Congratulations to the 2011 National Champion UC San Diego Softball Team!

Record winning season at 45-13
Title game 10-3 blow-out of #1 ranked University of Alabama, Huntsville

Welcome CAP Executive Board

June 2, 2011

CAP Leadership 2009 - 2010

CAP Chairman:
Danny Brown, Ph.D.
VP Technology Development, Cymer

CAP Vice Chairman:
Anton Monk, Ph.D. UCSD '94
Co-founder & VP Technology Entropic Communications

Welcome New CAP Members!

CORNING

GOODRICH

NOVO ENGINEERING

NTREPID

TrellisWare® TECHNOLOGIES

Welcome CAP Guests!

mitchell

Engineer Erez Nir
Chief Technology Officer

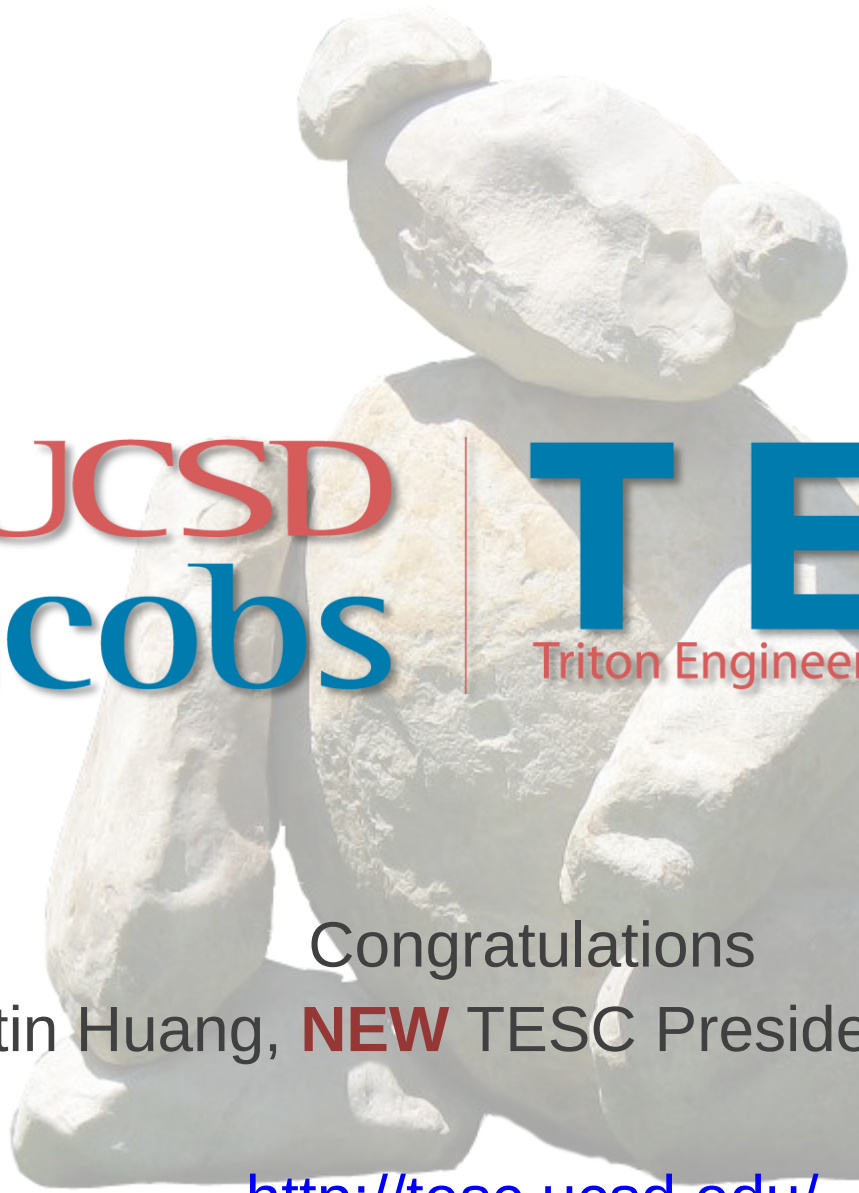
Jack Farnan
Senior Vice President, Human Resources

Welcome Distinguished Students

- **Jacobs School Scholars and Fellows**
- **Powell Foundation Fellows**

UCSD Jacobs | TESC Triton Engineering Student Council

- **Triton Engineering Student Council**



UCSD Jacobs | TESC
Triton Engineering Student Council

Congratulations

Justin Huang, **NEW** TESC President 2011-12

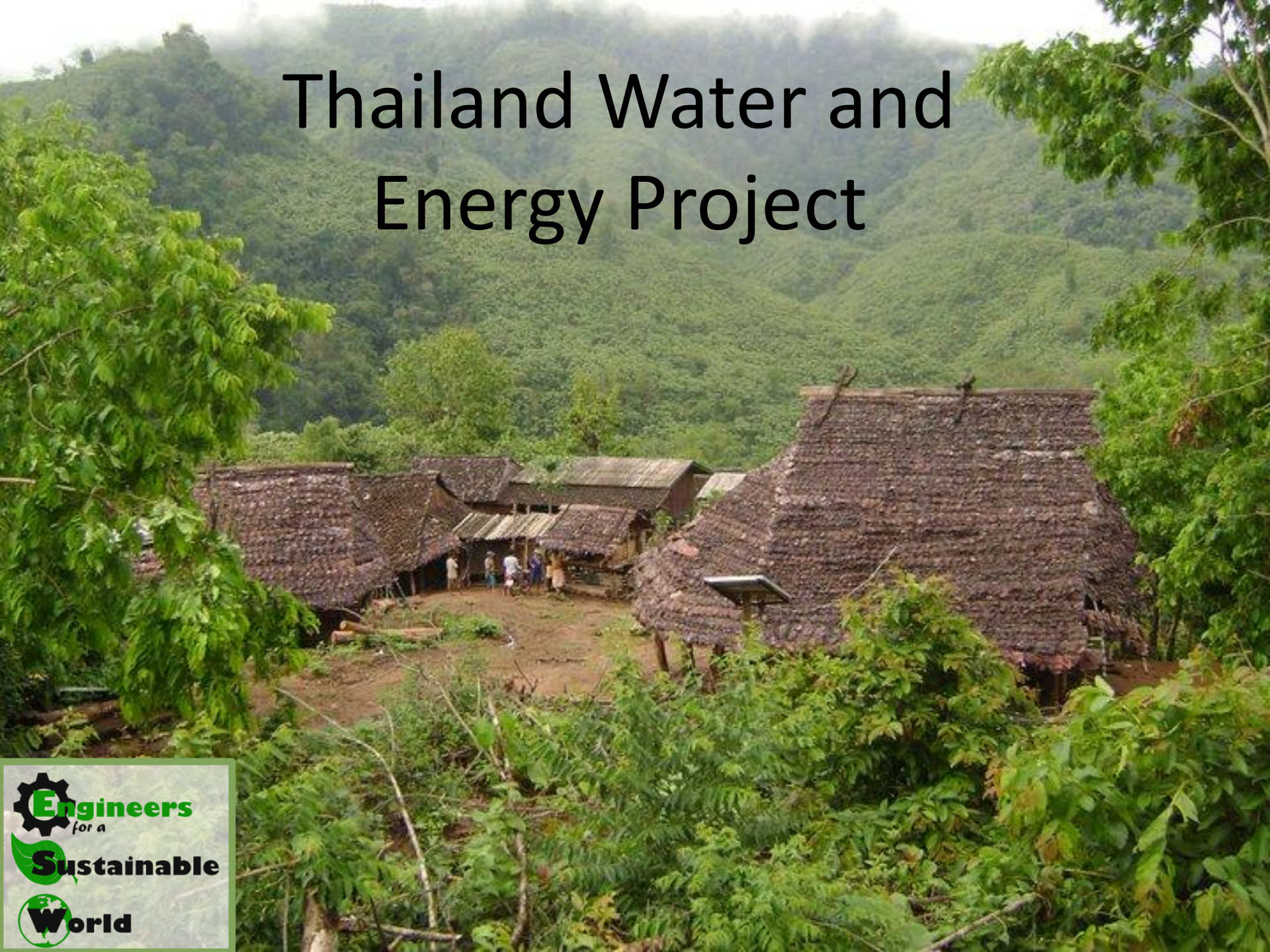
http://tesc.ucsd.edu/

Engineers for a Sustainable world

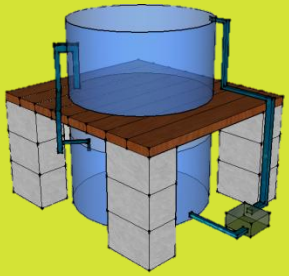
And a world of possibilities 6/2/2011

R. Derek Chung
Environmental Engineering'12

Thailand Water and Energy Project



Accomplishments



- Thailand Project - $3,000 / 20 – 25 Members
- Mobile Solar Tower Project – $13,150 / 20 Members
- 4 Other Projects - $3,000 / 20 Members

POSSIBILITIES

R. Derek Chung, Environmental Engineering'12

President, Engineers for a Sustainable World

(909) 238 - 8630

esw.ucsd@gmail.com

rdchung@ucsd.edu

Dean's Report

Dean Frieder Seible
Jacobs School of Engineering

Time to Celebrate: Topping Out and Half-Way Point

Structural and Materials Engineering/EBUIV


SMEB 03/22/2010 08:00:01

TIP – Summer 2011

200+ intern positions, 70+ teams, 34 companies

TIP Summer 2011 International Teams

Schaan, Liechtenstein

HILTI

Beijing, China

QUALCOMM

Sydney, Australia

RESMED

Guangzhou, China

SUN International 瀚阳科技

Seoul, Korea

QUALCOMM

TIP Training Day on Saturday June 4, 2011

- **Day-long training**
- **Topics include:**
  - **Personality Types**
  - **Leadership Heroes**
  - **Five Faces of Genius**
  - **Your Professional Persona**

Preparing your interns before they arrive to you!

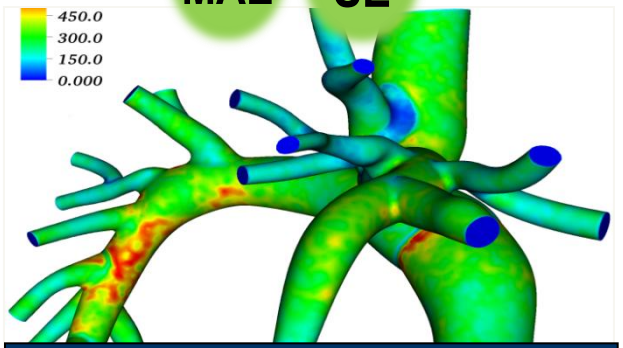
Master of Advanced Study Programs

Executive Education for Engineering Professionals

CSE MAE

Architecture Based Enterprise Systems

MAE SE



Simulation Based Engineering

ECE SE

Structural Health Monitoring

CSE ECE

Wireless Embedded Systems

BE MAE

Medical Devices

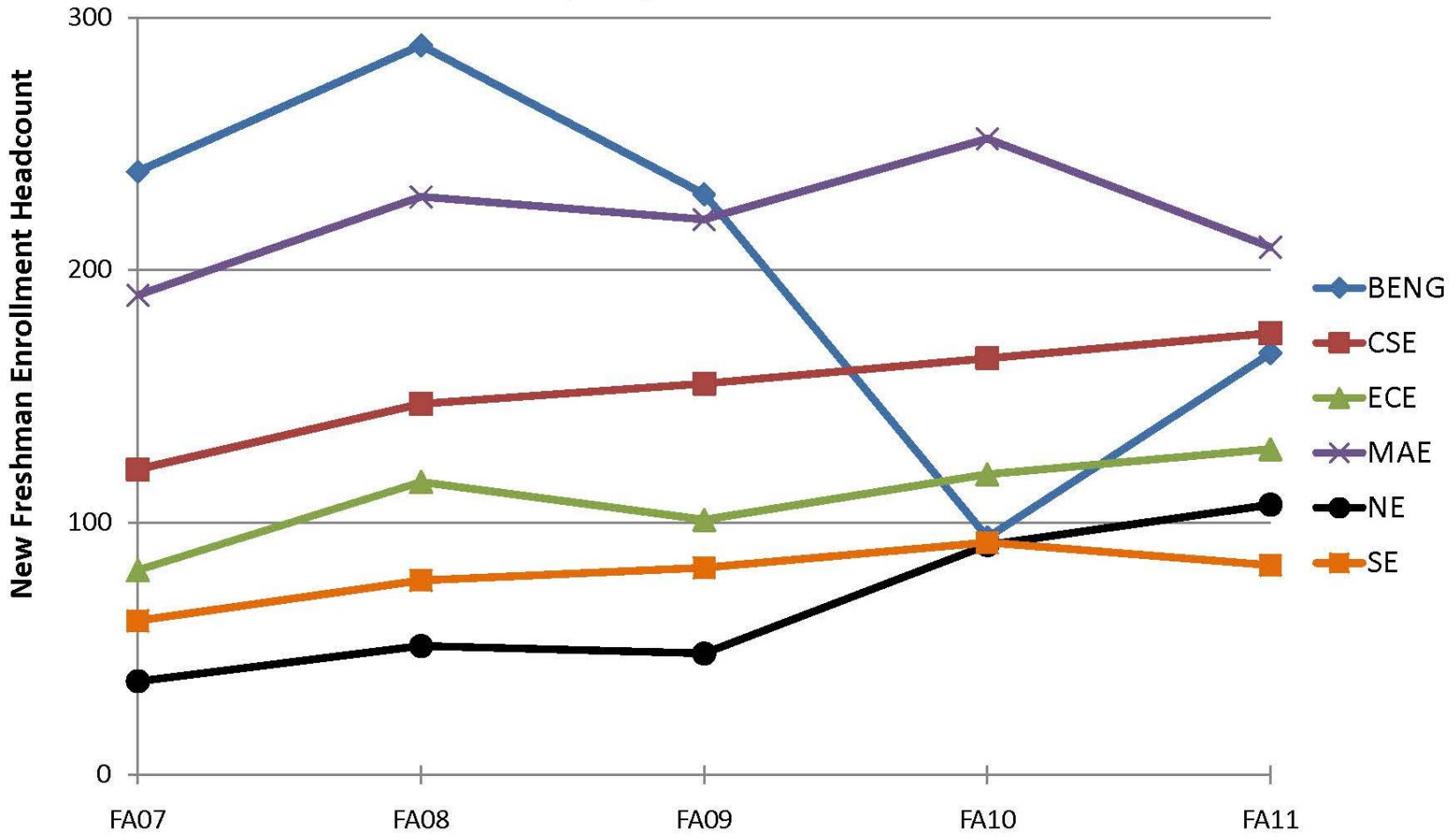
Faculty Hiring 2010-2011 Centers Around Focus Areas

1. Excellence FTE (diversity leadership)
2. Biochemical, Bioelectronics/optics or Neuroengineering (BIOE)
3. Aviation safety of composite structures (SE)
4. Environmental engineering (experimental/modeling) (MAE)
5. Bio-Nano Instrumentation (MAE)
6. Computer Science LSOE (CSE)

+ 2 Excellence Opportunity positions

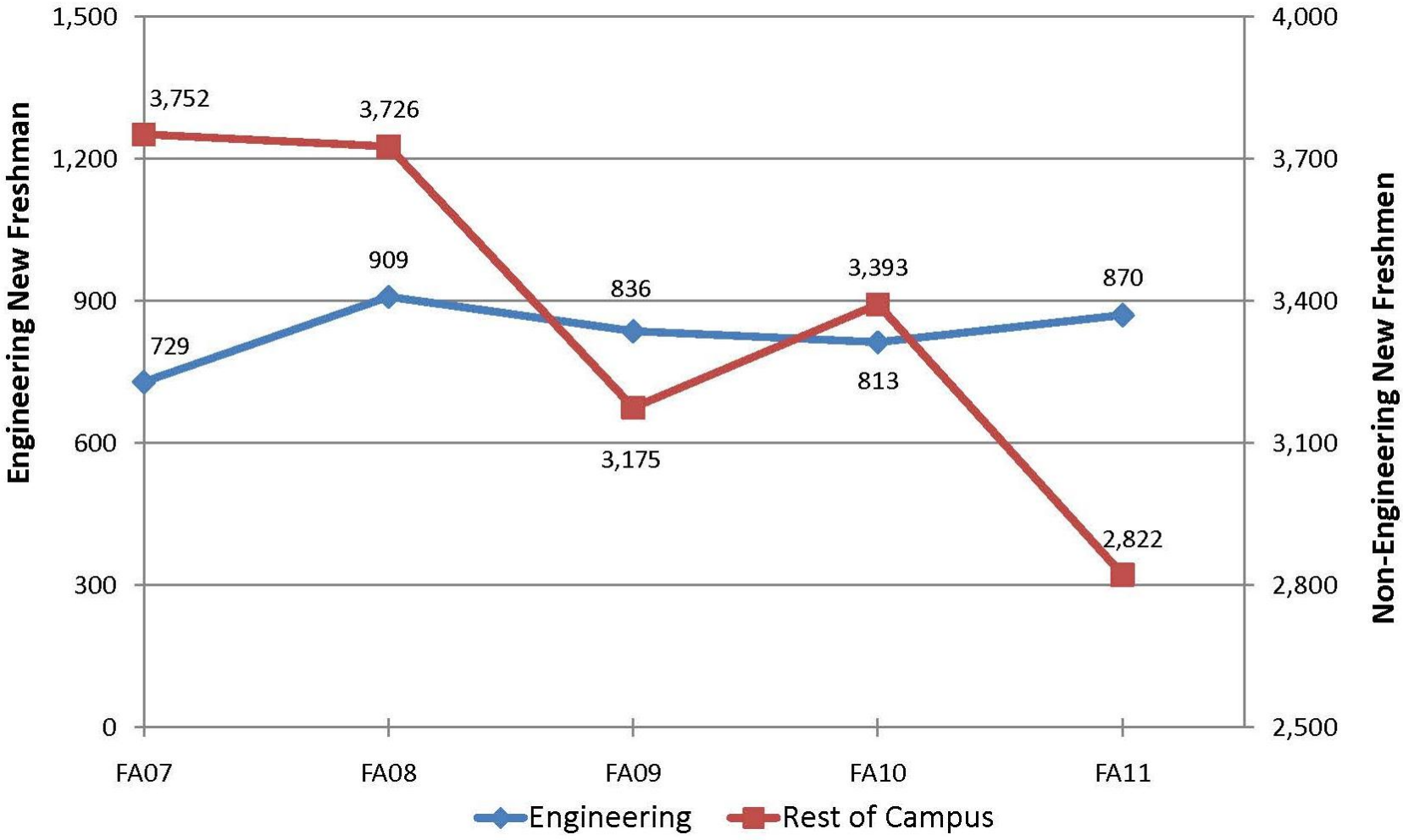
Jacobs School New Freshman Enrollment

as of May Registration Deadline



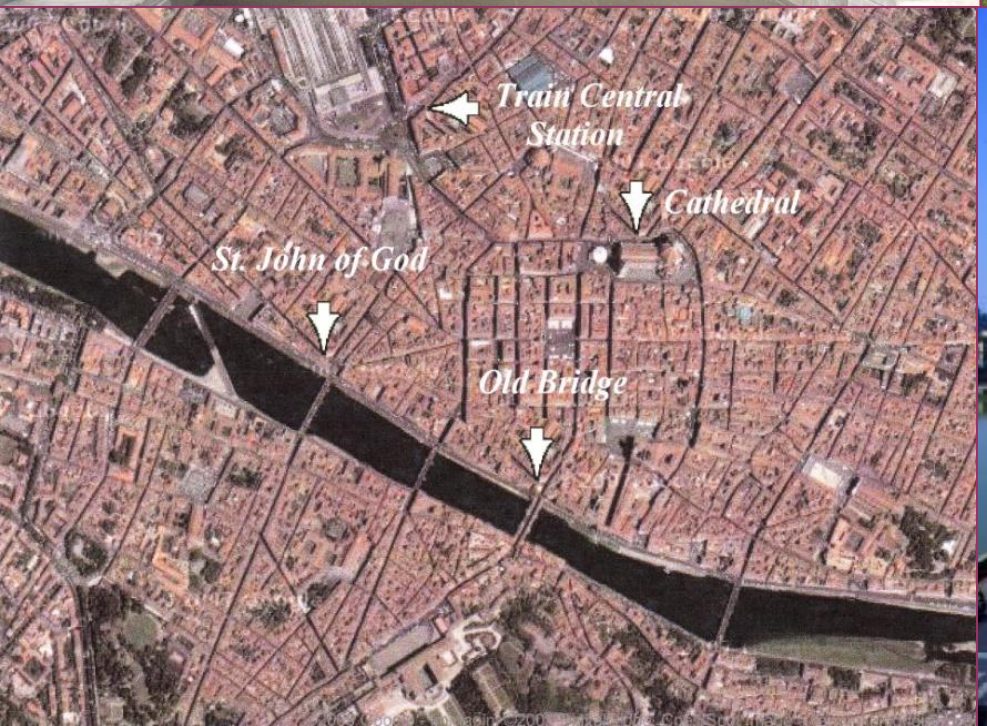
Jacobs School New Freshman Enrollment

as of May Registration Deadline



7% **Increase**

12% **Decrease**


Train Central Station
Cathedral
St. John of God
Old Bridge

SAPER
Studiosi Americani per Eccellenza Regionale

House of Amerigo Vespucci

Research Center in heart of Florence, Italy

- Medical and health research
- Computer science applied to health care
- Cultural heritage diagnostics

Distinguished Faculty Presentation

Dr. George Papen
Vice Chairman and Professor
Electrical & Computer Engineering Department
Jacobs School of Engineering

"*Optical Switching in Data Centers*"

Optical Switching in Data Centers

George Papen and Shaya Fainman,
Dept. of Electrical and Computer Engineering

Nathan Farrington, George Porter and Amin Vahat
Dept. of Computer Science and Engineering

Jacobs School of Engineering

CAP Meeting

June 2, 2011

The network is changing

- Before:
  - Network connects servers to users
  - Massive computing → tightly coupled supercomputer
    - With special interconnects, proprietary technology
- Today:
  - Network also connects servers to each other
  - Data-intensive, web-scale computing
  - Massive computing → Datacenters
    - Scale commodity Ethernet switches, end hosts, interconnects, optical links, etc.
    - Datacenter network *becomes the computing backplane*

The State of the Web (Mar 2011)

Search + Email

#1: Google
#11: Windows Live
#14: Bing

E-Commerce

#5: Amazon.com
#9: eBay
#10: CraigsList
#18: PayPal
#26: Apple

Social Media

#2: Facebook
#7: Twitter
#8: Blogger
#12: LinkedIn
#19: WordPress
#22: Flickr

Streaming

#4: YouTube
#20: NetFlix
#40: Hulu

Portals

#3: Yahoo!
#13: MSN
#15: Go.com
#16: AOL
#17: CNN
#21: ESPN
#24: NYT

Reference

#6: Wikipedia
#23: IMDB

Source: http://www.alexa.com/topsites

“Front-End” Datacenter traffic

Wide-area Internet

Web

Video

Voice

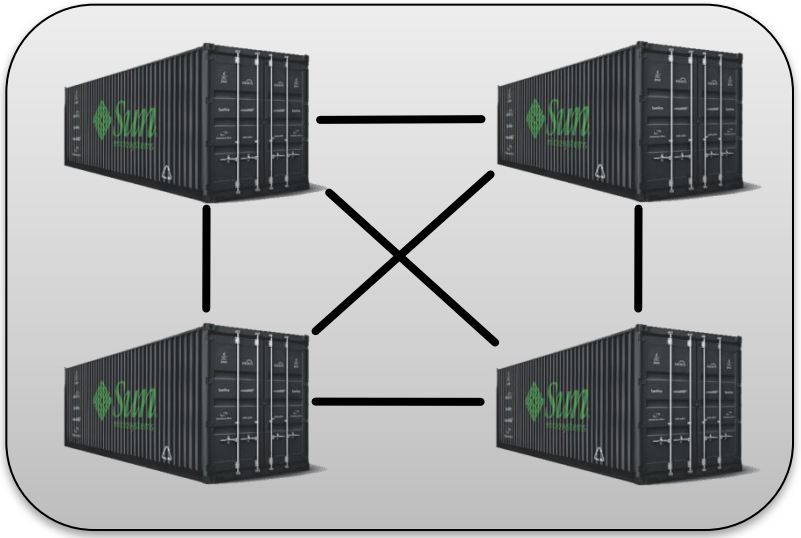
Music

Photos

- Data sizes driven by the content that users actually consume
  - Growth largely due to higher bitrate content (IP TV/movies, iPhone Facetime)
- Mobile Internet source of new users
- Often constrained by the “last mile”

“Back-end” Datacenter traffic

- Back-end analytics:
  - Connections between information
  - “Users who bought X also bought Y”
- Key differentiator determining success
  - Facebook vs Friendster
  - Amazon vs Buy.com
- Large-scale “join” computations spanning thousands of nodes
  - Need bandwidth as well as all-to-all connectivity



- Sorting / Searching
- Collaborative Filtering
- Map/Reduce
- Distributed Key/Value stores

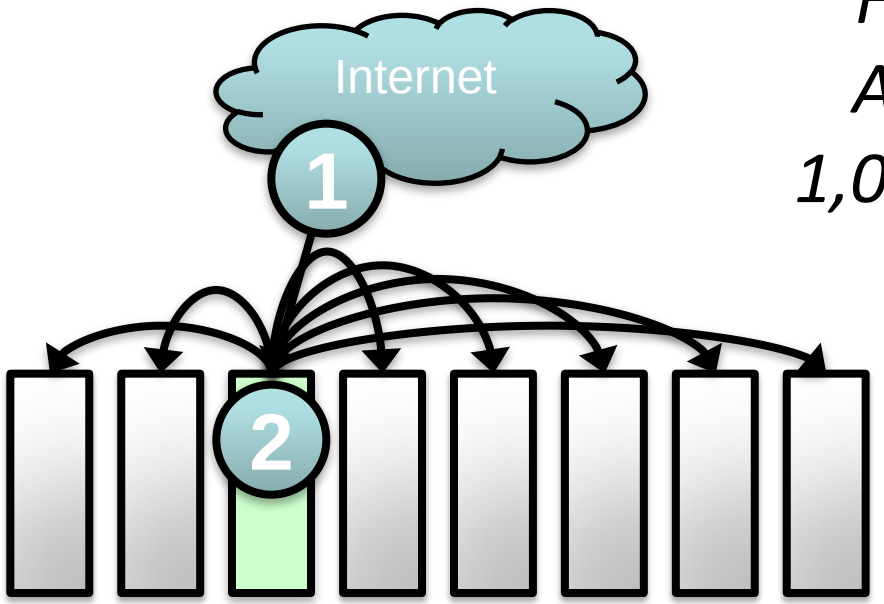
Front-end vs. Back-end Traffic

- Back-end processing is the core IP of all large service providers
- Mining correlations translates into revenue
  - Difference between Friendster and Facebook
- Find correlations using back-end processing
  - High data rate
  - High all-to-all connectivity

The "Where Is It?" Front-End Problem

e.g. Search (online part), Facebook

1. Search request
2. Do you have it?
3. Yes/No
4. Return result

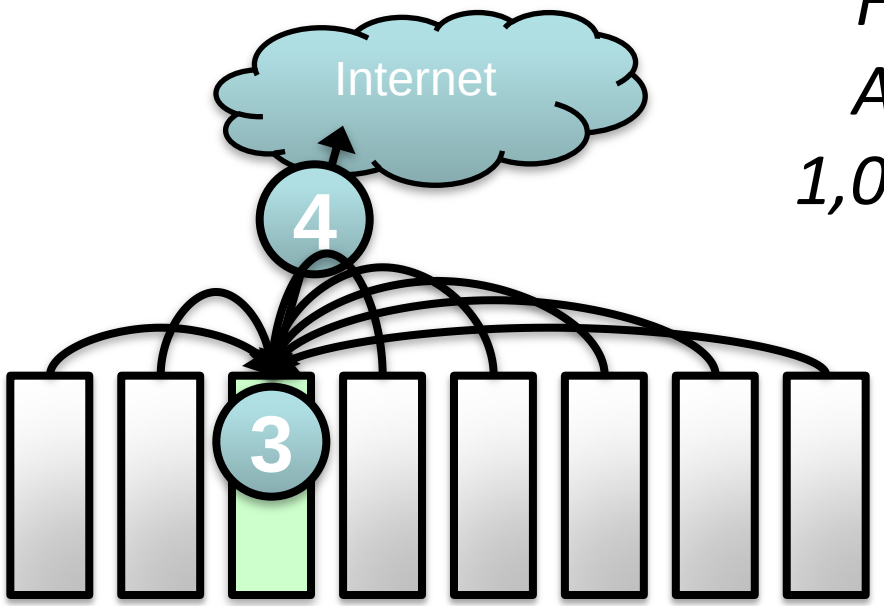


HTTP Request Amplification: 1,000x to 10,000x

The "Where Is It?" Front-End Problem

e.g. Search (online part), Facebook

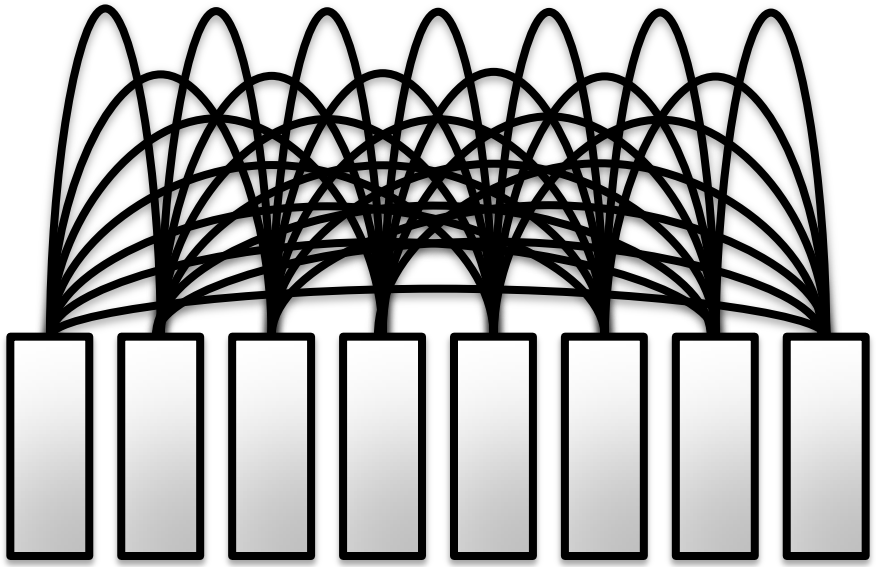
1. Search request
2. Do you have it?
3. Yes/No
4. Return result



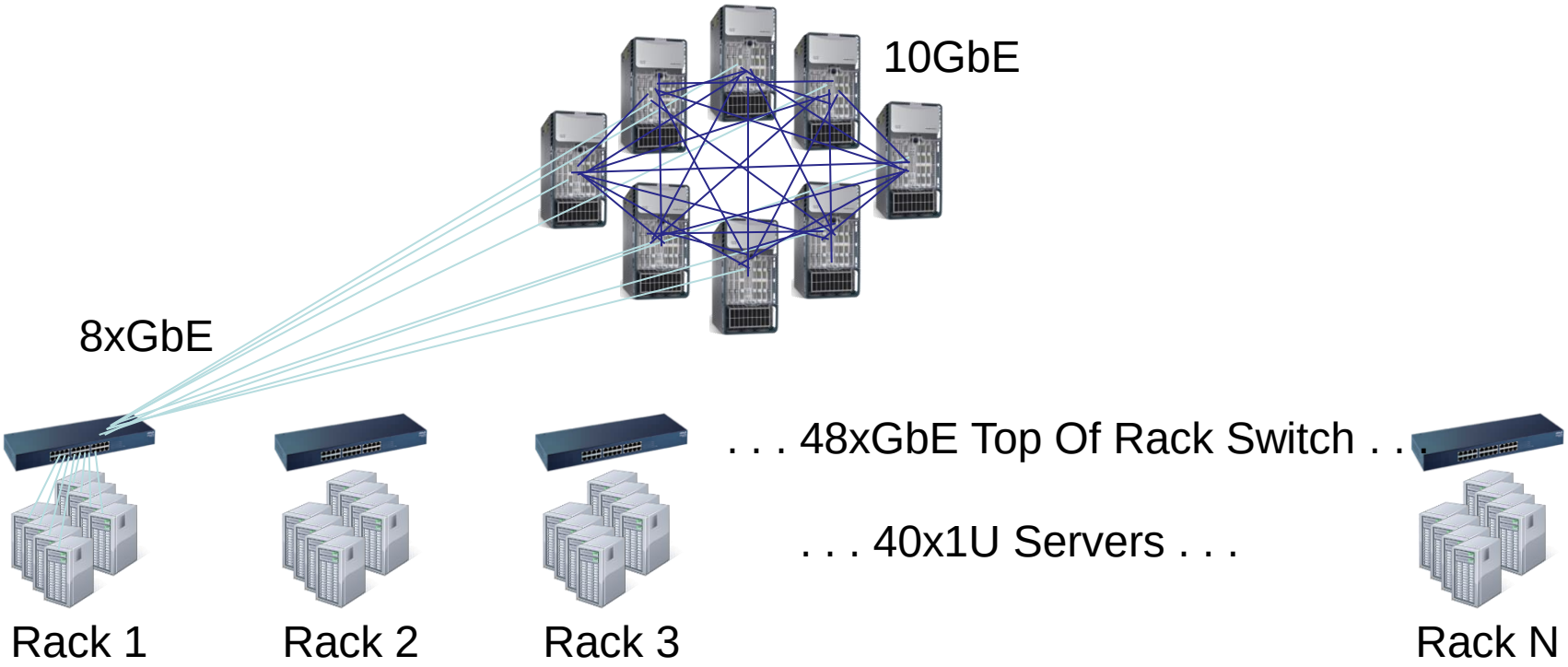
HTTP Request Amplification: 1,000x to 10,000x

The “It’s Everywhere!” Back-End Problem

e.g. Search (offline part), Analytics

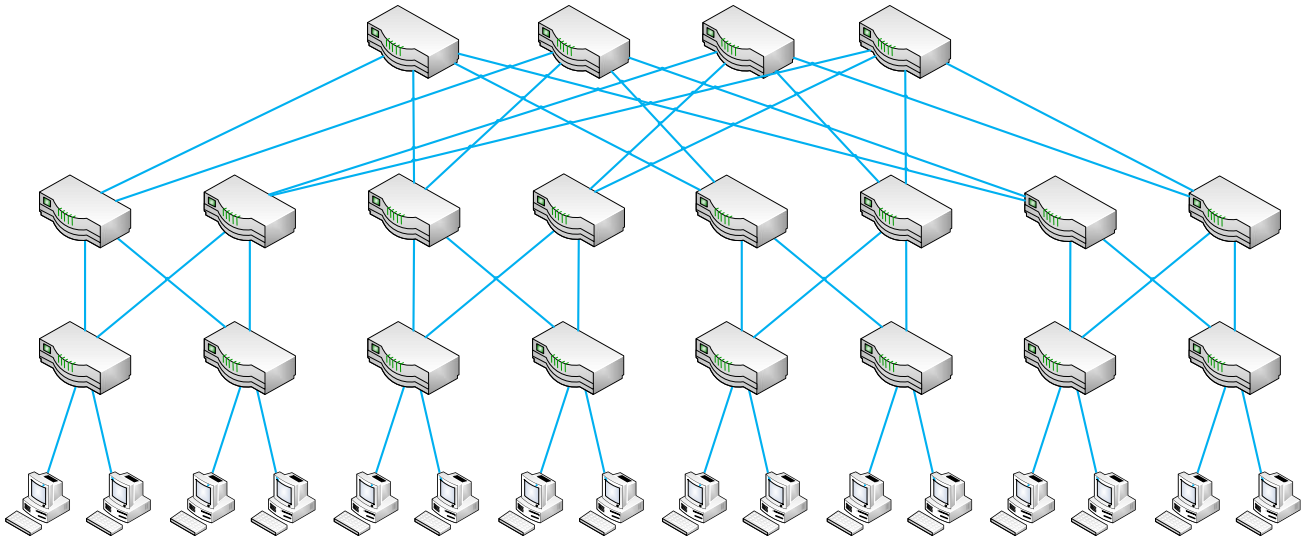


Existing Datacenters are Expensive



Many existing data centers oversubscribed – not fully connected

Why not just use a “fat tree” of commodity switches?



Problem - Tons of Cabling

- System built w/48 port switches requires 55,296 Cat-6 cables!
- 1,128 separate cable bundles
- If optics is used for transport (10 G), transceivers are ~80% of cost of interconnect

The “Yellow Wall”

1G/10G End Host "Barrier"

- We know that optics must be used if link is:
- > 10m @ 10G or ~ 1m @ 100G

- For a 10G switch port:
  - Power: 12.5W per 10 G switch + 1W transceiver
  - Cost: $16 switch + $40 to $250 transceiver (based on 64-port 10G switch chip @$1000)

- For common data center network (Fat Tree):
  - Each server needs 6 switch ports + 6 transceivers

- Optics dominates cost for 10G end host systems
- Electrical ports dominate power

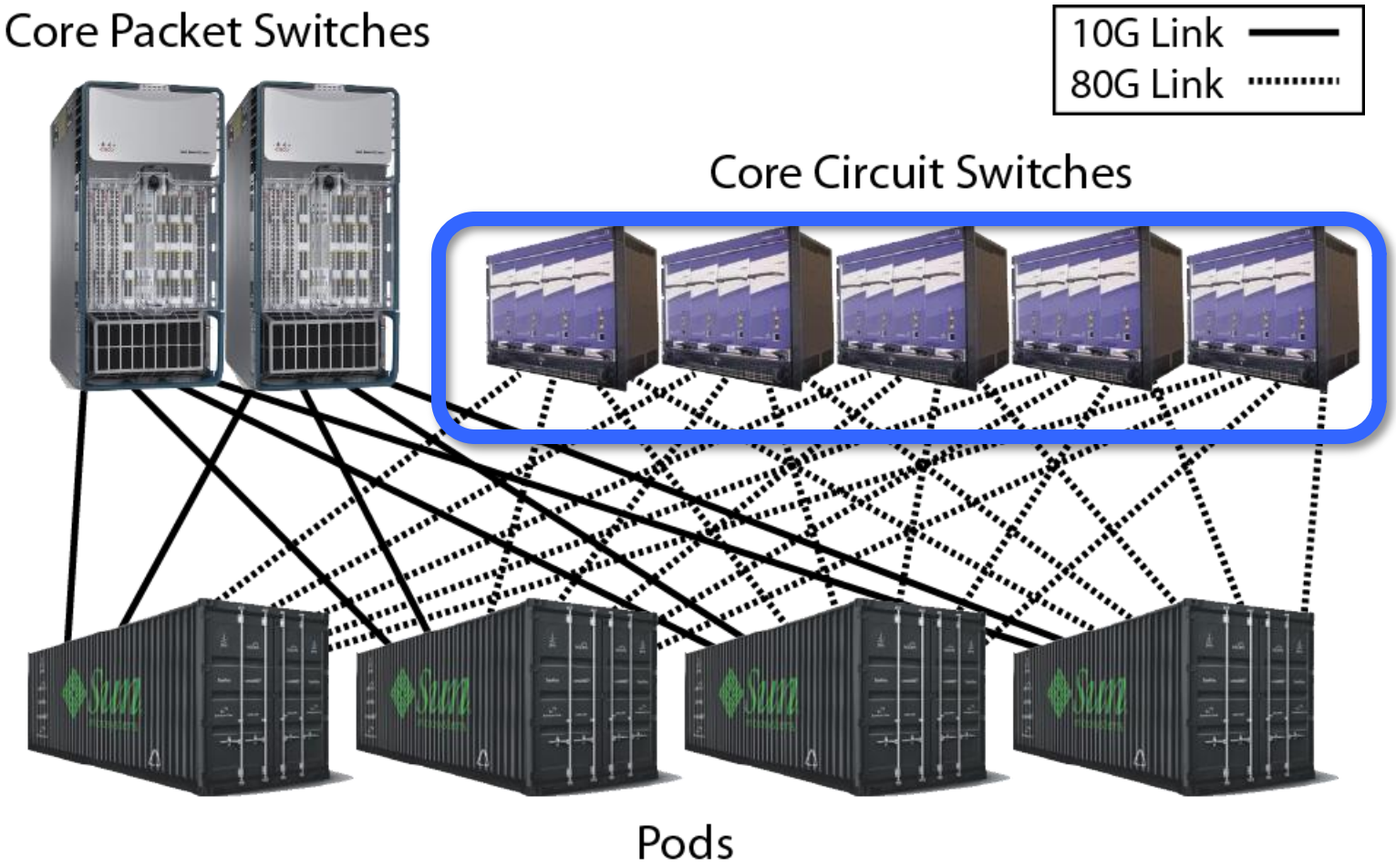
Revisiting an Old Idea

- Electrical Packet Switch$500/port
- 12 W/port
- 10 Gb/s fixed
- Per-packet switching

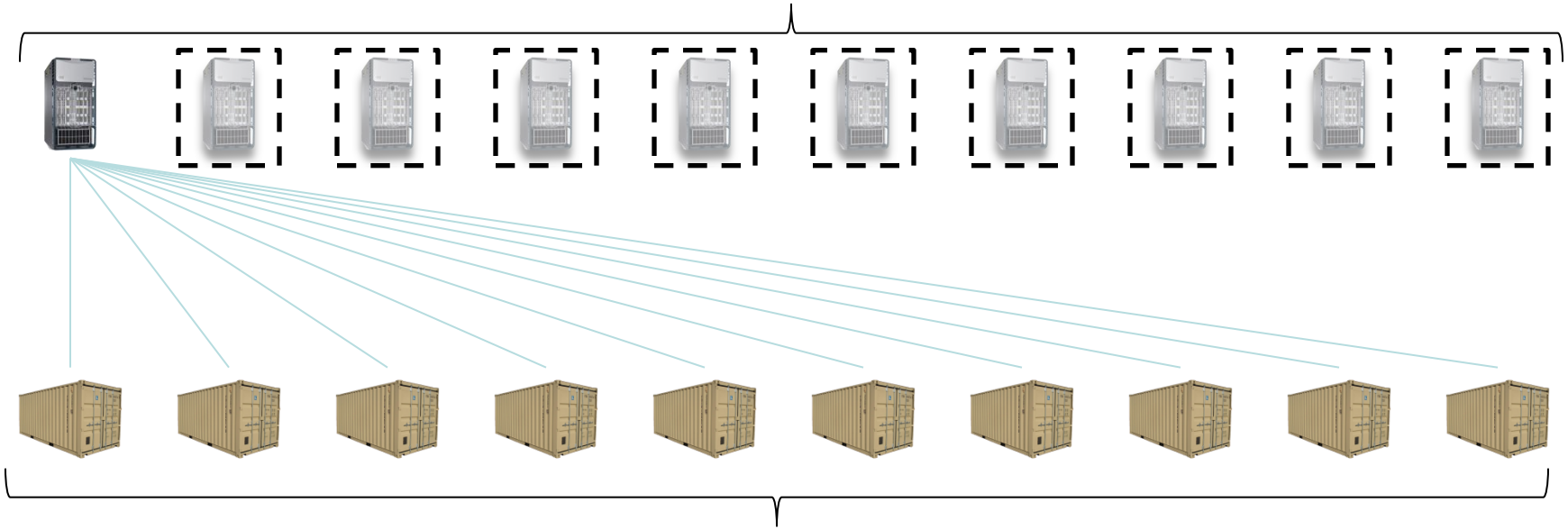
- Optical Mems Switch
- $500/port
- 240 mW/port
- Rate free
- 12 ms switching (3-D MEMS)

Mixing both types of switches in the same network allows one type of switch to compensate for the weaknesses of the other type. The optimal ratio of packet switches and circuit switches depends on the data center workload.

State of the art: Helios [SIGCOMM '10]



k switches, **N**-ports each

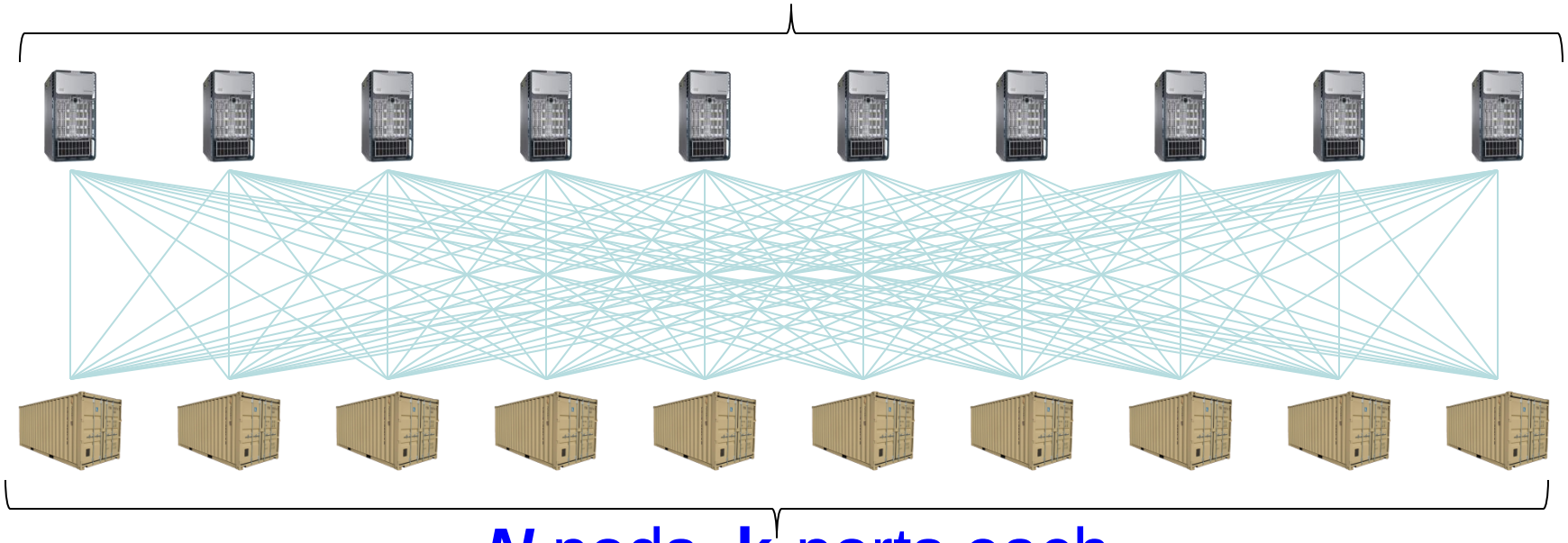


N pods, **k**-ports each

Example: N=64 pods * k=1024 hosts/pod = 64K hosts total; 8 wavelengths

Bisection Bandwidth	10% Electrical (10:1 Oversubscribed)	100% Electrical	Helios Example 10% Electrical + 90% Optical
Cost	$6.3 M		
Power	96.5 kW		
Cables	6,656		

k switches, **N**-ports each

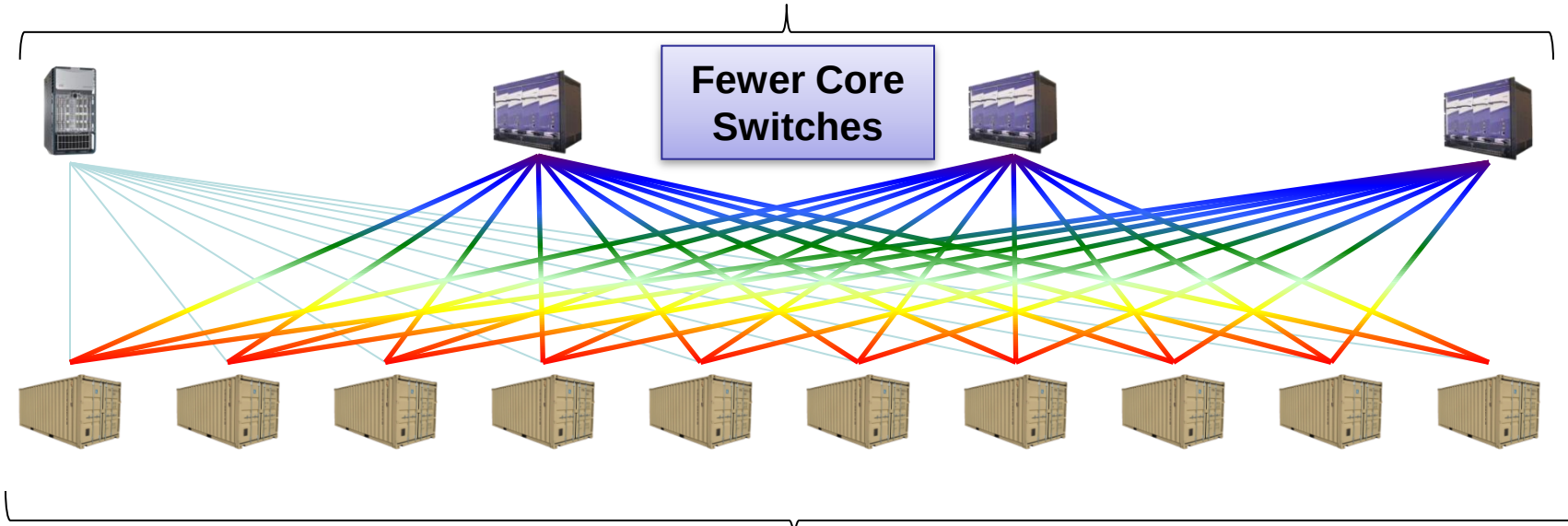


N pods, **k**-ports each

Example: N=64 pods * k=1024 hosts/pod = 64K hosts total; 8 wavelengths

Bisection Bandwidth	10% Electrical (10:1 Oversubscribed)	100% Electrical	Helios Example 10% Electrical + 90% Optical
Cost	$6.3 M	$62.3 M	
Power	96.5 kW	950.3 kW	
Cables	6,656	65,536	

Less than *k* switches, **N**-ports each



N pods, **k**-ports each

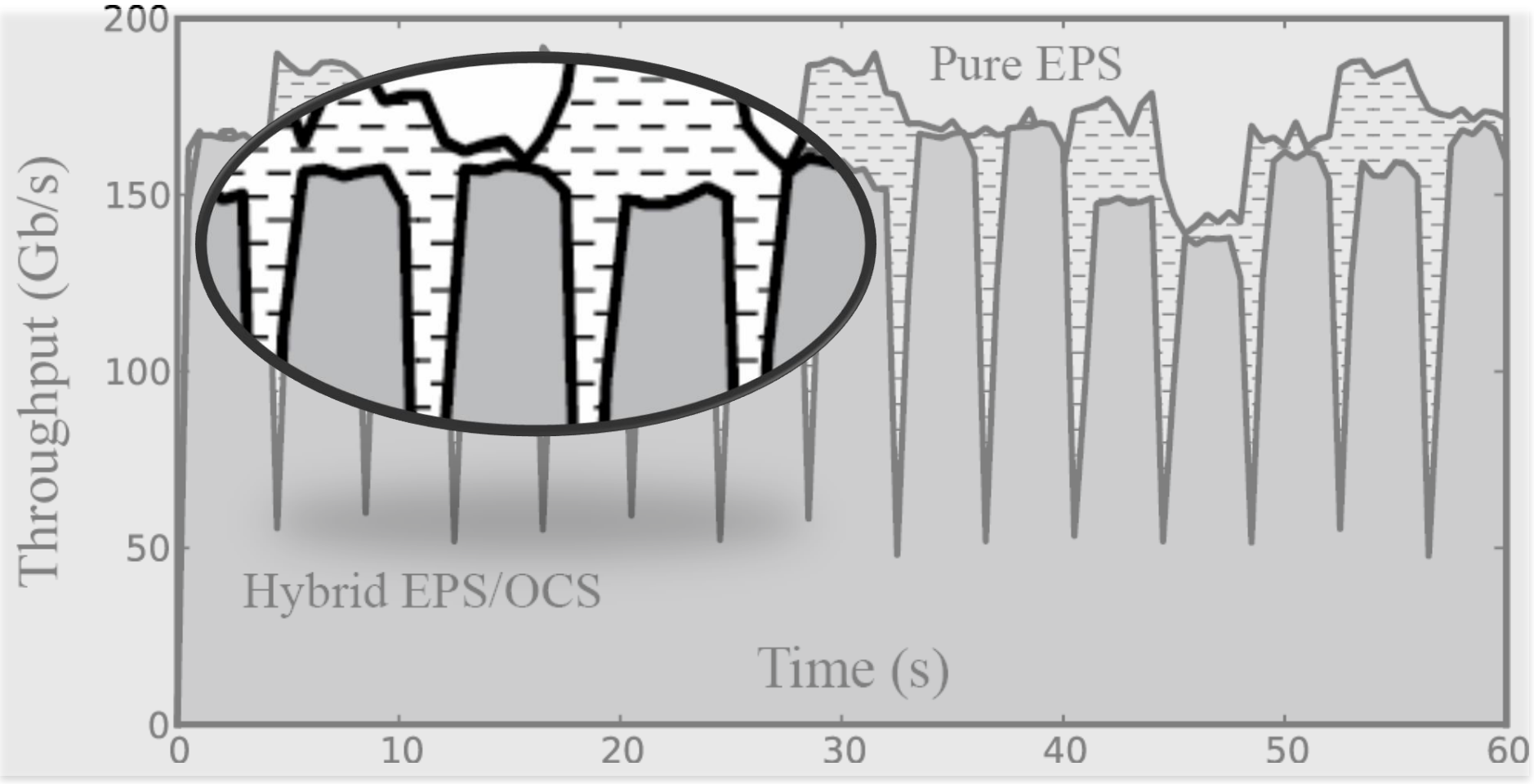
Example: N=64 pods * k=1024 hosts/pod = 64K hosts total; 8 wavelengths

Bisection Bandwidth	10% Electrical (10:1 Oversubscribed)	100% Electrical	Helios Example 10% Electrical + 90% Optical	
Cost	$6.3 M	$62.2 M	$22.1 M	**2.8x Less**
Power	96.5 kW	950.3 kW	157.2 kW	**6.0x Less**
Cables	6,656	65,536	14,016	**4.7x Less**

DataCenter Testbed

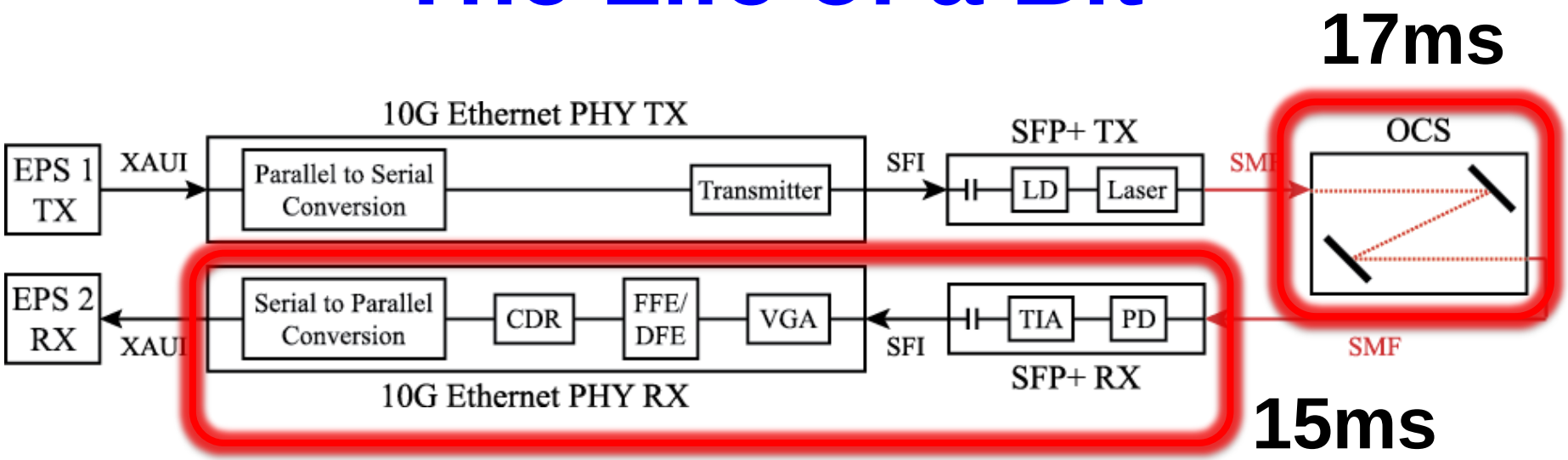
- Leverage from NSF MRI
- 70 servers
  - HP DL380
  - 2 socket (E5520) Nehalem
  - Dual Myricom 10G NICs
- 7 switches
  - One Dell 1G 48-port
  - Three Fulcrum 10G 24-port
  - One Glimmerglass 64-port optical circuit switch
  - Two Cisco Nexus 5020 10G 52-port

Measured gaps in throughput



In this experiment, performance is 20% worse.

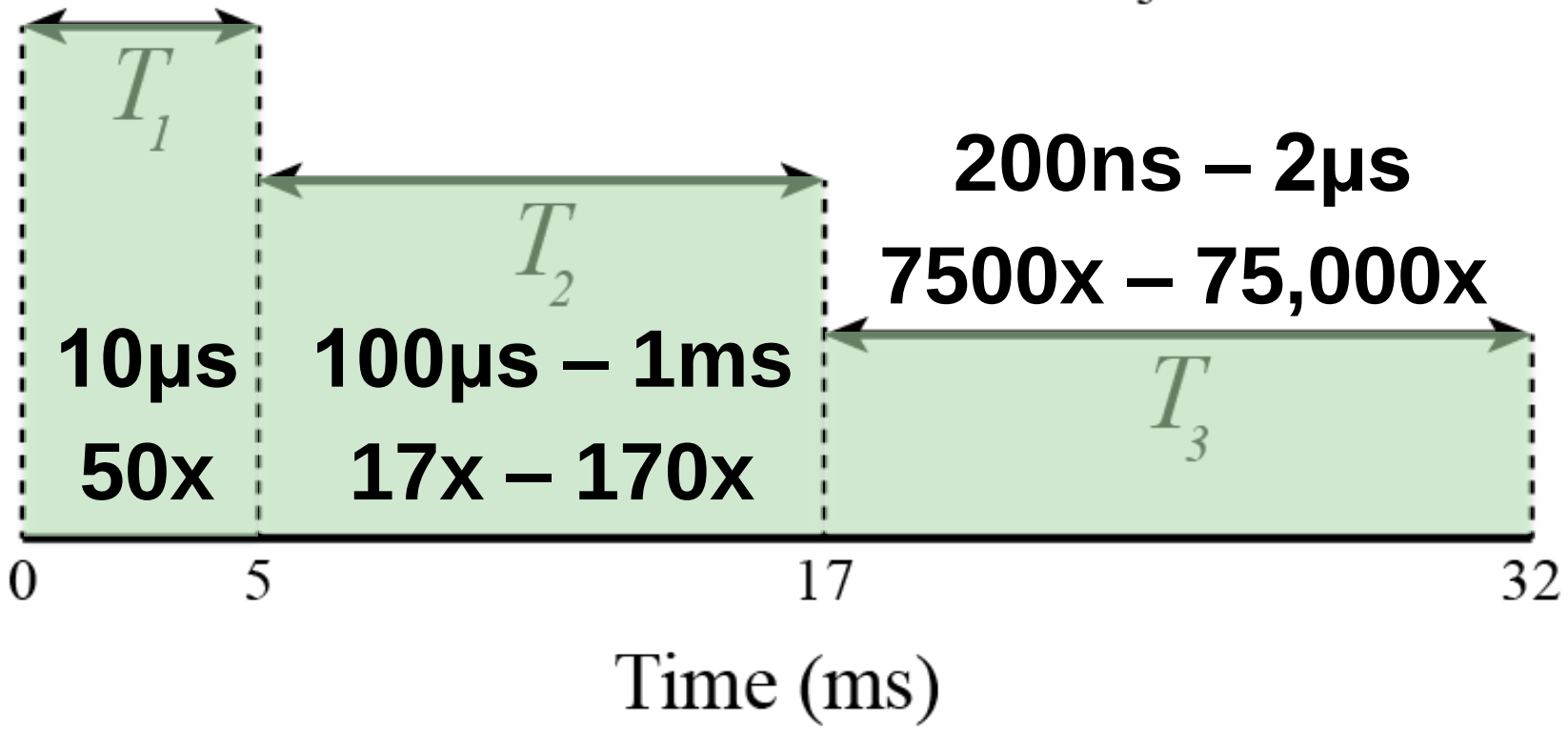
Data Center Latency
The Life of a Bit



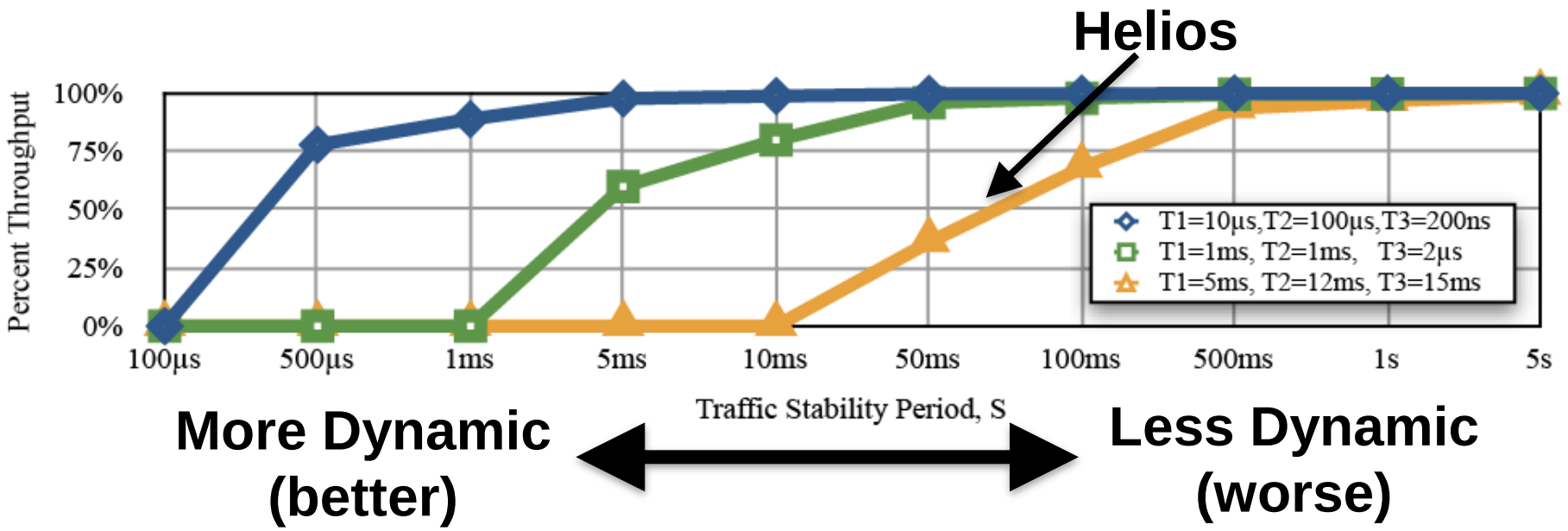
CDR: Clock/Data Recovery
DFE: Decision Feedback Equalizer
EPS: Electronic Packet Switch
FFE: Feed-Forward Equalizer
LD: Laser Driver
OCS: Optical Circuit Switch
PD: Photodetector
PHY: Physical Layer Device
SFI: SFP+ Electrical Interface
SFP+: A 10G Transceiver Form Factor
SMF: Single-mode Fiber
TIA: Transimpedance Amplifier
VGA: Variable Gain Amplifier
XAUI: 10G Ethernet Attachment Unit Interface

Timing across the whole stack

Command Processing, T_1: 5ms
Mirror Reconfiguration, T_2: 12ms
Receiver Initialization, T_3: 15ms



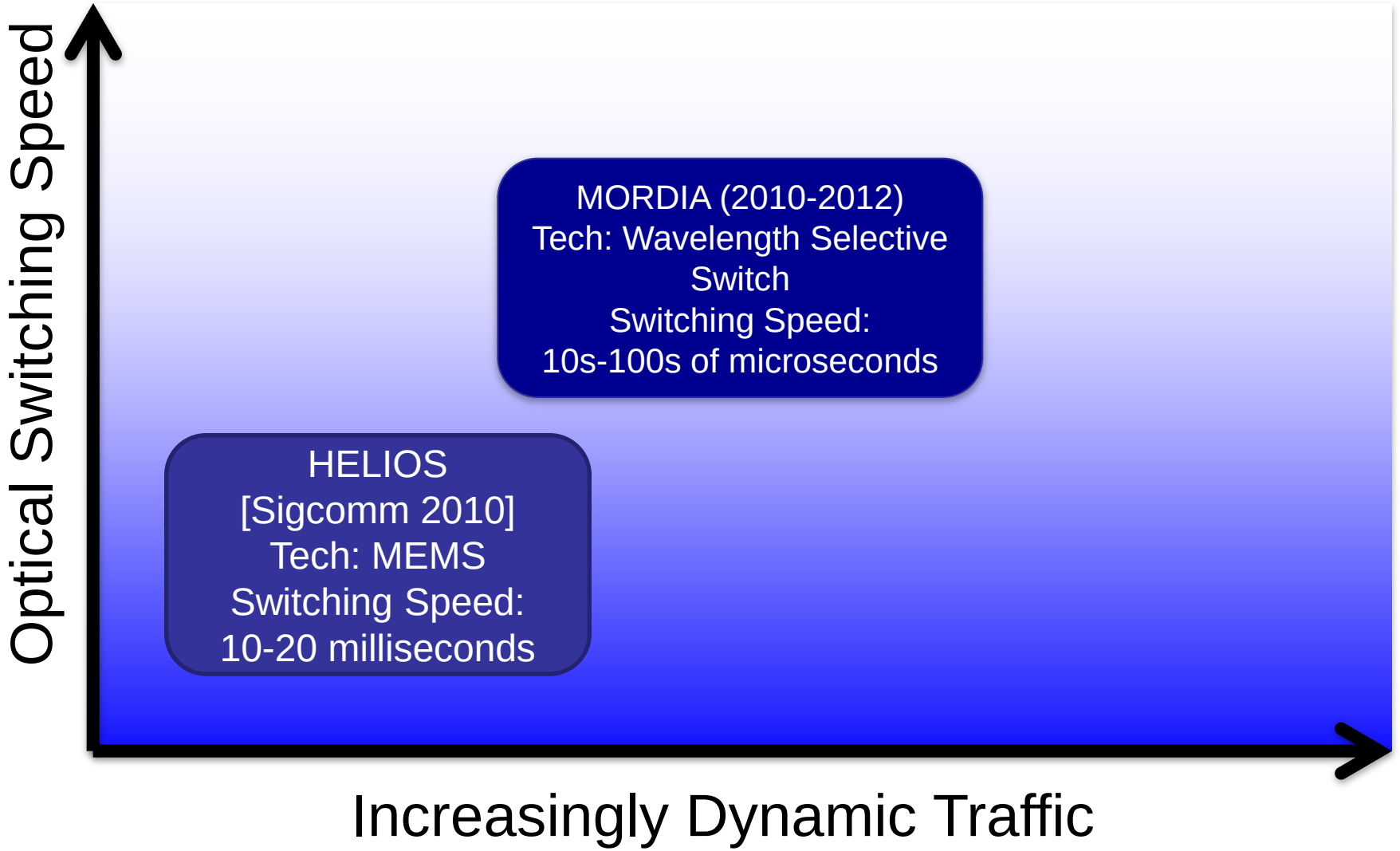
Importance of optical subsystem latency



- **Lower latency switching supports increasingly dynamic traffic**

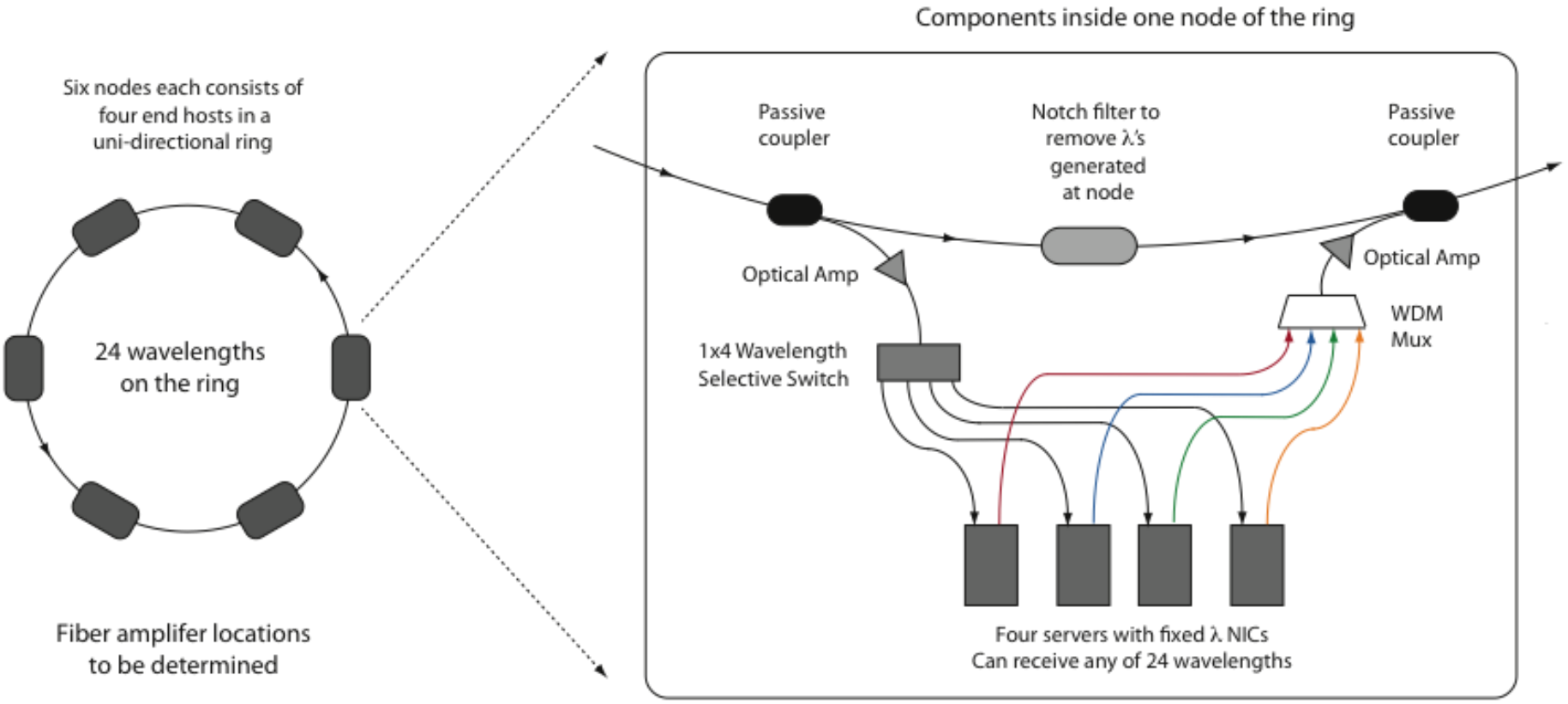
"Hardware Requirements for Optical Circuit Switched Data Center Networks", *Nathan Farrington, Yeshaiahu Fainman, Hong Liu, George Papen, Amin Vahdat,* Optical Fiber Communication Conference (OFC) 2011, Paper OTuH3.

Datacenter Optical Switching Research Trajectory



Mordia: Approach

Microsecond **O**ptical **R**esearch **D**atacenter **I**nterconnect **A**rchitecture



Objectives for Mordia

- Can a hybrid network that can switch optical in the range of microseconds have the same throughput as a traditional data center?
- Hypothesis from the lessons from our first-gen system: yes.
- Mordia will switch ~100x faster than first gen system
- System currently under construction at UCSD

Summary

- Key design metric is to reduce *network latency & increase bisection bandwidth* at an energy/cost point that is economical
- Optical interconnect switching speed dictates the amount of *dynamism* and *total level of support* for datacenter applications
- Conjecture: today's data center interconnect is a what the core will look like in the future
- A mix of circuit (optical) and packet (electrical) switch technologies will probably be required

CAP Business

Anne O'Donnell
Director
Corporate Affiliates Program
Jacobs School of Engineering

UCSD Jacobs | School of Engineering

RESEARCH EXPO

Innovation for Life

Thursday, April 14, 2011
University of California, San Diego

2011 results:

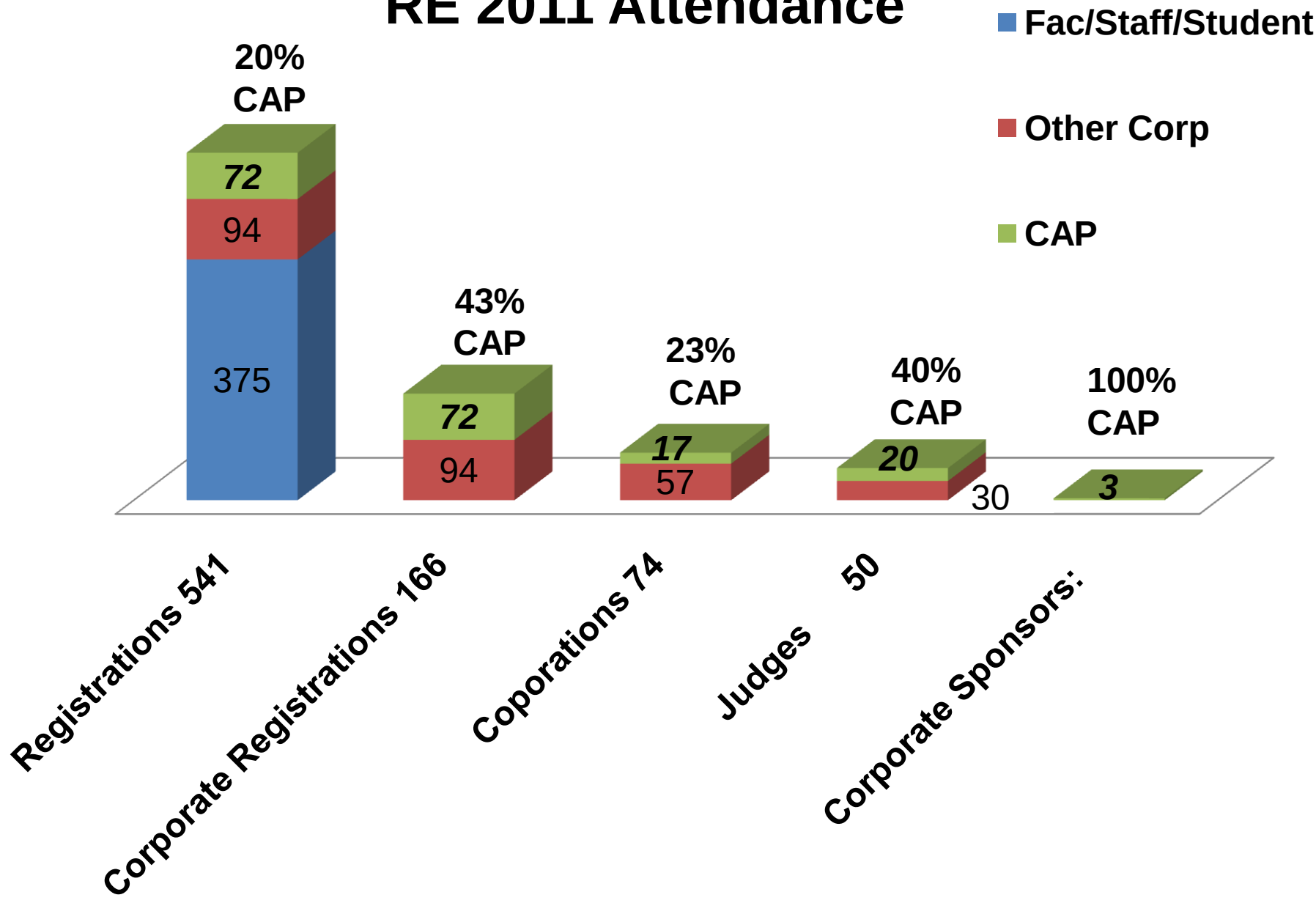
- **'Outstanding Poster' highlights High Power, Large-Force and Temperature-Stable Metal Contact Switches**
- **Keynote speaker on Engineering Advances in Medicine**
- **CAP sponsors**

life technologies™ , QUALCOMM® , ViaSat®

- **You can sponsor the 2012 event**

"Best access to research at the Jacobs School"

RE 2011 Attendance



Brainstorm: Serving the Needs of CAP members at Research Expo each year

What would entice you to send more of your colleagues and employees to Research Expo next year?

Junkyard Derby 2011 Re-Cap

2,000 burgers
300 participants
39 teams later

Thank you to:

YAHOO!

Yahoo! Hack Week April 6-9, 2011

"Enthusiasm, creativity, and level of sophistication across each of the hacks this year is what keeps us coming back to UC San Diego"

Jamie Lockwood, Academic Relations Manager-Research and Engineering, Yahoo!

- 400 Students participated in a week of focused activities
- 16 Disciplines – 8 Outside of Engineering
- 30 Talented Hack Teams
- Winners "What's In My Fridge" head to New York for World Grand Hack

Gordon Engineering Leadership Center

Thank You!

David Esbeck
Former Vice President
Solar Turbines, presented keynote at
Gordon Leadership Center Forum
May 24, 2011

'Winning Globally Through Engineering Leadership'

ordoncenter.ucsd.edu

CAP Business

Dates to Remember in 2011:

September 26 ***Spirit of Solar*** **Cruise on San Diego Bay**

October 6 **CAP Executive Board Meeting**

Thank you CAP 2010 - 2011 Leadership

CAP Chairman:
Danny Brown, Ph.D.
VP Technology Development, Cymer

CAP Vice Chairman:
Anton Monk, Ph.D. UCSD '94
Co-founder & VP Technology Entropic Communications


UCSD
Jacobs
School of
Engineering