Just-in-Time Optical Burst Switching

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1 Introduction

We describe the new switching method for the optical wavelength division networks (WDM) called Just-in-Time Optical Burst Switching. It is a reservation based architecture whose distinguishing characteristics are its relative simplicity, amenability to hardware implementation, the performance. It is suitable for the high-speed optical networks with the ultra-low latency.

2 Switching

In the optical network we can switch the signal in the electric domain (O/E conversion, switching, E/O conversion) or in the optical domain. If the data remain in the optical domain throughout their paths except end the ends, then these networks are called all-optical networks. We will study all-optical networks, because this method is designed for it. The signals can be switched in the space, in the time and in the frequency or wavelength.

The communication can be on the base circuit switching, packet switching. It means that the circuit switching can be in the space, time and frequency or the packet switching can be in the space, time and frequency.

2.1 Circuit Switching

In optical circuit switching the channel is still busy during the whole connection. In this case we separate the set up phase, the transmission phase and the release phase. After the connection was set up, the all capacity of the channel is afforded for transmission a message. The capacity is independent of load in a transmission system.

The data transfer path is set up prior to the transmission of the data burst. The signalling is usually transmitted an individual channel. It is called out-of-band signalling. The source station that has a data to transmit initiates an out-of-band distributed signalling procedure to determinate path, wavelengths and set up switches (cross-connects). When a data transfer path is available, the data can be transmitted from the source station to end station by this path. The set up time is significant. The set up time for data burst can be improved by pipelining the switch set up times with the propagation time.

If at some intermediate node no wavelengths are available on the output port, then the message is sent back about it from this node to source. The call is blocked and it is lost.

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2.2 Packet Switching

In the packet switching the message is divided in the several packet. The every packet is the same length and each of them has control information. The control information have to include a destination address. In the packet switching case we know two ways of traffic. If the all packet of the same message are transmitted the same route this traffic way is called service of packets by virtual channel (logic connection). If the packet of the same message are transmitted the any route this traffic way is called service of packets by without virtual channel (not logical connection or datagram service).

For optical packet switching the control information associated with a data and it travels with the data as the packet header the same route. At each node, the packet header is separated from the data or burst data. It is processed to determinate the output-port. A routing and assignment protocol may be used to determinate the next-hop towards the destination. The WDM switch controller sets up the switches (cross-connect) along with assignment wavelength (wavelength conversion). The data or burst is buffered during the period of header processing and cross-connect set up.

If an output port is not available then the data is dropped and lost. No message send about it from this node to the source station.

2.3 Just-In-Time Optical Burst Switching

The Just-In-Time (JIT) Optical Burst Switching (OBS) is the switching method, which use to switch the optical data burst. The burst switching as contrasted to circuit or packet switching, implies that the network is cable of switching data in variable sized length. Signalling is just-in-time, it means that signalling messages of its data burst travel slightly ahead of the data burst. The signalling is out of band, signalling messages and data bursts are transmitted by the different channels. The signalling packet of every data burst undergoing electro-optical conversion at every hop, but data burst travel from source station to destination station transparently (only optical domain).

It combines desirable features of circuit and packet switching, that means an out-of-band signalling (separate control channel from data channel) and an explicit feedback. It is designed for ultra-low-latency unidirectional transport of data bursts across the optical networks.

The main difference between the optical burst switching and the circuit switching is that in the circuit switching case, the channel is still reserved although the data is not transmitted. The main difference between the optical burst switching and the packet switching is the signalling message is separated from the data burst. It is the out-of-band signalling. In the optical burst switching, the signalling massage and data burst are transmitted separately, each of them are travelled different route. The signalling messages are sent just ahead of data burst to inform the switches. The signalling messages are converted from the optical to the electrical domain at each nodes to determinate destination and to set up switch. However, the data burst are transmitted only optical domain (transparently).

This switching method is designated for the high-speed and the ultra-low-latency. It means that the method is designated for no buffering inside the network and to switch variable-sized data bursts. The switch are only configured for a brief period of time, just enough to pass the burst. The switch are available to switch other bursts immediately after. The different between the method and packet switching method is the lack of buffering and the much wider range of burst length, from very short (packets) to very long (circuit).

3 JIT Signalling Architecture

The JIT OBS method is characterised by the fact that the signalling messages are sent just ahead of the data bursts to inform the switches. The common this method is the elimination of the route-trip waiting time before the information is information is transmitted. It is called the tell-and-go approach. The switching elements inside the switches are set up for the arrival burst as soon as the first signalling message announcing the burst is received. We know the different signalling method with respect to the fact, that how soon before the burst arrival and how soon after its departure the switching elements are available to route other incoming burst. We know the following approach:

- **Explicit setup and explicit release**. The switching elements inside the switch are configured for incoming data burst immediately after the arrival of the *setup* message, and remain in that configuration until a *release* message arrivals.
- **Explicit setup and estimated release**. The *setup* message carries the information about the duration of the burst. It is meant that no *release* message is needed to mark the end of the burst. This information is determined by the switch from the arrival time of the *setup* message and the information about length of the burst contained in it.
- **Estimated setup and explicit release**. This approach is the opposite of approach 2. It means that the instead of estimating the end of burst, the start of it is estimated based on information contained in the *setup* message. This approach requires an explicit *release* message release the switching elements so they become available for routing other bursts.
- **Estimated setup and estimated release**. The start and end both of the burst are predicted based on information contained in the *setup* message.

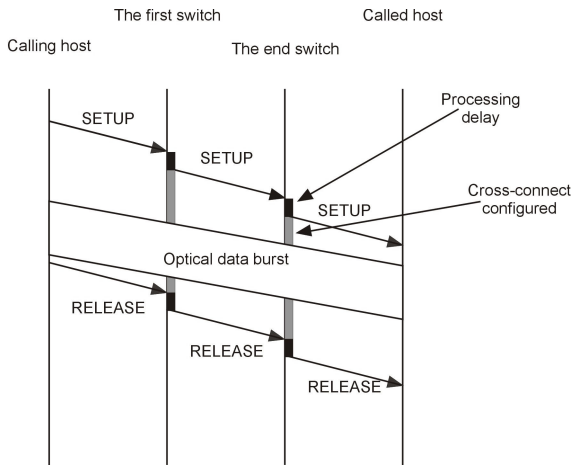

Fig.1 Explicit setup and release

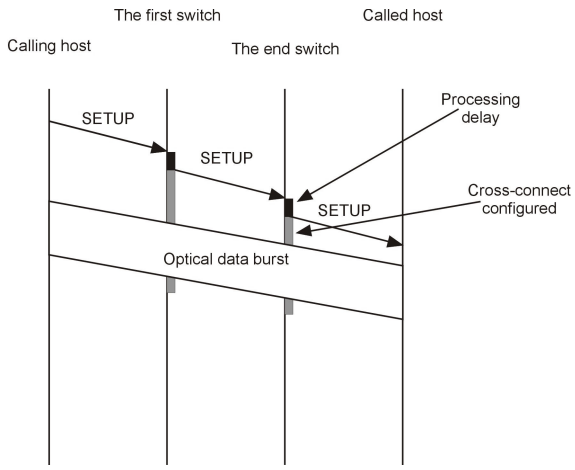

Fig.2 Explicit setup and estimated release

These approach are different in amount of the time the same data burst would occupy the switching elements. The more accurately estimation of start and end of the data burst results in lower holding time switches and lower blocking probability. The explicit notification approach give the worst estimates (it is their own arrival time). On the other hand, the predictive approach are the best (it is assuming the estimates are accurate). However, we have to find a compromise between the number of signalling messages and the complexity of the switch scheduler. You can see every approach in the picture.

In the case that the any node has no available output wavelength, the call is blocked and lost. This node send message about it to the source station.

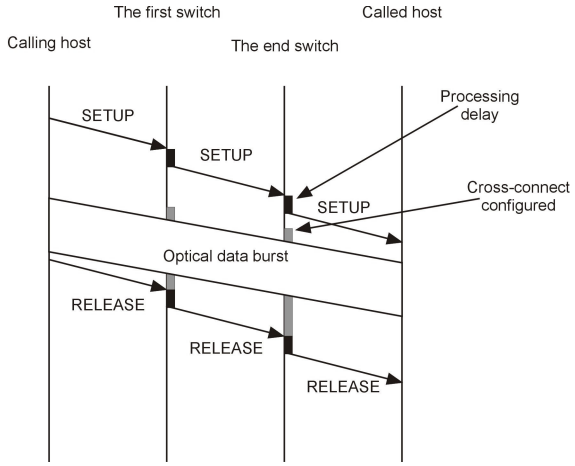

Fig. 3 Estimated setup and explicit release

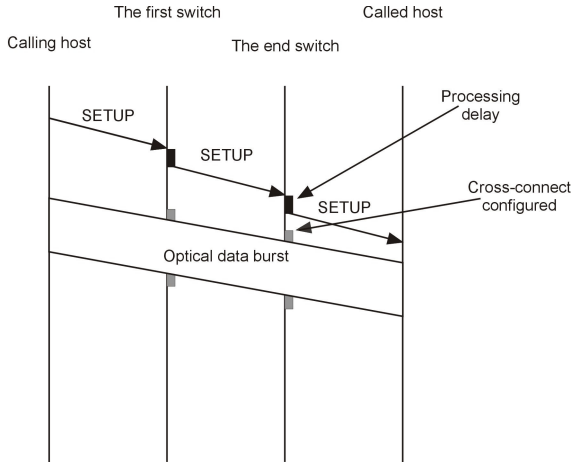

Fig. 4 Estimated setup and release

3.1 Extract from the unicast signalling flow

The source station that has the a data to transmit sends message *setup* to its access node. The *setup* can carry the information about the duration of the burst. The switch respond with a *call proceeding* to indicate that connection set up is on its path to the destination. In the reply message there is a *delay parameter*. It is indicates how long the source should wait before launching its data burst. The delay is estimated by the switch from the number of hops to the destination (transmission time), the set up time of the switch along the path. When a switch receives a *setup* it will try to reserve the idle wavelength and forward the *setup* to next hop towards destination. The switch set up is performed in parallel witch transmission *setup* to next node. It is very important. If the switch has no wavelength available on the next hop, this node sends back a *blocked* to the source station. When the destination receives the *setup*, it responds with *connect*. It is travels back to the source. After transmitting the optical data burst, the source sends *release* to release all served wavelengths.

4 Conclusion

We have studied this the new switching scheme called Just-in-Time optical burst switching. This method combines the advisable features of circuit and packet switching methods. It seems that it will be future.

References

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SUMMARY

In diesem Artikel habe ich mich mit der neue Methode der WDM Netzevermittlung beschäftigt, die JIT heisst. Diese Methode ist entwickelt fu:r sehr schnelle optische Netze mit der kleine Verspätung. Diese Methode nutzt entsprechende Eigenschaften der Paketvermittlungsmethode und der Kanalvermittlungsmethode. Am Schluss habe ich auch den Signalisierungsnachrichtenlauf entwerft.