
OPTRONICS TECHNOLOGIES A.B.E.T.E.	OPT	Greece
III V LAB GIE	35L	France
BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY	BT	United Kingdom

Abstract:
This deliverable reports the actions taken by the COCONUT consortium in terms of dissemination and exploitation of the project results during the 1st year of the project covering the period from November 2012 to October 2013. It also summarises the opportunities for commercialisation, exploitation and standardisation identified by the industrial partners in the first year of the project. The next steps are also identified herein.

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10				
	Comments:			
11				
	Comments:			
12				
	Comments:			
13				
	Comments:			
14				
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Table of Contents

1. Introduction

COCONUT comes to meet the requirements of the next generation access networks with improved features with respect to reach, bandwidth, number of users and cost-effectiveness. Nonetheless, COCONUT is not targeting an alternative to NGPON2 but rather aspires to influence the definition of NGPON3. In terms of dissemination, the goal of the consortium is to clearly communicate this objective to the interested parties with activities that targeted both the research and the industrial community. These activities are reported in the first part of this deliverable.

During the first year of the project the consortium defined the COCONUT architecture. Therefore, having a more comprehensive view of the benefits of the COCONUT solution, the purpose of the second part of this deliverable is to identify potential contributions for commercialisation, exploitation and standardisation. BT, Ericsson, 35L, Optronics and Promax explain how they foresee to exploit the COCONUT innovations and comment on the commercialisation opportunities. In the end of document, the course of action is described should a standardisation opportunity arise within COCONUT.

2. Dissemination Activities and Plans

To disseminate the project results and promote its visibility several actions were taken by the different partners:

- The project web site was created containing all public information related to the project, including a concise summary of the project mission and vision.
- Press releases have been issued by the partners.
- Significant presence and presentation of the COCONUT concept and solutions at the most relevant conferences and events in 2013.
- Submission of scientific papers to the most significant journals in the field.
- Organisation of one conference workshop and one industrial workshop.
- Project promotion at the ECOC 2013 Exhibition.

2.1. Website

The website of COCONUT (www.ict-coconut.eu) acts as a point of reference both for the external visitors and the consortium members. The content of the website is being regularly updated with information about the project concept, latest achievements, news and events. Partner OPTRONICS, as the COCONUT dissemination leader, designed and established the COCONUT web-site within the first month of the project. By the end of the first month the site was fully operational with all necessary material highlighting the project goals and methodologies. Apart from maintaining the project webpage, OPTRONICS has established a Twitter account (https://twitter.com/ict_coconut) and an RSS feed to ensure the dissemination of the projects results, news and achievements to the interested readership.

The COCONUT website contains a public area with:

- ✓ News and events
- ✓ Dissemination Activities
- ✓ Public Deliverables
- ✓ Information about the consortium etc

and a restricted area with access only to the COCONUT partners. This area enables the Consortium to manage the diffusion of the information and exchanges between partners and contains a directory with the relevant files of the:

- ✓ Deliverables
- ✓ Milestones
- ✓ Task Detailed Work-Plans
- ✓ Meeting Minutes
- ✓ Project Grant
- ✓ Templates etc

Figure 1: Snapshot of the COCONUT home page.

2.2.Dissemination activities to the scientific community

2.2.1. Publications

During the first year of the project, the consortium has published a total of 5 scientific articles in peer-reviewed international journals and conferences, acknowledging the project. Among those, the COCONUT consortium presented a paper that describes in a comprehensive manner the main concept of COCONUT (D7.1 Concept paper of COCONUT project). Nonetheless, the consortium also plans to submit a more extended manuscript to a high-impact journal such as the IEEE Communications Magazine.

A list of the publications and submitted papers is provided below:

Journals

1. M. Presi, R. Corsini, G. Cossu, E. Ciaramella et al., "All DFB-based Coherent UDWDM PON with 6.25 GHz Spacing and a > 40 dB Power Budget", accepted for publication on IEEE Photonic Technology Letters.

Conferences

1. M. Presi, F. Bottoni, G. Cossu, R. Corsini, E. Ciaramella et al., "A 1.25 Gb/s Low-Cost Coherent PON", presented at ECOC 2013, paper We.3.F.
2. A. Lerín, I. N. Cano, Victor Polo, J. Tabares, Josep Prat "Simple ONU Transmitter Based on Direct-Phase Modulated DFB Laser with Heterodyne Detection for udWDM-PON", Conference Proceedings, ECOC 2013, Paper We.2.F.4.
3. G. Vall-llosera, A. Rafel, E. Ciaramella, J. Prat, "COCONUT requirements for residential, business and outdoor scenarios", ICTON 2013.vol., no., pp.1,4, 23-27 June 2013.

Invited

1. J. Prat, M. Angelou, C. Kazmierski, R. Pous, M. Presi, A. Rafel, G. Vall-llosera, I. Tomkos, E. Ciaramella, "Towards Ultra-Dense Wavelength-to-the-User: The Approach of the COCONUT Project" invited paper at ICTON 2013.

Submittted

1. E. Ciaramella "Polarization-Independent Receivers for low-cost Coherent OOK systems", submitted for publication on IEEE Photonics Technology Letters
2. M. Presi, R. Corsini, E. Ciaramella "Experimental demonstration of a novel polarization-independent coherent receiver for PONs", submitted to OFC-2014.
3. F. Bottoni, M. Presi, R. Corsini, E. Ciaramella et al. "Low-Cost 10 Gb/s Coherent PON Based on Phase-Diversity Homodyne Detection", submitted to OFC-2014.
4. I. Cano, M. Presi, A. Lerín, V. Polo, E. Ciaramella, J. Prat " -51dBm Sensitivity 1.25Gb/s System for Cost-Effective udWDM- PON with Homodyne Detection" submitted to OFC-2014.

2.2.2. Workshops and conference sessions

Workshop at Future Network & Mobile Summit 2013

COCONUT in collaboration with the FP7-ICT-ACCORDANCE project submitted and got accepted a workshop proposal on *"Opportunities, Challenges and Interplay of Next Generation Optical and Wireless Access Networks"* at FuNeMS 2013 (Lisbon, Portugal, July 3-5, 2013). Therein Prof. Prat (UPC) and Dr. Vall-llosera (EAB) gave the following talks:

- J. Prat: "*Overview of the COCONUT EU Physical Layer Benefits and Challenges"*
- G. Vall-llosera: "UDWDM-PON Based Solutions for Small Cell Backhauling"

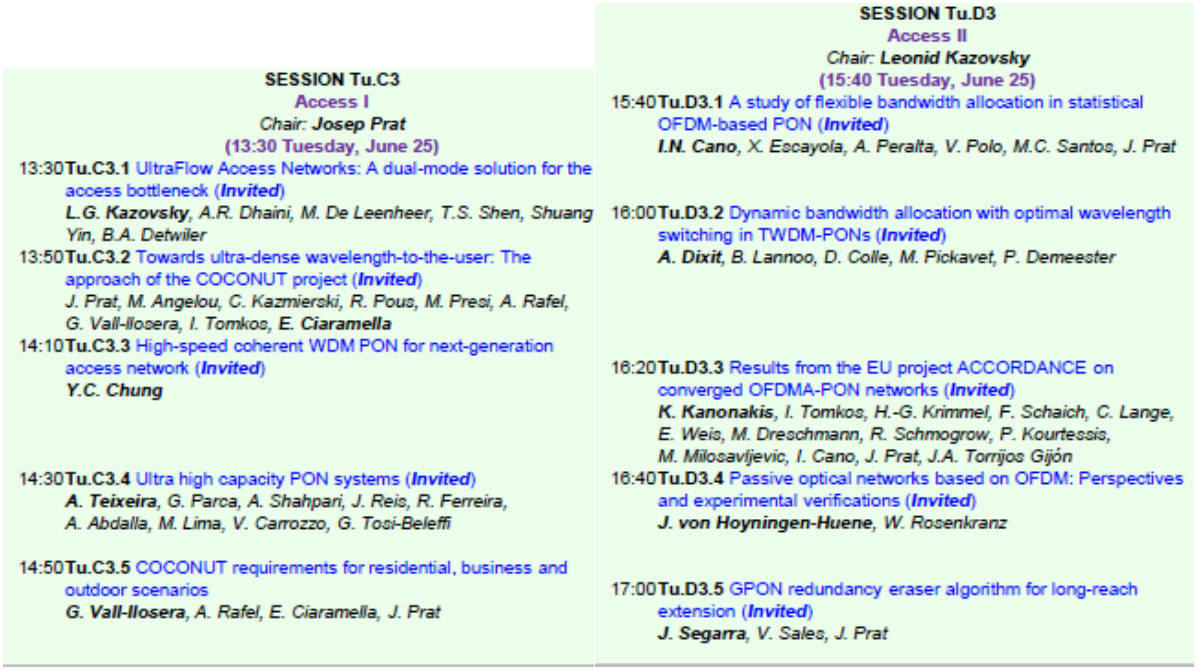
Organisers of the workshop were Prof. Prat from COCONUT and Dr. K. Kanonakis from ACCORDANCE.

Figure 2: Snapshots from the Future Network Summit 2013 Agenda

Special session at ICTON 2013

COCONUT in collaboration with the FP7-ICT-ACCORDANCE project organised a Special Session at ICTON 2013 (Cartagena, Spain, June 23-27, 2013) on Broadband Access (http://www.itl.waw.pl/icton-2013-coconut). The scope of the session covered the techniques that can assure that the optical channel available is used advantageously, without limitations in terms of bidirectional capacity, length, user density, quality of service, etc, towards what is being defined as the Next-Generation PON (NGPON2, NGPON3).

The final structure of the session program is shown below:



SESSION Tu.C3
Access I
Chair: ***Josep Prat***
(13:30 Tuesday, June 25)

13:30 **Tu.C3.1** UltraFlow Access Networks: A dual-mode solution for the access bottleneck (***Invited***)
L.G. Kazovsky*, A.R. Dhaini, M. De Leenheer, T.S. Shen, Shuang Yin, B.A. Detwiler*

13:50 **Tu.C3.2** Towards ultra-dense wavelength-to-the-user: The approach of the COCONUT project (***Invited***)
J. Prat, M. Angelou, C. Kazmierski, R. Pous, M. Presi, A. Rafel, G. Vall-llosera, I. Tomkos, ***E. Ciaramella***

14:10 **Tu.C3.3** High-speed coherent WDM PON for next-generation access network (***Invited***)
Y.C. Chung

14:30 **Tu.C3.4** Ultra high capacity PON systems (***Invited***)
A. Teixeira*, G. Parca, A. Shahpari, J. Reis, R. Ferreira, A. Abdalla, M. Lima, V. Carrozzo, G. Tosi-Beleffi*

14:50 **Tu.C3.5** COCONUT requirements for residential, business and outdoor scenarios
G. Vall-llosera*, A. Rafel, E. Ciaramella, J. Prat*

SESSION Tu.D3
Access II
Chair: ***Leonid Kazovsky***
(15:40 Tuesday, June 25)

15:40 **Tu.D3.1** A study of flexible bandwidth allocation in statistical OFDM-based PON (***Invited***)
I.N. Cano*, X. Escayola, A. Peralta, V. Polo, M.C. Santos, J. Prat*

16:00 **Tu.D3.2** Dynamic bandwidth allocation with optimal wavelength switching in TWDM-PONs (***Invited***)
A. Dixit*, B. Lannoo, D. Colle, M. Pickavet, P. Demeester*

16:20 **Tu.D3.3** Results from the EU project ACCORDANCE on converged OFDMA-PON networks (***Invited***)
K. Kanonakis*, I. Tomkos, H.-G. Krimmel, F. Schaich, C. Lange, E. Weis, M. Dreschmann, R. Schmogrow, P. Kourtessis, M. Milosavljevic, I. Cano, J. Prat, J.A. Torrijos Gijón*

16:40 **Tu.D3.4** Passive optical networks based on OFDM: Perspectives and experimental verifications (***Invited***)
J. von Hoyningen-Huene*, W. Rosenkranz*

17:00 **Tu.D3.5** GPON redundancy eraser algorithm for long-reach extension (***Invited***)
J. Segarra*, V. Sales, J. Prat*

Figure 3: The program of the COCONUT-ACCORDANCE special session at ICTON 2013

The goal of this workshop was to attract invited and contributed presentations from both the industry and the academia on the hot topic of converged next generation broadband access networks. The participation in this session exceeded 50 people (no official participation data per session are available by the organizers).

COCONUT presented at OFC/NFOEC 2014 workshop
Prof. J. Prat (UPC) presented the COCONUT concept in the OFC 2014 Workshop entitled "Post NG-PON2: Is it More About Capacity or Something Else?" The workshop was held on March 17 and was organised by Jun Shan Wey - Nokia Siemens Networks, USA and Thomas Pfeiffer - Alcatel-Lucent, Germany.

2.3.Dissemination activities to the wider public

2.3.1. Press Releases

Upon the commencement of COCONUT, OPTRONICS released a press release to several electronic magazines. A version of that release was also published "Lightwave Online" which is quite popular among the optical communications professionals.

- http://www.lightwaveonline.com/articles/2013/01/coconut-project-to-develop-coherent-ultra-dense-wdm-pon.html?cmpid=EnlDirectJanuary222013
- http://www.ethernut.net/
- http://bbpmag.com/wordpress2/2013/01/coconut-consortium-begins-wdm-pon-project/
- http://www.siliconinvestor.com/readmsg.aspx?msgid=28681614

2.3.2. Presentations at international and industrial workshops

International Workshop on "Wireline Next Generation Access (NGA) Network Technologies supporting future requirements of fixed and mobile users"

OPTRONICS and AIT took the initiative to organise an International Workshop on the topic of "Wireline Next Generation Access (NGA) Network Technologies supporting future requirements of fixed and mobile users" (October 9, 2013 in Athens, Greece) under the auspices of COCONUT and the Greek National Research Project PANDA

The aim of this workshop was to disseminate research results to the executives of the telecommunications market in Greece, the related government agencies and members of the academic community.

The Workshop program included presentations by Prof. J. Prat - UPC, Prof. E. Ciaramella – SSSA and Dr P. Urban - Ericsson AB as well as by executives of companies operating in Greece (e.g. OTE , COSMOTE, Optronics Technologies, etc.) that have experience in developing relevant infrastructure. The COCONUT participants presented the COCONUT benefits with the following presentations:

- E. Ciaramella, "An overview of the COCONUT project"
- J. Prat, "Research Progress on FTTH architectures and technologies"
- P. Urban, "Fiber backhaul for Small Cells"

The workshop was attended by representatives from all major stakeholders including telecom operators, system vendors and infrastructure providers (attendance exceeded 150 people).

Figure 4: Photograph from the Workshop panel (Left) and the Workshop Poster (Right)

EU-Japan Workshop and other EU-related activities

Prof. J. Prat was invited to talk in the EU-Japan Workshop on "R&D Co-operation in the field of Networked Technologies & Systems" held on April 18, 2013 in Brussels. The objectives of this workshop were *"to identify future collaborative research items of mutual interests and to identify a limited set of common objectives to set up a partnership under their respective R&D strategies for EU and Japan"*. Prof. Prat talked about "Research on Next Generation Optical Access Networks" in the stream that focused on the "Technology for realizing high-speed and large-capacity broadband Network".

Besides, COCONUT is regularly represented in the EU Future Networks Concertation meetings by Prof. Ciaramella (SSSA) and Prof. Prat (UPC). In addition, Prof. Ciaramella and

Prof. Prat will be the chair and co-chair respectively of the CaON working group on Broadband Access Networks towards Horizon2020.

2.3.3. ECOC Exhibition 2013

As part of the promotion of the project activities to the photonic industrial community OPTRONICS participated in the ECOC 2013 Exhibition. Among its other research activities, OPTRONICS advertised COCONUT with a summary poster, leaflets and a constantly-rolling overview presentation. The technical personnel of OPTRONICS were available for information to the interested attendees. The feedback was quite positive both from the academic and the industrial visitors. The ECOC exhibition was indeed a great opportunity to promote COCONUT with more than 5000 visitors attending.

Figure 5: (Left) OPTRONICS Booth at ECOC Exhibition 2013, (Right) The COCONUT Poster at the ECOC Exhibition

3. Exploitation Activities and Plans

This deliverable describes the exploitation plans and activities per consortium partner. The plan of each partner for the exploitation of the COCONUT results was reported in detail in the COCONUT DoW. After the end of each reporting period in M24 and M36 respectively, this deliverable will be updated to capture the up-to-date status and any performed activities.

3.1. Patent Applications and Innovations

Although COCONUT just completed its first year, 2 inventions developed within COCONUT have shown substantial innovation to be protected by a patent. 2 applications/proposals are now in progress.

SSSA
Inventor: E. Ciaramella
Title: "Independent Polarization Coherent Receivers"

Status: Patent pending.
Main Idea: Exploiting the 3rd input of a 3x3 coupler in a phase diversity receiver to achieve polarization independency.

35L
Inventors: C.Kazmierski, A.Garreau
Title: "Integrated semi-conductor IQ modulator and transmitter without phase modulation and control"
Status: The proposal has been accepted for patenting (internal 35L procedure).

3.2. Exploitation plans per industrial partner

3.2.1. BT

BT expects some technologies that are being studied within the COCONUT project to be useful in PON system technologies over legacy fibre infrastructure and to achieve larger loss budgets. In order to achieve this goal, simplified coherent based transceivers would be used at both ends of the fibre access network, i.e. at the ONU on the customer side, and at the OLT on the network side.
Larger loss budgets would allow BT to offer high bandwidth services to more customers than the current PON technologies allow, both within the legacy commercial deployments footprint, and in new, more rural areas where current technologies are unable to offer the same level of services as in urban areas.
The possibility of offering point to point wavelength services, also opens the opportunity to use the same PON technology to connect business customers as well as backhaul and fronthaul. The latter connectivity service is foreseen to become very important for the advanced 4G mobile networks, where a large number of small cells need to be interconnected to a Base Station for coordinating the remote nodes and running the network protocol.

3.2.2. ERICSSON

Rising traffic levels and end-user expectations around data rates and latency are driving network change. Ericsson's heterogeneous networks toolbox – improve macro, densify macro and add small cells – addresses these needs. It enables operators to keep their mobile broadband access offerings competitive through constant evolution, dimensioning and optimization of the network.

In urban city streets and squares outdoor micro cells are attractive, as they have sufficient power both to cover a sizeable outdoor area and reach indoor users on lower floors of buildings. If fiber is available, micro remote radio units (mRRUs) can be deployed, otherwise VDSL2 over telephony copper or microwave non-line of sight (NLOS) backhaul may be used to serve complete micro base stations (mRBS).

For small indoor hotspots such as cafés, where stand-alone Wi-Fi is often already deployed (and so sites are available), operators can deploy indoor pico base stations (pRBS), backhauled over the available fixed broadband.

In stadiums, shopping malls, train stations, airports and offices – dedicated in-building solutions may be required to meet local capacity and end-user data rate needs, and here a mix

of cell types can be used, depending of the nature of the building and on the backhaul available. Fiber cabling enables the use of RRUs and the recently announced Ericsson DOT system http://www.ericsson.com/news/130925-ericsson-radio-dot-system-revolutionizes-indoor-coverage_244129227_c?gclid=CIerwKnEoLoCFcF4cAodJR0ATw can be deployed over legacy Category 5/6 Ethernet cable or telephony copper.

The COCONUT architecture and link technology is applicable in any of these scenarios where fibre is already available and for those still greenfield where fibre will be deployed. Also, because the project does not exclude fibre-to-the-cabinet, legacy infrastructure can also make use of the coconut solution. Because of the extended budget we target and partially achieved already, further distances and many more radio base stations can be served. Low-cost is also very important to reach residential users where the sharing factor is very low.

3.2.3. OPTRONICS

OPTRONICS expects to gain valuable exposure in the technologies to be developed within the project such as the novel coherent systems and their application in the future access networks. Through the results of the project, the company expects to be able to expand and address new markets where combination of the current know-how will be complemented by the project innovations. Indeed OPTRONICS is renowned in Greece for its expertise in the deployment of optical networks (having designed, managed, constructed and commissioned networks consisting of thousands of kilometres of fibre including two FTTH pilot projects). Regarding this corporate activity it is crucial to be involved in the development of such a cost-effective PON solution.
Despite the fact that the project is still at a very early stage, during these past 9 months OPTRONICS contributed in the definition of the COCONUT architecture and identified the deployment and service application scenarios that are of interest to the company. Purely greenfield deployment is the case that interests more OPTRONICS due to the limited fiber access penetration in its target markets. Considering the current 4G expansion, mobile backhauling is the most promising service application scenario. It is also expected that the benefits of the COCONUT architecture in terms of cost and performance will allow it to be easily adopted and incorporated in complete system solutions for residential customers (including small businesses). As a consequence, the COCONUT concept and benefits were communicated and discussed in private meetings with customers of the company including the local incumbent and alternative operators. Their feedback was quite positive.

3.2.4. PROMAX

Regarding Commercialization / exploitation of the results of COCONUT, until now, PROMAX is studying the different techniques suitable for spectral analysis of the contents of the COCONUT network.
It has observed a significant evolution of existing technologies, and the emergence of new systems and techniques for the detection and measurement of UD-WDM signals.
Technical developments seen in photonics devices from manufacturers and Universities advance the future needs of the UD-WDM networks, for spacing up to 6.25 GHz between lambdas.
Taking part in the COCONUT project may allow PROMAX reach the market with new test equipments developments for UD-DWM being optimal technical solution, both standpoint of technological maturity and stability, and in cost and convenience as well.

The developments of the project could have application to other areas also involved in the evolution of FTTH.

3.2.5. 35L

We expect this work will allow multilevel modulation migration towards low cost applications such as in the customer Optical Network Unit (ONU) in PONs and in short reach data links. There is also a strong corporate business interest in very high bit rate data-communications and short reach. These applications require often phase modulated components in order to completely or partially remove transmission distance impairments due to a fiber dispersion by a coherent detection.

Component expertise and prototypes will be delivered to corporate equipment development studies. In a case of business interest in large component quantities we will target a technology transfer to an industrial partner.

In addition to the corporate business exploitation plans, this work will also be exploited to validate and stabilize a new Photonic Circuit Integration technology on InP together with a new concept of components having "more functionality with fewer electrodes" expected to improve chip size/power/speed while preserving low cost potential. The generated knowledge and its dissemination is a mandatory step for further industrializations. To this aim, we specially focus on innovation and patenting as a tool for further results exploitation.

4. STANDARDISATION EFFORTS

4.1. Current Situation – Year 1

The COCONUT approach covers solutions for the next generation optical access. This indicates the relevance of fora and standardization groups that deal with the definition of the next generation PON such as FSAN, IEEE and ITU-T. IEEE 802.3 have finalized the 802.3av 10Gbps EPON specification in Sept 2009 and are having currently no successor activity towards higher capacities in the last mile. ITU-T's next generation standard following on from G-PON is the G.987 for 10G-PON also known as XG-PON.

In search for a more flexible and scalable solution, the FSAN Group are working on a future fibre access generation (termed NG-PON2). FSAN’s NGPON2 activity is dedicated to the next generation access after 10Gbps PONs. Although FSAN is not a standards definition organisation, their output is submitted to ITU-T Study Group Q2/15 to facilitate the development of global PON standards. The first result is the description of the drivers and requirements that any candidate PON system needs to meet. There are a number of proposals under discussion as candidates to become a Standard with the FSAN support with a timeframe around 2015. The considered and most intensively investigated approaches within the research community have been:

- WDM/TDMA scheme by stacking XG-PON systems (10G per wavelength)
- General WDM-PONs with tuneable or colourless ONUs.
- Single-carrier 40Gbit/s DQPSK TDMA-PON
- SCM/OFDMA-PONs with direct detection
- Space-multiplexed XG-PON schemes
- OCDMA with electrical or optical correlation coding.

- Ultra-Dense Wavelength Division Multiplexed (UDWDM) PON networks with coherent receivers

The main proposals for NG-PON2 achieve different levels of performance and meet a number of requirements, but not all at the same time, which can be of interest in a wide range of application scenarios, once the technological hurdles are solved.

In early 2012 the operators in FSAN have decided to select TWDM with OOK modulation as the primary solution for NGPON2. DWDM-PON (ptp via DWDM over a PON ODN) has been accepted as an optional overlay. Meanwhile the NGPON2 physical layer definition is in its final stage at ITU-T. It will be released as recommendation G.989.2 which is expected to be ratified still in 2013. *"Recommendation ITU-T G.989.2 describes a flexible optical fibre access network capable of supporting the bandwidth requirements of mobile backhaul, business and residential services. The G.989 series of standards allows for multiple upstream and downstream line rates. This recommendation defines passive optical networks with an aggregate bandwidth of nominally 40 Gbit/s in the downstream direction and 10 up to 40 Gbit/s in the upstream direction, hereinafter referred to as NG-PON2"* (from the summary of recommendation ITU-T G.989.2 currently under study).

Nonetheless, COCONUT is not targeting an alternative to NGPON2 but rather aspires to influence the definition of NGPON3.

4.2. Course of Action

When a suitable solution can be identified in the COCONUT activities, it can be proposed and discussed within the FSAN Group where BT currently holds the position of co-chair of the NGPON Task Group. Both BT and Ericsson are part of the FSAN group and a joint contribution can be anticipated.
Once the solution has been discussed and agreed within the FSAN Group, the next step would be to bring it to the ITU-T for Standardisation.
The innovations that the work in COCONUT could bring about, would be applied either to enhance the PON technologies currently being defined in FSAN/ITU (NG-PON2) or for a future system.

- End of document -