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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?

Views: Ten Steps to Achieve 1000-fold Improvement in Photonic Network Energy

Contents

What's going on in STRONGEST?

STRONGEST activities started about 6 months ago, and first results are coming out.

In this half-year thorough studies on energy efficiency in transport networks have been firmly set up, while a roadmap for the STRONGEST reference architectures has been clearly established. Furthermore main requirements for reference networks have been defined, while the general design of Control Plane, architectures of Path Computation Element (PCE), and Operations, Administration & Maintenance (OAM) functions has been performed by specific task forces.

In the energy efficiency domain, particularly, focused studies were carried out on the energy-efficient design of wavelength switched optical networks, on the use of optical bypasses for energy efficiency, and on the applicability of a dynamic optical bypass. The deployment of photonic technologies, to bypass electronic IP packet processing, was identified as a key starting point for the subsequent studies.

Focused studies were carried out on the energy-efficient design of wavelength switched optical networks

In the control plane area, as well, STRONGEST has produced its first results; at both conceptual and experimental level. STRONGEST is proposing a control plane architecture for the integration of the PCE functionality on the Resource and Admission Control Subsystem (RACS). This architecture, particularly innovative, has been considered feasible by the majority of Partners.

On the standardization side STRONGEST has been active in IETF, for PCE protocol (PCEP) definition, and had preliminary contacts with ETSI EE (Environmental Engineering). A specific liaison exchange was proposed to ETSI in order to gain access to latest work of the Environmental Engineering group, and to provide in turn information about positions and developments in STRONGEST.

The STRONGEST Gender Action Plan

In spite of the cultural and social evolution that occurred in the last decades, the scientific and technical fields in Europe still suffer, like other areas, from an unbalance of professional opportunities being offered to women; in some cases, truly discriminatory behaviours still survive inside the companies and public administrations. Many efforts have been specifically exerted by the EC to promote gender equality; this holds as well for EC funded research activities, that have been the object of detailed gender studies, recommendations and actions, with a particular emphasis being devoted since FP5.

Statistical data, resulting from monitoring investigations started during FP6, show us that the key project roles in the Information Society Technologies (IST) area were covered by women only in a limited number of cases, ranging between 10 and 15 % (a desirable objective would be at least 40%!). This obviously reflected a general condition to be noticed in European industry, public administrations and academia.

As a consequence a clear commitment of all the players inside European projects is mandatory, to overcome present limitations. The EC has identified the "Gender Action Plan" as a key management tool, for Integrated Projects and Networks of Excellence, to increase gender awareness in project participants and to establish operational objectives aimed at improving the female participation and promoting gender issues in the content of research.

STRONGEST has carefully prepared its Plan that, according to the EC recommendations, is built around two steps: a diagnosis on the initial gender situation within the Project, and practical proposed actions based on the above diagnosis.

From a simple analysis of the kick-off gender data it turns out, for instance, that STRONGEST has assigned work package responsibility roles to women in the 20% of cases, which is not so bad, but still far from the desirable 40% objective – clearly, room exists for improving women participation. Furthermore, a number of gender related objectives and actions have been identified in the Plan and recommended to the beneficiaries, i.e.: balancing gender within the Project workforce, raising gender awareness, promoting the presence of women in scientific activities, and promoting leadership roles for women.

Gender data and results of planned actions will be carefully monitored throughout the Project lifetime, and an effective steering action will be carried out to ensure that equal opportunity policies are firmly applied inside STRONGEST and that, in general, the awareness of gender issues be increased in all beneficiaries.

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Interview

My opinion on *green* networking

The so called "green networking" is a widely debated issue, while social attention to energy savings is increasing, and telecom operators are crushed between the urgent request to reduce emissions by challenging technical choices and the need to ensure satisfactory returns to the shareholders. On these topics Andrea Di Giglio, the STRONGEST Coordinator, has recently given an interview whose main passages are reported in the following.

NETWORK USAGE

At the moment optical networks can provide large bandwidth but limited flexibility.

Will these applications drive the deployment of optical networks equipped with auto configuration tools and on demand network set-up?

Improving flexibility is crucial for the future of optical transport networks. Since the beginning of STRONGEST, one of the key challenges for the Project has been the overcoming of flexibility limitations that currently affect our networks.

A first answer to this issue is the development of an efficient and highly performing control plane. Sophisticated paradigms, based for instance on GMPLS, enable fast and automatic end-to-end provisioning – also allowing the integration of different switching domains, i.e. Ethernet, IP/MPLS, MPLS-TP and WSON. Furthermore the availability of a next generation control plane will offer fast and efficient resilience mechanisms, and multi-layer traffic engineering; these features will allow a more efficient and thrifty bandwidth usage.

GREEN NETWORK ARCHITECTURES

• Is it more a matter of architecture or of devices engineering?

• At the present stage do you expect more from advances in network architectures or in equipment components?

• Should we look for a global optimization?

I will answer this group of questions starting from the last one: Yes, a global optimization is possible and actually, just following the guidelines of EC Framework Programme 7 (FP7), STRONGEST is looking for this.

Now, we can better justify this statement saying that STRONGEST (and other FP7 projects like MAINS, ETICS, GEYSERS and EARTH) is facing with the problem of reducing the power consumption of telecom networks by exerting leverage on a number of approaches based on:

technologies, e.g.: use of more efficient CMOS technology, more efficient transmission techniques based on coherent detection and polarization multiplexing,...

architectures, e.g.: use of optical bypass, multi-layer traffic engineering , sleep mode for unused circuits, increase of reliability, proper choice of data centres and servers location

other complementary approaches, e.g. use of micro-power generation

While the attention about technologies is already high, it is important to leverage more and more on enhanced architectures to achieve the desired (but challenging) 1000-fold improvement in network energy-efficiency for a Gbit/s connection.

This approach, on the telecom side, might strongly support the achievement of the ambitious "20-20-20" global objective promoted by the European Commission, that means: a 20% cut in emissions of greenhouse gases by 2020, compared with 1990 levels; a 20% increase in the share of renewable sources in the energy mix; and a 20% cut in energy consumption.

ENERGY EFFICIENCY

• Green networking: a real issue or just a "green" research topic?

My personal feeling is that "green networking" is a real issue, and to design less consuming networks is an important challenge, in particular for the transport ones.

Access networks (that currently dominate the overall telecommunications consumption) are moving the right way, having already identified the substitution of copper with optical fibres as the main solution that will significantly mitigate the energy problem – for fixed access.

About transport networks, if the massive routers deployment will go on at today rates, while the switching technology remains the same, the networks will probably collapse, due to excessive power consumption. So my answer is: "green networking" is definitely a real issue, not just a "green" research topic.

Will there be any form of green networking without specific regulations?

Regulation is really important, but not strictly essential for the development of "green networks", at least not the only one. Beside states' regulation, it is very important the timely agreement on technical rules provided by the relevant standardization bodies. STRONGEST has purposely initiated a liaison with ETSI EE, to feed this body with the concept of energy efficiency based on enhanced network architectures, beside technology advances.

GREEN NETWORKING BILL

• Who will pay the bill for a green Internet?

Operators and manufacturers are struggling in economic crisis and Governments have the problem of sovereign debt

• Will the final users pay for it?

I hope, or better I believe, that nobody will pay an extra bill for the new Internet based on scalable, flexible and energy efficient networks. This is a hope for telecommunications in general, but becomes certitude for transport networks.

My optimistic view is driven by the comparison between transport networks and other industrial fields, where "to become green" is really an awkward commitment. In the heavy industry, for example, or, even more, in the waste disposal, to be "green" implies massive expenditures.

Luckily, in today telecom market, equipment has a relatively short life-cycle, and the replacement of old equipment with a new, power efficient one is likely to happen smoothly (provided that standards will be available soon), as it will result in significant savings on the power bill for network operators.

Furthermore, and even more important, the true driver for energy savings will be the choice of a new, clever network architecture, forced at first by the urgent need to ensure more transport scalability. Minimizing the number of routers while enhancing the functions in the optical layer, one of the hinges of the STRONGEST innovative network concept, will guarantee an increase of scalability, the assurance of end-to-end quality of service, and a strongly reduced power consumption, at the same time. The new balance between electronic and optical functions will not necessarily imply larger investments while, at the same time, it will reduce the power bill. To conclude, nobody will pay the bill "to be green", because, luckily, there will be nothing to pay in addition.

Views

Ten Steps to Achieve 1000-fold Improvement in Photonic Network Energy Efficiency

STRONGEST aims to design scalable and energy-efficient transport networks operating at data capacities 100x greater than currently. Strategies to keep power consumption within sustainable limits (e.g. currently 20 GW globally) despite an anticipated 100x increase in traffic by 2025 form a key component to STRONGEST's outputs. Here we identify ten independent principles (within 4 themes) in photonic network design, collectively yielding 1000-fold (30 dB) improvement in overall telecoms energy efficiency. Each principle offers individual improvement of at least 50% ($2^{10}\approx1000$, i.e. 30 dB).

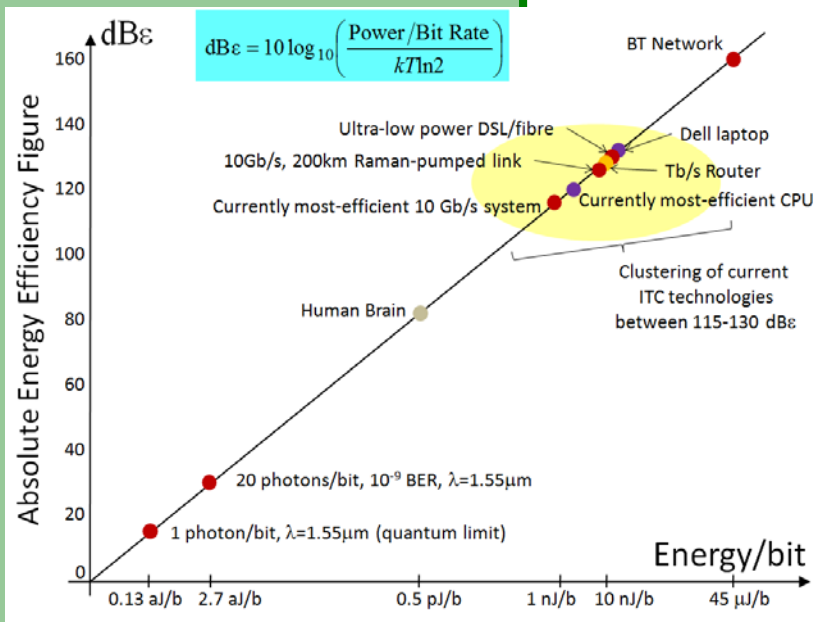
A) **Improved energy-efficiencies offered by electronics**: 1) More efficient CMOS technologies with dissipated power $P\alpha C^{2/3}$ (clock-rate, C) such that 50% improvement in energy-efficiency is achieved if CMOS clock-rates increase by a factor of 8. 2) High temperature operation of ICs (e.g. SiN, SiC or GaN) reduces the need for forced cooling. With PUEs currently about 2.0, a 50% improvement is available to reach PUE≈1.0.

B) **Sophisticated network resource management**. 3) Source and channel coding with compression factors reaching 40x, leading to 16 dB gain in network energy efficiency. 4) Multi-layer traffic engineering (MLTE) exploits traffic statistics to re-route traffic from under-utilised nodes and onto more popular nodes which exhibit higher efficiency at max capacity. Routers in under-utilised nodes can be switched into idle states. 5) Initial experiments with powering down, sleep/idle modes and burst-mode operation show 3.4 dB energy savings; although interdependence with MLTE limits the combined figures of (4) & (5) to 6dB.

C) **Inherent energy efficiencies offered by optics**. 6) Optical bypass avoids OEO conversions at routers. E.g. if half the no. of nodes are optically bypassed by packets traversing the network, this represents 50% saving in IP router energy. 7) Coherent detection offers an intrinsic 3dB gain in receiver sensitivity, offering a potential 50% improvement in energy efficiency. 8) Polarisation-multiplexing offers a maximum 50% energy saving in the limit of all signals remaining in the optical domain across the network; the energy efficiency advantage of pol-mux increases with degree of optical bypass employed.

D) **Environmentally-sustainable approaches**. 9) Deployment of (renewable) micro-power generation at network nodes avoids power-line transmission losses (approx 8%), whilst IPv6 "green" bits also minimise fossil-fuel consumption & CO_2 footprint. 10) Increased reliability & robustness of network equipment via more software-defined operation of photonic components (soft photonics) - 50% redundancy is frequently required in network architectures to satisfy QoS provision. Avoiding network dualling and reduced truck-rolls allows a further 50% saving in network energy consumption.

STRONGEST aims to design scalable and energy-efficient transport networks. The idea to keep power consumption within sustainable limits despite 100x increase in traffic by 2025 form a key component to STRONGEST's outputs.



Plot of absolute energy efficiency figure (dBe) against energy/bit (J/b) metric showing the potential for multi-decadal improvements in photonic networking energy efficiencies.

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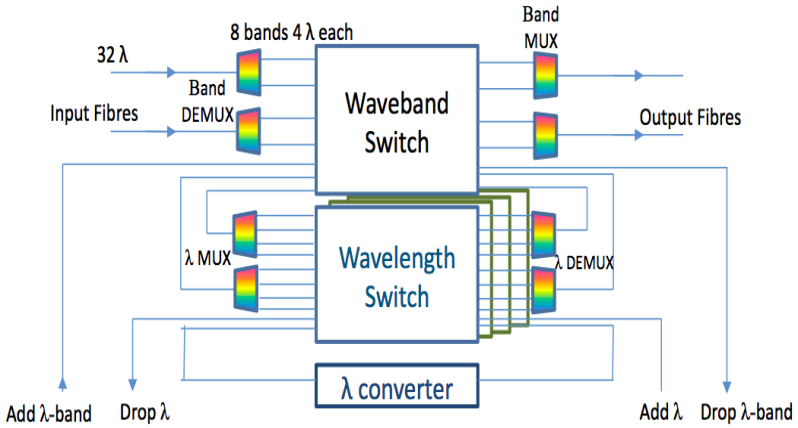
STRONGEST experimental activities: the test beds

STRONGEST implementation and demonstration activities, based on four different test beds, are focused on two innovative and evolutionary networking approaches:

Medium-Term networking solutions, based on the introduction of a PCE - based architecture for efficient inter-domain inter-carrier path computation in multi-layer GMPLS-controlled transport networks such as hybrid Wavelength Switched Optical Networks (WSON) and connection-oriented packet transport networks (e.g MPLS-TP) for Ethernet service delivery. This scenario is experimentally evaluated in two different testbeds:

- L2/WSON testbed at CTTC (Barcelona, Spain) combining both multi-layer data and control plane. This testbed is mainly used for routing and restoration algorithms implementation and performance analysis
- Pure control plane testbed based on the interconnection of five control plane testbeds (CTTC, TID, CNIT, NSN, TI). This testbed is mainly used for multi-domain control plane implementation and demonstration. The goal of this test-bed is the validation of PCE interworking, according to the multi-domain architecture defined by STRONGEST conceptual studies. Interworking is carried out by interconnecting distributed control plane testbeds from participating partners.

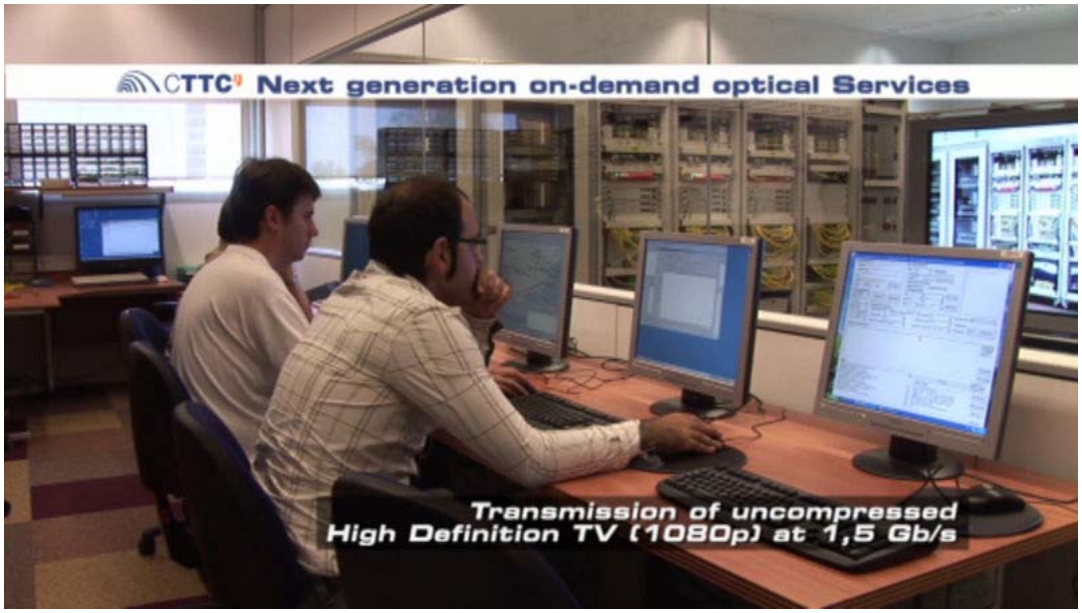
Long-Term networking solutions based on new optical metro and core switching nodes. For the metro domain, the solutions will support enhanced network dynamics and finer (sub-lambda) granularity while for the core nodes they will achieve scalability to multiple tens of Terabit throughput per node with best cost and energy efficiency. Experimental activities on long-term data plane technologies will be carried out on two testbeds:



General waveband / wavelength Switch Architecture

Four test-beds are used for evaluation and demonstration purposes:
- layer 2 / WSON (Barcelona)
- pure control plane (distributed)
- λ and sub-λ granularity (Colchester)
- ultra high capacity (Stuttgart)

- Sub-lambda granular testbed at University of Essex (Colchester, UK). This testbed will be focused on multi-granular switching nodes to provide waveband, wavelength and sub-wavelength granularity. This will allow the evaluation of different architectures, with regard to such parameters as: flexibility, implementation complexity, technology control and operation, transport format (slotted, asynchronous), required number of ports, optimum aggregation (e.g. number of wavelengths per band, end-to-end waveband switching or intermediate waveband switching)
- Ultra High Capacity Testbed at Alcatel-Lucent Germany (Suttgart, Germany). This testbed will focus on ultra high capacity and power efficient L2 technologies. The goal of this test-bed is the development and the demonstrations of a sub -equipped ultrahigh capacity optical node based on: 100G packet processing board , 100G packet processing, hybrid Optical-electrical switch, dynamic optical bypass , traffic monitoring and management for L2 QoS.



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Outline

OAM in advanced trasport networks

OAM (Operations, Administration and Maintenance) plays a noteworthy role in telecommunication networks, providing procedures for fault management (detection and localization) and performance monitoring (loss/degrade of received information, delay). The OAM concept might be applied to both the transport and the service layers in order to improve their ability to support services with guaranteed and strict Service Level Agreements (SLAs), while reducing their operational costs.

Traditional transport networks (i.e. SDH and OTN) are endowed with very complete and highly performing mechanisms of Operation, Administration and Maintenance (OAM), including performance monitoring (PM).

On the other hand existing intra-office Ethernet offers very poor OAM and PM instruments; when the Ethernet technology was extended to long distance packet transport (especially in metropolitan networks) the development and standardization of OAM features for packet networks became mandatory, to ensure suitable quality.

For this reason both in IEEE and ITU-T, respectively, Recommendations Y.1731 and 802.1ag have specified the OAM features for Ethernet networks, with the primary aims to detect failures, to trigger the network protections and to locate faults. These Recommendations are the basis for OAM in emerging packet transport networks.

The advanced packet transport technologies (in particular MPLS-TP) have been designed to extend the concept of packet connectivity for transport purposes. For this reason ITU-T has developed a set of requirements for the transport profile of MPLS (MPLS -TP, TP = Transport Profile) and those regarding OAM represent an important section. Among the required functions, the most important are: a very fast fault detection and localization, the estimation of packet loss and the delay measurement.

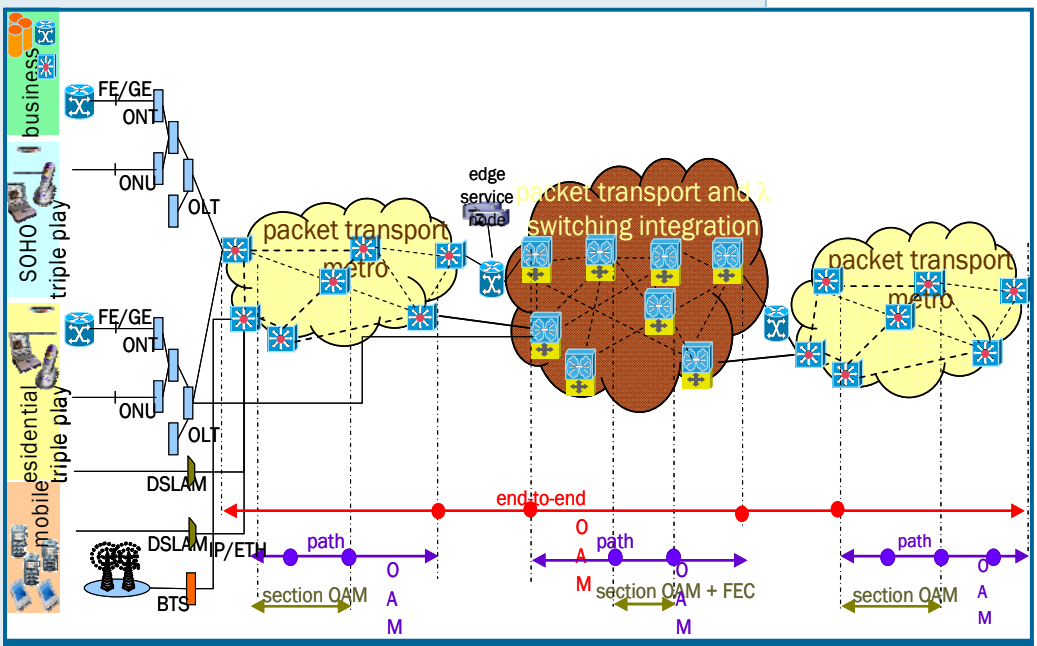
The satisfaction of these requirements can be reached in two ways, differing essentially for implementation and not for functionalities; this alternative is currently object of heated debate in the standardization bodies meetings.

The first proposal means to use the framework and the toolset defined by the Bi-directional Forwarding Detection (BFD), a mechanism based on IETF RFC 5884 and widely adopted in routers. This approach is supported by traditional IP vendors and by the majority of American Carriers.

The competing approach is based on the extension to MPLS-TP of the toolset defined by ITU-T Y.1731 that, as mentioned above, specifies the OAM features for Ethernet networks. This approach is supported by traditional vendors of transmission equipment and by the majority of incumbent European Carriers and emerging Chinese Operators.

STRONGEST is deeply involved in studying OAM aspects as well, as required by the contractual documents, where this theme is clearly quoted among the Project goals: "*...to pursue end-to-end services delivery crossing domains that are heterogeneous in terms of technologies (circuit transport networks and connection-oriented packet transport networks), control plane models (e.g. multi-layer/multi-region), OAM mechanisms, vendors and operators.*"

At this stage, STRONGEST is not taking a position on the two competing OAM standardisation proposals, but is rather studying OAM functions complying with its objectives and matching its target network architecture. The project is pursuing particularly QoS monitoring of network services in a complex network scenario, fast fault notice for triggering recovery mechanisms and individuation of degrades for accurate maintenance.



STRONGEST reference architecture, including OAM features

OAM in STRONGEST for:

- **QoS monitoring for network services in a complex network scenario**
- **Fast fault notice for triggering recovery mechanisms**
- **Individuation of degrades for accurate maintenance**

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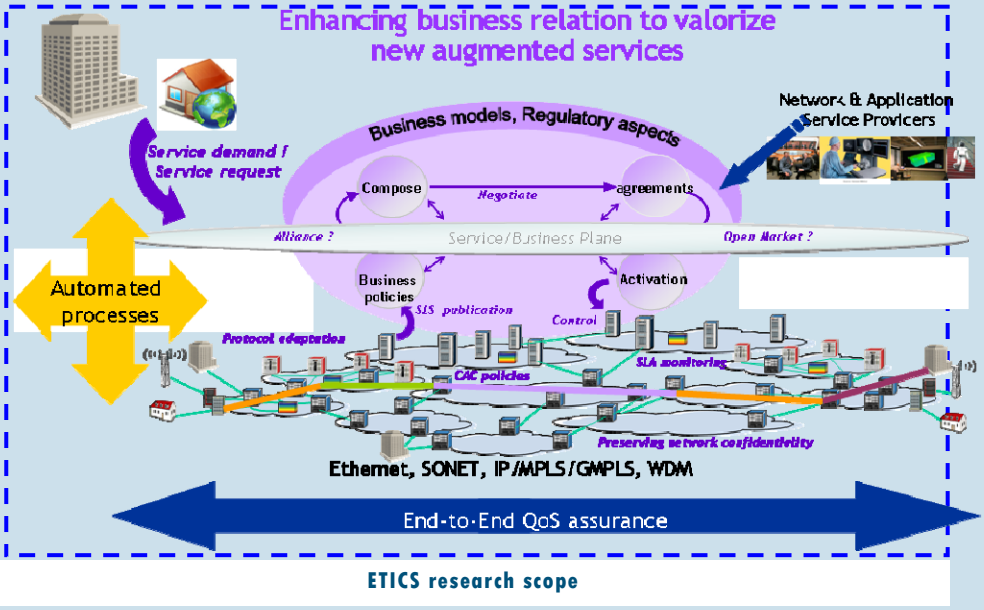
Collaborations

The ETICS project

ETICS (Economics and Technologies for Inter-Carrier Services), an FP7 call 4 Integrated Project, aims at creating a new ecosystem of QoS-enabled interconnection models, allowing for a fair distribution of revenue shares among actors of the service delivery value-chain. To this end, the project is defining new business and regulatory models, to provide incentives for carriers to collaborate in the deployment of advanced End-to-End QoS assurance mechanisms across multiple heterogeneous carrier networks.

ETICS analyzes, specifies and implements new network control, management and service plane technologies for automated QoS-enabled services.

Collaborations with STRONGEST are expected on control plane technologies for multi-layer/domain QoS provisioning (e.g. the Path Computation Element (PCE) and GMPLS), with interconnection at L2/L3 in ETICS and L1/L2 in STRONGEST. ETICS shall also benefit from the work done on high bit rate data planes in STRONGEST, while STRONGEST may benefit from the ETICS business models implemented in a Network Service Plane on top of the carrier control planes.



Further information about

Events, participations and contributions

The **STRONGEST second plenary meeting** was held in Munich (Germany) on May 18th-20th, 2010, hosted by Nokia Siemens Networks.

This meeting was mainly focused on the presentation of the Project Management Plan as a working tool and to the sharing of preliminary technical results obtained by the work packages.

STRONGEST participated at Future Internet & Mobile Summit (Florence, Italy, 16-18 June 2010) with two presentations: "STRONGEST: Challenges for Network Architectures" and "Green features of STRONGEST". During the summit, A. Di Giglio also participated at a panel discussion about "Power savings in next generation Internet".

STRONGEST also presented two works at the 15th European Conference on Networks and Optical Communications (NOC) 2010 (Faro, Portugal, 9th June 2010): "Migration steps towards STRONGEST architecture" (J. F. Palacios) and "Efficient Sub-wavelength Switching Based on Hierarchical Traffic Aggregation" (A. Stavdas).

STRONGEST will actively partecipate in ECOC 2010 (Turin, Italy, Sep. 19 - 23), since several papers provided under the STRONGEST umbrella, have been accepted.

In the near future

- Turin, early November, 2010: STRONGEST third plenary meeting.
- Stockholm, October 6th - 8th, 2010: Converged and Optical Networks (CaON) cluster workshop, organized by Alpha Project.
- Turin, Sept. 19th –23th ECOC 2010

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

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 & Co. KG (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)*

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