Cognitive Heterogeneous Reconfigurable Optical Network

Project Number: 258644
Call Identifier: FP7-ICT-2009-5
Funding Scheme: Collaborative project

CCW 2011 – energy efficient networking

Idelfonso Tafur Monroy, Technical coordinator

Technical University of Denmark, DTU Fotonik
The CHRON consortium
Jorge Lopez Vizcaino
Yabin Ye
Current optical transport networks are facing increased levels of heterogeneity

- Different transmission technologies (coding/modulation formats, data rates)
- Different switching paradigms (e.g., semi-static and dynamic wavelength switching)
- Different services with different QoS requirements
- Energy efficiency considerations

Existing monitoring and control systems are not sustainable

How to efficiently control and manage those heterogeneous resources?
Strategy: Use of cognitive techniques

🌟 What is a **cognitive** network?

- A network which **perceives current conditions**, then **plan**, **decide**, and **act** on those conditions.
- A network which **learns from those adaptations** and uses them to make future decisions, taking into account end-to-end goals.

🌟 Cognitive techniques are **promising for heterogeneous environments** (e.g., significant work on radio communications)

**CHRON** proposes the utilization of **Cognitive techniques** in **Heterogeneous Reconfigurable Optical Networks**
Services and Traffic Demand

requirements on PLR, delay, jitter, bandwidth

Cognitive Decision System

decides for each request
- Transmission Technology (format, modulation, bit rate)
- Switching Paradigm
- Resource Assignment (wavelength, transceiver, ...)
- Route
- Fault tolerance

Network Monitoring System

provides network status:
- Energy consumption
- Performance monitoring
- Traffic monitoring

Sensors

Knowledge base

uses previous history

stores scenarios
Energy efficiency aspects

• Evaluation and quantification of energy consumption of end-to-end paths
  • Modulation format
  • Spectral defragmentation
  • Mixed rate and modulation format

• Incorporate energy efficiency aspects into cognitive routing module

• Status monitoring of energy consumption

• Simulations and emulations scenarios

• 10G, 40G and 100G scenarios under consideration
Example of routing with energy efficient multiplexing

**DT Network**  [1]

- 14 nodes and 23 links
- Traffic Matrix (2009)  [1]
- Avg. demand (2009): 15.34 Gb/s
- Diameter of 874 km

**GÉANT2 Network**  [1]

- 34 nodes and 54 links
- Traffic Matrix (2009)  [1]
- Diameter of 7575 km

**DT Network: Static Scenario**

**Energy Efficiency:** Elastic OFDM & MLR most efficient

**Blocking Ratio:** Elastic OFDM significantly lower

**Conclusion:** Elastic OFDM-based network is the most energy efficient
Average flow demand: 230.03 Gb/s

Energy Efficiency: Elastic OFDM & MLR most energy efficient

Blocking Ratio: Elastic OFDM significant lower blocking

Conclusion: Elastic OFDM-based network can be considered as the most energy efficient due to its significant lower blocking ratio.
Conclusions

Fine granularity brings significant benefits in energy efficiency

WDM network with MLR operation
Elastic OFDM-based network

Spectral efficiency directly affects energy efficiency: more traffic transported $\rightarrow$ reduction in power consumption

Further work in CHRON:
Incorporating energy efficiency in cognitive routing for heterogeneous optical networking