Large scale optical circuit switches for future data center applications

ONDM2017 workshop

Yojiro Mori and Ken-ichi Sato

NAGOYA UNIVERSITY

Outline

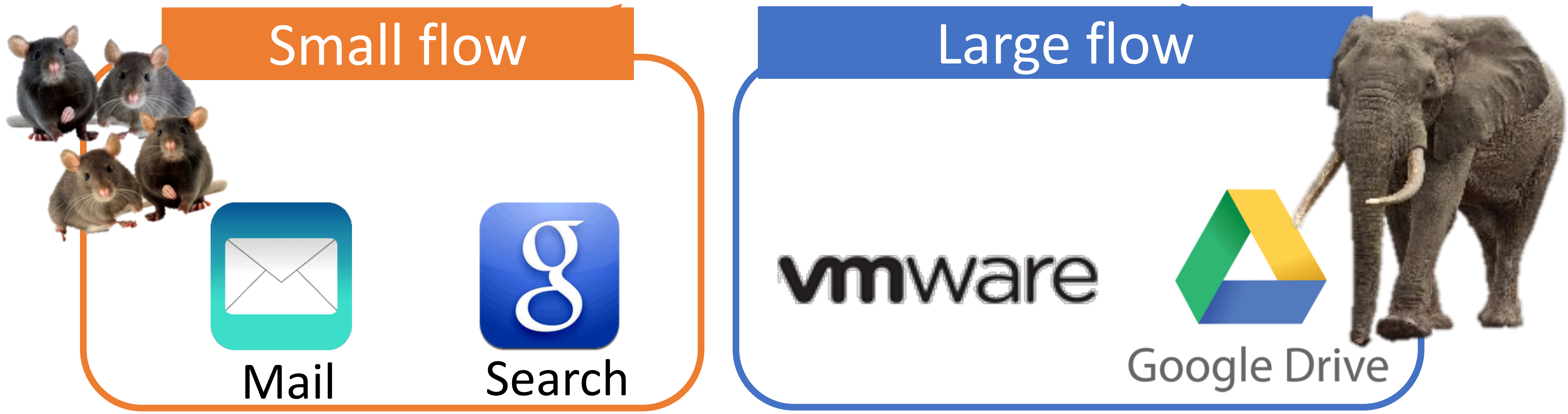
1. Introduction
   -Optical circuit switch for datacenter-

2. Sub-switch configuration

3. Large-scale optical switch
   - ➢ based on tunable laser
   - ➢ based on tunable filter

4. Summary

Datacenter Flow



Datacenter flow= Mice flow + Elephant flow

Yojiro MORI, Nagoya University

Hybrid Network Architecture

Internet

Intra-datacenter network

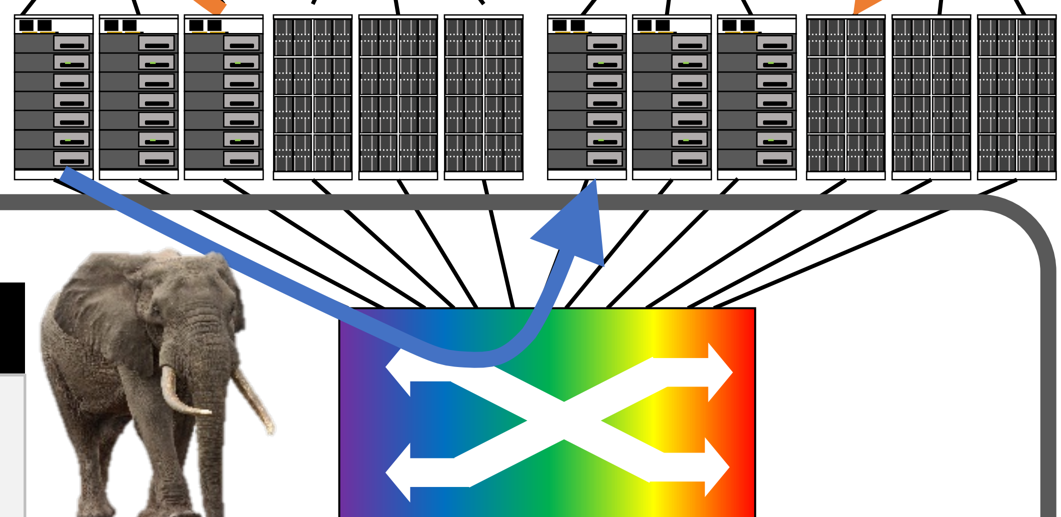
Electrical packet switch net

Mice
ele

Requirements

1. Large port count for supporting many ToR switches
2. High speed switching to reduce latency
3. Low cost

Mice flow
Elephant flow



Optical circuit switch network

Elephant flows are processed by an optical circuit switch

Optical circuit switch

Large-scale optical circuit switch

Space switch

Pros:
Wavelength independency

Cons:
Complexity $\propto$ (Port count)^2

Wavelength-routing switch

Pros:
Cost effectiveness

Cons:
Bandwidth limitation

Combination of
space switch and wavelength-routing switch

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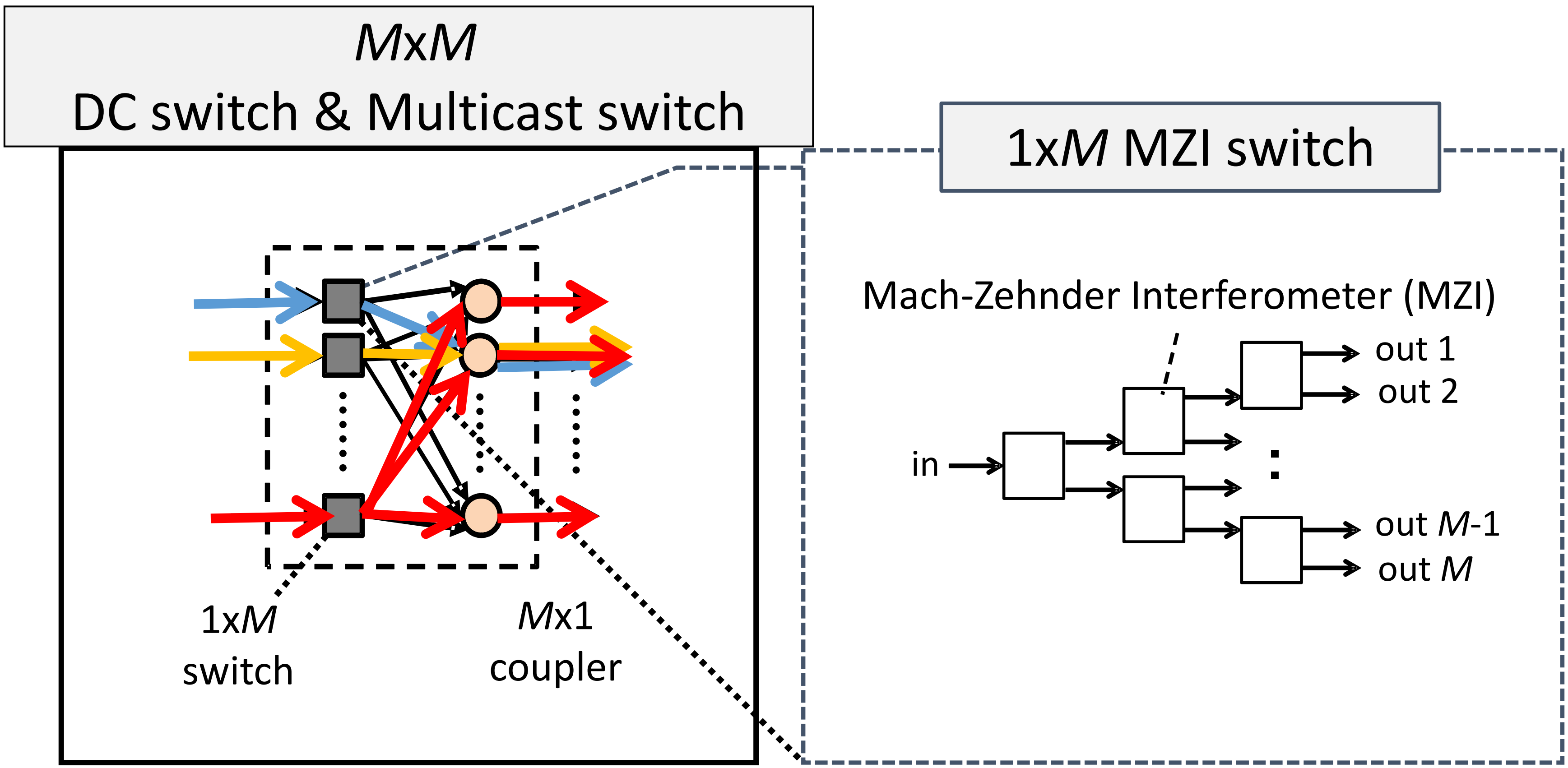
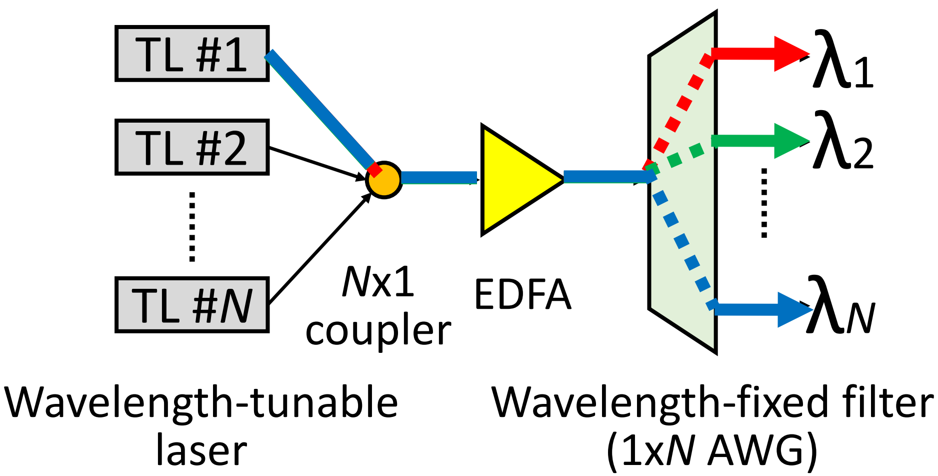
Space Switch



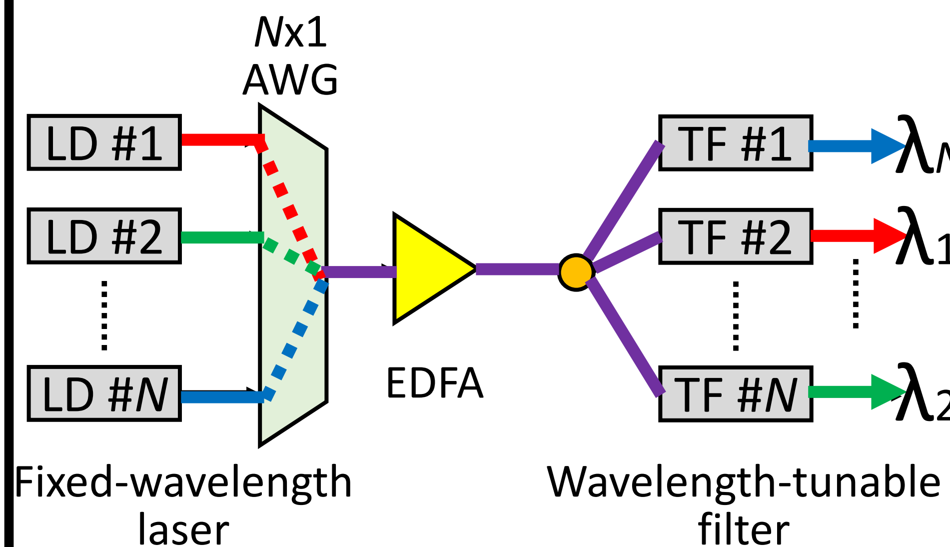
DC: Delivery and coupling

Wavelength-routing Switch

*N*x*N* wavelength-routing switch based on **tunable laser**



*N*x*N* wavelength-routing switch based on **tunable filter**



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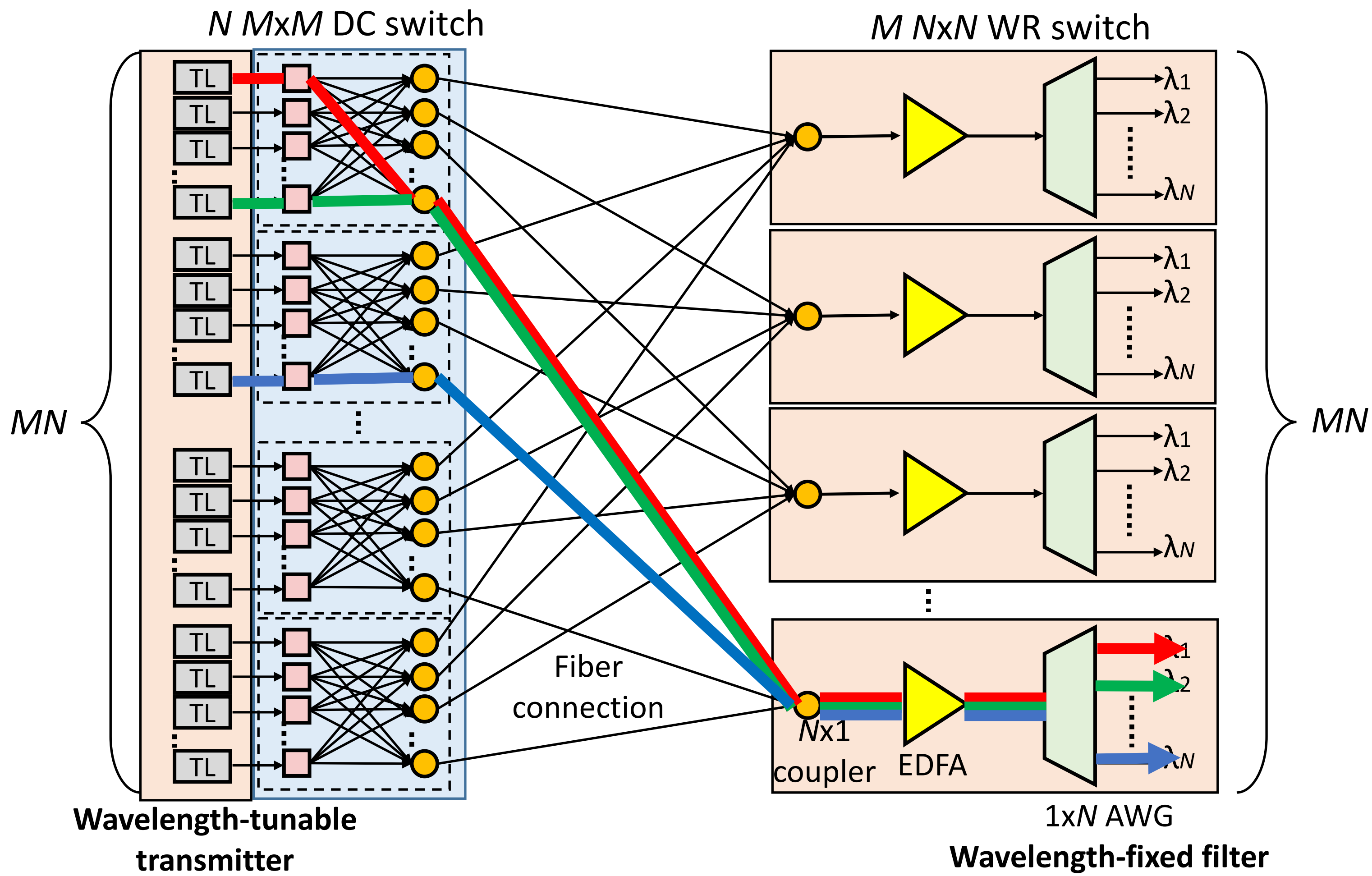
Switch based on Tunable Laser



	Tunable laser	*MxM* DC switch	EDFA	1x*N* AWG
Total #	*MN*	*N*	*M*	*M*
Per-port	1	1/*M*	1/*N*	1/*N*

Experimental Demonstration [OECC2016]

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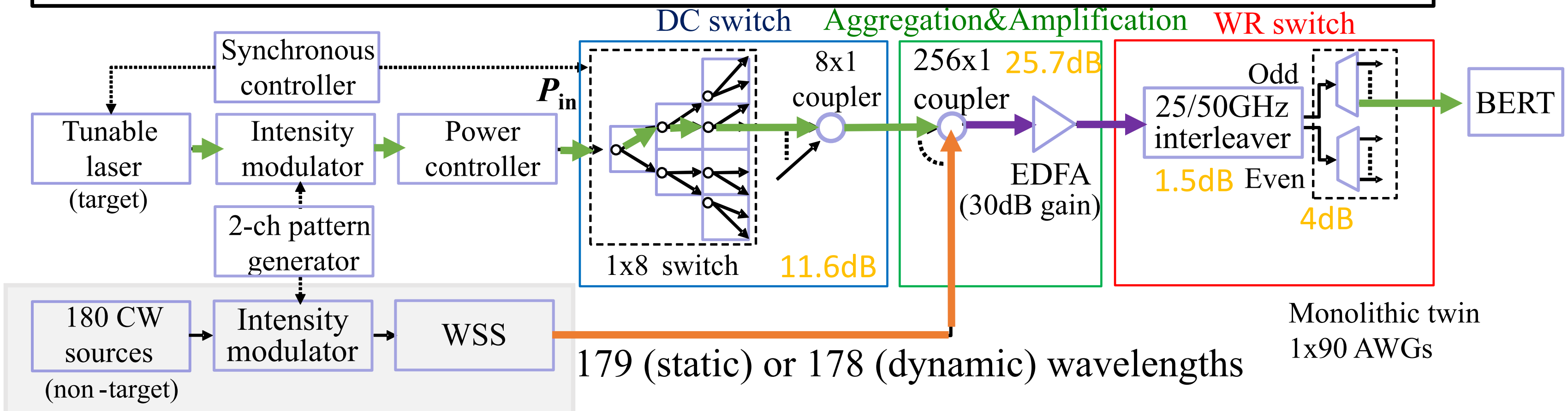
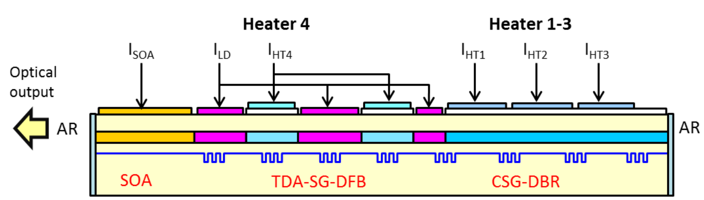
- **1,440x1,440 optical switch**
  - DC-switch scale is **8**
  - # of wavelengths is **180** (on 25-GHz grid)
- 10Gbps intensity-modulated signals



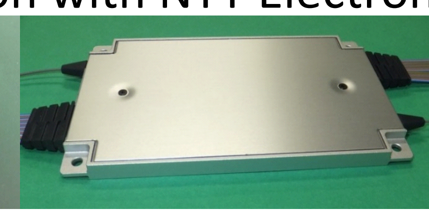
Crosstalk source

Structure of fast-tunable laser
(Collaboration with AIST)



PLC-based AWG
(Collaboration with NTT Electronics)

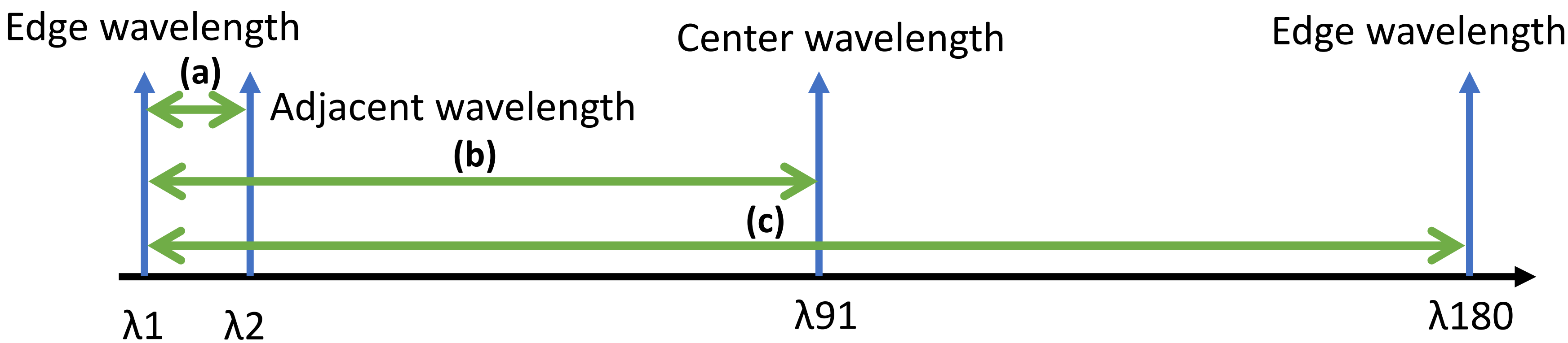
PLC chip
36.4x44.0 mm^2

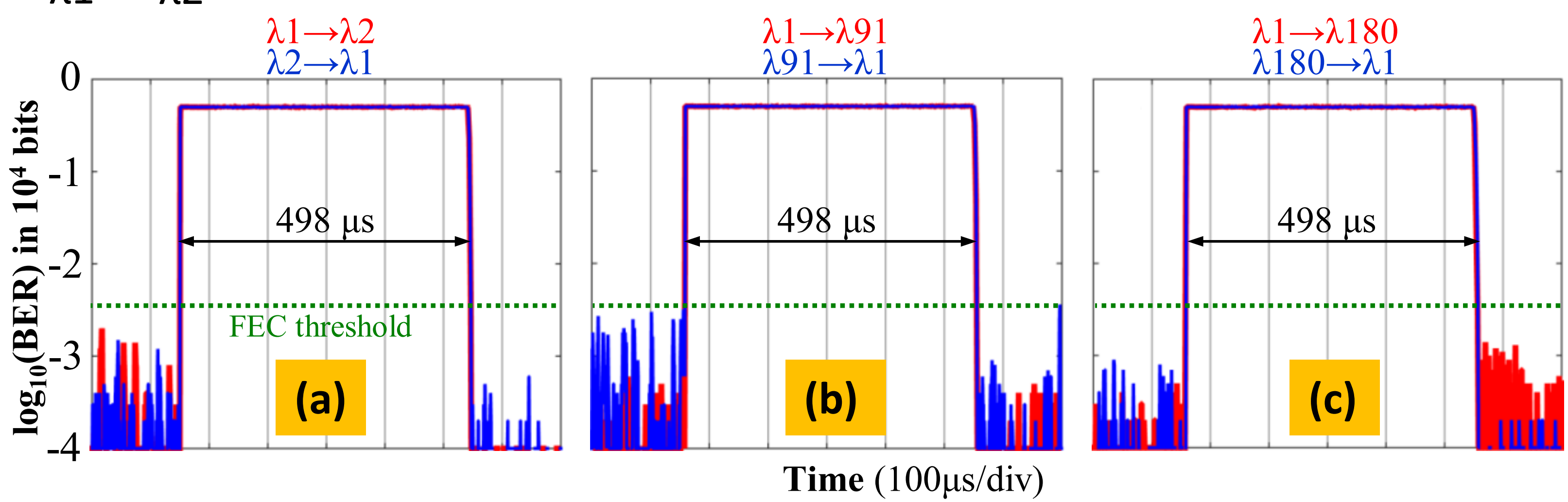


Module box
120x70x7 mm^3

Yojiro MORI, Nagoya University

Switching Time [OECC2016]





Good transmission characteristic with <500µs switching time

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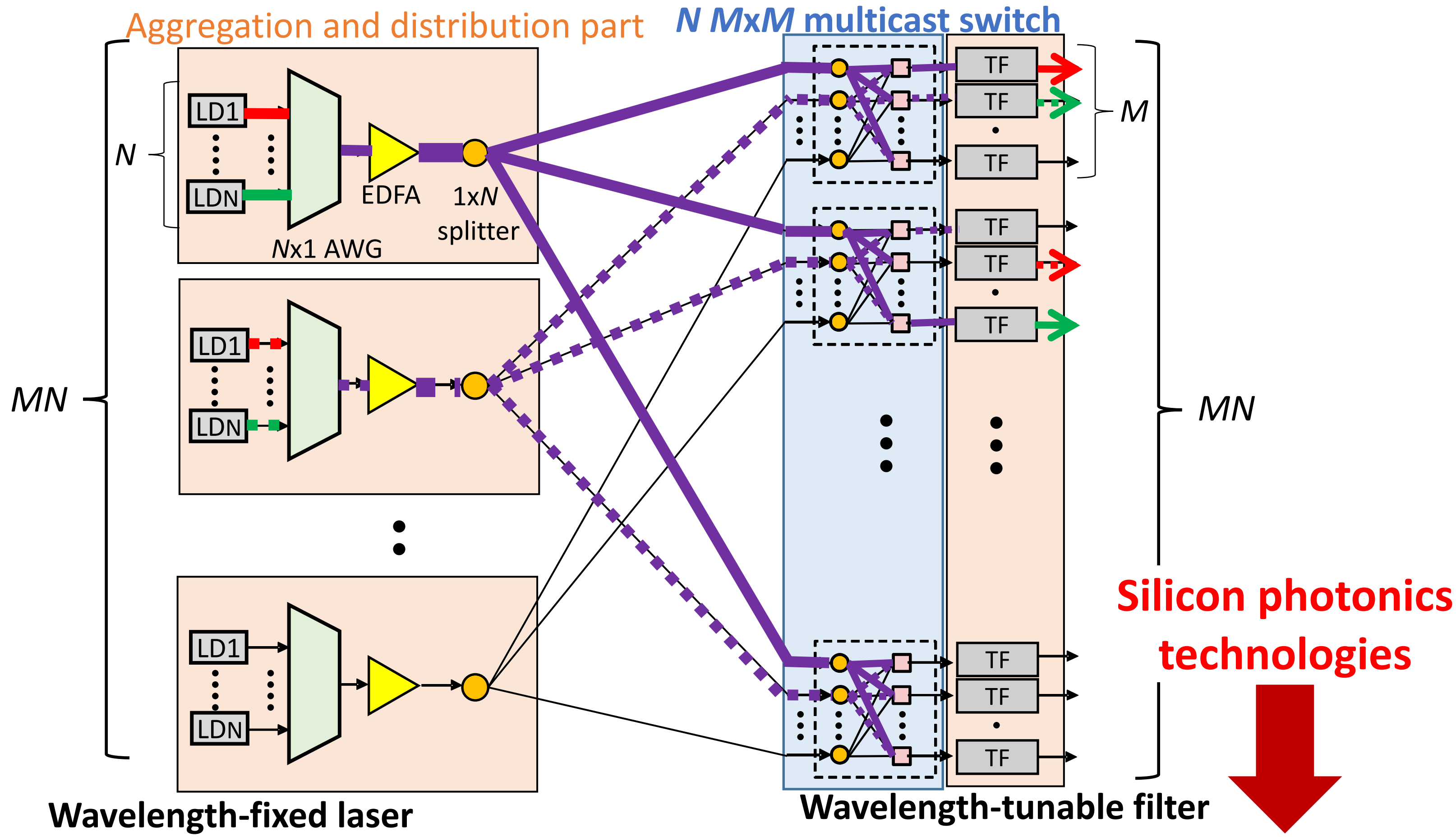
Switch based on Tunable Filter



	Fixed laser	Nx1 AWG	EDFA	MxM multicast switch	Tunable filter
Total #	MN	M	M	N	MN
Per-port	1	$1/N$	$1/N$	$1/M$	1

Silicon-Photonic Switch Components [ECOC2016]

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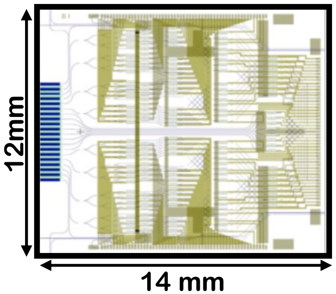
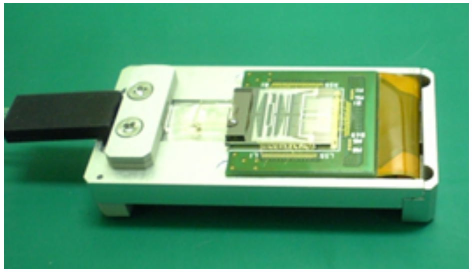
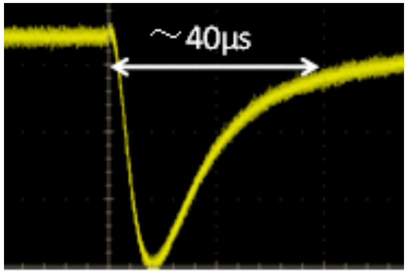
Fabricated 8x8 MC/DC switch (collaboration with NEC)



(a) chip

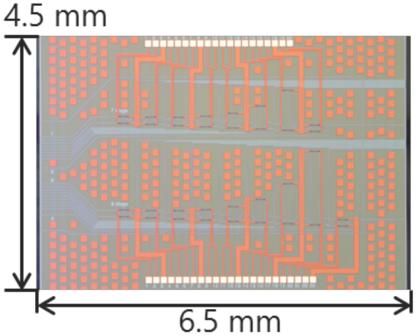

(b) module



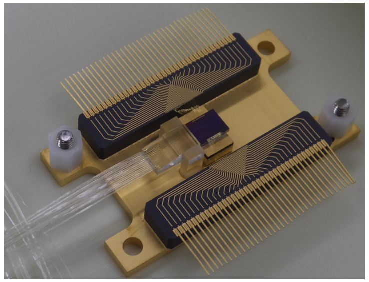
(c) measured switching time

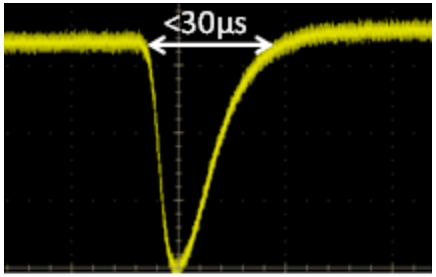
Total loss: 16 dB
On-chip loss: 4 dB

Fabricated tunable filter switch (collaboration with AIST)



(a) chip


(b) module



(c) measured switching time

Total loss: 18 dB
On-chip loss: 4 dB

Proof-of-Concept Experiment [ECOC2016]

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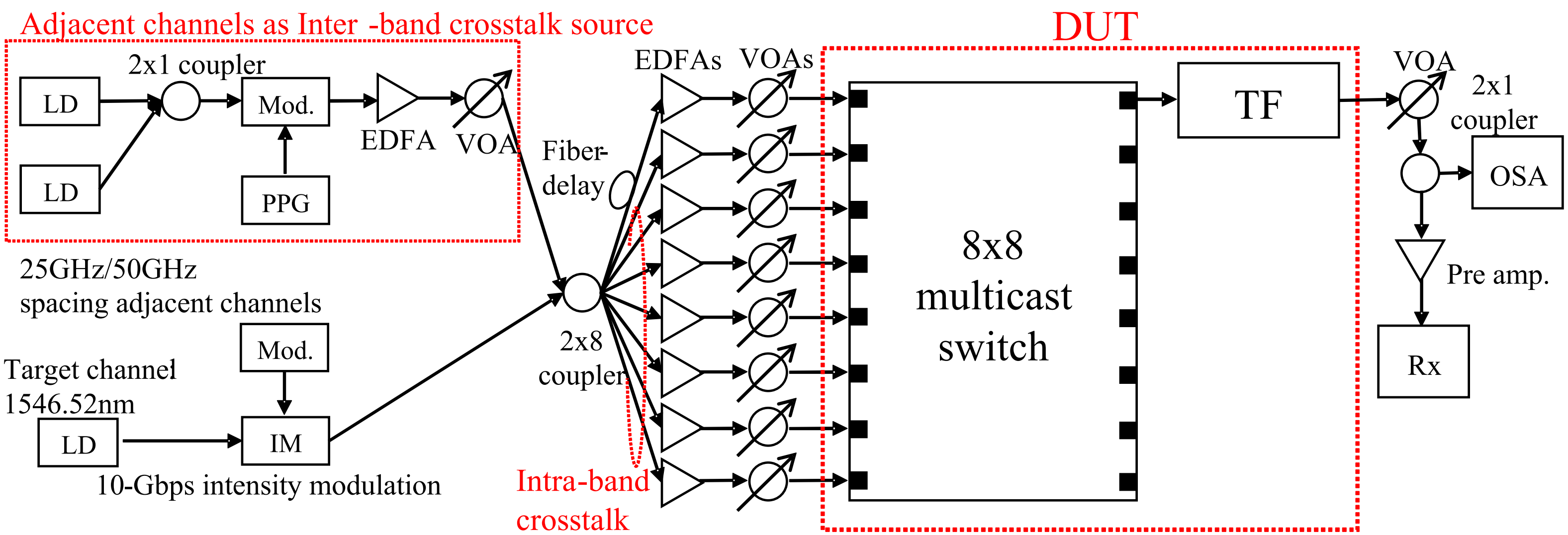

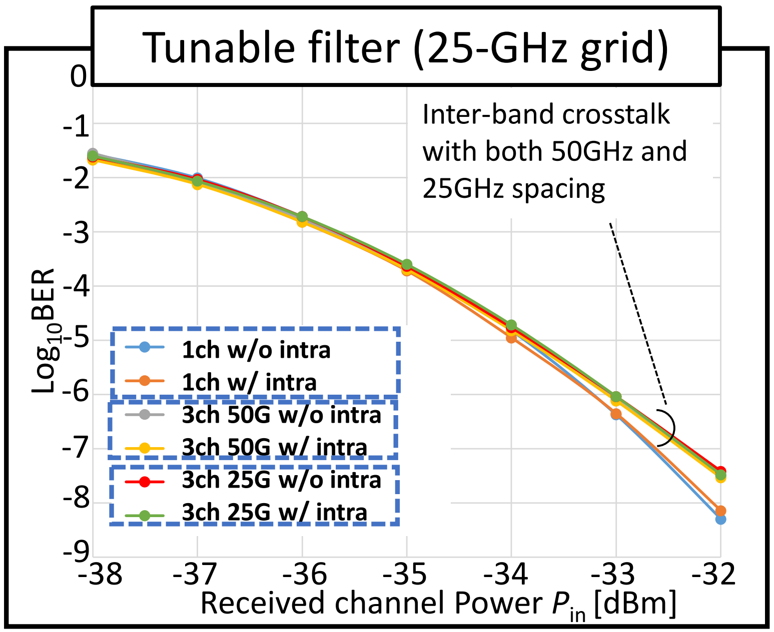

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Summary

- We introduced large-scale optical circuit switches for future intra-datacenter applications.

- The large-scale switch can be attained with a combination of space switches and wavelength-routing switches.

- We demonstrated optical switches based on tunable laser or tunable filter.

- Considering the switching time, tunable-filter-based switch may be suitable for future applications.

Thank you for you kind attention