Digital Optical Processing and Latency Challenges

2017 NSF Workshop on Free Space Optical Networks

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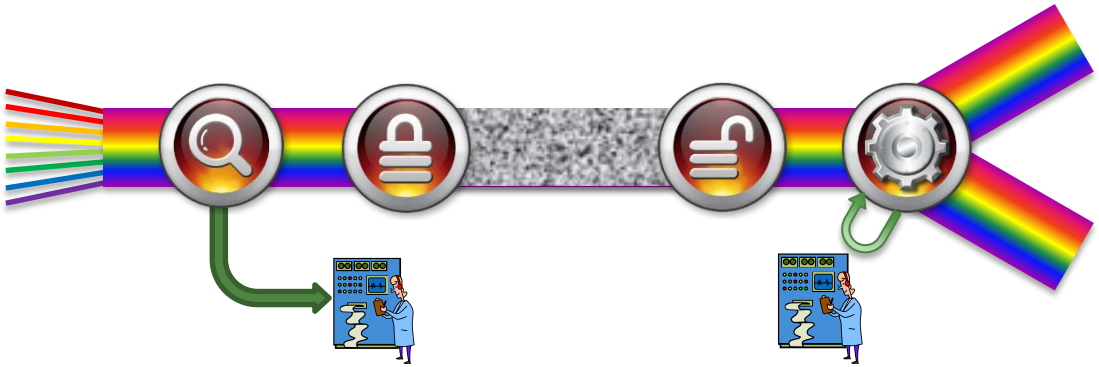
Digital Optical Processing

- In-transit computation is needed
  - *Forwarding* improves network flexibility
  - *Crypto* enables cross-channel entropy mixing
  - *Filtering* selects from data to big to store



Optical Turing Machine

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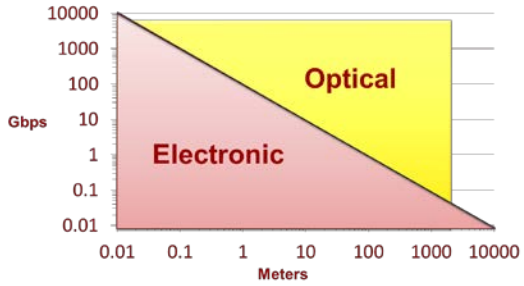
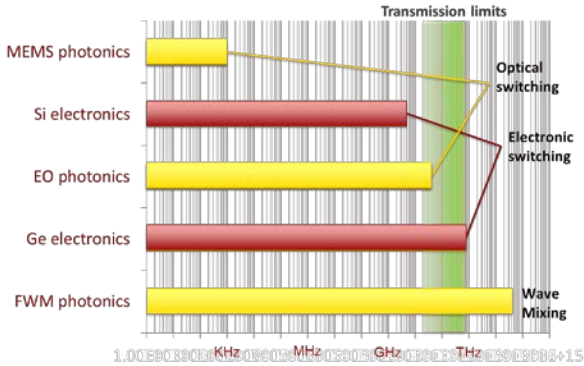
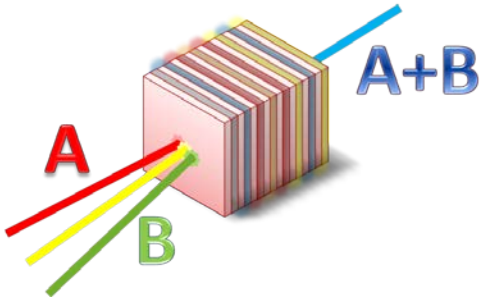
- Focus on optics
  - BW*dist > 100 Gb-m/s requires optics
- Unify computation and communication
  - One encoding for both
  - Avoid OEO and OO'O
- Leverage native properties
  - Optical mixing to compute
  - Switching to program



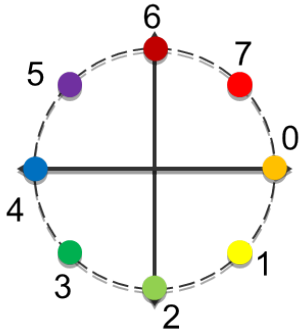


Key OTM Observations

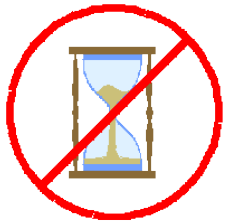
- Processing requirements
  - Supports a field
  - Recirculates
  - Semantics-preserving
- Encoding requirements
  - High-density
  - Regenerates



Wave Mixing

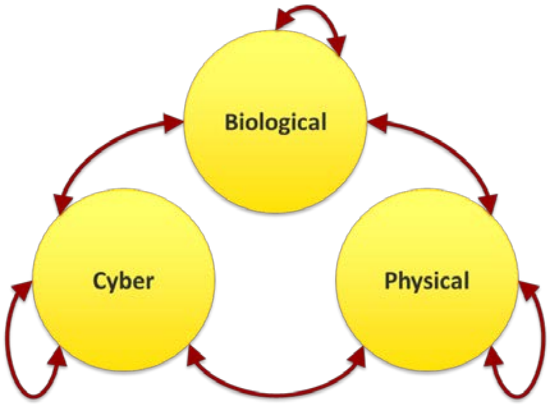


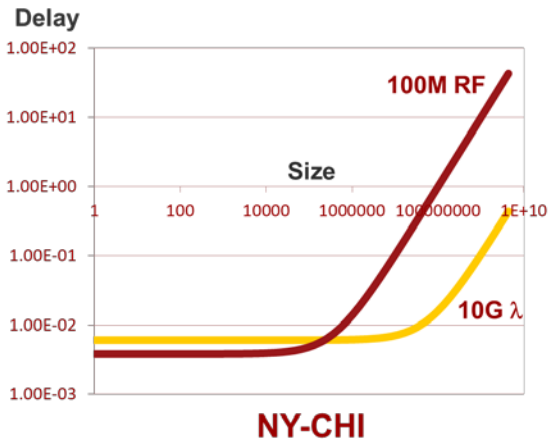
M-PSK

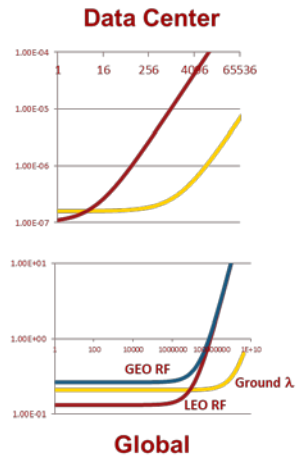


Latency Issues

- Messages have a budget
  - Delay is a message property
  - Interaction defines a budget
- Multiple sources of latency
  - Generation, transmission, processing, sharing, grouping
- Mitigations are complex
  - Some interact
  - Others require context







Integrated Solutions

- The challenge of nonlinear composition
  - OTM requires nonlinearities to create a field
  - Latency combines in nonlinear ways
- Both require a multifaceted approach
  - Transmit, compute, and regenerate while preserving encoding semantics
  - Use application context to reduce latency

Combining aspects of many dimensions and layers