DISCUS - An end to end architecture for a high performance, economic and low power future broadband network

Prof. David Payne
Trinity College Dublin, Ireland
& Aston University, UK

The DIStributed Core for unlimited bandwidth supply for all Users and Services

Co-ordinating partner: Trinity College Dublin, Ireland
Project Coordinator: Prof. David Payne
Tel.+44 (0)1728 747019
Mob. +44(0)7918 658723
e-mail: david.b.payne@btinternet.com
Project Manager: Dr. Marco Ruffini
Tel: +353 1 896 4336
e-mail: marco.ruffini@tcd.ie

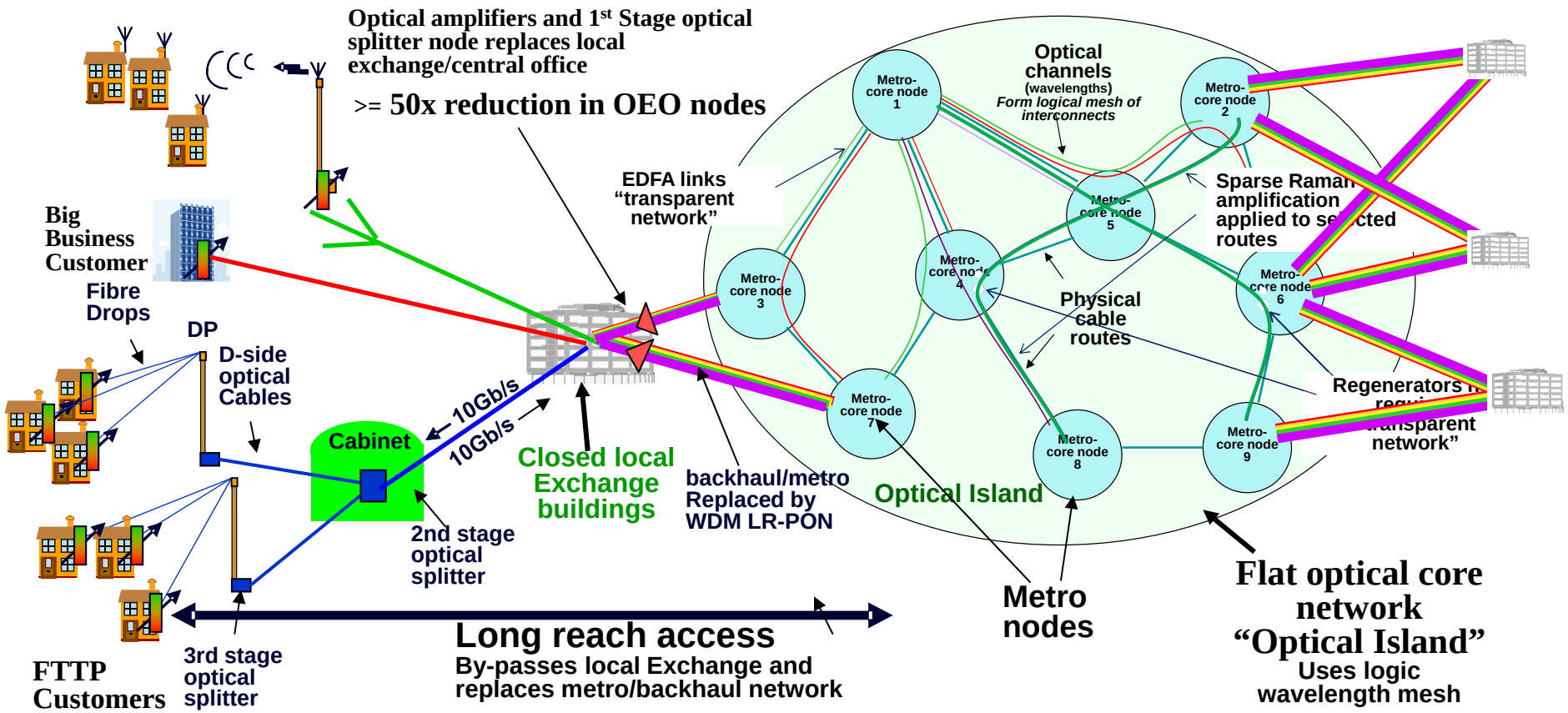
Duration 1-11-2012 to 31-10-2015
Funding Scheme: IP
Total Cost: € 11,652,198
EC contribution € 8,112,824
Proposal No. 318137:

- Universities
- Telecoms vendors
- Telecoms components fabrication facilities
- National operators
- National research centres
- SME

DISCUS – A solution to the 3 major problems facing future broadband networks:

1. **Financial** - The cost of network provision:
   - Large mismatch between revenues and the cost of providing capacity.
2. **Environmental** -The huge growth in power used by the worlds telecommunications networks.
3. **Social** - The need to avoid a "digital divide".
   - Provide the same service capability for customers in sparse rural communities as dense urban areas.
   - W*ith minimal government subsidies*!

The DISCUS end to end architecture



DISCUS – Main objectives and Achievements 1:

Objectives, targets and achievements:

Produce an end-to-end network architecture (access, metro and core networks) that economically scales for 1000x user bandwidth increase.

- Achieved: solution based on LR-PON with flat optical core network which eliminates metro-access network and closes majority of the LEs/COs.
- Targets minimum symmetrical bandwidth of LR-PON 10Gb/s, split 512 ways minimum split 512 ways logical split 1024 ways – achieved and demonstrated at ECOC and at the Tyndall Institute, Cork, Ireland in December 2015.
- 40Gb/s upgrade of downstream bit rate – achieved and demonstrated.
- 100Gb/s core wavelength delivered to access edge over same LR-PON infrastructure and interleaved with 10Gb/s LR-PON modulated wavelengths – achieved and demonstrated.
- Reduction in network buildings with traffic processing >98% – achieved and demonstrated for UK - 98.7% , Italy - 98-9%, Spain - 98.0% and Ireland - 98.5%.
- Reduction in customer network ports 99% – achieved until ~2030 (~500times today's bandwidth) after which port count reduction may fall to ~97% due to very large customer bandwidth >1000 times today's.
- Reduction in network port cards of >70% – achieved by elimination of metro-access network , flat optical core network and shared protection systems (enabled by LR-PON dual parenting) which gives availability as good as 1+1 protection in the core.
- Produce a network architecture that has lowest power consumption with minimal and reducing power per unit bandwidth as network bandwidth grows. Target minimum 1 order magnitude reduction – achieved: the power consumption modelling (for 500 times bandwidth increase) indicates at least, a16 fold reduction for the DISCUS network including CPE compared to BAU with CPE. If CPE is removed from the calculation the network power reduction is a 116 fold reduction for the DISCUS network.

DISCUS – Main objectives and Achievements 1:

Objectives, targets and achievements:

- Produce a flexible control plane that allows multi-layer (fibre, wavelength, layer 2 and layer 3) switching of traffic flows at the core nodes. Achieved: This has been demonstrated at ECOC 2015 and in more detail at a demonstration in December 2015 at the Tyndall Institute, Cork, Ireland.
- Ensure the solution is able to adopt new technologies as they arise while co-existing with previous generation technologies – graceful evolution. Achieved:
  - The LR-PON fibre infrastructure is transparent and any optical technology can be used over the wavelength paths. We have shown mixed bit rates and mixed modulation schemes working seamlessly together.
  - The optical switching layer in the MC-node, as proposed in the DISCUS architecture, can be partitioned and used to create separate areas of the switch for new and even experimental technologies including completely new protocol stacks that could replace Ethernet and IP/MPLS in the future.
  - These new technologies can co-exist with existing technologies and if successful will eventually displace the old legacy technologies. This can continue indefinitely into the future.
- Produce a network architecture with a combined wireless edge with ubiquitous optical access and demonstrate the benefits to customers that the combined architecture produces. Achieved: designs produced that can accommodate front hauling with very tight latency requirements, back hauling can operate without any difficulty over the DISCUS architecture. see deliverables D4.7
- Produce white papers to help guide regulatory policy that enables a truly competitive environment that is controlled by the customers and users rather than network operators and service providers. Achieved:
  - Four white papers have been produced addressing wavelength usage , business models and regulatory issues. There was a good level of feedback following the first two white papers and this was incorporated in the second two white papers.

Summary of technical achievements

- DISCUS is and end to end architecture solution to tackle the three problems : **Economic Viability**, **Power Consumption** and the **Digital Divide.**

LR-PON is a key enabler for the required architecture change.

- It enables the flat core which has been shown to be the lowest cost solution for the future network
- TDMA+DWA provides future proof bandwidth allocation to all users.
- DWA solutions analysed and preferred solution, without needing AMCC or synchronised quiet windows identified.
- LR-PON protocol channels can co-exist with 100Gb/s DP-QPSK λs .
- 40Gb/s upgrade using bit-interleaved protocol.
- Technology gaps investigated: burst-mode EDC, burst mode FEC, tuneable filter and low cost tuneable laser, burst mode FEC (not in DISCUS) demonstrated.
- SOA amplifier options can open up other optical windows on same LR-PON fibre infrastructure.

Thank you