



Wireless Network Solutions

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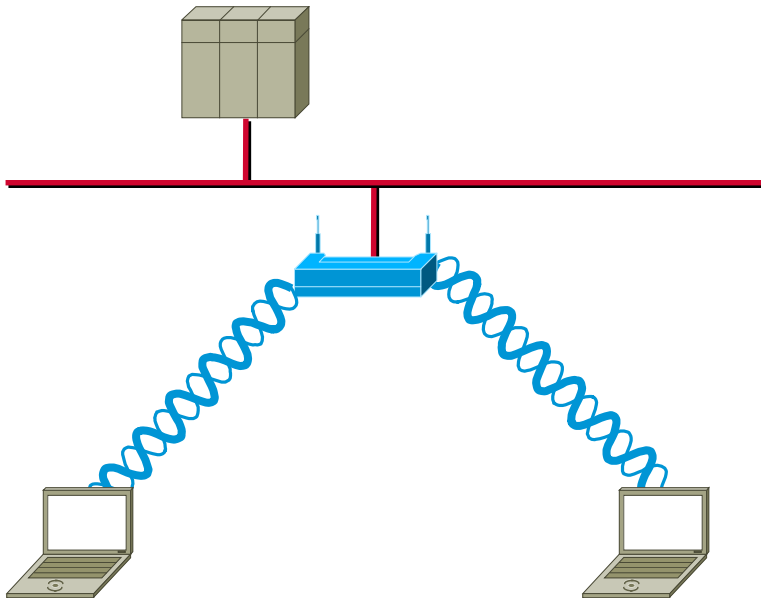


Wireless LAN Topologies

Two Different Implementations of Wireless LAN Technology

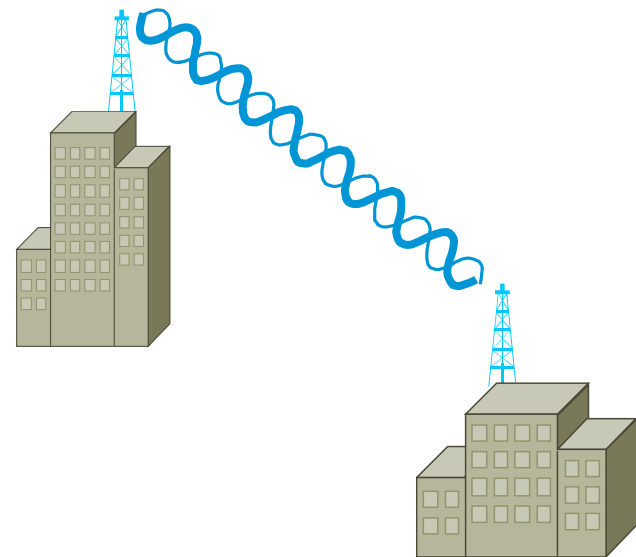
Wireless Networking

- Mobile user connectivity



Wireless Bridging

- LAN-to-LAN connectivity



What Are Wireless LANs?

- **They ARE:**

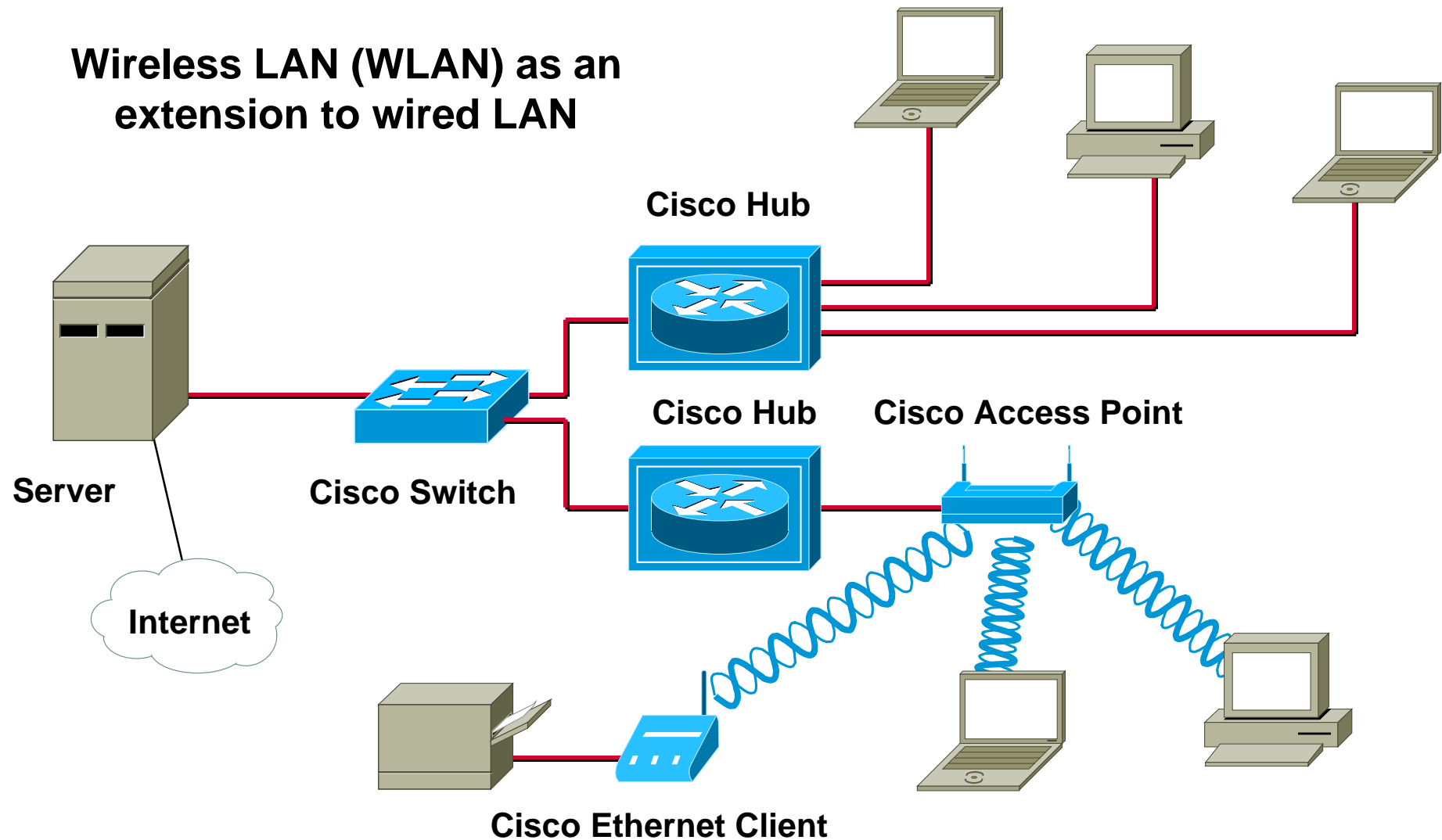
- Local, not wide area
- In-building or campus area coverage for mobile users
- Up to several miles for point-to-point (LAN to LAN)
- Radio or infrared
- FCC licenses not required
- Customer owns the equipment (no usage charges)

- **They ARE NOT:**

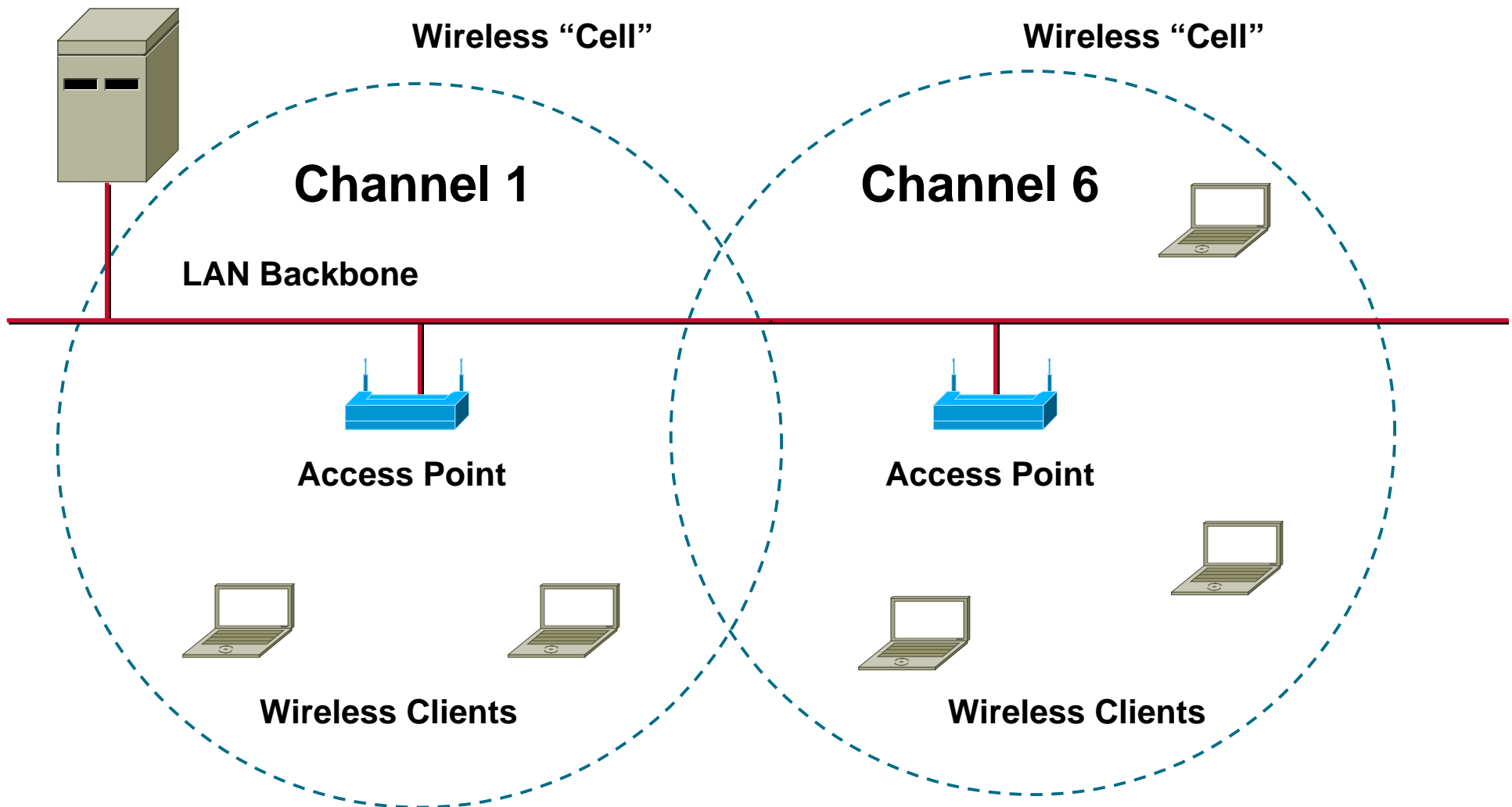
- Cellular phones/DECT
- Pagers
- Packet Data
 - Ardis
 - CDPD
 - RAM Mobile Data
- PCS

Local Area Network (LAN)

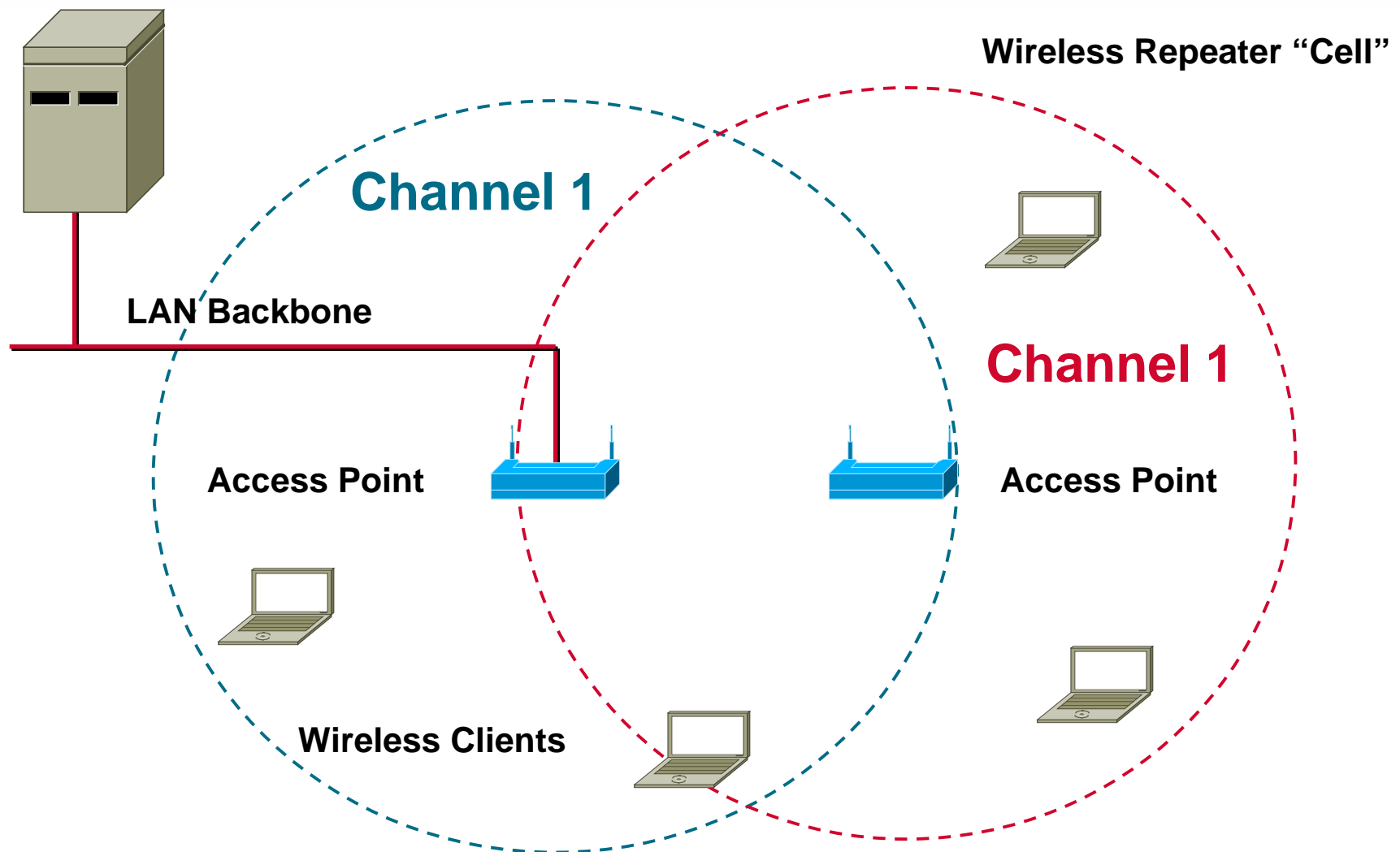
Wireless LAN (WLAN) as an extension to wired LAN



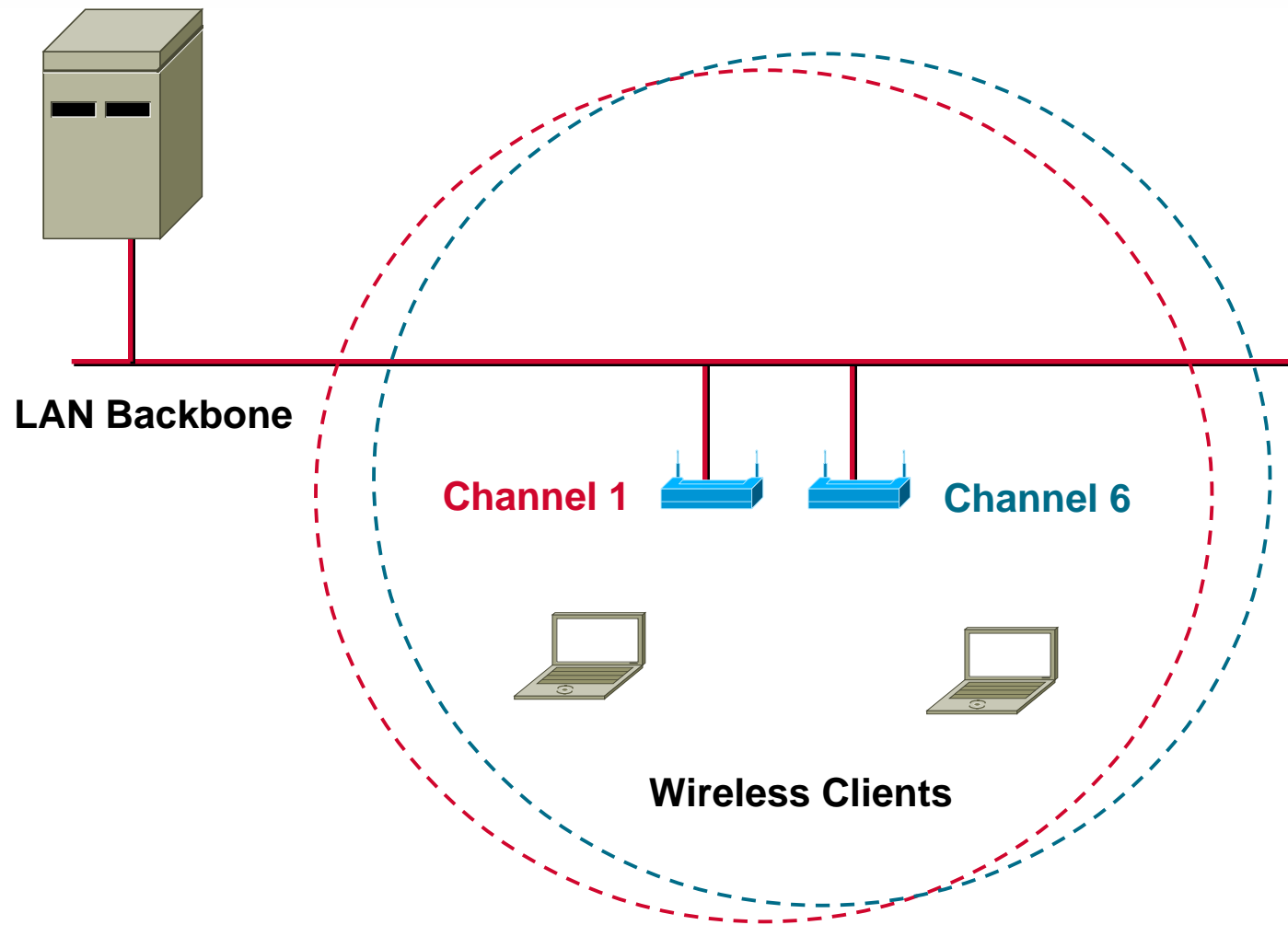
Typical LAN Topologies



Wireless Repeater Topology

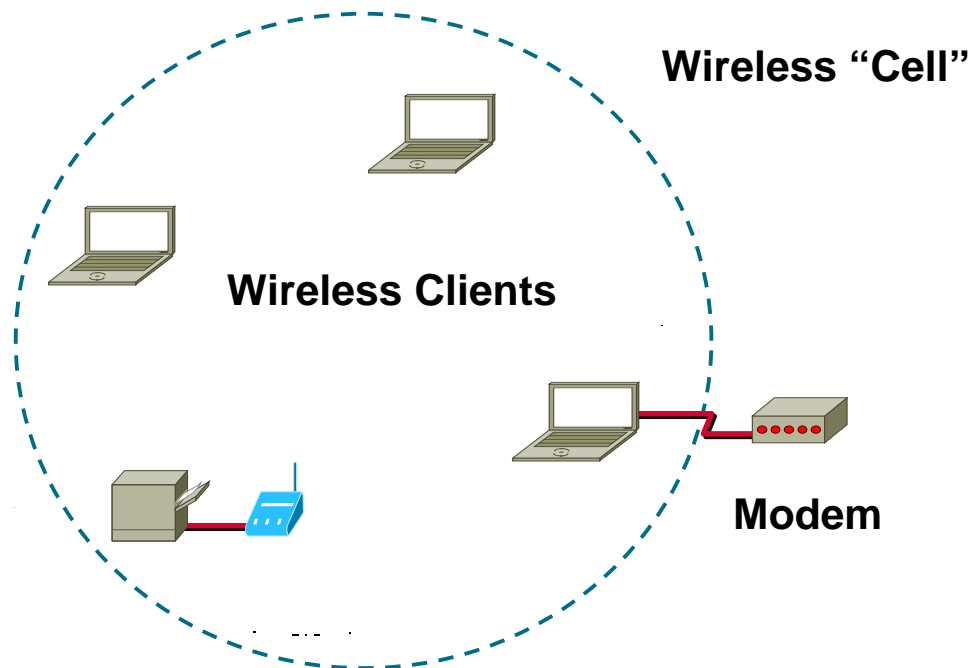


System Redundancy Topology



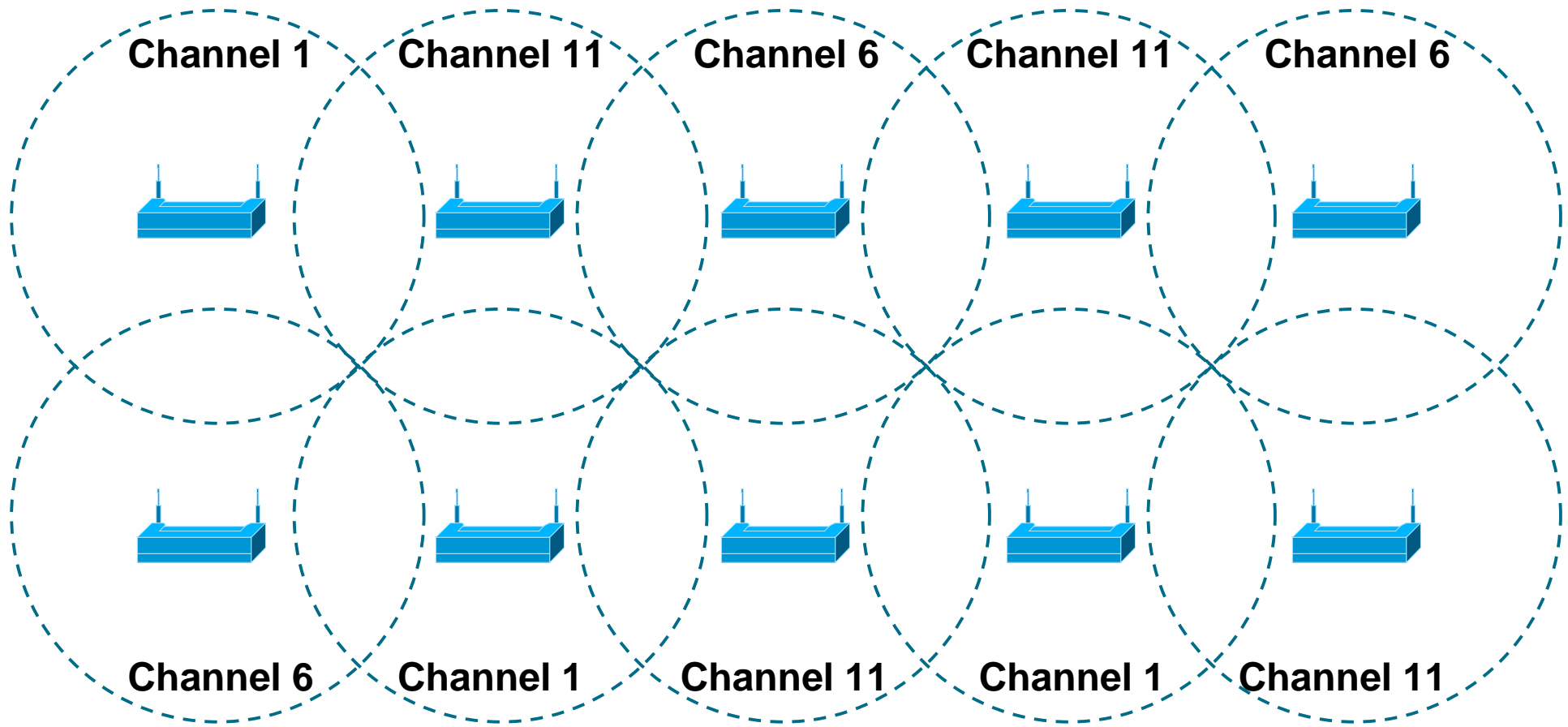
Alternative Peer-to-Peer Topology

Peer-to-Peer Configuration (ad hoc mode)

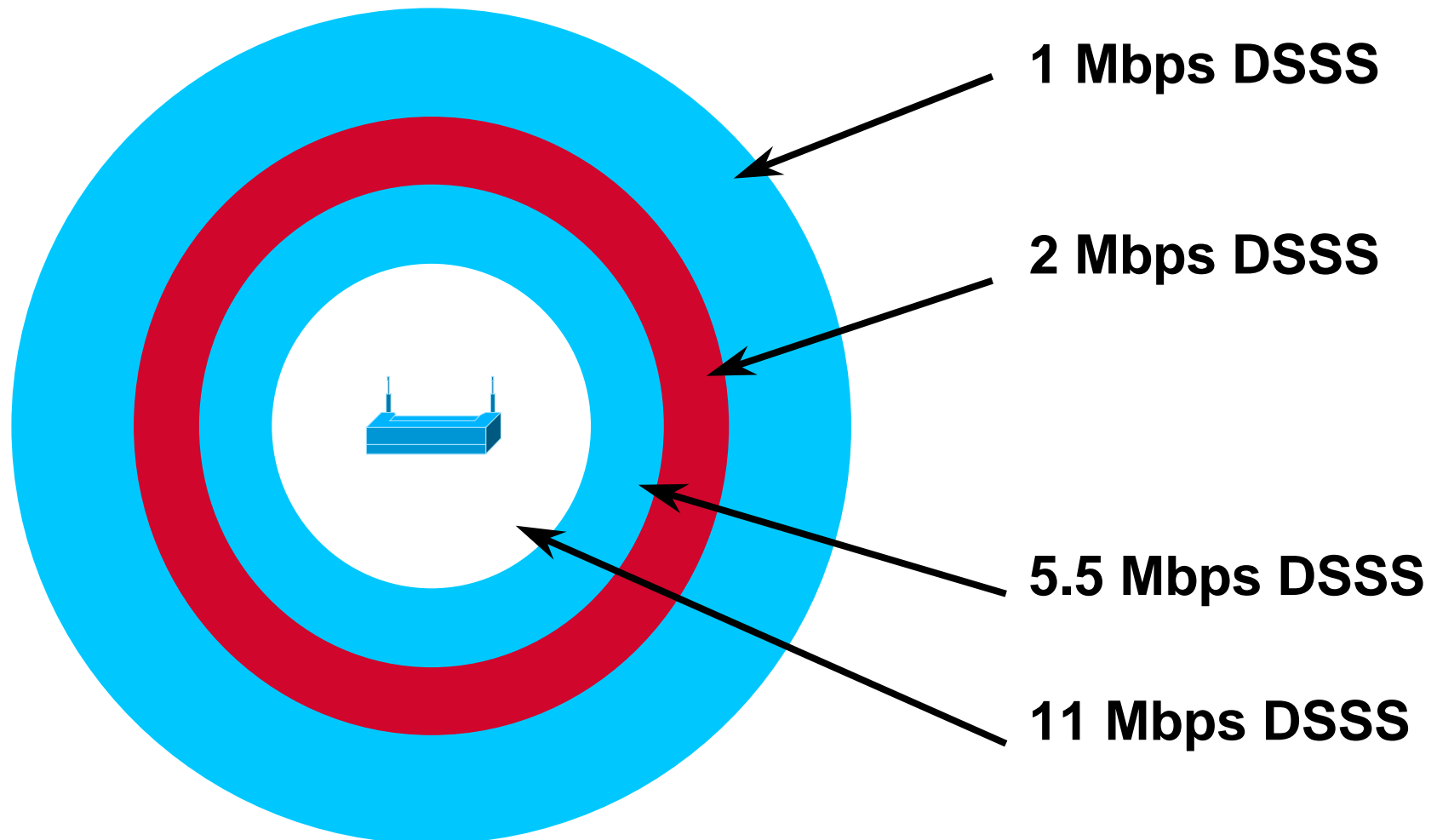


Channel Setup

Site Survey Channel Example

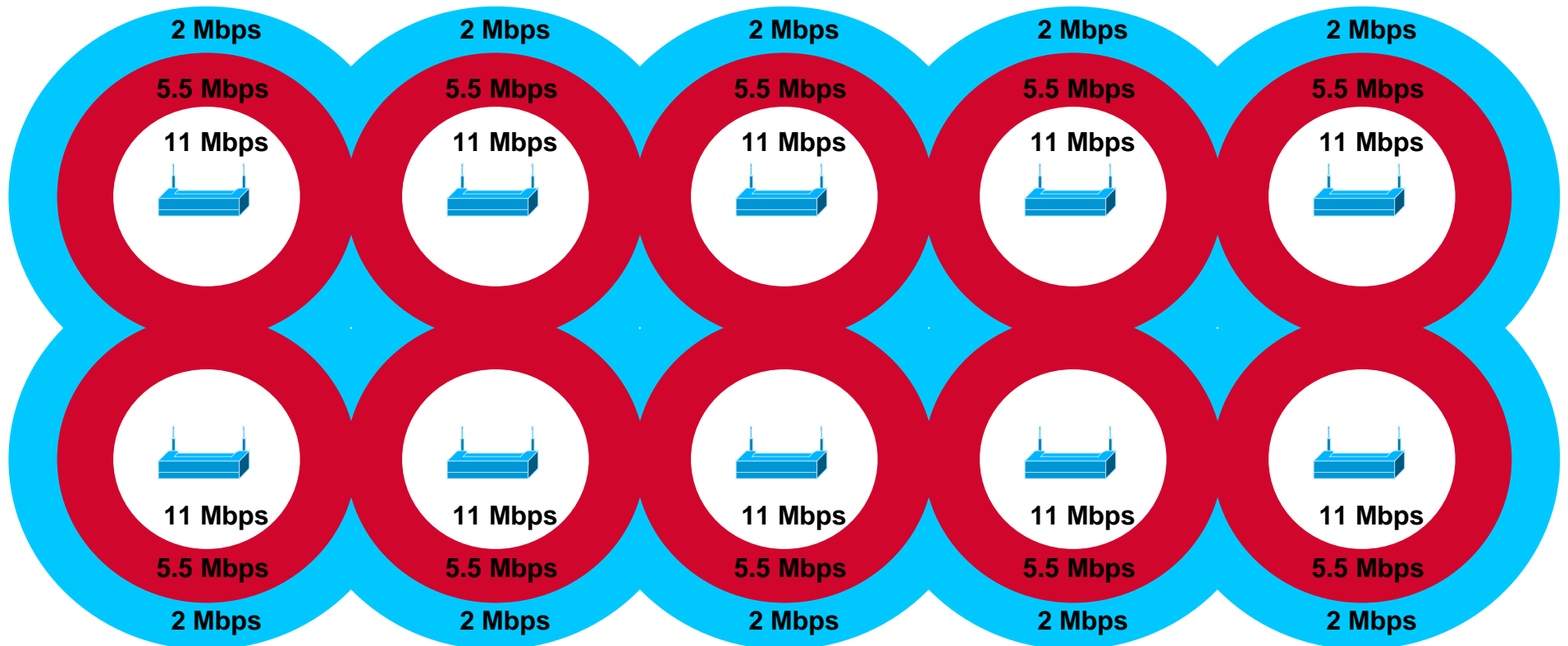


Access Point Coverage & Data Rate Shifting Review

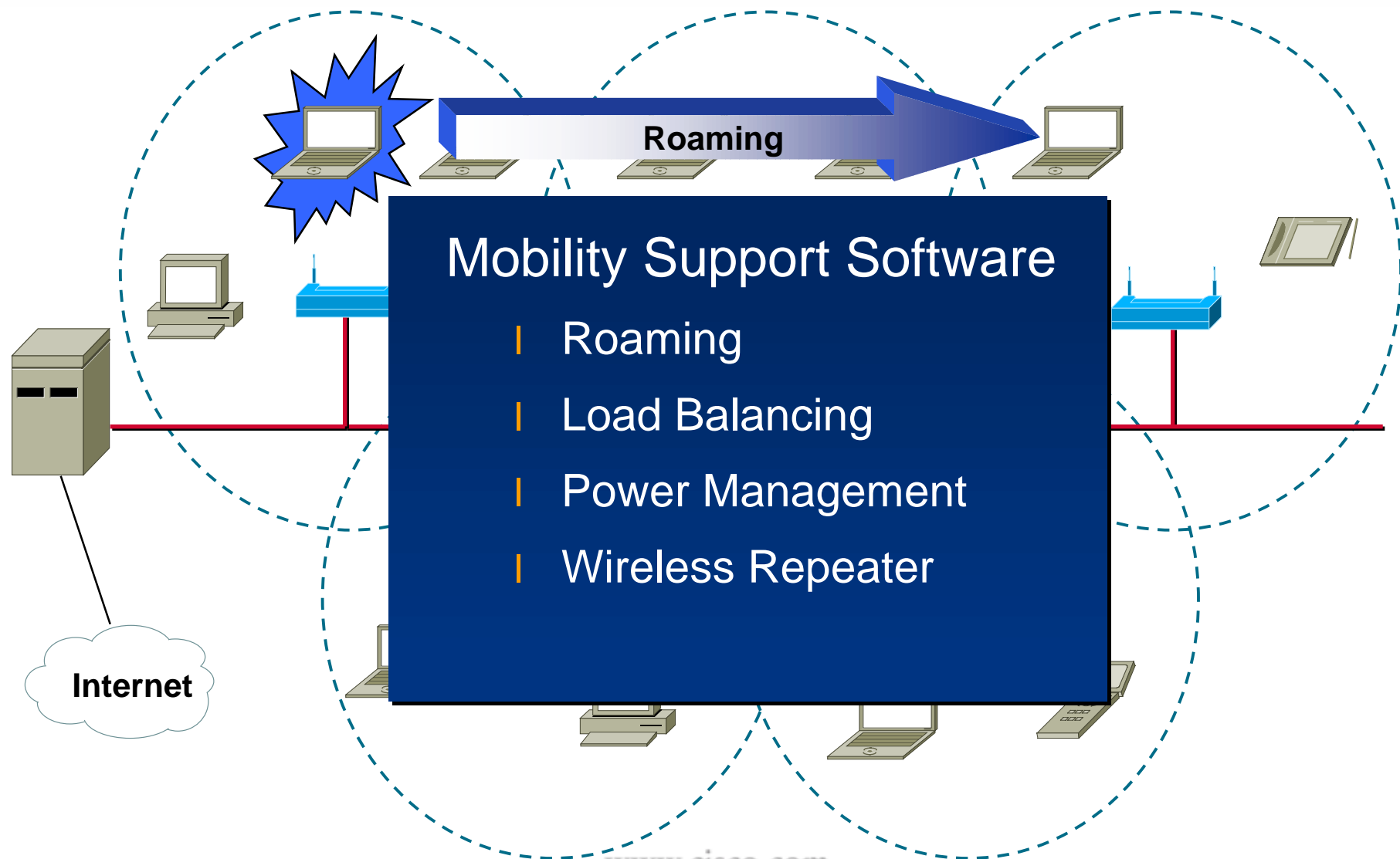


Multi-rate Implementation

Site Survey Bandwidth Example



Microcellular Architecture



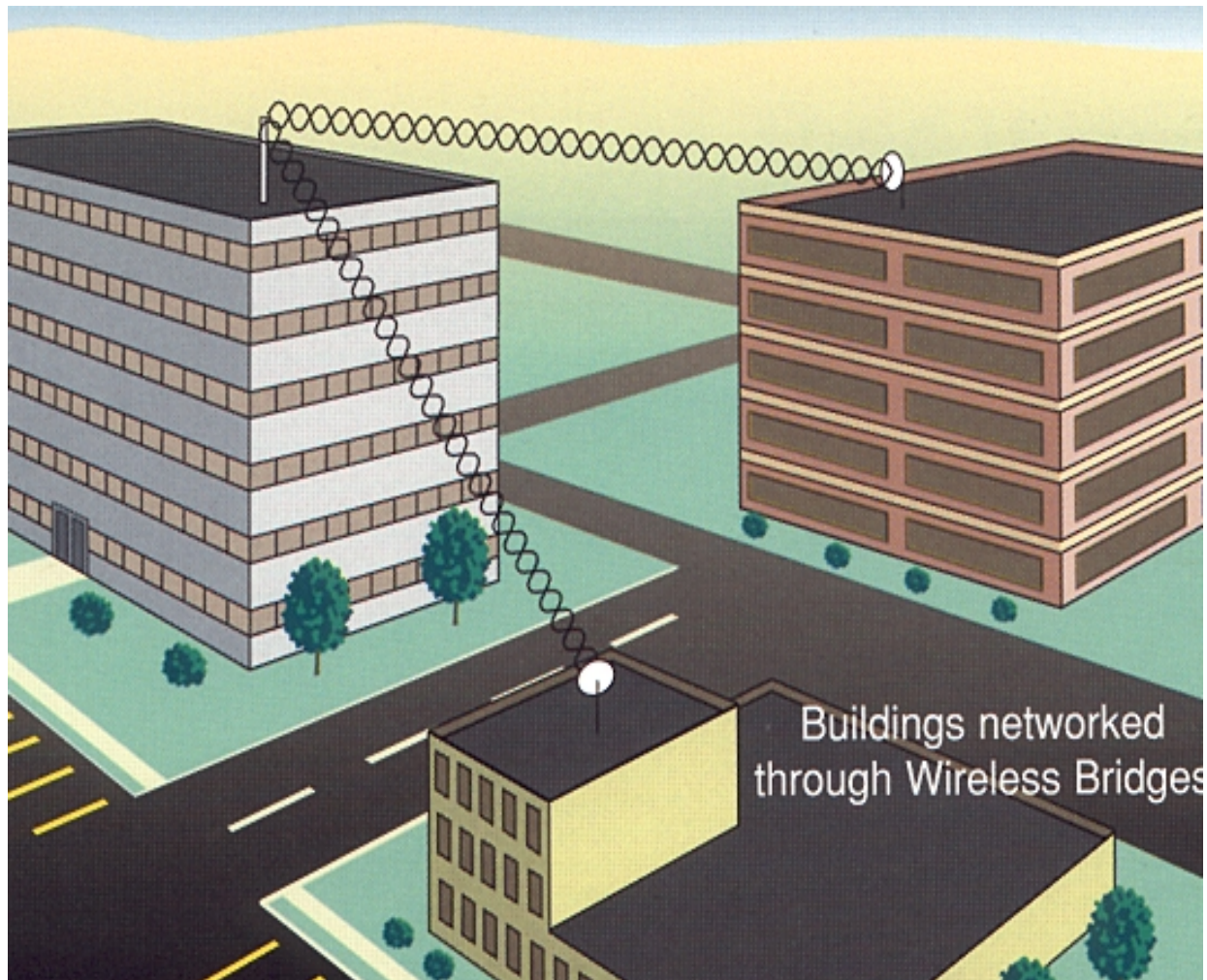
Common Questions

Questions	340 Series
How fast? Maximum data rate Typical throughput	 11 MB 5.5 MB
How far (at maximum data rate)? Outdoors Indoors	 500 feet 100 feet
How many? Maximum clients per AP Typical clients per AP Co-located APs	 2048 Same as Ethernet seg. 3

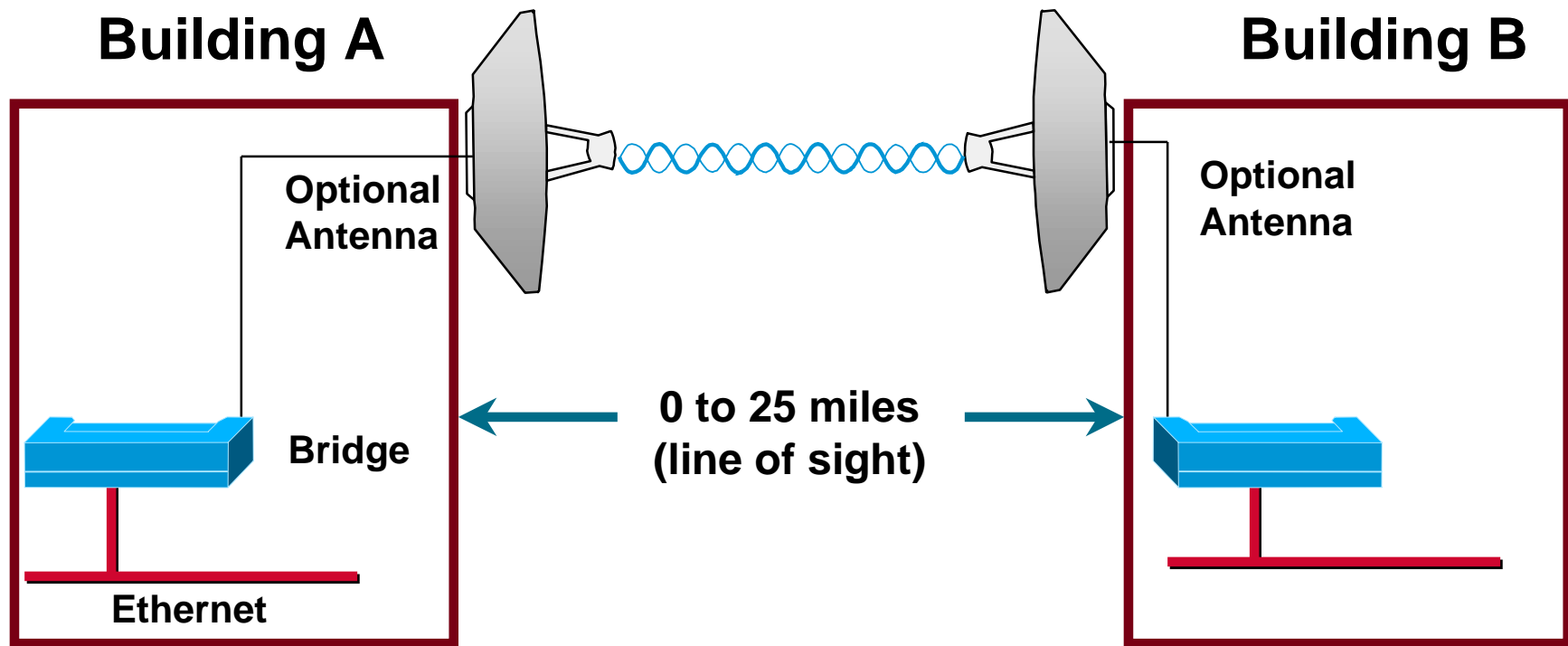


Wireless Bridges

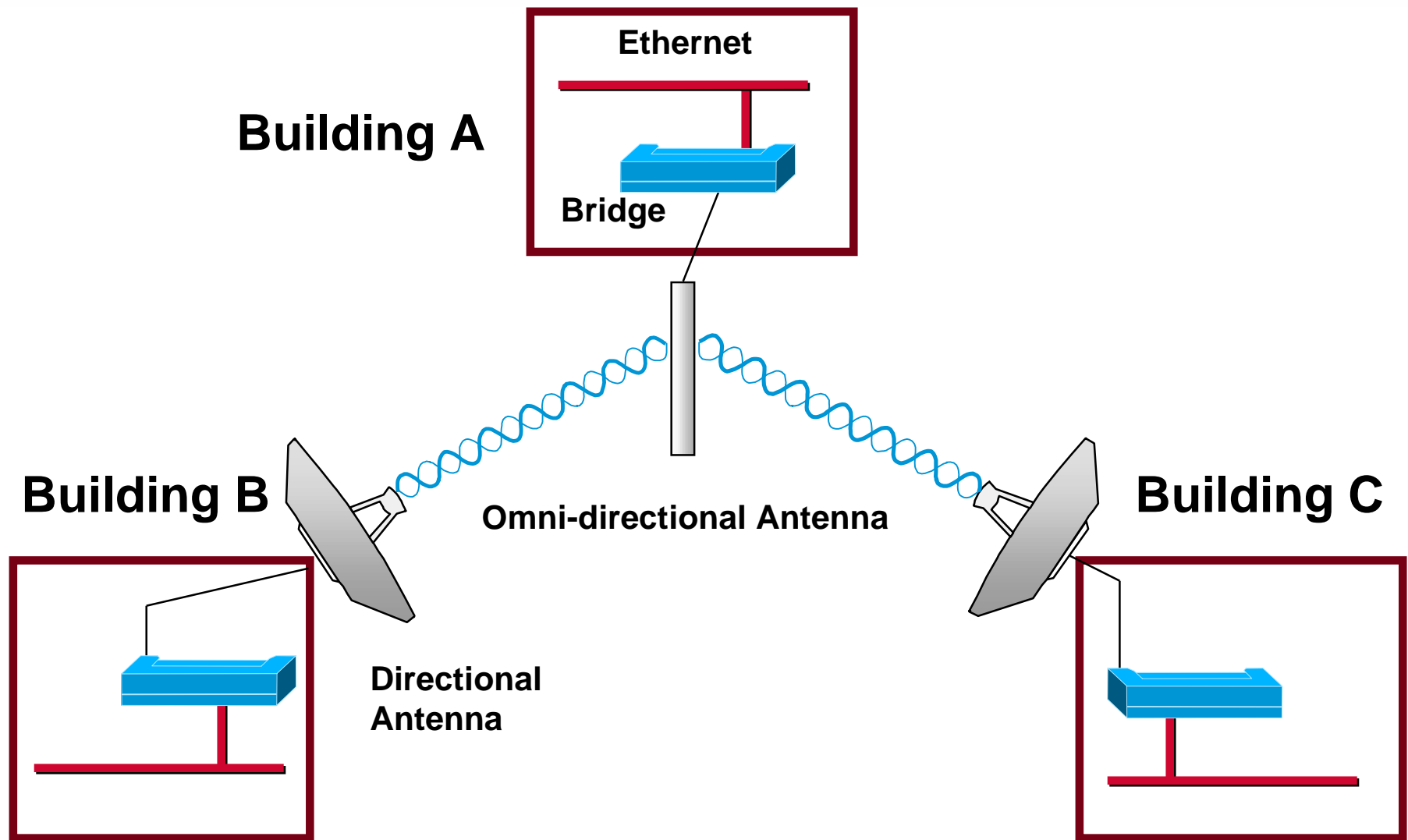
Bridging Defined



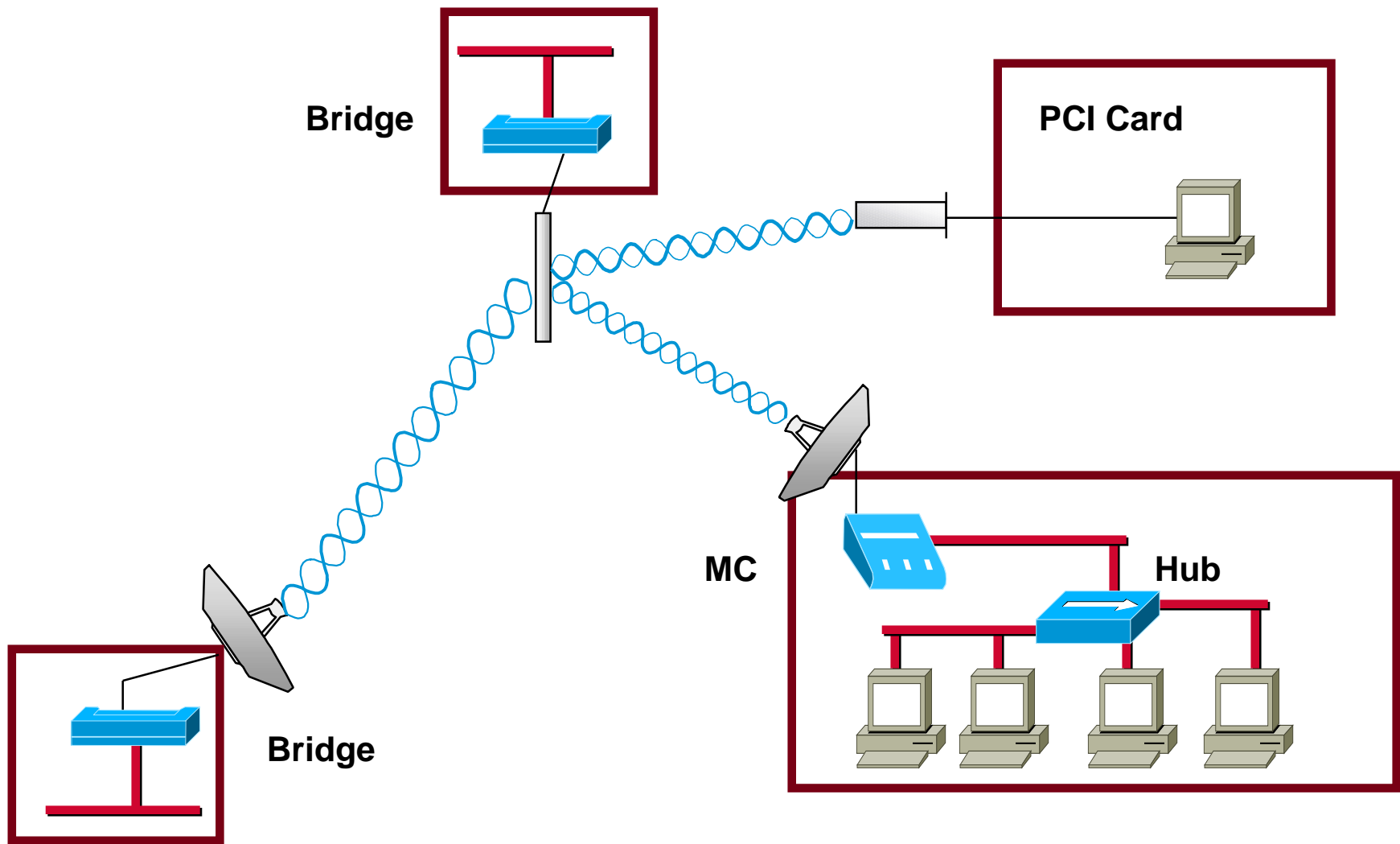
Point-to-Point Configuration



Point-to-Multipoint Configuration



New Addition to the System!



Products: Wireless Bridges

Bridge Model	Data Rate	Max. Distance	Optional Antenna	Standard Cable (6.7dB/100FT)
340	11Mb	11.5 Miles	21dBi Dish	50ft/side
	11Mb	18 Miles	21dBi Dish	20Ft/side
	5.5Mb	16 Miles	21dBi Dish	50ft/side
	2Mb	25+ Miles	21dBi Dish	50ft/side
	1Mb	25+ Miles	21dBi Dish	50ft/side

What Makes Cisco's Bridges Best?

- Flexibility: point-to-point and multipoint
- Management capabilities
 - SNMP, telnet, FTP, HTML
 - 802.1d spanning tree
- Breadth of product line
 - 1,2,5.5, and 11mbps
 - Antenna/range options
- Price/performance



Optional Antennas for Long Range



13.5dBi Yagi
Distances over
6.5miles @ 2Mbps and
2miles @11Mbps



21dBi Solid Dish
For distances up to
25+ miles @ 2Mbps
11.5miles @ 11Mbps

Note: Distances include 50 feet of low loss cable and 10dB fade margin

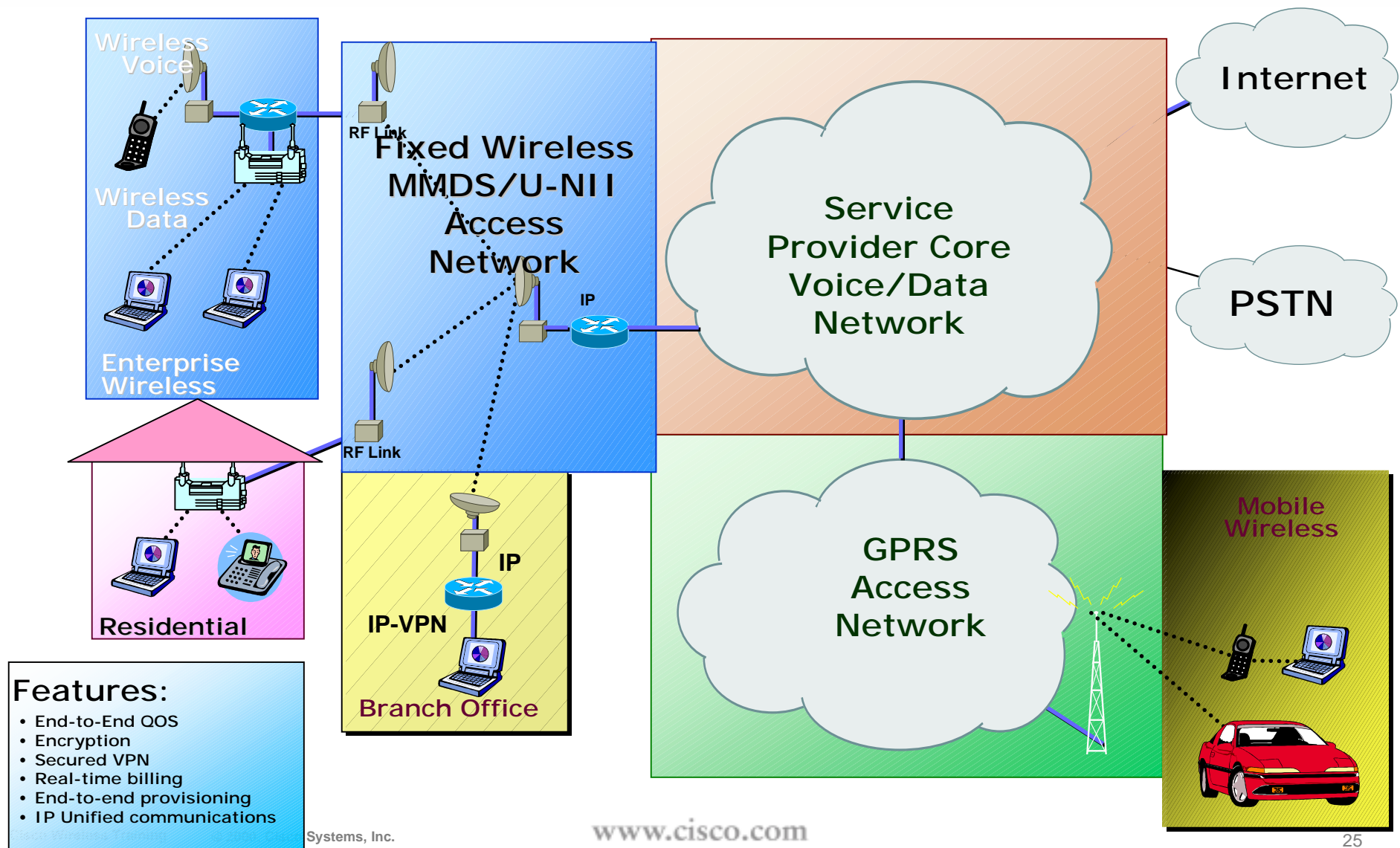
Common Questions

	340 Wireless Bridge	
How Fast?		
Max data rate	11Mbps	2 Mbps
Typical throughput	5.5Mbps	1.4 Mbps
How Far? (at MAX rate)		
Yagi antenna	2miles	6.5 miles
Dish antenna	11.5 miles	25+ miles

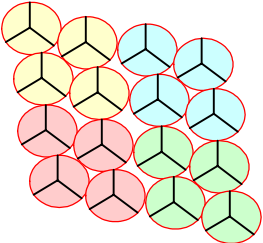
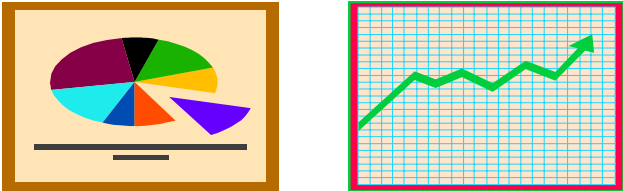
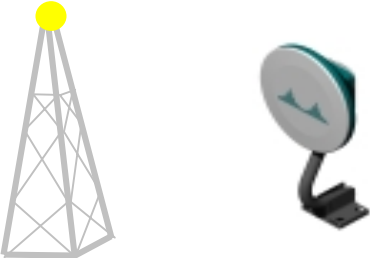



Fixed Broadband Wireless



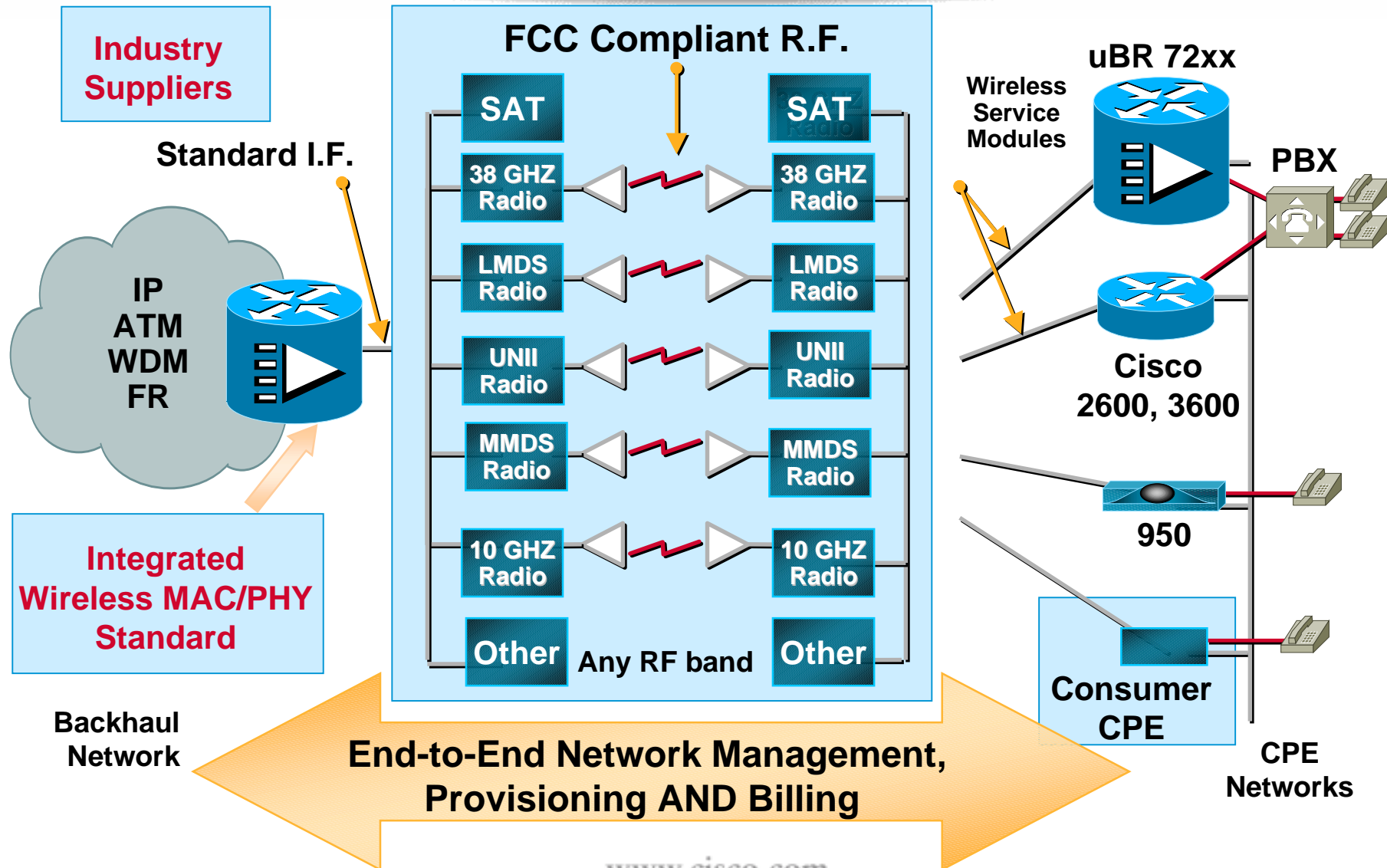
Cisco's Wireless Initiatives



Cisco Value Proposition

<p>Cellular network deployments</p> 	<p>More Coverage + More Capacity = Higher Penetration</p> 
<p>Robust RF technology</p> 	<p>Fewer Service Requests + Truck Rolls = Lower Churn</p> 
<p>Multi-service offerings</p>  <p>Internet Access Voice VPNs</p>	<p>Multi-Service Platform = More Revenue per Channel</p> 

Unified Wireless Reference Architecture



Delivering Fixed Wireless

RF Sub-system



Cisco Built



Partner Built



3rd Party Built

PTM System

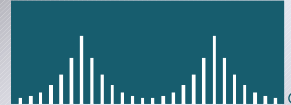
CISCO SYSTEMS



Netro

CPE

CISCO SYSTEMS



TOSHIBA



NEW WORLD
ecosystem
CISCO SYSTEMS

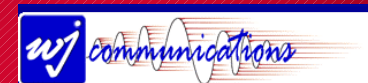
Integration



FLUOR GLOBAL SERVICES
— SYSTEMS INTEGRATION



RF Components



End-End Services

Integrated Solution

Broadband Wireless Internet Forum

- Open forum of 17+ companies
(Silicon, SI, RF, CPE, OSS)
- IEEE-ISTO Sponsored
- Drive Industry Standards
- Based on open VOFDM technology
- Focused on performance and reliability
- Ensure Interoperability of end-to-end solutions
- Cross license to members on a royalty free basis



www.bwif.org

Why is BWIF important?

- Revolutionary technology available for the mass market
- Lowered product costs and simplified deployment
- Increased product availability
- Rapid time to market
- Compelling end-user services and applications
- BWIF members make Wireless Ecosystem Stronger



Activities to Date



- **First Meeting August 30, 2000**
Over 60 companies Attended
**Presentations from Service Provider Customers,
Industry Analysts, BWIF Members, IEEE-ISTO**
- **Public Relations Program Beginning**
- **Technical Councils and Marketing Committees
formed**
- **BWIF Version 1.0 VOFDM Specifications approved by
board and released to members**

MultiPoint Spectrum

- **Licensed spectrum**

North America: 2.5GHz, 24GHz, 28/31GHz, 38GHz

Europe: 3.5GHz, 10GHz, 26GHz, 28GHz, 41GHz

Latin America : 3.5GHz, 10GHz, 26GHz, 28GHz, 38GHz

Asia: 3.5GHz, 28GHz, local allocations, others TBD

- **Unlicensed spectrum**

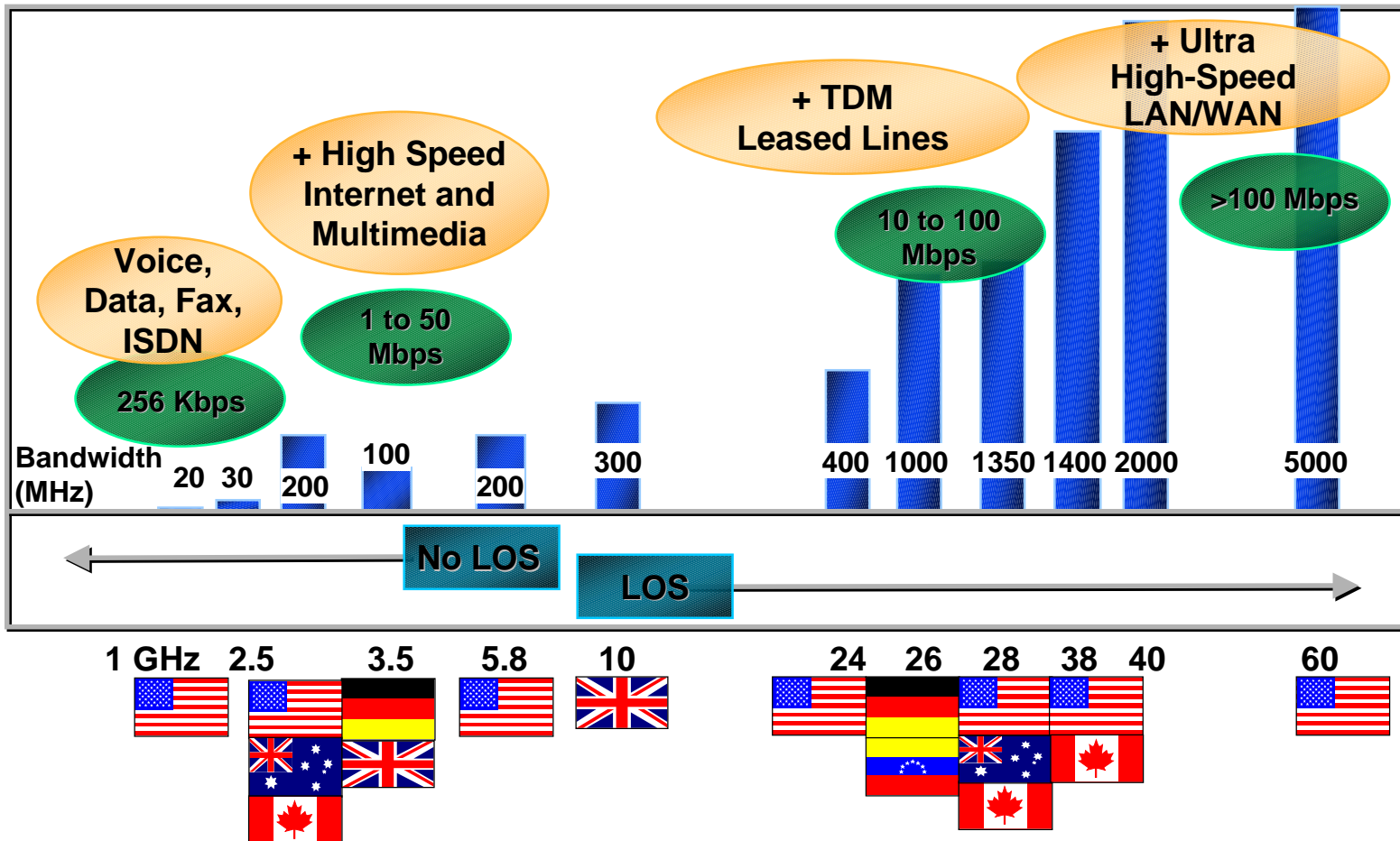
North America: 2.4 GHz (ISM), 5.7GHz (U-NII)

Europe: 2.4 GHz (ISM)

Latin America: 2.4 GHz (ISM)

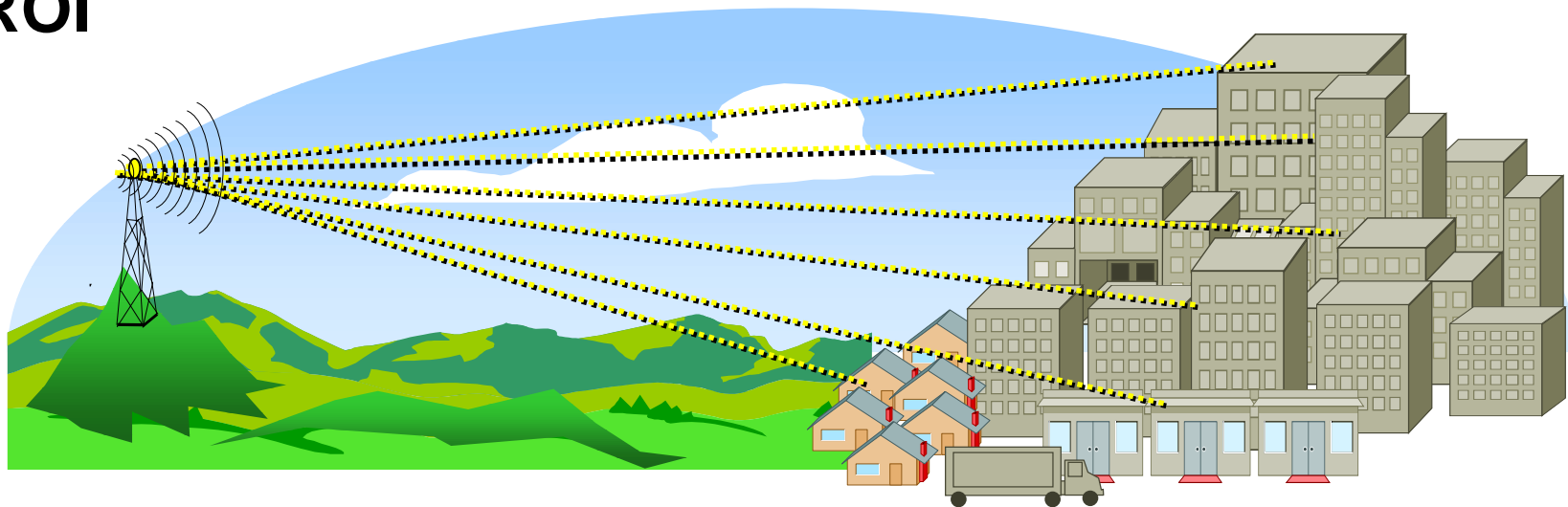
Asia: 2.4 GHz (ISM)

Access Spectrum Availability

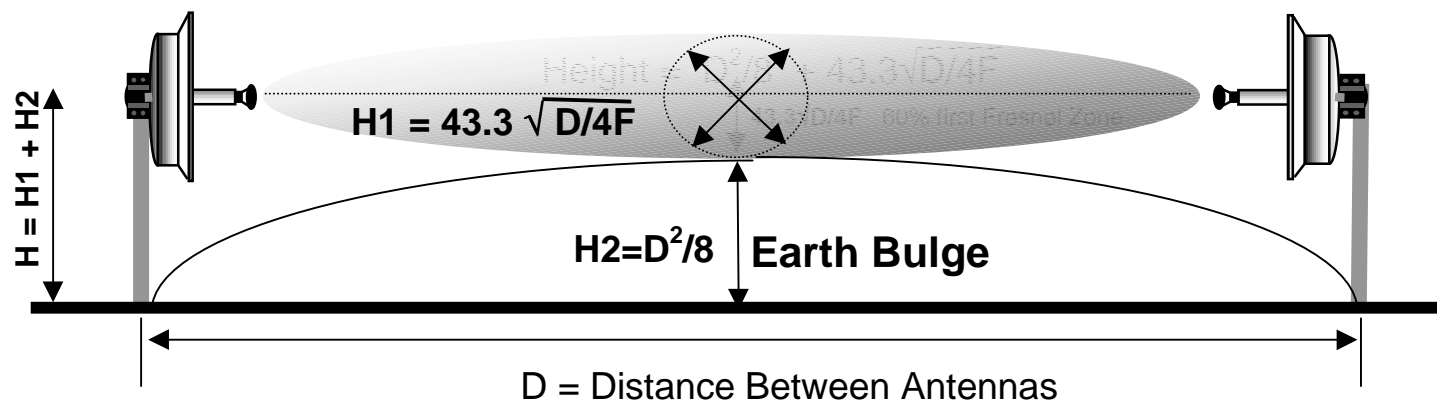


The Old Way: Macrocells and LOS

- Towers, zoning, installation
- Spectrum is consumed for only one Macrocell
- Less bandwidth per subscriber
- Coverage holes exist due to obstructions
- Large capital outlay; requires many subscribers for ROI

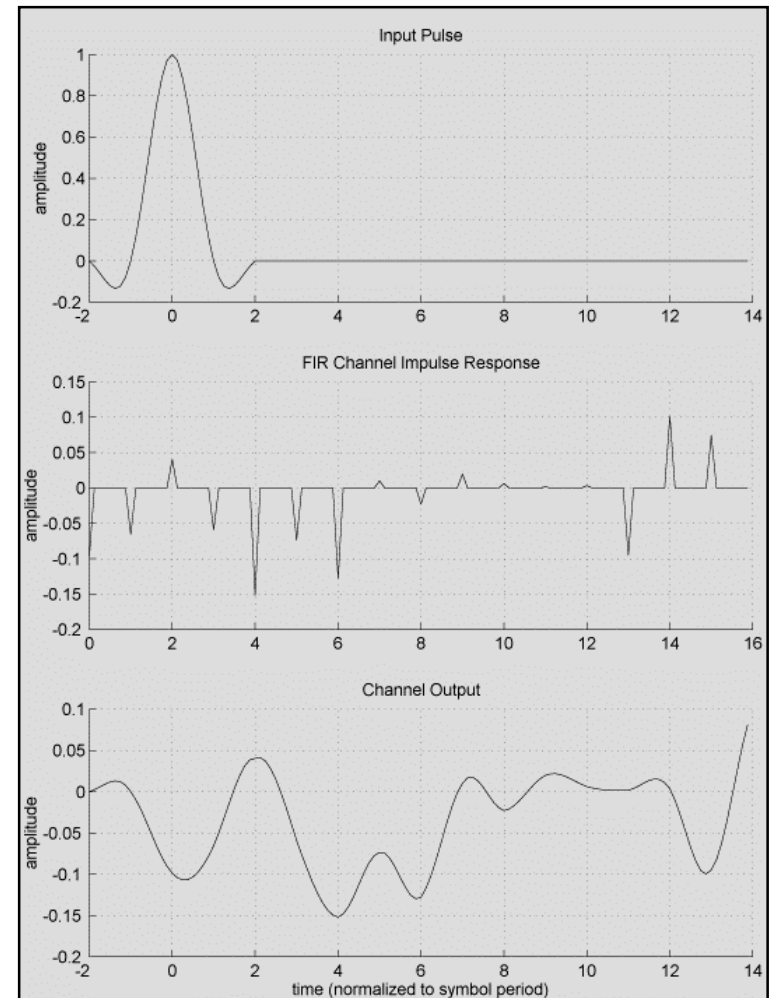
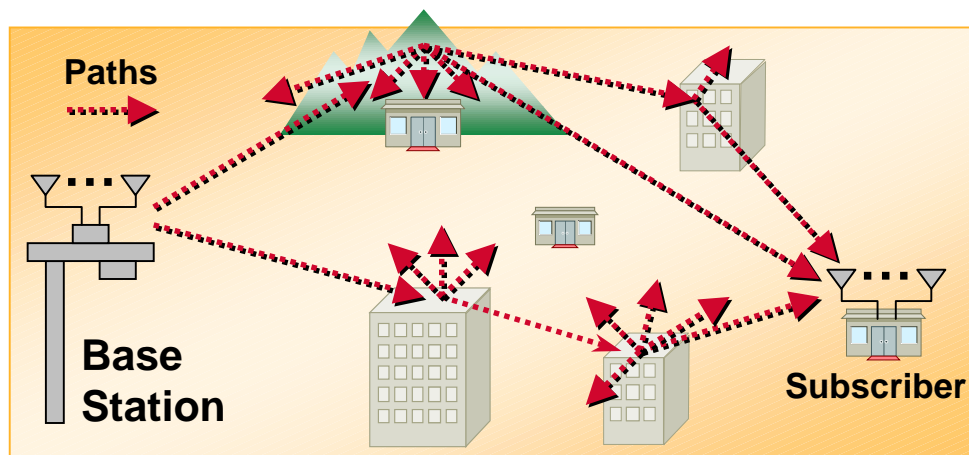


Line-of-Sight



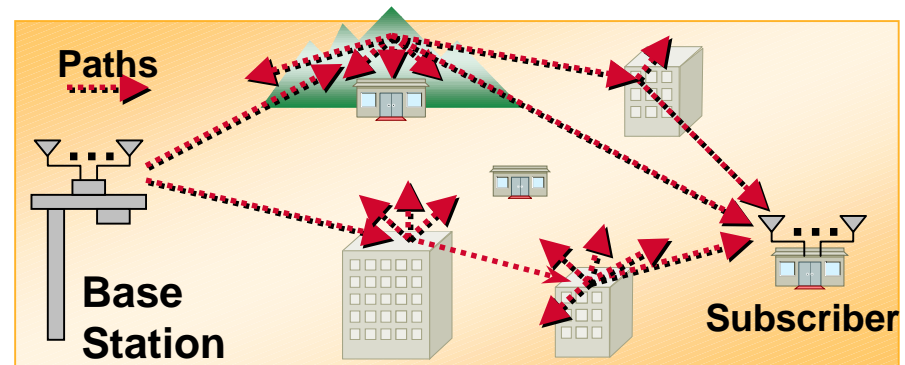
Multipath Wireless Communication

- Wireless communication involves multipath transmission
- Each path has an associated delay which causes intersymbol interference (ISI)
- Conventional wireless approaches exhibit degraded performance
- Other approaches designed to mitigate the effects of multipath:
 - Equalization
 - Direct sequence spreading
 - Complex adaptive space-time
 - Coding solutions



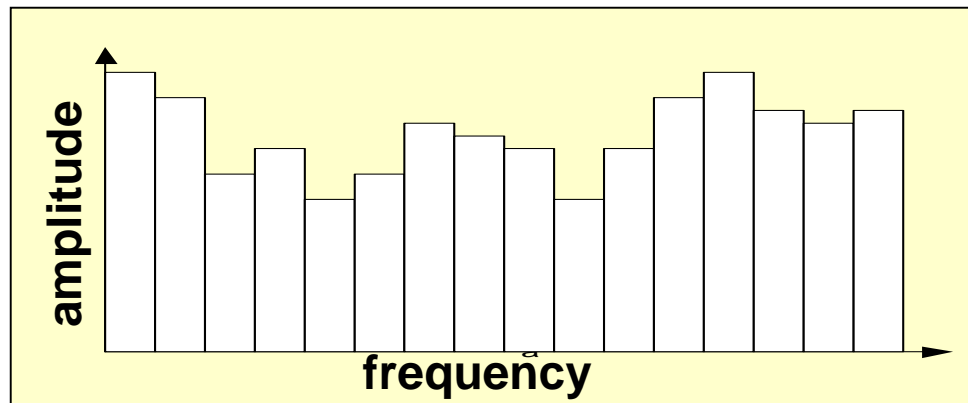
The Solution

- Thus far, the wireless communication field has concentrated on “mitigating multipath”
- Multipath actually presents a fundamental advantage to communication capacity
- Cisco’s breakthrough technology exploits multipath - VOFDM
- **High bandwidth N-LOS communication is now possible**



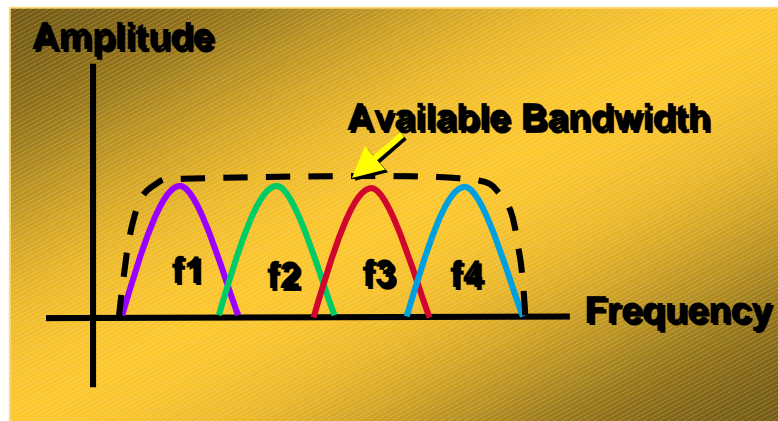
OFDM Concept

- **Narrow, slower channels are free of ISI**
- **OFDM splits data into parallel independent narrowband channels (“tones”)**
- **Exploit frequency diversity instead of equalization**
- **Bit error rate (BER) performance is greatly improved!**

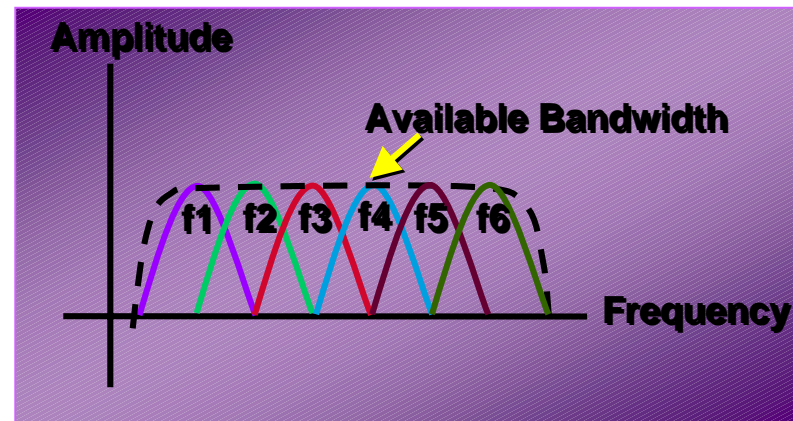


OFDM Concept

- The carriers for each channel are made orthogonal to one another, allowing them to be spaced very close together, without individual carrier guard band overhead as in FDM

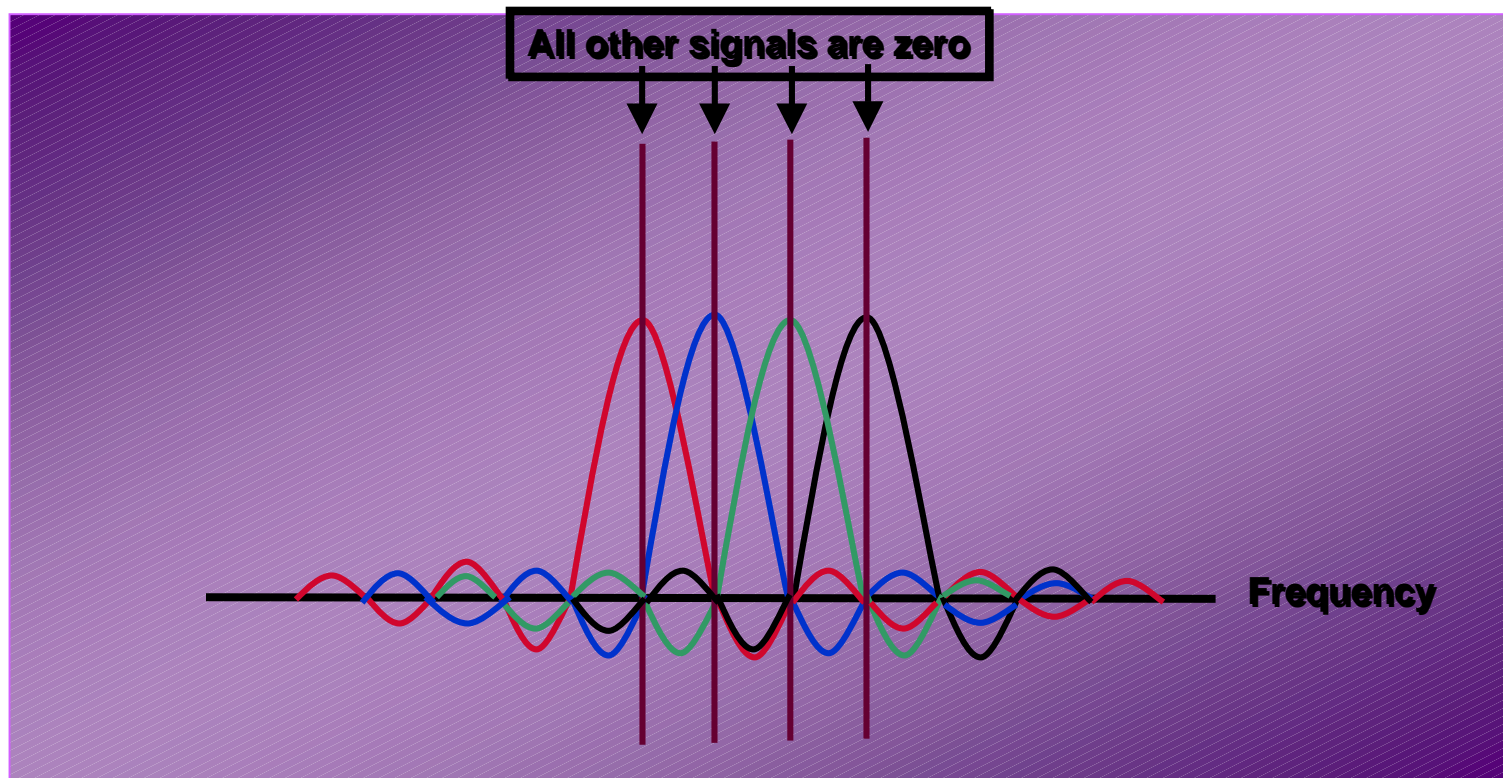


Frequency Division Multiplexing



Orthogonal Frequency Division Multiplexing

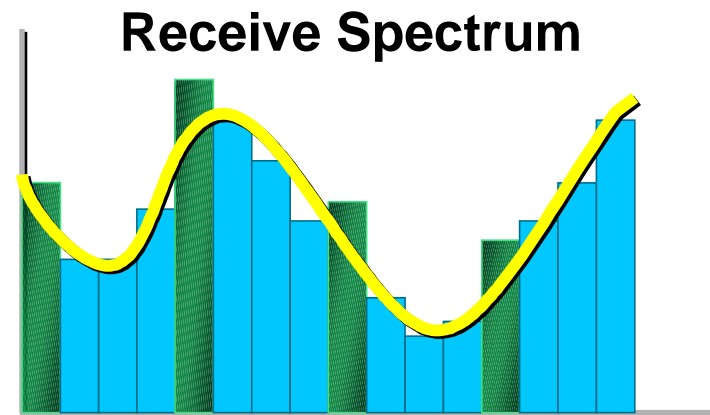
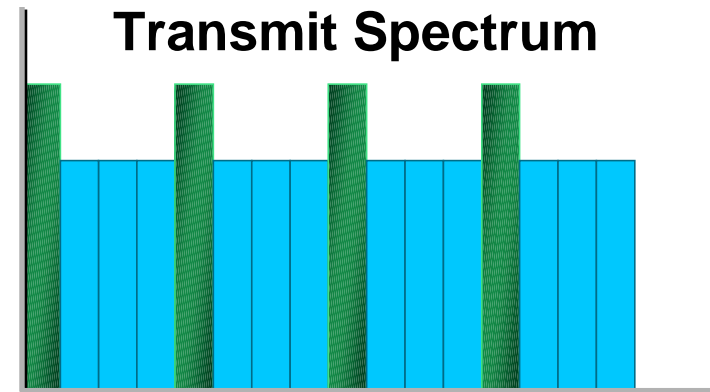
OFDM Concept



The spectrum of each carrier has a null at the center frequency of each of the other carriers in the system

Frequency Diversity

- Each OFDM burst carries data and training
 - Corrects for amplitude and phase shifts caused by the channel
 - Reduces effect of frequency offset
- OFDM, interleaving and coding
 - Create a robust processing technique for multipath fading and narrow band interference

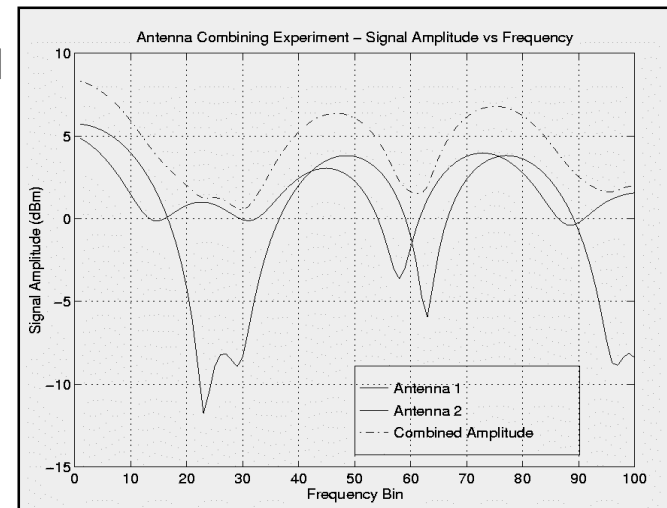
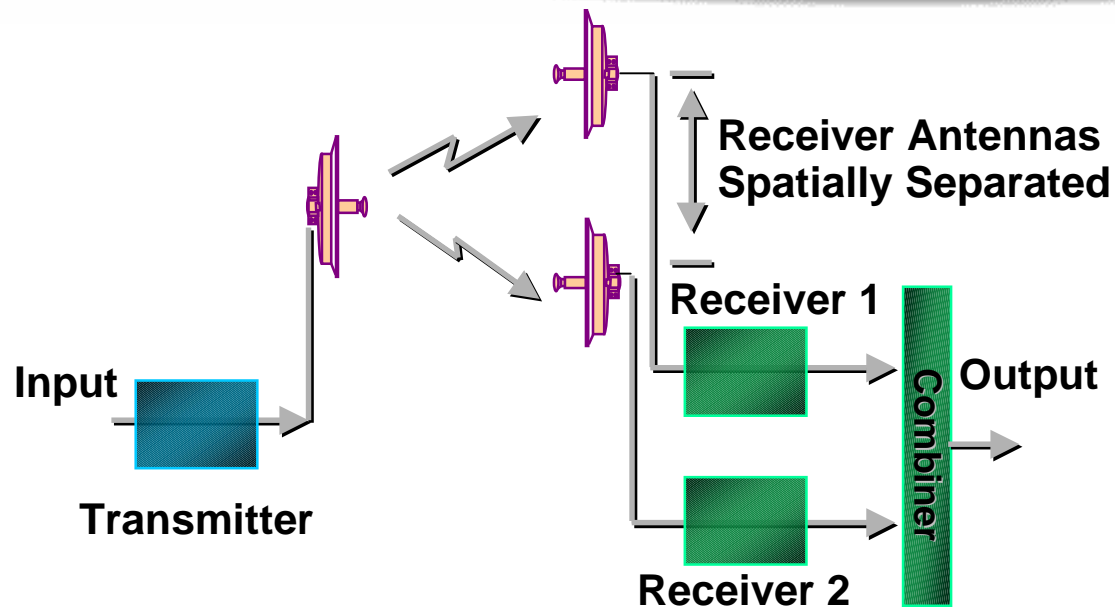


 Channel Training Tone
 Data Tone

VOFDM

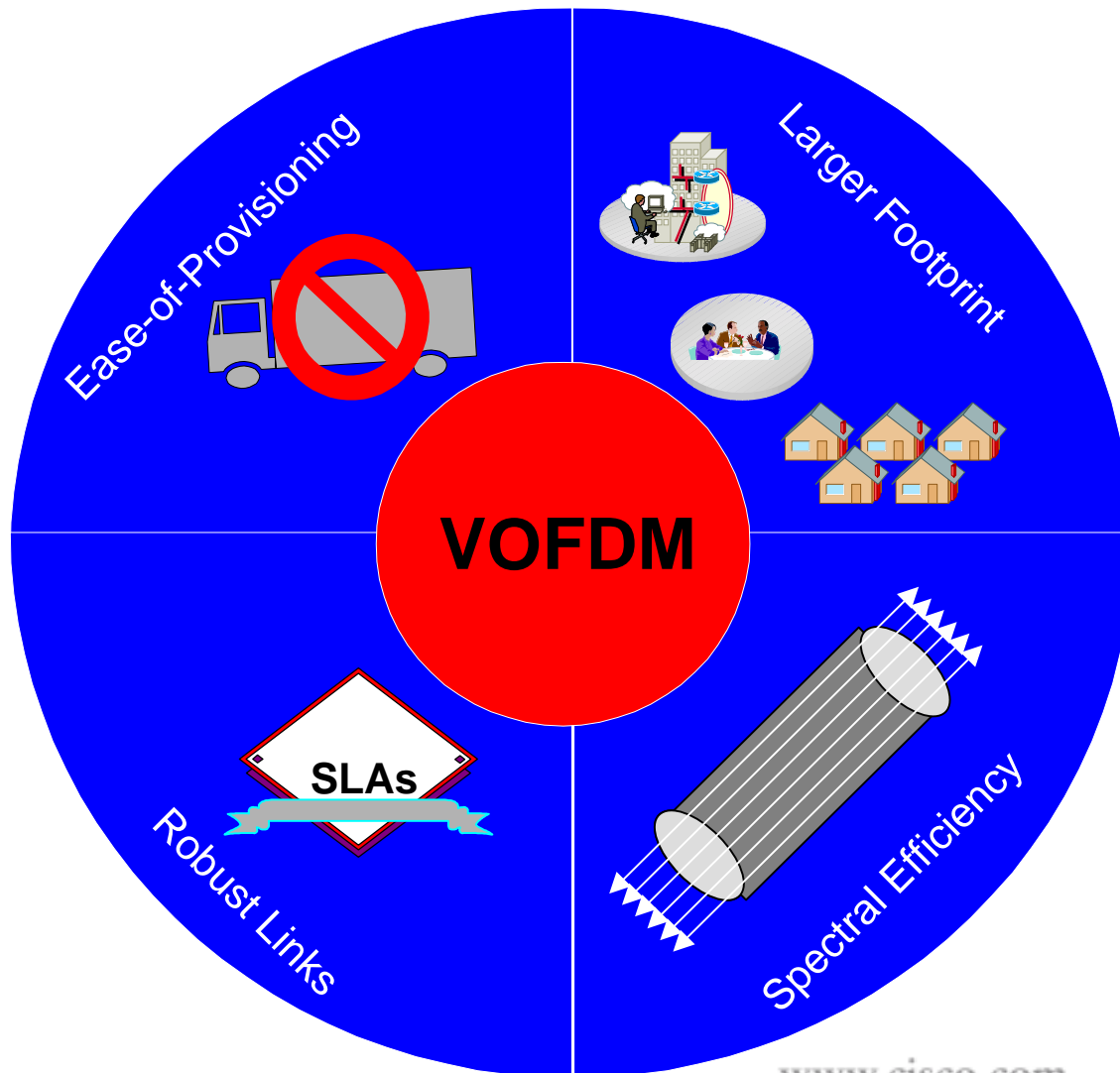
- **Conventional OFDM utilizes single transmit and receive antenna.**
- **Cisco solution combines OFDM with spatial processing: VOFDM (Vector Orthogonal Frequency Division Multiplexing)**
- **Great benefit comes from exploiting both frequency and spatial diversity**

Spatial Diversity



- In the presence of multipath fading, two received signals will have uncorrelated fading effects due to different path lengths
- Thus, a combined received signal will have a higher SNR than any of the individual signals
- **The greatest processing benefits come from exploiting both frequency and spatial diversity**

VOFDM Wireless Technology: Open Standards Based Market Enabler



- Space/Frequency diversity increases SNR and allows operation in channels that disable single carrier QAM
- Improves penetration through enhanced spectral efficiency and coverage
- Lowers install costs
- Improves robustness, BER and availability

WT 2750 Wireless Technology Suite



- **Point-to-point T3/E3 wireless solution**

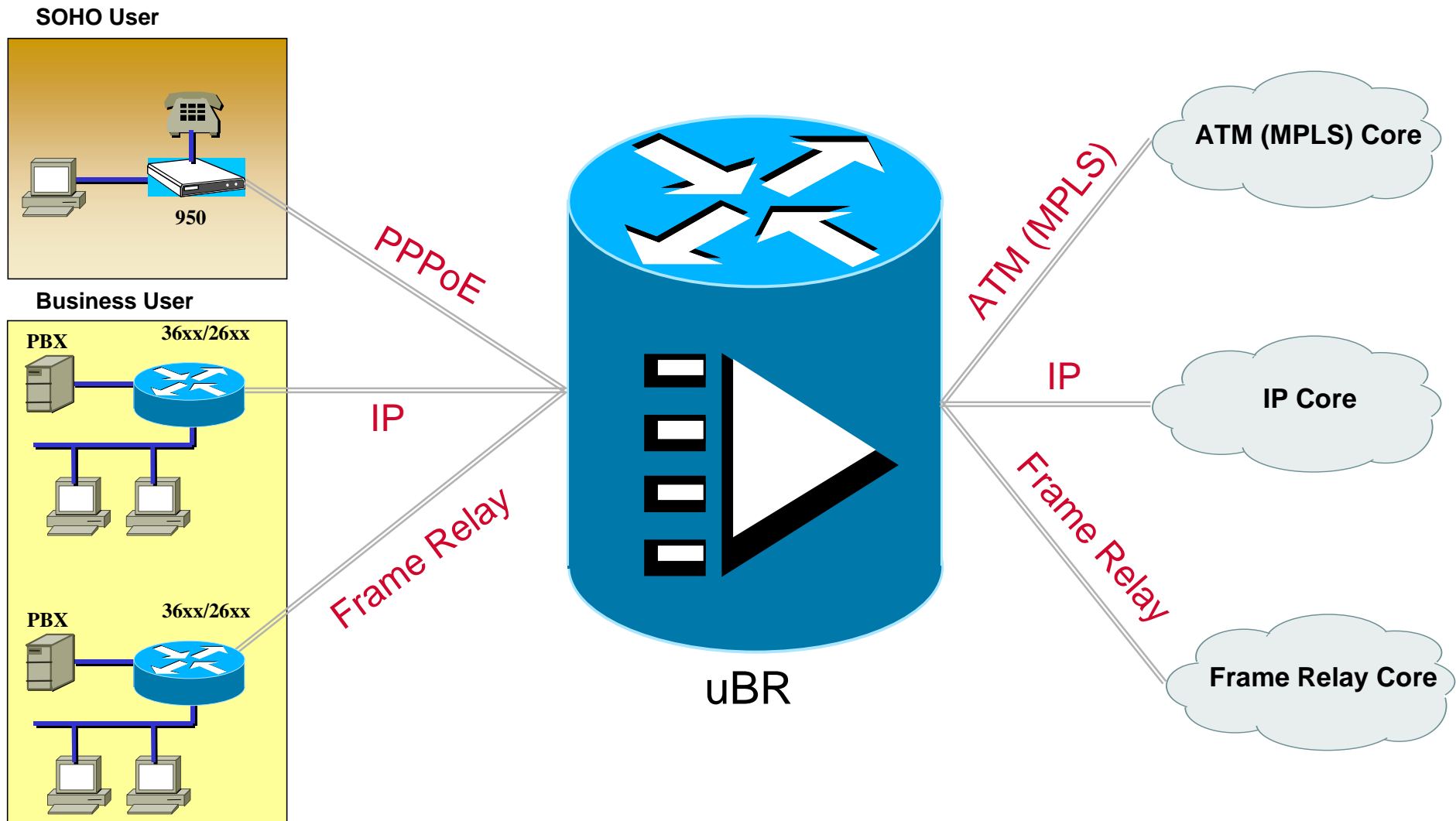
uBR Universal Broadband Router Family

Wireless Modem Line Card

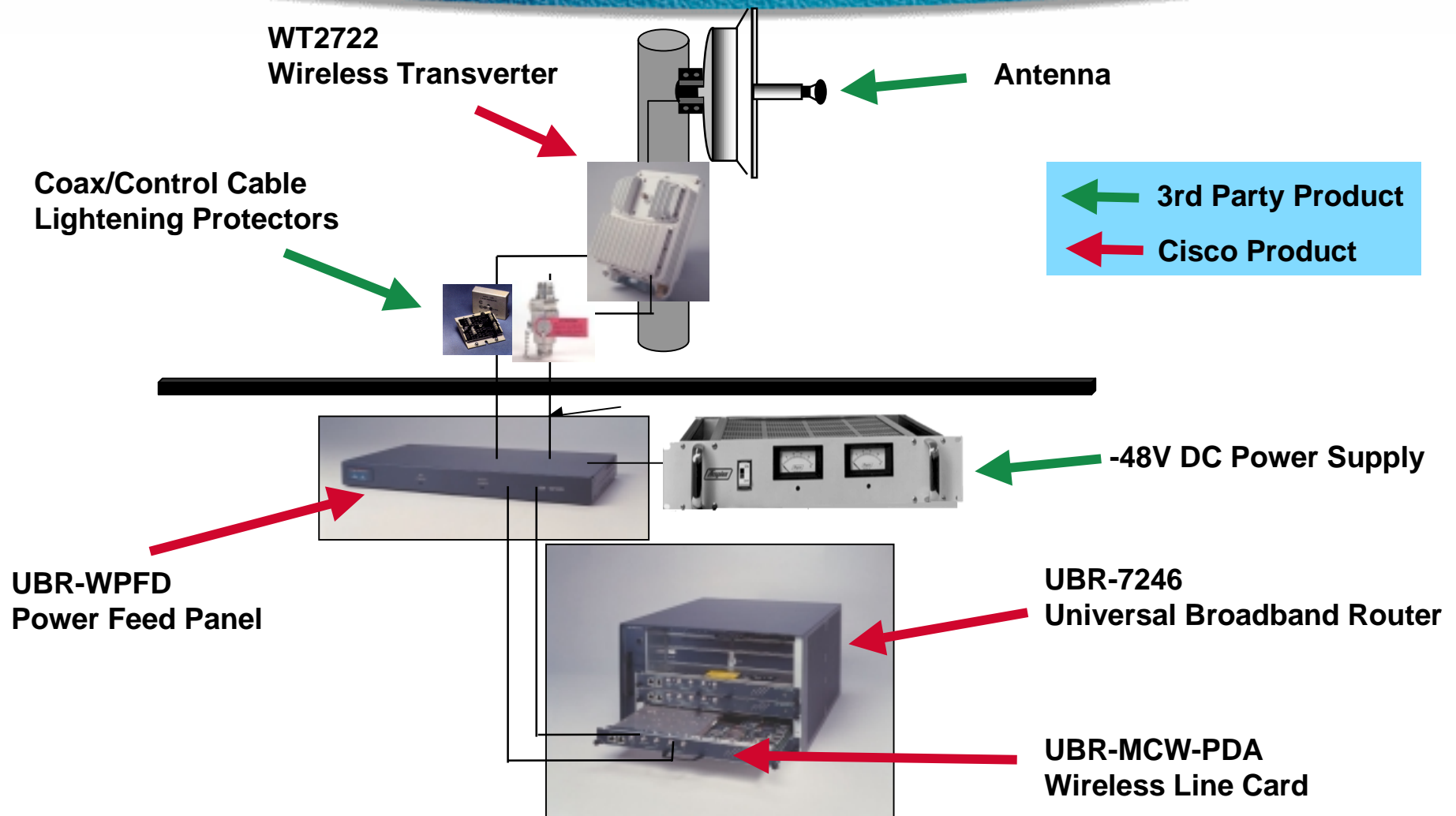
Power Feed Panel

RF Head (ODU)

Flexible Access and Transport Options



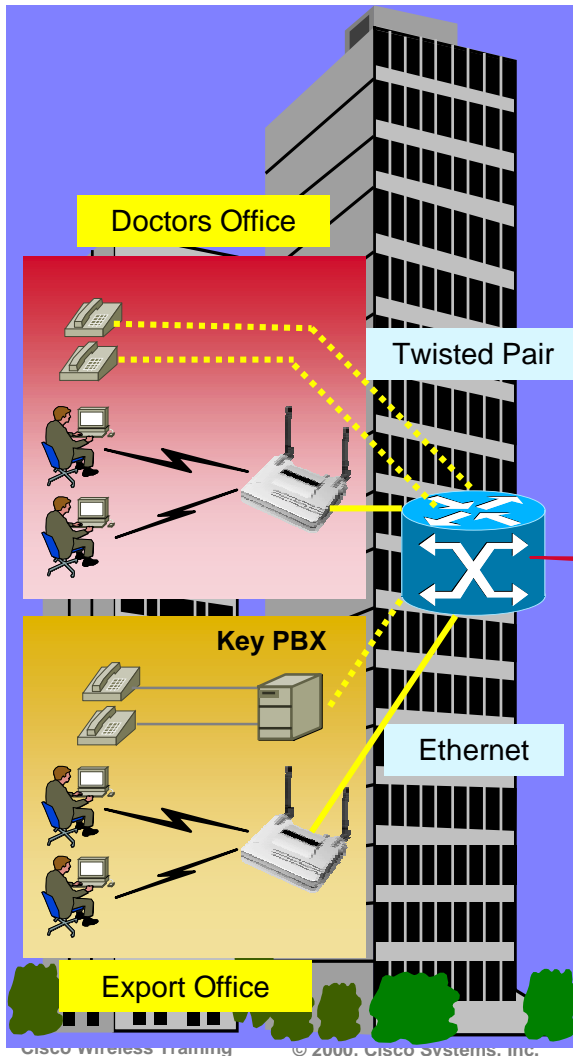
WT2700 Components for P2P



WT-2700 Key Features for P2P

- **IP Packet Based Solution**
- **Up to 44.4 Mbps full-duplex throughput (12 Mhz)**
- **Fiber quality link**
 - > 10^{-11} BER for Data**
- **Integrated to uBR 7246 and uBR 7223**
- **Supports UNNI (5.7 GHz) ~ 20-25 miles LOS**
- **Encryption support: 56 bit DES with RSA key management**
- **Managed via IOS CLI and CiscoWorks**

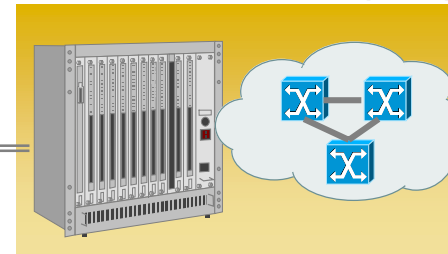
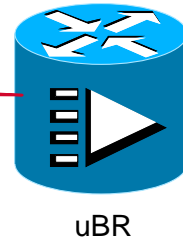
MTU Solution



Compelling Business Case

- Target Office Parks, Hotels, Hospitals, Campus
- Amortize the capital expense across tenants
- Flexible in-building distribution (wire & wireless)
- Provide value-added services: Internet Access, VPNs, Voice (Local & Long Distance)

Point of Presence (POP)



Synergy Between Wireless LAN and Wireless WAN. If Wired use a Catalyst Switch

Network Services

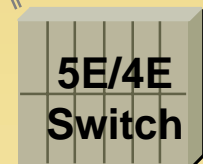
Public Internet



Enterprise HQ

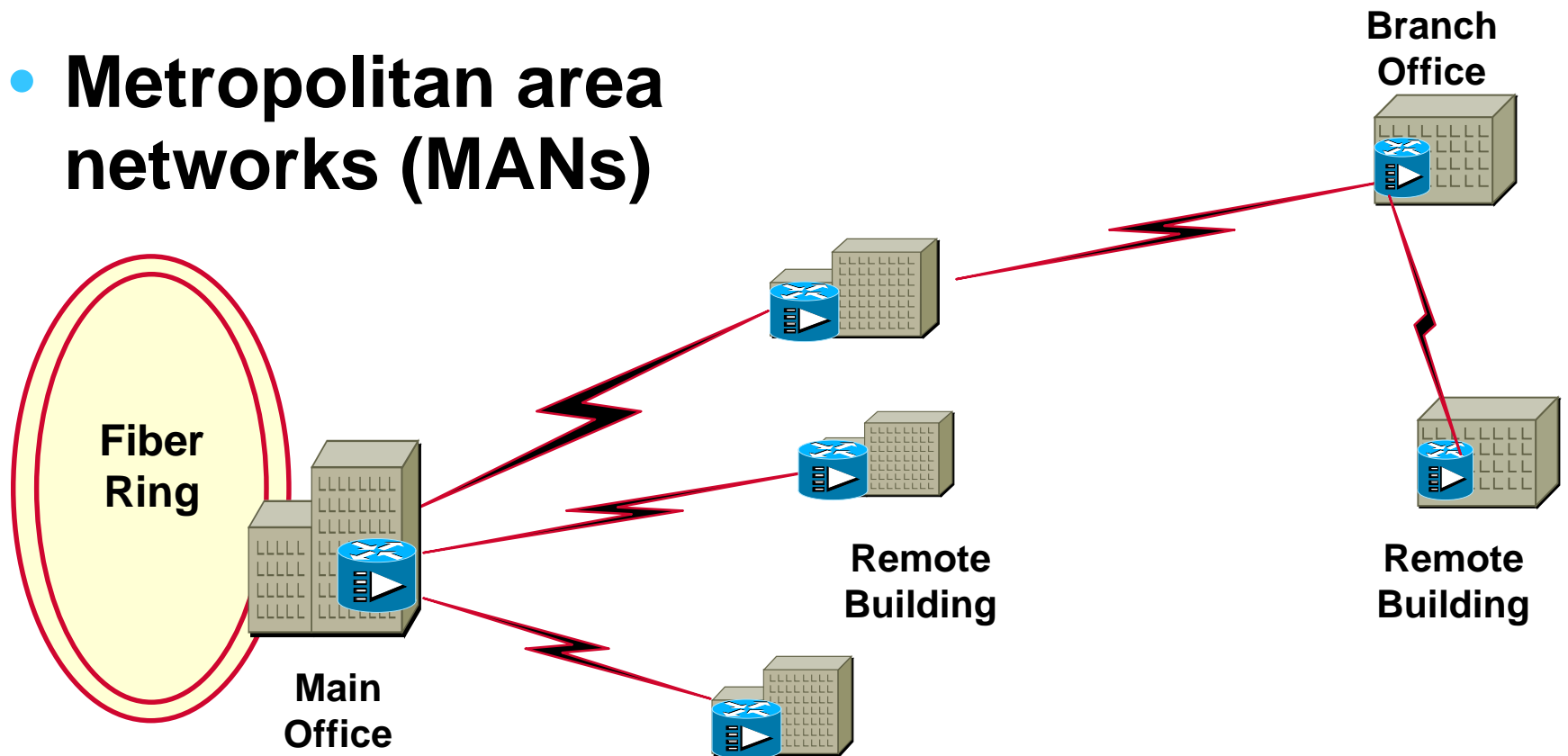


PSTN

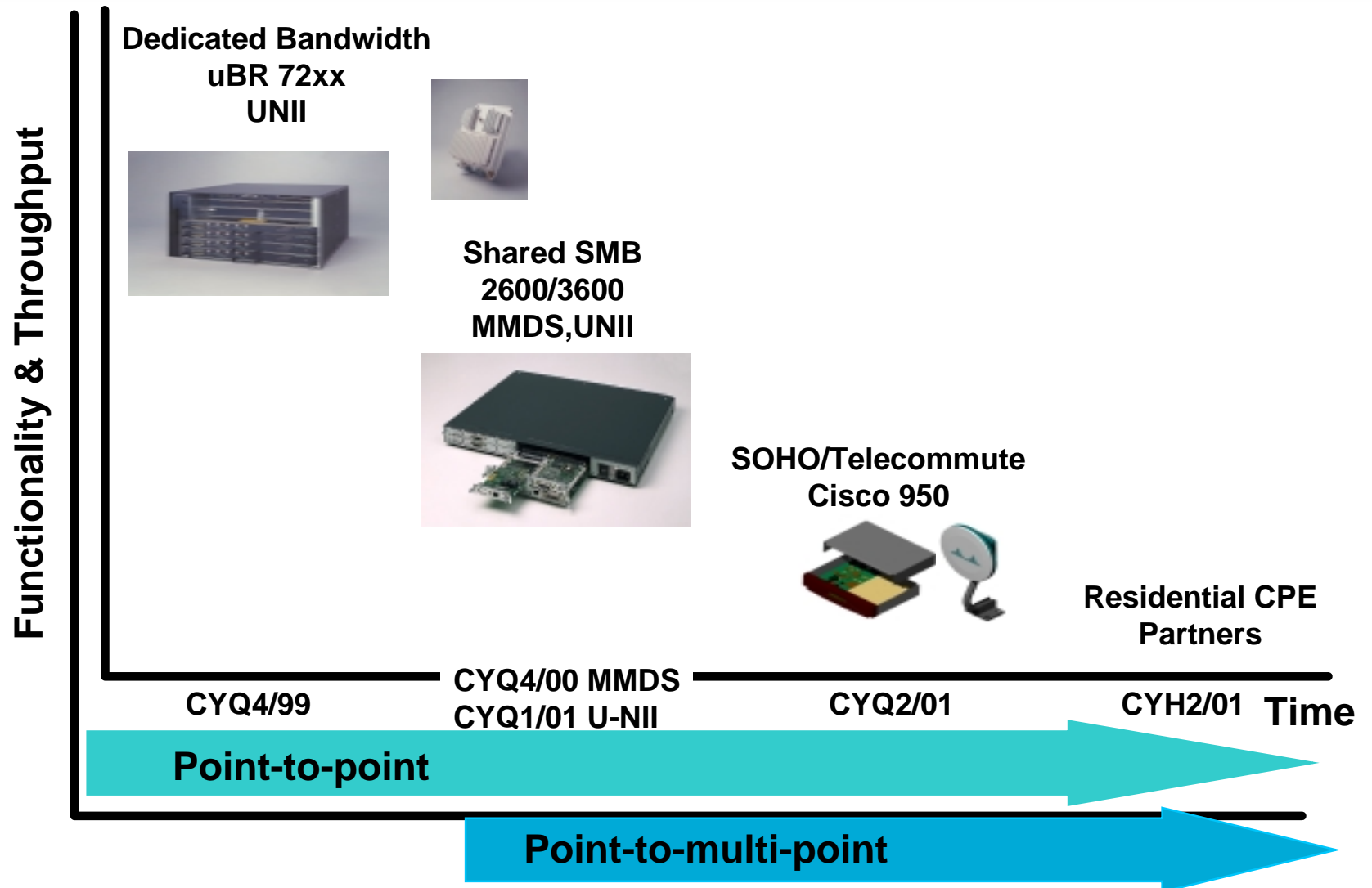


P2P Application

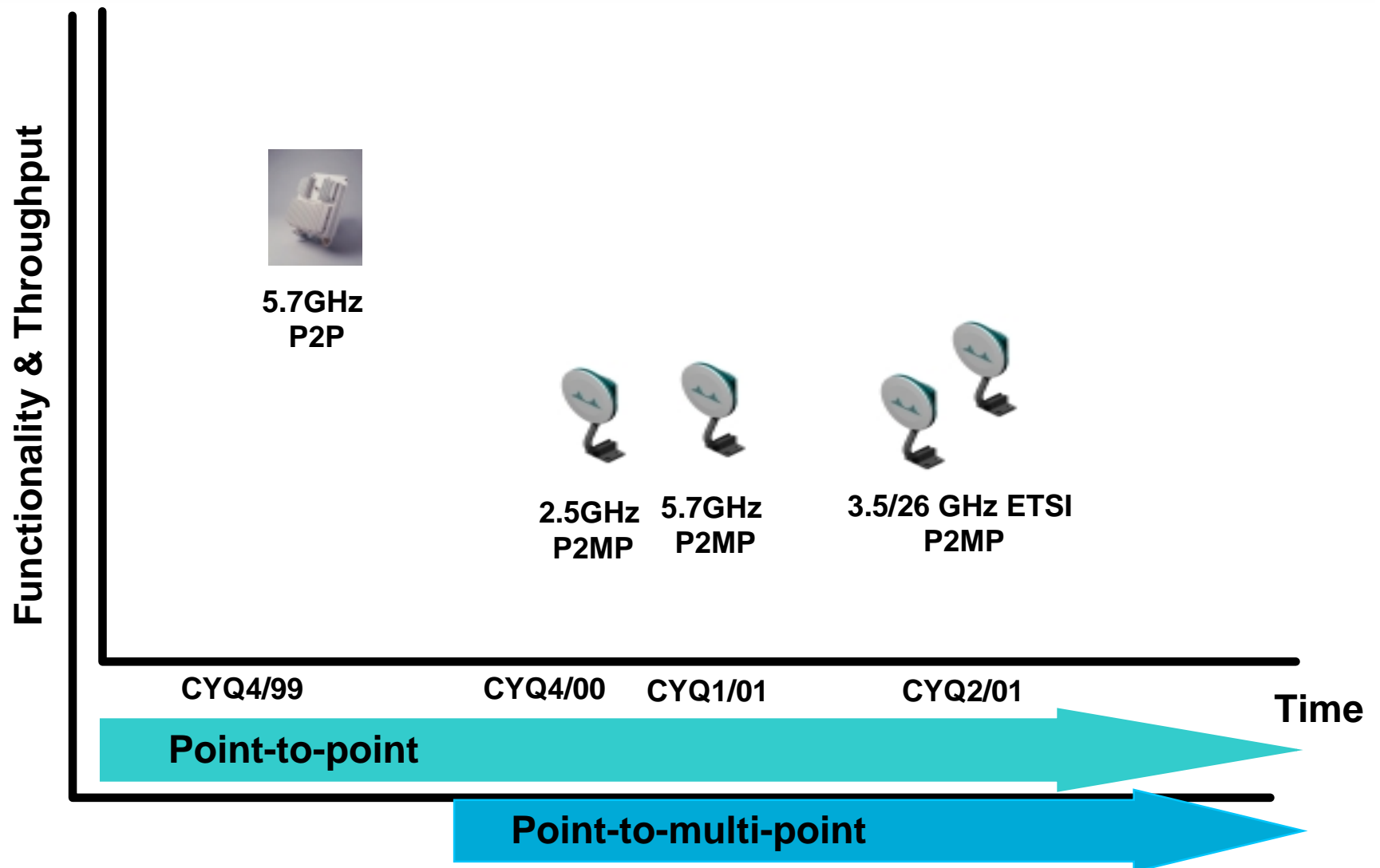
- Enterprise campus networks
- Metropolitan area networks (MANs)



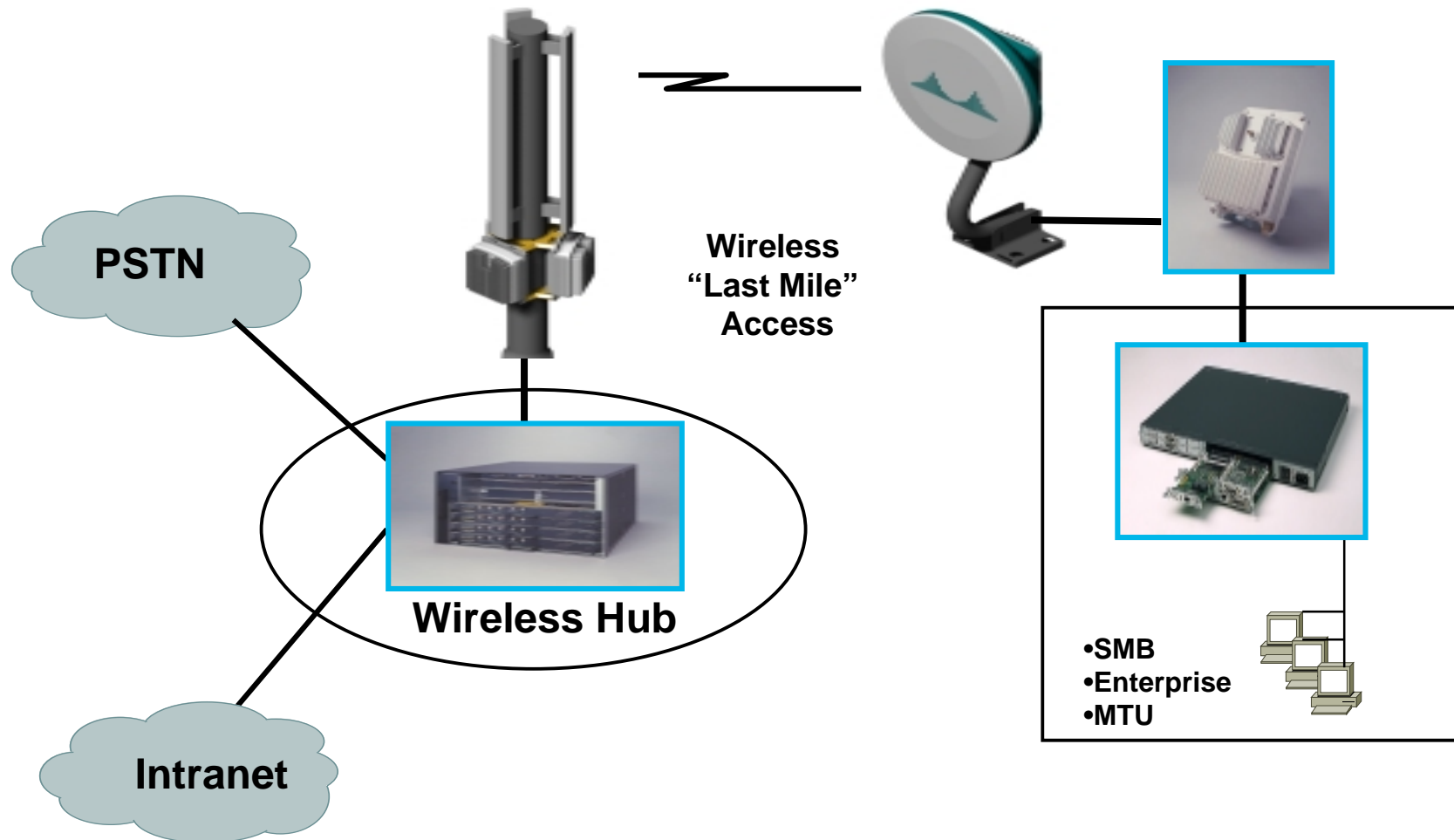
Product Roadmap



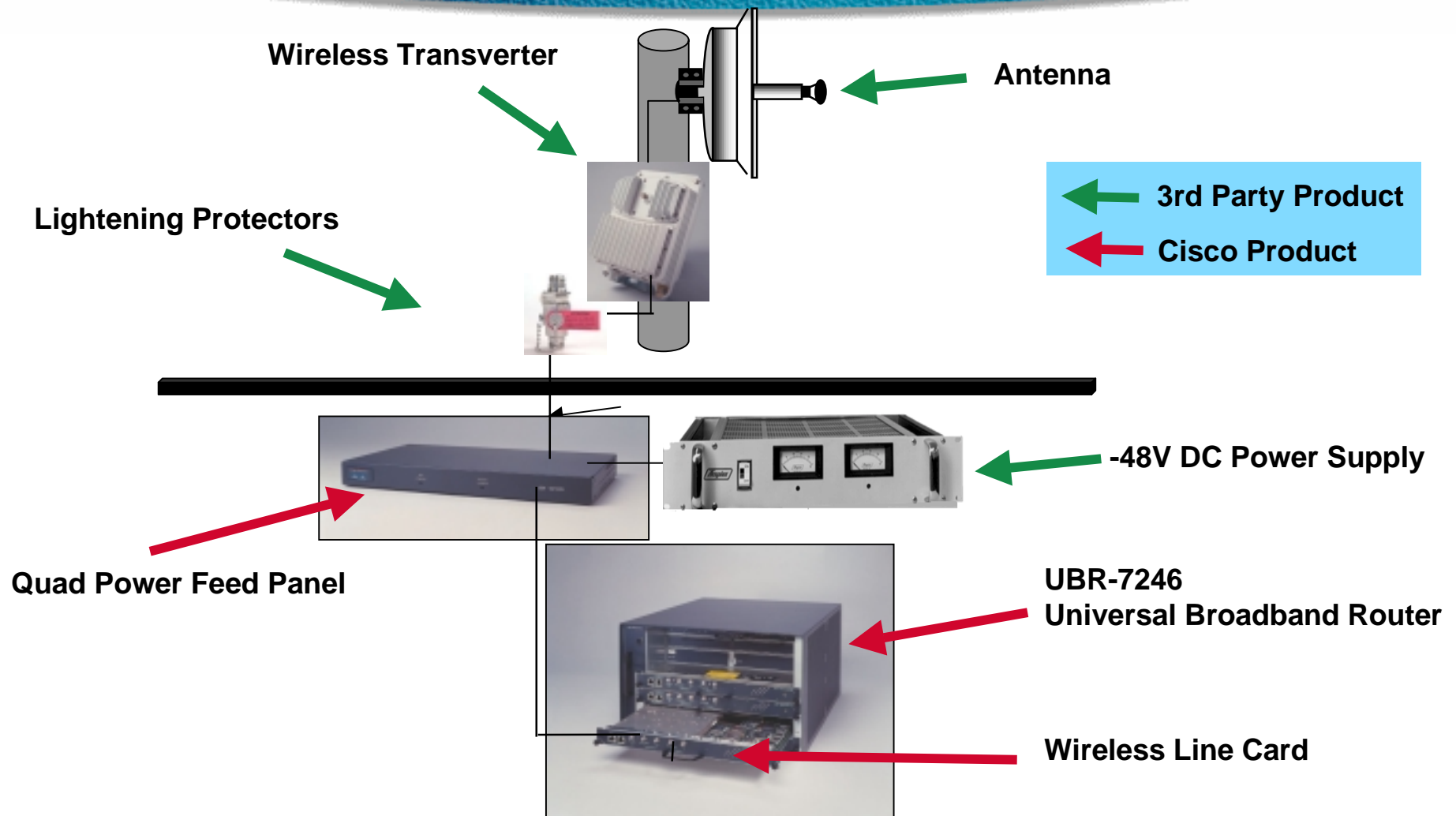
RF Roadmap



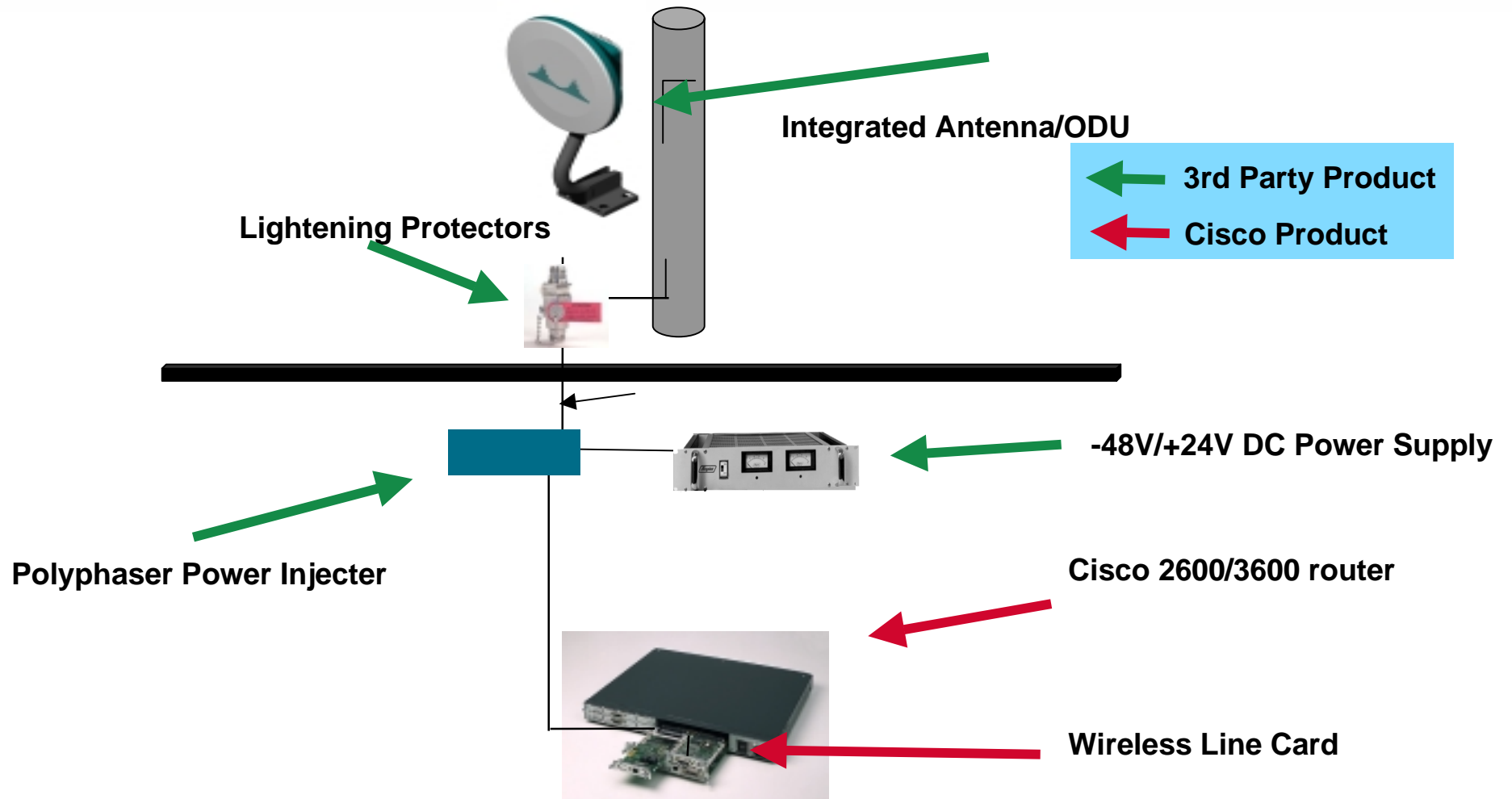
P2MP Product Overview



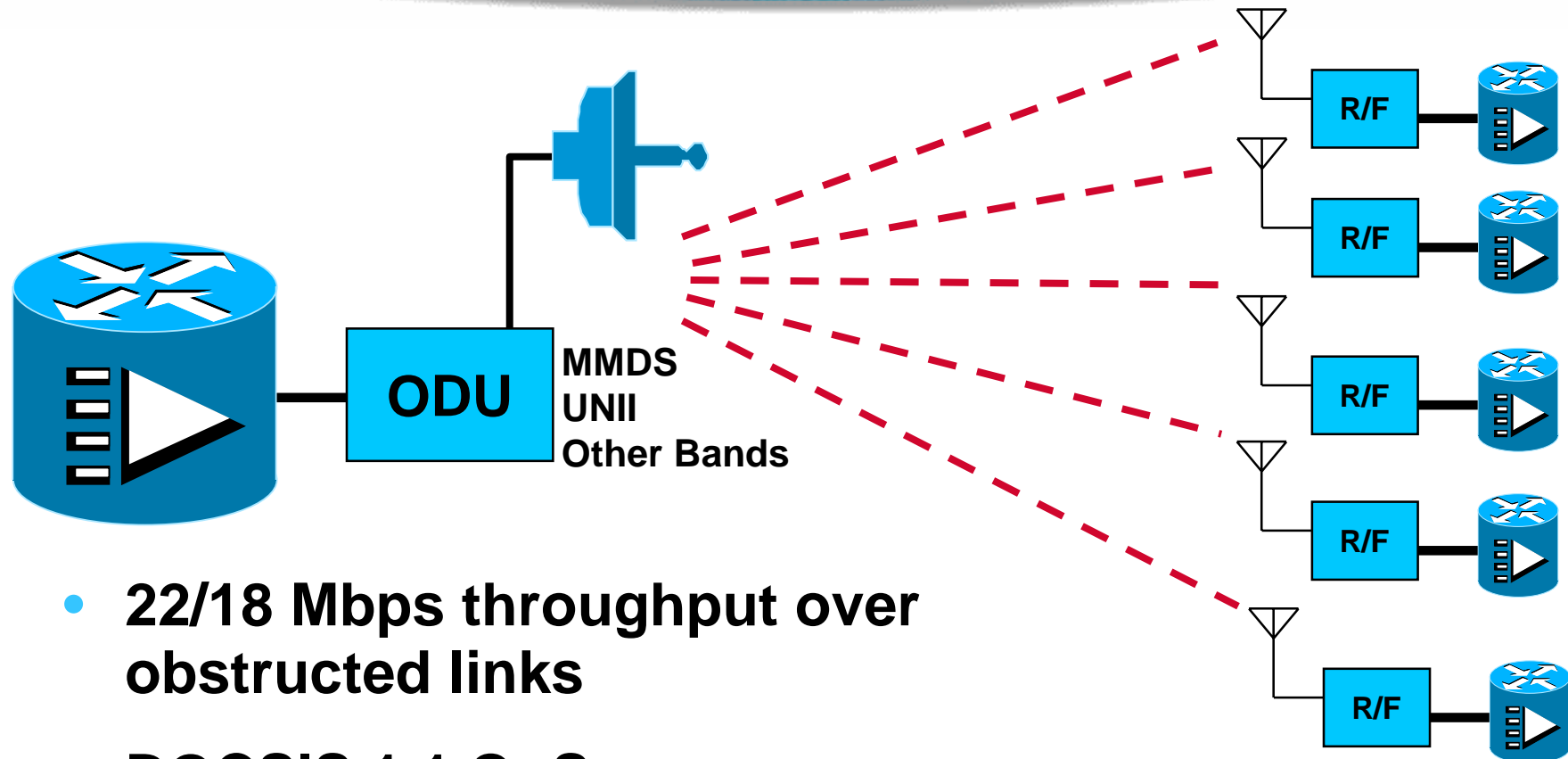
Hub Components



SU Components



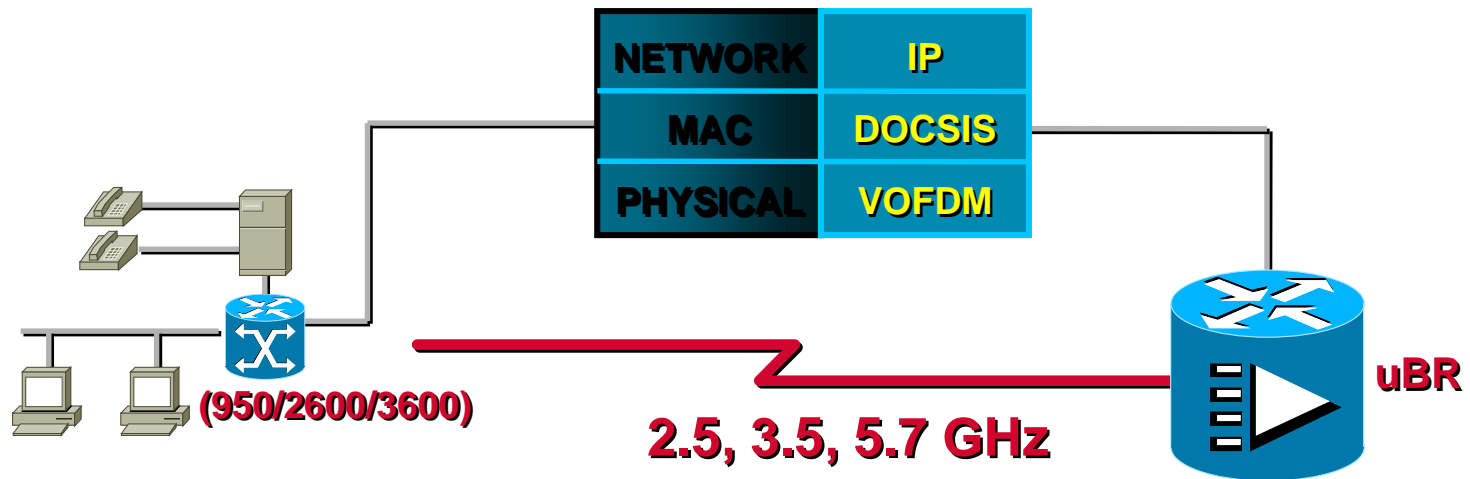
Point To Multi-point



- 22/18 Mbps throughput over obstructed links
- DOCSIS 1.1 QoS
- VOFDM Advanced Phy applicable

Protocol Architecture

IP Architecture

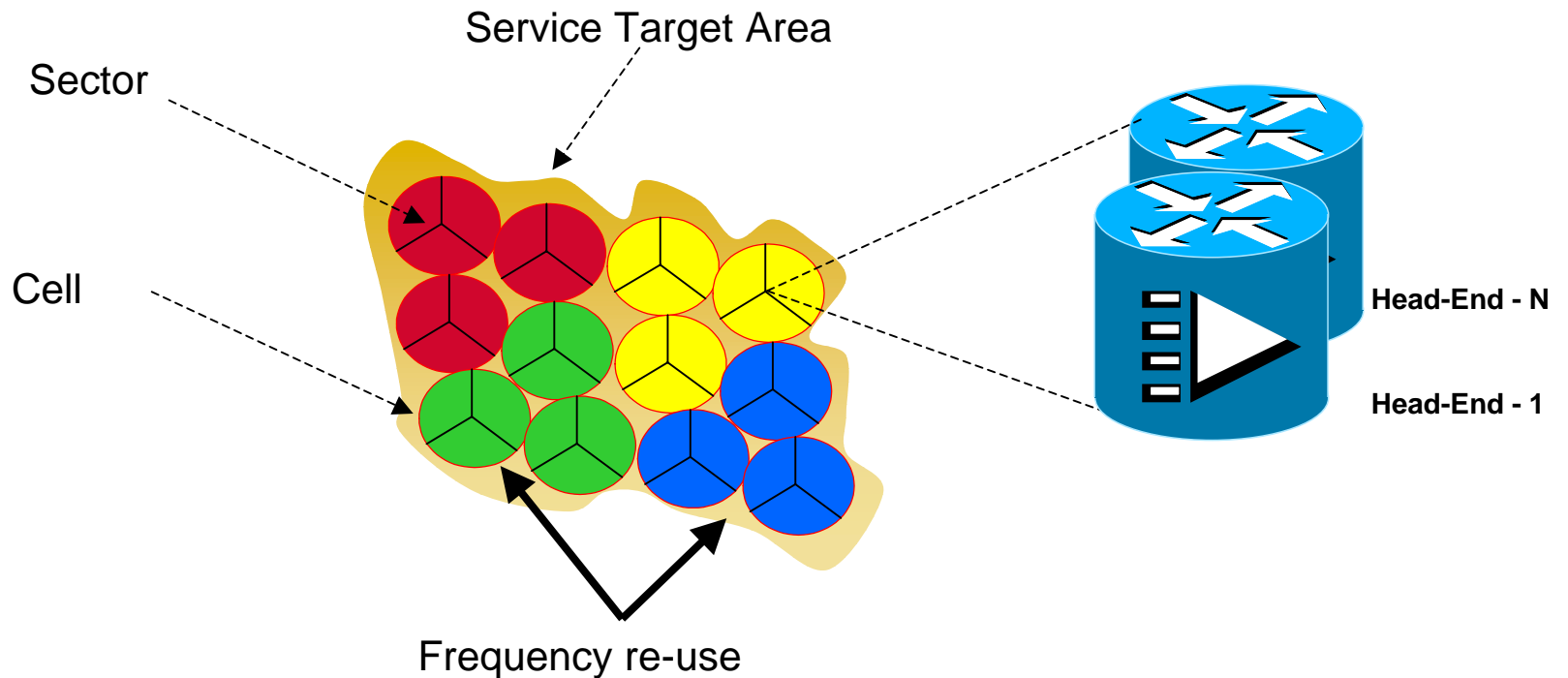


Key Features

- **IP Packet Based Solution with DOCSIS 1.1 support**
- **Up to 22.2 Mbps DS throughput/18 Mbps US shared**
- **~ 25-30 Miles in connection distance (MMDS) LOS**
- **~6 miles in connection distance (U-NII) LOS**
- **Fiber quality link**
 - > 10^{-11} BER for Data**
- **Integrated Cisco routing solutions**
- **Encryption support: 56 bit DES with RSA key management**
- **Managed via IOS CLI and CiscoWorks**

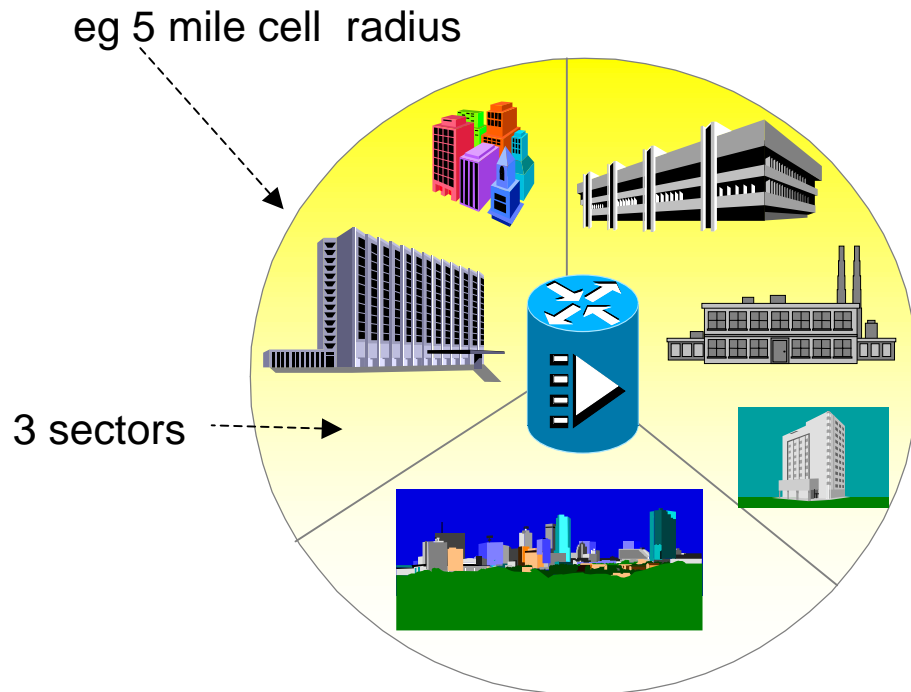
Cellular Network Deployment = Bandwidth & Scalability

Demand dictated cells and cell size



How Many Subscribers Can I Support?

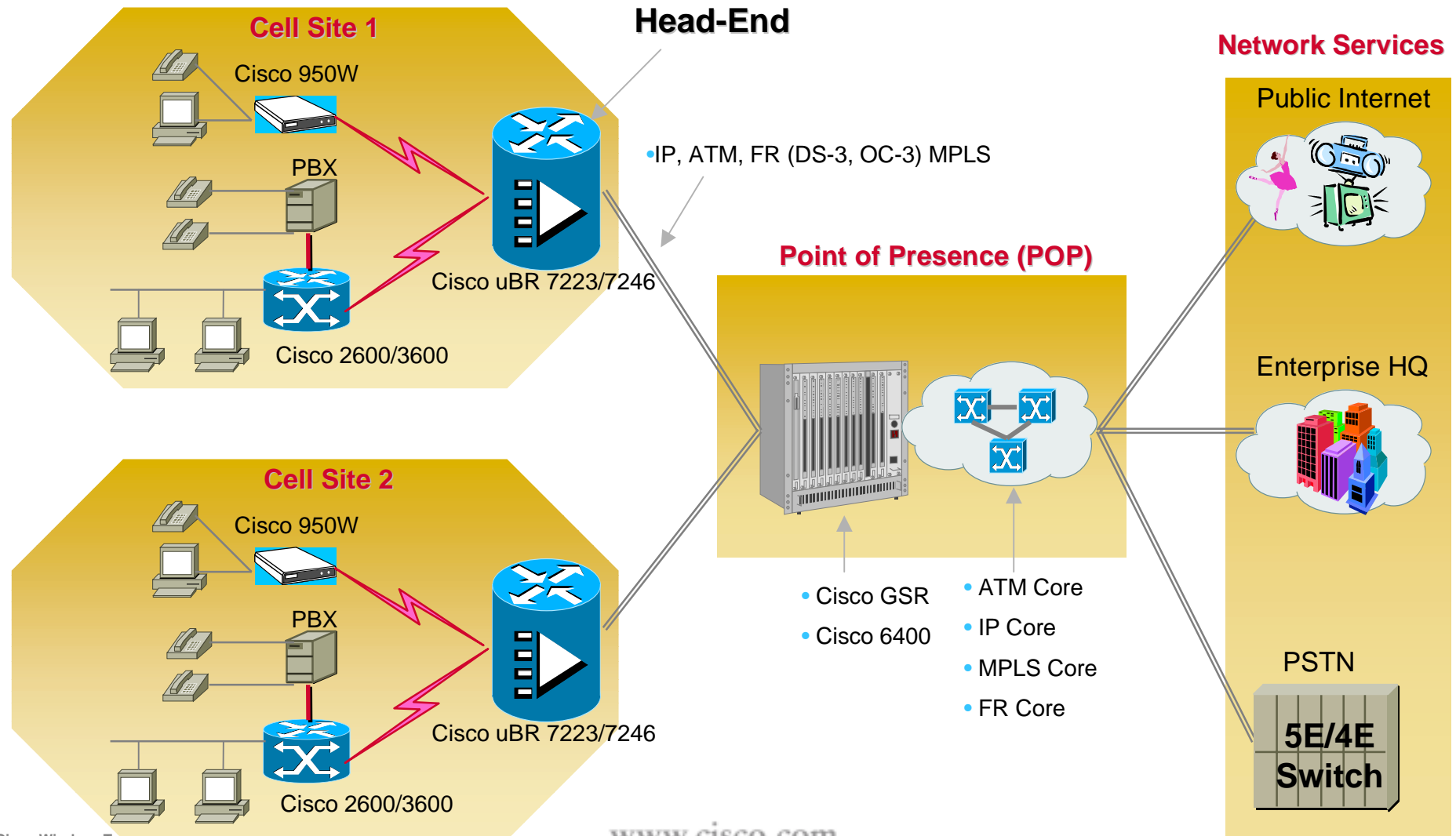
It Depends!



- Target Market Density
 - Penetration Rate
- Data Rate Requirements
 - Busy Hour Traffic
 - Active Online User Rate
- Frequency Re-Use Plan
- Number of sectors
- Bandwidth/sector
- Over-subscription Rate

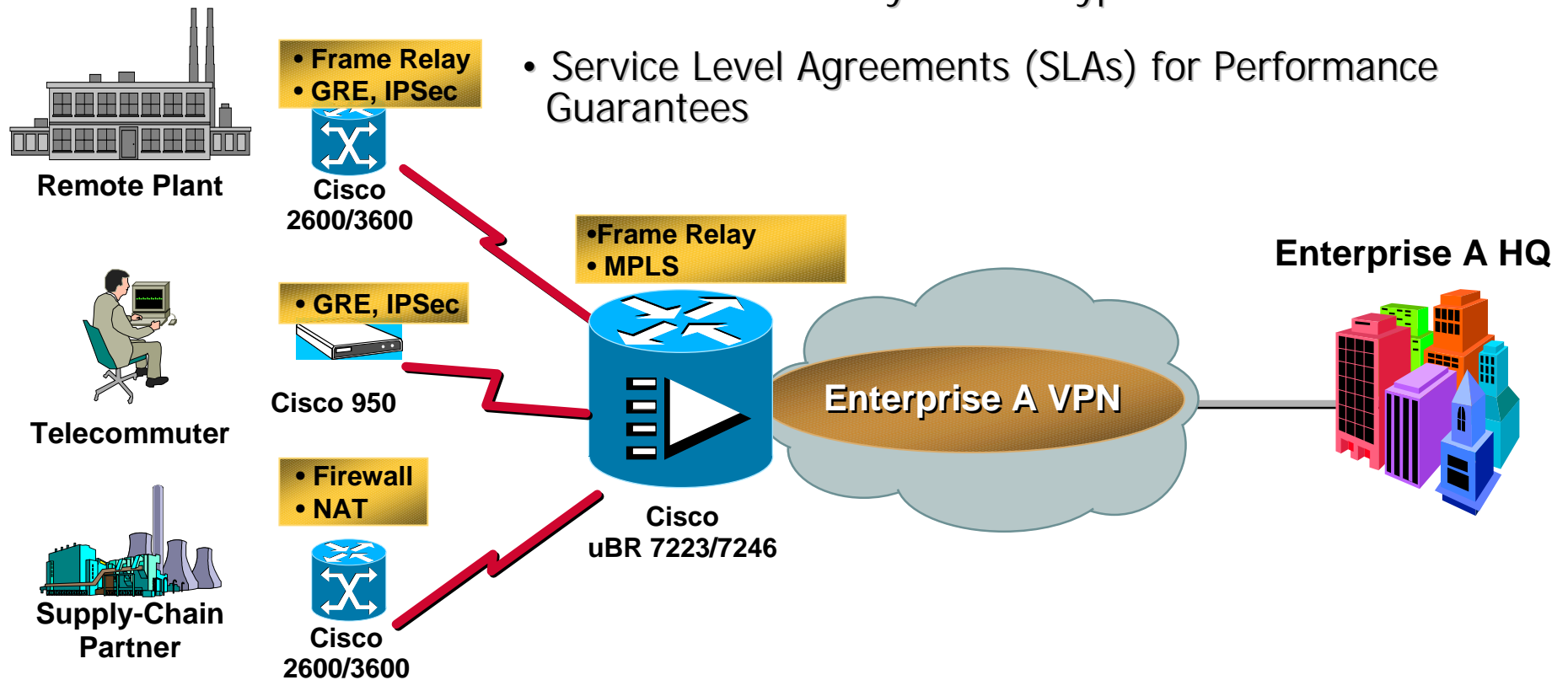
**Currently Each LineCard can support 1,000 SU's
But the above questions need to be answered**

Typical Network Architecture

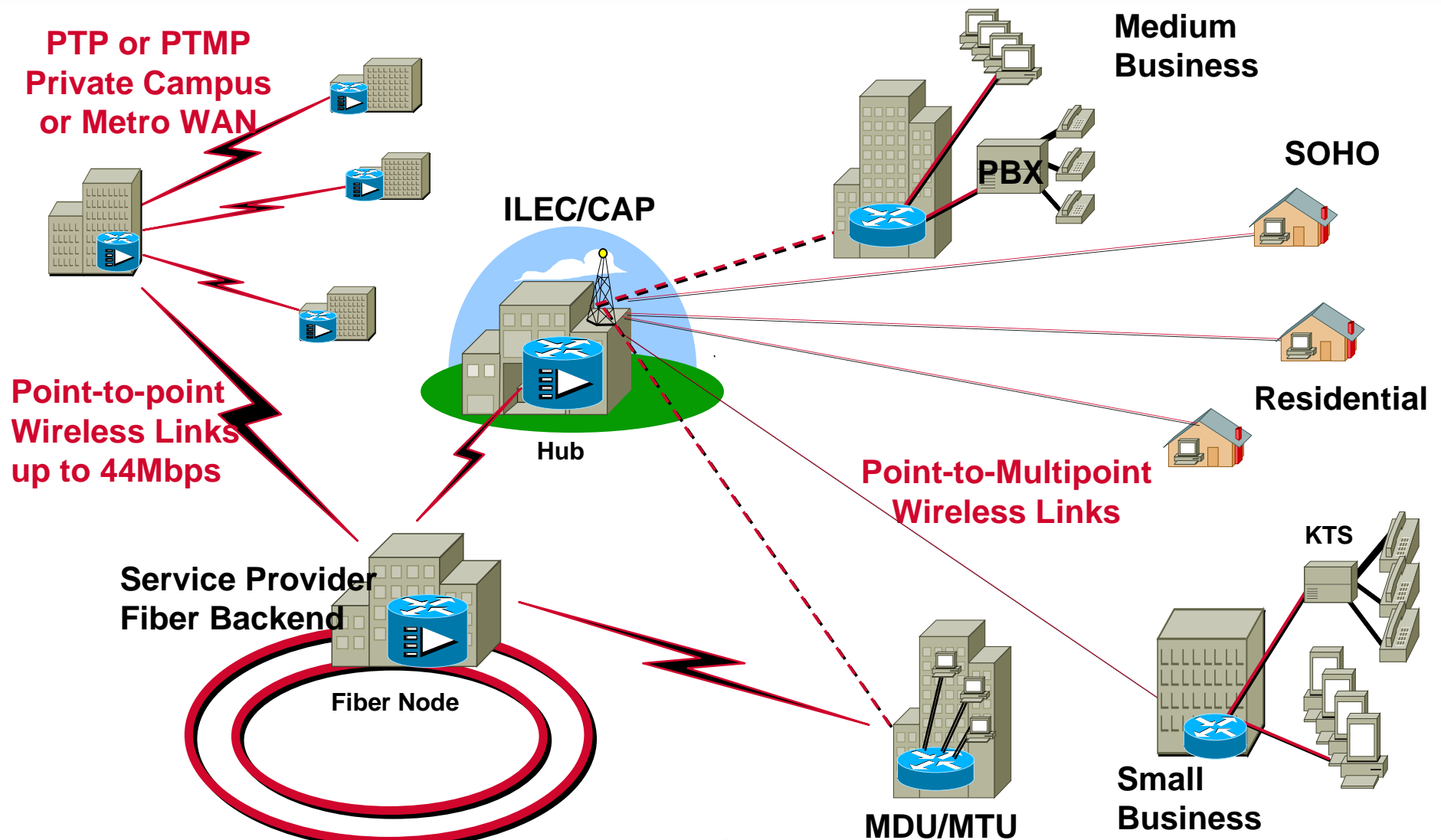


VPN Services

- Seamless Extension of VPNs over BBFW
- CPE and Network Based VPNs
- End-to-End Security and Encryption
- Service Level Agreements (SLAs) for Performance Guarantees



Broadband Fixed Wireless Today and Tomorrow



Cisco Fixed Wireless Systems

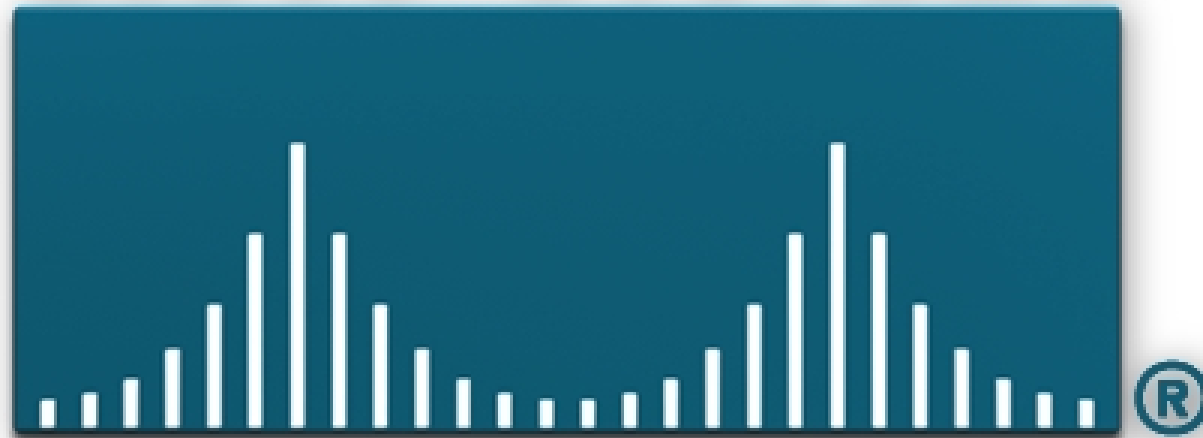
- **Industry's First Service Provider Class Solution for Fixed Wireless**
- **Leverages Industry Leading UBR72XX and 26XX/36XX Modular Access Routers**
- **Leverages Cisco IOS for an Integrated End-End IP Solution with QOS & Security**
- **Leverages Industry proven DOCSIS Protocol with MultiPoint Product**
- **Revolutionary VOFDM technology for Fiber Quality BER with or w/o LOS**
- **Committed to BBWIF Standards Initiatives**

Make Sure You are Comparing Apples to Apples
Remember: Its an IP based Cisco end-end solution

The Cisco Wireless Advantage

- **Integrated Cisco End-to-End network**
one box, one CLI, one management and provisioning system
- **Fixed wireless is “just another ‘wire’ ” to deliver differentiated services with wireline availability and performance**
- **Multi-path centric technology**
No requirement for large towers and LOS
Enables a microcellular approach for efficient use of spectrum
- **Ease of deployment - Lower cost of deployment**
Robust technology—antenna and repeater diversity
- **Lower equipment cost per megabit**
Technology scales with high bandwidth

CISCO SYSTEMS



EMPOWERING THE INTERNET GENERATIONSM