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The STRONGEST NEWS

Periodic newsletter based on views and achievements from the FP7 STRONGEST project

Hot topics

What's going on in STRONGEST?

STRONGEST—a year later

Contents

What's going on in STRONGEST?

STRONGEST has just completed its first year of activity, and is moving resolutely towards its main objective, i.e. the design and demonstration of an innovative transport network architecture compatible with access rates of 100 Mbit/s in 2015 and 1Gbit/s in 2020. The first moves towards the achievement of this goal have been done by defining five evolutionary steps that, starting from the current network architecture, based on an IP network and an underlying independent circuit layer, at first integrate packet with circuit layers, and then progressively eliminate the IP transit routers from the core network. In parallel to this evolution of the data plane, it is essential that an adequate control platform is introduced, capable of managing thousands of connections, for set-up, tear down and parameter modifications. Furthermore, the identification of efficient OAM mechanisms, to monitor the connection status and to quickly detect failures, is necessary to complete the devised network solution. In its first year of activity STRONGEST has at first qualitatively analyzed the envisaged architectural steps, and then has verified their feasibility; in parallel, an innovative control platform architecture has been intensively studied and provided. To summarize, during 2010 the Project has laid the basis of an innovative transport network by precisely defining its target architecture and by starting a quantitative analysis to demonstrate that such a solution will eliminate the current scalability and flexibility bottlenecks, furthermore enabling energy and cost savings. During the past year, finally, STRONGEST has set four test-beds and planned the experimental activities that will be essential to validate the proposed architecture and node solutions .

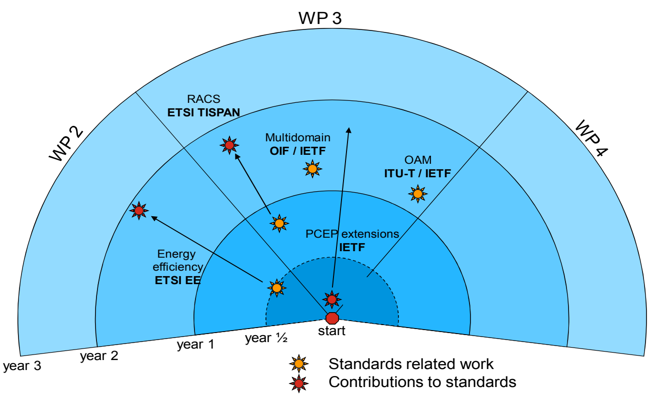
During the first year of activity the Project has laid the basis of an innovative transport network by precisely defining the target architecture and by starting a quantitave analysis to demonstrate the merits and advantages of the STRONGEST solution.

STRONGEST in Standardization Bodies

STRONGEST is watching carefully the main international standardization bodies, i.e. ETSI, IETF, ITU-T and OIF, that are relevant to the technical scope of the project and that could be impacted by the project outcomes in such areas as future internet and optical networks.

During the first year, almost all STRONGEST standardization activity was focused on the IETF, where substantial progress was made in the area of PCEP extensions to GMPLS.

Other standards-related activities remain in a preparatory phase, with intentions to move to relevant standardization bodies in the second year after some more progress has been made in the Project. These include work on resource and admission control in relation to path computation elements and on energy efficiency and power consumption of network elements. In addition, there are several other candidate areas for standards activity, where initial proposals have been made.



Map of STRONGEST standardization contributions

The cooperation with standardization bodies can have a variety of benefits for STRONGEST: for ongoing work, it ensures the full awareness of activities carried out at those bodies and is a valuable source of technical feedback from a large pool of interested experts. For completed work, the inclusion in standards is a very concrete form of dissemination, placing it in a position where it will form the basis for actual implementations, later on. Standardization-oriented activities that are carried out by STRONGEST in its various technical areas are described in the following.

Energy efficiency and power consumption

The reduction of the energy consumption in telecommunication networks through efficient combination of optical and electrical components is one of the key topics of STRONGEST, that is working to find an energy efficiency metric suitable to its target networks, and to define a model similar to the cost model which permits designing and optimizing a network from an energy consumption point of view.

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If you wish to get in touch with us, please contact: contact-strongest@ac.upc.edu.

STRONGEST in Standardization Bodies *(continued)*

A first presentation of the STRONGEST project and its goals has been made to ETSI *Environmental Engineering* (EE), and a liaison exchange has been started in order to gain access to latest ETSI work and to inform EE about positions and developments at STRONGEST. It is expected that STRONGEST extensions to the metric will be contributed to ETSI EE once the work has sufficiently progressed.

In parallel, work carried out in ITU-T Study Group 5, Question 20, will also be monitored.

Resource and admission control

In order to coordinate end-to-end quality of service while crossing domain boundaries, it has been proposed inside the Project to use the *Resource and Admissions Control Subsystem* (RACS) from ETSI TISPAN as a control layer functional element. The objective is to define a complete Control-Layer and Control-Plane architecture, which is also applicable in a more complex inter-domain and inter-carrier environment.

Originally, TISPAN RACS was geared towards resource control in an access network. Core network aspects have only been included recently and are mostly limited to intra-domain applications. In order to adapt RACS to the STRONGEST architecture, its scope has to be extended to take account of PCE and MPLS control elements.

A first contact with ETSI TISPAN has been made, and it is intended to present STRONGEST there in the next year. Once a suitable RACS extension will be defined within STRONGEST, it is planned to contribute it to TISPAN.

Path computation element (PCE) for GMPLS

As part of the work on end-to-end control plane, STRONGEST studies PCE architecture and protocols for their applicability to GMPLS networks. Particular attention is being paid to multi-layer and multi-domain path computation.

In this field standardization-oriented activities have been going on in the Project since its very start to feed IETF. They focus on extending the GMPLS unified control plane in order to support the path computation elements protocol (PCEP). A first contribution was brought to the IETF draft draft-ietf-pce-gmpls-pcep-extensions-01, providing extensions for the Path Computation Element communication Protocol (PCEP) to support GMPLS control plane. A second contribution was brought to draft-gonzalezdedios-pce-resv-res-context-state-00, proposing an extension to the PCEP protocol to allow a temporary reservation of resources. A third contribution, on PCE extensions for multi-domain point-to-multipoint path computation, was given to draft-zhao-pce-pcep-inter-domain-p2mp-procedures-06.

Multi-domain multi-layer architectures

The task of multi-carrier traffic engineering is to provide effective network resource utilization while guaranteeing the adequate level of confidentiality. The hierarchical OIF E-NNI Routing solution is a candidate technology to perform multi-domain TE, and it is also being investigated by STRONGEST.

Unfortunately, the E-NNI approach is not harmonized with the GMPLS approach at the IETF. It has been proposed to integrate the PCE plus GMPLS architecture from the IETF with the E-NNI hierarchical model from the OIF within STRONGEST, taking the best from both worlds. This would require standardization activities both at OIF and IETF. In general, it is planned to open communication with OIF, presenting STRONGEST and establishing a liaison channel, at the earliest opportunity.

End-to-end OAM

Existing OAM standards are not equipped to handle inter-carrier issues arising from SLA violation in packet transport networks. An agreed method is required which permits the location of faults and their association to domains, so that appropriate reactions and compensations can take place. This would require extensions to OAM requirements laid down in several standards: RFC 4377, RFC 5860 at the IETF, Y.1731 at the ITU-T, and MEF 17 at the Metro Ethernet Forum. Work has been initiated as by STRONGEST in order to define a mechanism for multi-domain multi-carrier OAM. The consequences on standardization are still being investigated.

In addition, it has been proposed to study OAM for photonic switching and, later on, also for sub-lambda switching. As this would impact MPLS-TP standards at ITU-T and IETF, contributions in both bodies would be required.

THE STANDARDIZATION BODIES

ETSI (*European Telecommunications Standards Institute*, http://www.etsi.org/, http://portal.etsi.org/) is a European standardization organization which is now operating globally, with many non-European member companies. The actual standardization is mostly carried out in technical committees dedicated to specific topics. Two of them are specially interesting for STRONGEST: the *Environmental Engineering* (EE), and the *Telecoms & Internet converged Services & Protocols for Advanced Networks* (TISPAN).

IETF (*Internet Engineering Task Force*, http://www.ietf.org/) is the major body for standardizing anything related to the internet. The work is structured into areas and further into working groups (WGs) and progressed mostly via mailing lists. A number of WGs within the routing area are relevant to STRONGEST such as Path Computation Element (PCE) Multiprotocol Label Switching (MPLS), Common Control and Measurement Plane (CCAMP) Layer 2/3 Virtual Private Networks (L2VPN and L3VPN), and Pseudowire Emulation Edge-to-edge (PWE3).

The International Telecommunication Union (**ITU**) is the leading United Nations agency for information and communication technology issues, and the global focal point for governments and the private sector in developing networks and services. **ITU-T** is the standardization branch of ITU, making this the most important body for truly global telecommunication standards. A number of study groups (SG) and questions (Q) within the ITU-T work are relevant to STRONGEST, particularly SG 5, on *Environment and Climate Change*, and SG 15 on *Optical Transport Networks and Access Network Infrastructures*

The **OIF** (Optical Internetworking Forum, http://www.oiforum.com/) main work is to define interoperability agreements for hardware interfaces, for optical interfaces, and at software level (UNI, NNI, security, etc). The OIF work is divided between two main groups: *Physical and Link Layer* and *Networking*.

STRONGEST – a year later

Twelve months have passed since the beginning of the STRONGEST adventure. We've been working hard during this period, and we have seen the first results coming out. So, it may be useful for our readers to summarize here the main achievements of the Project in the past year.

The STRONGEST Consortium was originated following the observation that the TLC market is rapidly changing under the thrust of growing penetration of broadband services, continuous traffic growth, need to reduce costs, and increasing request to reduce carbon emissions. As an answer to these requirements, STRONGEST aims to design and demonstrate an evolutionary ultra-high capacity multilayer transport network, based on optimized integration of optical and packet nodes, and equipped with a multi-domain, multi-technology control plane.

Project management

The Project started on Jan 1st, 2010. Its technical content, scope, objectives, workplan and impact have been detailed in Deliverable D1.1 "Project Presentation" (January, 2010). The way the Project is executed, monitored and controlled have then been established in Deliverable D1.2 "Project Management Plan", defining the approach to be used by the Project team to deliver the intended project management scope of the project, addressing such areas as scope, time, cost, quality, communications, risk and consortium changes. Particular attention was devoted to the gender equality issue, as described in Deliverable D1.3 "Gender equality plan" (June, 2010), illustrating the gender actions that have been planned by the STRONGEST project to ensure non-discriminatory behaviours and to increase opportunities for women inside the Project. This plan starts from a diagnosis of gender status at the Project kick-off, and indicates objectives and specific actions to improve the female condition inside the Project; it also briefly describes other gender related activities like monitoring of gender actions, collection of statistical gender data and dissemination of gender actions.

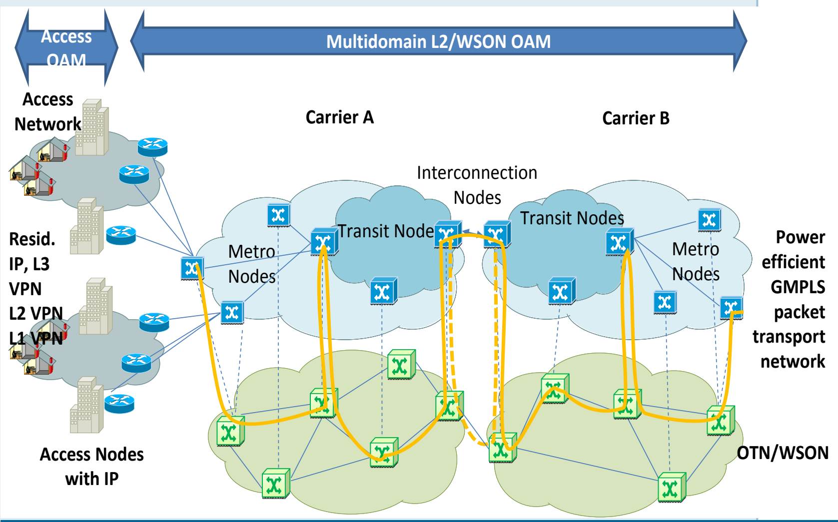
The way the Project is executed, monitored and controlled have been established by the Project Management Plan, defining the approach to be used by the Project team to deliver the intended project management scope of the project, addressing such areas as scope, time, cost, quality, communications, risk and consortium changes

During the past year the Project met three times: in Torino, on 19-21 January; in Munich, on 18-20 May; and finally in Torino, on 16-18 November. During these circumstances the key technical issues were discussed in depth in dedicated WP meetings, and then shared in the plenary ones; the General Assembly was also convened, to discuss and cope with administrative and management issues such as voting methodology, contract amendments, collaborations with other projects, contributions to standardization bodies and dissemination policy.

Technical results

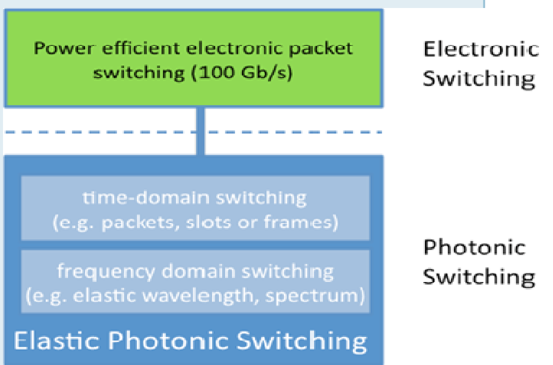
The first step of the Project technical activity has been the establishment of the basic requirements for future transport networks and the definition of the architecture evolutionary steps towards medium and long term scenarios, resulting from specific studies carried out by work package 2 (WP2 – "Network efficiency and optimization"), as described in Deliverable D2.1 "Efficient and optimized network architecture: requirements and reference scenarios" (September, 2010). The main characteristics of the existing network infrastructures, as supplied by the operators belonging to the Project, have been described and traffic forecasts for both medium and long term scenarios defined, together with a traffic model that can provide the traffic matrices. All these outcomes form the basis for further conceptual, dimensioning and optimization studies to be carried out by the Project on large multi-domain transport networks.

In particular, for the medium term scenario, the Project has identified an architecture that assures the desired scalability, cost reduction and energy efficiency by eliminating all transit routers, and limiting the presence of IP equipment to the network edges (access and interconnection). Intra-carrier multi-service traffic switching is done by a layer 2 over wavelength switched (WSON) structure with GMPLS functions that include multi-domain, multilayer and intra-carrier end-to-end capabilities for operation, administration and maintenance (OAM). This scenario is completely changing the current IP architecture, and asks for solutions assuring scalability to both IP and layer 2 over WSON control planes. The long term architecture is further characterized by the definition of a new data plane technology that will guarantee the QoS and optimize power consumption by means of multi-granular switching nodes and power efficient ultra high capacity packet processing, thus enabling scalability to more than 100 Tbit/s throughput per node. The photonic part of the hybrid node architecture under study will support gridless elastic services as well as flexible time and spectral domain allocation.



Proposed medium term architecture, leveraging on the elimination of transit routers (IP equipment only at the edge)

Control plane and quality of service related issues have been considered in details by work package 3 (WP3 – "End-to-end solutions for efficient networks"), assuming that automatic provisioning coupled with traffic engineering has become essential to operate large size networks in a dynamic and cost-efficient way. This activity aimed, specifically, at providing efficient solutions to support end-to-end service delivery crossing domains that are heterogeneous in terms of networking technologies, control plane models, and vendors/operators.



Multi-granular hybrid node

STRONGEST – a year later

The first outcomes have been described in Deliverable D3.1 "Medium-term multi-domain reference model and architecture for OAM, control plane and e2e services" (August 2010), that is focused on a medium-term network scenario, and addresses the interworking between heterogeneous GMPLS-controlled networks such as the WSON and MPLS-TP ones. The main studies have been dedicated, in detail, to the definition of network scenarios, OAM model, control plane architecture, and end-to-end services.

It is worth noting that, as a result of this activity, a complete control-layer and control-plane architecture has been proposed for the multi-domain/multi-region/single-carrier scenario, addressing basic requirements as regards routing, signaling and path computation, and being specially concerned with scalability. The proposed control plane solution relies on a hierarchical path computation element (PCE) and is implemented in a wider control-layer framework, like the resource and admission control subsystem (RACS) defined by ETSI TISPAN, thus resulting in better flexibility with respect to service offer, charging and billing, and operator policies.

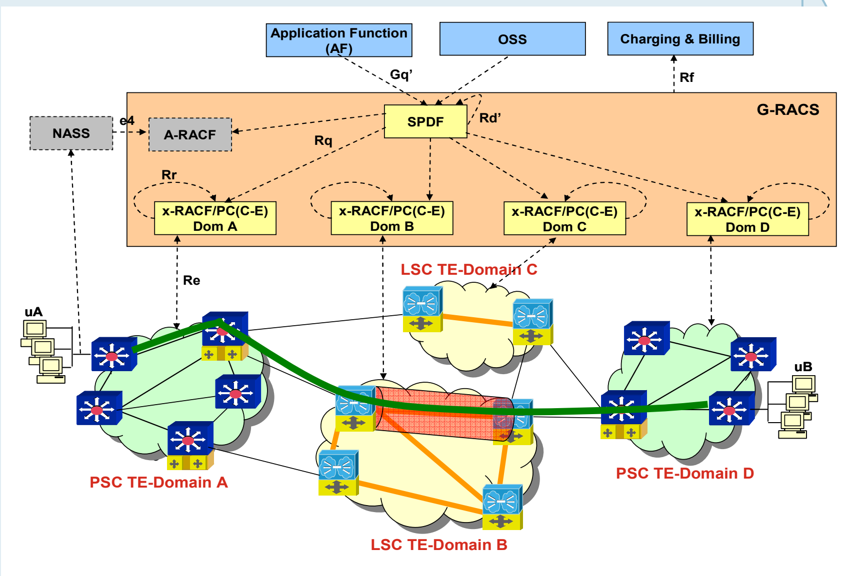
Further studies carried out in the last months of the year have produced some innovative proposals, as reported in Deliverable D3.2 "Next generation transport networks: efficient solutions for OAM, control, and traffic admittance" (December 2010).

Firstly, novel effective OAM mechanisms have been devised to predict, monitor, quantify and certify SLA degradation in packet transport networks due to packet loss induced by congestion, physical impairments or network failures.

Furthermore, innovative control plane solutions and procedures have been proposed and analyzed including novel protocol extensions and operational techniques. In particular the PCE-based architectures have been widely investigated, defining new procedures in the context of hierarchical PCE, GMPLS translucent networks and WSON, multi-layer networks and point-to-multi-point scenarios. Also, solutions have been proposed to provide the PCE with updated reachability and TE information, and to improve the efficiency of path computation techniques, e.g. by exploiting temporary reservations or by selecting ad-hoc routing algorithms. Additional studies have been provided as well, to combine path computation capabilities with admission control functionalities (e.g. C-RACF). Finally specific solutions have been identified in the context of multi-carrier networks, with special attention to confidentiality issues.

The experimental validation of the new metro and core networking solutions designed by STRONGEST WP2 and WP3 is the main objective of work package 4 (WP4 – "Network prototypes implementation and demonstration"); this activity necessarily comes after a reasonable stabilization of the technical solutions provided by the other work packages. Therefore, during the past year, WP4 has prepared the experimental activity to be carried out during the next two years; the implementation and demonstration plans for the innovative data plane and control functions envisaged in STRONGEST have been described in Deliverable D4.1 "Report on implementation and demonstration plans" (December 2010).

Data plane demonstration plans have been conceived for both medium-term and long-term networking approaches. According to these plans the experimental demonstration of the medium-term STRONGEST networking solution, based on the integration of wavelength switched optical networks and connection-oriented packet transport networks (PTN) for Ethernet service delivery, will require the combination of such technologies as: multiprotocol label switching - transport profile (MPLS-TP), pseudo-wire emulation edge-to-edge (PWE3); wavelength switching; GMPLS-enabled control plane; field programmable gate arrays (FPGA) for software/hardware co-design; and software/hardware defined adaptable network (SHDAN). The plans to demonstrate the long-term STRONGEST networking solution envisage the implementation of multi-granular photonic nodes and power efficient ultra high capacity packet processing. The multi-granular photonic node will support elastic optical circuit switching as well as enhanced network dynamics and finer (sub wavelength) bandwidth granularity, thus enabling scalability to multiple tens of Terabit throughput per node with optimized cost and energy efficiency.



Control-Layer and control-plane architecture based on G-RACS and PCE

The planned WP4 experimental activities regarding the innovative control plane solutions that are under study in other STRONGEST work packages, for both medium- and long-term scenarios, will be mainly focused on the implementation of: GMPLS-controlled, single-domain, dual-region (MPLS-TP and WSON) control plane; multilayer routing, grooming and restoration algorithms; multi-domain and multi-technology PCE test bed; control plane architecture based on the combination of RACS and PCE.

Coordination, dissemination and standardization

Several actions have been at first planned, and then carried out, during the past year, by work package 5 (WP5 – "Technical coordination, dissemination and standardization"), as described, respectively, in Deliverable D5.1 "Plans for coordination, dissemination and standardization activities" (June 2010) and Deliverable D5.2 "Coordination, dissemination and standardization activities in Year 1" (December 2010), in all the areas that are considered coordination-critical by the Project management team. As reported by the latter document the main activities carried out during 2010 have been: internal coordination to ensure harmonization and consistency among technical WPs; external coordination with other projects (like GEYSERS, MAINS, ETICS from EC FP7, or AKARI from Japan); dissemination through production of quarterly newsletter and website pages, participation in world-class conferences (NOC2010, ICTON2010, Globecom 2010, ECOC2010), and publication of papers; organization of training events (academic lectures and company-internal courses). Specific contributions to standardization bodies (IETF and ETSI) have been produced; in particular a liaison has been established with ETSI *Environmental Engineering*.

Outline

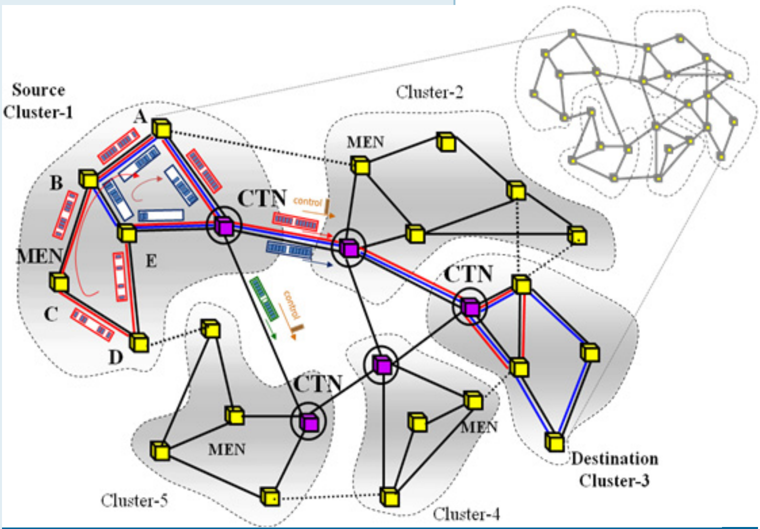
Clustered Architecture for Nodes in an Optical Network (CANON)

Contemporary core networks will be struggling to meet 2020 transport requirements scoring a capacity which will be at least an order of magnitude higher than today under stringent and diversified Quality of Service (QoS) performance. For that time period there is a forecast for core network links able to provide capacities in the order of Tbit/s and switching nodes able to cope with Pbit/s loads under dynamic traffic patterns with high spatial and temporal asymmetry. While advances in optical transport technologies are expected to have renderable such high-capacity transmission systems, a networking architecture providing a balanced performance over an extended QoS parameter list is still illusive.

Indeed, when considering the performance across all QoS parameters as figure of merit, it has been shown that the existing networking paradigms are largely ineffective. The static reservation of WDM channels on the optical layer (i.e. implementing an Optical Circuit Switching – OCS – mode) as used in IP/WDM optical networks is severely limiting scalability, since it cannot efficiently adapt to the dynamic traffic fluctuations that are frequently observed in today's networks. OCS employs pre-provisioning, based on a semi-static network resource allocation scheme, meaning that a wavepath is assigned a-priori for interconnecting two nodes, possibly in a multi-hop scheme. This static reservation (provisioning) model of OCS leads to a significant over-provisioning of links and large port-count switches in order to guarantee QoS with minimum losses or delay at a high overall cost and poor resource utilization. Solutions employing Optical Burst Switching (OBS) achieve dynamic resource reservation over optical networks, but their performance suffers due to high burst loss probabilities.

In order to overcome the severe scalability limitations of the existing networking platforms, schemes allowing for a) statistical multiplexing gains enabling sharing of resources and b) grooming of the sub-wavelength granularities are sought.

To facilitate dynamic optical networking allowing for statistical multiplexing, dynamic resource allocation and efficient grooming of transportation granularities, the use of the *Clustered Architecture for Nodes in an Optical Network* (CANON) has been proposed. CANON refers to both network architecture and node architecture. Electronic buffering is still employed at Metro Edge Nodes (MENs). All MENs, exploiting a ring topology sub-net are forming up a "cluster". Moreover, CANON is readily introducing two new granularities in the optical layer: the slot and the frame such as MENs add slots in the ring based on a Medium Access Control (MAC) protocol executed by a Core Transit Node (CTN), which acts as a centralized arbiter. Thus, the role of the CTN is to coordinate both inter and intra-cluster operations. In the latter process, the MENs contribute fixed size contiguous optical slots (in the order of several microseconds), which are marshaled into appropriately sized optical frames (in the order of several milliseconds) destined to other clusters. MENs are guided by the MAC executed at the CTN to transmit data destined towards nodes residing in a specific remote cluster within allocated slots of the same frame. Frames serve as containers that facilitate grooming of traffic (slots) over the entire cluster that will be casted altogether towards distant clusters over specifically reserved wavelengths (Figure 2). Through this hierarchical layered architecture, each ring is effectively operating as a "distributed switch" efficiently enforcing statistical multiplexing at the optical layer. Consequently multiplexing gains appear as a collective effect of many network nodes and not the outcome of an individual node leading to gains that are not feasible using other schemes which need many more WDM channels to provide same class performance. Simulation results carried out within the project confirm the validity of these claims.



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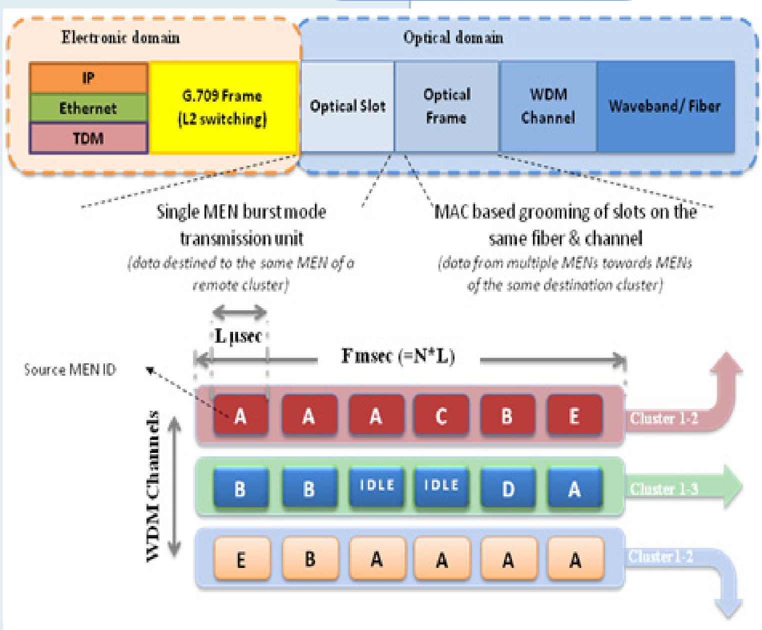


CANON layered architecture and transmission granularities

Collaborations

The AKARI project

The japanese AKARI Architecture Design Project aims to implement the basic technology of a new generation network , developing a network architecture and correspondingly designing the network. It is a specific AKARI approach to pursue an ideal solution by researching new network architectures from a clean slate, without being impeded by existing constraints.

On July 9th, 2010, a joint meeting was held at the National Institute of Information and Communications Technology (NICT) premises in Japan to start a collaboration between AKARI and STRONGEST.

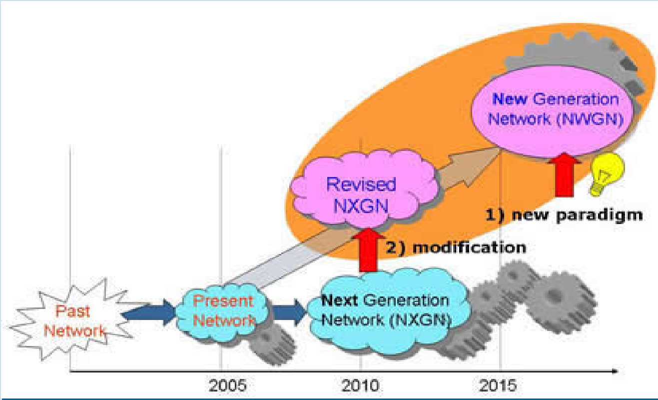
During this meeting both projects presented themselves to each other and agreed that the collaboration would at first consist in exchanging technical information. Some specific points for materializing this collaboration were discussed.

Being STRONGEST an industry driven project, it is focusing on a comparatively shorter-term perspective with respect to AKARI. The japanese project, indeed, has no direct involvement of industrial partners, and is focusing on a longer-term perspective, with a broader scope than STRONGEST. Beside the optical/transport network layer and network virtualization that are considered in both projects, AKARI is also looking at ID/Locator Split, wireless/sensor network architectures.

As regards the collaboration, it was concluded that an active exchange of information would be the first step in cooperating. A couple of proposals from the STRONGEST side were discussed and agreed during the meeting, to materialize this exchange. They basically consist of:

- Exchanging project deliverables (documents)
- Inviting speaker(s) of the other project when organizing workshops, to present the other viewpoint, as well.

STRONGEST can benfit from the collaboration with AKARI, that started the design of innovative network architectures years ago. On the other hand AKARI, that is mainly an academic project, can gain some benefits from a liaison with STRONGEST that, being industry-led, allows AKARI to discuss with representatives of the industrial world from the STRONGEST consosrtium about the possible practical deployment of AKARI's vision and research outcomes.



The AKARI project roadmap

Events, participations and contributions

In the fourth quarter 2010 STRONGEST held its third plenary meeting in Turin, on 16-18 November.

The meeting was mainly focused on the discussion about control plane evolution and innovative network and node architecture. Particular attention was paid to the introduction of multi-granular gridless optical switching technologies.

In the plenary session STRONGEST beneficiaries were encouraged to undertake actions in support of gender equal opportunities inside the Project.

The Project actively partecipated in ONDM 2011 (Bologna, Italy, Feb. 7—11), where some papers were presented under the STRONGEST umbrella; furthermore STRONGEST delegates participated in a panel discussion about the evolution of network control planes, where the need of a common view on standardization-oriented activities among FP7 Projects was raised.

STRONGEST also participated in the Converged and Optical Networks (CaON) cluster meeting that was held in Brussels, on February 12.

The Project will increase its involvement in CaON, as Dimitra Simeonidu (University of Essex) has been elected chair of the cluster for 2011, while Juan Fernandez Palacios (STRONGEST architecture chief) and Andrea Di Giglio (STRONGEST projet coordinator) have been designated co-chairs.

In the near future

- University of Essex, Colchester, UK , April 4th-7th , 2011: STRONGEST fourth plenary meeting.
- Los Angeles, USA, March 6th-10th, 2011: STRONGEST delegates will participate in OFC 2011, disseminating first results about the experimental demonstration of a gridless multi-granular optical network supporting flexible spectrum switching.

Scalable, Tunable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport

STRONGEST

website: www.ict-strongest.eu

Partners: *Telecom Italia (IT), Alcatel-Lucent Deutschland (D), British Telecom (UK), CTTC (ES), CNIT (IT), Deutsche Telekom (D), Ericsson (IT), IBBT (BEL), Nokia Siemens Networks Germany (D), Telefonica (ES), Universitaet Stuttgart (D), Universitat Politècnica de Catalunya (ES), University of Essex (UK), University of Peloponnese (GR), VECOMM (IT), PrimeTel PLC (CY), Nokia Siemens Networks Israel (IS)*

Project Coordinator

Andrea DI GIGLIO

Telecom Italia S.p.A.

Email:andrea.digiglio@telecomitalia.it

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