Intra-Rack Resource Disaggregation Using Emerging Photonics

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Special Focus Optics

Intra-Rack Resource Disaggregation Using Emerging Photonics

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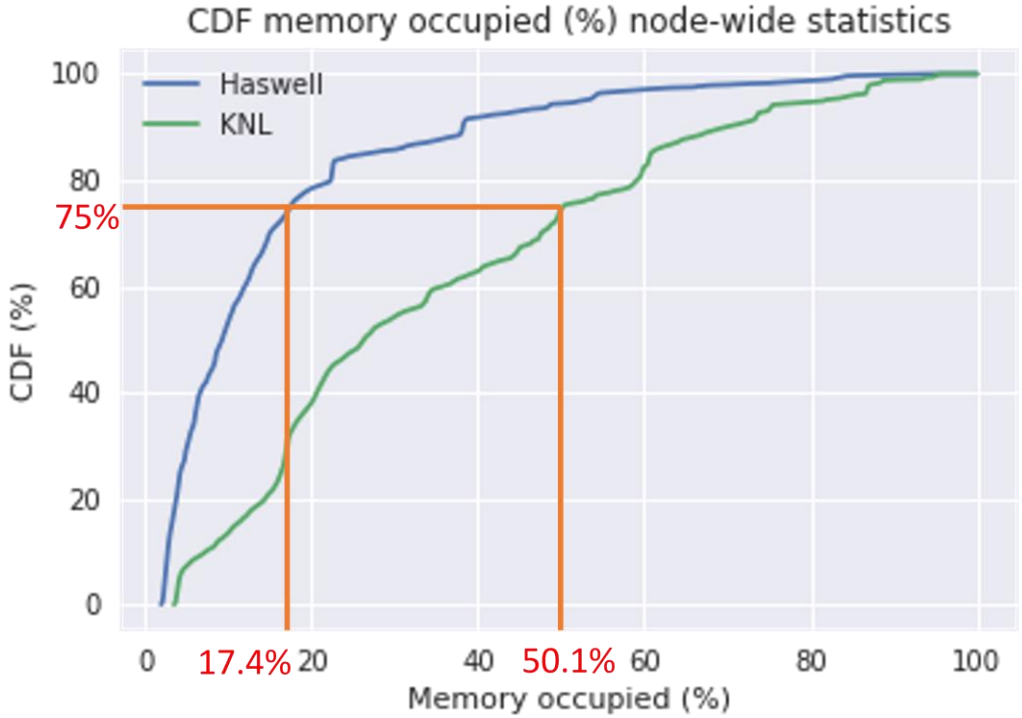
PINE

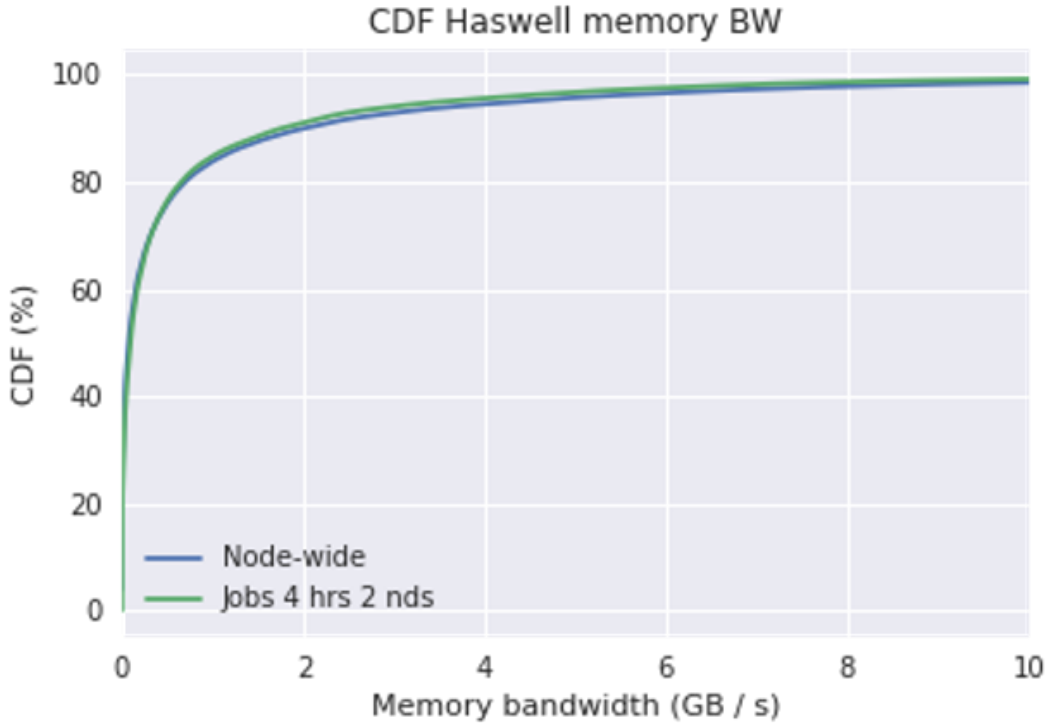
CHANGING WHAT'S POSSIBLE

Resources in HPC are Underutilized



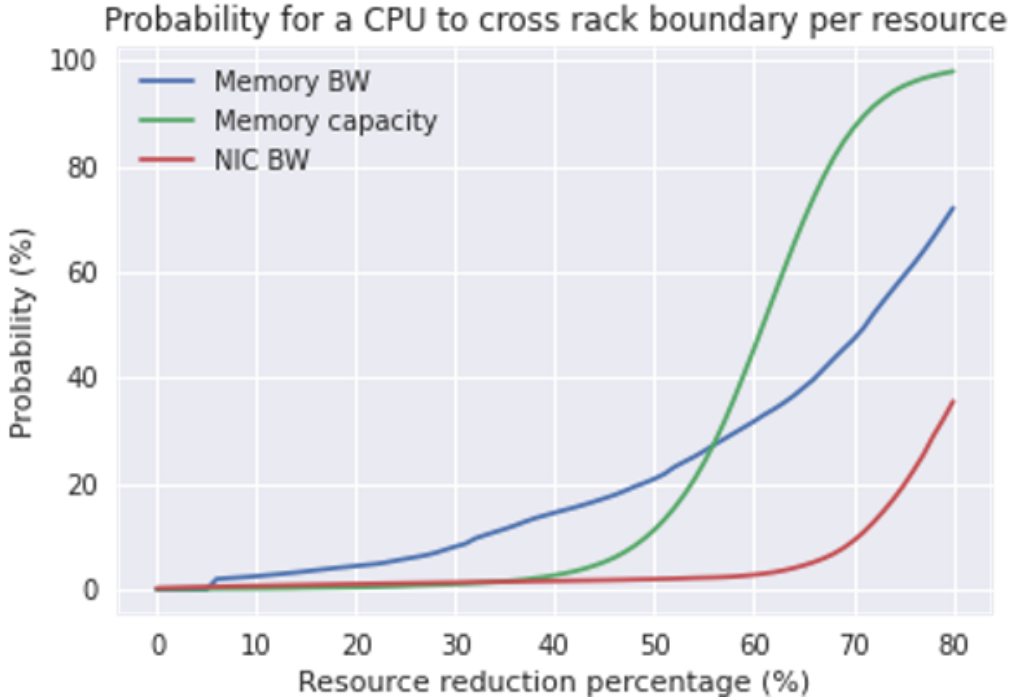
G Michelogiannakis et al., "A Case for Intra-Rack Resource Disaggregation", ACM TACO 2022

Resources in HPC are Underutilized



G Michelogiannakis et al., “A Case for Intra-Rack Resource Disaggregation”, ACM TACO 2022

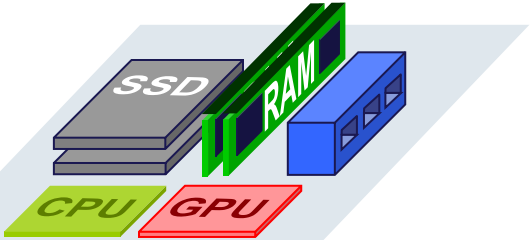
Intra-Rack Disaggregation Suffices



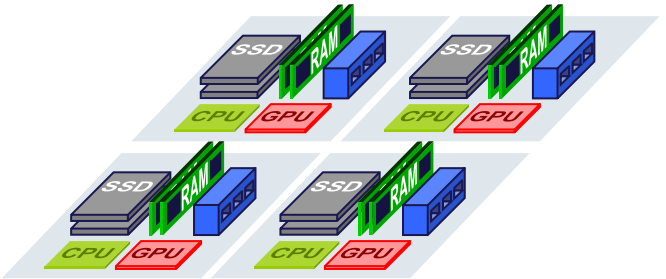
G Michelogiannakis et al., “A Case for Intra-Rack Resource Disaggregation”, ACM TACO 2022

Towards Racks That Pool and Compose

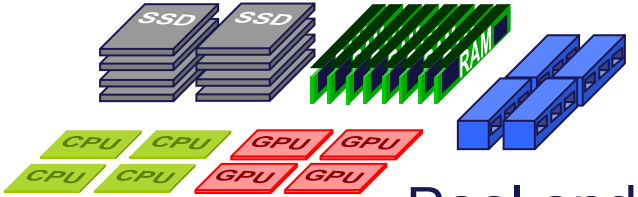
Current server



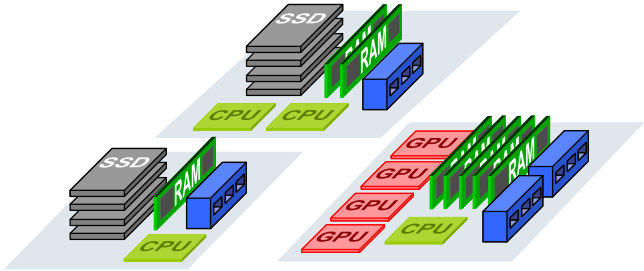
Current rack



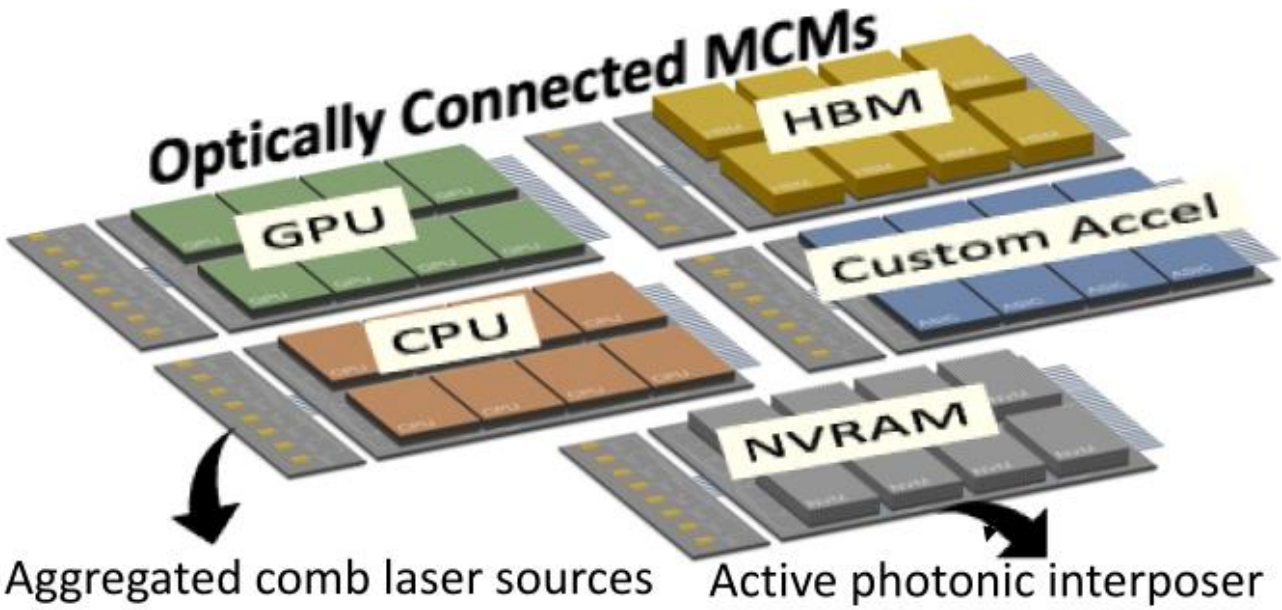
Disaggregated rack



Pool and compose

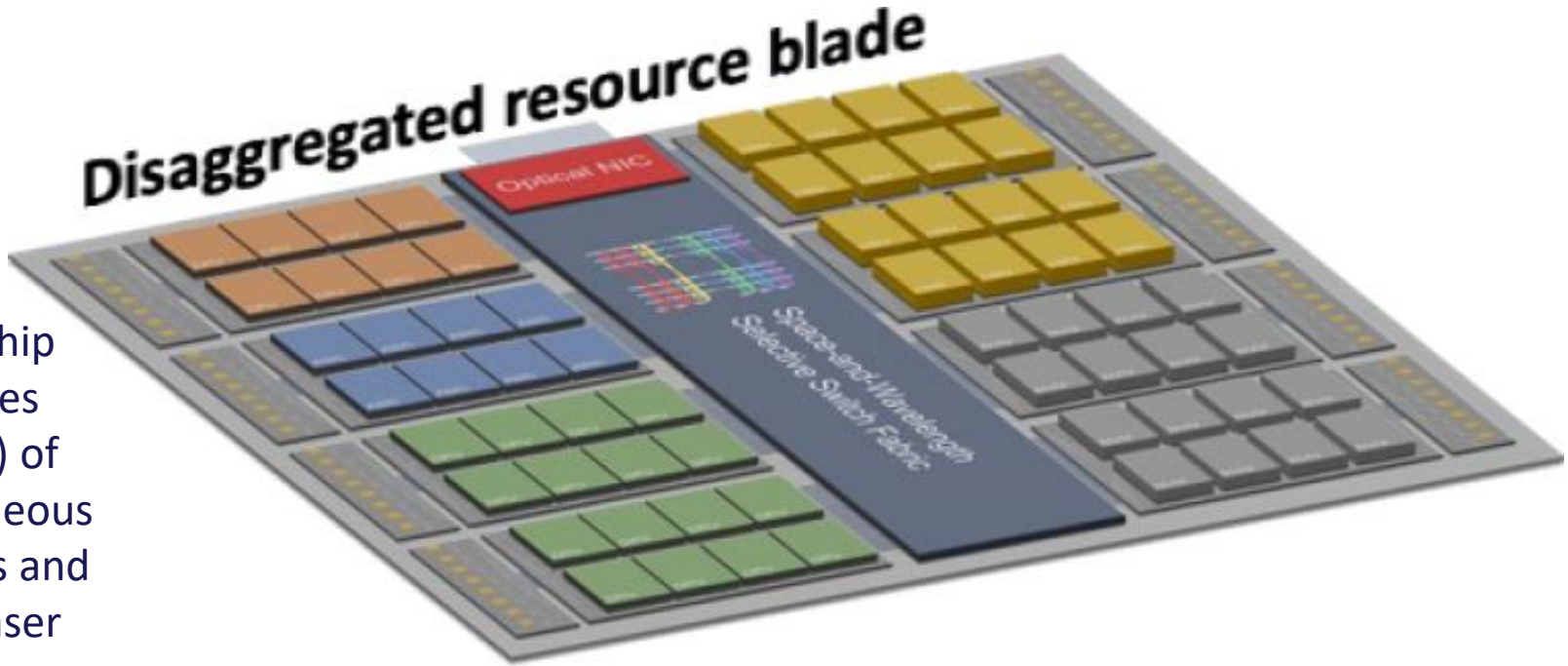


Photonic-Based Hardware Implementation

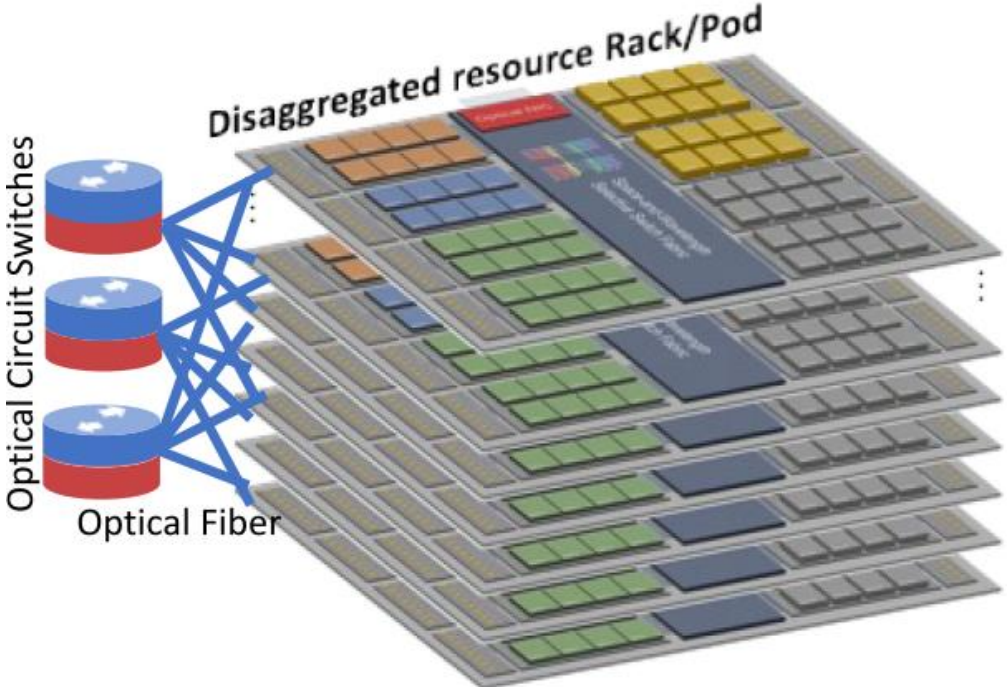


Photonic Switch at the Center of a Blade

Multi-chip modules (MCMs) of homogeneous resources and comb laser sources

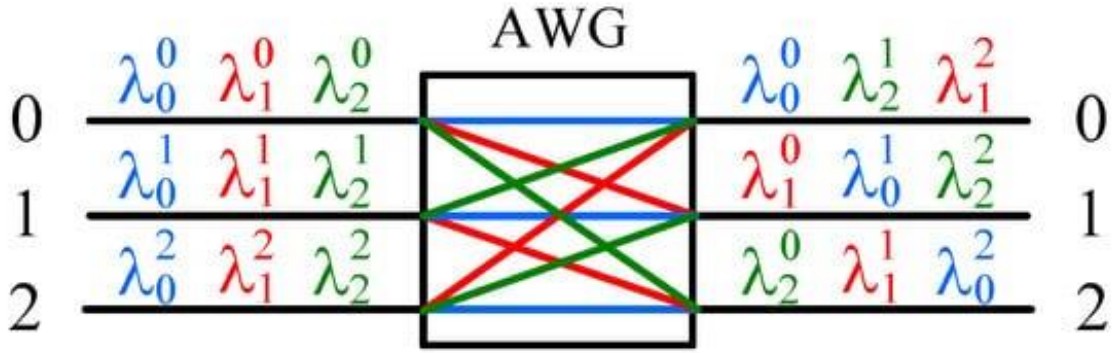


Scaling Up To a Rack



All-to-All Optical Switch

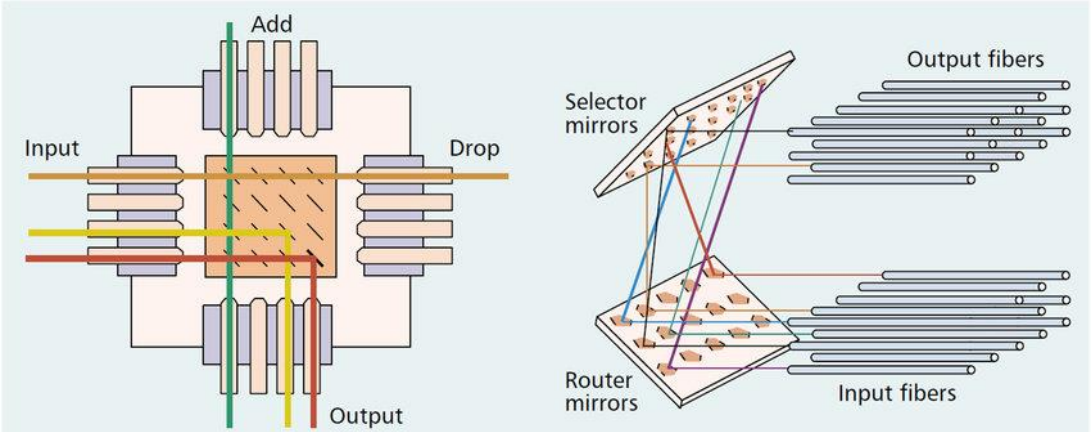
- Popular example: arrayed waveguide grating routers (AWGRs). All-to-all connectivity. Equal number of wavelengths from every source to every destination
- State of the art example: 400 x 400, 400 wavelengths per port, 25 GHz bandwidth per wavelength
- Y. Hida et al., “400-channel 25-ghz spacing arrayed-waveguide grating covering a full range of c- and l-bands,” in OFC 2001
- Challenge: Single wavelength’s bandwidth may not be adequate. Requires indirect routing



B Lin., “Generalization of an Optical ASA Switch”, 2019

Spatial Optical Switch

- Popular examples: microelectromechanical systems (MEMS), microring resonators (MRRs)
- All wavelengths are connected from one port to another port
- State of the art example (MEMS): 240x240, one wavelength per port
- Challenge: Quantization of bandwidth. For example, 21 wavelengths escape an MCM

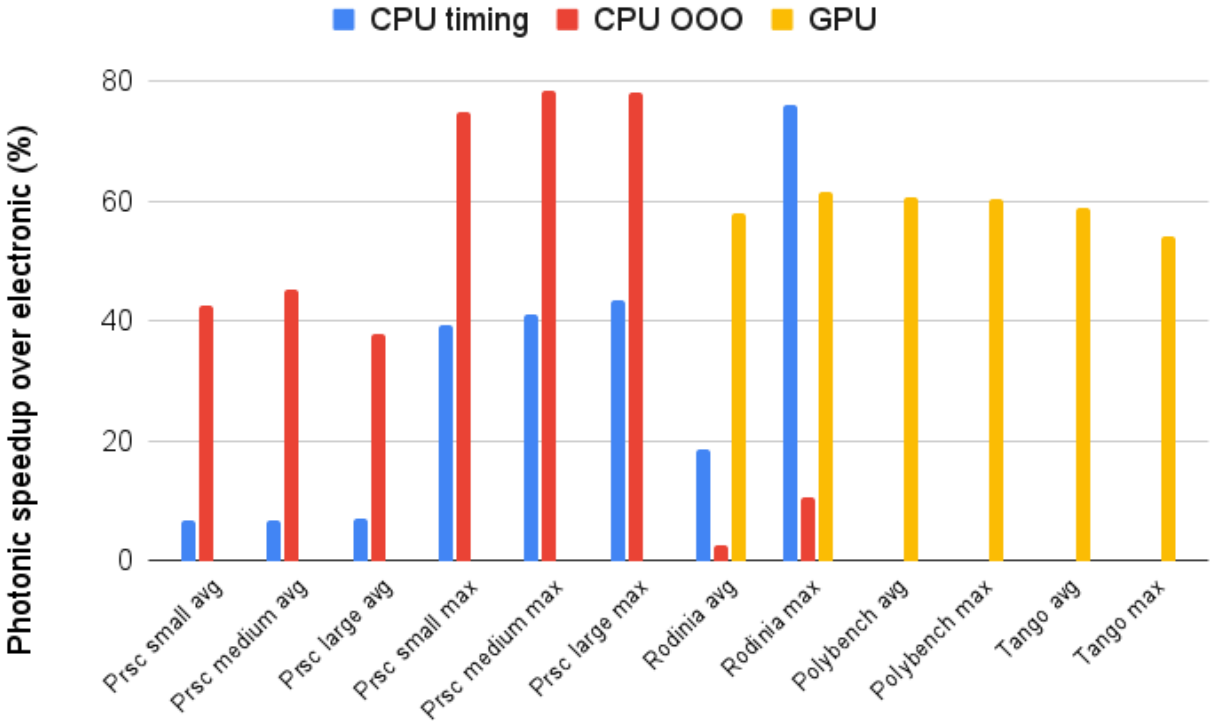


Q Cheng et al., "Photonic Switching in High Performance Datacenters", 2018

Other Considerations

- “Intermediate” optical switches exist: Wave-selective
- Wave-selective and spatial switches reconfigure in micro to milli seconds
- CXL can be the link protocol
- Forward error correction can achieve necessary bit error rates with only an additional 5ns latency
- With modern photonic links, **we meet all design goals**. But what about the additional latency?

Speedup Over Electronic Switches



[Call to Action]

- Lets build efforts on the usability and programmability of resource-disaggregated systems: resource allocation algorithms, usage monitoring, programming models, runtime management, etc.
- Contact the speaker: mihelog@lbl.gov
- More information on the project ecosystem:
  - https://arpa-e.energy.gov/sites/default/files/Columbia_Bergman_ENLITENED_Annual_Meeting.pdf

Thank you!

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