



Interconnection Strategies for ISPs

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Agenda

Background

Internet Interconnection Strategies

Research

Findings

Financial Models: White Paper Available

NSFNET to Post-NSFNET Era Internet

NSFNET (1987-1994) Regional Techs Meetings

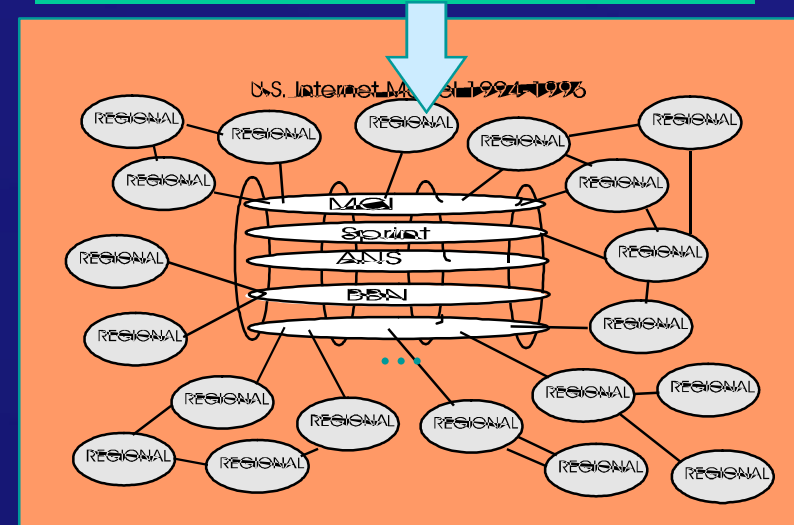
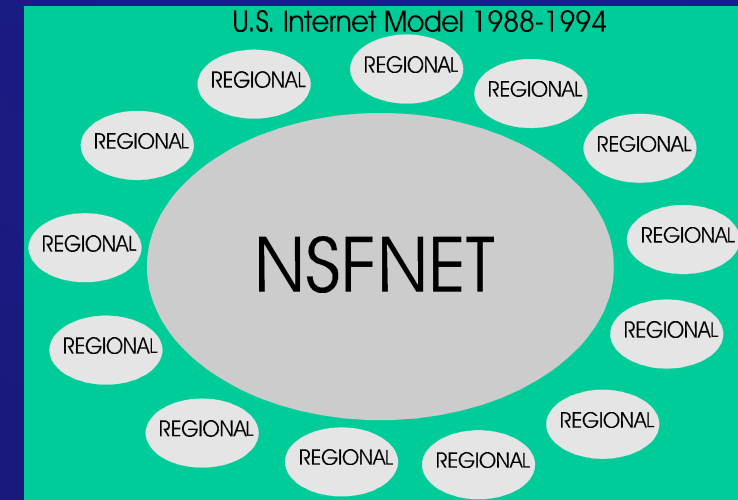
Performance & Operations

Reporting & Coordination

Routing & Network Planning

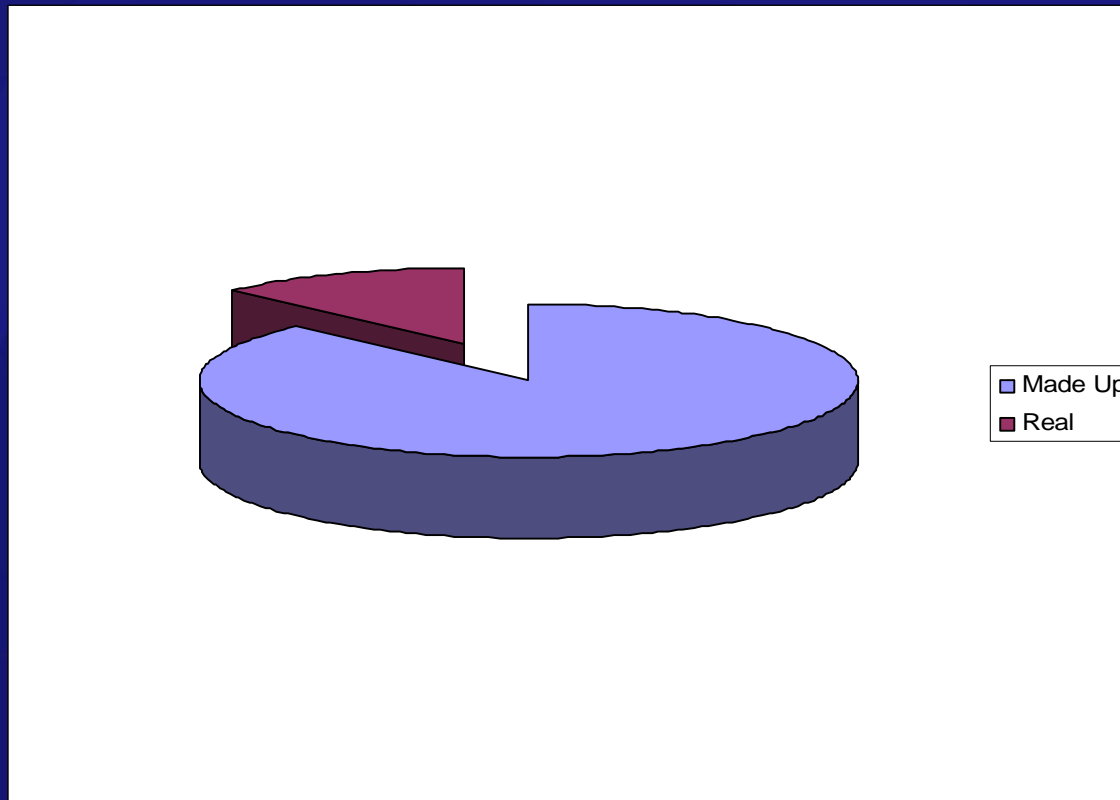
Privatization (1994-Now) North American Network Operators Group

(NANOG) Meetings



Internet Statistics

- 87.5% of all Internet statistics are made up.



Research Focus

- Interconnection Strategies :

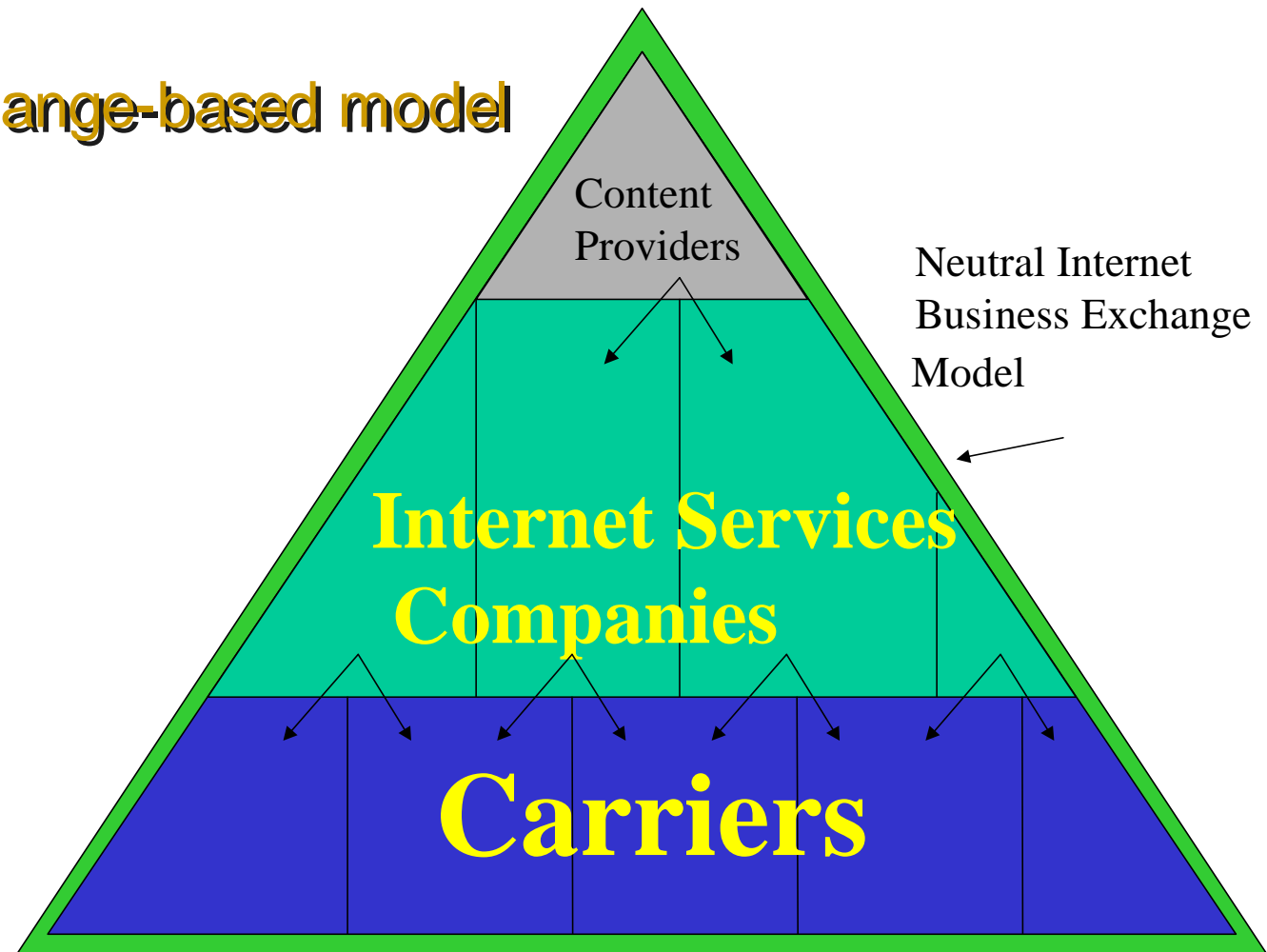
Direct Circuit Interconnect Model vs.

Exchange-based Interconnection Model

- When do each of these make sense?
- Based on current practices, existing or soon to exist technology
- White Paper & Financial Model

Neutral Internet Business Exchange Model

- Basis for Exchange-based model comparison
- Infrastructure
- Neutrality
- Facilitation
- Players



Direct Circuit Interconnection Strategy

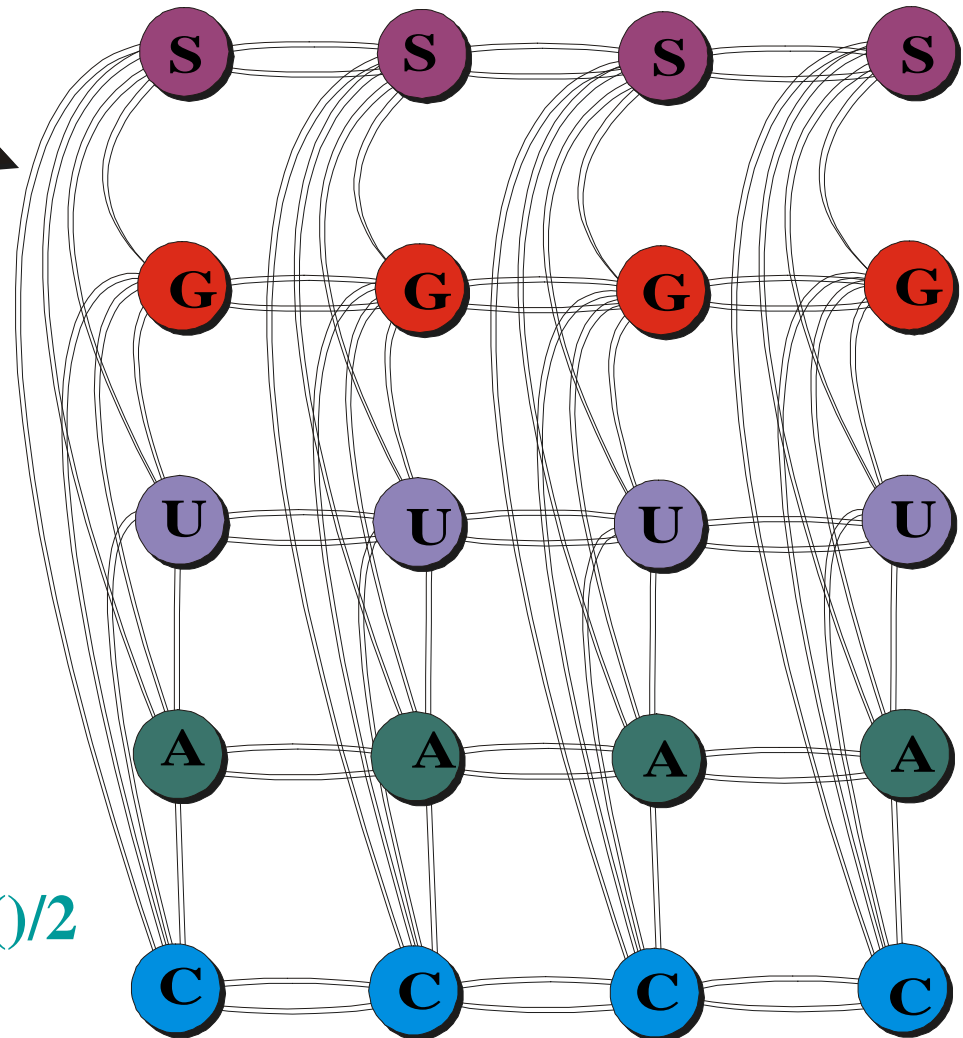
Point-to-point circuits for ISP interconnection
for regional presence

Cost drivers:

- Circuit sizes (c)
- Circuit miles (m,loc)
- CircuitCost=fn(c,m,loc)
- # of participants (n)
(1/2 cost paid by each party)

Direct Circuit Cost Function:

$$\text{ISPXC Cost} = (n-1) * \text{CircuitCost}() / 2$$



Exchange-Based Interconnection Model

Direct circuits replaced with:

- OC-12 into Exchange
- Fiber cross connects

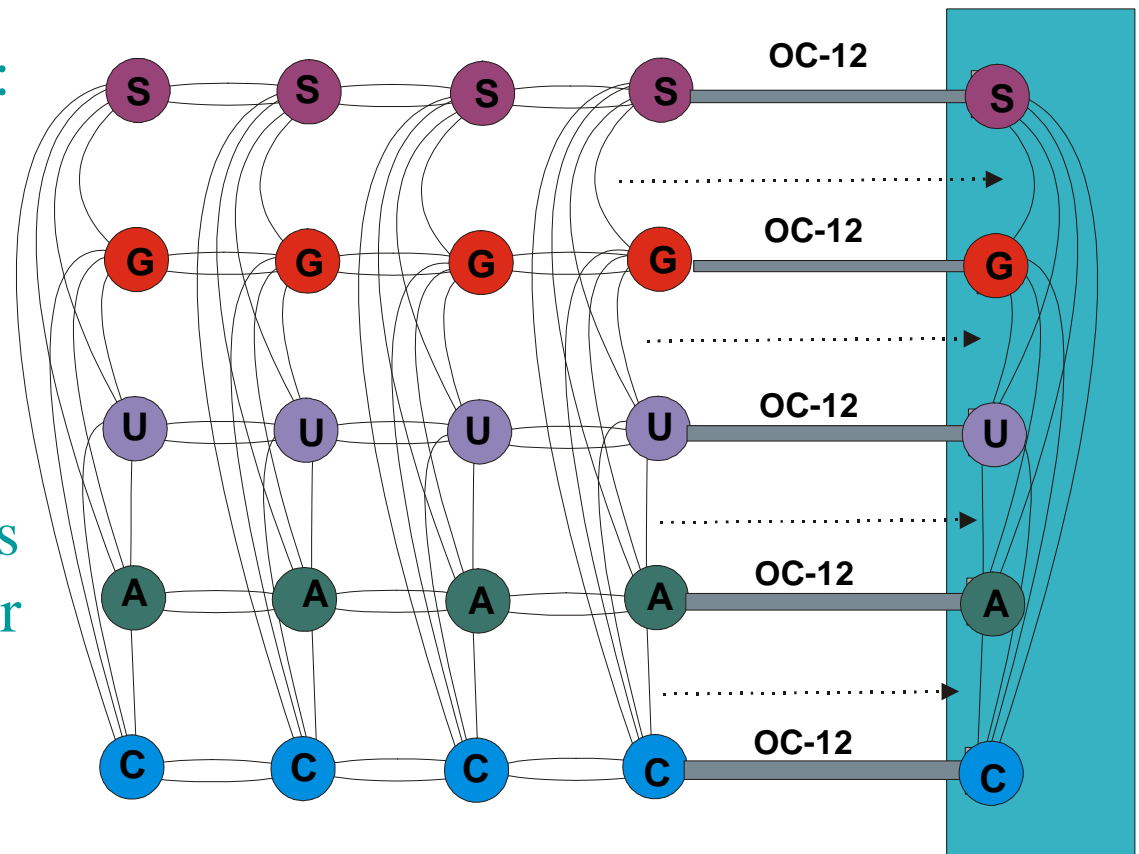
Cost Drivers:

- Big OC-12 Direct Circuit
- Cheap Fiber Cross Connects
- Aggregation Efficiency over OC-12 (2:1,3:1)

• RackXC Fees

Cost Formula:

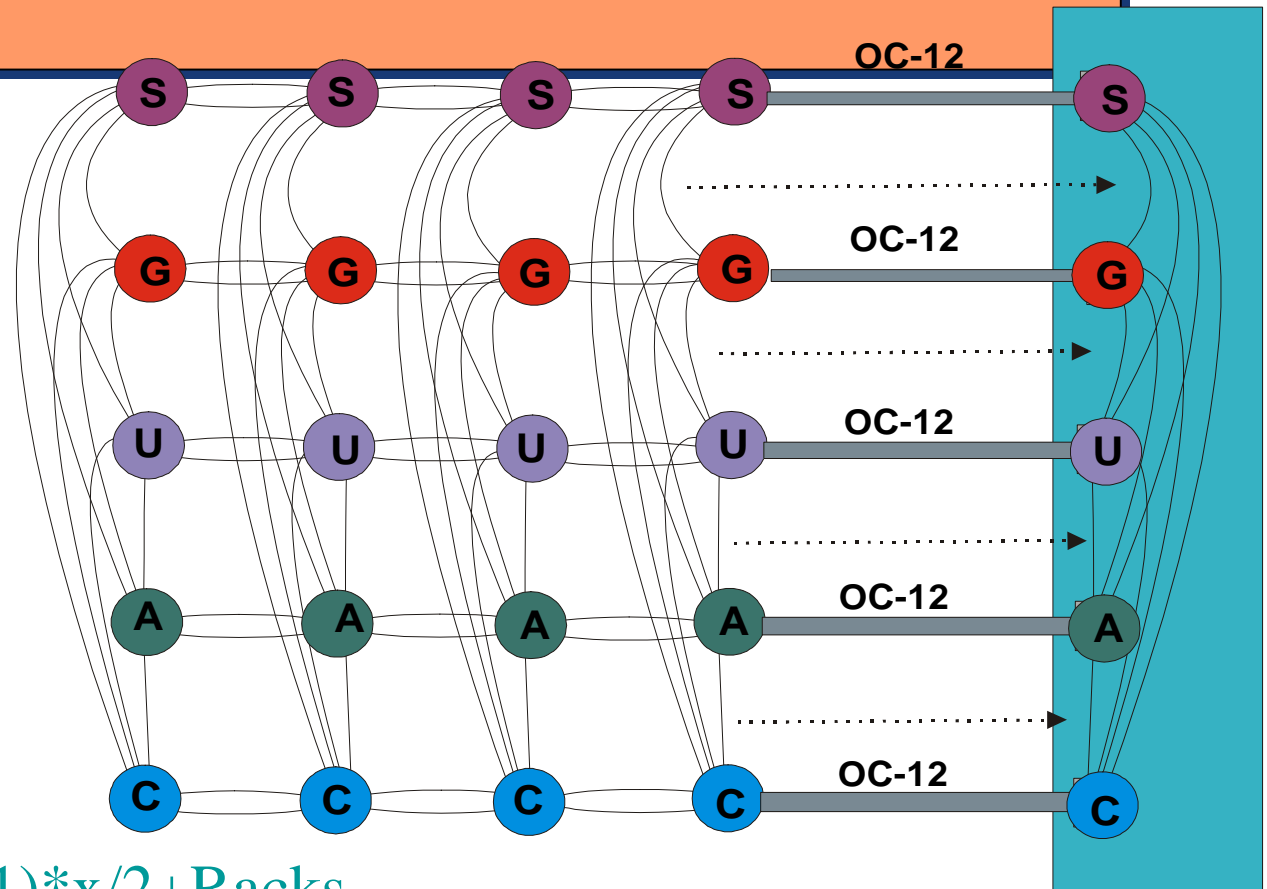
$\text{ExchangeModelCost} = \text{BigDirectCircuit}() + (n-1) * x / 2 + \text{RackXC} \text{ Fees}()$



Cost Comparison at n=5

$\text{costDCfn}() = (n-1) * C / 2$
 $C = \text{OC-3} @ \$11,400$
 $n = 5$
 $\text{costDC} = (4) * \$11,400 / 2$
 $\text{costDC} = \$22,800/\text{mo}$

$\text{costExchfn}() = \text{BDC} + (n-1) * x / 2 + \text{Racks}$
 $\text{BDC} = \text{OC-12} @ \$23,000$
 $n = 5, 1 \text{ Rack} @ \1500
 $\text{costExch} = \$23,000 + (4)(200/2) + \1500
 $\text{costExch} = \$24,900/\text{mo}$



More expensive to use Exchange-Based Interconnection Strategy at n=5. N>5?

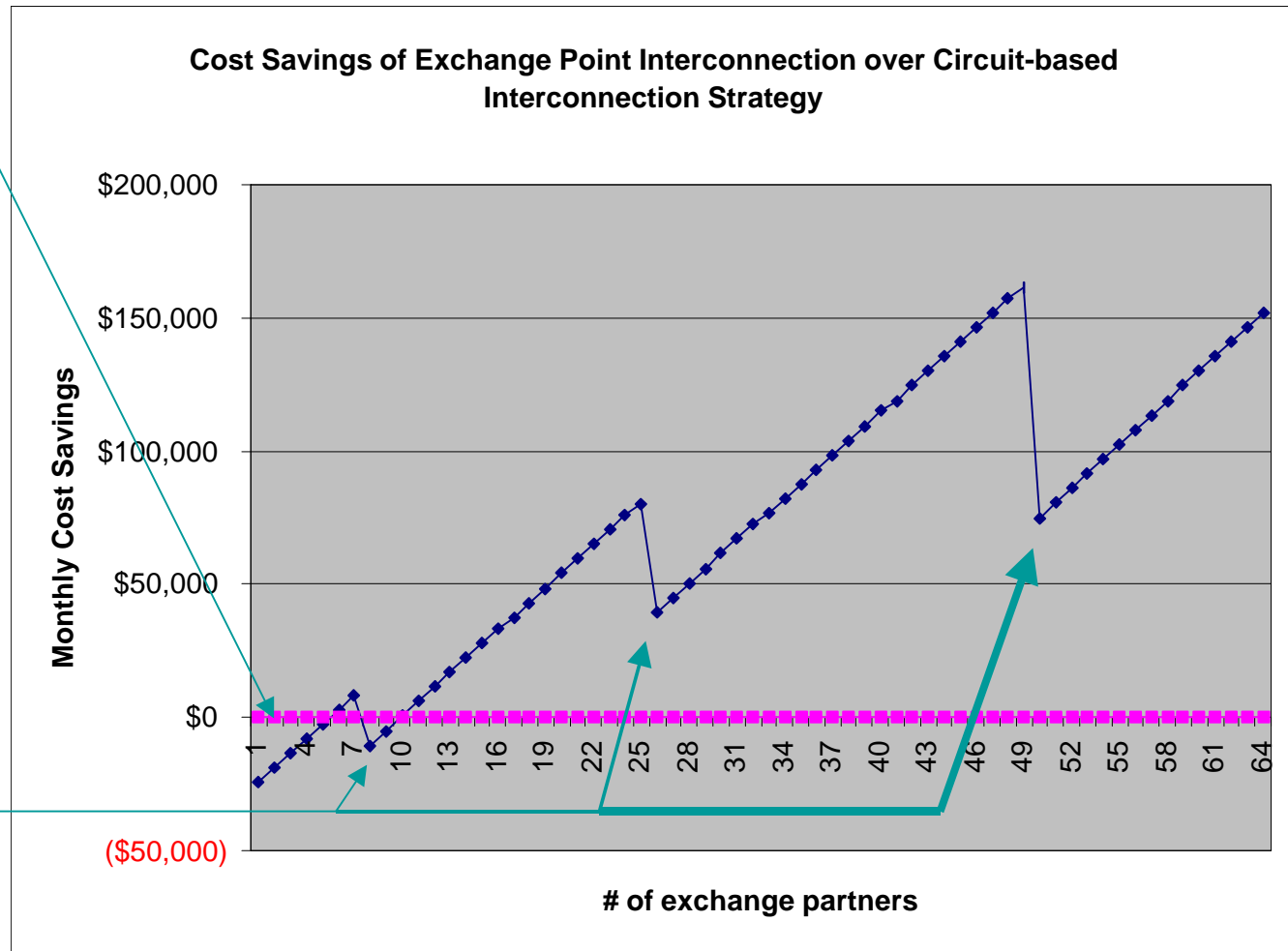
Cost Savings: Exchange-based vs. Direct Circuit Cost Model

At low n, cost of big circuit is greater than half-circuit costs.

Steps represent incremental circuit growth required for interconnection.

Aggregation kicks in... efficiency @ 2:1 (to 3:1)

Dynamics accelerate as BW requirements grow... Today's quotes->Monthly savings can get huge



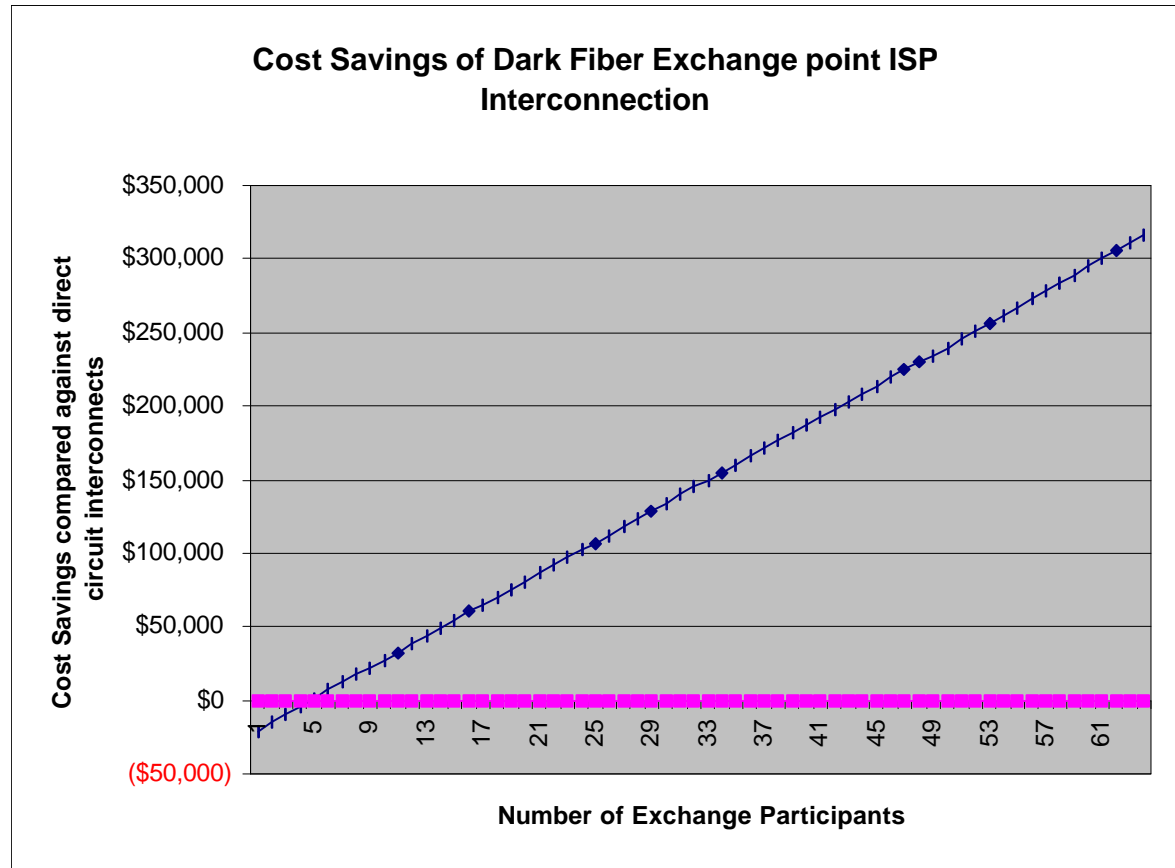
Exchange-based applying DWDM over dark fiber

Facilities-based providers win big!

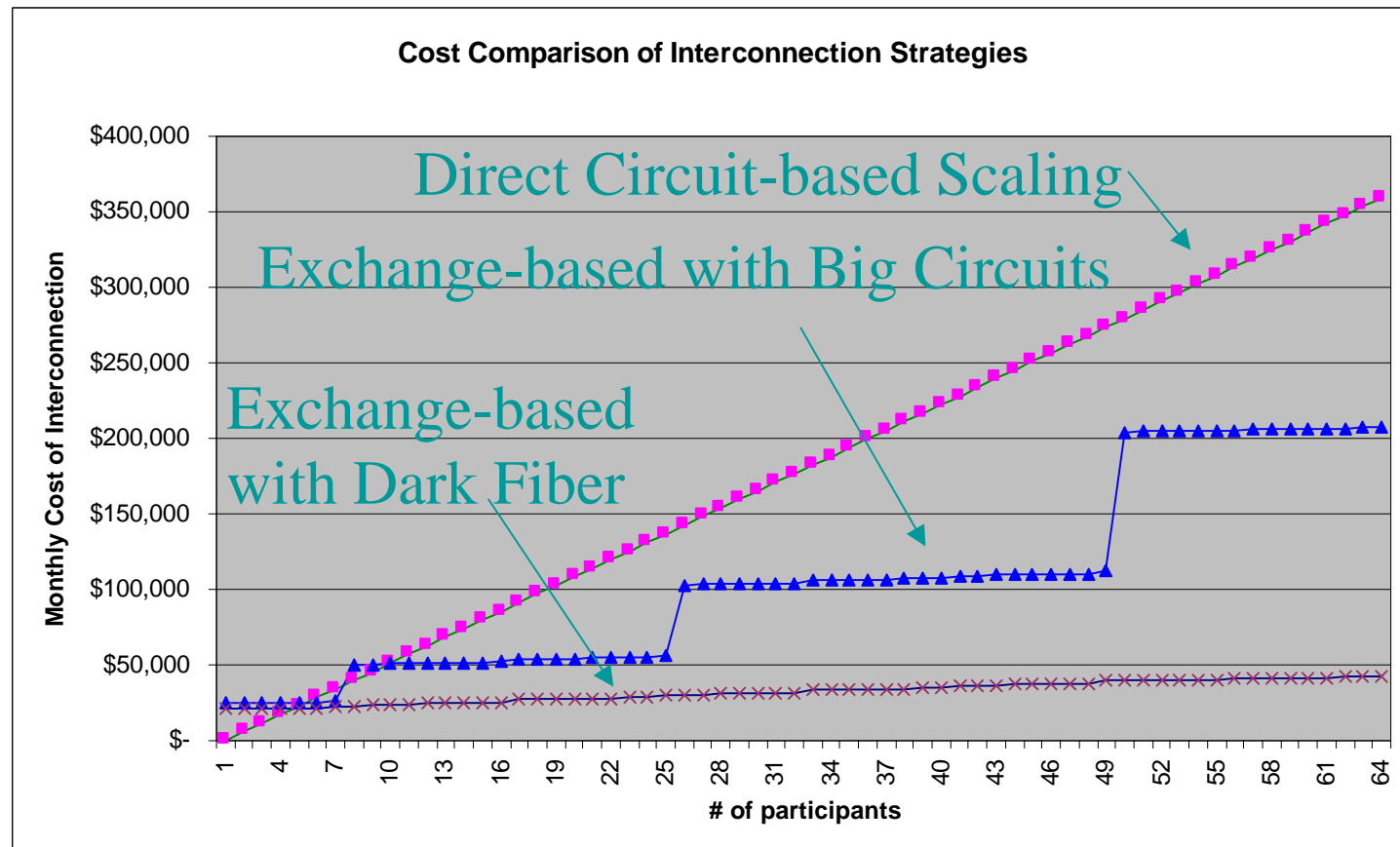
Seamlessly scale BW into exchange

Seamlessly scale BW within exchange to other ISPs/CPs

Aggregation back to net



Direct Circuit vs. Exchange-based Interconnection Strategies



BW Scaling:

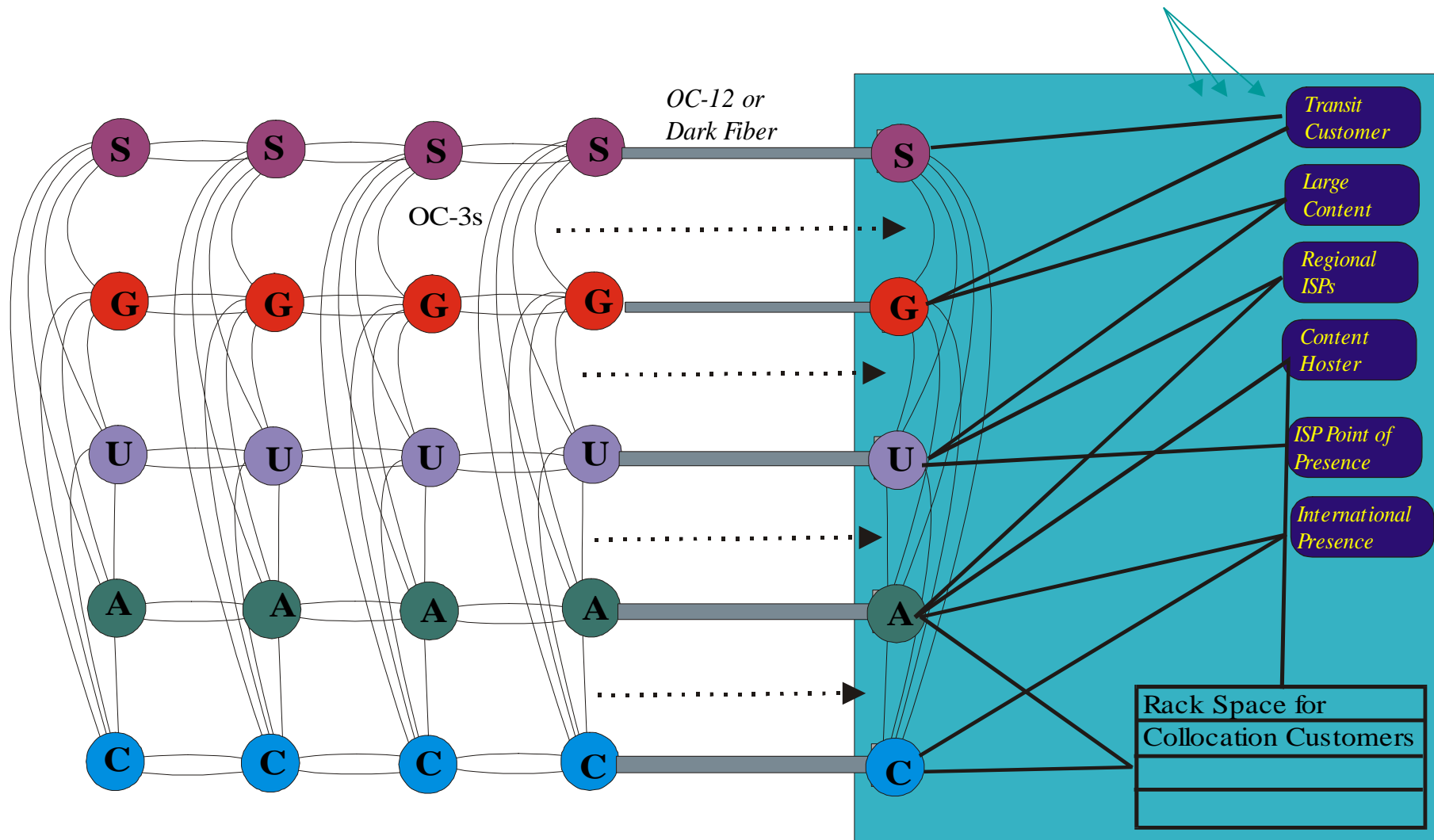
DC: Linear

BC: Stepped Linear

DF: Linear Efficient

But this ignores a key aspect of the exchange model...

IX Revenue Generation Potential



Transit Revenue Projections

# Transit Sales	Attachment Speed for New Transit Customer	Revenue to ISP per New Customer per Month	Monthly Revenue from Participation	Total Annual Revenue from Participation
6	DS-3	\$65,000	\$390,000	\$4,680,000
1	OC-3	\$120,000	\$120,000	\$1,440,000
			Annual Incremental Revenue:	\$6,120,000

Financial Model Assumptions

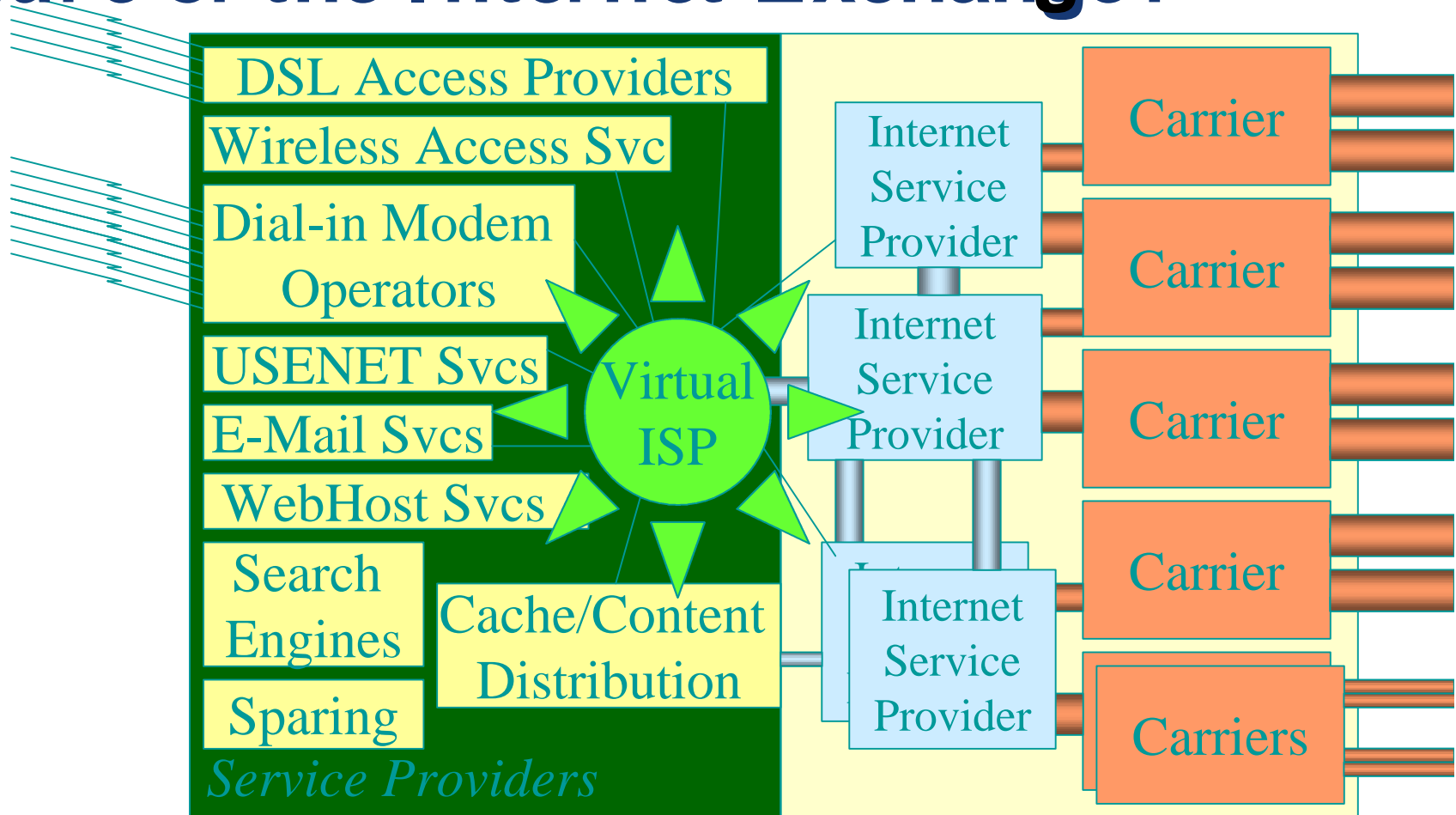
- 65 participants (5 carriers, 10 Autonomous Content Providers, 50 ISPs)
- Revenue & Projections figures based on interviews and participation modeled from PAIX
- Assuming zero growth in bandwidth demand through period
- Sufficient bandwidth into exchange to accommodate load

The Point: Incremental Revenue Generation not possible with Direct Circuit Model

Source: Dave Rand Interview

(DS3:UUNet=\$65,000/GTE=\$70,000/mo), UUNet Src: OC-3=~\$120K/mo

Future of the Internet Exchange?



MarketPlace: Stratification of component operations, fast creation & provisioning of packaged operations services

Implication: IXP \uparrow Content Sources, \uparrow bandwidth demands

Conclusions

- Direct Circuit Interconnection Strategy makes sense for interconnection among ~5 or fewer parties
- Aggregation and Optical efficiencies lead to tremendous cost efficiencies by using big circuits into exchange
- Facilities-based providers win big applying DWDM into exchange
- Large bandwidth (OC-12) for interconnections and/or large # of participants exhibit good scaling properties for exchange-based model
- Incremental transit sales possible in exchange-based model
- White paper available -- comments welcome Business Cards or e-mail to: wbn@equinix.com

Special Thanks To:

Ted Hardie (Equinix)

Bill Woodcock (Zocalo)

Pat Binford-Walsh (UUNET)

Lauren Nowlin (_____)

Vab Goel (Qwest)

Joe Payne (IXC)

Jeff Rizzo (Equinix)

Bill Manning (USC/ISI)

Jeff Payne (Real Networks)

Bill Maggs (Inktomi)

My Mom

Peter Lothberg

Rodney Joffe (Centergate)

Dave Rand (AboveNet)

Steve Feldman (WorldCom)

Paul Vixie (M.I.B.H., LLC)

Dave O'Leary (Juniper)

Tony Bates (Cisco)

Ian Duncan (Nortel)

Stephen Stuart (M.I.B.H., LLC)

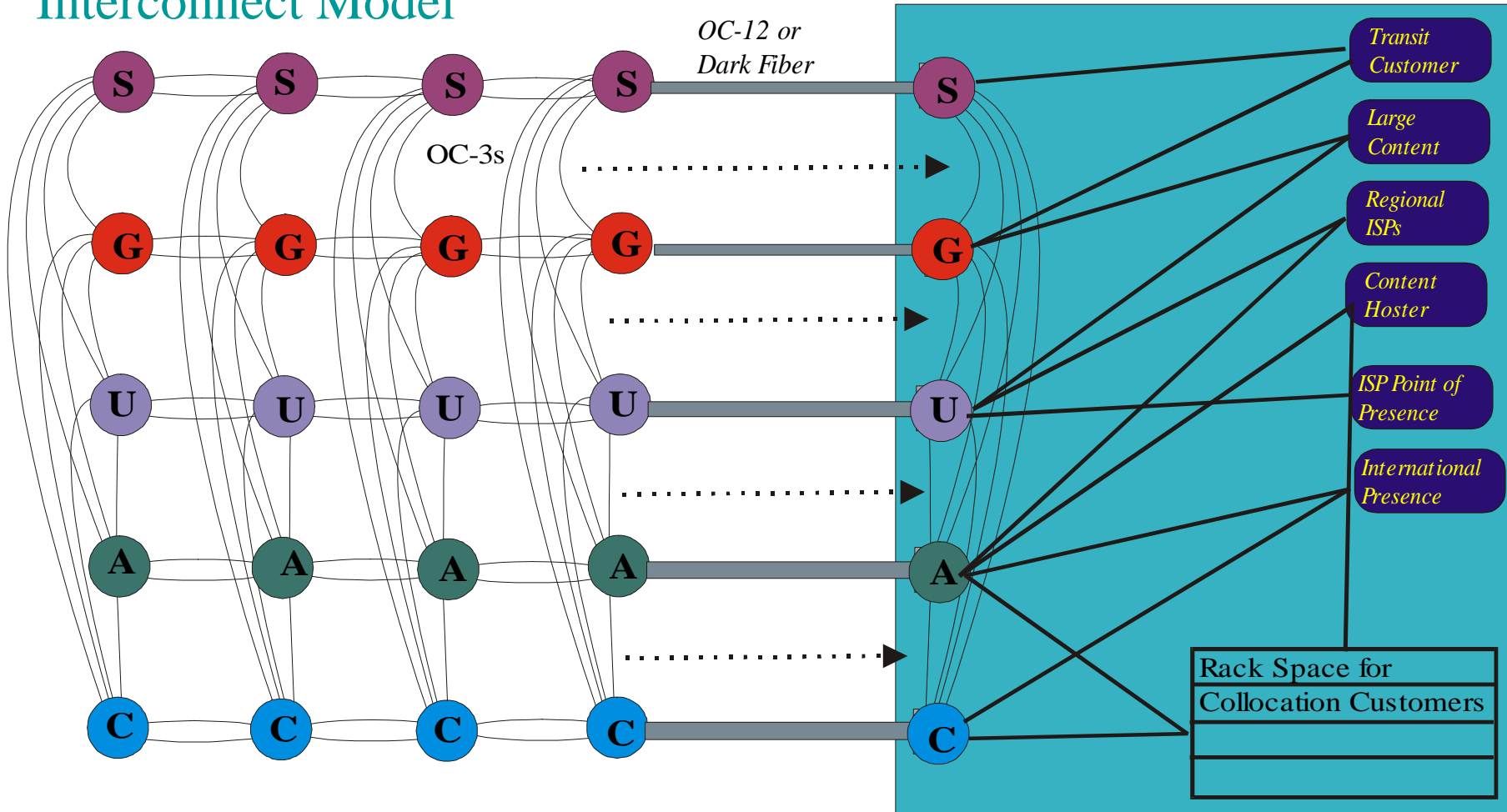
David Conrad (ISC)

Doug Humphrey (SkyCache)

Questions?

Direct Circuit

Interconnect Model



White Paper: wbn@equinix.com (or Business Card)

Exchange-Based Interconnection Model