Fixed Broadband Wireless: NLOS Systems

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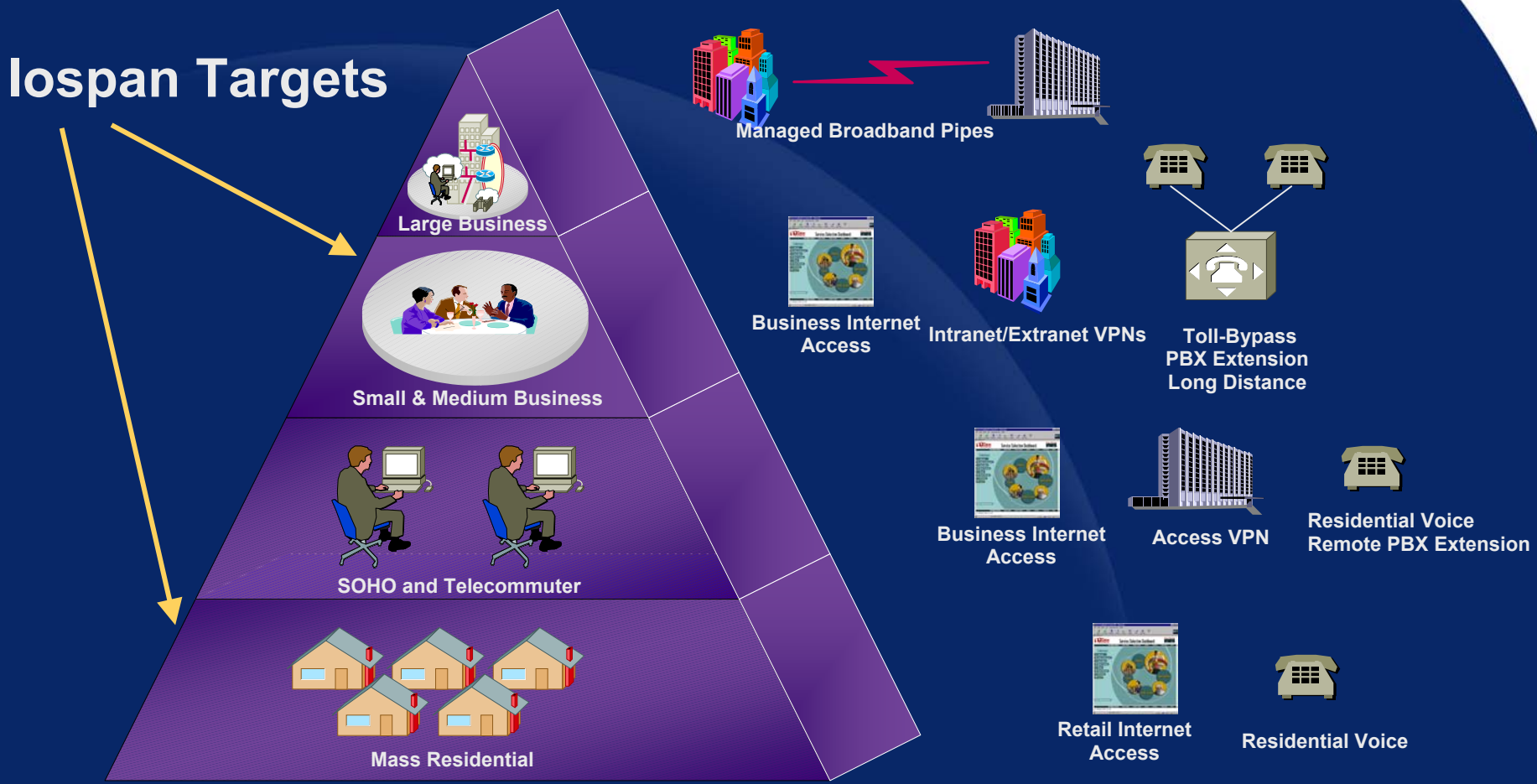
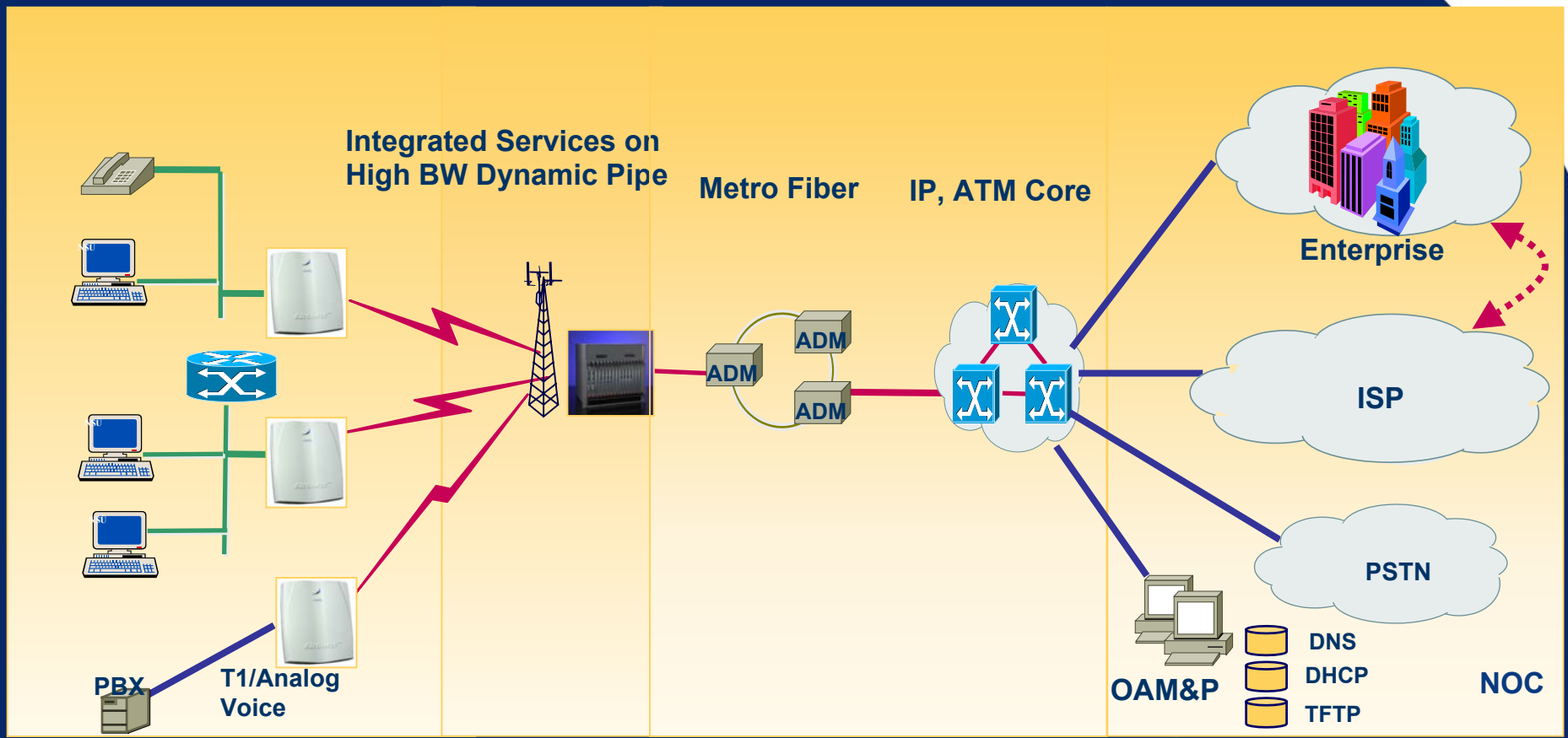
Iospan Wireless

Business Drivers

Fixed BB Wireless Access Market



Network Architecture



Customer Premise Equipment (CPE)

Cell Site
Access Shelf
PA, Antennas
Alarms,..

Service Provider Metro & Core

Network Service Provider (NSP)

NOC Management Servers

(DHCP, DNS, TFTP, …)

Exploring Alternate Access

LMDS

- Pure Line of Sight
- High Fade Margins in Indian Monsoon - Small Ranges
- High cost of equipment

xDSL

- Copper Plant Condition
- Loop Unbundling

Lower Frequency Wireless

SP Requirements

Requirements	
Infocom Market Focus	SMB SOHO HER
Non-LOS Performance (K=0)	✓
Reliability & QoS	✓
Cellular – Outdoor/Indoor CPE (4-6 miles)	✓
Low Cost ($/sub)	✓
High Data Rates (10Mbps+ Peak)	✓
Feature Parity With Legacy Services	✓

Airburst Service Provider Economics

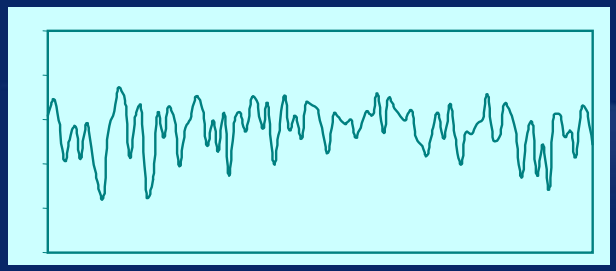
- Multi-Service Platform (Data and Voice) - Broadband User Experience
  - Low Cost Per Subscriber
  - High capacity w/ 75% fewer base stations
  - High coverage(> than 90% subscriber penetration)
  - High Frequency Re-use
  - Indoor/Outdoor CPE Installations
- Wireline Performance (Fading and Interference Mitigation)
  - Peak Data Rates - 14 Mbps Today, 50 Mbps '03
  - High QoS - Service Level Agreement
  - Wireline Availability
- Scalability - Multi-Cell Architecture

Non-LOS Channels

Wireless Impairments

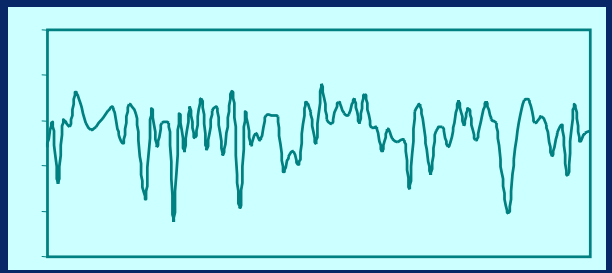
Fading

Space-Selective Fading



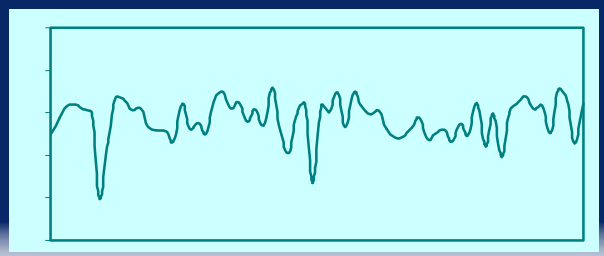
space ⇨

Time-Selective Fading



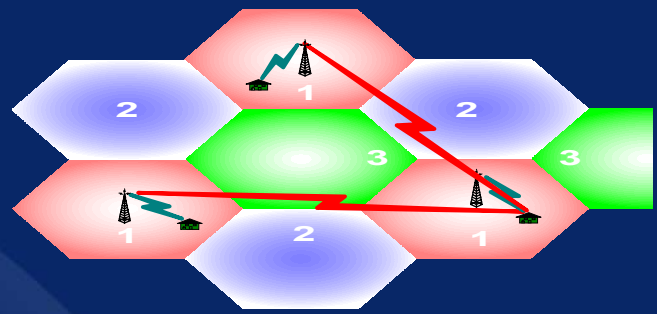
time ⇨

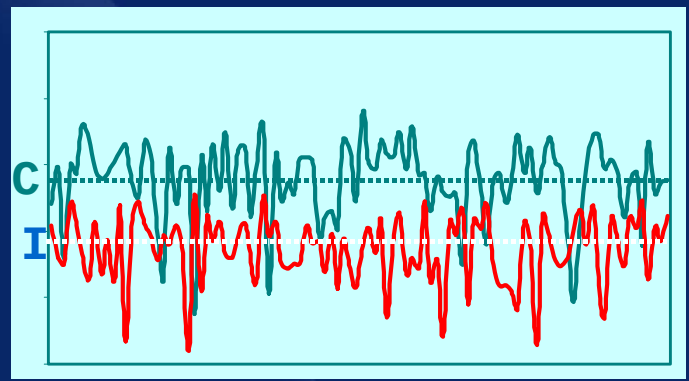
Frequency-Selective Fading



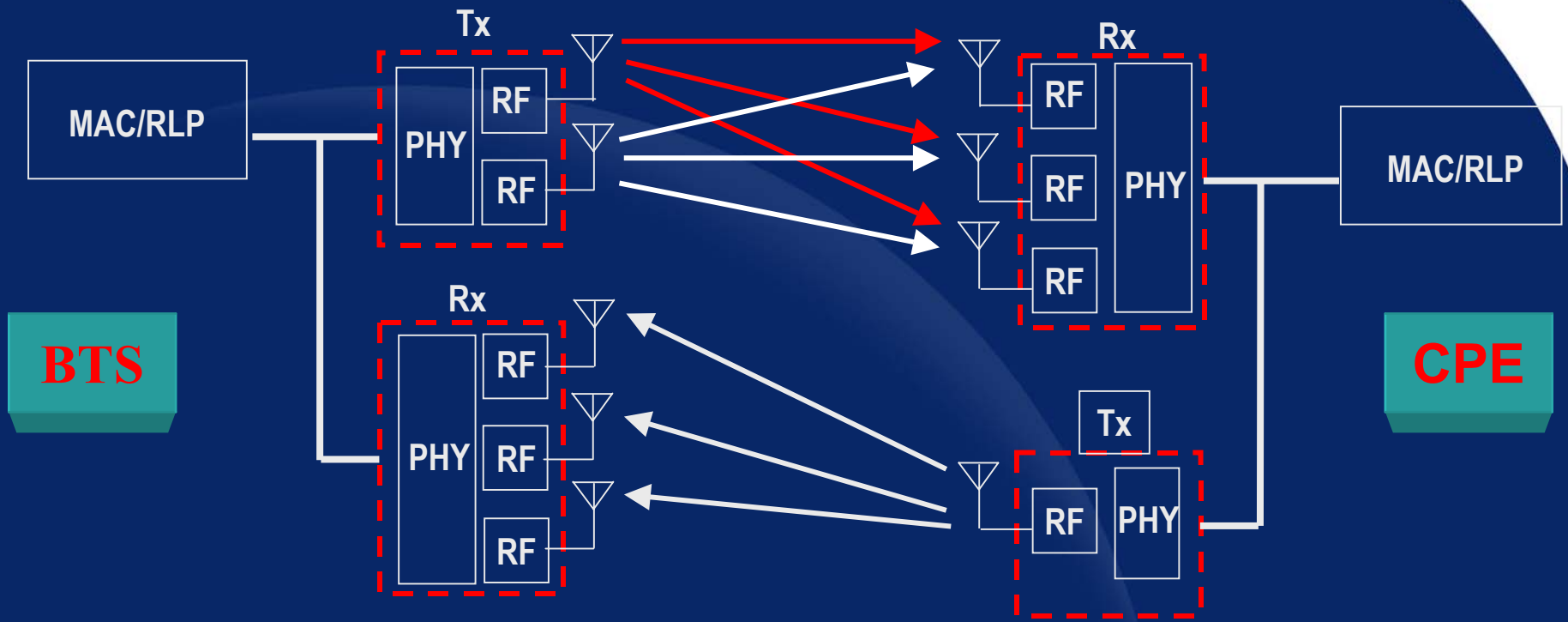
frequency ⇨

Co-Channel Interference

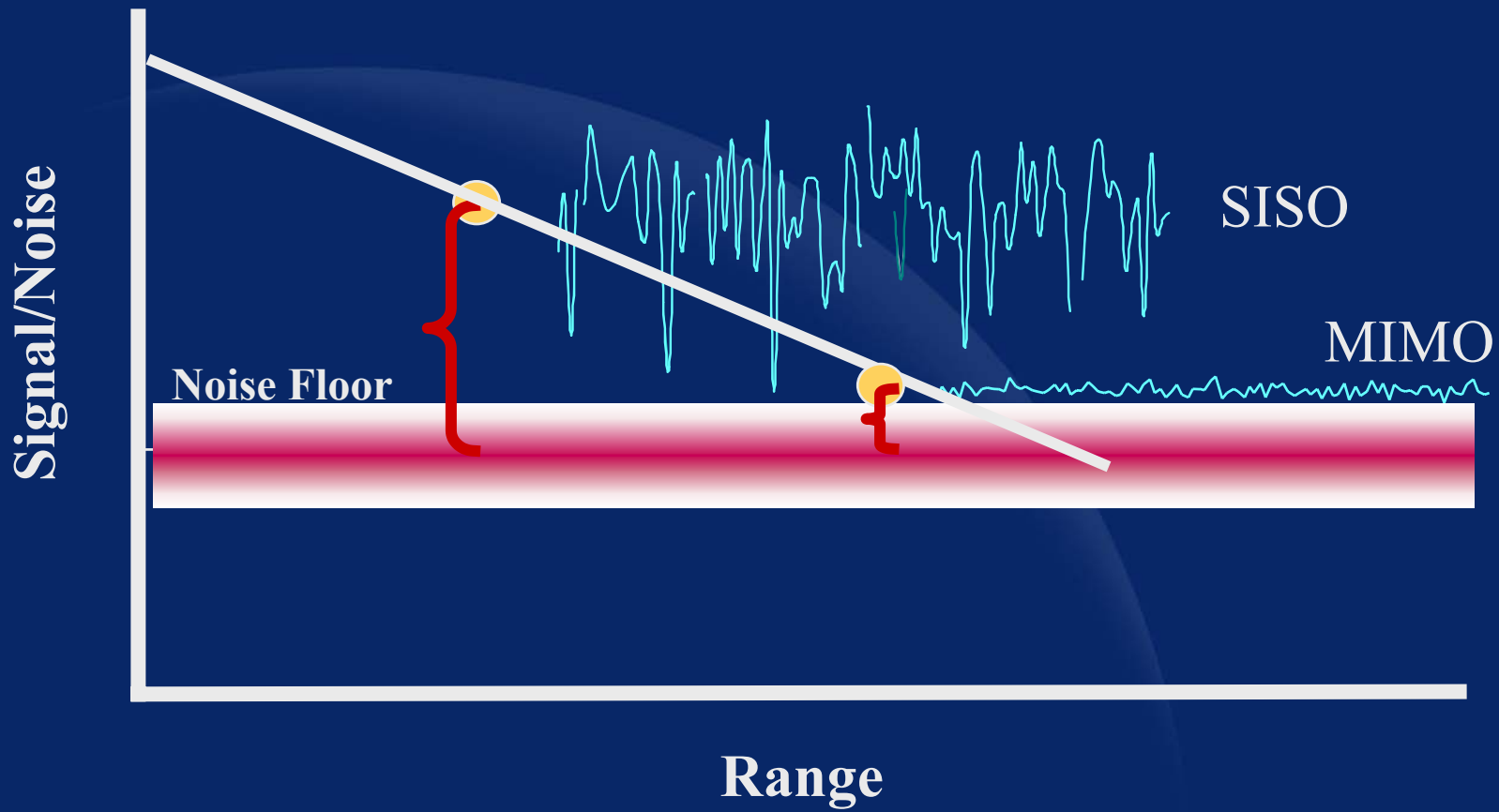




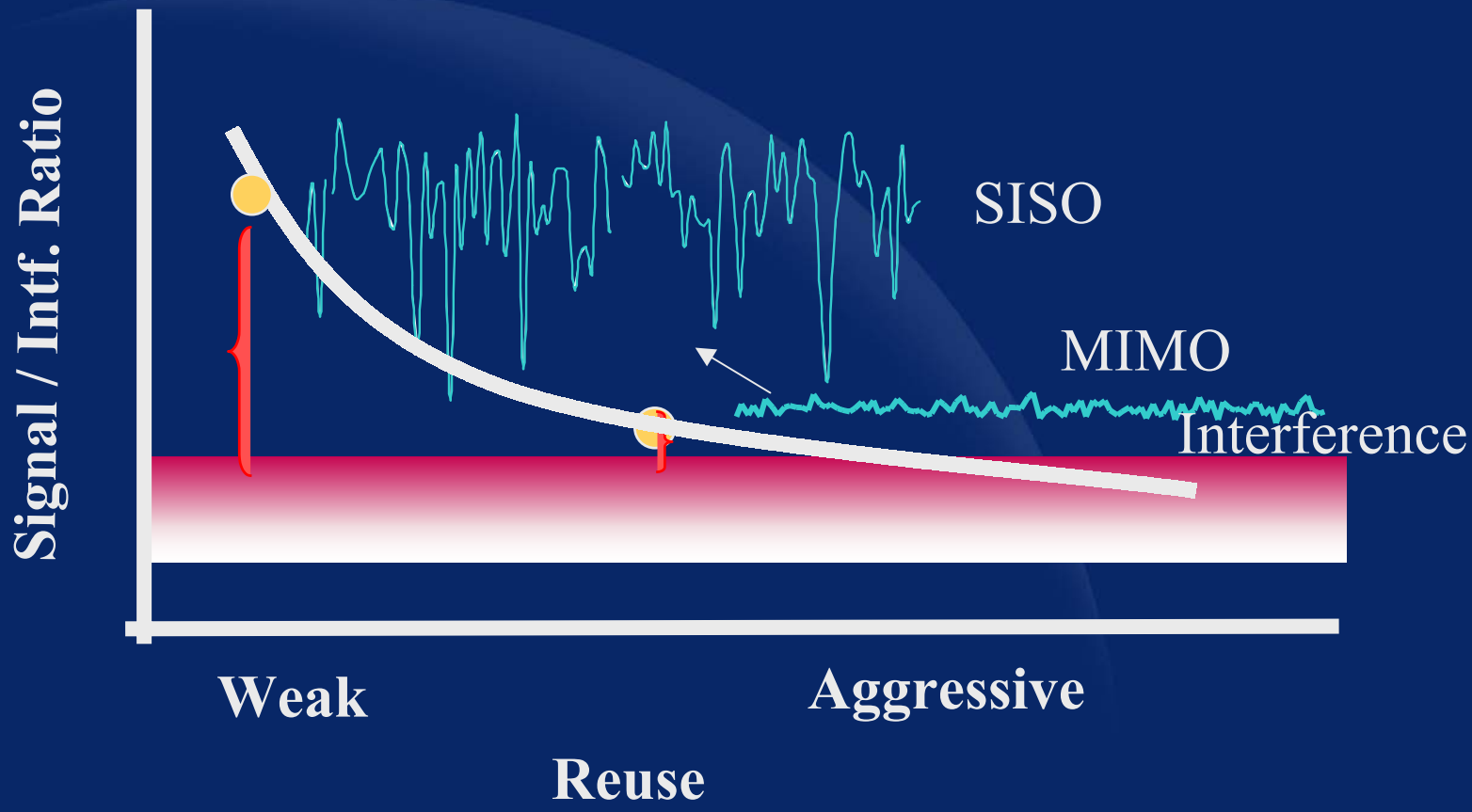
Spatial Processing System



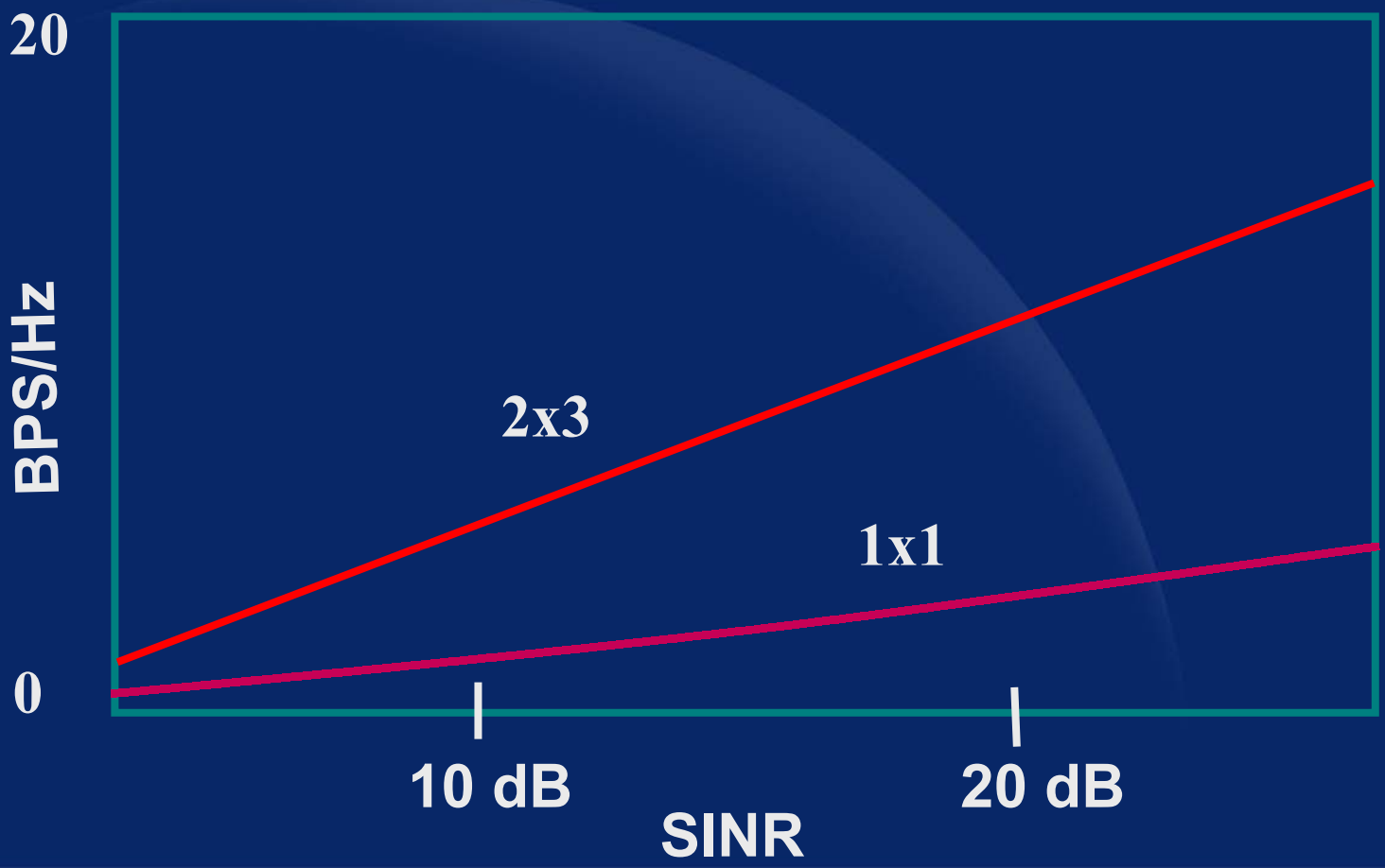
Diversity Enables Better Coverage



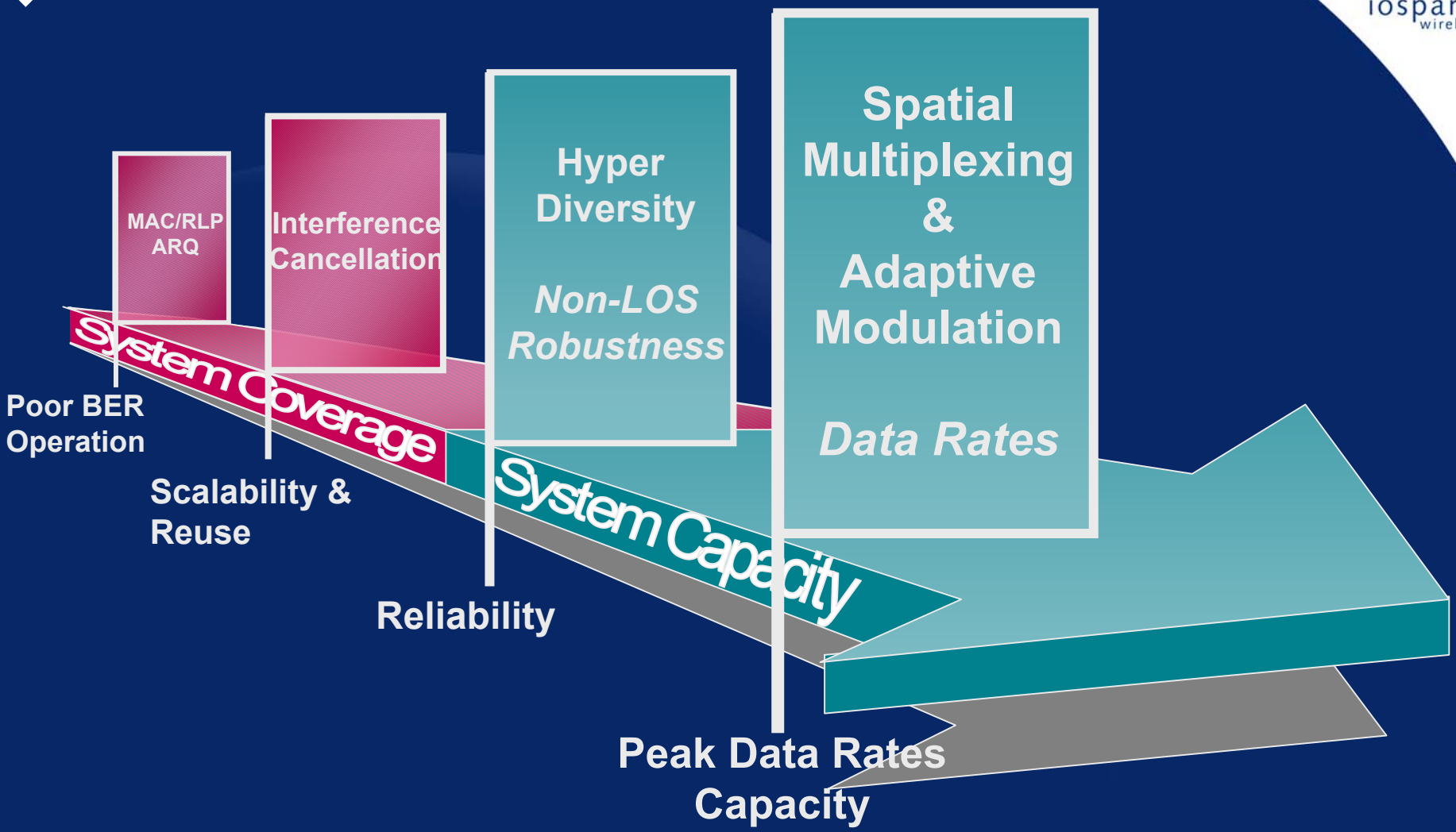
Diversity Enables Better Reuse



Spatial Multiplexing Increases Speed



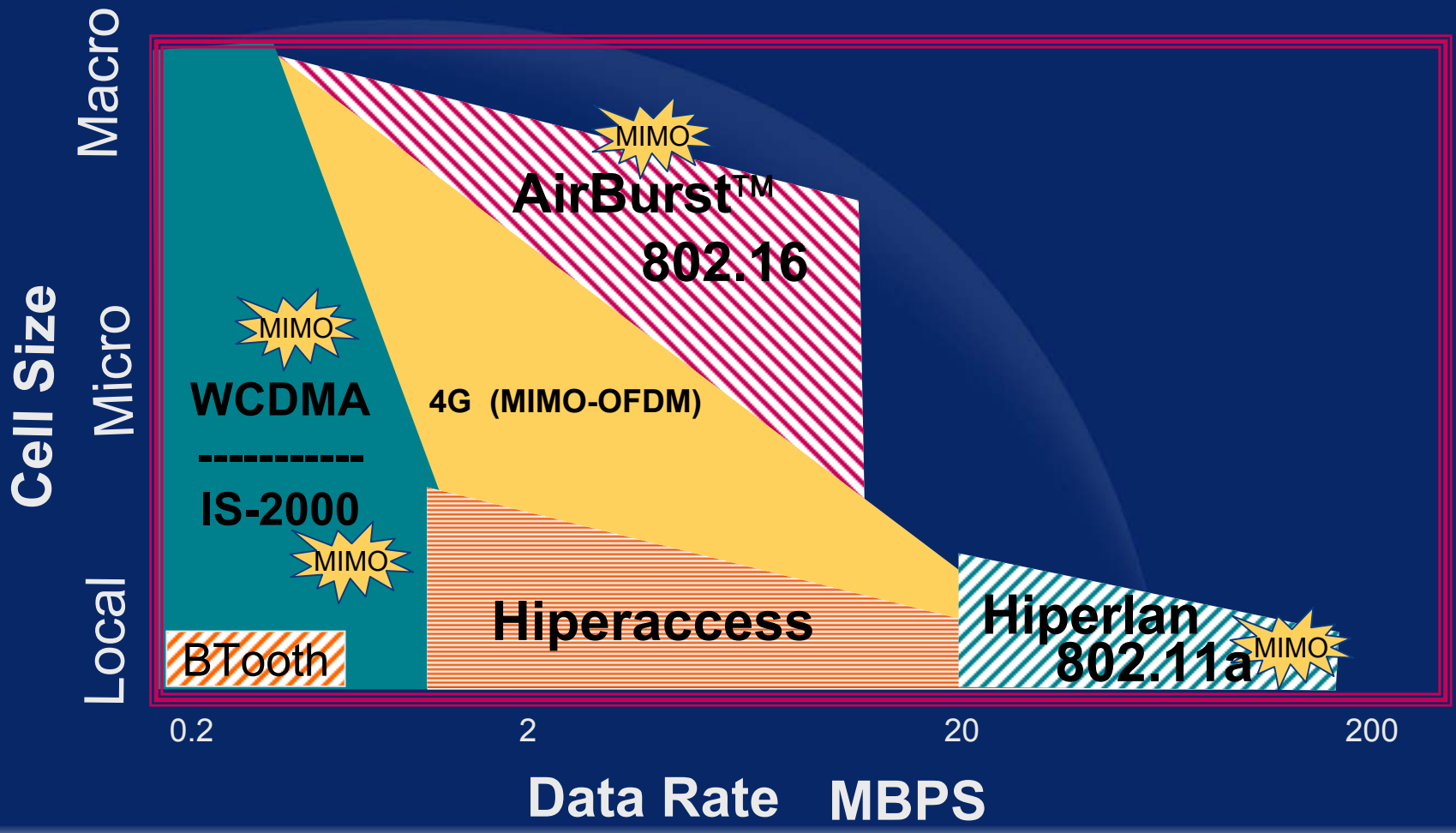
Building Blocks



IEEE Channel Models

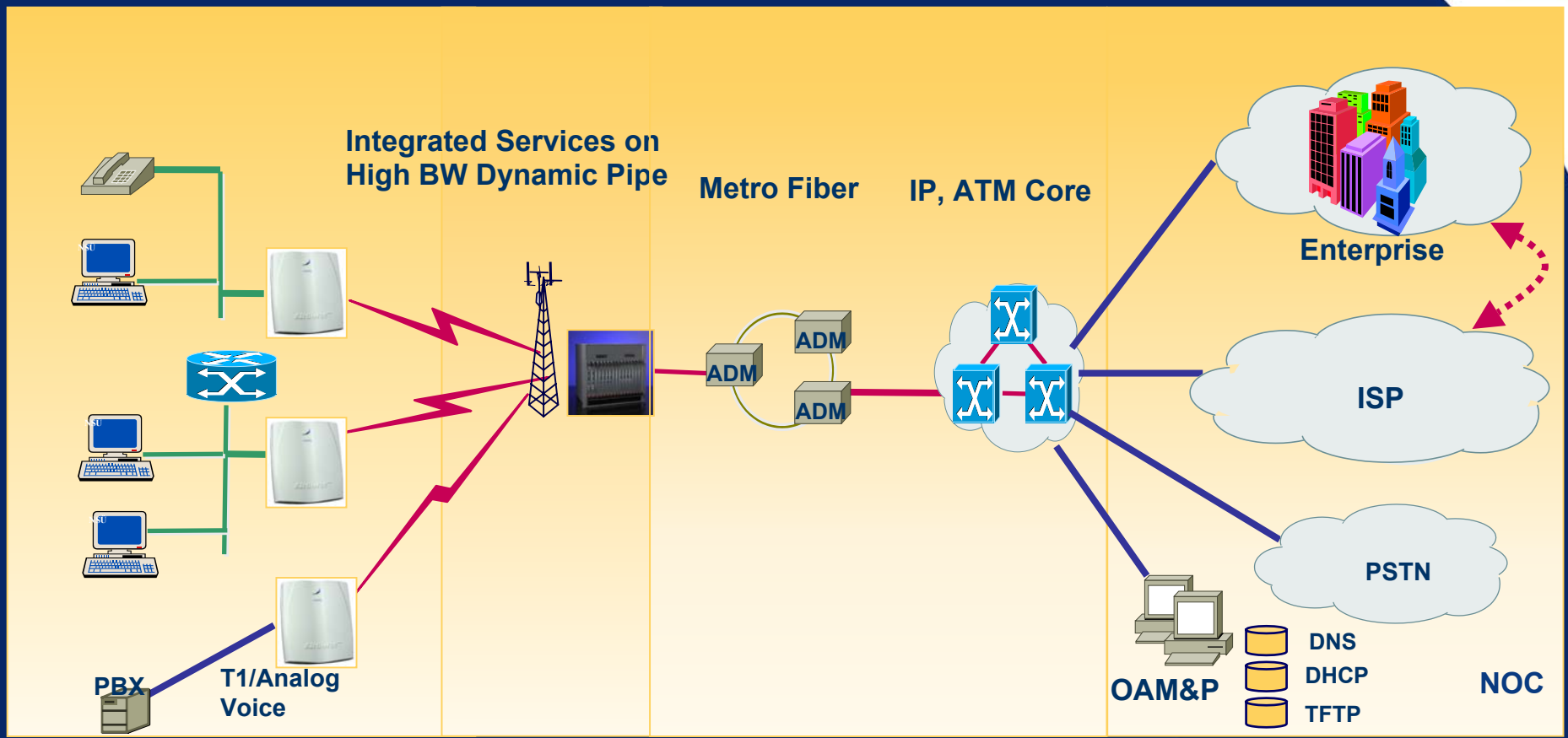
- **Extensive in-house channel measurements - Models characterize:**
  - Rician K-factor vs. range, NAU height, antenna beamwidth
  - Channel selectivity in frequency, time (Doppler, Delay Spread)
  - Antenna Correlation and XPD models
  - Antenna Gain Reduction Factor
  - Path Loss Models

MIMO - Entering All Standards



System Solution

AirBurst™ Network Architecture



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(DHCP, DNS, TFTP, …)

Cellular Network Deployment

Demand Dependent Cell Radius

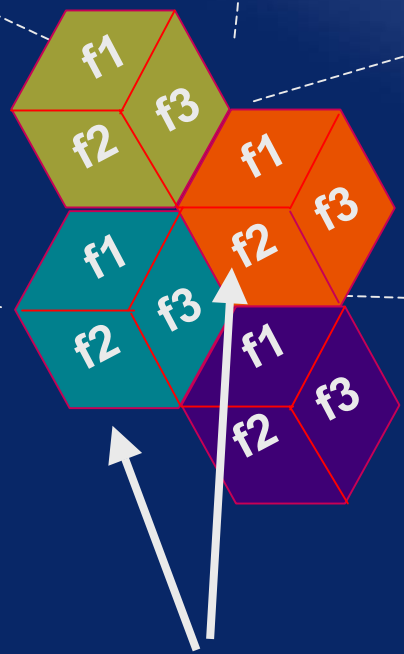
3 sectors per cell

2Tx, 3 Rx Antennas

2 MHz, 1.75 MHz Channel settings per sector (Up or Down)

48 MHz FDD Separation

Adaptive Modulation per Subscriber



Frequency re-use of 1x3

Interference Cancellation

ABS10000

14 slots, 14 Mbps/slot Peak Throughput

Each line card serves a Up or Down Channel

Flexible Configuration

Airburst PHY and MAC Features

PHY

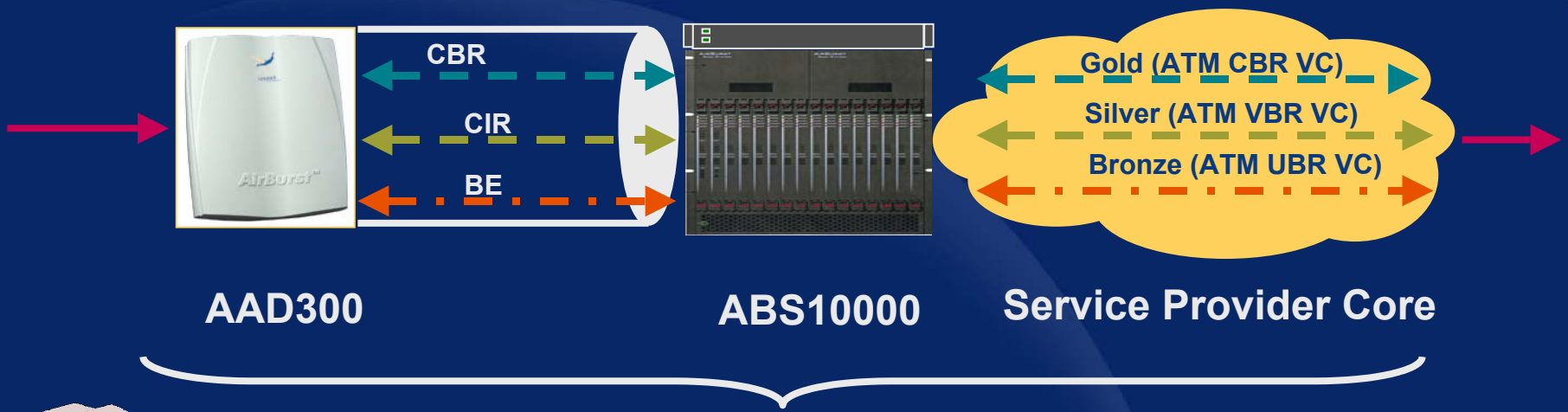
- OFDM Modulation - Robust for Broadband MIMO
  - Diversity Mode - Eliminates Fading
  - Spatial Multiplexing - Increases Spectral Efficiency
  - 12 Adaptive Modem Modes - 6 Diversity, 6 SM
- 10x better spectral efficiency than 3G systems

MAC

- ATM-like Fragmentation / Re-assembly
- Advanced ARQ
- Down Link scheduling - GoS, QoS Support
- Up link scheduling - Request/Grant
- CBR, CIR Support - Voice, Leased Lines

End to End QoS

Packet Classification	AirBurst QoS	Mapping Function	Transport QoS



Class of Service (CoS)

Subscriber Based Service Profiles
RES, SOHO, SME

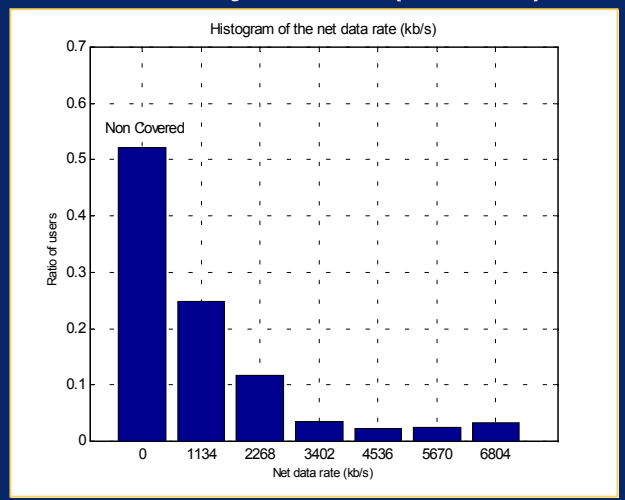
CBR Constant Bit Rate (Gold)
CIR Committed Information Rate (Silver)
BE Best Effort (Bronze)

Diversity: Throughput & Coverage

Throughput & coverage for Uplink under-the-eaves *self-installed CPE*

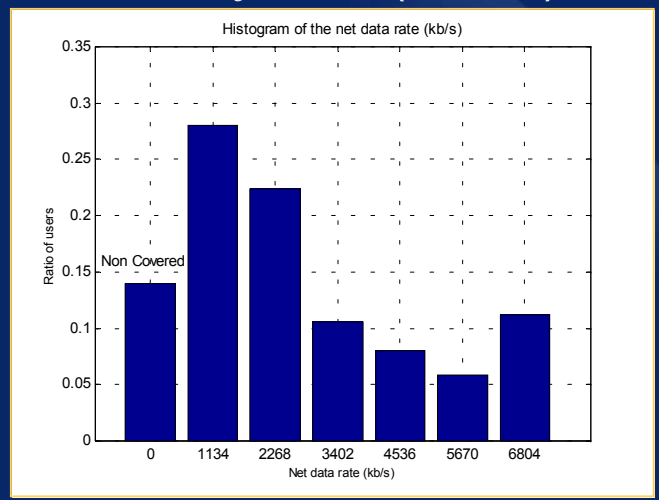
Example: cell radius = 6km

1x1 System (SISO)



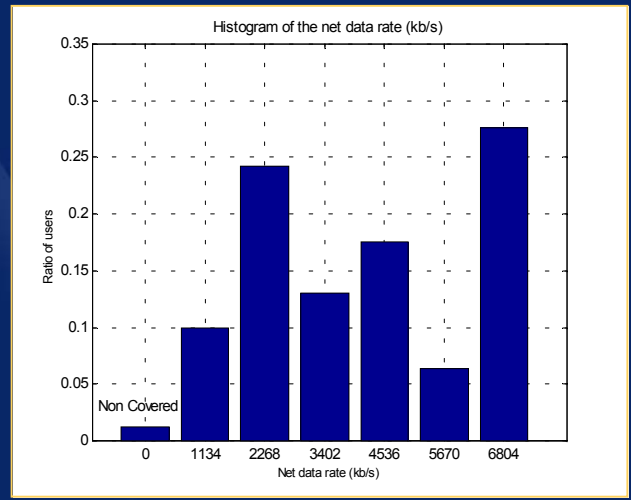
G1

1x2 System (SIMO)



G1.5

2x3 System (MIMO)



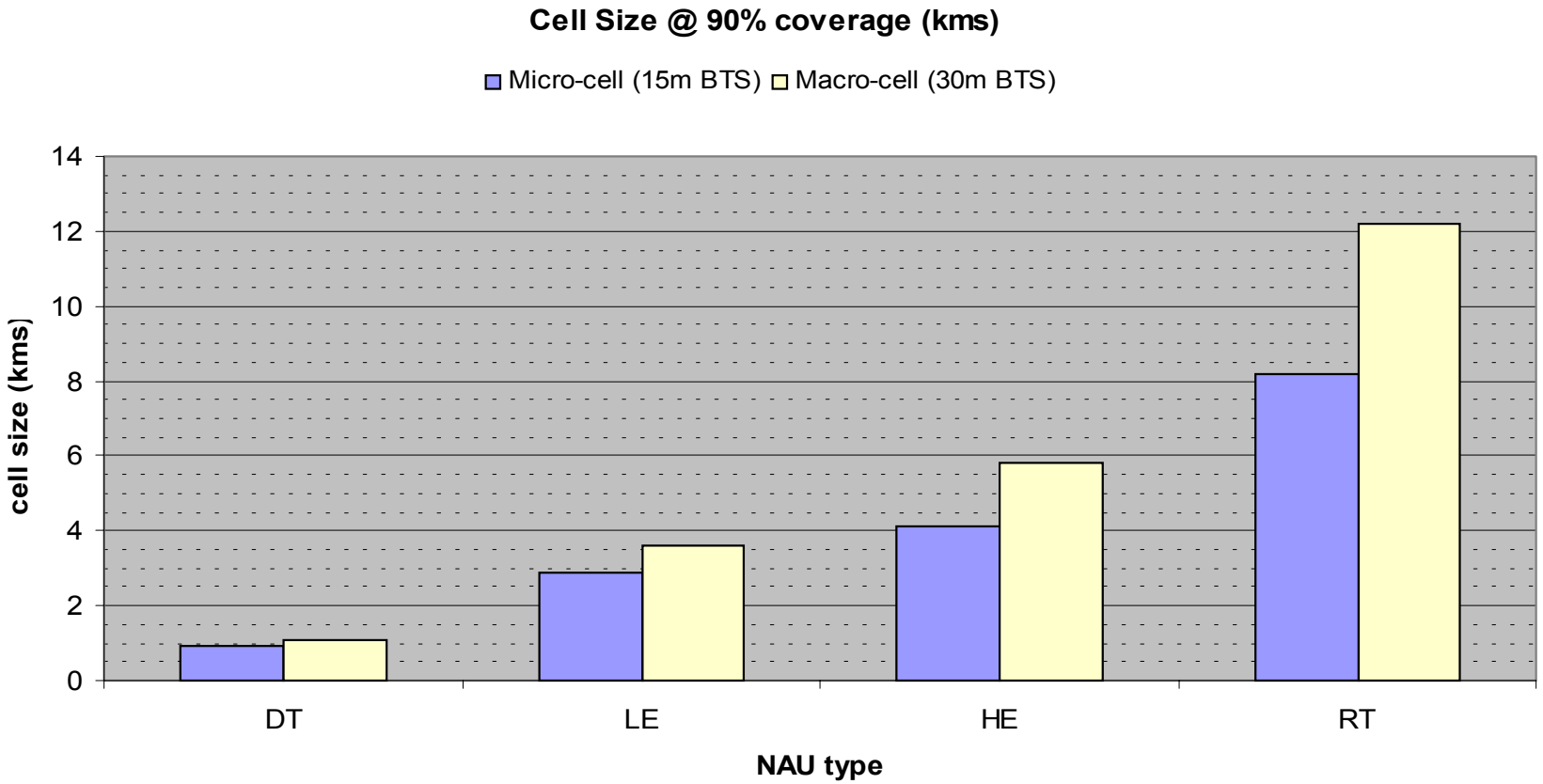
Mass Deployment

Airburst Performance Outline

- Fixed Wireless Access Channel Characterization
- PHY Level Performance
  - Modem Set Points: Operating signal-to-noise-plus-interference ratio to meet PER and availability targets
- Link Level Performance
  - Link Adaptation Performance
- System Level performance
  - Coverage (Cell radius @ 90% area reliability)
  - Capacity (Mbps/Cell/Hz)
  - Frequency Reuse

System Coverage

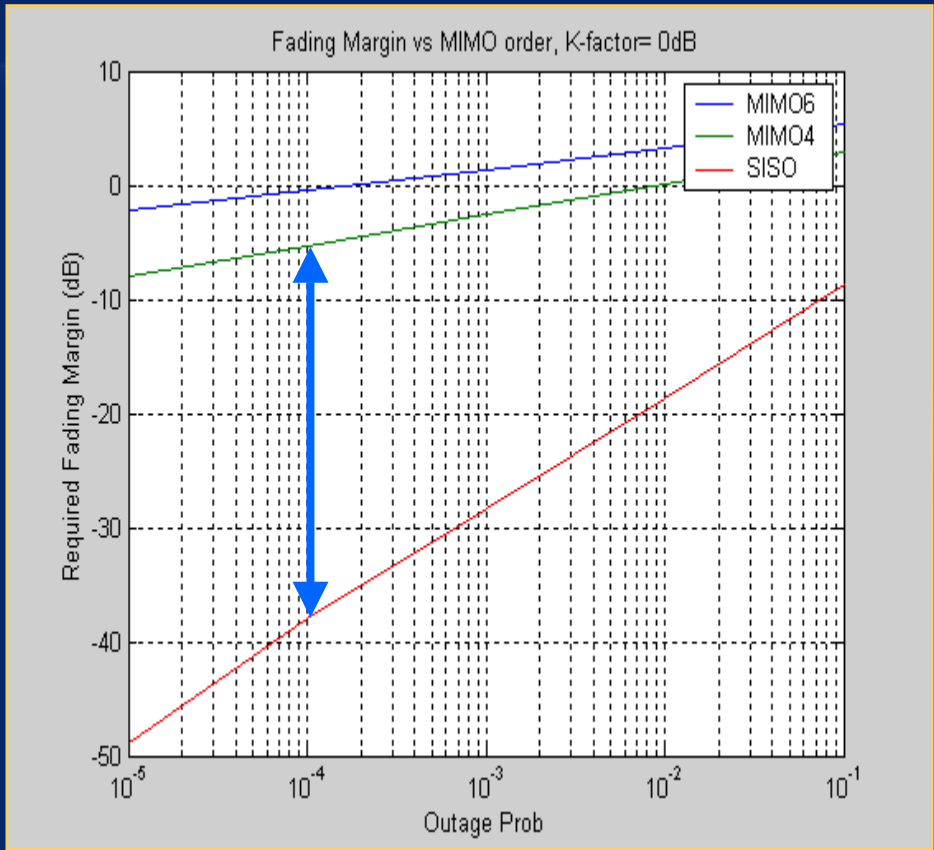
Random K factor and Delay Spread According to Models



NAU installation	Desktop (DT)	Low eaves (LE)	High eaves (HE)	Rooftop (RT)
Antenna & pointing	Omni-antenna random pointing	90deg antenna Best wall pointing.	90deg antenna, Best wall pointing.	90deg. Pointing toward BTS
Height	1.5 meters	2.5 meters	4 meters	7.5 meters

S-T Processing- Coverage & Reliability

Cell Planning, Deployment, & Provisioning



99.99% reliability

- **30 dB gain**
- **⇒ 4 times distance reach (16 times coverage)**

Link Budget Gains

Coverage

- 30 dB results in about 4x radius (~16x in coverage area, or subs)

Data Link Rate

- 30 dB results in 4-8x data rate increase
- Spatial Multiplexing adds another factor of 20 - 100% on top of this

Reuse

- 30 dB results in reuse improvement of ~4
- We are targeting 1x3; competition is 4x3 or worse

Capacity

- Increases 16 or greater based on link rate and reuse

Cost

- 30 dB will result in PAs, heat sink, power supply, boards, etc. which are considerably cheaper at both ends

Link Budget Gains (2)

- **Interference Mitigation and Cancellation**
  - Results in better frequency reuse, better signal quality (higher SNR) and higher user data rate and capacity
- **Dynamic Link Adaptation**
  - Results in lower SINR margin to guarantee data rates, availability, and QoS
  - Consequently results in better frequency reuse and easier cell planning
- **Spatial Multiplexing**
  - Results in doubling the data rate
- **Wider CPE Beam-width**
  - Results in easier installation (makes self install possible)
  - Enables easier cell-splitting to scale as capacity demands grow

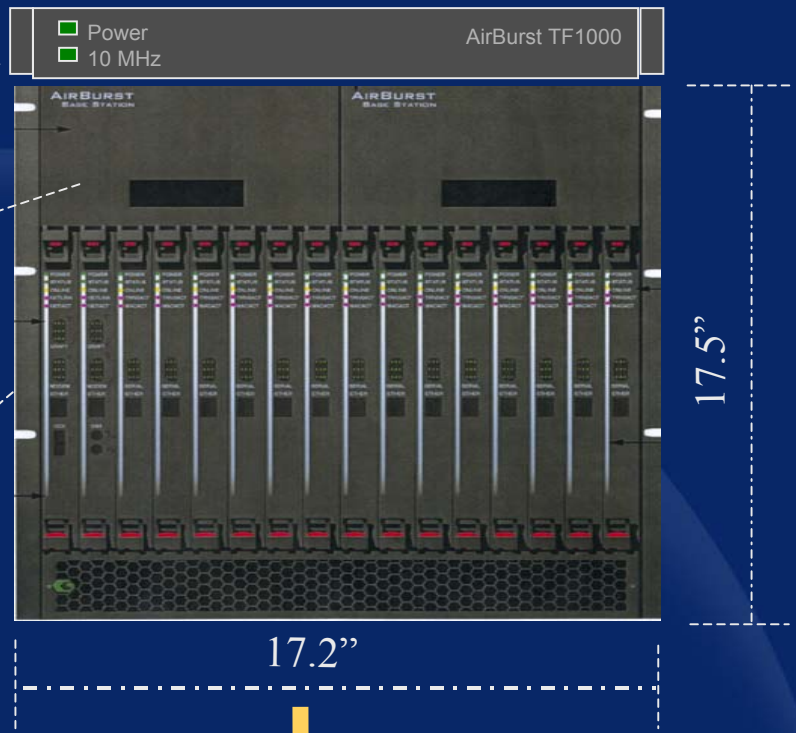
Products & Trial

AirBurst™ Base Station - ABS10000

TF1000
RF Combine &
Timing

Redundant
Cooling

ABS10000
Channel Assembly



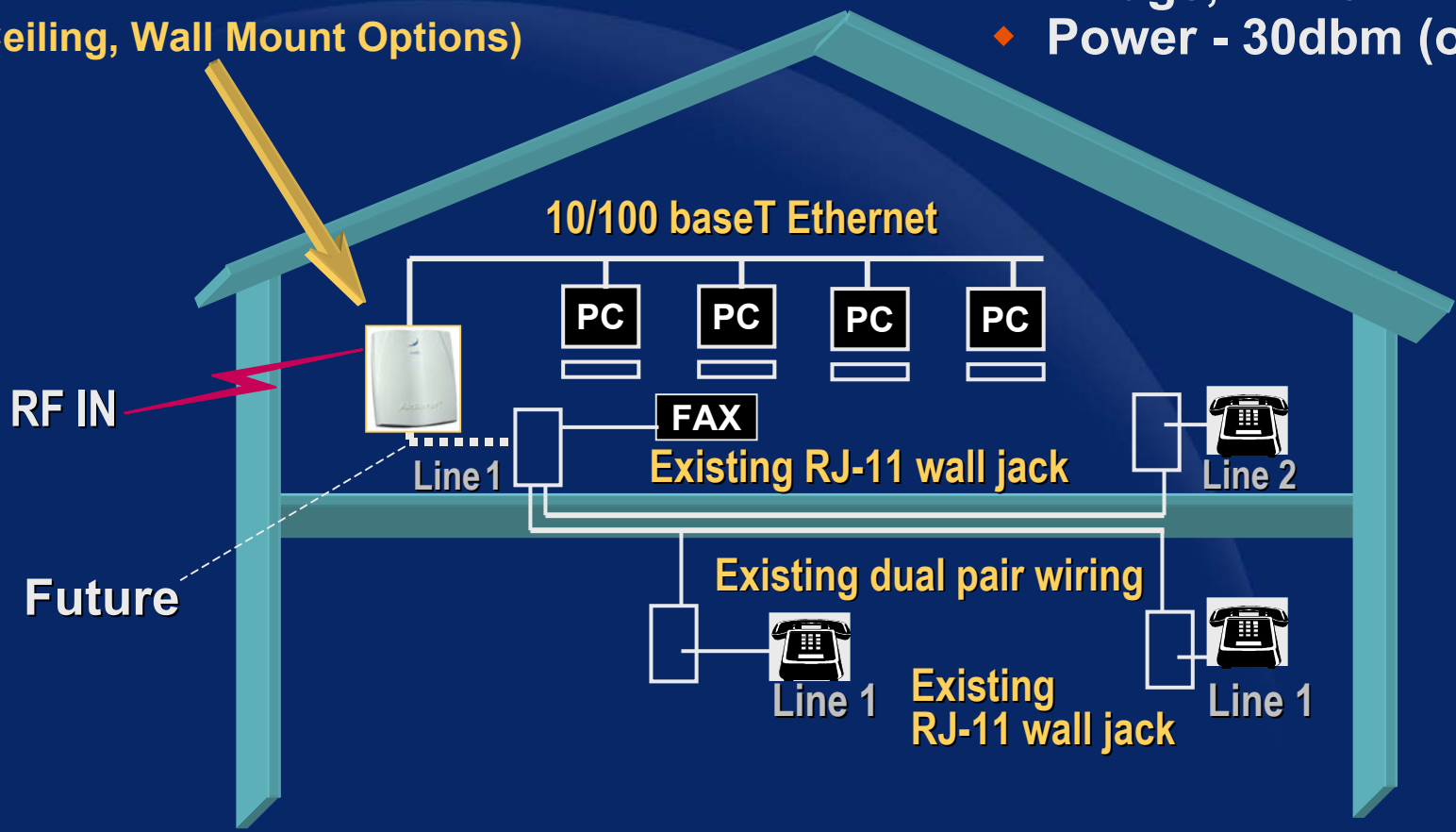
ABS10000 Chassis

- **All Carrier Class Features - Future**
- **Multiple Sector Modular Design**
- **OC-3, DS3/E3 WAN Interface**
- **Remote Diagnostics**

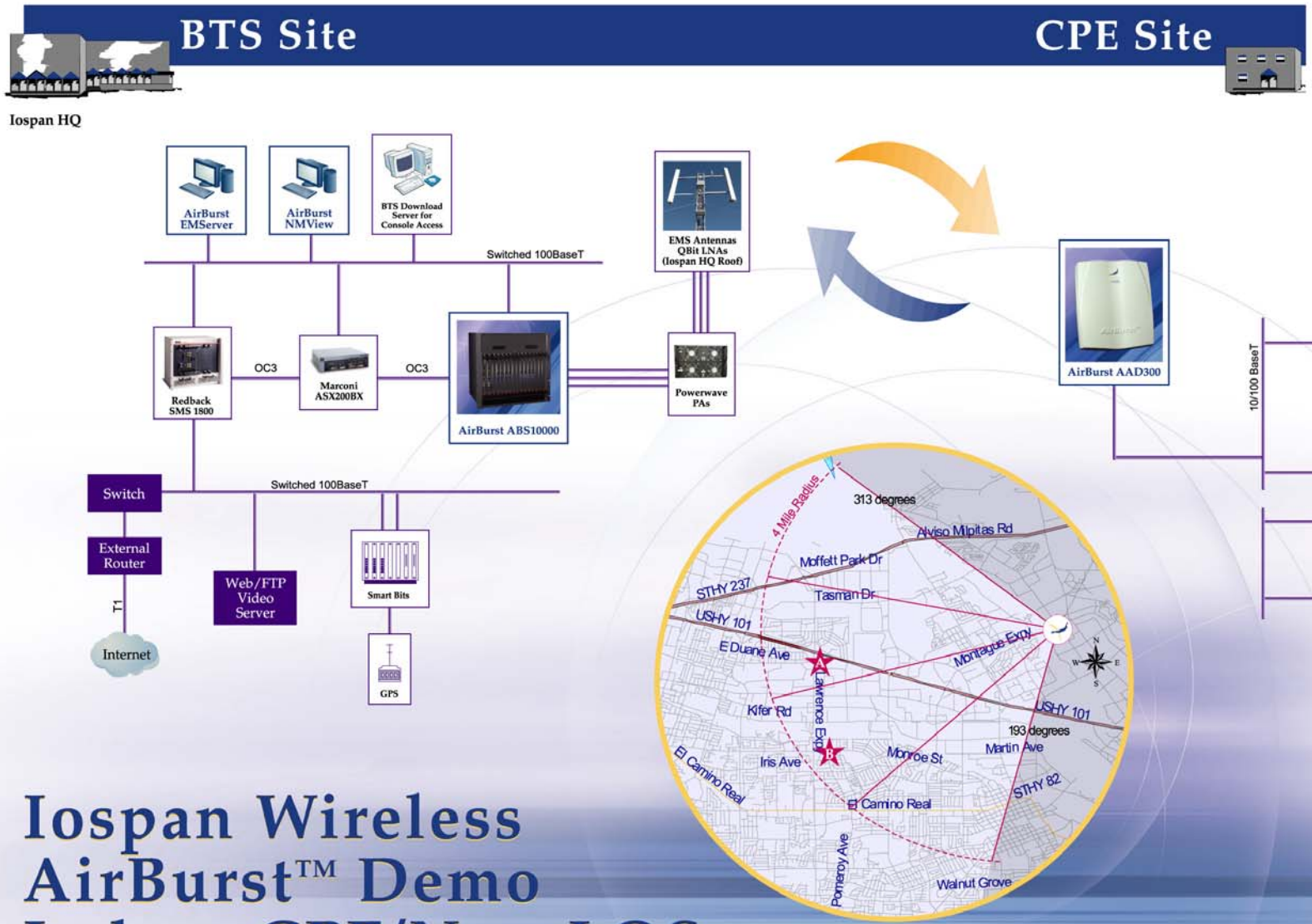
AirBurst™ Access Device - AAD300

Indoor Table Top or Outdoor Under Eaves
(Ceiling, Wall Mount Options)

- 1 Ethernet
- 1 Tx, 3Rx Antennas
- Bridge, PPPoE Mode
- Power - 30dbm (outdoor)



Trial In-Progress



Iospan Wireless AirBurst™ Demo Indoor CPE/Non-LOS