



# Optical Network Architecture

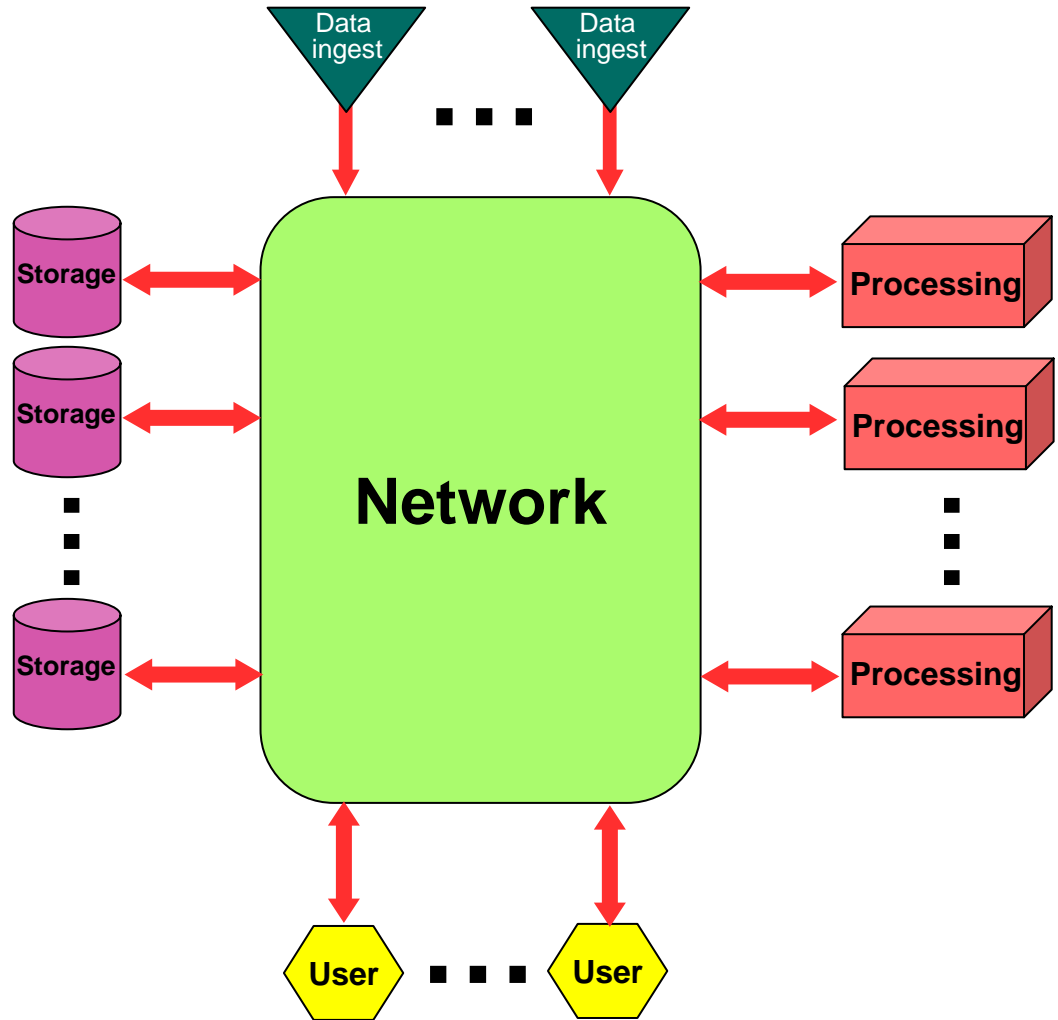
**Vincent W. S. Chan**

*April 6, 2009*

# Distributed storage and computing application

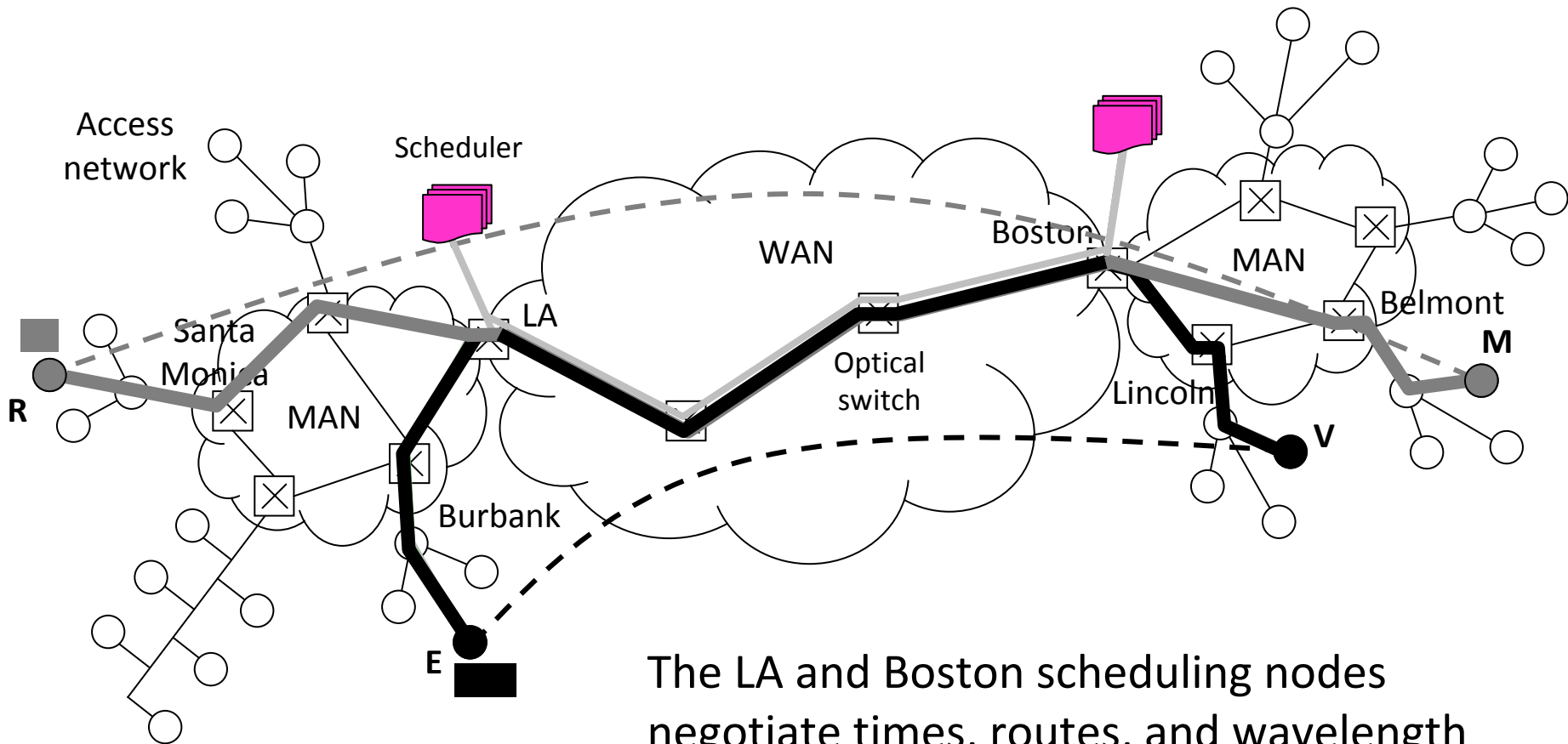
- *bursty, high speed and large volume*

- **Massive data ingestion rate, meta-data processing, tagging**
- **Distributed large volume data storage for efficiency and redundancy**
- **Bursty user demand**
- **Distributed high speed computing services**
- **SOA, cloud computing, defense applications...**
- **Flow switching of bursty high volume data**
- **Low blocking and latency**
- **Cost effective**



# Our solution: Optical Flow Switching (OFS)

*OFS employs agile, end-to-end, all-optical connections*

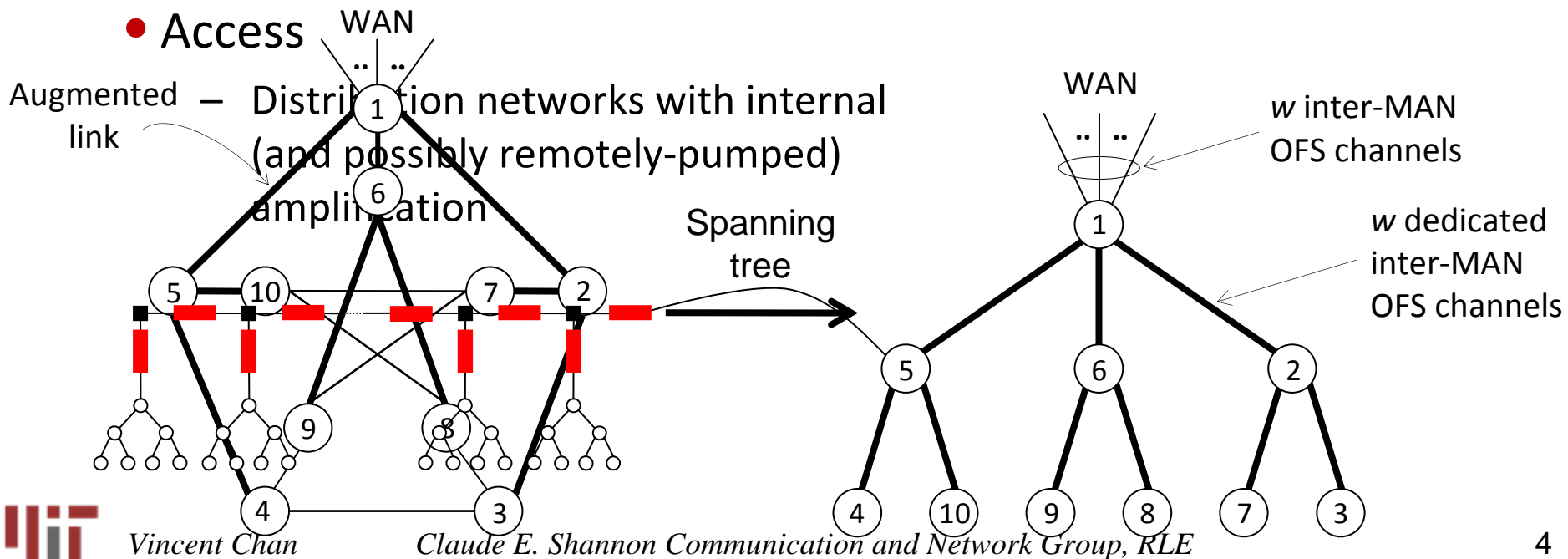


The LA and Boston scheduling nodes negotiate times, routes, and wavelength channels for the transmissions

# Scheduling inter-MAN traffic: Key Assumptions

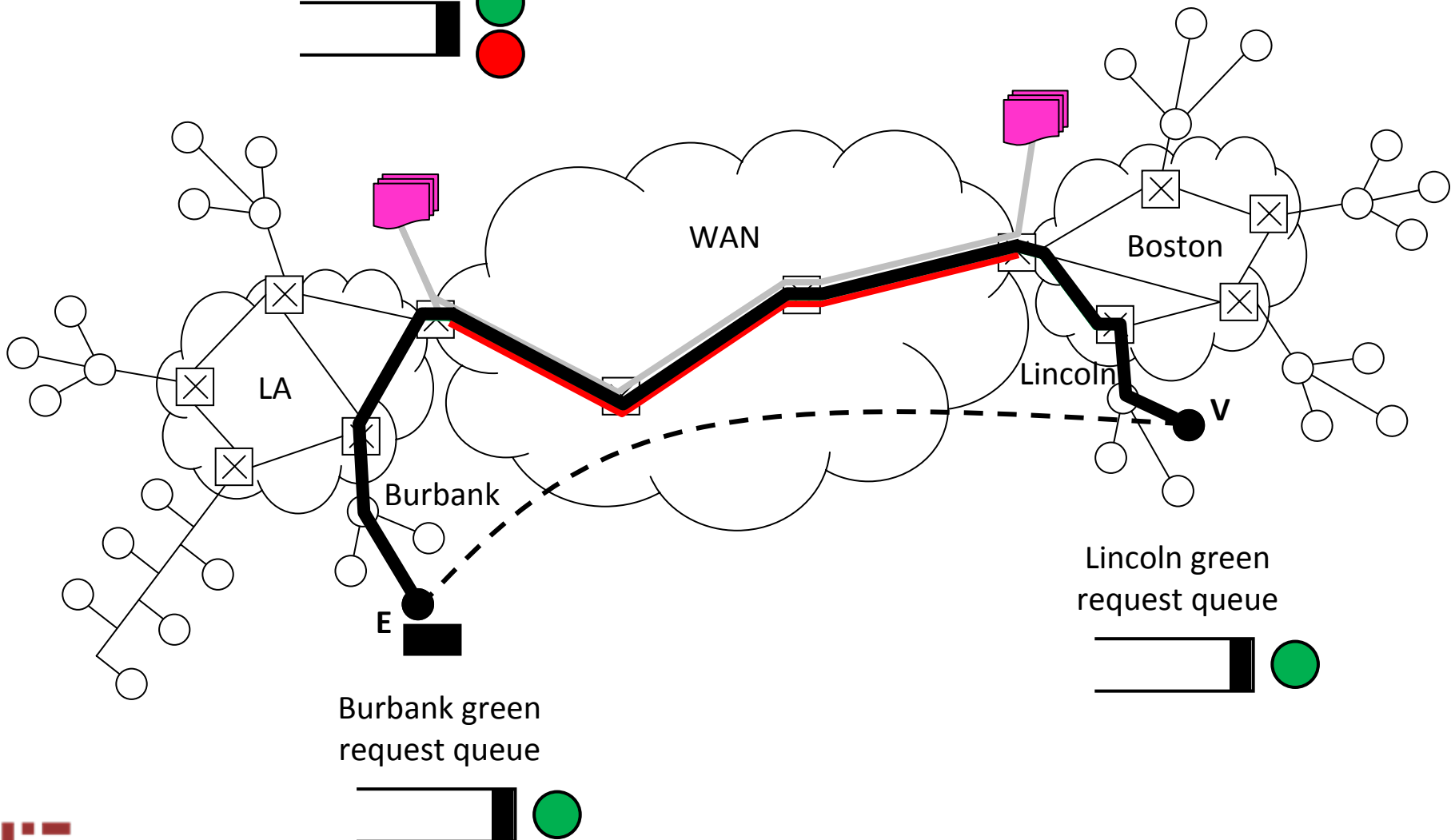
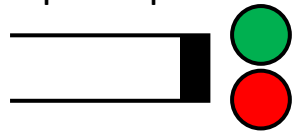
- Wide-area
  - Quasi-static WAN logical topology for scalability
- Metro-area
  - Spanning tree augmented with dedicated inter-MAN wavelengths
  - Generalized Moore Graphs minimize total network cost under shortest path routing

- Access

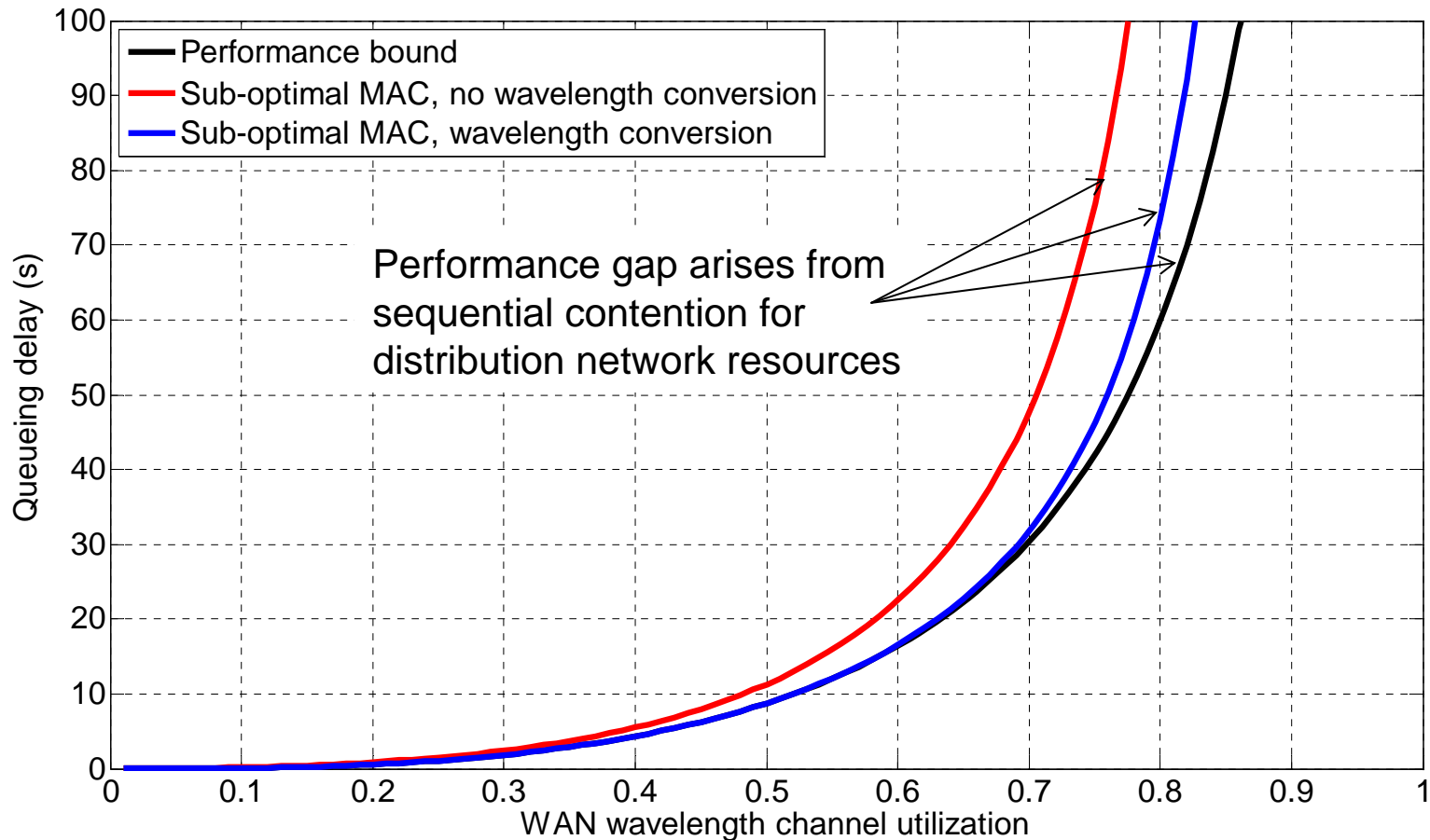


# Scheduling inter-MAN traffic: Algorithm

LA-to-Boston  
request queue



# MAC protocol: Performance



MAC model:

- Dedicated MAN/WAN OFS wavelength channels
- Resources in source/destination distribution networks reserved after MAN/WAN resources are reserved

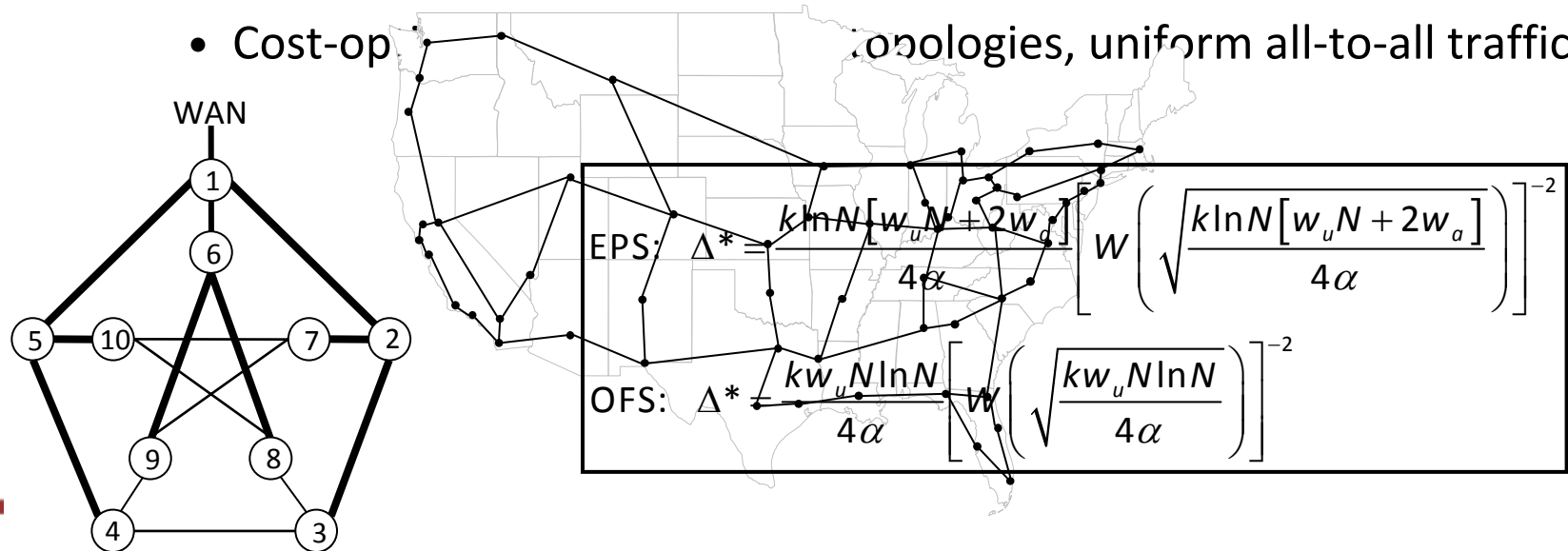
# Throughput-Cost study: Modeling assumptions

- Cost model

- Capital expenditure: Transceivers, switches, routers, amplifiers, regenerators, dispersion compensation, fiber deployment
- Operating expenditure: Not included

- Network model

- Wide-area: EPS, OCS, OFS
  - 60 node US backbone topology, realistic traffic (Simmons 08)
- Metro-area: EPS (for EPS and OCS in WAN), OFS
  - Cost-op technologies, uniform all-to-all traffic



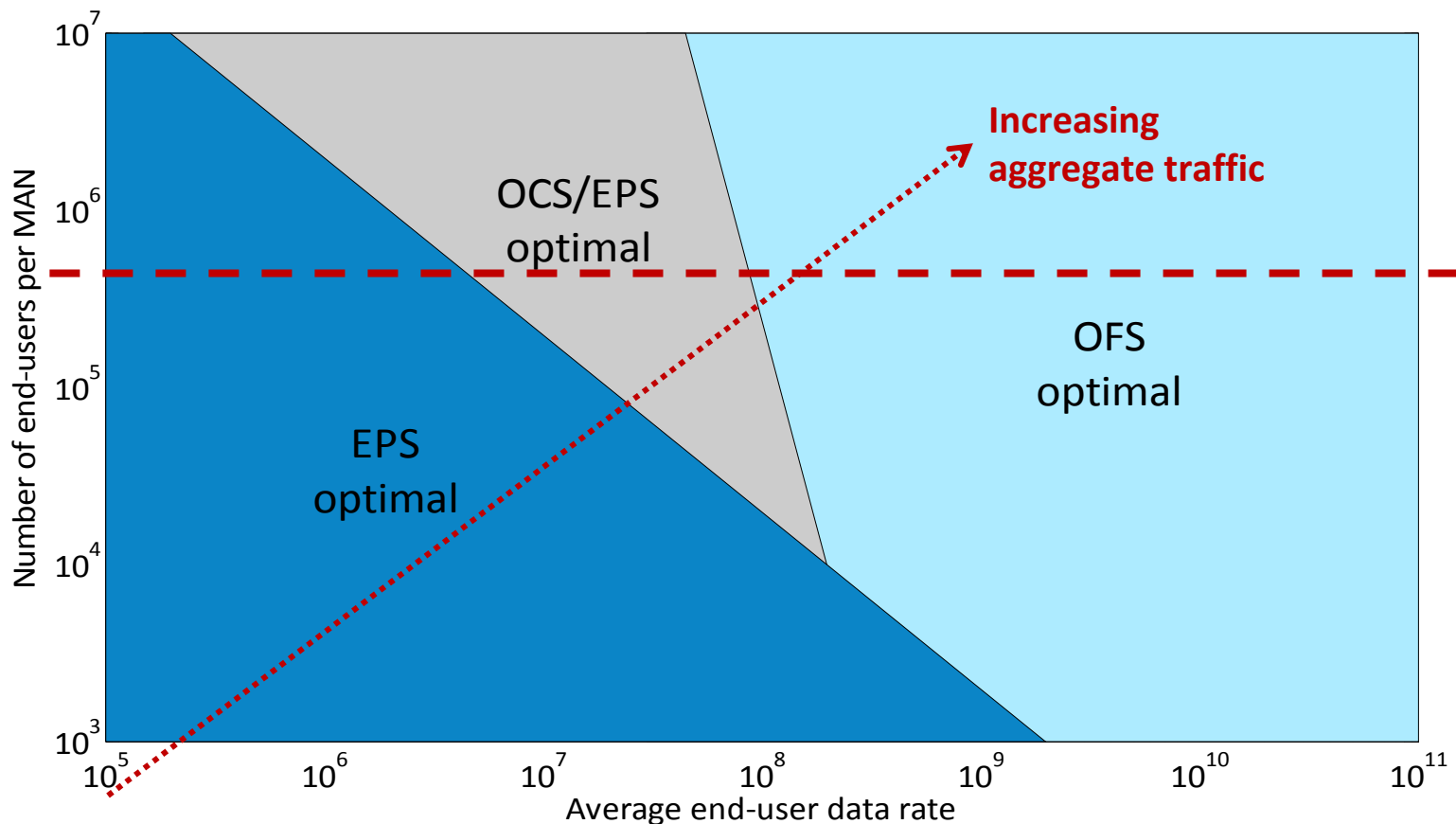
# Homogeneous architectures

- Candidate architectures

1. “EPS” =  $\text{EPS}(w) + \text{EPS}(m) + \text{PON}(a)$
2. “OCS/EPS” =  $\text{OCS}(w) + \text{EPS}(m) + \text{PON}(a)$
3. “OFS”

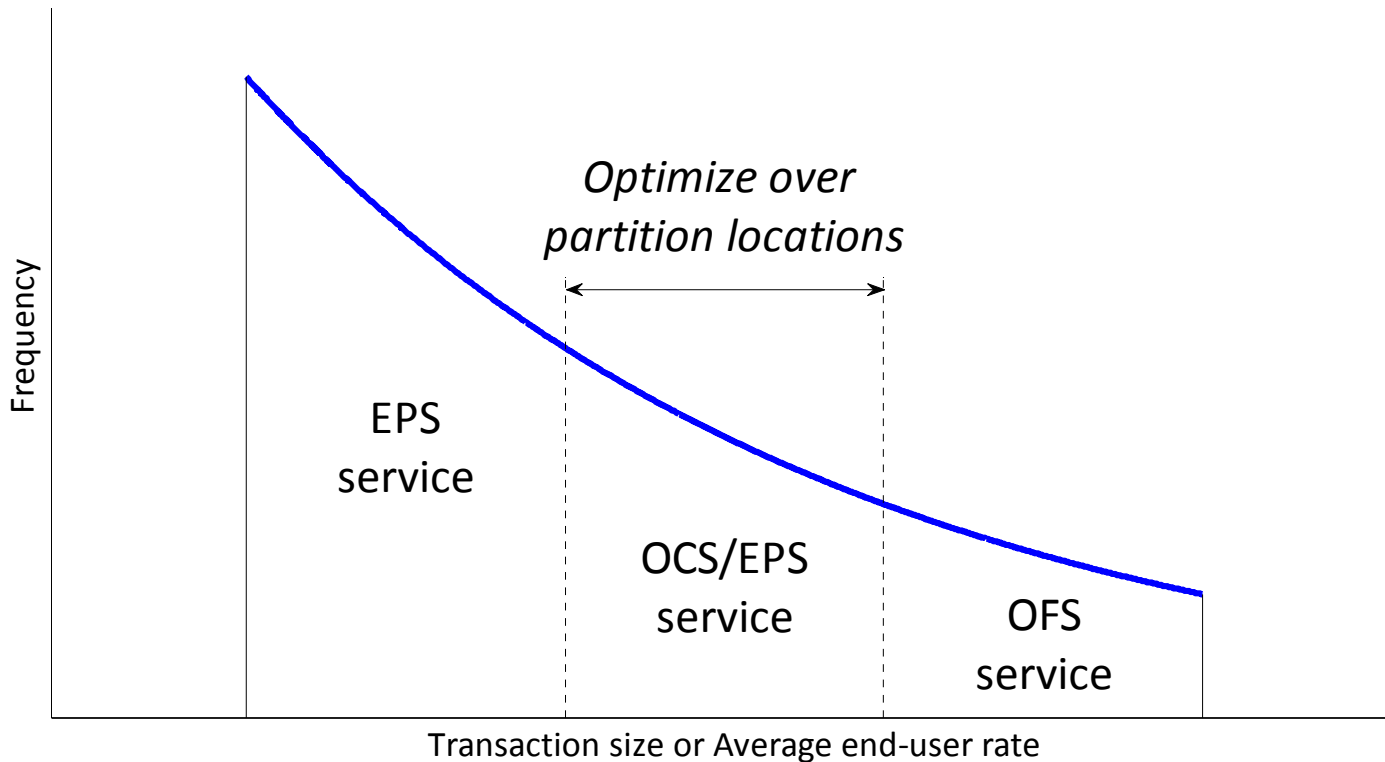
- Traffic

- Inter- and intra-MAN equal
- Transaction lengths from truncated heavy-tailed distribution

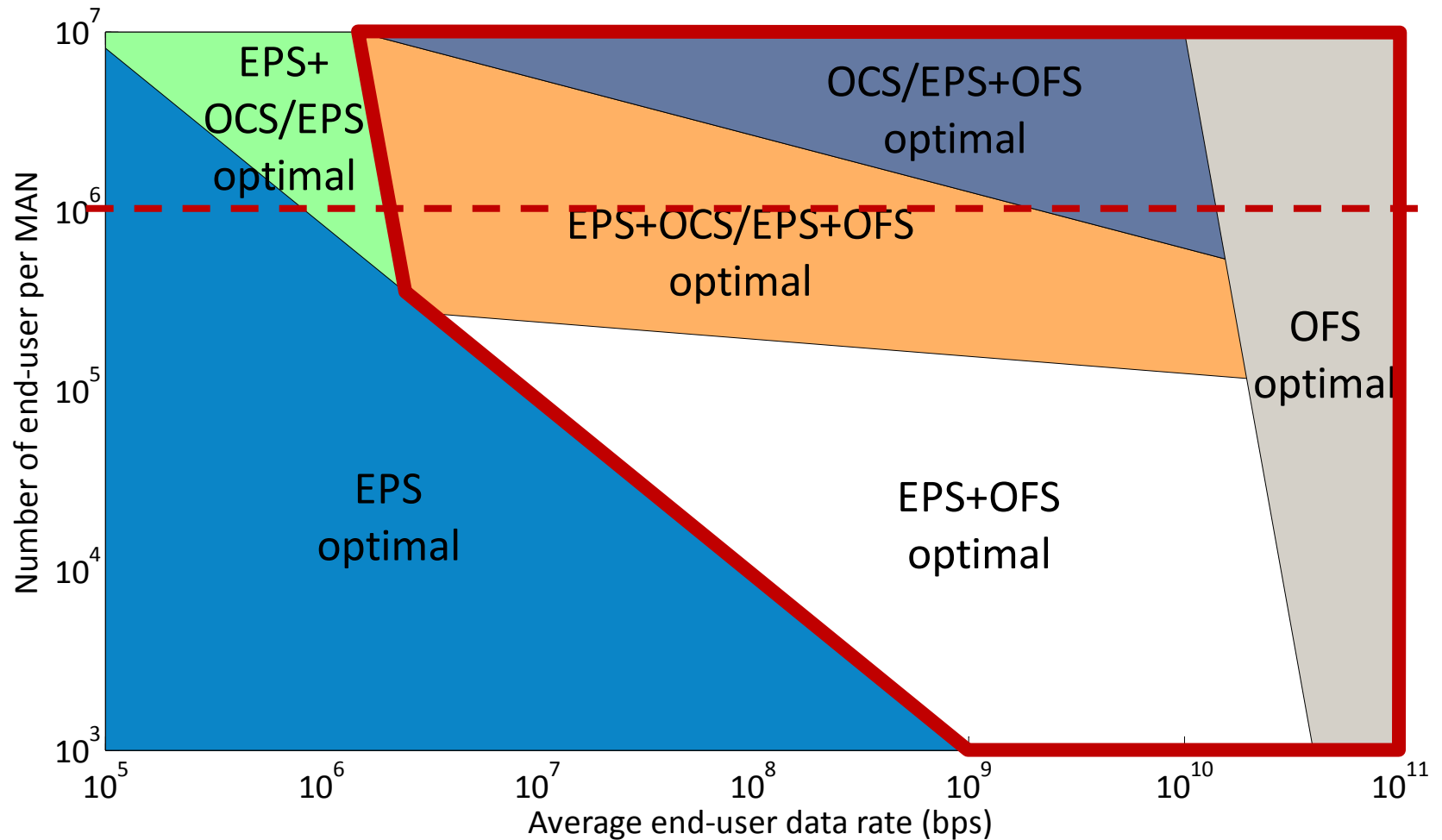


# Hybrid architectures: Model

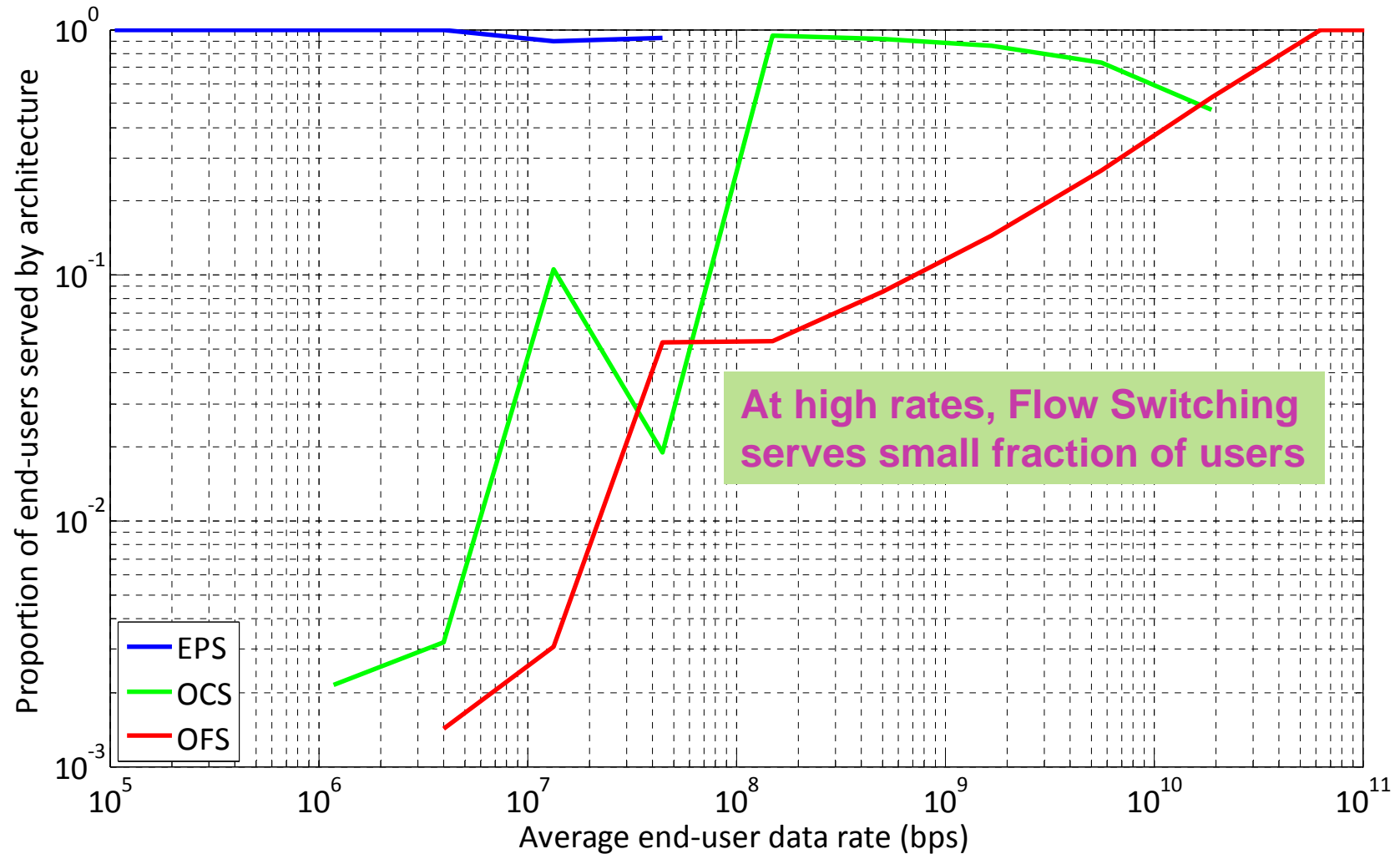
- Combination of EPS, OCS/EPS, OFS
- Each end-users sends transaction drawn from heavy-tailed distribution



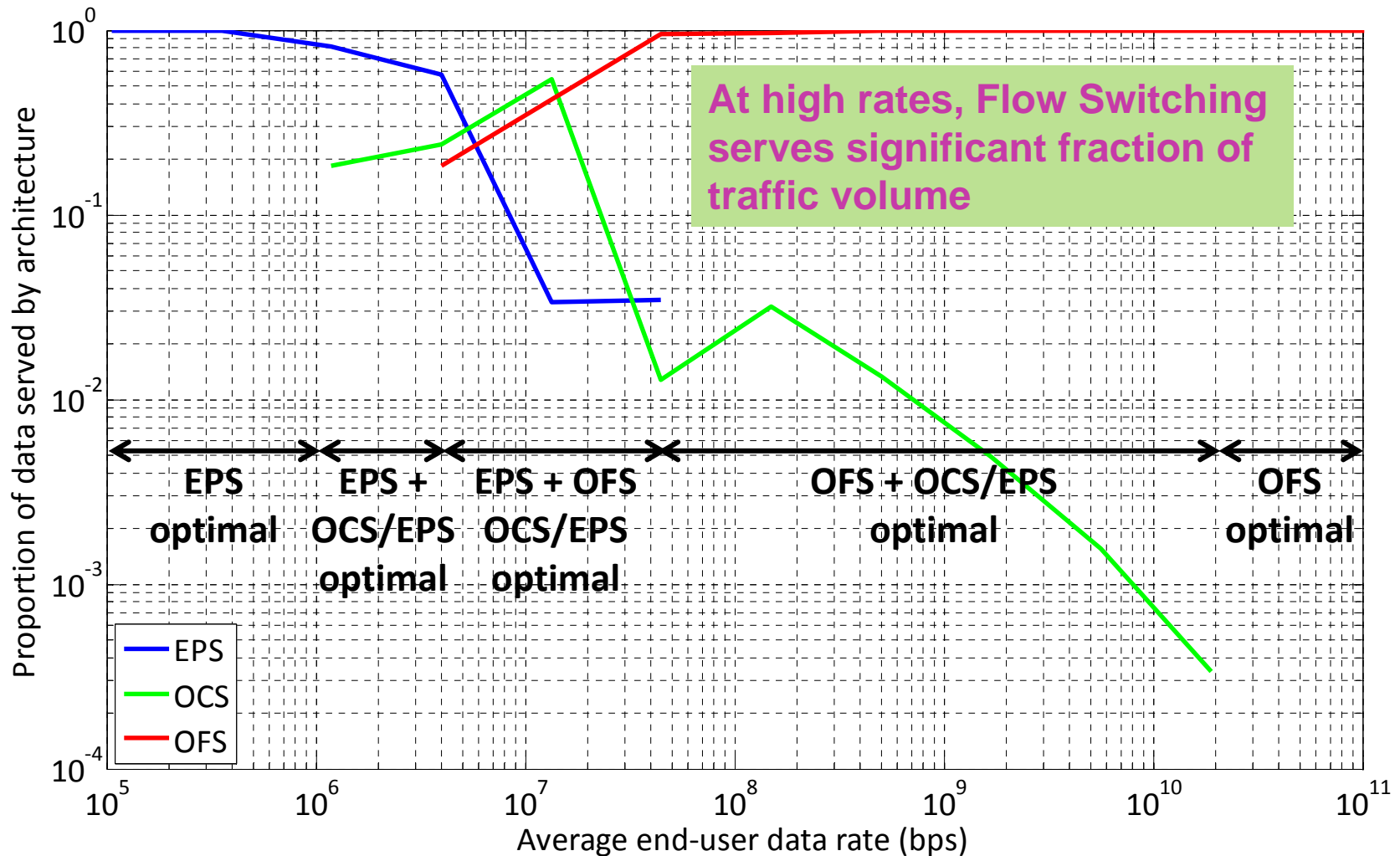
# Optimal hybrid architecture



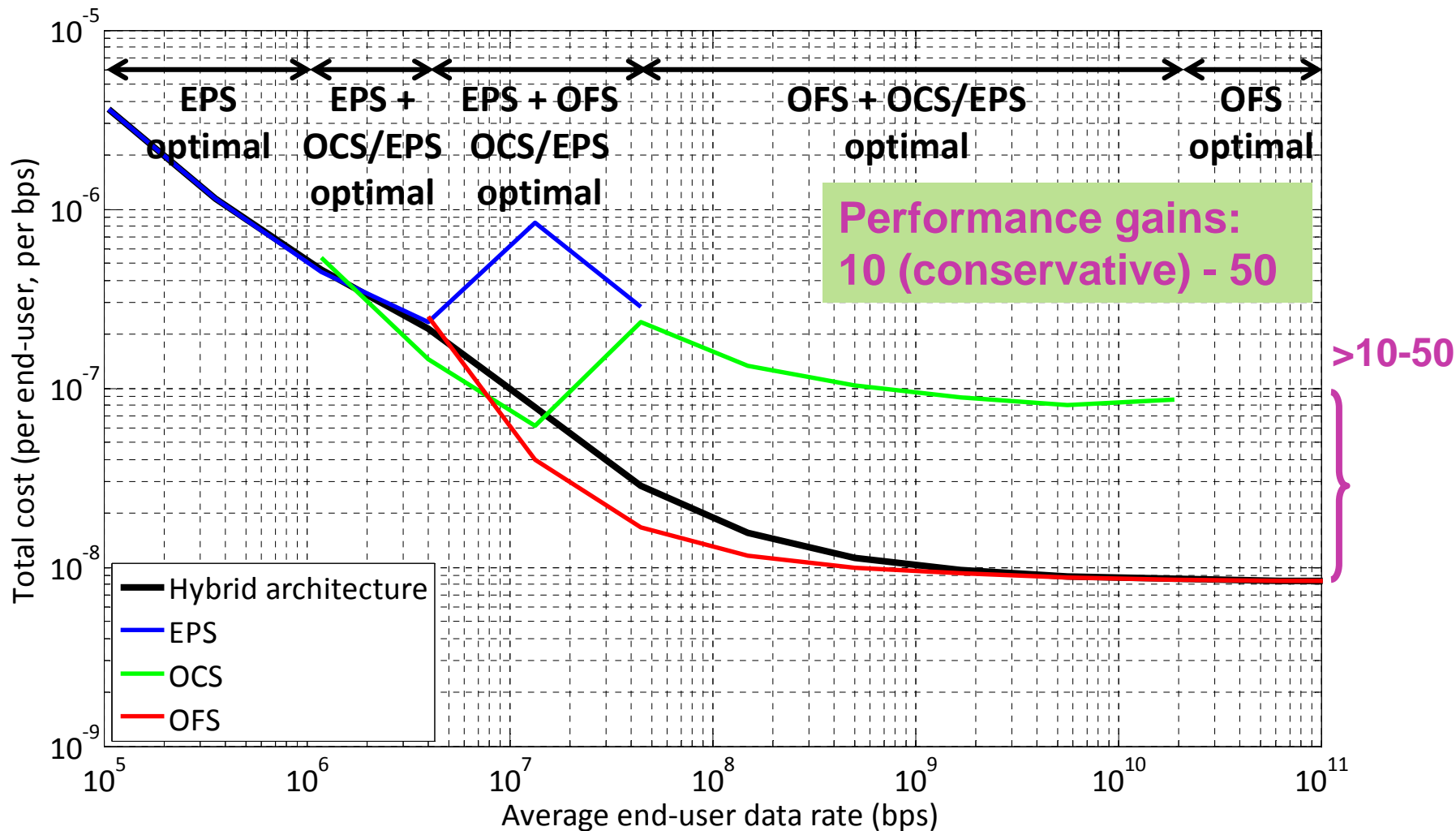
# Proportion of end-users served by components of the optimal hybrid architecture (for $10^6$ end-users/MAN)



# Proportion of data served by components of optimal hybrid architecture (for $10^6$ end-users/MAN)



# Cost components of the optimal hybrid architecture (for $10^6$ end-users/MAN)



Open problems: time deadline routing, end-to-end reliability, Physical Layer



# GOALI Program: Optical Flow-Switched Core Networks MIT & Alcatel-Lucent Bell Laboratories (*Dan Kilper*)

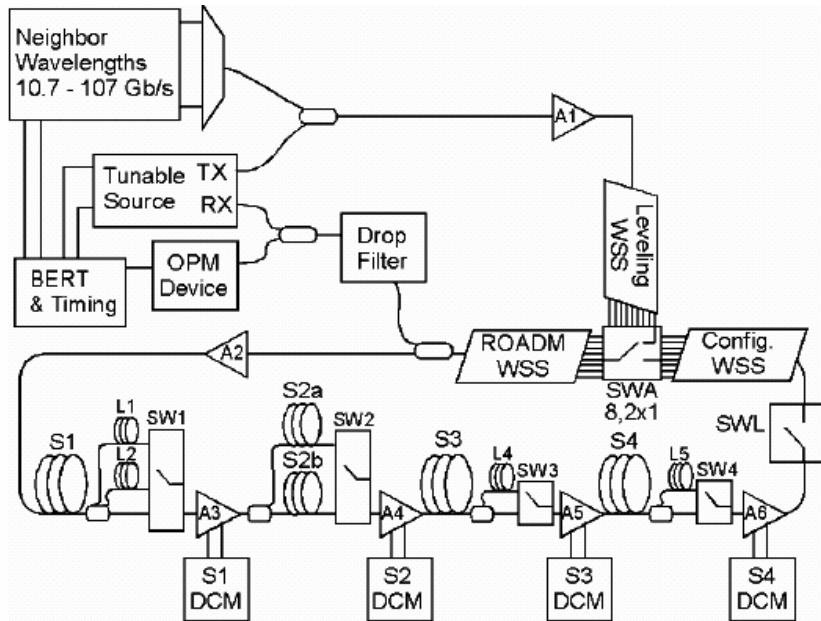
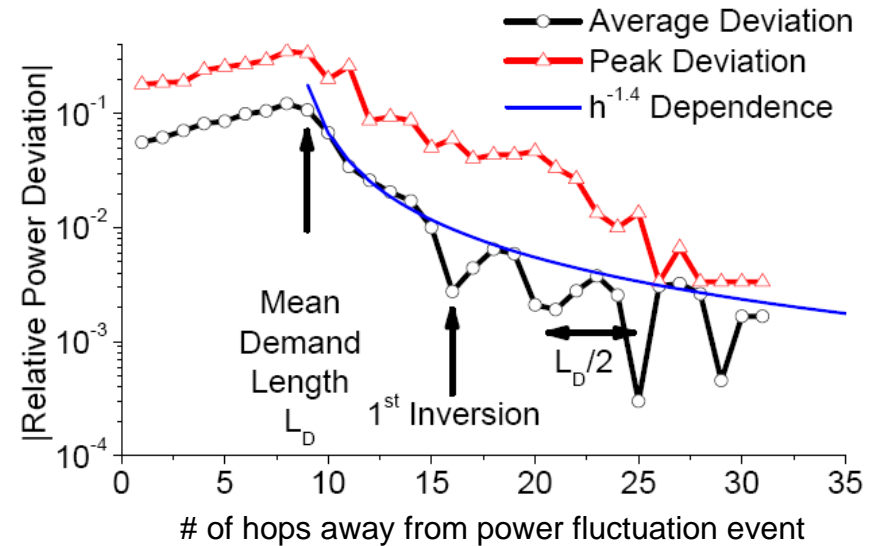
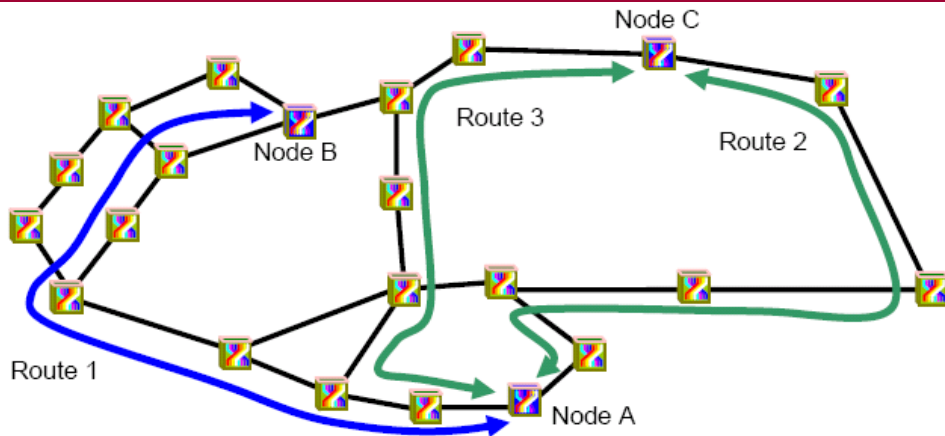


Fig. 7. Optically transparent mesh testbed configuration for mesh transport studies with 1 ROADM/loop and up to 8 re-configurable channel groups.

- *Testbed implementation at Crawford Hill of architecture developed at MIT*
- *Signaling between Physical Layer and upper layers*
- *Find architecture implications and solutions to deal with dynamics of bursty sessions*