Funding Application for Joint Applied Research Projects
PN-II-PT-PCCA-2011-3

Project

"Optical Wireless – based Multi-Gb/s Hybrid Access Network for Broadband Multiservices Applications"

OWHAN

Table 1. General outline

Title of the project	**Optical Wireless – based Multi-Gb/s Hybrid Access Network for Broadband Multiservices Applications**		
Acronym	**OWHAN**		
Type 1		**Type 2**	**Project type 2**
Project duration (months)	**32 months**		

Contact details	**Name and surname**	**Email**	**Phone**	**Fax**
Project manager		**name@inscc.ro**	**0213000011**	**0213189575**

List of participants	**Participant organisation name**	**Web page**
Coordinator (CO)	**National Research Communications Institut - INSCC Bucharest**	www.inscc.ro
Partner 1	**Universitatea Transilvania Brasov**	www.unitbv.ro
Partner 2	**Universitatea din Pitesti**	www.upit.ro
Partner 3	**Universitatea Politehnica Bucuresti**	www.upb.ro

	Person incharge from partners (Name and surname)
Partner 1	**Croitoru Otilia**
Partner 2	**Lita Ioan**
Partner 3	**Schiopu Paul**

Project expertise domain *	1 – Information and communication
Research field*	1.3 Tehnologii, sisteme si infrastructuri de comunicatii
Thematic area*	1.3.3 Tehnologii de acces si transport in banda larga si sisteme incluzand retele terestre si satelitare pe medii variate de transmisiune

*according to Annex 1

Project scientific field **	PE INFORMATION AND COMMUNICATION
Subdomain code**	PE7 Systems and communications engineering: electronic, communication, optical and systems engineering
Research area code**	PE7_8 Networks

**according to Annex 5

Total budget (lei)	**2.000.000**
Total funding requested from Public Budget (lei)	**2.000.000**
Own budget of partners (lei)	

Table 2. Consorţiu

Titlul proiectului		**Optical Wireless – based Multi-Gb/s Hybrid Access Network for Broadband Multiservices Applications**					
Acronimul		**OWHAN**					
Instituţie							
Coordonator (CO) / Partener (P1 – P3)		**CO**					
Denumire instituţie		**National Research Communications Institut - INSCC Bucharest**					
Reprezentant legal		**Dr.ing. Ion STANCIULESCU**					
Statut instituţie		Organizaţie de cercetare	**X**	Mică	Mijlocie	Mare	
		Întreprindere					
Tip instituţie	**INCD**	CUI	1570140		CAEN	7216	
Adresa	Bd Preciziei nr 6			Localitate / Judeţ	Bucureşti, sector 6		
Telefon	0213189571	Fax	0213169575	Email	cnscc@co.cnscc.ro		
Web site	www.inscc.ro						
Director de proiect (CO)							
Numele	**CONSTANTINESCU**		Prenumele	**Florin**	**CNP**	**1441122400042**	
Gradul ştiinţific	Doctor inginer		Funcţia	Profesor			
Profilul şi experienta instituţiei							
INSCC is a research and development organisation established in 1955. Its main activities include studies, research regarding technologies and advanced applications in the communications field. The research areas include radio-communications (3G, 4G technologies and applications, radio wideband access networks), electronic communications: interfaces, protocols, access configurations. Starting with 2001, INSCC was involved in projects for the telematics field in health, and it has participated in the competitions organized by MCEd, coordinating projects in INFOSOC, CALIST, CEEX programs or in projects organised under MCTI. Since 2008, INSCC has been involving optical communications and optical networking technologies in its research domains. Relevants projects: *Study on free-space communications, Study on solitons-based optical communications, Wavelength division multiplexing – based optical transport networks – structure, performances, characteristics.*							
Contribuţia instituţiei în proiect							
INSCC is the leading coordinator of the project. It contributes with analysis, models, solutions and schemes to materialize the concept of the optical wireless-based hybrid acces network for multiservices applications. INSCC will be attending all the project stages, from the very first setup of activities up to the last finish. INSCC will be approaching conferences, journals, and workshops to disseminate the relevant information produced by the project.							

Data: .....

REPREZENTANT LEGAL AL INSTITUŢIEI
Dr.ing. Ion STANCIULESCU

DIRECTOR DE PROIECT
Dr.ing. Florin CONSTANTINESCU

Titlul proiectului		**Optical Wireless – based Multi-Gb/s Hybrid Access Network for Broadband Multiservices Applications**							
Acronimul		**OWHAN**							
Instituţie									
Coordonator (CO) / Partener (P1 – P3)		**P1**							
Denumire instituţie		**University Transilvania of Brasov**							
Reprezentant legal		Prof. Dr. Ing. Ion VISA							
Statut instituţie		Organizaţie de cercetare	**X**	Mică		Mijlocie		Mare	
		Întreprindere							
Tip instituţie	**UNI**	CUI		4317754		CAEN	8542, 7219, 7211, 7220		
Adresa	B-dul Eroilor nr. 29				Localitate / Judeţ	Brasov			
Telefon	0268410525	Fax	0268410525		Email	rector@unitbv.ro			
Web site		www.unitbv.ro							
Responsabil de proiect (P1)									
Numele	**CROITORU**			Prenumele	**Otilia**	**CNP**	**2590906221171**		
Gradul ştiinţific	Dr. ing			Funcţia	Sef lucr. univ.				
Profilul şi experienta instituţiei									
Transilvania University of Brasov provides resources and develops processes and tools to conduct scientific research and education, quality standards necessary to ensure competitiveness in the European Higher Education and Research. It includes: faculties, departments and other functional structures for scientific research, cooperation with educational institutions and research at home and abroad, with extensive experience in national and international project management (CEEX, Research platforms, CNCSIS, FP, COST, Leonardo da Vinci, Minerva, PN II).									
Contribuţia instituţiei în proiect									
Phase no.4 – A Traffic Grooming Solution Phase no.5 – The Fault Management Approach									

Data: .....

REPREZENTANT LEGAL AL INSTITUŢIEI
Prof.dr.ing. VISA Ion

RESPONSABIL DE PROIECT
Sl.dr.ing. CROITORU Otilia

Titlul proiectului	**Optical Wireless – based Multi-Gb/s Hybrid Access Network for Broadband Multiservices Applications**
Acronimul	**OWHAN**

<table>
<tr><td colspan="8">Instituţie</td></tr>
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<tr><td colspan="2">Denumire instituţie</td><td colspan="6">University of Piteşti</td></tr>
<tr><td colspan="2">Reprezentant legal</td><td colspan="6">Prof. univ. dr. Gheorghe BARBU</td></tr>
<tr><td colspan="2" rowspan="2">Statut instituţie</td><td>Organizaţie de cercetare</td><td>X</td><td>Mică</td><td>Mijlocie</td><td colspan="2">Mare</td></tr>
<tr><td>Întreprindere</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Tip instituţie</td><td>UNI</td><td>CUI</td><td colspan="2">4122183</td><td>CAEN</td><td colspan="2">8030, 7219</td></tr>
<tr><td>Adresa</td><td colspan="3">Targu din Vale, Nr.1, 110040</td><td>Localitate / Judeţ</td><td colspan="3">Piteşti/Argeş</td></tr>
<tr><td>Telefon</td><td>0348453227</td><td>Fax</td><td>0348453200</td><td>Email</td><td colspan="3">ioan.lita@upit.ro</td></tr>
<tr><td colspan="2">Web site</td><td colspan="6">http://www.upit.ro/</td></tr>
<tr><td colspan="8">Responsabil de proiect (P2)</td></tr>
<tr><td>Numele</td><td colspan="2">LIŢA</td><td>Prenumele</td><td>IOAN</td><td>CNP</td><td colspan="2">1550915034989</td></tr>
<tr><td>Gradul ştiinţific</td><td colspan="2">Prof. dr. ing.</td><td>Funcţia</td><td colspan="4">Director Departament</td></tr>
<tr><td colspan="8">Profilul şi experienta instituţiei</td></tr>
<tr><td colspan="8">University of Pitesti is a state institution of high education founded in 1962. It represents a young and dynamic academic community which offers large educational possibilities for people from Romania and other regions of the world.
The priorities of the University of Pitesti are directed toward the development of a high quality scientific research activity, the training of young people as future high specialists, able to work in advanced domains in industry of Romania or even Europe.
In the all form of learning existent in the University of Pitesti are involved more than 26,000 students and the academic stuff is composed by approximately 200 professors, associate professors and assistants.
Electronics, Computers and Communications Department from the University of Pitesti it is situated in the same location with the university headquarter, at Târgul din Vale Street, Nr.1.
The academic stuff of Electronics, Computers and Communications Department has a number of 14 professors and associate professors and 15 assistants and researchers.
The structure of the Electronics, Computers and Communications Department related to the specializations being part of it is the following: Applied Electronics, Computers and Information technology, Telecommunications, Electromechanics, Metrology and Electrical Industry. The students can chouse to specialize in these domains.
In the Electronics, Computers and Communications Department has been elaborated or are in course of elaboration many doctoral and master thesis having as research thematic issues form the</td></tr>
</table>

communication domain.

In the present the University of Pitesti develops national projects, European projects and N.A.T.O. projects. As main research domains involved in this projects can be reminded: optoelectronics, laser physics, radiocommunication equipments for different types of modulations, networking and data traffic optimization, signal and image processing, database design and management for multimedia applications, development of services for e-learning and videoconference, design and experimentation of algorithms for de-noising images, signal and image compression, investigation of ground particularities from the radio coverage point of view, investigation of existent local communication infrastructure in the south-east art of Romania, studies about data protection through cryptography, satellites based communication systems, positioning and calculus for mutual protection.

Contribuţia instituţiei în proiect

The Electronics, Computers and Communications Department from University of Pitesti will be implicated in all phases of the research project "Optical Wireless – based Multi-Gb/s Hybrid Access Network for Broadband Multiservice Applications" but with focus on the following activities:

- Analyze of optical transmission & multiplexing: optical transmission in fiber optics, loss and bandwidth windows in fiber, loss budget in terrestrial laser transmission, dispersion and nonlinearities in fiber, optical time division multiplexing, space division multiplexing, wavelength division multiplexing;
- Analyzing of optical components/devices: the components described in the project, the most important devices of the optical communications system, are couplers, lasers, photodetectors, optical amplifiers, optical switches;
- Hybrid access networks: HFC and RoF hybrid access technologies are explored as they are able to provide high bandwidth and higher bit rate to end users by connecting optical domain to either the wireless or the electric domain
- Design multicast-capable switch architecture: formulates the approaches to design switches capable of supporting multicasting;
- Traffic grooming solution: formulates the graph model and the mathematical formulation of the traffic grooming problem.
- Fault management mechanisms: evaluates appropriate protection and restoration schemes in the network so as data loss when a link failure occurs get minimized

- Simulation program capable to runs the path protection scheme and to evaluate the protection performances of the proposed algorithms.

Data: 02.11.2011

REPREZENTANT LEGAL AL INSTITUŢIEI
Prof. Univ. Dr. Gheorghe BARBU

RESPONSABIL DE PROIECT
Prof. Dr. Ing. Ioan LIŢĂ

Titlul proiectului		**Optical Wireless – based Multi-Gb/s Hybrid Access Network for Broadband Multiservices Applications**							
Acronimul		**OWHAN**							
Instituţie									
Coordonator (CO) / Partener (P1 – P3)		**P3**							
Denumire instituţie		**University Politehnica Bucharest**							
Reprezentant legal		Prof. Dr. Ing. Ecaterina Andronescu							
Statut instituţie		Organizaţie de cercetare	**X**	Mică		Mijlocie		Mare	
		Întreprindere							
Tip instituţie	**UNI**	CUI		**4183199**		CAEN		**8031 high education**	
Adresa	Splaiul Independentei 313, sector 6			Localitate / Judeţ		Bucuresti			
Telefon		Fax		Email		e_andronescu@rectorat.pub.ro			
Web site		www.pub.ro							
Responsabil de proiect (P3)									
Numele	**SCHIOPU**			Prenumele	**PAUL**		**CNP**	**1480629400228**	
Gradul ştiinţific	Prof. univ. Dr.Ing			Funcţia	Sef catedra/Director CCO				
Profilul şi experienta instituţiei									
The Optoelectronics Research Center, developed in the frame of "Politehnica" University of Bucharest, Faculty of Electronics, Telecommunications and Information Technology (**UPB-CCO)**, is created and organized on the basis of the Education Law no. 51/1996 through the Decision of the UPB Rector no.255/124 from 11.12.1998. The domain of activity of the center is OPTOELECTRONICS, having the following sub-domains: *Photonic micro and nanostructures, Optical processing of information, Optical fiber communications and Electronic devices-circuits related to the optoelectronic systems*, with applications in all the fields of social life, including in the field of national defense and security.									

Optoelectronics Research Center develops activities of research-development, education, information, documentation, expertise and consulting in the field of photonic micro and nanostructures, optical processing of information and optical fiber communications. UPB-CCO promotes collaboration at national and international level, supporting the activities of promotion and dissemination of scientific and technical knowledge through conferences, seminars, scientific publications, affiliation to professional associations and exchange of specialists. The UPB-CCO staffs is currently composed of 19 persons (2 full professors, 3 senior researchers, 2 researchers, 2 lecturers, 9 Ph.D. students and 1 administrative). Optoelectronics Research Center organized the first international symposium in the field of Optoelectronics, in 2002- Advanced Topics in Optoelectronics Micro and Nanotechnology – ATOM-N 2002, and also editions: ATOM-N 2004, 2006, 2008 and 2010(www.atom-n2010.ro). As a previous experience, we mention that the center members have published, in certified publishing houses, eighteen books (14 in Romania, 4 abroad); articles published in magazines (16 in the last four years); articles published: 8, out of which 6 in Romania and 2 abroad; Scientific papers: 78, out of which 69 in Romania and 9 abroad; Representation in scientific forums: 3 scientific committees at IMT, INOE and Hyperion University; Members in program committees: at four scientific conferences: International Semiconductor Conference - CAS; International Symposium for Design and Technology in Electronic Modules- SIITME International Symposium of Education and Research Advanced Topics in Optoelectronics Micro and Nanotechnology –ATOM-N. Experience in national project directing: CNCS/ Relansin/ Calist/ PN I and PN II.

Contribuţia instituţiei în proiect

Phase no.1 – A Traffic Grooming Solution

Phase no.2 – The Fault Management Approach

Phase no.3 – A Traffic Grooming Solution

Data: .....

REPREZENTANT LEGAL AL INSTITUŢIEI **RESPONSABIL DE PROIECT**

Prof. Dr. Ing. Ecaterina Andronescu **Prof. Dr. Ing. Paul Schiopu**

Executive summary

Optical Wireless-based Multi Gb/s Hybrid Access Network for Broadband multiservices Applications (OWHAN) is a promising architecture intended for being deployed as municipal access solutions and hard to reach areas access solutions. OWHAN is combining optical wireless, wireless, fiber and wirelines to compel solution that optimize the best of the optical and wireless access. This project presents relevant research challenges, namely, network setup, network connectivity, and fault-tolerant behaviour of the OWHAN.

OWHAN provides much higher bandwidth for multiservices applications than current solutions, as well as deeper fiber penetration.

OWHAN combines the high capacity of optical fiber with the 10 Gb/s traffic speed of the optical wireless and the low installation and maintenance cost of a passive infrastructure.

OWHAN is essentialy a wavelength division multiplex (WDM)-based solution, therefore the network provides high scalability to support multiple wavelengths over the same fiber infrastructure, it is inherently transparent to the channel bit rate, and it may not suffer power-splitting losses.

The OWHAN architecture can be employed to benefit from (a) the reliability, robustness, and high capacity of wireline optical technologies and (b) the flexibility (anytime, anywhere) and cost savings of a wireless network.

The objectives of the project:

1. To provide each end user with whenever needed, 100 Mb/s traffic bit rate;
2. To quickly and easily deploy flexible and scalable bandwidth throughout the access network;
3. Security within an OWHAN network;
4. Mobility within an OWHAN network;
5. Dissemination of partial and final results regarding the OWHAN network.

The innovative nature of the project is regarding the migration of DWDM solutions into the access arena, wavelength on demand, DWDM services to independent carriers, high connectivity, and high scalability.

The project will result in thorough analysis of the optical wireless-based multi Gb/s optical access network, models of scalable, flexible, high connectivity, and cost effective optical access network, and solution for multicasting schemes, traffic grooming and collisions.

1. Importance and Relevance of the Technical and/or Scientific Content

1.1. Concept and objectives:

1.1.1 Concept of the project.

The optical wireless-based hybrid access network (OWHAN) is a promising architecture intended for being deployed as municipal access solutions and hard to reach areas access solutions. OWHAN is combining optical wireless, wireless, fiber and wirelines to compel solution that optimize the best of the optical and wireless access. This project presents relevant research challenges, namely, network setup, network connectivity, and fault-tolerant behaviour of the OWHAN.

The network setup review the design of an OWHAN where the front end is an optical wireless connectivity, the back end is a wireless or a wired optical subnetwork, and, in beetwin, the tail ends of the optical network unit (ONU) communicate directly with gateway routers.

The project presents algorithms to optimize the placement of ONUs in an OWHAM. Then, the project examines the routing properties (network connectivity), and deals with the fault-tolerant design of such hybrid networks.

OWHAN provides much higher bandwidth for multiservices applications than current solutions, as well as deeper fiber penetration. Based on current standards, the optical wireless-based hybrid access network may cover up to 20 km from the optical line terminal (OLT) in the central office (CO) to the ONU. Fiber-to-the-building (FTTB), fiber-to-the-home (FTTH) or fiber-to-the-curb (FTTC) solutions have the ultimate goal of fiber reaching all the way to end-user premises.

OWHAN combines the high capacity of optical fiber with the 10 Gb/s traffic speed of the optical wireless and the low installation and maintenance cost of a passive infrastructure. The optical carriers are shared by means of passive splitters among all the users. The number of ONUs is limited by the splitting loss and by the bit rate of the tranceivers in the OLTs and in the ONUs.

OWHAN is essentialy a wavelength division multiplex (WDM)-based solution, therefore the network provides high scalability to support multiple wavelengths over the same fiber infrastructure, it is inherently transparent to the channel bit rate, and it may not suffer power-splitting losses.

OWHAN employes a separate wavelength channel from the OLT to each ONU, both in the upstream and downstream directions. This approache creates a point-to-point link between the OLT and each ONU. Each ONU can operate at the full bit rate of a wavelength channel. Different wavelengths may be operated at different bit rates, if necessary; hence, different types of services may be supported over the network.

The concept of the project is to run fiber optics as far as possible from the CO to the end user and then having fiber or wireless access technologies take over. Running fiber optics to every end user premises from the CO could be costly; in addition, wireless access from CO to every end user is not possible due to limited spectrum. Therefore OWHAN may be an excellent compromise to optimize the engineering design of how far the fiber should penetrate before wireless takes over.

The OWHAN architecture can be employed to benefit from (a) the reliability, robustness, and high capacity of wireline optical technologies and (b) the flexibility (anytime, anywhere) and cost savings of a wireless network. A OWHAN is a optical wireless network at the front end, and it is supported by an fiber or wireless network at the back end. The OWHAN is dominated by the optical wireless and the passive optical access technologies. Different passive optical network (PON) segments can be supported by a CO, with each PON segment radiating from the CO. The head end of each PON segment is driven by an OLT via an optical wireless system. The tail end of each PON segment contains a number of ONUs, which typically serve end user in a standard PON architecture. The ONUs can be connected to wireless base stations (BS) for the wireless portion of the OWHAN. The wireless BSs are gateway routers of both the optical domain and the wireless domain. Besides theese gateways, the wireless back end of a OWHAN consists of other wireless routers/BSs to efficiently manage the network. Thus, the back end of a OWHAN might be essentially a multihop wireless mesh network with several wireless routers and a few gateways (to connect to the ONUs, and, consequently, to the rest of the Internet through OLTs/CO). the wireless portion of the OWHAN may employ standard technologies such as WiFi or WiMax. Since the ONUs will be located far away from the Co, efficient spectrum reuse can be expected across the BSs with much smaller range but with much higher bandwidth. Thus, the OWHAN is able to support a much larger user base with high bandwidth needs.

The OWHAN architecture assumes that an OLT is placed in a CO and that it feeds several ONUs. From ONUs to the CO there is a fiber optics network that assembles in into an optical wireless terrestrial laser system. From ONUs, end users are wirelessly connected (in single-hop or multi-hop fashion) or wireline connected (VDSL, coax fashion, FTTx).

1.1.2 The project objectives

The objectives of the project:

1. To provide each end user with whenever needed, 100 Mb/s traffic bit rate;
2. To quickly and easily deploy flexible and scalable bandwidth throughout the access network;
3. Security within an OWHAN network;

4. Mobility within an OWHAN network;
5. Dissemination of partial and final results regarding the OWHAN network.

1.1.3 Emphasise the original, novelty and innovative nature of the project

The innovative nature of the project:

1. Optical wireless system (known as free-space optics as well) bridges the metropolitan DWDM (dense wavelength division mutiplexing) ring and the optical access network. As metropolitan DWDM systems migrate into the access arena, they will be supporting both SDH and native data services, increasing the requirement for protection, and restoration in the optical domain;
2. Wavelength on demand. Idle wavelengths can be quickly allocated to carriers through the implementation of optical switching systems. These systems allow an operator to treat the optical layer of the network much like it treats the ATM layer: as a pool of available bandwidth within a cloud to be quickly allocated in virtual optical circuits. The virtual optical cirfcuits are new optical circuits that are managed by optical switching systems using constraint-based routing algorithms. The optical edge equipments can be agile enough with wavelengths so as the carriers may offer users the opportunity to purchase wavelength services not as a fixed lease but as a flexible service;
3. DWDM services. Optical wireless is integrating DWDM into the access network so as independent players would be able to build their own fiber rings, yet might own only part of the ring. This solution saves rental payment to incumbent local exchange carriers, which are likely to take advantage of this situation;
4. High connectivity. The connectivity bottleneck is shifting from the metropolitan gateway towards the edge of the access optical network. That allows the cost per bit to decrease and makes the optical capacity available to the end users;
5. High scalability. The combination between optical wireless and WDM-PON solutions into a flexible optical access network enables cost effective, accelerated optical networking into multiple areas and not just last mile.

1.1.4 Expected results of the project end products.

1. Thorough analysis of an optical wireless-based multi Gb/s optical access network as a solution to high capacity, high speed optical support of broadband multiservices applications at the end users premises;

2. Model of a scalable, flexible, high connectivity, and cost effective optical access network for enterprises and users premises;
3. Multicasting solution. A multicasting scheme would allow point-to-multipoint connections and straightforward link-disjoint backup tree;
4. Traffic model. The traffic solution generates the graph and formulates the mathematicals of the traffic grooming;
5. Collisions management solution. The fault management approach designs the traffic rerouting and presents the fault-recovery solutions.

1.2. State of the art:

There is a continuing, relentless need for more capacity in the network. This demand is fueld by a tremendous growth of the Internet and the World Wide Web, both in terms of number of users and the amount of time, and thus bandwidth taken by each user. Internet traffic has been growing rapidly. Estimates of growth have varied considerably over the years, with some early growth estimates showing a doubling every four to six month. Despite the variations, these growth estimates are always high, with more recent estimates at about 50% annualy. Broadband access technologies, which provide 1 Mb/s bandwidth per user, have been deployed widely. Meanwhile, business today relies on high-speed networks to get conducted. The networks are used to interconnect multiple locations within a company as well as between companies for business-to-business transactions. Large corporations are commonly leasing 1 Gb/s connections today.

There is a strong correlation between the increase in demand and the cost of bandwidth. Technological advances have succeeded in continously reducing the cost of bandwidth. This reduced cost of bandwidth in turn spurs the development of new applications that make use of more bandwidth and affects behavioral patterns. This positive feedback cycle shows no sign of abating in the near future.

The traffic in a network is dominated by data as opposed to traditional voice traffic. The legacy network were designed to efficiently support voice rather than data. Today, data transport services are pervasive and are capable of providing quality of service to carry performance sensitive applications such as real time voice and video.

Such factors have driven the development of high-capacity optical networks. Optical networking is the technology of choice for meeting the growing demands for bandwidth in the information society. Today

there have been existing an abundance of dark fiber and WDM transmission capacity, still a tremendous need for optical switching equipment, high-capacity, high-density optical crossconnects, for managing high-capacity optical signals, rises up.

The access network enables end-users (business and residential customers) to get connected to the rest of the network infrastructure. The access network spans a distance of a few kilometers. The current access solutions are dial-up modems, high-speed lines, digital subscriber lines, and cable modem. However, the access network continues to be a bottleneck, and users require higher bandwidth to be delivered to their machines. Passive optical networks based on inexpensive, proven, and ubiquitus Ethernet technology is an attractive proposition for this market. With fiber now directly available to office buildings in metropolitan areas, networks based on SDH or Ethernet-based technologies are being used to provide high-speed access to large business users.

Efforts to develop high-capacity access networks were devoted to developing networks that would accommodate various forms of video, such as video-on-demand and high-definition television. However, the range of services that users are expected to demand in the future is vast and unpredictible. Today, end-users are interested in both Internet access and other high-speed data access services, for such applications as telecommuting, distance learning, entertainment video, and videoconferencing. Future, unforeseen applications are to arise and make ever-increasing demands on the bandwidth available in the last kilometer. At a broad level, the services can be classified based on three major criteria. The first is the bandwidth requirement, which can vary from a few kilohertz for telephony to tens of megabits per second per video stream or even tens of gigabits per second for high-speed leased lines. The second is weather this requirement is symmetric, for example, videoconferencing, or asymmetric, for example, broadcast video. Today, while most business services are symmetric, other services tend to be asymmetric, with more bandwidth needed from the service provider to the user (the downstream direction) than from the user to the service provider (the upstream direction). The last criterion is whether th eservice is inherently broadcast, where every user gets the same information, for example, broadcast video, or whether the service is switched, where different users get different information, as in the case with internet access.

Different combinations of services and network topologies are made possible – a broadcast service may be supported by a broadcast or a switched network, and a switched service may be supported by a broadcast or a switched network. Broadcast networks may be cheaper than switched networks, are well tailord for delivering broadcast services, and have the advantage that all the interface units are identical, making them easier to deploy. Switched networks are well suited for delivering switched services and

provide more security. Faukt location is easier in a switched network than in a broadcast network. In broadcast networks, the intelligence is all at the interface units, whereas in switched network, it is in the network. Thus, the network interface units may be simpler in switched networks than in broadcast networks.

Several approaches have been used to upgrade the access network infrastructure to support the emerging set of new services. The integrated service digital network provided 144 kb/s of bandwidth over the existing twisted-pair infrastructure. The digital subscriber line is another technique that works over the existing infrastructure but provides more bandwidth, sophisticated modulation and coding techniques to realize a capacity of a few megabits per second over twisted pair, which is sufficient to transmit compressed video. Satellites provide another way of delivering access services. A satellite may provide more bandwidth than a terrestrial coaxial cable system. However, the amount of spatial reuse of bandwidth is limited, since a single satellite has a wide coverage area within which it broadcasts signals. Wireless access is another viable option. Although it suffers from limited bandwidth and range, it can be deployed rapidly and allows providers without an existing infrastructure to enter the market. Among the variants are multichannel multipoint distribution services (MMDS) and the local multipoint distribution service (LMDS), both of which are terrestrial line-of-sight systems. MMDS provides 33 6 MHz channels in the 2-3 GHz band with a range of 15 to 55 km. LMDS operates in the 28 GHz band with 1.3 GHz of bandwidth and is suitable for short range (3-5 km) deployment in dense metropolitan areas. LMDS is a part of IEEE 802.16 wireless communication standards, commonly known as WiMAX. These standards can provide up to 70 Mb/s of symmetric bandwidth and up to a distance of 50 km. wiMAX can operate in a wide range orf frequencies below 66 GHz, including 2.3 GHz to 3.5 GHz in the licensed spectrum and 5 GHz in the public spectrum.

IEEE 802.11 is a common wireless local-area access technology to the internet. It operates in the 2.5 nad 5 GHz public spectrum and can provide data rates of about 50 Mb/s. They are limited by a very short range of tens of meters to an access point.

Optical wireless systems using lasers transmitting over free space into the home are also being developed as an alternative approach. These systems can provide about 622 Mb/s of capacity over a line-of-sight range of 200 m to 4 km.

In the context of next-generation access network, hybrid fiber coax (HFC) approach and fiber to the curb (FTTC) approach are being considered. The HFC approach is still a broadcast architecdture, whereas the FTTC approach incorporates switching.

Advances in optical networking have made bandwidth-intensive multicast applications, such as HDTV,

interactive distance learning, live auctions, distributed games, movie broadcast from studios, etc., widely popuoar. These applications require point-to-multipoint connections from a source node to the destination nodes in a network. Multicasting provides an easy means to deliver messages to multiple destinations without requiring too mush message replication.

Traffic grooming is a practical problem for designing optical networks. Konda & Chow formulates the static traffic grooming problem as an integer linear program and propose a heuristic to minimize the number of transceiver. Brunato & Battiti present several lower bounds for regular topologies, and greedy and iterative greedy schemes are developed. Thiagarajan & Somani consider a dynamic traffic pattern in wavelength division multiplexing mesh networks, and propose a connection admission control scheme to ensure fairness in terms of connection blocking. Cox & Sanchez study the problem of planning and designing a wavelength division multiplexing mesh network with certain forecast traffic demands, to satisfy all the connections as well as minimize the network cost.

In an optical network, a link failure, due to the high capacity of the link, can lead to the loss of a large amount of data. Appropriate protection and restoration schemes, which minimize the data loss when a link failure occurs, are mandatory. Anderson, Doshi, Dravida, and Harshavardhana uses procedures of upper layers of protocols (ATM, IP, MPLS) to recover from link failures. The fault-recovery time in optical layer should be on the order of milliseconds in order to minimize data loss. According to Gerstel, the fault-recovery mechanisms should be considered in the optical layer because (a) the optical layer can efficiently multiplex protection resources (such as spare wavelengths and fibers) among other several higher-layer network applications, and (b) survivability at the optical layer provides protection to higher-layer protocols that may not have built-in fault recovery.

Table 3. Phase list

Phase no.	Phase title	Involved partners	Start month (1 ... n-1)	End month (2 ... n)
1	**The Optical Networking Solution**	**CO, P2, P3**	**1**	**8**
2	**The Hybrid Access Networking Model**	**CO, P2, P3**	**9**	**14**
3	**An Optical Multicasting Scheme**	**CO, P2, P3**	**15**	**20**
4	**A Traffic Grooming Solution**	**CO, P1, P2**	**21**	**26**
5	**The Fault Management Approach**	**CO, P1, P2**	**27**	**32**

Table 4. Phase description

Phase **no.**	**1**				
Phase title	**The Optical Networking Solution**				
Involved partners	**CO**	**P1**	**P2**	**P3**	**Total**
Person-months	**5**		**1,29**	**3**	
Start month	**1**				
End month	**8**				
Objectives					
1. The Choice of the Optical Network Architecture; **2. Multiplexing Techniques;** **3. Enabling Technologies.**					
Description of work (possibly broken down into tasks) and role of participants					
1. Analysis of Optical Networks: backbone, metropolitan and access networks architectures are overviewed to design an optical communications network; a point-to-point terrestrial laser communications system is described as it is commissioned for backhauling the hybrid optical network in the project. **CO: coordinator and contributor**					

P3: contributor

2. **Analyzing Telecom Business Models: comm. services offered by the carriers (service providers) are considered for investigation and telecom business models are generated that permit broadband multiservices applications. CO: coordinator and contributor**
3. **Analyzing Optical Switching: certain switching functionalities migrates from electronics to optics so as wavelengths and bandwidth provisioning are expedited in the optical layer. Wavelength switching, optical packet switching and optical burst switching are taken into consideration to offer the optical network flexibility, efficient resources utilization, potential functionality and finer switching granularity.**
   CO: coordinator and contributor
   P3: contributor
4. **Analyzing Optical Transmission & Multiplexing: optical transmission in fiber optics, loss and bandwidth windows in fiber, loss budget in terrestrial laser transmission, dispersion and nonlinearities in fiber, optical time division multiplexing, space division multiplexing, wavelength division multiplexing.**
   CO: coordinator and contributor
   P2: contributor
   P3: contributor
5. **Analyzing Optical Components/Devices: the components described in the project, the most important devices of the optical communications system, are couplers, lasers, photodetectors, optical amplifiers, optical switches, filters, and multiplexers.**
   CO: coordinator and contributor
   P2: contributor
   P3: contributor
6. **Analyzing Wavelength Conversion: full wavelength conversion, fixed conversion and limited conversion are accounted in the project to solve the routing and wavelength assignment in the optical wavelength-routed network. Opto-electronic wavelength conversion, wave-mixing conversion, and cross modulation conversion are approached.**
   CO: coordinator and contributor
   P3: contributor

Deliverables (brief description and month of delivery)

D1.1. The Choice of the Optical Network Architecture (access network, metropolitan network, backbone network, point-to-point terrestrial laser communication, telecom business models, services landscape, circuit & packet switching, transparency & all-optical networks, optical layer, second generation optical networks);
D1.2 Multiplexing Techniques (wavelength division multiplexing, (optical) time division multiplexing, space division multiplexing);
D1.3 Enabling Technologies (optical fiber characteristics & performances, optical transmission in fiber, optical transmitters & receivers, optical multiplexers & filters, optical amplifiers, switching elements, wavelength conversion)

Phase **no.**	**2**				
Phase title	**The Hybrid Access Networking Model**				
Involved partners	**CO**	**P1**	**P2**	**P3**	**Total**
Person-months	**6**		**1,15**	**3**	
Start month	**9**				
End month	**14**				

Objectives

1. Optical Access Networks;
2. WDM Network Elements;
3. Hybrid Access Networks.

Description of work (possibily broken down into tasks) and role of participants

1. **Analysis of Optical Access Networks: FSO, PON, EPON, WDM-PON, FTTx access optical networks are approached to transmit the traffic from the optical metro network to the end users, in terms of topologies, operation, bandwidth allocation, scalability, and deployment.**
   CO: coordinator and contributor
   P3: contributor
2. **WDM Network Elements: this chapter explores the architectural aspects of the network elements that are part of the network, namely, optical line terminals, optical add/drop multiplexers, optical crossconnects. The WDM network elements provides circuit-switched lightpaths with varying degrees of transparency. Wavelengths may be reused in the network to support multiple lightpaths.**
   CO: coordinator and contributor
   P3: contributor
3. **Hybrid Access Networks: HFC and RoF hybrid access technologies are explored as they are able to provide high bandwidth and higher bit rate to end users by connecting optical domain to either the wireless or the electric domain.**
   CO: coordinator and contributor
   P2: contributor

Deliverables (brief description and month of delivery)

D2.1. Optical Access Networks (FSO, PON, EPON, WDM-PON, FTTx optical access technologies, topologies, operation, bandwidth allocation, scalability, deployment);
D2.2 WDM Network Elements (optical line terminals, optical line amplifiers, optical add/drop multiplexers, optical crossconnects);
D2.3 Hybrid Access Networks (HFC, RoF hybrid access technologies, connectivity to wireless mesh networks)

Phase **no.**	**3**				
Phase title	**An Optical Multicasting Scheme**				
Involved partners	**CO**	**P1**	**P2**	**P3**	**Total**
Person-months	**6**		**1,15**	**2**	
Start month	**15**				
End month	**20**				

Objectives

1. Set Up Multicast Connections: studies architectures and approaches for establishing multicast connections in the hybrid access optical network using light trees. Multicasting permits point-to-multipoint connections to support multicast applications, such as HDTV, e-learning, live auctions, distributed games, movie broadcasts from studios, etc.
2. Multicast Tree Protection: formulates a solution of setting a straightforward link-disjoint backup tree, according to the physical layer of the hybrid optical access network ;
3. Dissemination : results from the phase number 1 to the phase number 3 are presented as papers at conferences.

Description of work (possibly broken down into tasks) and role of participants

1. **Design Multicast-Capable Switche Architecture: formulates the approaches to design switches capable of supporting multicasting.**
   CO: coordinator and contributor
   P2: contributor
   P3: contributor
2. **Set Up a Group of Multicast Sessions: establishes several directed multicasting trees at a minimum aggregate cost, assuming that the network resources are available to accommodate all conections requests.**
   CO: coordinator and contributor
   P3: contributor
3. **Approaching Backup Trees for multicast Sessions: formulates the problem of protecting a multicast tree by a link-disjoint backup tree.**
   CO: coordinator and contributor
   P3: contributor

Deliverables (brief description and month of delivery)

D3.1. Set Up Multicast Connections (architectures and approaches for multicast connections);
D3.2 Multicast Tree Protection (link-disjoint backup tree, direct-link-disjointness).

Phase **no.**	**4**				
Phase title	**A Traffic Grooming Solution**				
Involved partners	**CO**	**P1**	**P2**	**P3**	**Total**

Person-months	**6**		**1,15**		
Start month	**21**				
End month	**26**				
Objectives					
1. Optimization Criteria for the Traffic Grooming Problem: formulates the scenarios and criteria to optimizing the traffic grooming, according to network configuration, network resources, and traffic pattern. **2. A Traffic Grooming Provisioning Model: designs a traffic grooming solution that incorporates network elements and accomodates different grooming policies.**					
Description of work (possibily broken down into tasks) and role of participants					
1. The Problem Statement: defines the inputs and the outputs of the grooming, on the given physical topology and traffic requests. **CO: coordinator and contributor** **P1: contributor** **P3:** **2. Assumptions for the Traffic Grooming Network: formulates the constraints in the network (available resources) and the objective functions (wavelengths conversion models, optical switching models, connections demands, propagation delays, etc.) as well.** **CO: coordinator and contributor** **P1: contributor** **P2:** **P3:** **3. A Traffic Grooming Solution: formulates the graph model and the mathematical formulation of the traffic grooming problem.** **CO: coordinator and contributor** **P1: contributor** **P2: contributor** **P3:**					
Deliverables (brief description and month of delivery)					
D4.1. Optimization Criteria for the Traffic Grooming Problem (scenarios and criteria to optimizing the traffic grooming); **D4.2 A Traffic Grooming Provisioning Model (graph model and mathematical formulation of the traffic grooming).**					

Phase **no.**	**5**				
Phase title	**The Fault Management Approach**				
Involved partners	**CO**	**P1**	**P2**	**P3**	**Total**
Person-	**6**		**1,15**		

months					
Start month	**27**				
End month	**32**				
Objectives					
1. Path Protection Scheme : design a traffic rerouting through a link-disjoint backup route around the failed link. **2. Simulation Program : evaluates the performance of the path protection scheme ;** **3. Dissemination : results from all the phases of the projects are presented as papers at conferences.**					
Description of work (possibly broken down into tasks) and role of participants					
1. Fault Management Mechanisms: evaluates appropriate protection and restoration schemes in the network so as data loss when a link failure occurs get minimized. **CO: coordinator and contributor** **P1: contributor** **P2: contributor** **P3:** **2. Fault-recovery Solutions: presents pre-computed and reserved in advance backup resources (wavelengths and routes) to hold the traffic alive around a failed link.** **CO: coordinator and contributor** **P1: contributor** **P2:** **P3:** **3. Simulation Program: runs the path protection scheme to evaluate the protection performances.** **CO: coordinator and contributor** **P1: contributor** **P2: contributor** **P3:**					
Deliverables (brief description and month of delivery)					
D5.1. Path Protection Scheme (model of a traffic rerouting around a failed link); **D5.2 Simulation Program (path protection scheme performances);**					

Table 5. Deliverables List

Deliverable No.	Deliverable Name	Phase no.	Type of Deliverable *	Phase delivery date (1 ... n)
D1.1	**The Choice of the Optical Network Architecture**	1		M8
D1.2	**Multiplexing Techniques**	1		M8
D1.3	**Enabling Technologies**	1		M8
D2.1	**Optical Access Networks**	2		M14
D2.2	**WDM Network Elements**	2		M14
D2.3	**Hybrid Access Networks**	2		M14
D3.1	**Set Up Multicast Connections**	3		M20
D3.2	**Multicast Tree Protection**	3		M20
D4.1	**Optimization Criteria for the Traffic Grooming Problem**	4		M26
D4.2	**A Traffic Grooming Provisioning Model**	4		M26
D5.1	**Path Protection Scheme**	5		M32
D5.2	**Simulation Program**	5		M32

2. Implementation

2.1. Management structure and procedures

The management of the OWHAN project is accomplished by the project manager and the representatives from the partners. The project manager originates from the coordinator entity, which is a communications research institute. The representatives from the partners are professors or lecturers within electronics and communications faculties of universities.

The Project Manager is responsible for the planning, organizing, leading, and controlling the project. The Project Manager is representing the consortium in any relation with UEFSCDI.

The Project Manager makes decisions in respect with all the important facts, procedures, policies. He does the work required to achieve understanding, leave adequate documents, keep informed and keep other informed, report on progress, motivate to inspire/encourage, improve knowledge/training/attitude.

The Project Manager responsibilities include :

- ✓ Review work to be accomplished;
- ✓ Determine the resources required to perform the work;
- ✓ Program the work to establish the sequence of activities in order to reach the defined objectives and goals;
- ✓ Schedule the work to establish when things must be done;
- ✓ Determine the procedure to perform the work;
- ✓ Define policies and constraints of the framework;
- ✓ Allocates available resourcfes to do the work;
- ✓ Develop a working structure;
- ✓ Achieve mutual understandings of responsabilities and authorities;
- ✓ Establish conditions for mutually cooperative efforts of the partners;
- ✓ Take action to assess and regulate work in progress;
- ✓ Use systematic methods to measure performance, productivity, and progress;
- ✓ Evaluate results – determine the significance of variances and exceptions in the comparison of actual versus planned performances;
- ✓ Take corrective actions to do what is necessary to bring exceptions into line;
- ✓ Follow-up on work completed;
- ✓ Establish and monitor standards of quality and performance;
- ✓ Look for situations which need improvement;
- ✓ Re-evaluate changing conditions to readjust planning, organizing, and leading strategy;

- ✓ Give and use new ideas;
- ✓ Improve all communicating skills;
- ✓ Emphasize accountability and control.

A **Consortium Agreement** will state the legal provisions that all the participants in the project obey to. The legal clauses will be regarding internal organization and management of the consortium, copyright issues, disputes, financial issues.

2. Individual participants

The project consortium consists of one research institute (coordinator), and three technical universities (partners).

Coordinator – ***National Communications Rsearch Institute - INSCC Bucharest*** is a research and development organisation established in 1955. Its main activities include studies, research regarding technologies and advanced applications in the communications field. The research areas include radio-communications (3G, 4G technologies and applications, radio wideband access networks), electronic communications: interfaces, protocols, access configurations. Starting with 2001, INSCC was involved in projects for the telematics field in health, and it has participated in the competitions organized by MCEd, coordinating projects in INFOSOC, CALIST, CEEX programs or in projects organised under MCTI. Since 2008, INSCC has been involving in optical communications and optical networking technologies. Starting with 2001, INSCC was involved in projects for the telematics field in health, and it has participated in the competitions organized by MCEd, coordinating projects in INFOSOC, CALIST, CEEX programs or in projects organised under MCTI.

INSCC is the leading coordinator of the project. It contributes with analysis, models, solutions and schemes to materialize the concept of the optical wireless-based hybrid acces network for multiservices applications. INSCC will be attending all the project stages, from the very first setup of activities up to the last finish. INSCC will be approaching conferences, journals, and workshops to disseminate the relevant information produced by the project.

Relevant projects:

- ✓ *Study on free-space communications,*
- ✓ *Study on solitons-based optical communications,*
- ✓ *Wavelength division multiplexing – based optical transport networks – structure, performances, characteristics.*

Key participants:

Radu DRAGOMIR (engineer, PhD, senior scientific researcher). He has a MSc degree in electronics and telecommunications from the Polytechnical Institute of Bucharest, and a Ph.D degree in electric engineering from the University Politehnica Bucharest. Currently, he is a senior scientific researcher with the National Communications Research Institute in Bucharest. His main research is concerning fiber optics transmissions, optical multiplexing technologies, optical soliton-based transmissions, terrestrial laser communications, and optical networking. He is project manager in three optical transmission project and one networking project. He is a participant in another four communications security projects.

Viorel MANEA (engineer, researcher). His research areas include the free space optics communications and signal coding. Since 2009 is a project manager in signal coding and compression techniques project and partner in several optical communication projects.

Partener 1 - Universitatea Transilvania Brasov

Transilvania University of Brasov provides resources and develops processes and tools to conduct scientific research and education, quality standards necessary to ensure competitiveness in the European Higher Education and Research. It includes: faculties, departments and other functional structures for scientific research, cooperation with educational institutions and research at home and abroad, with extensive experience in national and international project management (CEEX, Research platforms, CNCSIS, FP, COST, Leonardo da Vinci, Minerva, PN II).

Key participants:

Lecturer dr. ing. Otilia CROITORU

Between 1990-2001 senior engineer, then senior researcher at Transilvania University of Braşov. She received his Ph.D. degree in Engineering Sciences, the field of Electronics and Telecommunications Engieering from Transilvania University of Brasov in 2006. Since 2000 she is teaching radio communications at the same university. Current research interests include digital communications, multiple access techniques, especially CDMA.

Assoc. Prof. dr. ing. Marian ALEXANDRU

He received his Ph.D. degree from Transilvania University of Brasov in 2005. He is teaching (since 1996) radars and courses from the telecommunications field at the same university. Current research interests include applications of virtual and remote laboratories, digital communications, wireless

networks and e-Learning finalized with published papers and a brevet. He participated in national and EU projects where he developed relations with people from academic and industrial areas. He contributed to the Leonardo da Vinci TR/06/B/F/PP/178036 European Remote Radio Laboratory project (2006 – 2008) where microwaves and communications remote laboratory tools were created and where he co-ordinated the activities of the romanian partner. Also, now he is management comitee member in IC1004 COST programme, Cooperative radio for green smart environments.

Partener 2 - Universitatea din Pitesti

The academic stuff of Electronics, Computers and Communications Department has a number of 14 professors and associate professors and 15 assistants and researchers.

The structure of the Electronics, Computers and Communications Department related to the specializations being part of it is the following: Applied Electronics, Computers and Information technology, Telecommunications, Electromechanics, Metrology and Electrical Industry. The students can chouse to specialize in these domains.

In the Electronics, Computers and Communications Department has been elaborated or are in course of elaboration many doctoral and master thesis having as research thematic issues form the communication domain.

In the present the University of Pitesti develops national projects, European projects and N.A.T.O. projects. As main research domains involved in this projects can be reminded: optoelectronics, laser physics, radiocommunication equipments for different types of modulations, networking and data traffic optimization, signal and image processing, database design and management for multimedia applications, development of services for e-learning and videoconference, design and experimentation of algorithms for de-noising images, signal and image compression, investigation of ground particularities from the radio coverage point of view, investigation of existent local communication infrastructure in the south-east art of Romania, studies about data protection through cryptography, satellites based communication systems, positioning and calculus for mutual protection.

Key participants:

Mr. Ioan Lita received in 1980 the bachelor degree in electrical engineering and telecommunications from Polytechnic University of Bucharest, Bucharest, Romania. In 1991 he received also the bachelor degree in economy from Academy of Economic Studies from Bucharest, Romania. Prof. Ioan Lita has

a doctoral diploma in the specialization "Materials for electronics".

Since 1987, he has been with the Electronics, Communications and Computers Department at University of Pitesti, where is currently professor and sustain scientific research activity in area of interest and teaching activities of graduate and postgraduate courses.

His main research interests include data acquisition systems, optical communication systems, computer networks and materials for optoelectronics including lasers with solid state active medium.

Mr. Daniel Alexandru Visan received in 1998 the bachelor degree in electrical engineering and telecommunications from University of Pitesti, Pitesti, Romania.

Mr. Daniel Visan has currently a doctoral diploma in the specialization "Electronics and telecommunication engineering".

Since 2001, he has been with the Electronics, Communications and Computers Department at University of Pitesti, where is a lecturer and sustain scientific research activity in area of interest and teaching activities of graduate and postgraduate courses.

His research interests include optical and radio communication systems, materials for electronics, data acquisition and measurement systems, data traffic and quality of service management in computer networks.

Partener 3 – ***Universitatea Politehnica Bucuresti***

The Optoelectronics Research Center, developed in the frame of "Politehnica" University of Bucharest, Faculty of Electronics, Telecommunications and Information Technology (**UPB-CCO)**, is created and organized on the basis of the Education Law no. 51/1996 through the Decision of the UPB Rector no.255/124 from 11.12.1998. The domain of activity of the center is OPTOELECTRONICS, having the following sub-domains: *Photonic micro and nanostructures, Optical processing of information, Optical fiber communications and Electronic devices-circuits related to the optoelectronic systems*, with applications in all the fields of social life, including in the field of national defense and security. Optoelectronics Research Center develops activities of research-development, education, information, documentation, expertise and consulting in the field of photonic micro and nanostructures, optical processing of information and optical fiber communications. UPB-CCO promotes collaboration at national and international level, supporting the activities of promotion and dissemination of scientific and technical knowledge through conferences, seminars, scientific publications, affiliation to professional associations and exchange of specialists. The UPB-CCO staffs is currently composed of 19 persons (2 full professors, 3 senior researchers, 2

researchers, 2 lecturers, 9 Ph.D. students and 1 administrative). Optoelectronics Research Center organized the first international symposium in the field of Optoelectronics, in 2002- Advanced Topics in Optoelectronics Micro and Nanotechnology –ATOM-N 2002, and also editions: ATOM-N 2004, 2006, 2008 and 2010(www.atom-n2010.ro). As a previous experience, we mention that the center members have published, in certified publishing houses, eighteen books (14 in Romania, 4 abroad); articles published in magazines (16 in the last four years); articles published: 8, out of which 6 in Romania and 2 abroad; Scientific papers: 78, out of which 69 in Romania and 9 abroad; Representation in scientific forums: 3 scientific committees at IMT, INOE and Hyperion University; Members in program committees: at four scientific conferences: International Semiconductor Conference - CAS; International Symposium for Design and Technology in Electronic Modules-SIITME International Symposium of Education and Research Advanced Topics in Optoelectronics Micro and Nanotechnology –ATOM-N. Experience in national project directing: CNCS/ Relansin/ Calist/ PN I and PN II.

Key participants:

Paul Şchiopu, Ph. D. is professor in the "Politehnica" University of Bucharest, at the Faculty of Electronics, Telecommunications and Information Technology, and head of Electronics Technology and Reliability Department and Center for Research in Optoelectronics, being active in the domains of the Optoelectronic Devices and Circuits and of the Advanced Materials for Electronics. His didactics activities contain lectures for : Optoelectronics, Devices and Photonic Materials, and Photonics Mesurements and Transducers, and he guidances masters and physicians degree in Optoelectronics. He published more then 60 scientific studies in the Proceedings of the Scientific International and National Symposiums or Conferences and 11 books in the domains of the Optoelectronic Devices and Circuits and of the Advanced Materials for Electronics. Also, he managed scientific researchs in following sub-domains: *Photonic Micro and Nanostructures, Optical Processing of Information, Optical Fiber Communications and Electronic Devices-Circuits related to the Optoelectronic Systems*. He is the Editor of the Optoelectronics series. His last books are: Cristale si pensete fotonice, Ed. MatrixRom,2006, Optoelectronica-Indrumar de laborator, Ed. MatrixRom, 2009, Optoelectronics, MatrixRom,2009, Electronic Materials, editura AETERNITAS, Alba Iulia 2009, Dispozitive Dielectrice şi Magnetice, Ed. MatrixRom, 2010, Măsurători optoelectronice. Îndrumar, Ed.MatrixRom, 2011, Materiale pentru electronică. Îndrumar, Ed.MatrixRom, 2011, Dispozitieve piezoelectrice, Ed. MatrixRom, 2011.

Adrian Manea, Ph. D. is professor in the "Politehnica" University of Bucharest, Romania, Deputy Dean of the Faculty of Electronics, Telecommunications and Information Technology, and CCO deputy director, being active in the domains of Optoelectronic Devices and Circuits and of the Advanced Materials for Electronics. His didactics activities contain lectures for : Optoelectronic Devices, Optical System for Communication, Technology and Photonic System, and Realization and Testing Photonic Equipment. He published 6 articles in scientific reviews , 20 scientific studies in the Proceedings of the Scientific International and National Symposiums or Conferences and 8 books in the domain of Optoelectronic Devices and Circuits and of the Advanced Materials for Electronics. Also, he managed 6 scientific researchs and he was member in 12 scientific collective for research in following sub-domains: *Photonic Micro and Nanostructures, Optical Processing of Information, Optical Fiber Communications and Electronic Devices-Circuits related to the Optoelectronic Systems*, with applications in all the fields of social life, including in the field of national defense and security. The last book is: Adrian Manea " *Optical Systems for Communication*", MatrixRom Press, Bucharest, Optoelectronics series no.4 / 2006.

2.3. Consortium as a whole

Consortium formed has been in component specialties needed to achieve the project objectives:

CO has a research activities in the areas that include radio-communications (3G, 4G technologies and applications, radio wideband access networks), electronic communications: interfaces, protocols, access configurations, optical communications and optical networking technologies. It contributes with analysis, models, solutions and schemes to materialize the concept of the optical wireless-based hybrid acces network for multiservices applications. INSCC will be attending all the project stages, from the very first setup of activities up to the last finish. INSCC will be approaching conferences, journals, and workshops to disseminate the relevant information produced by the project.

Partner 1 has a active and modern research activity in domains like electrical engineering and computer science. The Faculty of Electrical Engineering and Computer Science is recognized at national level for the research carried out in a large number of fields of electrical engineering and computer science, as "Measurement and Data Acquisition Systems, Wireless Communication, Information and Communications Technologies, Techniques and Technologies for Digital Communication. An important number of research centers, respectively teams of researchers

constituted ad-hoc, on different themes, successfully put in practice the scientific research strategy of the university, within the framework of numerous grants and contracts won by competition. The results of the research are materialized in papers, patents and products, all bringing for the University prestige, as well as important funds. University Transilvania Brasov possesses an educational and research infrastructure - both buildings and equipments.

Partner 2 has expertize in optoelectronics, laser physics, radiocommunication equipments for different types of modulations, networking and data traffic optimization, signal and image processing, database design and management for multimedia applications, development of services for e-learning and videoconference, design and experimentation of algorithms for de-noising images, signal and image compression, investigation of ground particularities from the radio coverage point of view, investigation of existent local communication infrastructure in the south-east art of Romania, studies about data protection through cryptography, satellites based communication systems, positioning and calculus for mutual protection.

Partner 3 has expertize in optoelectronics, having the following sub-domains: photonic micro and nanostructures, optical processing of information, optical fiber communications and electronic devices-circuits related to the optoelectronic systems. The Opoelectronics Research Center, developed in the frame of „Politehnica" University of Bucharest develops activities in research, education, information, documentation, expertise and consulting in the field of photonic micro and nanostructures, optical processing of information and optical fiber communications.

In this way, the consortium formed can to solve problems that all four major activities of the proposed project:

1. *Initial activities* –consist in the research of the operational scenarios, the user's requirements and preparing the specifications of technical requirements. These will consider the interoperability aspects between the elements of the system.

2 Research&development activities – Research & development activities will create innovative solutions for implementing the teleassistance service. These activities are divided in three major areas, the hardware and software support and respectively the information contained in the applications.

3. Validation activities – the validation activities consist of integrating the modules resulted from the research and development activities, users testing and also of evaluating the technologies developed, related to the interoperability, usability and commodity for the user. The user attempts are made in order to demonstrate what was accomplished until that moment and for the assessment of the

usability and the technology impact over the users, also for validating the integrity and interoperability aspects.

4. Project's activities – The project's activities consist of coordination, management of the project and of disseminating of its results.

2.4. Resources to be committed

In order to accomplish the **OWHAN** project, the following material and financial resources are needed: *Project specific, additional material resources:* computational equipments, electronic components, optical devices and equipments, telecommunication equipments for the development of typical applications**.**

The financial resources had been established through the assessment of the minimum need of component equipments, software licenses, in order to complete the already existing resources at the executants, thus accomplishing the project. The fact that the equipments have a medium- or high-complexity has to be mentioned, as it also gives a measure of the cost.

2.5. Methodology and associated work plan:

The overall strategy of the work plan

The activities of the projects are separated into ***5 Phase package (PhP):***

- ✓ **PhP1 - The Optical Networking Solution**
- ✓ **PhP2 - The Hybrid Access Networking Model**
- ✓ **PhP3 - An Optical Multicasting Scheme**
- ✓ **PhP4 - A Traffic Grooming Solution**
- ✓ **PhP5 - The Fault Management Approach**

Description of each phase

Php1

The Optical Networking Solution phase one package is intended to undertake actions that motivate, technically as well as businesswise, the choice of the optical access network solution to support broadband multiservices applications at the users premises.

The following activities are to be undertaken:

- **Analysis of Optical Networks:** backbone, metropolitan and access networks architectures are overviewed to design an optical communications network; a point-to-point terrestrial laser communications system is described as it is commissioned for backhauling the hybrid optical network in the project.

- **Analyzing Telecom Business Models:** comm. services offered by the carriers (service providers) are considered for investigation and telecom business models are generated that permit broadband multiservices applications.

- **Analyzing Optical Switching:** certain switching functionalities migrates from electronics to optics so as wavelengths and bandwidth provisioning are expedited in the optical layer. Wavelength switching, optical packet switching and optical burst switching are taken into consideration to offer the optical network flexibility, efficient resources utilization, potential functionality and finer switching granularity.

- **Analyzing Optical Transmission & Multiplexing:** optical transmission in fiber optics, loss and bandwidth windows in fiber, loss budget in terrestrial laser transmission, dispersion and nonlinearities in fiber, optical time division multiplexing, space division multiplexing, wavelength division multiplexing.

- **Analyzing Optical Components/Devices:** the components described in the project, the most important devices of the optical communications system, are couplers, lasers, photodetectors, optical amplifiers, optical switches, filters, and multiplexers.

- **Analyzing Wavelength Conversion:** full wavelength conversion, fixed conversion and limited conversion are accounted in the project to solve the routing and wavelength assignment in the optical wavelength-routed network. Opto-electronic wavelength conversion, wave-mixing conversion, and cross modulation conversion are approached.

Php2

The Hybrid Access Network Model phase two package comprises the activities, mentioned underneath, which result in an optical wavelength division multiplexing-based access network solution for a high bit rate (100 Mb/s) traffic at each and every end-user.

- **Analysis of Optical Access Networks:** FSO, PON, EPON, WDM-PON, FTTx access optical networks are approached to transmit the traffic from the optical metro network to the end users, in terms of topologies, operation, bandwidth allocation, scalability, and deployment.

- **WDM Network Elements:** this chapter explores the architectural aspects of the network

elements that are part of the network, namely, optical line terminals, optical add/drop multiplexers, optical crossconnects. The WDM network elements provides circuit-switched lightpaths with varying degrees of transparency. Wavelengths may be reused in the network to support multiple lightpaths.

- **Hybrid Access Networks:** HFC and RoF hybrid access technologies are explored as they are able to provide high bandwidth and higher bit rate to end users by connecting optical domain to either the wireless or the electric domain.

Php3

An Optical Multicasting Scheme phase three package includes the actions below:

- **Design Multicast-Capable Switche Architecture:** formulates the approaches to design switches capable of supporting multicasting.

- **Set Up a Group of Multicast Sessions:** establishes several directed multicasting trees at a minimum aggregate cost, assuming that the network resources are available to accommodate all conections requests.

- **Approaching Backup Trees for multicast Sessions:** formulates the problem of protecting a multicast tree by a link-disjoint backup tree.

Php4

A Traffic Grooming Solution phase four package is, basically, the traffic engineering of the optical access network, and generates a virtual lightpaths network so as the access network provides the end-users with seamless communications.

The next activities are accomplished:

- **The Problem Statement**: defines the inputs and the outputs of the grooming, on the given physical topology and traffic requests.

- **Assumptions for the Traffic Grooming Network:** formulates the constraints in the network (available resources) and the objective functions (wavelengths conversion models, optical switching models, connections demands, propagation delays, etc.) as well.

- **A Traffic Grooming Solution:** formulates the graph model and the mathematical formulation of the traffic grooming problem.

Php5

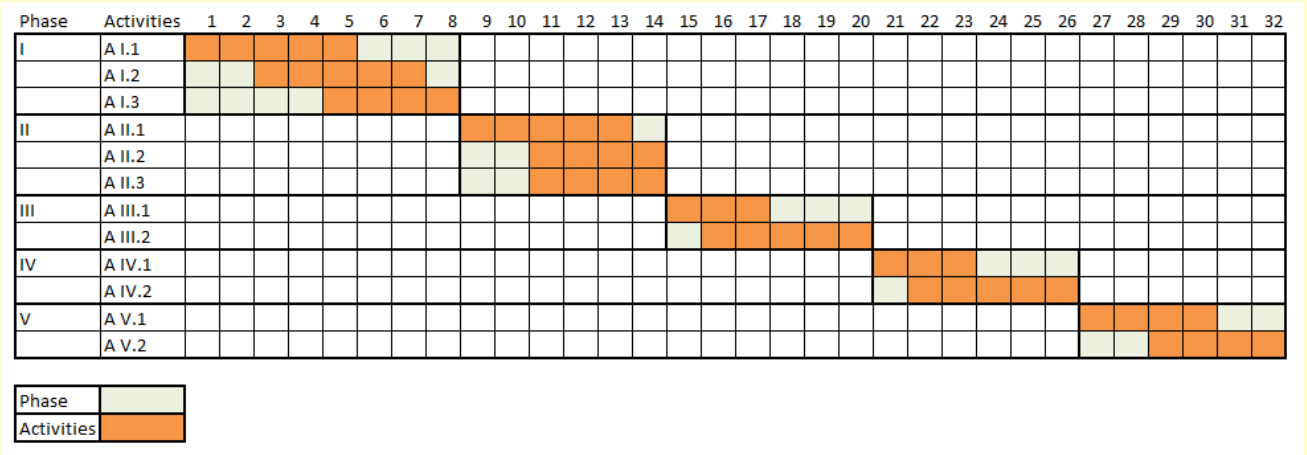
The Fault Management Approach phase five package is a mix of activities, presented below, which delivers appropriate protection and restauration schemes to the optical access network for Q0S services.

- **Fault Management Mechanisms:** evaluates appropriate protection and restoration schemes in the network so as data loss when a link failure occurs get minimized.

- **Fault-recovery Solutions:** presents pre-computed and reserved in advance backup resources (wavelengths and routes) to hold the traffic alive around a failed link**.**

- **Simulation Program:** runs the path protection scheme to evaluate the protection performances.

The timing of the different phases and their components



Deliverables

D1.1 **The Choice of the Optical Network Architecture**

D1.2 **Multiplexing Techniques**

D1.3 **Enabling Technologies**

D2.1 **Optical Access Networks**

D2.2 **WDM Network Elements**

D2.3 **Hybrid Access Networks**

D3.1 **Set Up Multicast Connections**

D3.2 **Multicast Tree Protection**

D4.1 **Optimization Criteria for the Traffic Grooming Problem**

D4.2 **A Traffic Grooming Provisioning Model**

D5.1 **Path Protection Scheme**

D5.2 **Simulation Program**

Table 6.

Key persons list				
	Name and surname*	**Scientific title**	**Phase**	**Person-month**
Coordinator (CO)	Dragomir Radu	Dr. eng.	1,2,3,4,5	0.5
	Manea Viorel	eng.	1,2,3,4,5	1
Partner 1	Croitoru Otilia	Dr. eng.	4,5	0.5
	Alexandru Marian	Dr. eng.	4,5	0.5
Partner 2	Lita Ioan	Dr. eng.	1,2,3,4,5	0.5
	Ionita Silviu	Dr. eng.	1,2,3,4,5	0.5
Partner 3	Schiopu Paul	Dr. eng	1,2,3	0.5
	Manea Adrian	Dr. eng.	1,2,3	0.5
Total				

*the CVs will be uploaded on the web platform, www.uefiscdi-direct.ro

Available research infrastructure

1. ICT resources:
   - Desktop PCs (Intel Core 2 Duo, 2 GB RAM DDR2, video RAM 512 MB, HDD 320 GB, DVD-RW, 6x USB 2.0, Ethernet 100/1000, Windows 7 32 bit, Office 2010)
   - Laserjet printer, multifunction 300 dpi
   - Color Inkjet printer
   - LAN
2. Research resources:
   - Matlab Environment

Table 7.	Budget breakdown by year (mii lei)												
	Public Budget				Private cofinancing				Total				Private cofinancing
	2012	2013	2014	Total	2012	2013	2014	Total	2012	2013	2014	Total	%
Coordinator (CO)	300	450	450	1.200					300	450	450	1.200	
Partner 1			320	320								320	
Partner 2	60	120	100	280					60	120	100	280	
Partner 3	120	80		200					120	80		200	
Total	480	650	870	2.000					480	650	870	2.000	

Table 8. Budget breakdown by category of expenses

Budget breakdown / destination (lei)[1]								
		Personnel costs	Logistics			Travel	Indirect costs	Total
			Equipments	Materials	Subcontracting			
Coordinator (CO)	Public Budget	781.287	35.000	73.713		77.000	233.000	1.200.000
	Private cofinancing							
Partner 1	Public Budget	192.000	70.000	10.000	5.000	5.000	38.000	320.000
	Private cofinancing							
Partner 2	Public Budget	110.000	28.000	80.000		20.000	42.000	280.000
	Private cofinancing							
Partner 3	Public Budget	160.000					40.000	200.000
	Private cofinancing							
Total		1.243.287	133.000	163.713	5.000	102.000	353.000	2.000.000

[1]According to Chapter 8 – Budget

Table 9. Justification of purchasing major pieces of equipment

	Equipment name and characteristics	Justification
Coordinator (CO)	Notebook 1 buc Intel Core i3 mobile, 64 bit, RAM 4GB DDR3, HDD 500 GB, cache 8 MB, 7200 rpm, video RAM 1 GB, optical DVD –RW, UTP RJ 45 100/1000 Mb/s, Wi-Fi 802.11/b,g,n, port 4 x 2.0 USB, bluetooth, port SD/MMC, webcam & mick, Windows 7 (64 bit), Office 2010 Pro 64 bit	Mobile work desk
	Software: Optical components, devices, and networking simulator	Optical access network program simulator
Partner 1	1. Wireless and optic simulator program (real-time performance measurements, alarms quality/quantity, compatibility measurements, standard MIBs simulation. 2. PCs (Intel Core i5, HDD 640 GB SATA, RAM 4 GB, DVD SuperMulti, NVIDIA GForce, video RAM 1GB, Ethernet 100/1000, IEEE 802 11 b,g,n. 3. Display 17”	Provide solutions model communications devices, protocols, technologies and architectures and simulate their performance in a dinamic virtual network environment. Enable: • Evaluating and enhancing wireless protocols i.e., WiMAX, WiFi, UMTS, etc. • Designing MANET routing protocols • Analysing optical network design Allow to run software simulators, designing virtual network environment and collision analysing.
Partner 2	Free Space Optics System (Full dúplex, 1400 -1600 nm, tunable laser, min. 10 GB/s, self alignment system, auto-tracking)	Inplementation of the model approach
Partner 3		

3. Expected impact

3.1. Added value of the project results at National, European and International level

The OWHAN project is expected to

1. provide the university partners with innovative solutions which could enrich the knowledge in the domain;
2. improve the theoretical approach of the generated solutions so as new paradigms could take over in a developing cycle;
3. produce social-economical results by deploying flexible, highly configurable, high bit rate communications networks;
4. cause the development of new business objectives;

3.2. Dissemination and/or exploitation of project results, and management of intellectual property rights

The project results shall be disseminated by different channels, such as the web pages of the entities involved in the project, papers in journals, papers in proceedings of national/international conferences, presentations at workshops, seminars, scientific meetings.

The management of knowledge (results, copyright, patents, designs, etc.) resulting from the OWHAN project, involves the ongoing identification, tracking, and registration of knowledge as it is produced. It is also concerned with the decisions on ownership of Intellectual Property (IP) and the procedures to be included in a Consortium Agreement.. Regulations concerning the dissemination and exploitation of knowledge, and access rights, will be defined in a Consortium Agreement to be signed by all project participants.

The information in this application is hereby certified to be correct.

Project leader, INSCC
Director General,
Dr. Ing. STANCIULESCU Ion

Date: 04.11.2011

Project Manager,
Dr.Ing. CONSTANTINESCU Florin