“PROJECT PERIODIC REPORT”

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Distribution Level: {One of the Following in both short and long format}

- ***Distribution level***
  PU = Public,
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PROJECT PERIODIC REPORT

Grant Agreement number:	**216338**
Project acronym:	**DICONET**
Project title:	**Dynamic Impairment Constraint Networking for Transparent Mesh Optical Networks**
Funding Scheme:	**SEVENTH FRAMEWORK PROGRAMME** **ICT-2007.1.1: The Network of the Future (STREP)**

Date of latest version of Annex I against which the assessment will be made: **15 February 2009**

Periodic report:	**1st X 2nd ☐ 3rd ☐ 4th ☐**
Period covered**:**	**from January 1st, 2008 to December 31st, 2008**

Project co-ordinator name, title and organisation: **POINT Jean-Charles, CEO, JCP-CONSULT**

Tel: **+33 223 271 246**

Fax: **+ 33 299 277 782**

E-mail: **pointjc@jcp-consult.com**

Project website address: **http://www.diconet.eu**

Declaration by the project coordinator

I, as co-ordinator of this project and in line with my obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate):
  - ✓ **has fully achieved its objectives and technical goals for the period;**
  - ☐ has achieved most of its objectives and technical goals for the period with relatively minor deviations[1];
  - ☐ has failed to achieve critical objectives and/or is not at all on schedule.
- The public Website is up to date, if applicable.
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 3.6) and if applicable with the certificate on financial statement.
- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 5 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Name of Coordinator: Jean-Charles Point

Date: .16.../ .02.../ .2009

Signature of Coordinator: .....

[1] If either of these boxes is ticked, the report should reflect these and any remedial actions taken.

Table of content

1. Publishable summary

http://www.diconet.eu

Duration: 01/2008 – 06/2010
Total Cost: *€ 4,854,712*
EC Contribution: *€ 3,198,874*
Grant agreement n° 216338

DICONET: Dynamic Impairment Constraint Networking for Transparent Mesh Optical Networks

Partners: JCP-Consult SAS (FR) / Athens Information Technology (GR) / Center of REsearch And Telecommunication Experimentations for NETworked Communities (IT) / Télécom ParisTech (FR) / Huawei Technologies Deutschland GmbH (DE) / Interdisciplinair Instituut voor Breedband Technologie, VZW (BE) / Research Academic Computer Technology Institute (GR) / University of Essex (UK) / Universitat Politècnica de Catalunya (SP) / ADVA AG Optical Networking (DE) / Deutsche Telekom AG (DE) / Alcatel-Lucent Bell Labs France (FR) / ECI Telecom (IL)

Europe's future communications networks promise to usher in a new world of business and lifestyle-enabling capabilities – many of which have not yet even been dreamed of. In particular, the widespread use of broadband opportunities is very important in order productivity gains to be achieved for the European economy. Among the current priorities of the European Union is to support proper strategic frameworks for creating an innovative knowledge-based marketplace, where information and communication technologies (ICTs) can be fundamental "tools" for evolution, thus providing multiple benefits both to users (corporate and residential) and the society as a whole.

With its strengths in communication equipment, devices, networks and eServices, Europe is well placed in the world-wide race to define and develop the network and service infrastructures of the future. However, Europe would like to further strengthen its position in this domain. The future network infrastructures envisaged to be developed as part of EU research efforts will need to be highly dynamic, offering very high capacities to users, at low costs, and guarantee robustness, resilience, trust and security compatible with networks and software service platforms reaching a complexity and scale that are an order of magnitude greater than those of today's infrastructures.

In full compliance with Europe's vision of future network infrastructures, the DICONET project aims to a) provide ultra high speed end-to-end connectivity with quality of service and high reliability through the use of optimized protocols and routing algorithms, b) propose a network infrastructural scheme that can support a wide diversity of service attributes and requirements, scalability, and intelligent managing schemes, c) enable networking with dynamic features, with reconfigurability of resource allocation, through optimized protocols and routing, management and QoS and d) guarantee robustness and network resilience.

The key innovation of DICONET is the development of a dynamic network planning and operation tool residing in the core network nodes, incorporating real-time measurements of optical layer performance into IA-RWA algorithms, and which is integrated into a unified control plane. This tool is the key enabler for networks capable of automated, rapid network reconfiguration. This feature of fast dynamic reconfiguration upon user or network request is fundamentally different

from slow, planned provisioning and reconfiguration used today. In addition, our dynamic approach provides advanced network resiliency features not currently available in today's static networks. The DICONET project is a 30-month project partially funded by the European Commission, starting in January 2008 and ending in June 2010.

Main Objectives

We summarize here the objectives of the DICONET project, emphasizing on the work done and results achieved during the first year:

1. Development of Impairment Aware RWA Algorithms

We performed a survey of the IA-RWA algorithms in the literature (both offline and online): 100 papers were surveyed, algorithms were classified for 28 criteria, 12 algorithms (3 offline and 9 online) were re-implemented for comparison on common ground (reference networks identified in T2.1: a national network, DT Network, and a Paneuropean network, Geant2). We showed the necessity for impairment awareness in RWA in transparent/translucent networks. This research is published or under submission. We then developed a series of offline IA-RWA, using various techniques (linear programming, genetic algorithms, heuristics), compared them for blocking rate and computation time, for the transparent case (smaller networks); for the translucent case (larger networks), we studied the regenerator placement and RWA approaches either combined (ILP; does not scale well with network size) or separated (use of standard technique for each subproblem, scales well with size). This research is published or under submission. Solutions for the online case (development of multicost IA-RWA and IA-RWA algorithms in presence of spare regeneration) are in progress. We submitted a draft to the IETF: "draft-bernstein-ccamp-wson-impairments-01", dealing with how the definition and characterization of optical fiber, devices, subsystems, and network elements contained in various ITU-T recommendations can be combined with common control and measurement plane and path computation element technologies to support IA-RWA in optical networks.

2. Optimum equipment (regenerators & monitors) placement

Not addressed this year.

3. Study of failure localization algorithms to enable resiliency

We investigated monitoring requirements and technique availability in the context of a number of applications, including failure localization. We determined the necessity and needed characteristics for power (per link and per channel) and channel wavelength monitors to localize faults in the DICONET framework. Localization algorithms based on information provided by the afore-mentioned monitors will be studied in Year 2.

4. Study of OPM/OIM techniques

We identified and described the most important physical effects to be considered throughout the DICONET project; in particular, crosstalk and filter concatenation were found to be negligible at 10 Gb/s with 50 GHz grid spacing. Parameters to be considered and possibly monitored are BER, Q factor, power (per link/per channel), wavelength, OSNR, channel accounting/routing state, residual chromatic dispersion, PMD, amplifier noise and transients. For each of these, monitoring solutions were investigated, along with the required accuracy, measurement range, availability, cost, acquisition time. In addition, we studied experimentally the Q-factor asynchronous and sampling techniques. Polarization mode dispersion (PMD) monitoring was also studied in depth in this task, using state-of-the-art equipment provided by one partner, in the framework of the participation of a partner within the IEC standardization body (IEC 86C group).

5. Development of fast and accurate modeling tools

We defined and prioritized which monitoring information will be made available to compute lightpaths. A first version of a Q-Tool able to compute signals' quality of transmission (QoT) was released, along with a "signature" to allow abstraction of the QoT computations and coordinate work by all partners. In addition, we have shown the interest of a more realistic approach that accounts for the uncertain knowledge of the physical parameters and the uncertainty of the quality of transmission estimator. This new approach can also quantify the reliability of the network dimensioning results. Such a feature is of interest for the network designers and operators. We also investigated the advantage to derive the channel OSNR from the power of the whole WDM comb measured after each optical amplifier and the channel powers measured in each optical network node. This approach was shown more accurate that the simple OSNR estimate from component specification but not as efficient as the direct OSNR measurement above all for the transparent connection the reach of which exceeds several hundreds of km.

6. Experimental verification of the models

During the first year, we conducted experiments which will be used in particular to validate in Year 2 the Quality of Transmission estimation tool (abbreviated by "Q-Tool"), which was developed in Year 1. Experiments with equipment compatible with the DICONET project were conducted to evaluate the impact of several impairments as signals propagate. Experiments with equipment compatible with the DICONET project were conducted to evaluate the impact of several impairments as signals propagate. Unlike with SMF fiber, the transmission performance over LEAF fiber is strongly related to the wavelength of the channel under study. For this reason, the experiments were carried out for different wavelengths. The impact of receiver characteristics (in particular, threshold) was studied analytically and via experiments, showing that a Gaussian+Chi-square mixture for noise statistics is more accurate than the usual Gaussian assumption. In addition, several 2R regenerations schemes were evaluated and compared. A new regeneration scheme was presented and the improvement in signal quality induced by this regeneration device was assessed both through simulations and experiments.

7. Realization of dynamic network planning tool

The planning/operation tool itself will be developed in Year 2 once a decision on the control plane architecture is reached. However, we designed a high level design for the tool integration for two versions of the control plane architecture.

8. Protocol extensions to enable an IA-control plane

We defined interfaces between monitors and the Generalized Multiprotocol Label Switching (GMPLS) control plane and the Network Management System (NMS). A schematic architecture considered in the DICONET project is presented taking into account four control plane approaches proposed in DICONET project: PCE model, signaling model, routing model, and hybrid (signalling/routing) model. We analyzed the relationships between monitors and control plane for 13 different application scenarios, covering relevant aspects of network operation. We defined a unified functional architecture of the interfaces based on a middle-box that can aggregate and temporarily store the information provided by the monitors for dissemination using a common XML format.

9. Verification of the DICONET tools, algorithms and protocols

Not addressed this year.

10. Dissemination of project results

The online presence of DICONET dates back from Month 1 through a dedicated website which is kept up-to-date: http://www.diconet.eu. A factsheet and a poster were produced and presented at various events, in particular, FP7 events (Concertation meetings, Future Internet Assembly, Meeting of future Internet cluster during Mobile Summit, NEM summit). During the first year, 16

papers, including 15 conferences, 1 journal, 9 peer-reviewed and 6 invited papers were presented or accepted for a presentation in 2009. In addition, DICONET is sponsoring a technical session at the ONDM 2009 conference [Session 6: Provision and physical layer impairments (Sponsored by DICONET) and chaired by Matthias Gunkel, Deutsche Telekom, Germany

11. Techno-economic studies to support exploitation of results

We analyzed the applications and services that are expected to be deployed in a dynamic optical network. Trends in the broadband market have been investigated in order to give an indication on how the adoption of these applications and services may evolve in the coming years. Then the requirements from these applications and services influencing the network architecture have been analyzed. This preliminary study will be completed by a more extended techno-economic study in Years 2 and 3.

Expected Impact

If EU takes the leadership in transforming the broadband networks as proposed by this project then it will help to **reinforce European industrial leadership in wired networks.** Based on the DICONET innovative solutions, new bandwidth demanding services and service attributes will be developed to take advantage of the optical layer intelligence. This leaves no question that DICONET will have a significant impact in the **service development sector** in Europe.

The fact that **four global leaders in high speed network equipment manufacturing** participate in the consortium is a clear indication of the novelty or our proposed approach and **the demand that exist for such developments.** The **major network operator** that also participates in the consortium has made clear to all other partners that **the proposed solution is highly desirable for future network equipment deployments and network operation** as it will significantly reduce the capital and operational expenditures. The advantages that our proposed solution will bring to the telecom operators will translate in better services, quality of experience and most importantly reduced prices for end users who will be enabled to increase their productivity and improve their quality of life.

These partners have commercial interest in promoting standards in domains addressed by DICONET. The DICONET project and its results are expected to contribute directly in the **definition of standards in the domain of high speed networking,** with a focus on control plane protocols and techniques standardization within the Optical Internetworking Forum (OIF), ETSI, ITU-T, and IETF.

Besides the direct impact to the market leaders that are partners in our consortium, our activities will open unique opportunities to develop new optical devices for impairment and performance monitoring, develop specialized software tools and related technological advancements, which will **enable a sustainable growth in the ICT sector.** The technological advancements our consortium will realize will help **spur the emergence of new SME companies** that will specialize on specific technology aspects and will enable job creation across Europe. All proposed solutions of the DICONET proposal can be prototyped and become commercially available units. In this new market sector, Europe can play a key role, since many R&D groups have already invested tremendous research effort and have published significant results.

In this respect, DICONET will contribute significantly to the realization of the goals and objectives set by the renewed Lisbon agenda and the i2010 European Union ICT policy framework. Fulfilling these objectives, an extensive set of stakeholders will benefit from the DICONET project, including network operators, service providers, equipment manufacturers, and end-users.

Project Coordinator
Jean-Charles POINT, JCP-Consult SAS
Tel: +33 223 27 12 46, Fax: +33 299 27 77 82, Email: pointjc@jcp-consult.com

Technical Coordinator
Ioannis TOMKOS, Athens Information Technology (AIT)
Tel: +30 210 668 2771, Fax: +30 210 668 2729, Email: itom@ait.edu.gr

2. Project objectives for the period

Objective 1: Development of Impairment Aware RWA Algorithms

Objective 1 deals with the development of novel Routing and Wavelength Assignment (RWA) algorithms that take into account the signal impairments (IA-RWA) and constrain the routing of wavelength channels according to the variable physical characteristics of the dynamic optical network paths. Multi- and single-cost routing algorithms will be examined for both off-line and on-line network planning purposes under both static and dynamic traffic and network conditions. The algorithms to be developed will enable QoS routing and SLAs fulfillment in high-speed reconfigurable multi-layer optical networks. Considerations will be taken in the direction of optimizing path setup times, while enabling multi-layer, multi-service provisioning.
Measurable results can be summarized as follows:

- QoS aware IA-RWA for static traffic and dynamic network conditions
- QoS aware IA-RWA for dynamic traffic and static network conditions
- QoS aware IA-RWA for dynamic traffic and dynamic network conditions
- Feedback on related standardization bodies

The objective will be implemented by: **WP2** ***(task 2.2)*****, WP4** ***(task 4.1 & task 4.2)*****, WP7** ***(task 7.2)***.

Objective 3: Study of failure localization algorithms to enable resiliency

Objective 3 deals with the study and development of efficient failure localization algorithms based on the received information by the network management system to enable physical layer aware protection/restoration schemes.
Measurable results can be summarized as follows:

- Failure localization algorithms for transparent networks

The objective will be implemented by: **WP2** ***(task 2.2)*****, WP3** ***(task 3.2)*****, WP4 (task 4.4)**.

Objective 4: Study of OPM/OIM techniques

Objective 4 deals with the study of the capabilities of optical performance and impairment monitoring (OPM/OIM) techniques that enable: a) IA-RWA and b) fault localization.
Measurable results can be summarized as follows:

- Define capabilities and requirements of OPM technologies
- Feedback on related standardization bodies

The objective will be implemented by: **WP3** ***(task 3.1)*** **and WP7** ***(task 7.2)***.

Objective 5: Development of fast and accurate modeling tools

Objective 5 deals with the development of fast and accurate modeling tools that relate the network characteristics to the performance of the transmitted signals. These modeling tools should consider recent advancements in transmission technology (e.g. new modulation formats) and should take into account issues that have not been explored in detail in the literature (e.g. EDFA and Raman amplifier gain transients and gain tilt effects, PMD, and in case of managed-reach networks incorporating regenerators the impact of jitter).
Measurable results can be summarized as follows:

- Models for the identification of the impact of the various deleterious effects involved in high speed networks

The objective will be implemented by: **WP3** ***(task 3.2).***

Objective 6: Experimental verification of the models

Objective 6 deals with the experimental verification of the physical layer models that will be used in the IA-RWA algorithms and the network planning tool. Studies will use the unique dynamically re-configurable re-circulating loop facility at Research & Innovation Labs that is used to prototype next generation optical transport products for Alcatel-Lucent.
Measurable results can be summarized as follows:

- Experimental measurements that verify the validity of the assumptions on the models.

The objective will be implemented by: **WP3** ***(task 3.2).***

Objective 7: Realization of dynamic network planning tool

Objective 7 deals with the development of a dynamic network planning tool that could be used in real time applications during the network operation to support optimum network design and engineering under dynamically changing traffic and physical network conditions. The tool will integrate advanced physical layer models with novel routing and wavelength assignment algorithms. It will serve as an integrated framework that considers both physical layer parameters and networking aspects with optimize automated connection provisioning in transparent networks.
Measurable results can be summarized as follows:

- A software tool that integrates (in real and non-real time) information from physical layer performance monitors and computes the network paths that utilize the network resources in the most efficient way.

The objective will be implemented by: **WP2** ***(task 2.2)*****, WP3 (*****tasks 3.2, 3.3*****)**.

Objective 8: Protocol extensions to enable an IA-control plane

Objective 8 deals with the proposal of adequate extensions to existing protocols in order to enable the realization of a combined (routing, path computation, signaling) impairment aware (IA) control plane solution that will address traffic engineering, resiliency and QoS issues and will support automated and rapid optical layer reconfiguration. The protocol extension will enable automated routing of traffic demands, efficient utilization of network resources and fast network restoration.
Measurable results can be summarized as follows:

- Proposed extensions to the GMPLS protocol suite to realize an IA control plane
- Implementation of the proposed extensions in the GMPLS protocol stack
- Provide feedback on related standardization bodies

The objective will be implemented by: **WP2** ***(task 2.3)*****, WP5 (*****task 5.1, task 5.2*****), WP7** ***(task 7.2)***.

Objective 10: Dissemination of project results

Objective 10 deals with dissemination activities of the project visions and results and has significant importance in the DICONET project since we realize that in order to make the DICONET vision to become a reality in the future, information about the proposed changes must be brought out to the research community and the decision-making actors in the market.
Measurable results can be summarized as follows:

- A dissemination plan
- Publications in high quality journals/magazines
- Presentations in high quality conferences/workshops
- Web-site establishment

The objective will be implemented by: **WP7** ***(task 7.1)***.

Objective 11: Techno-economic studies to support results exploitation

Objective 11 deals with techno-economic studies that will support the exploitation of project results by equipment manufacturers, telecom operators and academic partners (with the goal to create SME companies as spin-offs out of their participating labs).
Measurable results can be summarized as follows:

- Results of the techno-economic study presenting the superiority of DICONET solutions

The objective will be implemented by: **WP2** ***(task 2.1)*** **and WP7** ***(task 7.3)***.

3. Work progress and achievements during the period

3.1 WP2 – Network architecture and support studies

Workpackage number	**2**	**Start date:** M1- **End date:** M16
Activity type	RTD	
WPL	IBBT	
Sub-tasks	Task 2.1: Development of dynamic optical network architectures [AIT]	
	Task 2.2: Investigation of planning and optimization aspects in dynamic optical networks [UPC]	
	Task 2.3: Investigation of techniques for disseminating physical impairment info across the network [Create-NET]	
Deliverables / Y1	D2.1 - Definition of dynamic optical network architectures [M6]	
	D2.2 - Planning and optimization aspects of dynamic optical networks [M12]	
	D2.3 - Description and analysis of techniques for disseminating physical impairment info across the network [M16]	
Milestones / Y1	M2.1- Identification of network scenarios and possible routing approaches to be included in the studies of the proposal [M06]	
	M2.2- Recommendations on dissemination physical impairment info across the network [M12]	

Participant MM expenses – Total Project (TP) / Cumulated expenses Year 1 (CE)													
JPC		**AIT**		**Create-NET**		**ENST**		**Huawei**		**IBBT**		**RACTI**	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE
-	-	6	4,10	7	6,38	5	5	8	6,55	15	9,75	-	-
UEssex		**UPC**		**ADVA**		**DTAG**		**ALF**		**ECI**		***TOTAL***	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	*TP*	*CE*
-	-	6	5,35	1,5	1,20	6	5.05	11	10,32	5	5	***70,50***	*58,75*

According to the Annex I, the objectives of WP2 “Network architecture and support studies” are as follows:

- Identification of dynamic optical network architectures and their evaluation with respect to planning and optimization processes
- Analysis of techniques for dissemination of physical impairment information across the network.
- To evaluate efficient failure localization algorithms for use in existing network recovery techniques
- Provide reference network architectures (network topology, characteristics and traffic demands) to be used in simulation studies that will target the evaluation of the various algorithms and tools to be developed in other WPs.

During the kick-off meeting, the workplan has been discussed in more details for, e.g. clarifying where the responsibility of one workpackage starts and of another ends. Following clarifications were made:

- Regarding monitoring of physical parameters, T2.2 is responsible for investigating what parameters would be useful to monitor in the ideal case (specification of monitoring requirements) and for what purpose. On the contrary, T3.1 is responsible for investigating what would be feasible in terms of monitoring, taking into account practical limitations.
- In addition, it was decided that WP4 is responsible for the development of new algorithms for optimizing the monitor placement, whereas WP2 considers a network with the locations of the monitors given.
- Similarly, WP4 is responsible for developing new efficient failure localization algorithms, while T2.2 surveys the current state-of-the-art in this domain.
- As WP4 is responsible for the development of new IA-RWA algorithms, the study of T2.2 will be based on a state-of-the-art IA-RWA survey. Given the timing of WP4, the work in T2.3 will be based in first instance on this state-of-the-art study of T2.2, and later on (M20) an update of deliverable D2.3 will be foreseen to incorporate the results of WP4. In order not to slow down the work in WP5, a first version of D2.3 will be delivered in M16.
- It was also decided the DICONET project would focus on the optical layer only and thus make abstraction of the electrical layer above. This means that by default a given demand will be considered from the electrical layer; nevertheless, issues related to traffic grooming will be investigated in (and only in) T2.2.

Based on these findings, the description of work has been refined: WP2 objectives were kept as initially planned; mainly the individual partner contributions were refined according to these discussions and decisions.

3.1.1 Task 2.1 Development of dynamic optical network architectures

Fulfils: objective 11– Techno-economic studies to support results exploitation

Task T2.1 was active during the first two quarters of the project (January – June 2008). As planned it resulted in deliverable D2.1 “Definition of dynamic optical network architectures” and reached together with T2.2 milestone M2.1 “Identification of network scenarios and possible routing approaches to be included in the studies of the proposal” in June 2008.

Task T2.1 started with an analysis of applications and services that are expected to be deployed in a dynamic optical network. First of all, trends of the broadband market have been investigated in

order to give an indication on how the adoption of these applications and services may evolve in the coming years. Then the requirements from these applications and services influencing the network architecture have been analyzed: requirements like bandwidth, QoS constraints and requirements on availability/rerouting and failure localization.

Afterwards, a technology survey of data and control plane technologies was made. OTN, (NG-) SDH and Optical Circuit Switching (OCS) were part of the data plane technology survey. The need for impairment aware routing in OCS networks was also highlighted. Regarding the control plane technologies, the GMPLS and PCE related protocols were briefly discussed before the routing based, signaling based and PCE based models were introduced and where in the model extensions would be needed to disseminate the impairment related information across the network. Based on this, recommendation on which technologies to adopt and modify were formulated.

Next, a list of available physical building blocks was assembled, together with their characterization in terms of different optical parameters like allowable power levels, attenuation, dispersion characteristics, bandwidth, etc. Transmission fibres, dispersion compensators, attenuators, optical (de)multiplexers, transponders, splitters and couplers, filters, wavelength selective switches and optical amplifiers have been studied. Based on this, several optical node architectures with varying flexibility – and thus complexity / cost – have been proposed. Figure 1 below illustrates the base reference node architecture to be considered within the DICONET project.

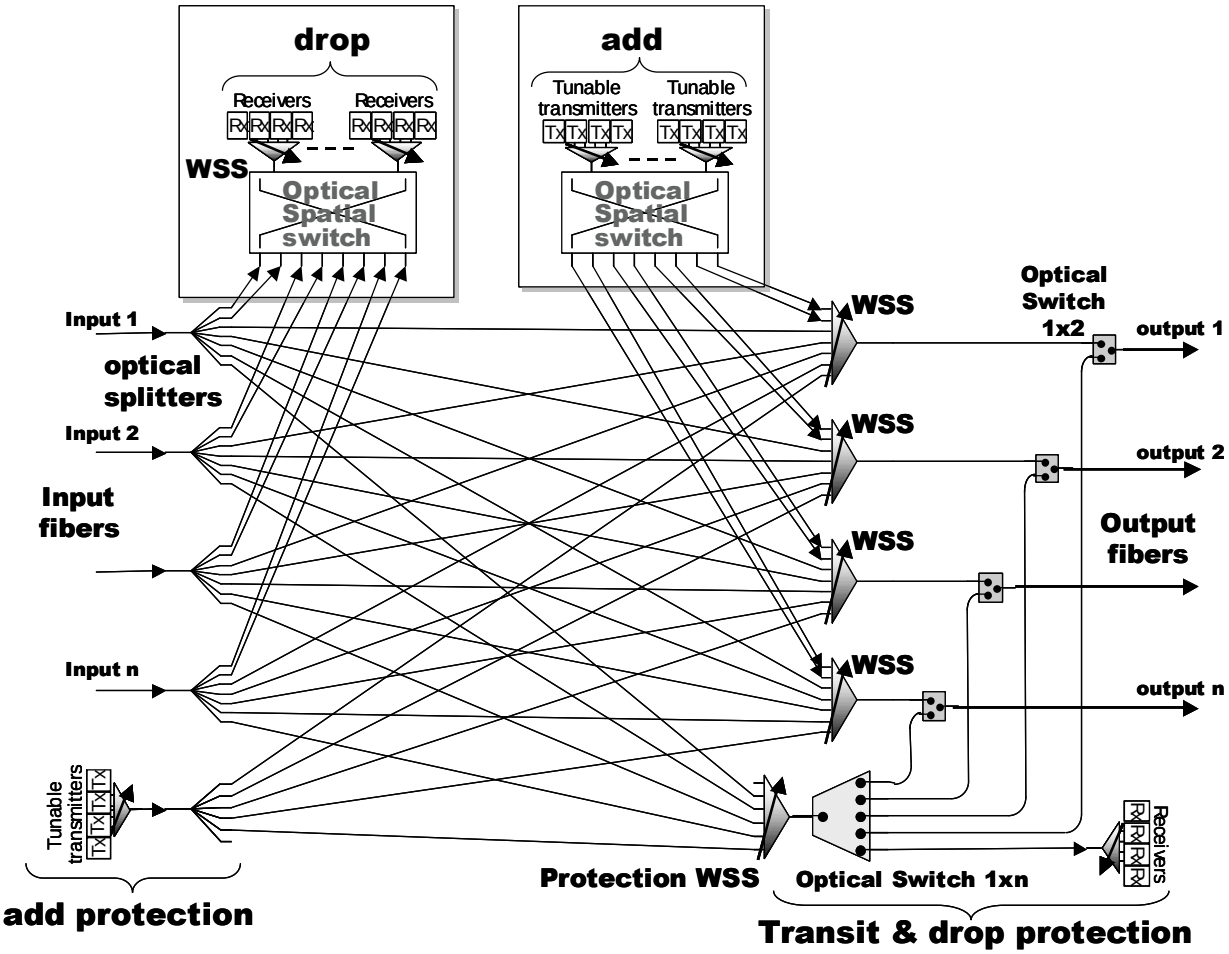


Figure 1- base reference node architecture to be considered within the DICONET project

Finally, several network architectures were discussed. This include: optical point-to-point networks, ring networks and mesh networks (each of these network architectures requiring an increasing

complexity/flexibility of the adopted node architectures). Based on previous studies highlighting the marginal cost savings of shared protection/restoration in all-optical networks, it was decided to consider only dedicated protection in the DICONET network. For further studies in the DICONET project, two reference network scenarios were defined: a generic national (German) network consisting of 14 nodes and 23 links resulting in an average path length of 410 km / 2.35 hops (and up to maximally 874 km / 5 hops); and a continental (pan-European) network consisting of 32 nodes and 53 links resulting in an average path length of 2397 km / 4.12 hops (and up to maximally 7575 km / 11 hops).

3.1.2 Task 2.2 Investigation of planning and optimization aspects in dynamic optical networks

Fulfils: objective 1 – Development of Impairment Aware RWA Algorithms,

objective 3 – Study of failure localization algorithms to enable resiliency

objective 7 – Realization of dynamic network planning tool

Task T2.2 was active during the whole first project year (January – December 2008). As initially planned, the work of this task resulted in deliverable D2.2 “Planning and optimization aspects of dynamic optical networks” in December 2008. As this task performed an extensive state-of-the-art IA-RWA study, it helped WP2 reaching its milestone M2.1 “Identification of network scenarios and possible routing approaches to be included in the studies of the proposal” in June 2008.

Several monitoring applications (including for example provisioning, protection/restoration or impairment mitigation) exist for optimizing and planning dynamic optical networks. For this purpose, T2.2 analysed the acquisition time and accuracy requirements on the Optical Performance (Q-factor, BER) and Impairment (total and channel power, channel wavelength, OSNR, PMD and residual CD, routing state, amplifier noise and transients) Monitoring (OPM and OIM) process for different applications (see summarizing Table 1 below). This analysis also resulted in a prioritization of the parameters to be monitored and in first indications where in the network to monitor them. In addition to that functional requirements (what is the role of the monitors at one side and the control/mgmt plane at the other: e.g., what side should trigger protection mechanism, what side should validate/verify that the signal quality meets the connection requirements) on the interface between the control/management plane and the monitors have been specified per monitor application.

Rank	Type	Parameters	Requirements on		Goal	Location
			Time	Accuracy		
	OPM	Q-factor	~100ms	±10%	**Network provisioning, restoration**	To be defined (WP4 issue)
	OPM	BER	~sec		**Network provisioning, restoration**	To be defined (WP4 issue)
1	OIM	Total power	<50ms	±0.5dBm	**Protection**, **impairment mitigation, upgrading,** fault localization, degradation detection	By default in every link (input and output), every amplifier
2	OIM	Channel power	<50ms	±0.5dBm	**Protection**, **impairment mitigation, network provisioning, restoration, upgrading,** fault localization, degradation detection	By default in every OXC

3	OIM	Channel wavelength	<50ms	±75pm	**Protection**, fault localization, network provisioning, restoration, upgrading, degradation detection	To be defined (WP4 issue)
4	OIM	OSNR	~100ms	±1.5dB	**Network provisioning, restoration**	By default NOT on every link, can be improved by using intermediate channel power monitors or equalizers
5	OIM	PMD	~100ms	±5%	**Impairment mitigation, network provisioning, restoration,** degradation detection, upgrading	To be defined (WP4 issue)
6	OIM	Residual CD	~100ms	±2%	**Impairment mitigation, network provisioning, upgrading, restoration,** degradation detection, upgrading	To be defined (WP4 issue)
7	OIM	Routing state	absolute	absolute	**All except upgrading**	
8	OIM	Amplifier noise	~min.	±0.5dBm	**Upgrading**	To be defined (WP4 issue)
9	OIM	Amplifier transients	~ms		**Degradation detection**	To be defined (WP4 issue)

Table 1 - Monitoring priorities and requirements for network operation in DICONET

An impressive state-of-the-art study on Impairment Aware – Routing and Wavelength Assignment (IA-RWA) algorithms has been carried out: algorithms presented in more than 100 recent papers have been reviewed and benchmarked against 28 metrics/criteria/aspects (like whether linear/non-linear impairments are considered, whether a centralized or distributed architectures is considered, performance metrics like blocking rates, computation time, etc.) and classified depending on whether impairment information is taking into account in the R and/or WA algorithms and whether measures are taken to verify afterwards that the signal quality is sufficient and accordingly if needed to adjust the result in order to meet the connection requirements. Based on this analysis, 3 offline and 9 online algorithms have been selected and tested. Within these tests it became clear that even for a national (German) network an RWA taking into account the physical impairments significantly improves the (blocking rate) performance, despite the fact that such a network only spans a geographic region for which the distances are smaller than the longest reach that can be achieved with current transmission systems. Figure 2 below illustrates this by showing the perceived blocking rate after the RWA step (only accounting for resource shortages) and after the signal quality (Q) verification step. In the state-of-the-art study on IA-RWA algorithms, T2.2 also investigated how grooming algorithms may interact with the RWA algorithms: although both algorithms can influence each other, it was decided during the kick-off meeting that this is beyond the scope of the project (except T2.2 illustrating that they might be coupled).

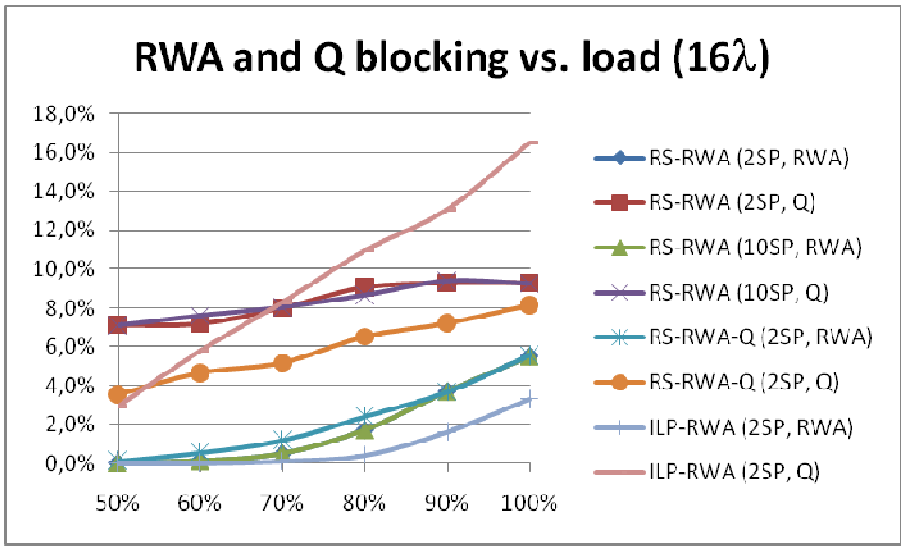


Figure 2- Monitoring priorities and requirements for network operation in DICONET

Another aspect investigated in T2.2 are algorithms and techniques for fault localization. It was concluded that spanning a network with monitoring cycles is a very cost-efficient technique to detect and often localize failures. However, a trail-based monitoring system should complement/replace the cycle-based technique to resolve any possible ambiguity in the failure localization process typically identifying the exact failure within a segment in the network (e.g., two or more links chained to each other by degree 2 nodes).

3.1.3 Task 2.3 Investigation of Techniques for Disseminating Physical Impairments info across the network

Fulfils: objective 8 –Protocol extensions to enable an IA-control plane

Task T2.3 became active after the first half project year and will continue further in the second project year. As initially planned, T2.3 will deliver in M16 (April 2009) a first version of deliverable D2.3 “Description and analysis of techniques for disseminating physical impairment info across the network”. However, as explained above, T2.3 will provide an update of this deliverable in M20 (August 2009), incorporating in the simulations the RWA algorithm under development in WP4.

As initially planned, T2.3 reached the milestone M2.2 “Recommendations on dissemination physical impairment info across the network” in December 2008. To reach this milestone T2.3 elaborated the different control plane architectures that were introduced in T2.1: routing based (making use of for example the OSPF-TE protocol), signalling based (making use of the RSVP-TE protocol) and PCE based control plane architectures for disseminating the physical impairment information. T2.3 also introduced a hybrid architecture combine the signalling based architecture with either the routing or PCE based architecture. Based on a qualitative comparison and an in-depth investigation of the involved protocols, it was concluded as recommendation in M2.2 that the hybrid (signalling complemented with few modifications to OSPF-TE) based and PCE based control plane architectures are the most relevant architectures to further investigate.

In addition to that, work on preparing and implementing the simulation environments for both the hybrid and PCE based architectures have started.

3.2 WP3 - Development of a network planning tool for dynamic traffic/impairments

WP3		**Start date:** M1 - **End date:** M16
Activity type	RTD	
WPL	AIT	
Sub-tasks	Task 3.1: Efficient optical layer impairment monitoring [ECI]	
	Task 3.2: Network modelling studies to evaluate the efficiency of monitoring [AIT]	
	Task 3.3 Development and evaluation of the network planning tool [AIT]	
Deliverables / Y1	D3.1- Network impairments in transparent networks and definition of monitoring strategy [M09]	
	D3.2 - Results on impairments' effects and evaluation of the monitoring requirements for the planned strategy of monitoring schemes [M12]	
	D3.3 - Design, development and evaluation of the network planning tool [M24]	
Milestones / Y1	M3.1- Definitions of possible monitoring technologies according to network architectures [M04]	
	M3.2 - Definition of network parameters and software platforms to be commonly used for the development of the network planning tool [M12]	

Participant MM expenses – Total Project (TP) / Cumulated expenses Year 1 (CE)

JPC		**AIT**		**Create-NET**		**ENST**		**Huawei**		**IBBT**		**RACTI**	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE
-	-	22	12,98	-	-	-	-	12	9,75	-	-	13	12,99

UEssex		**UPC**		**ADVA**		**DTAG**		**ALF**		**ECI**		***TOTAL***	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	*TP*	*CE*
-	-	-	-	18,5	7,57	4.5	1.8	16	12	18	14,23	***104***	*71,32*

This work package aims at the development of a network planning tool to be used by operators in order to estimate the network status and performance and provide optimum lightpath planning according to the network's physical impairments and the relative information received by the network monitors. Work in the first year focused on the monitoring and modeling requirements for this planning tool (Tasks 3.1 and 3.2), and early development of a component of the planning tool, the so called "Q-Tool" capable of estimating signals quality of transmission, has started early (Task 3.3).

Note that the development of Q-Tool is formally in T3.3 (M13-24) but the experimental validation takes place in T3.2 (M04-12); experiments have started on a setup that is compatible with the DICONET framework as defined and refined in WP2; development of a Q-Tool has started early, however, validation will take place in Year 2 as a part of T3.3. All other objectives have been reached as planned and deliverables were on time or in line with the Commission requirements.

Task 3.1 Efficient Optical Layer Monitoring

Fulfils: objective 4 – Study of OPM/OIM techniques

Task 3.1 was scheduled to last from M01 to M09. It has now ended, with the release of a deliverable (D3.1) on 30 September 2008 (on time). Four subtasks were identified and completed:

T3.1.1: identification of key impairments and existing technologies for monitoring these impairments

The key impairments can be found in Section 3 of D3.1. Existing technologies for monitoring these impairments are in Sections 6 (impairment monitoring techniques) and 7 (optical performance monitoring techniques) of D3.1. Section 8 describes several applications of existing monitors.

T3.1.2: effects and limitations that physical impairments introduce to the various network architectures

This can be found in Section 4 of D3.1.

T3.1.3: system transmission experiments to evaluate the use of key monitoring devices

This can be found in Section 6.4.1 in D3.1 (in-band OSNR).

T3.1.4: identification of appropriate monitoring techniques and examination of their implementation feasibility

The evaluation criteria of monitoring techniques are in Section 5 and a summary is in the conclusion of D3.1.

The conclusions of T3.1 can also be found in a tabled form in D2.2, Section 2.

Significant results:

The main impairments that arise in a transparent, high-bit rate optical network, such is the one considered in the DICONET project, were thoroughly described and summarized in a table at the beginning (Section 3) of D3.1. The most degrading effects were identified, based on the limitations that these impairments impose in 10 Gb/s transmission systems. From this study it has been concluded that some impairments, such as the filter concatenation and the in-band crosstalk have a small impact in the quality of the received signal, and, as a consequence, it is not necessary to account for them in the QoT estimator and the determination of the monitoring strategy. Based on this analysis, the physical parameters that need to be monitored in order of ascending significance and independently of the considered network structure were presented in Table 8 (Section 4). An extended study of existing and research-level impairment monitoring techniques (Section 6) and optical performance monitoring techniques (Section 7) has been performed, as well as the evaluation of their performance, based on specific criteria, such as the acquisition time, the accuracy, the measurement range (Section 5). The Q-factor asynchronous sampling technique has been studied experimentally and it has been concluded that it presents low speed and therefore cannot be used for real time applications, contrary to synchronous sampling techniques, where clock recovery is required. Finally, Table 22 in the conclusion of the deliverable gives an overview of the possible parameters that can/should be monitored, the required specifications that the monitoring system should satisfy, in terms of accuracy, speed etc, as well as the corresponding cost.

Task 3.2 Network Modelling Studies to Evaluate the Efficiency of Monitoring Schemes

Fulfils: objectives 5, 6, 7 – development of fast and accurate modelling tools, experimental verification of the models, realization of dynamic network planning tool.

Task 3.2 was scheduled to last from M04 to M12. It has now ended, with the release of a deliverable (D3.1) on 15 January 2009 (in line with the Commission requirements; originally planned M12, but deadline extended by 15 days by the Commission). Four subtasks were identified and completed:

3.2.1: System experiment and numerical studies for the evolution and formation of physical layer impairments

This can be found in Sections 3.1 and 3.2 of D3.2.

T3.2.2: The performance of regenerators in transparent network links

This can be found in Section 3.3 of D3.2.

T3.1.3: Performance evaluation of existing and new monitoring schemes

This can be found in Section 4 of D3.2.

T3.1.4: Summary – The effect of impairments and the practical requirements for their evaluation through monitoring schemes

This can be found in Section 5 of D3.2.

Significant results:

Experiments with equipment compatible with the DICONET project were conducted to evaluate the impact of several impairments as signals propagate. Differences between setups using SMF and LEAF fiber were observed, with one metric (OSNR penalty) varying with wavelength for the LEAF setup but not the SMF setup. The impact of receiver characteristics (in particular, threshold) was studied analytically and via experiments, showing that a Gaussian+Chi-square mixture for noise statistics is more accurate than the usual Gaussian assumption.

Several 2R regenerations schemes were evaluated and compared. A new regeneration scheme was presented and the improvement in signal quality induced by this regeneration device was assessed both through simulations and experiments.

The asynchronous Q-factor monitoring technique proposed in D3.1 was further studied and a technique to eliminate undesirable samples stemming from the asynchronous sampling was shown and evaluated. The technique is applicable to DICONET if the dispersion map is known or can be measured.

PMD monitoring was also studied in depth in this task, using state-of-the art, expensive equipment provided by one partner. Accuracy of two techniques was evaluated experimentally and shown to be extremely high, although the method is in-band and hence can be used only during maintenance periods. This activity, as well as the previous (asynchronous Q-factor monitoring), was performed by a partner in the follow up of the IEC standardization body (IEC SG86C group).

Task 3.3 Development and Evaluation of the Network Planning Tool

Fulfils objective: 7 – realization of dynamic network planning tool

Task 3.3 is scheduled to last from M13 to M24. Three subtasks are identified:

T3.3.1: Definition and design of the dynamic network planning tool

T3.3.2: Development of the network planning tool

T3.3.3: Evaluation of the network planning tool

Because the network planning tool is central to DICONET, it was decided to start the design and implementation of a part of it early. This is why AIT has already spent 3.43 MM on this task. AIT tackled the design and implementation of a so-called "Q-Tool", which can assess the quality of transmission of signals for already established of candidate lightpaths in a transparent optical network. The impairments included match the requirements of DICONET for 10 Gb/s with OOK modulation. For the 40 Gb/s case with DPSK modulation, preliminary studies including only ASE noise have been performed.

Therefore, parts of T3.3.1 and T3.3.2 have been achieved. The Q-Tool will be validated in the first few months of 2009, using the experimental data from T3.2 (see T3.2.1), and thus T3.3.3 has not started yet.

Significant results:

A milestone was published (as a preliminary version of the deliverable D3.3 – July 2008), to state what analytical models will be used to incorporate physical layer impairments in the Q-Tool. A Q-Tool was coded and its signature was released within the DICONET project for other workpackages to plan for compatibility accordingly. In addition, preliminary architectures compatible with several control plane choices (a centralized approach based on PCE and a distributed approach based on a hybrid signalling/routing architecture) that show the interaction of the network planning/operation tool (the central component of DICONET) were defined. Please refer to Figure 3 and Figure 4 for an illustration of each architecture.

The task started early, but this will have no impact in terms of resources/planning.

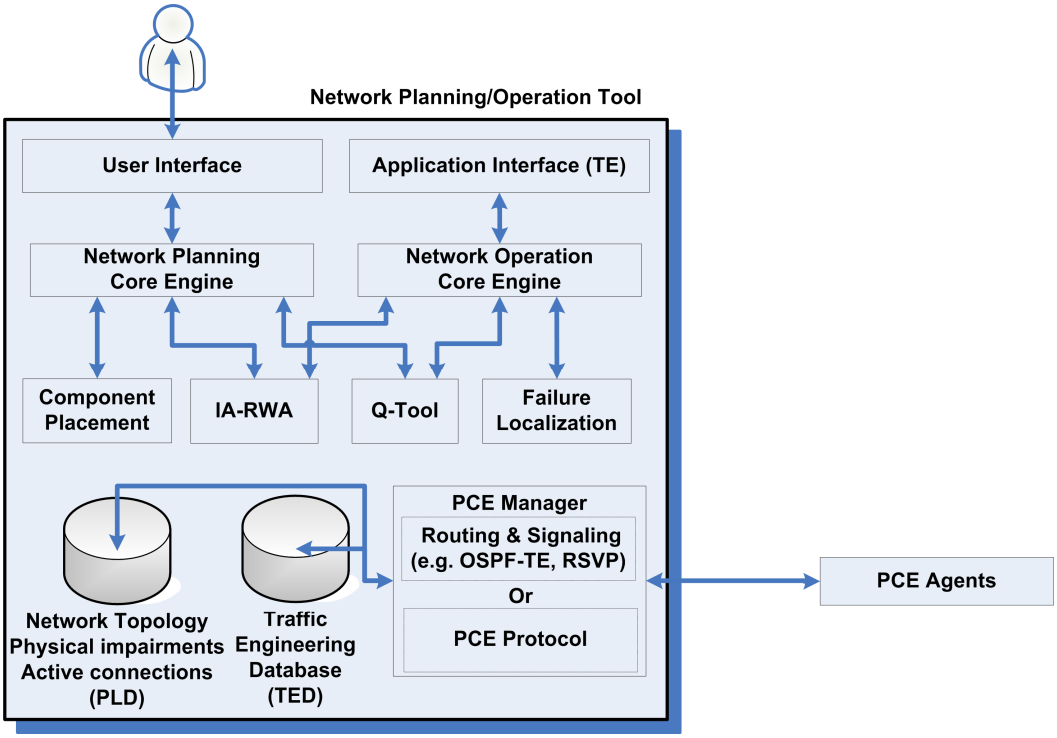


Figure 3: Interactions of the network planning and operation tool with other components designed in the DICONET project – Centralized/PCE control plane case.

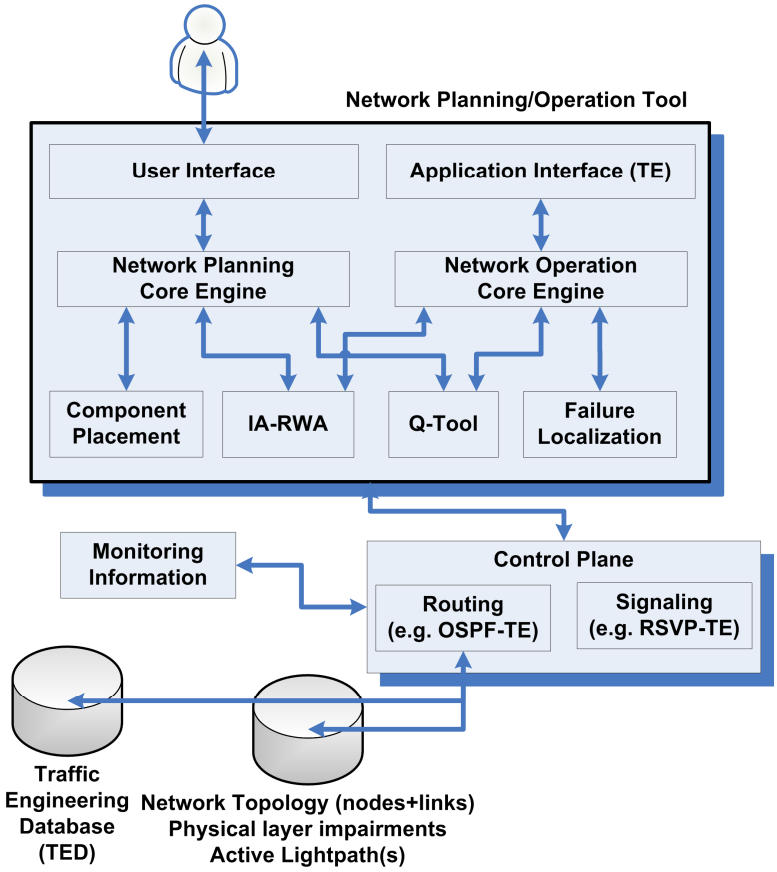


Figure 4: Interactions of the network planning and operation tool with other components designed in the DICONET project – Distributed/hybrid control plane case.

3.3 WP4 - Development of algorithms

WP4	**Start date:** M7 - **End date:** M24
Activity type	RTD
WPL	RACTI
Sub-tasks	Task 4.1 - Impairment aware offline RWA routing of multiple connections [RACTI]
	Task 4.2 - Impairment aware multi-constrain RWA for QoS routing of individual connections [RACTI]
	Task 4.3 - Optimization algorithms for component placement [ENST]
	Task 4.4 - Failure localization algorithms to enable resiliency [ENST]
Deliverables / Y1	D4.1 Offline Impairment aware RWA algorithms [M12]
Milestones / Y1	M4.1- Identify important network parameters that must be considered in the design of the routing and wavelength assignment algorithms for QoS routing.[M09]

Participant MM expenses – Total Project (TP) / Cumulated expenses Year 1 (CE)

JPC		**AIT**		**Create-NET**		**ENST**		**Huawei**		**IBBT**		**RACTI**	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE
-	-	16.8	4.1	-	-	28	19,8	-	-	12	0,25	20	6,11

UEssex		**UPC**		**ADVA**		**DTAG**		**ALF**		**ECI**		***TOTAL***	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	*TP*	*CE*
-	-	6	3,5	-	-	3	0,95	8	8	11	1,25	***104,8***	*43,92*

WP4 focuses on the design, development and testing of impairment-aware routing and wavelength assignment algorithms for quality of service routing. In particular, the main objectives are to design, develop and test:

- ✓ Routing and Wavelength Assignment (RWA) algorithms both for the offline (static) and the online (dynamic) case that take into account the signal impairments (IA-RWA) and constrain the routing of wavelength channels according to the variable physical characteristics of the dynamic optical network paths.
- ✓ Strategies for regenerator placement with the goal to best enable optimum performance at minimum cost for a high-speed reconfigurable network.
- ✓ Algorithms for efficient failure localization, which are based on physical layer information received by the network management system.

These objectives were successfully achieved within this first period's plan.

Task 4.1 Impairment aware offline RWA routing of multiple connections (M7-M12)

Fulfils: objective 1 – Development of Impairment Aware RWA Algorithms

Task 4.1 was scheduled to last from M06 to M12. It has now ended, with the release of Deliverable D4.1 on 30 December 2008.

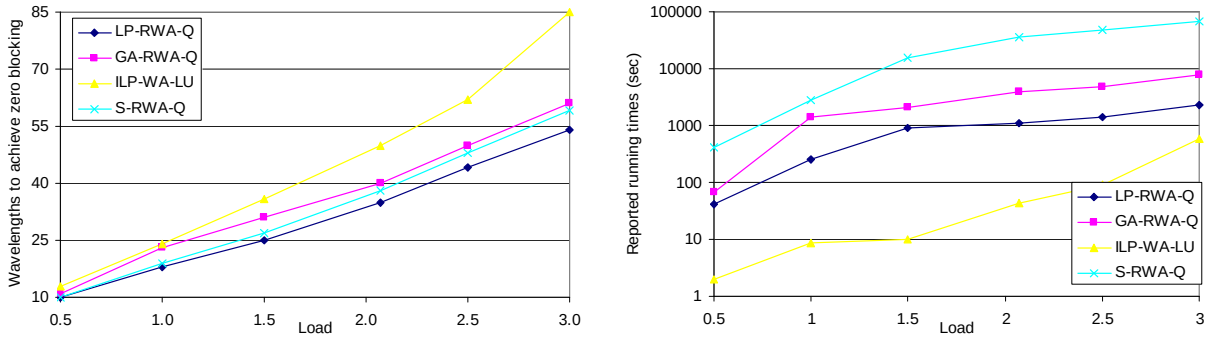
In accordance with the Technical Annex of DICONET project, Deliverable D4.1, addresses the offline impairment-aware Routing and Wavelength Assignment (RWA) task in optical WDM networks. This corresponds to a static traffic scenario where the set of connection requests that have to be served are known in advance and the RWA operations are performed offline. The objective is to assign routes and wavelengths to the demands so as to serve the given traffic matrix and satisfy impairment constraints, while minimizing at the same time some performance criterion of interest, such as the number of different wavelengths used. The main contribution of this deliverable is the development of a series of novel impairment aware (IA)-RWA algorithms that consider both linear and nonlinear impairments and provide improved network and physical layer performance. The RWA algorithms developed take into account the Quality of Transmission of the lightpaths as estimated by the Q-factor models developed in WP3.

Significant results:

The main contribution of deliverable D4.1 is the development of a series of novel impairment aware (IA)-RWA algorithms that consider both linear and nonlinear impairments and provide improved network and physical layer performance. Most of these algorithms have already been accepted to be published, while the remaining are in the submission phase.

In Section 2 of D4.1 we presented new algorithms for solving the pure (i.e., without impairments) offline RWA task with the objective of minimizing the number of used wavelengths. In particular we presented pure RWA algorithms that are based on linear program (LP)-relaxation formulations and on Genetic Algorithms. Our results indicated that both approaches provide good solutions to the pure RWA task in an acceptable (non-exponential) time frame.

In Section 3 of D4.1 we presented a number of novel offline IA-RWA algorithms for transparent WDM networks. Considering physical layer impairments in offline RWA is particular difficult, since it involves the joint assignment of lightpaths to the connections requests, and interference among the selected lightpaths cannot be avoided once the solution has been found. In particular, we presented two algorithms that are based on LP-relaxation formulations, an integer linear program (ILP) algorithm, two algorithms based on Genetic algorithm (multi-objective and single objective), and one heuristic algorithm that solves the offline traffic engineering task in a sequential manner. A comparison of these algorithms was performed under realistic network and traffic parameters, using a common Q estimator tool (Q-Tool) developed within the DICONET project (Task 3.3). Our experiments showed the applicability of these algorithms to real scale experiments and networks. Figure 5 shows an example of the performance results obtained for some of the proposed algorithms for the generic German network (“DT Network”) topology.



(a) **(b)**

Figure 5: Comparison of the proposed algorithms under realistic network and traffic parameters, in the generic German network ("DT Network") topology. Load equal to 1 corresponds to a traffic matrix where there is one lightpath demand for each source-destination pair. a) The number of wavelengths used in order to achieve zero blocking. b) The running times of the algorithms.

Finally, in Section 4 of D4.1 we considered the offline routing and wavelength assignment task in translucent WDM networks, where regenerators are also available, in the presence of physical impairments. In such a network there is the additional challenge of choosing the connections that have to be served using regenerators and the sequence of regenerators these connections are going to use (the regeneration assignment or RA task). We initially presented an ILP algorithm that jointly considers the IA-RWA and the regenerator assignment (RA) tasks. This algorithm was shown to exhibit good performance, but, due to its complicated and heavy ILP formulation, it does not scale well and is applicable only to small network scenarios. To overcome this drawback, we decomposed the IA-RWA-RA task into its constituent RA and the IA-RWA sub-tasks, and we presented a series of algorithms to solve the RA task by transforming it into a virtual topology problem. Then we use IA-RWA algorithms designed for transparent networks to route the connections. Our performance results indicated that these algorithms can provide efficient solutions to medium and large scale realistic networks under realistic traffic and regeneration placement scenarios with satisfactory execution times.

The research performed in Task 4.1 resulted in a number of conference and journal papers.

Task 4.2 Impairment aware multi-constrain RWA for QoS routing of individual connections (M7-M18)

Fulfils: objective 1 – Development of Impairment Aware RWA Algorithms

Task 4.2 is scheduled to last from M06 to M18.

In the context of this task, several online algorithms are being developed. These algorithms will be evaluated under common scenarios and their performances will be compared in order to choose the best performing ones.

In particular, we are developing two types of online multicost IA-RWA algorithms: one based on parameters that affect impairments (number of hops on the path, path length, number of other paths causing cross-talk, etc), and one based on noise variances (sigma bound). The first type of algorithm takes impairments into account indirectly (through appropriate parameters that affect impairments), while the second type of algorithm takes impairments into account directly (through an estimate of the noise variance they create). The development of the multicost algorithm which is based on the noise variances has finished and a related paper has been accepted for publication at the ICC 2009

conference. Rerouting connections, whose quality of transmission performance deteriorates due to the establishment of new lightpaths, were also evaluated. We will extend this algorithm to function in the presence of 3R regenerators (translucent networks).

We have also started working on enhancing and adapting offline algorithms (presented in Deliverable D4.1) to consider the multiple costs of the links and we try to find a solution for merging these costs, for the final (on-line) lightpath selection. Moreover, an online algorithm will be proposed that, given a limited number of regenerators at selected nodes, decides about the lightpaths to be taken by a new (dynamic) connection, taking physical impairments into account, so as to minimize the blocking probability. This algorithm will be based on the PBR (Prediction Based Routing) and the BBOR (BYPASS Based Optical Routing) concepts. Other online IA-RWA algorithms in the presence of regenerators will also be considered.

Furthermore, we are working on the accuracy of the Q-Tool and on its sensitivity to uncertainties in the actual values of the parameters involved. This work could also be useful in finding a safety margin for the Q-factor that could be used by the online algorithms in making their decisions.

Significant results:

A milestone M4.1 was released on M09, identifying the important network parameters that must be considered in the design of the routing and wavelength assignment algorithms for QoS routing.

Since the task is in progress most algorithms are still in development phase. Performance results on the sigma bound multicost online IA-RWA algorithm show that its performance is promising for the traffic scenarios it has been tested on.

Task 4.3 Optimization algorithms for component placement (M13-M24)

Fulfils: objective 2 – Optimum equipment (regenerators & monitors) placement

Task 4.3 is scheduled to last from M13 to M24.

This task started earlier than planned in order to perform some first investigations and to support other workpackages. Doing so, we have performed a literature review on regenerators and monitors placement. Moreover, we are developing a new heuristic, called CORPAM (Cross Optimization for Regenerator Placement and Monitoring), for routing and regenerator placement with the double-objective to minimize the total number of regenerators and the number of regeneration's sites. The performance of this algorithm is under evaluation.

Significant results:

Most algorithms are still in the planning, development or the evaluation phase and thus no significant results have been completed at this stage.

Task 4.4 Failure localization algorithms to enable resiliency (M13-M24)

Fulfils: objective 3 – Study of failure localization algorithms to enable resiliency

Task 4.4 is scheduled to last from M13 to M24.

This task started earlier than planned in order to perform some first investigations and to support other workpackages. Doing so, we have performed a literature search on fault localization and optical monitoring problems. Also, we implemented an integer linear program (ILP), proposed in the literature, that aims to define optimal monitoring trails in order to locate any fault or break in the network. Our goal is to test this program and study the ability to integrate new constraints related to physical impairments issues.

Significant results:
Most partners are planning their contributions while some algorithms are still in the development or the evaluation phase and thus no significant results have been completed at this stage.

3.4 WP5 - Network Management and Control Protocols

WP5	**Start date:** M7 - **End date:** M24
Activity type	RTD
WPL	Create-NET
Sub-tasks	Task 5.1 - Definition of the interface between monitors and the control plane [UPC]
	Task 5.2 - Implementation of modifications to G-MPLS control plane protocols via emulated nodes [Create-NET]
Deliverables / Y1	D5.1 - Definition of interface between monitors and the control plane and requirements **[**M12**]**
Milestones / Y1	M5.1 - Definition and development of the interface between monitors and the control plane [M09]

Participant MM expenses – Total Project (TP) / Cumulated expenses Year 1 (CE)													
JPC		**AIT**		**Create-NET**		**ENST**		**Huawei**		**IBBT**		**RACTI**	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE
-	-	7	3	24	-	-	-	11	3,2-	-	-	-	-
UEssex		**UPC**		**ADVA**		**DTAG**		**ALF**		**ECI**		***TOTAL***	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	*TP*	*CE*
8	3,74	9	4	-	-	-	-	3	3	4	4,05	***66***	*20,99*

According to the Annex I, the objectives of WP5 “Network Management and Control Protocols” are as follows:

- To define the interface between monitors and the control plane.
- To propose extensions to G-MPLS protocols (RSVP, OSPF, LMP) for impairment aware networking.
- To implement the modifications to G-MPLS control plane protocols via emulated nodes.
- To port the developed protocol extensions inside the testbed activities.

These objectives were successfully achieved within this first period's plan.

WP5 has two tasks - T5.1 dealing with "Definition of the interface between monitors and the control plane" which has started in M7 and ended in M12 and T5.2 dealing with "Implementation of modifications to G-MPLS control plane protocols via emulated nodes" which has started in M12 and will end in M24. Few changes were done to the work packages as discussed in detail in task description below. Task 5.1 has successfully completed and Task 5.2 is going inline with schedule. Several important decisions were taken and are described in detail in each of the task descriptions below.

Task 5.1 Definition of the interface between monitors and the control plane [M7-M12]

Fulfils: Objective 8 - Protocol extensions to enable an IA-control plane

With respect to the DoW, two major changes can be highlighted.
UPC substituted ECI as leader of Task 5.1 in month 4 during the Darmstadt meeting. As a consequence, UPC substituted Create-NET as the editor of the milestone M5.1 "Definition and development of the interface between monitors and the control plane" and deliverable D5.1 "Definition of interface between monitors and the control plane and requirements".
UEssex participated and contributed in this task with reference to requirements for Task 6.2 which is lead by UEssex. UEssex contributed in interfacing the hardware accelerator to the control plane architecture and proposed a solution to incorporate the reconfigurable logic hardware in the interface between monitors and control plane.
The overall work performed during these 12 months is reflected in D5.1.
The deliverable presents the definition of the interfaces between Optical Impairment Monitor and Optical Performance Monitor (OIM/OPM) and the Generalized Multiprotocol Label Switching (GMPLS) control plane and the Network Management System (NMS). A schematic architecture considered in the DICONET project is presented taking into account all approaches proposed in DICONET project: PCE model, signalling model, routing model, and hybrid (signalling/routing) model. This schematic architecture does not try to define the DICONET architecture but its aim is to highlight the location of the different interfaces and their purposes. In particular, several interfaces between various modules of the architecture is defined to handle the management of information from monitors.
An analysis on the relationships between OIM/OPM and CP/MP for different application scenarios is discussed. These scenarios were originally introduced in Deliverable D2.2. In that deliverable, for each scenario the monitoring requirements in terms of acquisition speed and accuracy are given to accomplish the DICONET goals. In Task 5.1, we try to understand when and what CP/MP and OPM/OIM communicate with each other to obtain the necessary information. More emphasis is put on the interworking between GMPLS-CP and OPM/OIM since fast actions must be triggered in the CP.
According to these scenarios, 13 use cases are defined covering all relevant aspects: e.g. provisioning, fault localization, degradation detection, protection, restoration, network upgrading, and impairment mitigation. For each use case, the list of operations and messages interchanged is presented.

Finally, a brief background about general network management system is provided followed by the sub-system definitions and descriptions. An example of conventional network management architecture adopted in the ECI network management-network element interface is illustrated. Among these different interfacing protocols and management systems, we define a unified functional architecture of the interfaces based on a middle-box. The middle-box is a software/hardware translator; its aim is to aggregate and temporarily store the information provided by the OIM/OPMs, translate any protocol to standard XML language and deliver the information to the CP/MP in continuous, periodical, or programmable time.

Task 5.2 Implementation of modifications to G-MPLS control plane protocols via emulated

Fulfils: Objective 8 - Protocol extensions to enable an IA-control plane

This task has started in December 2008. The objective of this task is to define extensions required to GMPLS protocol stack and implement them in emulation environment. In the Ghent meeting (September 2008), all partners agreed to use DRAGON software to be used for GMPLS protocol extensions. DRAGON architecture is based on open source GMPLS protocols to leverage to develop and demonstrate the power and flexibility of hybrid packet switched networks and circuit switched networks and used for provisioning the connections across the domain boundaries. As DICONET project is pursuing and extending several GMPLS protocols, it was decided to make use of existing software modules. The partners involved in T5.2 have downloaded and got acquainted with DRAGON software together with definition of protocol extensions. The major decisions taken are 1) Create-NET will implement RSVP-TE based approach and minimal modifications to OSPE-TE to arrive at hybrid approach. 2) IBBT is investigating the PCEP approach in T2.3 and Huawei/UEssex will further build on IBBT results and 3) Huawei and UEssex will work on centralized PCE based approach using OSPF-TE based approach. The work is going ahead according to the DoW.

3.5 WP6 - Lab Experimentation, evaluation and testbed implementation

WP6	**Start date:** M16 - **End date:** M30
Activity type	RTD
WPL	UPC
Sub-tasks	Task 6.1 Experimental assessment of DICONET concepts [UPC]
	Task 6.2 Protocols Implementation on FPGA hardware [UEssex]
	Task 6.3 Network planning tools evaluation and experimentation [AIT]
Deliverables / Y1	None
Milestones / Y1	None

Participant MM expenses – Total Project (TP) / Cumulated expenses Year 1 (CE)						
JPC	**AIT**	**Create-NET**	**ENST**	**Huawei**	**IBBT**	**RACTI**

TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE
-	-	4	0	4	-	-	-	-	-	-	-	-	-
UEssex		**UPC**		**ADVA**		**DTAG**		**ALF**		**ECI**		***TOTAL***	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	*TP*	*CE*
23	8,50	21	1	7,5		3.5	0	-	-	6	-	***69***	*9,5*

Discussions about partner's roles in WP6 were done during the Paris kick-off meeting. The effort of the different partners on the Tasks was revised. Only one remarkable change was done: 3.5 PMs from DTAG assigned to T6.1 in the initial DoW were moved to T6.3. Also the possibility to move equipment from other partners to UPC Labs during experiments was discussed. Some work about the interactions between the three WP6 tasks was also done.

Although no activities within WP6 were planned in 2008, some preliminary work has been carried out, so some resources have already been spent. This work mainly concerns the preparation of the test-bed as well as a preliminary review of the different tasks in order to advance and prevent possible problems during the active phase of WP6. As WP6 has to experimentally assess concepts derived from other WPs, it is of capital importance having a clear vision about what is going to be experimented. In this way, work plans for the different tasks have been drafted and discussed, as well as interaction with other WPs.

Next paragraphs show the work performed in each task.

Task 6.1 Experimental assessment of DICONET concepts [M16-M26]

Fulfils: Objective 9 - Verification of the DICONET tools, algorithms and protocols

The initial preparation of test-bed has been carried out. Different issues have been revised. How to integrate the OPM elements to the nodes has been analysed. Test-bed preparation for later inclusion of WP3-WP5 results has also been done. Finally, preparation of procedures allowing the integration of the different IA-RWA algorithms on the UPC control plane has started.

Discussions and decision on the GMPLS stack to be used (this issue also affects WP5, so Create-NET actively participated in this discussions). UPC has started working on the guidelines allowing the access to its GMPLS stack in an easy way. Initial work on preparation of a C language source code skeleton together with a set of libraries (topology, nodes, metrics, etc.), to allow DICONET partners working on the UPC test-bed was done.

During the second half of 2008, UPC has started working on the scheme of the planned experimental scenario, and on the drafting of the expected test-bed characteristics. A first draft of the DICONET test-bed characteristics was delivered for discussion in October.

Task 6.2 Protocols Implementation on FPGA hardware [M18-M30]

Fulfils: Objective 9 - Verification of the DICONET tools, algorithms and protocols

As an initial work, decisions on the Protocol Hardware Accelerator (PHA) and software to be used for DICONET have been taken. Below is a summary of the work that had been done:

- Work with WP5 regarding the PHA positing and its interfaces in DICONET control plane architecture. Result of this work has been reflected in wp5 deliverable (D5.1) and milestone (M5.1).

- Study outcome of WP3, WP4, WP5 with respect to speed requirements and identify potential processes in the DICONET protocols that can benefit from PHA
- Study and compare commercially available Network Processor evaluation board and FPGA technologies suitable for WP6 (test-bed implementation).
- Obtain a suitable hardware platform for protocol implementation.
- Initial preparation of the hardware platform for protocol implementation.

Furthermore a detailed workplan for this task has been prepared. The work in this task has been split in three subtasks:

Task 6.2.1 protocols requirements analysis for HW accelerator

We plan to identify and analyse processing intensive and time consuming processes of DICONET protocols including Q-Tool, Online QoS-based routing algorithm and DICONET GMPLS stack. This task specifically focuses on identifying time critical parts of process and protocols for DICONET online algorithms.

Task 6.2.2 Design and implementation of the protocol hardware accelerator

In this task, outcome of task 6.2.1 will be used to implement most time critical parts of the DICONET algorithms in a PHA based on advanced FPGA and multiple embedded processors.

In the first year, this sub-task has focused on indentifying and obtaining suitable Hardware Accelerator platform for PHA implementation.

Task 6.2.3 Test the developed hardware prototype in the UESSEX test bed and integrate the prototype into the final test bed in UPC.
In this sub-task, outcome of subtask 6.2.2 will be used first in UEssex optical test-bed to validate its functionality and later in UPC in DICONET test-bed to demonstrate and analyze the speed gain achieved through HW acceleration.

Task 6.3 Network planning tools evaluation and experimentation [M24-M30]

Fulfils: Objective 9 - Verification of the DICONET tools, algorithms and protocols

This task will start on M24. First discussions about the work plan have been carried out. The key point has dealt with the integration of the Q-Tool on the test-bed. The detailed work plan was finished during second quarter of the first project year.

3.6 WP7 – Dissemination & Exploitation

WP7	**Start date:** M1 - **End date:**M30
Activity type	RTD
WPL	ECI
Sub-tasks	Task 7.1 - Dissemination [JCP]
	Task 7.2 - Control Plane Extensions and Standardization [Huawei]
	Task 7.3 – Techno-economic Issues [AIT]
Deliverables / Y1	D7.0 – Project fact sheet [M0]
	D7.1 – Concept paper of DICONET [M12]

Participant MM expenses – Total Project (TP) / Cumulated expenses Year 1 (CE)													
JPC		**AIT**		**Create-NET**		**ENST**		**Huawei**		**IBBT**		**RACTI**	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE
2.5	1,24	7	1,99	2	0,93	1	0	8	2,04	9	0,3	3,5	0

UEssex		**UPC**		**ADVA**		**DTAG**		**ALF**		**ECI**		***TOTAL***	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	*TP*	*CE*
1	0,3	1	0,30	2	0,06	2	0,1	3	0,68	9	1,95	***51***	*9,82*

WP7 aims at addressing the exploitation and dissemination of the developed modules. The main objectives are as follow:

- ✓ Promote the project outputs through the participation in the technical exhibitions of major optical conferences and symposium.
- ✓ Disseminate the project results though the publications in scientific journals and magazines, presentation in international conferences and workshops as well as through lectures presented in academia, industry and EU policy makers.
- ✓ Coordinate activities toward possible contributions to standardization bodies.

Those tasks were successfully achieved within this first period.

Task 7.1 Dissemination

First of all, the website (described in 6.1.8) has been designed and delivered in January 2008, being an important tool for the DICONET dissemination activities. Other practical materials for dissemination was the DICONET factsheet production and, at the same time, a general poster presenting DICONET activities.

As presented in the tables below, during this first year, DICONET has been very active in dissemination; further actions can be also pointed out:

- DICONET was active and duly represented in the FP7 organized events and technical platforms activities
  - ✓ D1Concertation meetings in Brussels – [January 30th, 2008 and September 30 & October 1st]
  - ✓ First FP7 Future Networks Concertation Meeting – Brussels - March 11-12th 2008
  - ✓ "Future Internet Assembly" (FIA): DICONET was presented at the BLED conference [Slovenia -April 1st - 2nd, 2008], DICONET being one project signing the Bled declaration. DICONET was also represented at Madrid meeting (9-10 Dec 2008) and a paper has been submitted for the Prague meeting (May 2009)
- During ECOC 2008, a workshop called "All-Optical versus OEO Networks" has been organized under the auspices of EU Network of Excellence BONE and the support of EU projects TRIUMPH & DICONET
- Representation at the Meeting of future Internet cluster during Mobile Summit (Stockholm, June 10 to 12, 2008)
- Diconet had also its poster presented in NEM Summit (Saint-Malo- October 2008).
- All partners contributed in the writing of a Press Release that can be found on the partners' websites, as well as on the Cordis website; in addition, independent publications expressed their intention to relay information about the DICONET project when results are concretised.
- A "concept-paper" which summarizes the essence of the DICONET project in around 10 pages was submitted for publication in the IEEE Communication Magazine in August 2008 and is currently under review. An updated version of this paper was submitted to the Future of the Internet conference organized in Prague in May 2009 with the support of the European Commission. This updated version was then reformatted into a deliverable, D7.1, which was delivered on December 24, 08.
- During the first year, 16 papers, including 15 conferences, 1 journal, 9 peer-reviewed and 6 invited papers were presented or accepted for a presentation in 2009 (see Table 2 below)
- In addition, DICONET is sponsoring a technical session at the ONDM 2009 conference [Session 6: Provision and physical layer impairments (Sponsored by DICONET) and chaired by Matthias Gunkel, Deutsche Telekom, Germany [http://www.ida.ing.tu-bs.de/noncms/ondm2009/schedule/final_program.php]

Authors	Paper title/ Tutorial title	Name of journal, conference, etc.	Vol., no., pages, location	Date	Ref? (Y/N)
I.Tomkos	Network Planning for Dynamic Impairment Constraint Optical Networking: The Activities of DICONET EU Project.	OFC/NFOEC 2008 Planning Tools for Transparent Optical and Multilayer Networks (OsUc) Workshop	N/A	24 Feb. 08	N

Authors	Paper title/ Tutorial title	Name of journal, conference, etc.	Vol., no., pages, location	Date	Ref? (Y/N)
I.Tomkos, S. Azodolmolky, D. Klonidis, M.Angelou, K. Margariti	Dynamic Impairment Aware Networking for Transparent Mesh Optical Networks: Activities of EU project DICONET	ICTON 2008 (Conference)	Vol. 1, pp. 6-12.	22-26 June 08, Athens, Greece	Y
T. ZAMI	Robustness of Quality of Transmission Estimators for IC-RWA to Uneven Channel Powers in Core Optical Networks	ICTON 2008	TuB1.3,	22-26 June 2008, Athens, Greece	N
D. Monogios, K. Vlachos	On the use of genetic algorithms for solving the RWA problem employing the maximum quantity of edge disjoint paths	ICTON 2008	Vol 3., pp 154-157	22-26 June 2008, Athens, Greece	Y
K. Manousakis, K.Christodoulopoulos, E. Varvarigos	Avoiding Adjacent Channel Interference in Static RWA	CNSDSP 2008	pp. 552-556	23-25 July 2008, Graz, Austria	Y
K.Christodoulopoulos, K.Manousakis, E. Varvarigos	Comparison of Routing and Wavelength Assignment Algorithms in WDM Networks	IEEE GLOBECOM 2008	ON04W1-2	30 Nov. – 3 Oct, New Orleans, U.S.A., 2008	Y
T. Zami, A. Morea, F. Leplingard, N. Brogard	The relevant impact of the physical parameters uncertainties when dimensioning an optical core transparent network	ECOC 2008	Paper Wed.3.D.2, Brussels, BELGIUM	24 Sept. 2008	N
I. Tomkos, S.Azodolmolky, M. Angelou, D. Klonidis, Y. Ye, C.V. Saradhi, E. Salvadori, A. Zanardi, R. Piesiewicz	Impairment Aware Networking and Relevant Resiliency Issues in All-Optical Networks	ECOC 2008	Vol.3, pp 183-186, Wed.3.D.1, Brussels, BELGIUM	24 Sept. 2008	N
K.Christodoulopoulos, K. Manousakis, E. A. Varvarigos M. Angelou, I. Tomkos	A Multicost Approach to Online Impairment-Aware RWA	IEEE ICC 2009	To appear	Jun 14-18, 2009, Dresden, Germany	Y

Authors	Paper title/ Tutorial title	Name of journal, conference, etc.	Vol., no., pages, location	Date	Ref? (Y/N)
K. Vlachos A. Siokis	A Service-Transparent and Self-Organized Optical Network Architecture	IEEE ICC 2009	To appear	Jun 14-18, 2009, Dresden, Germany	N
K. Vlachos, D. Monoyios, M. Angelou, I. Tomkos	On the use of Multi-Objective Optimization Algorithms for solving the Impairment Aware- RWA problem	IEEE ICC 2009	To appear	Jun 14-18, 2009, Dresden, Germany	Y
S. Azodolmolky, Y. Pointurier, M. Angelou, J. Solé Pareta, and I. Tomkos	An Offline Impairment Aware RWA Algorithm with Dedicated Path Protection Consideration	IEEE/OSA Optical Fiber Communication Conference (OFC)	San Diego, CA, USA	24-26 March 2009	Y
K. Manousakis, K.Christodoulopoulos, E. Varvarigos	Impairment-Aware Offline RWA for Transparent Optical Networks	IEEE INFOCOM 2009	To appear	April 19-25, 2009, Rio De Janeiro, Brazil	Y
S. Azodolmolky M. Klinkowski E. Marin D. Careglio, J. Solé Pareta, I. Tomkos	A Survey on Physical Layer Impairments Aware Routing and Wavelength Assignment Algorithms in Optical Networks	Computer Network journal	To appear	2009	Y
M. Yannuzzi, M. Quagliotti, G. Maier, E. Marín-Tordera, X. Masip-Bruin, S. Sánchez-López, J. Solé-Pareta, W. Erangoli, G. Tamiri	Performance of translucent optical networks under dynamic traffic and uncertain physical-layer information	13th International Conference on Optical Networking Design and Modeling (ONDM 2009)	Braunschweig, Germany	18-20 February 2009	Y
V. S. Chava S. Subramaniam	Physical Layer Impairment Aware Routing (PLIAR) in WDM Optical Networks: Issues and Challenges	IEEE Communications Society Surveys and Tutorials	To appear	2009	Y

Authors	Paper title/ Tutorial title	Name of journal, conference, etc.	Vol., no., pages, location	Date	Ref? (Y/N)
V. S. Chava A. Zanardi, S. Dalsass, E. Salvadori and R. Piesiewicz	Performance of Impairment Aware End-to-End Failure Recovery in Transparent WDM Optical Networks	IEEE/OSA Optical Fiber Communication Conference (OFC)	To appear	24-26 March 2009	Y
F. Leplingard, A. Morea, T. Zami, N. Brogard	Interest of an Adaptive Margin for the Quality of Transmission Estimation for Lightpath Establishment	IEEE/OSA Optical Fiber Communication Conference (OFC)	San Diego, CA, USA	24-26 March 2009	Y
S. Azodolmolky, M. Klinkowski, E. Marin, D. Careglio, J. Solé-Pareta, Y. Pointurier, M. Angelou, I. Tomkos	On The Offline Physical Layer Impairment Aware RWA Algorithms in Transparent Optical Networks: State-of-the-Art and Beyond	13th International Conference on Optical Networking Design and Modeling (ONDM 2009) [invited paper]		18-20 february 2009	Y

Table 2 - List of published papers/ tutorials or accepted for publication / presentation

Task 7.2 Control plane extensions and standardization

The current status of the IETF standards related to DICONET project has been surveyed. The below table lists some of the drafts on wavelength switched optical network and their status in IETF. In general, the scopes of these drafts can be classified into two categories: routing and wavelength assignment (RWA) and impairment aware RWA (IA-RWA). Those drafts in the RWA category do not consider the physical impairments in the optical networks, while those drafts in the IA-RWA category consider impairment aware RWA for the optical control plane. In the first category, three drafts on RWA control framework, information model and wavelength labels have become WG drafts in IETF, which can help to facilitate the process of control plane extensions considering physical impairments. The other drafts are still ongoing discussion or to be discussed. The progress on control plane extensions considering physical impairments has to be synchronized with ITU-T for the physical impairment models standardization.

IETF draft name	Scope	Status
draft-ietf-ccamp-rwa-wson-framework-00	RWA	WG
draft-ietf-ccamp-rwa-info-01	RWA	WG
draft-ietf-ccamp-rwa-wson-encode-00	RWA	WG
draft-lee-pce-wson-routing-wavelength-03	RWA	Individual
draft-bernstein-ccamp-wson-signaling-03	RWA	Individual
draft-bernstein-ccamp-wson-impairments-01	**IA-RWA***	**Individual**
draft-bernstein-wson-impairment-info-00	IA-RWA	Individual
draft-martinelli-ccamp-opt-imp-fwk-00	IA-RWA	Individual

draft-ali-ccamp-rsvp-te-based-evidence-collection-01	IA-RWA	Individual
draft-martinelli-ccamp-optical-imp-signaling-01	IA-RWA	Individual

One draft from the DICONET project has been submitted to IETF in Oct. 2008 named “draft-bernstein-ccamp-wson-impairments-01”. This draft points out that the operation of optical networks can require a higher level of detail in the characterization of network elements, subsystems, devices, and cabling not typically encountered with today’s networking technologies. In addition, these physical characteristics may be important to consider during typical day-to-day operations such as optical path establishment and connection monitoring, as well as during the network planning, installation, and turn-up phases. Therefore, this draft discusses how the definition and characterization of optical fiber, devices, subsystems, and network elements contained in various ITU-T recommendations can be combined with common control and measurement plane and path computation element technologies to support IA-RWA in optical networks.

In activities to WP3.2, Q factor monitoring techniques and PMD measurement techniques have been analysed following the IEC SG86C related to this topic;

1. IEC 61280-2-11: Fibre optic communication subsystem test procedures, part 2-11: Digital systems – Average Q factor determination using amplitude histogram evaluation for optical signal quality monitoring.
2. IEC 61280-4-4: Fibre optic communication subsystem basic test procedures, part 4-4 : Fibre optic cable plant and links –Polarization mode dispersion measurements for installed links.
3. IEC 61282-9: Fibre optic communication system design guides – Part 9: Guidance on polarization mode dispersion measurements and theory.

The conclusions were reported in Deliverable 3.2.

Task 7.3 Techno-Economic issue

This task did not have significant activities during Year 1.
The milestone M7.3 originally announced for M12 in DoW will be provided in M24 as the task is only starting at M16. As practical implementations and experiments are expected to be ready or done in the later period of the project, it was decided to evaluate the techno-economic impact of the DICONET achievements and tools until the end of the project. Therefore, Task 7.3 will run until M30.

4. Deliverables and milestones tables

TABLE 1. DELIVERABLES

Del. no.	Deliverable name	WP no.	Lead participant	Nature	Dissem. level	Due delivery date Annex I	Delivered Yes/No	Forecast delivery date	Comments
D7.0	Project Fact sheet	WP7	AIT	R	PU	M00	Y	/	
D1.1	Project web site and continuous update	WP1	JCP	O	PU	M01	Y	/	www.diconet.eu
D1.2	Project Reference Manual	WP1	JCP	R	CO	M03	Y	/	
D1.3	Project Quality Insurance Manual	WP1	JCP	R	CO	M06	Y	/	
D1.4	Knowledge Management Guide	WP1	JCP	R	CO	M06	Y	/	
D2.1	Definition of dynamic optical network architectures	WP2	IBBT	R	PU	M06	Y	/	*
D3.1	Network impairments in transparent networks and definition of monitoring strategy	WP3	AIT	R	PU	M09	Y	/	*
D1.5	First year Annual Report	WP1	JCP	R	PU	M12	Y	M14	
D2.2	Planning and optimization aspects of dynamic optical networks	WP2	UPC	R	PU	M12	Y	/	*
D3.2	Results on impairments' effects and evaluation of the monitoring requirements for the planned strategy of monitoring schemes	WP3	AIT	R	PU	M12	Y	/	*
D4.1	Offline Impairment aware RWA algorithms	WP4	RACTI	R	PU	M12	Y	/	*
D5.1	Definition of interface between monitors and the control plane and requirements	WP5	UPC	R	PU	M12	Y	/	*
D7.1	Concept paper of DICONET	WP7	AIT	R	PU	M12	Y	/	*

***Remark: all the Public deliverables are available for download on the DICONET Website

TABLE 2. MILESTONES

Milestone no.	Milestone name	Due date From Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
M7.1	Dissemination of activities in the project's web site and continuous update	M01	**Y**	/	To be checked on http://www.diconet.eu
M3.1	Definitions of possible monitoring technologies according to network architectures	M04	**Y**	/	preliminary version of the deliverable D3.3 – July 2008
M2.1	Identification of network scenarios and possible routing approaches to be included in the studies of the proposal	M06	**Y**	/	
M7.2	Identification of possible contributions to standardization bodies and plans for dissemination	M06	**Y**	/	
M5.1	Definition and development of the interface between monitors and the control plane	M09	**Y**	/	
M4.1	Identify important network parameters that must be considered in the design of the routing and wavelength assignment algorithms for QoS routing	M09	**Y**	/	
M7.3	Identification and agreement upon future service requirements and demands and network model to be used in studies under economic impact and customer requirements	M12	**N**	**M24**	The milestone M7.3 originally announced for M12 in DoW will be provided in M24 as the task is only starting at M16

M3.2	Definition of network parameters and software platforms to be commonly used for developing the network planning tool	M12	**Y**	**M11**	Released as the "Q-Tool signature", containing required network parameters to compute Q factors. Software platform to be decided by M16 when actual coding starts.
M2.2	Recommendations on dissemination physical impairment info across the network	M12	**Y**		

5. Project management

WP1	**Start date** M1 - **End date** M30
Activity type	MGT
WPL	JCP-Consult
Sub-tasks	Task 1.1 - Project Organization and Management [JCP]
	Task 1.2 - Project Quality Management [JCP]
Deliverables / Y1	D1.1 – Project Website [M1]
	D1.2 - Project Reference Manual [M3]
	D1.3 - Project Quality Insurance Manual [M6]
	D1.4 - Knowledge Management Guide [M6]
	D1.5 - First year Annual [M12]

Participant MM expenses – Total Project (TP) / Cumulated expenses Year 1 (CE)													
JPC		**AIT**		**Create-NET**		**ENST**		**Huawei**		**IBBT**		**RACTI**	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE
15	5,96	1	0,47	1	0,9	0,5	0,39	0,5	0,36	1	0,3	1	-

UEssex		**UPC**		**ADVA**		**DTAG**		**ALF**		**ECI**		***TOTAL***	
TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	TP	CE	*TP*	*CE*
0,5	0,45	1	0,4	1	0,56	1.25	0,3	0,5	-	1	0,12	***25,25***	*10,21*

WP1 aims at addressing all the administrative and financial management of the project.

The main objectives are as follow:

- ✓ To establish appropriate relationships and communication channels with the funding actors as well as between consortium partners,
- ✓ To administrate the project resources, monitor the overall project performances and coordinate the several management tasks,
- ✓ To secure the Risk management,
- ✓ To report to the EU.

Those tasks were successfully achieved within this first period.

5.1 Task 1.1 - Project Organization and Management

During this first reporting period, WP1 coordinated the financial, legal and administrative work in the consortium.

Firstly, WP1 has addressed all the administrative matters relative to the launching of the project i.e.

- The distribution of the contract and Consortium Agreement,
- The budget distribution (agreement and payment)

- The installation of the Collaborative tool,
- The mailing lists,
- The templates of documents to be used during the project time life.

Further to the emails exchanges requested by the daily activity of the project (assistance to partners), WP1 assisted those who hosted the project meetings in organizing them (practical aspects as accommodation, list of attendees & agenda)

WP1 took care of the completion of the minutes and follow-up action items.

Further to the face-to-face meetings, WP1 helped in setting-up several conference calls on technical matters, and, when needed, on administrative matters.

With regards to the reporting matters, WP1 organized the monthly (internal purposes) and quarterly (contractual) reporting tools (templates and follow-up);

- ✓ the 1st Quarterly Management report (QMRM1-M3) has been delivered to the EC on May 23rd, 2008,
- ✓ the 2nd Quarterly Management report (QMRM4-M6)/released version has been delivered to the EC (draft version on July 25th, 2008) on August 29th, 2008,
- ✓ the 3rd Quarterly Management report (QMRM7-M9) has been delivered to the EC on November 25th, 2008.

DICONET being a project issued from FP7 - Call1, some new rules and processes with regards to FP6 had to be explained, the main ones concerning the URF process (Unique Registration Facility) and the NEF portal.

With regard to the legal aspect of the project, a General Assembly has been held during this first reporting year through teleconference and was mainly dedicated to financial decisions regarding payments.

The pre-payment has been received by JCP on 21/12/2007 and a first payment corresponding to the first year activity has been paid on 01/02/2008.

5.2 Task 1.2 - Project Quality Management

The consortium is fully aware that a high level of communication is one key factor of a collaborative project success; therefore regular project meetings were planned (see point 5.4 of this section);

In between those physical meetings, teleconferences (general and/or technical) have been organized: thus, decisions could be debated and progress towards deliverables achievements could be followed and improved.

The decision to provide internally a monthly report was agreed with the same objective: it allows each partner to check briefly that the work performed is on line with the expectation not only from a MM expenses point of view but also with the contractual deadlines and the technical orientation.

To assure the best quality level and respect of deadlines in its production, the consortium agreed on rules and procedures to achieve deliverables and deliveries. The D1.2 "project Quality Insurance Manual" delivered on July 1st 2008, describes the procedures to be followed if changes to the agreed specifications become necessary.

For instance, it has been decided that for each deliverable to be produced, at least 2 reviewers would be appointed inside the consortium companies: preferably, they are not

directly implicated in the project or at least they don't have been active in the deliverable to be produced. The Table 3 below summarizes the reviewers' participation.

Del. no.	Deliverable name		Reviewers
D7.0	Project Fact sheet	WP7	All partners included in Diconet
D1.1	Project web site and continuous update	WP1	All partners included in Diconet
D1.2	Project Reference Manual	WP1	All partners included in Diconet
D1.3	Project Quality Insurance Manual	WP1	All partners included in Diconet
D1.4	Knowledge Management Guide	WP1	All partners included in Diconet
D2.1	Definition of dynamic optical network architectures	WP2	Matthias Gunkel - DTAG Kyariakos Vlachos - RACTI
D3.1	Network impairments in transparent networks and definition of monitoring strategy	WP3	Michael Eiselt - ADVA
D2.2	Planning and optimization aspects of dynamic optical networks	WP2	Matthias Gunkel - DTAG Dimitri Staessens - IBBT
D3.2	Results on impairments' effects and evaluation of the monitoring requirements for the planned strategy of monitoring schemes	WP3	Maurice Gagnaire – ENST/IT Thierry Zami - ALU
D4.1	Offline Impairment aware RWA algorithms	WP4	Matthias Gunkel - DTAG Michael Eiselt - ADVA
D5.1	Definition of interface between monitors and the control plane and requirements	WP5	Reza Nejabati - UEssex Saradhi Chava – Create-NET
D7.1	Concept paper of DICONET	WP7	All partners included in Diconet
D1.5	First year Annual Report	WP1	All partners included in Diconet + Matthias Gunkel – DTAG Yvan Pointurier – AIT

Table 3 - Deliverables' reviewers list

5.3 Problems and solutions

No specific issue is to be reported. Some minor mistakes and/or inconsistencies in the Dow were pointed out and it was decided to have a revision to modify for instance:

- some timeline were not accurate (T7.3 ending on M26 with a deliverable on M30)
- some modifications in partners description of tasks within WP description, in order to provide a better quality of work in accordance with the partners competences.
- one modification on a Deliverable leader (D5.1)
- Some additional MM for some partners (DTAG for instance in WP1) to be able to intervene more accurately on requested work (but within the same budget level).

5.4 List of project meetings, dates and venues

- Kick-off in Paris (January 10 & 11, 2008) - hosted by ENST/IT
  Groupe des Ecoles des Télécommunications - ENST
  46, rue Barrault, 75634 Paris 13 – France

- Darmstadt (April 7-8-9, 2008) - hosted by T-Systems/DTAG
  T-Systems Enterprise Services GmbH

Deutsche-Telekom-Allee 7, 64295 Darmstadt - Germany

- Athens (June 26-27, 2008) - hosted by AIT,
Research and Education Laboratory in Information Technologies - AIT
Adrianiou 2 & Papada, 11525, Athens – Greece

- Ghent (September 17-18-19, 2008) - hosted by IBBT
Interdisciplinair Instituut voor BreedBand Technologie, VZW - IBBT
Gaston Crommenlaan 8, 9050 Gent - Belgium

5.5 Project planning and status

N°	Nom de la tâche
1	WP1 Project management
2	**WP2 Network architecture and support studies**
3	Development of dynamic optical network architectures
4	Indentification of network scenarios and possible routing approaches
5	Investigation of planning and optimization aspects
6	Recommendations on dissemination physical impairment info across the network
7	Investigation of techniques for disseminating physical impairement info
8	**WP3 Development of a network planning tool for dynamic traffic/impairements**
9	Efficient optical layer impairement monitoring and dissemination of information
10	Network modelling studies to evaluate the efficiency of monitoring schemes
11	Definition of network possible monitoring technologies according to network architectures
12	Definition of network parameters and software platforms to be commonly used for the development of the network planning tool
13	Development and evaluation of the network planning tool
14	**WP4 Development of a algorithms**
15	Impairment aware, multi-constrain RWA for QoS routing
16	Identify important network parameters that must be considered in the design of the routing and wavelengh assignment algorithms for QoS routing
17	Impairment aware offline RWA routing
18	Optimization Algorithms for component placement
19	Estimate the complexity of the proposed routing and wavelengh assignment algorithms and their implementation feasibility in the network planning tool
20	**WP5 Network Management and Control Protocols**
21	Definition of the interface between monitors and the control plane
22	Definition and development of the interface between monitors and the control plane
23	Modifications/extensions of G-MPLS control protocols extensions
24	Implement the proposed G-MPLS controls protocol extensions
25	Adopted solution for the control plane extension and implementation feasibility
26	**WP6 Lab Experimentation, evaluation and tesbed implementation**
27	Experimental assessment of DICONET concepts
28	Cheking of network test-bed availability and specification of tests to be carried out on the network planning tools evaluation
29	Protocols Implementation on FPGA
30	Decision on the GMPLS stack to be used
31	Network planning tools evaluation and experimentation
32	
33	**WP7 Exploitation Dissemination**
34	Dissemination
35	Dissemination of activities in the project's web site and continuous update
36	Control Plane Extensions and Standardization
37	Identification of possible contributions to standardization bodies and continuous update
38	Identification and agreement upon future service requirements and demands and network model to be used in studies under economic impact and customer requirements
39	Techno economic Issues

Projet : Diconet Gantt
Date : Lun 07/05/07

Tâche — Jalon — Tâches externes
Fractionnement — Récapitulative — Jalons externes
Avancement — Récapitulatif du projet — Échéance

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5.6 Impact of possible deviations from the planned milestones and deliverables

No deviation to be reported

5.7 Beneficiaries legal status

Deutsche Telekom AG: in 2008, the technical work of Deutsche Telekom AG was carried out by T-Systems Enterprise Services GmbH that acts as a third party of DTAG. The financial report presented by DTAG for 2008 will include all Forms C and a summary financial report for its subsidiary: T-Systems Enterprise Services GmbH.

Due to internal staffing changes the work will be done by Deutsche Telekom AG (DTAG) in 2009 and 2010 but no change in the key personnel contributing to the project is foreseen to during the complete project runtime.

Alcatel-Lucent Bell Labs France: a dedicated legal entity to host Alcatel Lucent Research activity in France has been created on December 1st, 2008 under the name of "Alcatel-Lucent Bell labs France" and is a 100% affiliate of Alcatel-Lucent France.

In accordance with French law, "ALCATEL-Lucent Bell labs France" is substituted to Alcatel-Lucent France for all rights and obligations related to its involvement in Diconet Project.

5.8 Project website

The DICONET website (www.diconet.eu) has been set-up at the very beginning of the project and was officially delivered to the EC (Deliverable D1.1) in January 2008.

Its goal is to appeal to a large audience to keep them informed upon the optical networking environment and related events.

Our intention is to present valuable information about the general news in the area, the events in the domain and the important headings of the European Commission and other related projects.

The web site / deliverables page also present our public deliverables that are available for download.

5.9 Use of Foreground

No commercial use of Foreground has to be reported after this first period of activities but as stated in Task 7.1, the DICONET consortium has been very active in disseminating the results achieved.

6. Explanation of the use of the resources

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 1 FOR THE PERIOD
JCP

Work Package	Item description	Amount	Explanations
WP1 & WP7	Personnel costs	43506 €	Personnel cost for 7,20 MM
WP1 & WP7	Subcontracting	5000 €	Corresponding to Website and collaborative tools
WP1	Major cost item "travel"	5666,42	Corresponding to Travel costs
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		5417242 €	

TABLE 3.2 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 2 FOR THE PERIOD
AIT

Work Package	Item description	Amount	Explanations
WP1, WP2, WP3, WP4, WP5 & WP7	Personnel costs	103546.19	
	Conferences	450	registration
	Travels	6907.93	Travel costs
	Depreciation costs	3289.96	depreciation cost for equipment purchased for the project
	Remaining costs	70,60	Hosting project meeting
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		114264.68	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 3 FOR THE PERIOD CREATE-NET			
Work Package	Item description	Amount	Explanations
WP2, WP5 and WP7	Personnel costs	35901,27 €	Personnel cost 7.7 MM
	Subcontracting		
	Travel	4152,42 €	Travels to DICONET meetings held in Paris, Darmstadt, Athens and Ghent
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		40053,69 €	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 4 FOR THE PERIOD ENST			
Work Package	Item description	Amount	Explanations
WP1	Personnel costs	1 572.93	
WP2	Personnel costs	3 670.17	
WP4	Personnel costs	4 3776.29	
WP7	Personnel costs	1 048.62	
	Subcontracting		
WP4	**TRAVELS**	4 335.68	
WP1	**MEETING DICONET**	1 360.44	
WP4	Remaining costs	629.71	
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		**56 393.84 €**	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 5 FOR THE PERIOD HUAWEI			
Work Package	Item description	Amount	Explanations
WP2, WP3, WP5, WP7	Direct personnel costs, R&D	68714 €	Direct costs for21.36 MM as reported in the QMR
WP1	Direct personnel costs, Mngmt	2632 €	Direct costs for0.54 MM as reported in the QMR
WP2-WP7	Indirect personnel costs, R&D	34357 €	Indirect costs for 21.36 MM as reported in the QMR
WP1	Indirect personnel costs, Mngmt	1316 €	Indirect costs for 0.54MM as reported in the QMR

	Travel expenses	1320 €	Traveling for meetings held in Paris, Darmstadt, Athens and Ghent.
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		108339 €	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 6 FOR THE PERIOD
IBBT

Work Package	Item description	Amount	Explanations
WP1	Personnel costs (mgmt)	3095	Personnel costs for 0.3 MM
WP2,4,7	Personnel costs (RTD)	56296	Personnel costs for 10.3 MM
	Subcontracting		
	Remaining costs	6411	DICONET related travel costs
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		65802	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 7 FOR THE PERIOD
RACTI

Work Package	Item description	Amount	Explanations
	Personnel costs	58400	Personnel costs for 19.11 MM
	Subcontracting		
	Travel and subsistence	6334.69	Diconet related travels
	Equipment	4023.83	
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		68758.52	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 8 FOR THE PERIOD
UESSEX

Work Package	Item description	Amount	Explanations
WP5-WP6	Personnel costs	15406.65	Research staff payment
	Subcontracting	0.00	
	Major cost item Materials	6086.66	FPGA boards, PC, software license
	Major cost item Travel	3081.70	Attended project meetings
	Remaining costs	14745.01	

TOTAL DIRECT COSTS AS CLAIMED ON FORM C	39320.02	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 9 FOR THE PERIOD
UPC

Work Package	Item description	Amount	Explanations
1,2,4,5,6	Personnel costs	87794.72	Amount corresponding to the 14.52MM reported in the QMR
	Subcontracting		
	Travel and subsistence	4947.63	Travels to DICONET meetings held in Paris, Darmstadt, Athens and Ghent
	Major cost item 'Y' ……..		
	Remaining costs		
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		92742.35	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 10 FOR THE PERIOD
ADVA

Work Package	Item description	Amount	Explanations
1,2,3,7	Personnel costs	68,779.00	Personnel costs for 9.39 MM
	Subcontracting		
	Travel costs	3,384.00	Travel to DICONET meetings held in Paris, Darmstadt, Athens and Ghent
	Major cost item 'Y' ……..		
	Remaining costs		
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		72,163.00	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 11 FOR THE PERIOD
DTAG

Work Package	Item description	Amount	Explanations
WP2-WP7	Direct personnel costs, R&D	58.132,56 €	Direct costs for 7,9 MM as reported in the QMR
WP1	Direct personnel costs, Mngmt	2.207,57 €	Direct costs for 0,3 MM as reported in the QMR
WP2-WP7	Indirect personnel costs, R&D	21.449,60 €	Indirect costs for 7,9 MM as reported in the QMR

WP1	Indirect personnel costs, Mngmt	814,54 €	Indirect costs for 0,3 MM as reported in the QMR
	Travel expenses	4.526,69 €	Travel tomeetings held in Paris, Athens and Ghent; hosting a meeting in Darmstadt
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		87.130,96 €	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 12 FOR THE PERIOD
ALF

Work Package	Item description	Amount	Explanations
WP2, 3, 4, 5	Personnel costs, R&D	241.427,99	Personnel costs for 33,26 MM
	Subcontracting		
WP 3	Equipments	26.645,52	
	Travel costs	4.285,51	meetings held in Darmstadt, Athens, Ghent
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		272.359,02	

TABLE 3.1 PERSONNEL, SUBCONTRACTING AND OTHER MAJOR COST ITEMS FOR BENEFICIARY 13 FOR THE PERIOD
ECI

Work Package	Item description	Amount	Explanations
1,2,3,4,5,7	Personnel costs	156,390	Personnel cost for 24.3 MM as reported in the QMR
	Subcontracting		
	Flights & meeting costs	3,255	
TOTAL DIRECT COSTS AS CLAIMED ON FORM C		159,645	

7. Financial statements – Form C and Summary financial report

A separate financial statement from each beneficiary together with a summary financial report which consolidates the claimed Community contribution of all the beneficiaries in an aggregate form will be provided through the NEF tool.

According to Article II.4.4 of the Grant Agreement, no certificate on financial statements shall be submitted by the any beneficiaries as the requested grant threshold of 375 000 € has not been reached.

8. Certificates

Beneficiary	Organisation short name	Certificate on the financial statements provided? yes / no	Any useful comment, in particular if a certificate is not provided
1	JCP	no	Expenditure threshold not reached
2	AIT	no	Expenditure threshold not reached
3	Create-NET	no	Expenditure threshold not reached
4	IT	no	Expenditure threshold not reached
5	Huawei	no	Expenditure threshold not reached
6	IBBT	no	Expenditure threshold not reached
7	RACTI	no	Expenditure threshold not reached
8	UEssex	no	Expenditure threshold not reached
9	UPC	no	Expenditure threshold not reached
10	ADVA	no	Expenditure threshold not reached
11	DTAG	no	Expenditure threshold not reached
12	ALF	no	Expenditure threshold not reached
13	ECI	no	Expenditure threshold not reached

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