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Optical Packet Networks – Conclusions from the IST DAVID project

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Abstract

This paper outlines the result from the European research project DAVID working with Optical Packet Switch solutions for both WAN and MAN. The project started July 2000 and has been completed successfully by the end of 2003.

Introduction

During the last 3½ year the European project DAVID, partly financed by the European Commission through the IST program, has researched and investigated the possible use and exploitation of optical packet switching as the key multiplexing function in the time domain. The optical packet switching technique is combined with wavelength multiplexing in space domain in order to improve flexibility and ease contention resolution introduced by the use of packet switching.

The DAVID (Data And Voice Integrated over DWDM) project is aiming at providing a flexible high performance network that enables service class differentiation down to the optical level realizing that future services even at aggregated level may have variable bandwidth demands and request for different type of QoS parameters.

Optical packet switching has for long been seen as the ultimate solution for the future broadband communication network. In a time when applications get more data centric and the bandwidth needs are more unpredictable the structure of the application interfaces and the network access structure migrates away from pure circuit systems towards more packet-based solutions. In a vision of a simplified network where IP packets are running directly on an optical infrastructure the idea of an optical packet network is born.

The last few years has clearly changed and modified the view on the future broadband network. The naïve view of a simple flat 2-layer network with IP-over-optics has faded and a more classical architectural approach (still allowing new techniques and protocols) has emerged. So the question could be do we still need a packet based operation in the optical layer – and further more is optics mainly a transport technology with multiplex granularity at the wavelength level.

The role of optical packet switching

Optical packet switching provides the ultimate flexibility in bandwidth usage in the transport network as basically any bit rate and any bandwidth profile can be supported. Even if the traffic originates from application or sources with a constant bandwidth demand the aggregated traffic may have strong variations in the demand – this is not the case for current voice traffic, but future applications are more likely to

have this characteristic, at least at some stages in the network hierarchy (and without hierarchy probably in the entire network).

In DAVID project we have investigated not only the feasibility of optical packet switching (this has been done before) but based on intensive network and traffic studies combined with the feasibility of current and emerging technology we defined a scenario covering both MAN and WAN. The main objective of this scenario was to keep the data-path in the optical domain for as long as possible, but also realising that when moving from one network area to another we would convert into electronic domain in order to enable traffic optimisation and potentially also higher layer functions defined by the application. The MAN and the WAN could as such be handled independently.

A clear difference between the MAN and the WAN is physical coverage, which in the MAN can be controlled while it in the WAN is more unpredictable. This affect not only the physical transmission aspects but perhaps even more the administrative issues that commonly are forgotten in feasibility studies.

With a well defined and controllable architecture as in the MAN a common administrative concept can be applied that can be optimised and handled in a predictable manner.

In DAVID we changed the focus during the project more and more towards the MAN (away from a balanced view on both MAN and WAN) as it enabled us to develop more integrated and viable solution the use optical packet switching. This re-focussing in the project affected both the demonstrator and the migration strategy with the definition of a sequence of steps towards the final objective – a path including e.g. the DBORN concept.

A problem with the WAN is the unpredictability of the path which complicates the administrative issues and specially the congestion handling. The physical layer performance might also be considered a critical issue as the length and characteristics of the optical path is strongly depending on routing strategy and protocol. However this is solvable by the use of all optical signal regeneration (3R) which in a future optical network should/must be a default function in all network elements.

Despite that new optical technologies usually start being applied in the very core of the network and through cost optimisation migrates closer to the edges, this might not be the case for optical packet switching. In this case the use of optical packet switching look more applicable for the MAN as viable approaches exist, the concept are much better understood and probably also the requirement. Optical packet switching in the WAN still needs significant research to be demonstrated feasible – at least as a common multiplex technique for all kinds of services.

That the role of optical packet switching is more obvious and well defined in the MAN than in the WAN puts an even stronger push on the issue of cost optimisation. The MAN area is characterised by strong competition from other non-optical solutions, but studies within the project has shown that it is realistic to make an optical packet switch MAN cost competitive to other solution – and then the cost optimisation in optics has almost just started.

Conclusion

A clear consequence of the recession in the communication industry has been a refocus on classical solution and very limited interest in long term approaches requesting both physical and mental investments. However optical packet switching will remain a clear target in solving the bandwidth bottlenecks when finally the network migrates to a true broadband network with fiber to the home etc. Especially the high flexibility of packet switching is very attractive, but also costly. This balance between cost/complexity and performance gain still need to be solved. While the gain to some extend is understood the true cost in realising an optical packet switch network is still an open issue as cost optimisation and network focus in optical component research still is in its infancy.

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