



# Cisco on Cisco Technology Seminar

## North America WAN Rearchitecture for Peer- to-Peer Applications



**Cisco Information Technology**

**Don Layton & Rich Gore**

**April 2007**

# Agenda

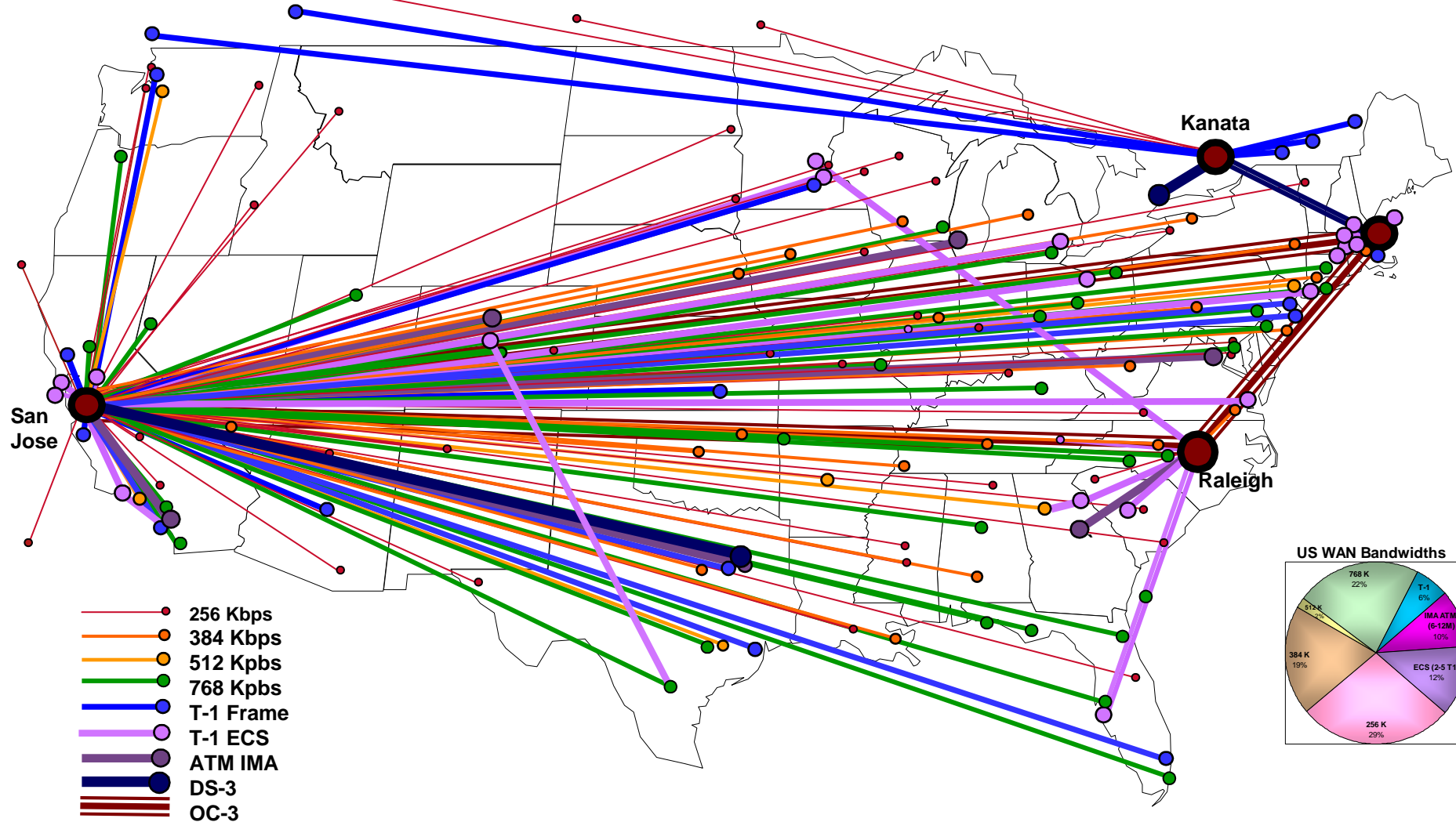
- WAN Rearchitecture Drivers
- WAN Design
- Hub Site Design
- Migration Steps
- Results

# Americas WAN Rearchitecture – Drivers

- **Previous Americas spoke & hub WAN was optimized for client / server apps in SJ; new WAN is optimized for both peer-to-peer and client-server (minimal latency, QoS enabled)**
- **Many newer apps are peer-to-peer**
  - **IP Telephony & voicemail & contact center applications, IP Video, and MeetingPlace application sharing**
- **Many newer apps should have regional presence (or presence at EVERY site) for acceptable performance:**
  - **e.g. Content Distribution, Unity Voicemail, E-mail and Calendaring**
- **Rapid growth in bandwidth demand requires a more cost-effective solution**

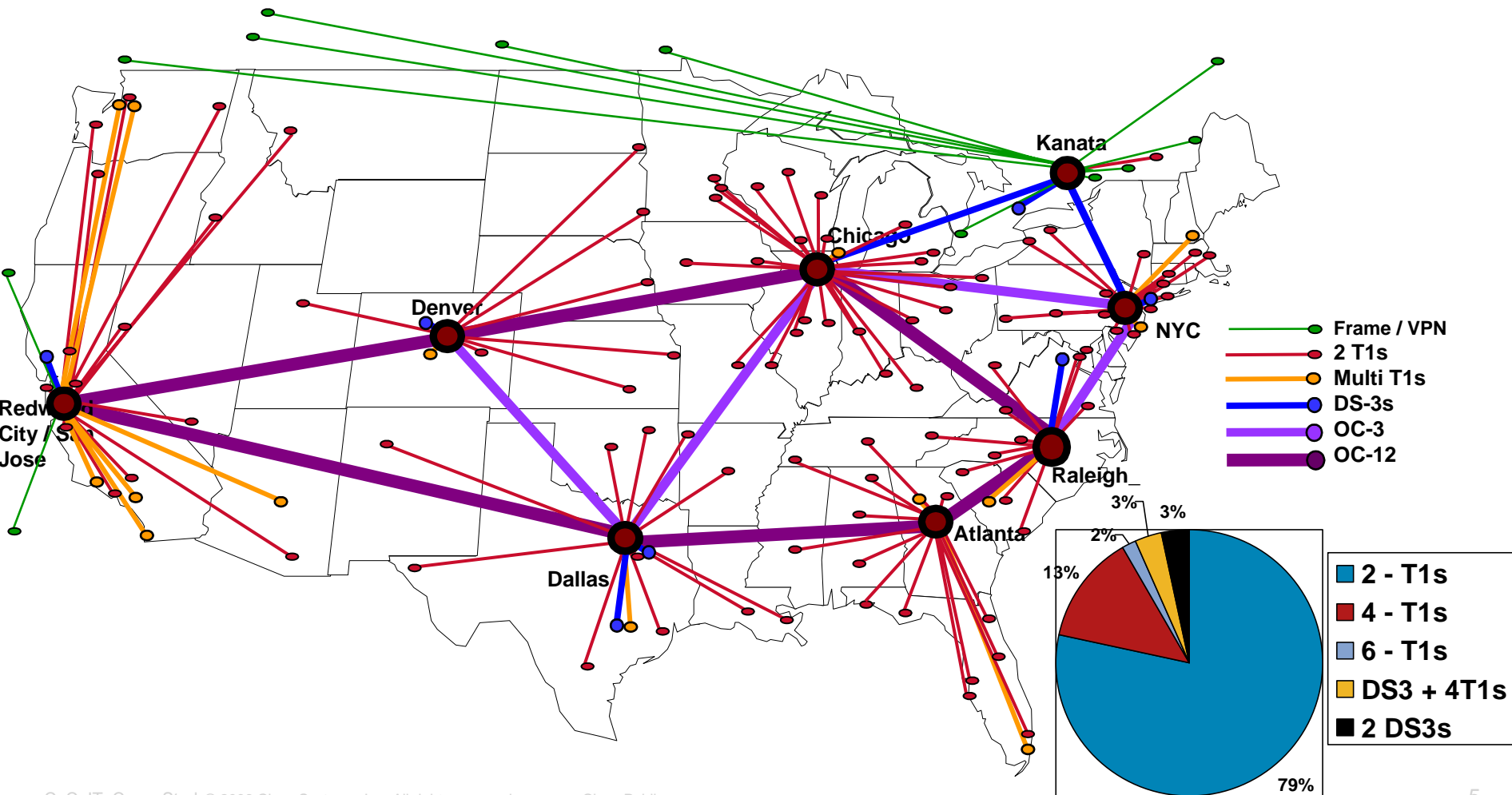
# Cisco North America WAN: Client / Server (2001)

■ Average site-to-hub circuit length = 1800 miles



# Cisco North America WAN: Peer-to-Peer (2003)

- Sum of US WAN Bandwidth: X 3.5 ( 264 Mbps → 972 Mbps )
- Cost: up 4% (average circuit length = 271 miles)



# WAN Rearchitecture Design Summary

- **Optimize US WAN by building regional hub architecture following existing fiber paths**
  - San Jose, RTP, Chelmsford, Kanata, Chicago, Dallas, Atlanta, Denver
  - Possibly Irvine, Miami, Seattle in the future
  - Telco hotelling at non-Cisco-owned sites
- **WAN Backbone becomes 12 inter-hub OC-3s / OC-12s**
- **WAN becomes 120+ T-1s / multiple-T-1s / DS-3s to nearest CAPNet hub**
- **Provide WAN QoS for multiple classes of service (per current WAN QoS project)**
- **Add bandwidth to support new applications**
- **Support regional hub IT locations for eventual application server sites**

# Comparing WAN Architecture Advantages

## 2001 (Hub in SJ)

- Optimized for Client / Server (in SJ)
- Easy to manage
- Easy capacity planning
- Cost effective for smaller networks
- Good performance for near-real-time apps

## 2003 (Regional Hubs)

- Optimized for both Peer to Peer and Client / Server (anywhere)
- Supports regional distribution of data, processing
- Cost effective for larger networks
- Good performance for real time apps

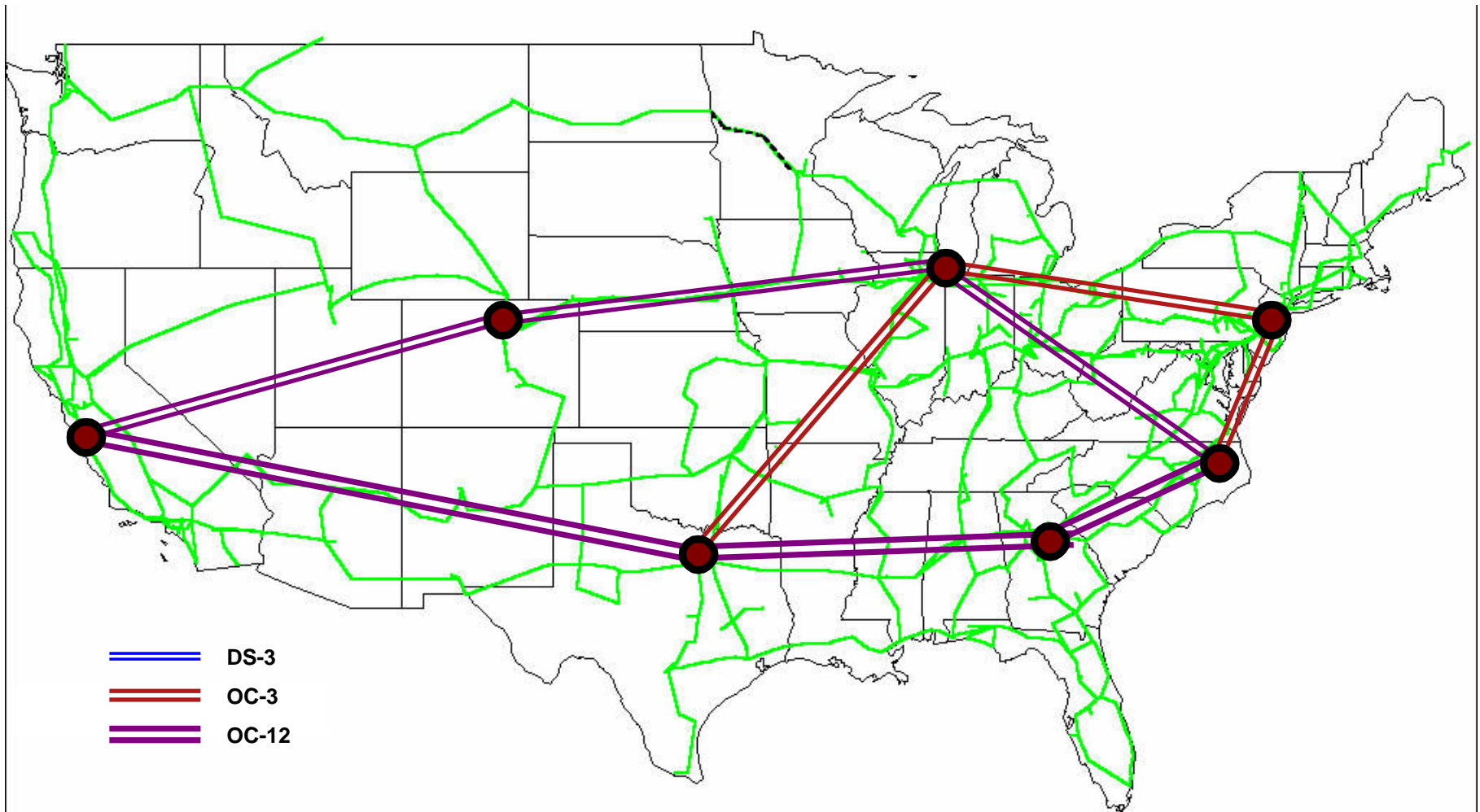
- **Flexible, scalable**



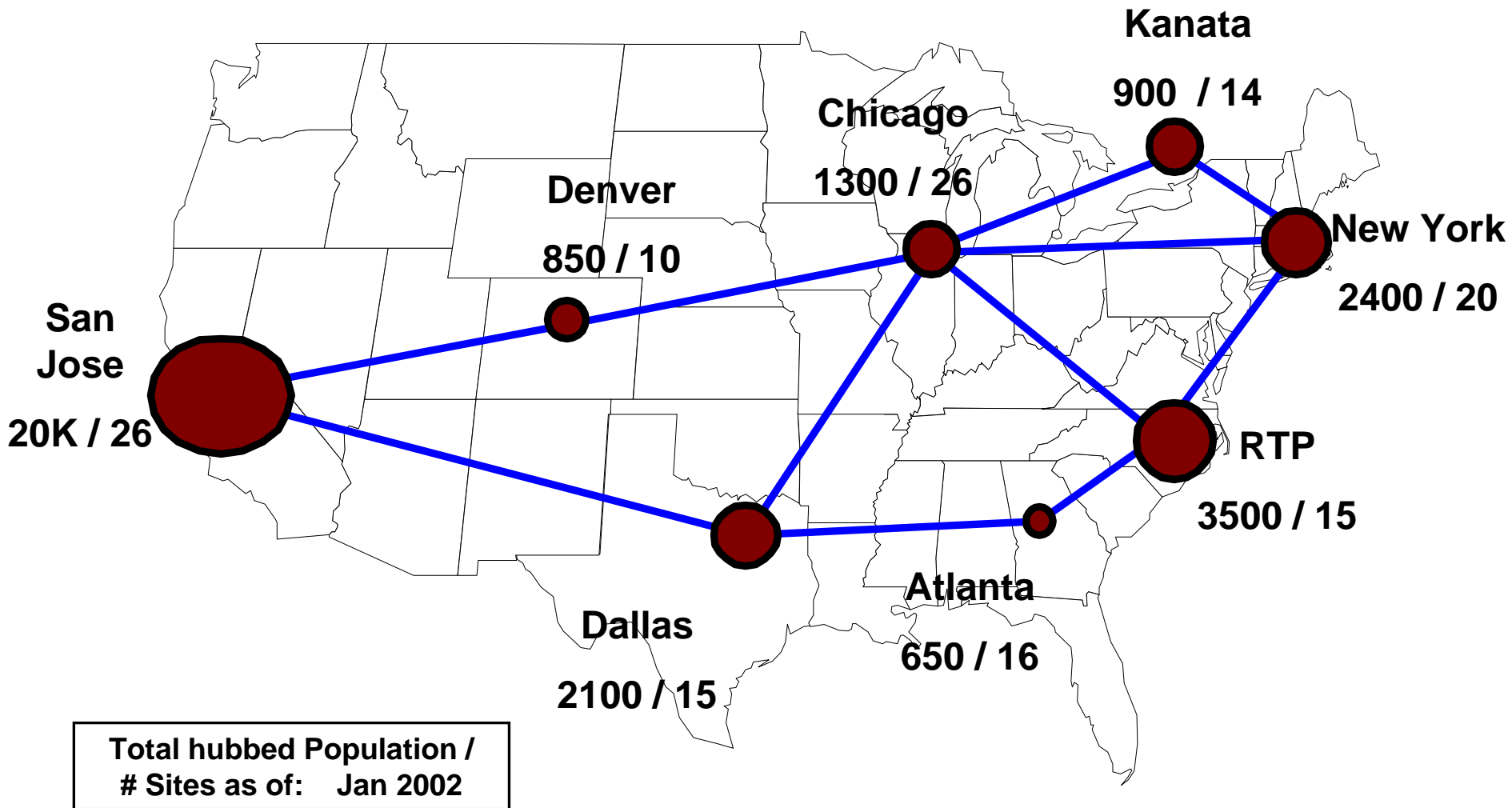
# WAN Design



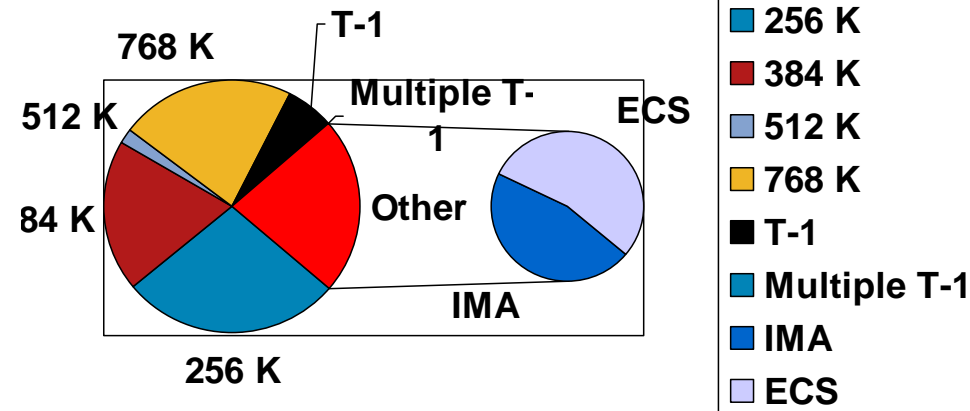
# WAN Route: Hub Locations on Underlying Fiber Path



# WAN Route: Hub Site Populations / Sites



# Branch Office Site Connections



- 2001:
  - 27% links @ 256K;
  - 24% links > T-1
  - Avg link length 1800 miles
- Re-architecture (2002-2003):
  - All Sub-T-1 frame replaced with dual T-1s (94 / 120)
  - All above T-1 replaced with 4 or 6 T-1s (load balanced); above 6-9 Mbps, replace with DS-3 + n x T-1 or dual DS-3s
  - Average link length 260 miles

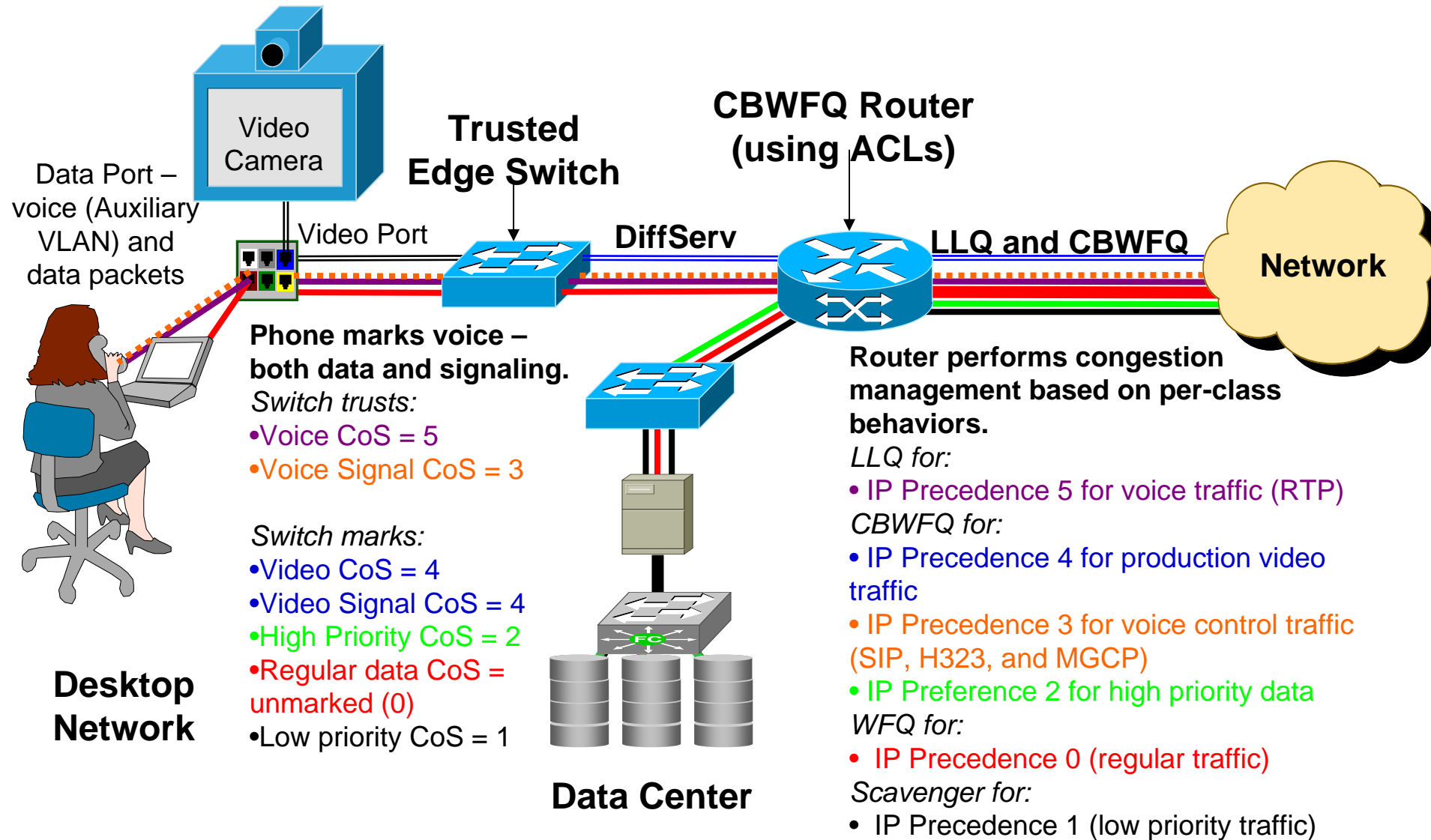
# Branch Office Backup Connections

- 2001:
  - BRI backup for all FSO links
  - T-1 backup for some ECS links
  - Average link length 1800 miles
- Re-architecture (2002):
  - Dual T-1s (primary plus backup) at all sub-T-1 to T-1 sites.
  - Multiple (load balanced T-1s) will not need backup.
  - N x T-1 or DS-3 backup for DS-3 links (depends on load, distance, cost)
  - Average link length 260 miles

# QoS on the WAN

<b>QoS Class</b>	<b>Description</b>	<b>IP Precedence</b>	<b>DSCP</b>
6	Network control / routing traffic	6 and 7	48–63
5	Voice bearer traffic	5	46
4	Videoconferencing bearer traffic	4	32–39
3	Signaling	3	24–31
2	High-priority data	2	16–23
1	Batch / scavenger traffic	1	8–15
0	Default / best-effort	0	0

# LAN and WAN QoS



# Vendor Strategy

- Selected single vendor with single project team
- Diversity through paths, equipment
- Work with 3<sup>rd</sup> party vendors where necessary
- Collected and consolidated contracts
- Business partner relationship

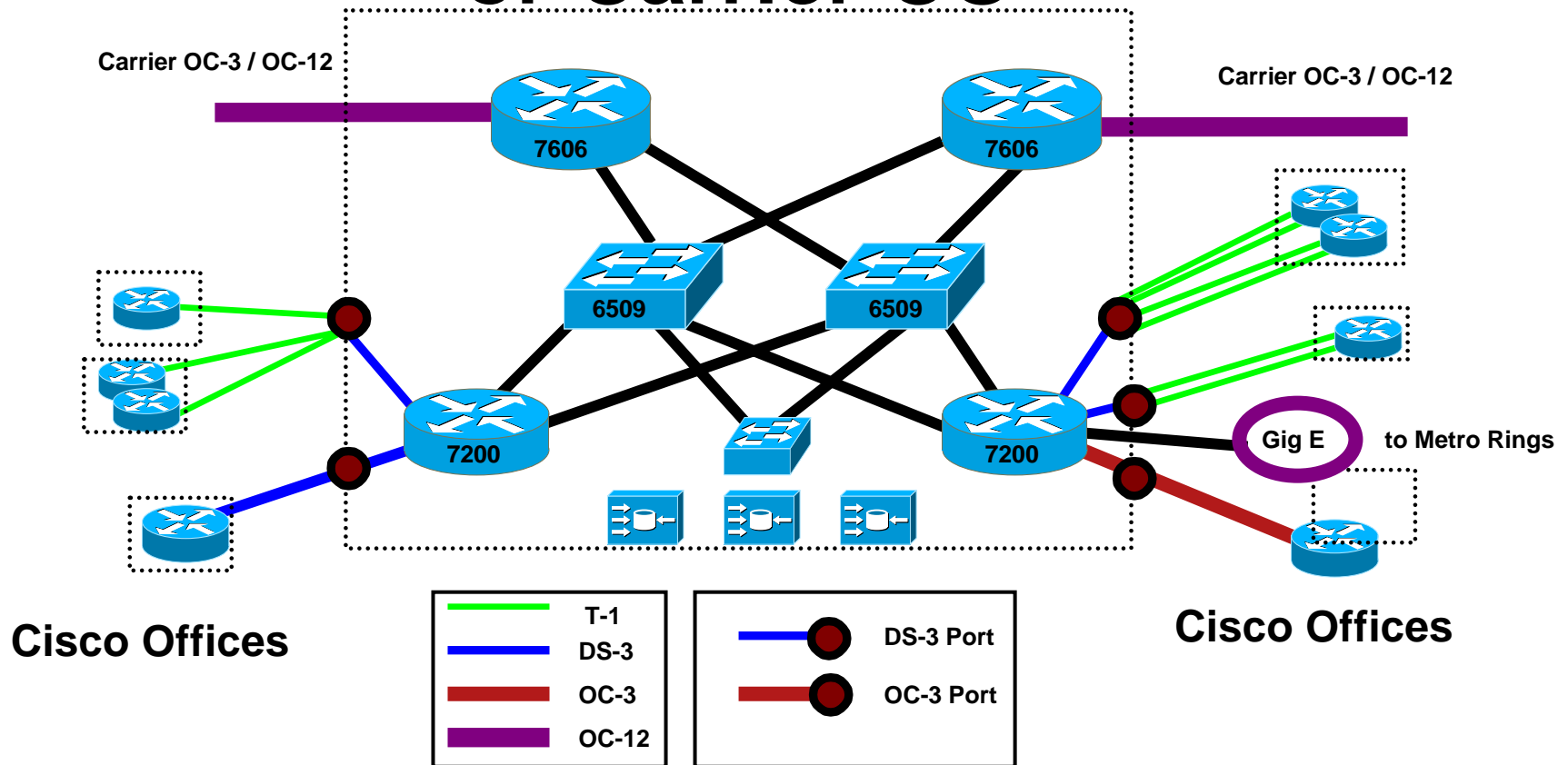


# Hub Site Design



# Hub Sites – Equipment

## Cisco Hub Office or Carrier CO



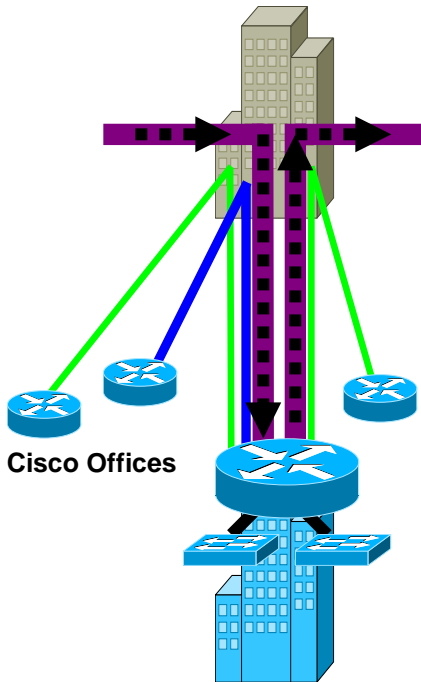
# Hub Sites – Telco Co-location

Without Telco co-location



With Telco co-location

Carrier CO



Cisco Hub Office

## Advantages:

### •Eliminates need for:

On-site IT personnel

Hardened site closet (power, security, etc.)

### •Reduces access line costs significantly

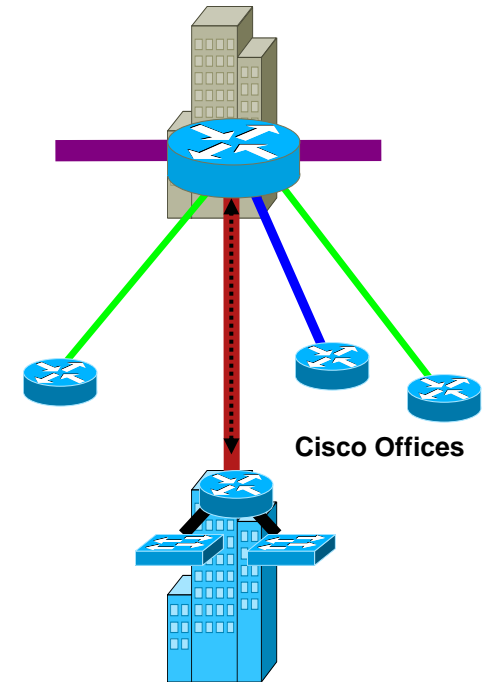
## Disadvantages:

### •Reduced control

### • Increased management overhead

### •Slight added vendor cost for hosting

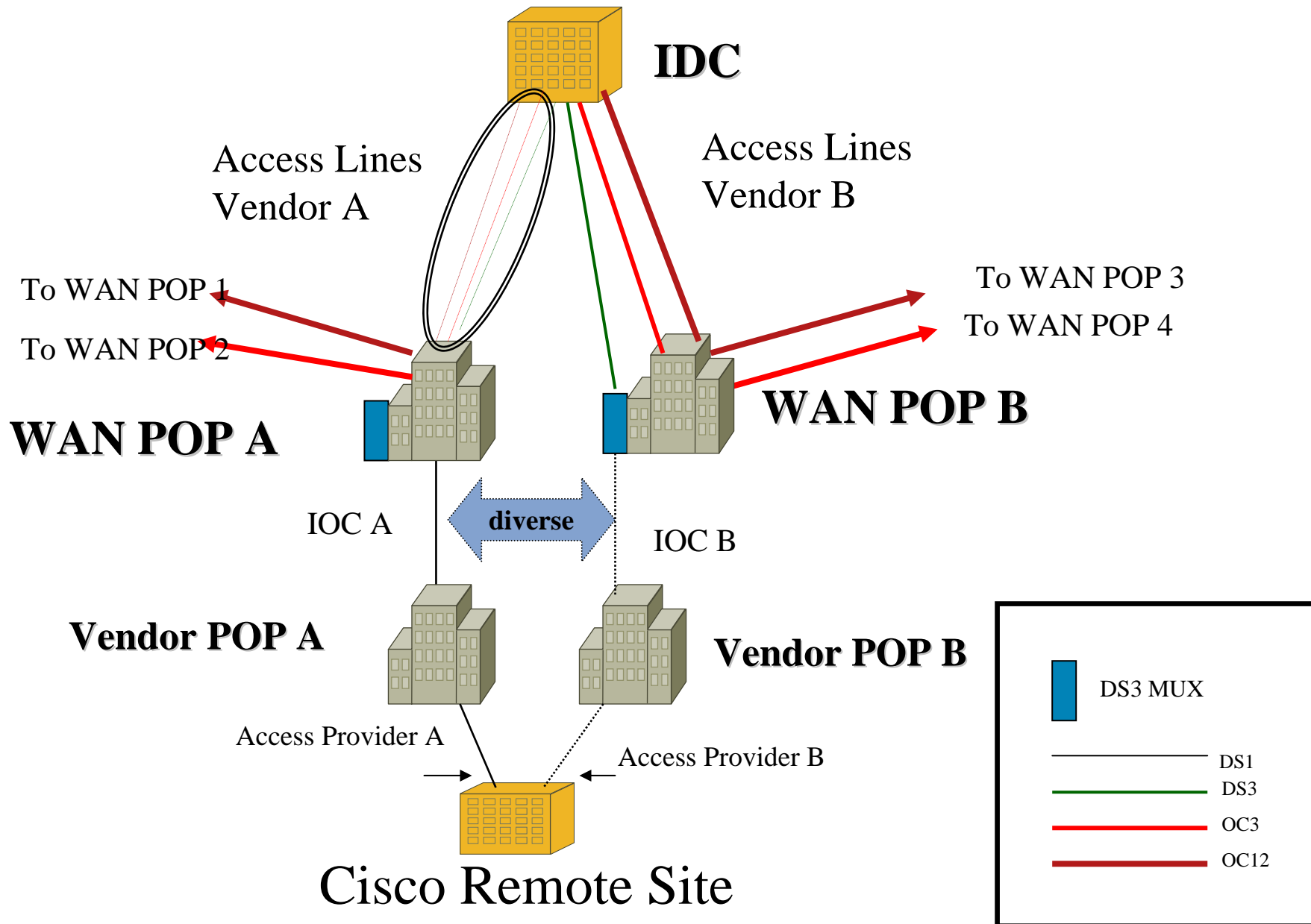
Carrier CO



Cisco Hub Office

*All sites except RTP and some SJ circuits use vendor Data Center co-location: Chicago, Denver, Redwood City, New York, Atlanta, Dallas.*

# IDC to Remote Design



# IP Addressing

- SJ (40%) and RTP (10%) kept current addressing; others required renumbering\*
- Each hub received an Internet-routing capable /19 (or more), plus RFC1918 block
- Addressing plan left room for growth, and took into account possible future topologies, to simplify routing plans.

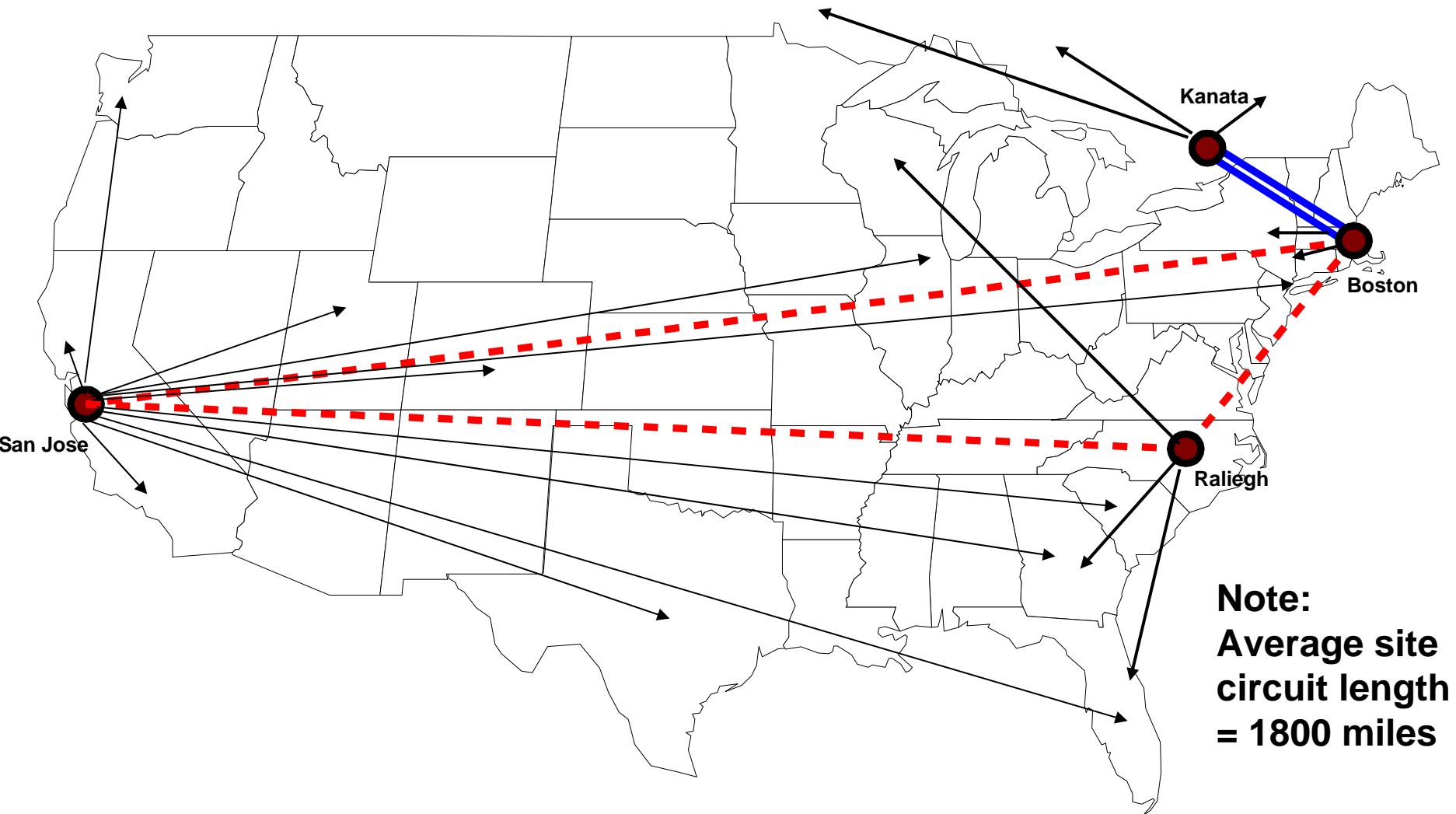
**\* Large engineering sites have recently been renumbered. Clear communication with client base of reasons, dates, and transition plans was required**



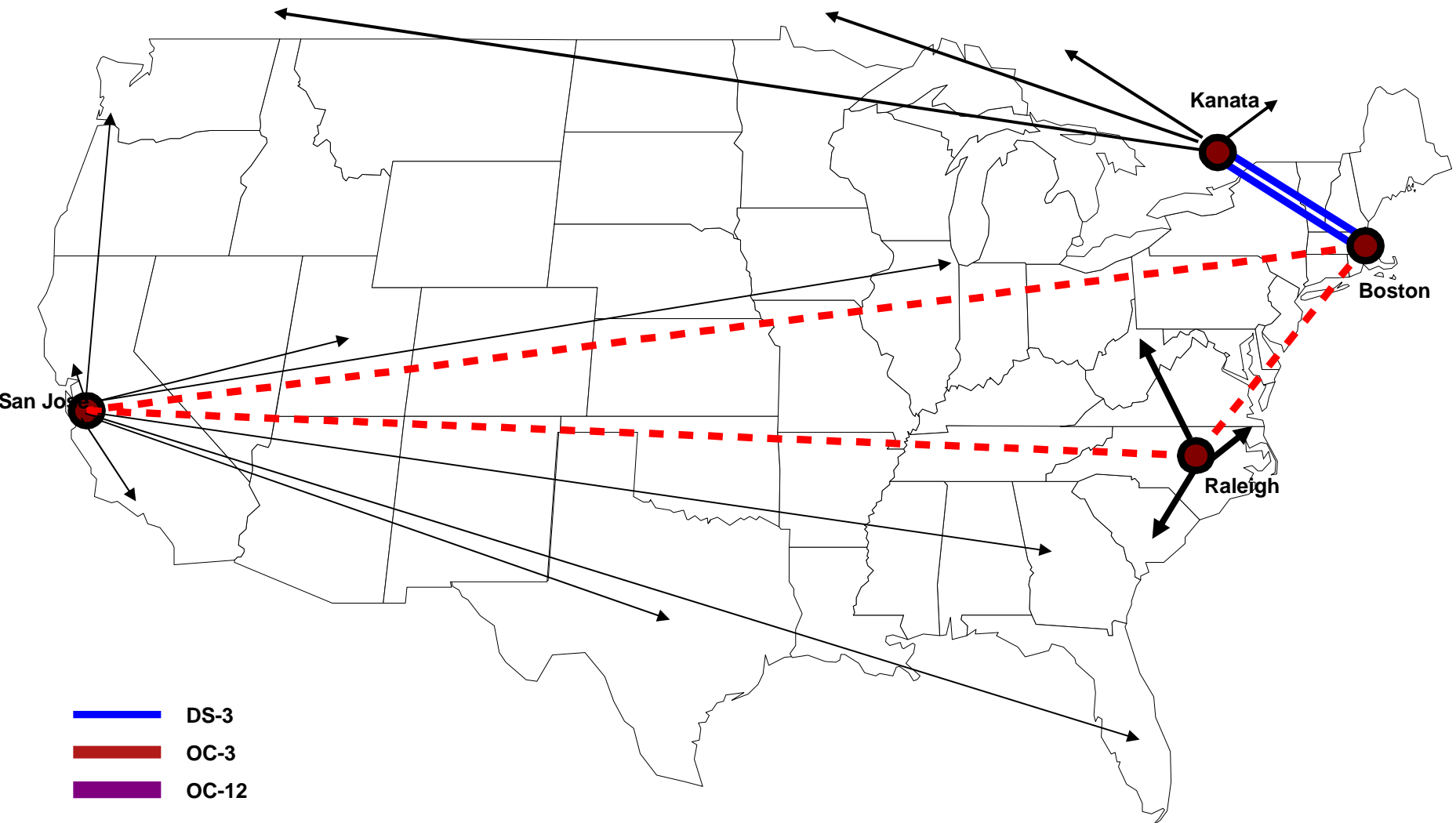
# Migration Steps



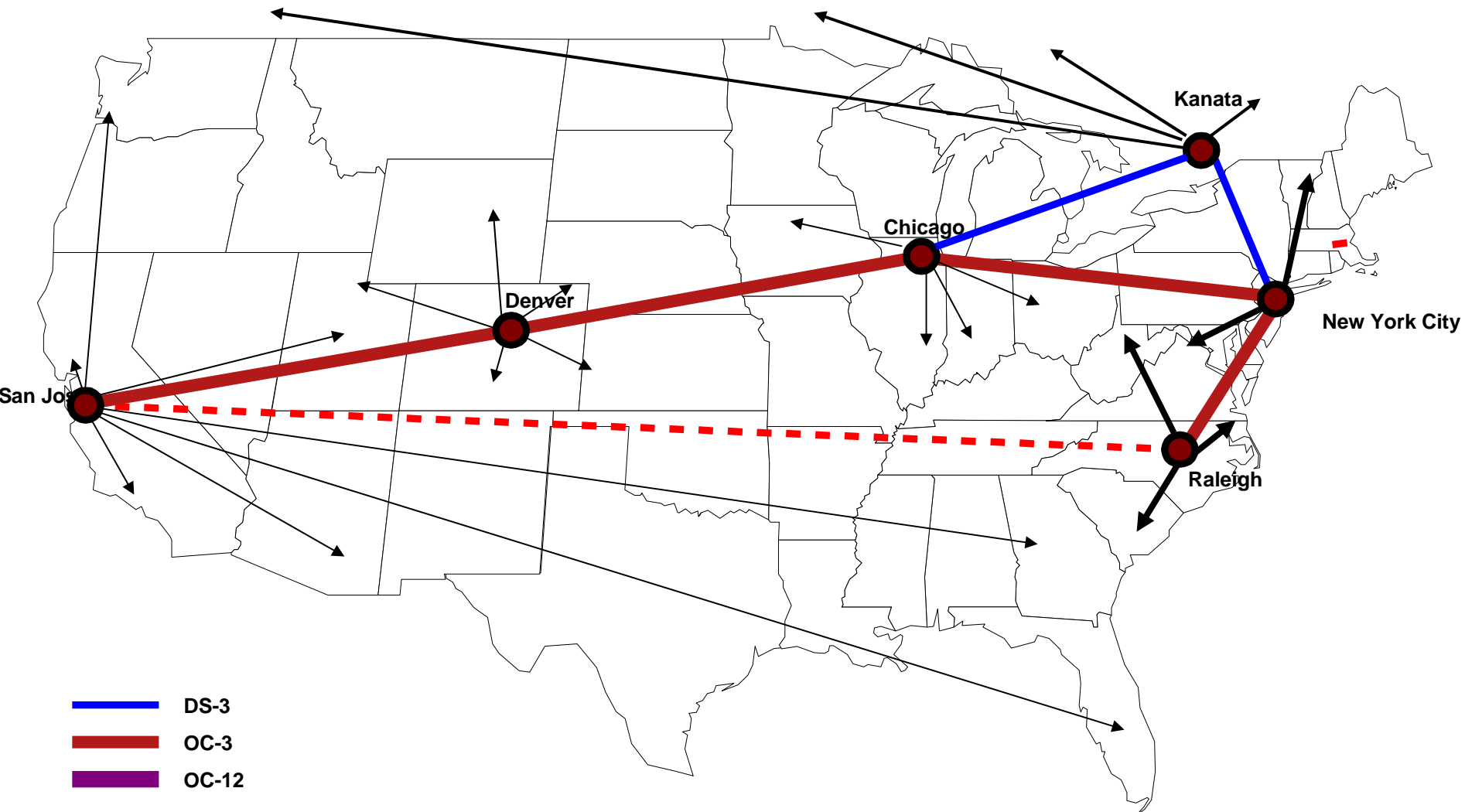
# Americas US / Canada WAN Backbone – August 2001 (before Rearchitecture)



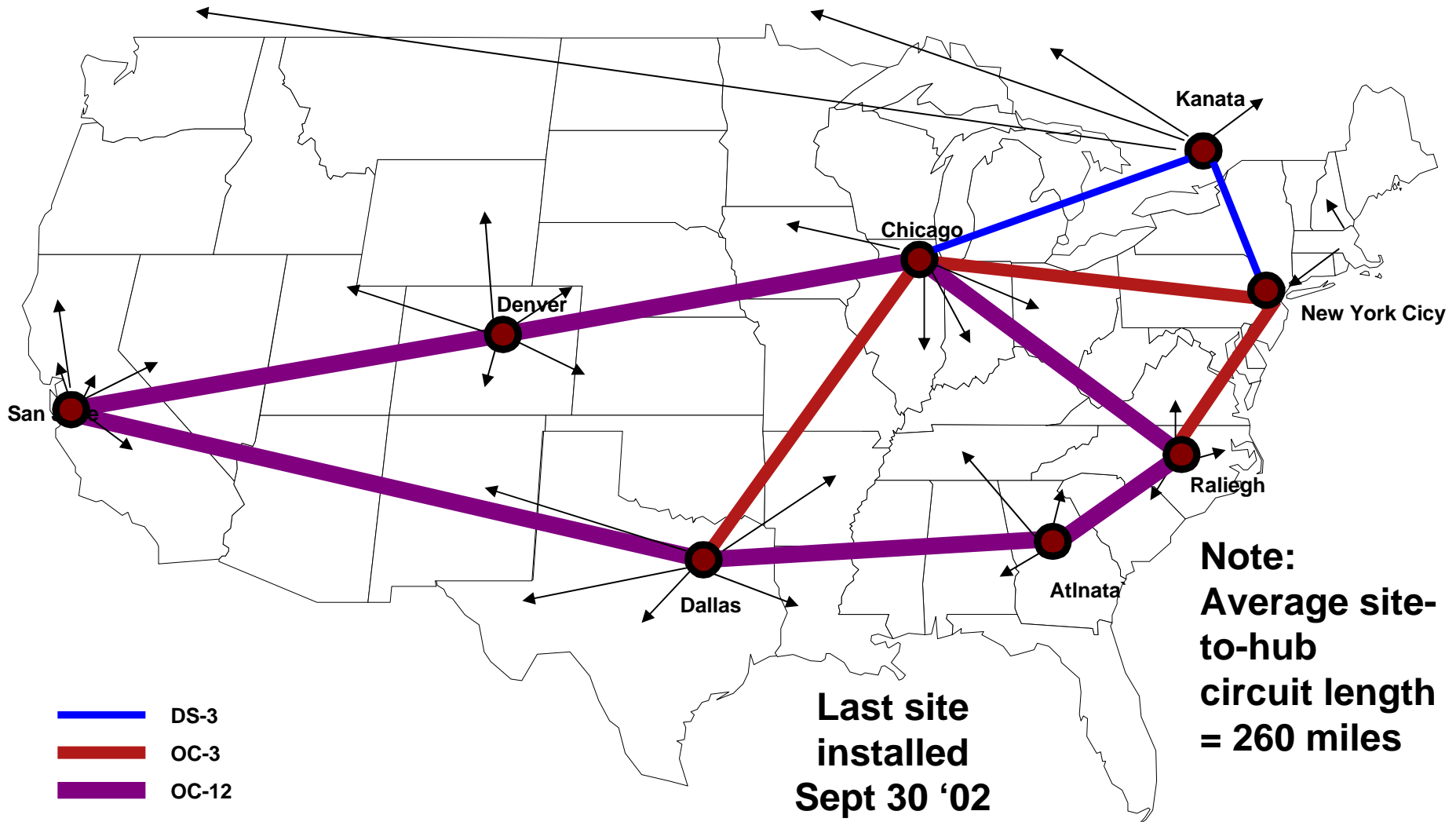
# Phase 1 Rearchitecture - Sep '01 – Nov '01



# Phase 2 Rearchitecture: Nov '01 – Apr '02



# Phase 3 Rearchitecture: April '02 - Sep '02





# Results



# Round-trip Performance Improvement in 15 Longest Peer-to-Peer Connections

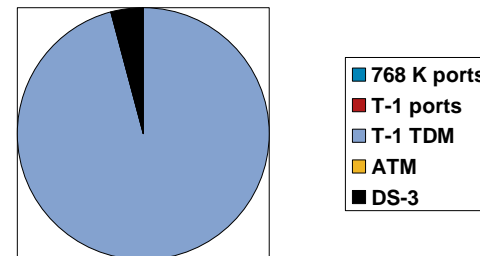
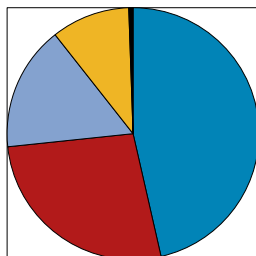
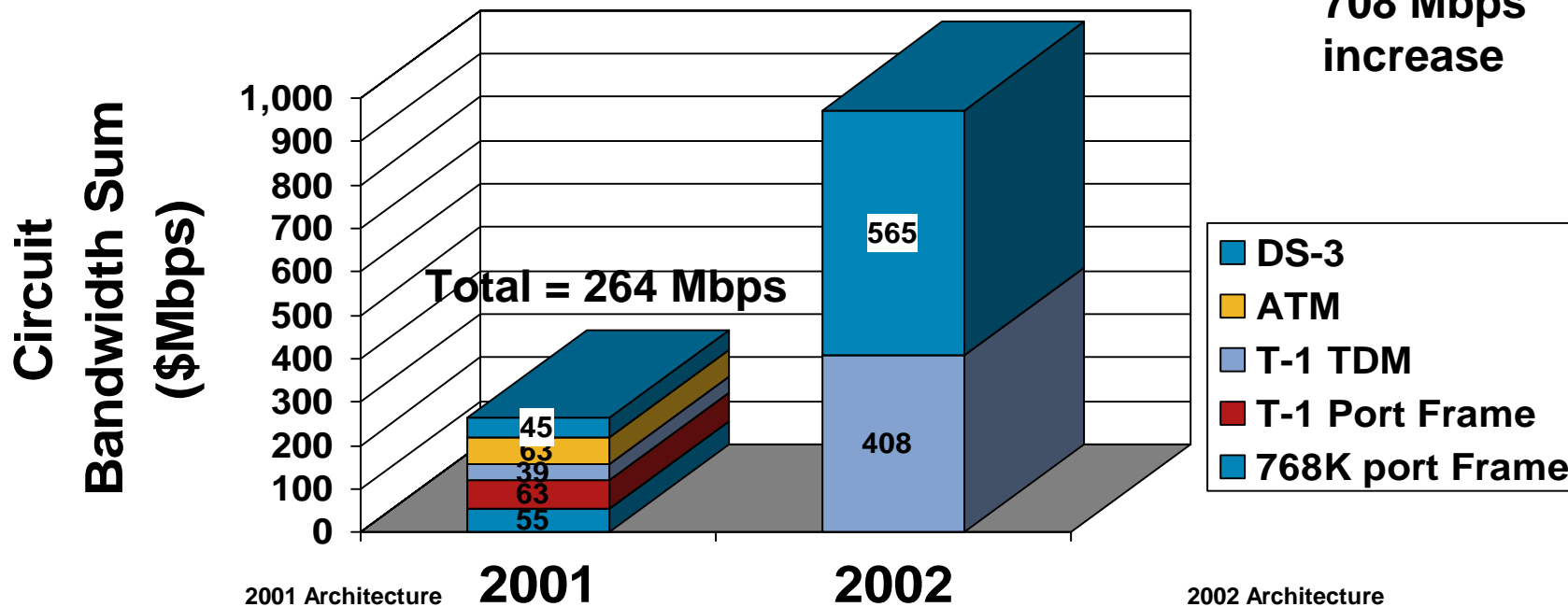
Site at Hub A	Site at Hub B	Current (ms)	Proposed (ms)	Dif	Abs dif (ms)
Chelmsford	Chelmsford	227	12	1725%	214
RTP	RTP	222	13	1649%	209
Chelmsford	Kanata	249	53	366%	195
Chelmsford	RTP	225	37	505%	187
Atlanta	Atlanta	206	24	752%	181
Atlanta	RTP	214	32	558%	181
Atlanta	Chelmsford	217	57	280%	160
RTP	Kanata	246	87	183%	159
Chicago	RTP	194	41	370%	153
Chelmsford	Chicago	197	49	299%	147
Chicago	Chicago	166	19	795%	147
Chicago	Kanata	218	71	208%	147
Atlanta	Kanata	238	98	144%	141
Atlanta	Chicago	186	61	204%	125
Atlanta	Dallas	174	50	249%	124

# Bandwidth Increase: 368%

## Site Bandwidth Comparison

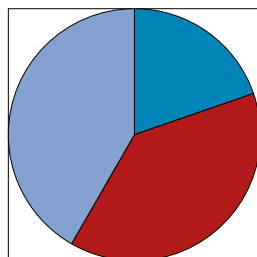
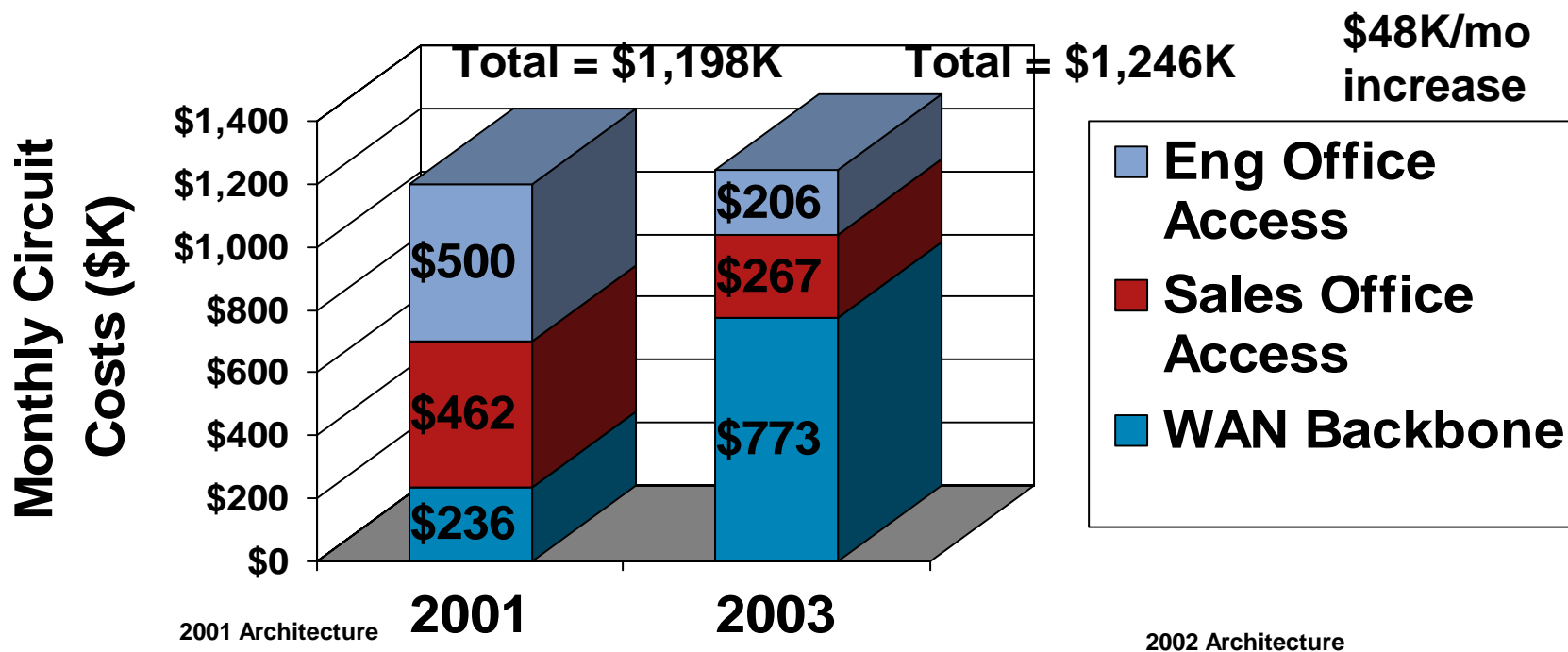
Total = 972 Mbps

708 Mbps increase

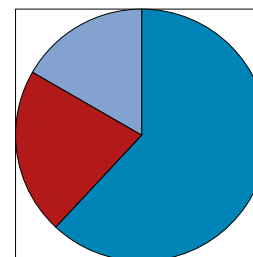


# Cost Increase: 4%

## Architecture Cost Comparison



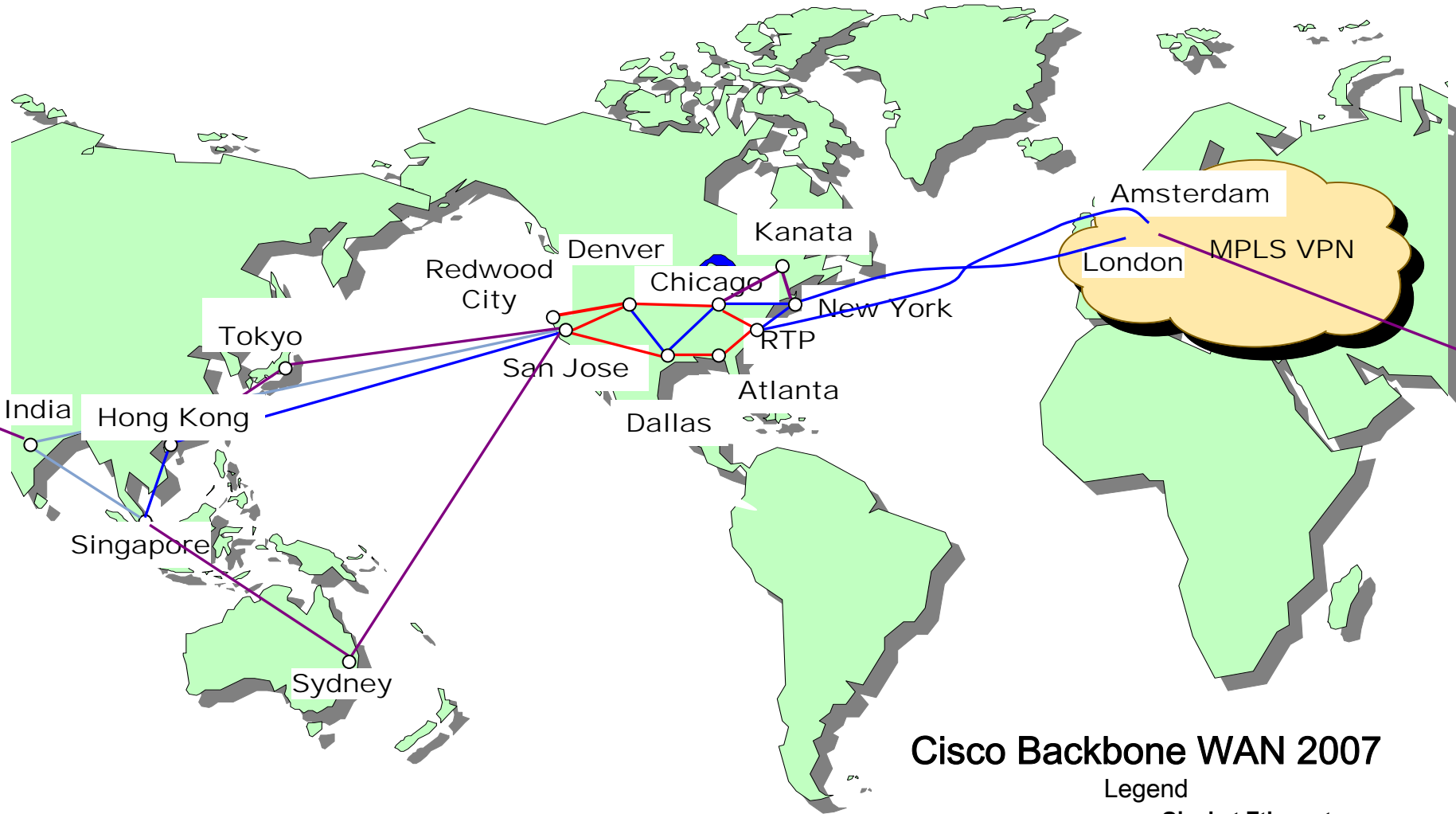
### Architecture



# Cost Fundamentals

- (1200 mile leased line \$ > Frame \$ > 800 mile leased line \$)
- Increased backbone costs offset by reduced tail circuit costs
  - More sites, closer to regional hubs reduces prices
  - Cisco's 120 sites, avg 270 miles from hubs, broke even at dual T-1 access
  - Increase site #, decrease site distance, reduce tail circuit bandwidth, all would result in lower costs
  - Fiber glut brought down all leased line prices – from OC-12 to T-1 (vendors needed to learn how to price OC-12 in 2001)
- Homing OC-12 into vendor IDC saved \$50K+ per hub site / mo in 2002

# Cisco Global WAN Backbone - 2007



Cisco Backbone WAN 2007

Legend

- Gigaset Ethernet
- OC12
- OC3
- DS3

# Global Peer to Peer Services in place

- **IP Telephony: All IP Telephony**

- 262 PBXs and Key Systems → 13 CallManager Clusters in Data Centers
- 70,000 IP Hardware phones, 30,000 IP Communicator (software phone) images

- **Unity Voicemail: All IP Voicemail**

- 160 Voicemail servers → 12 Unity Voicemail server clusters in Data Centers
- 59,000 Unity Voicemail boxes

- **Contact Centers: All IPCC**

- 17 Contact Centers supported by 2 Intelligent Contact Managers (ICMs) and 5 IPCC Clusters.
- 10 Million calls per year handled by 1,400 agents

- **Video: Cisco Unified Video Advantage**

- 17,000 desktop / laptop Video cameras in use within Cisco.

- **MeetingPlace Collaboration**

- 12+ million minutes per month voice / data collaboration

- **Telepresence**

- 120 sites planned for Cisco worldwide

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