Introduction:
Optical time-division multiplexing (OTDM) technology is a promising technique to realize the ultra-speed optical transmission system, which attracts much attention in terms of not only high capacity but also high flexibility. In achieving such ultrafast networks, various signal processing must be carried out in the optical domain in order to avoid bottlenecks due to the optical to electronic conversion. There are many technique for implementing all optical routing and switching for OTDM networks, which are based on cross-phase modulation (XPM) in conjunction with interferometric arrangements such as Mach-Zehnder interferometers (MZIs), terahertz optical asymmetric demultiplexers (TOADs) and ultrafast nonlinear interferometers (UNIs). A technique for separating the clock synchronization pulse from an incoming OTDM data packet, based on all-optical switching devices with optical feedback is presented. Three Symmetric Mach-Zehnder (SMZ) have been used to model a 1x2 router. Simulation result show that synchronization between clock and data packet is achieved and payload has successfully been switched to the correct destination port.

Network Technologies

Ultrafast Optical Time-domain Technology - Issues

Synchr

All-optical demultiplexing techniques and devices

Types of demultiplexing are being investigated:
- Optical loop mirror
- Interferometer with semiconductor optical amplifier (SOA)
- Optical loop mirror: Terahertz optical asymmetric demultiplexer (TOAD)
- Interferometer: Symmetric Mach-Zehnder (SMZ)

WDM Router

- Optical cross-connects and optical add-drop multiplexers have been implemented to perform routing and switching tasks
- The major nonlinear phenomena that effect the performance of WDM systems are four-wave-mixing (FWM), stimulated Raman scattering (SRS) and cross phase modulation (XPM).

Solution:
OTDM router using all-optical switches based on cross-phase modulation in SOA (e.g. TOAD, SMZ etc.).

Terahertz Optical Asymmetric Demultiplexer

Symmetric Mach-Zehnder (SMZ)

Switching window = \( \Delta t \) data and control signals co-propagate
Minimum switching window width = \( \approx 3 \text{ps} \), limited by control pulse width
Integratable structure
SMZ switching window, \( W(t) \),

\[
G_c(t) = \exp \left[ -\frac{r}{T} \right] \cdot \exp \left[ -\frac{r}{T} \right] \cdot \exp \left[ -\frac{r}{T} \right] 
\]

All Optical Router

Simulation Results

OTDM Input Signal
Extracted Clock Signal
Transmitted Output of SMZ
Reflected Output of SMZ
Transmitted Output of SMZ

Conclusions

- A node model for a 1 X 2 OTDM router for asynchronous packet routing is presented
- The switching devices employed for clock recovery and payload routing are carried out in optical domain using SMZs
- Simulation results demonstrated that clock recovery, address recognition and payload routing has been achieved successfully
- One of the method to evaluate the performance of an all-optical switch is to measure switching windows and to determine their width and contrast, which both values depend on the shape of the switching window
- The results show SMZ switch has better performance compared to TOAD switch

Further Work

- Noise and crosstalk analysis
- BER performance
- Simulation of multi-hop networks

SIMULATION OF 1X2 OTDM ROUTER EMPLOYING SYMMETRIC MACH-ZEHNDER
Razak Ngah, Zahib Ghassemlooy, and Graham Swift
Optical Communications Research Group, School of Engineering, Sheffield Hallam University, Sheffield, S1 1WB
Tel: +44 114 225 3301, Fax: +44 114 225 3433, Email: r.ngah@shu.ac.uk