



Fixed Broadband Wireless: NLOS Systems

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Business Drivers

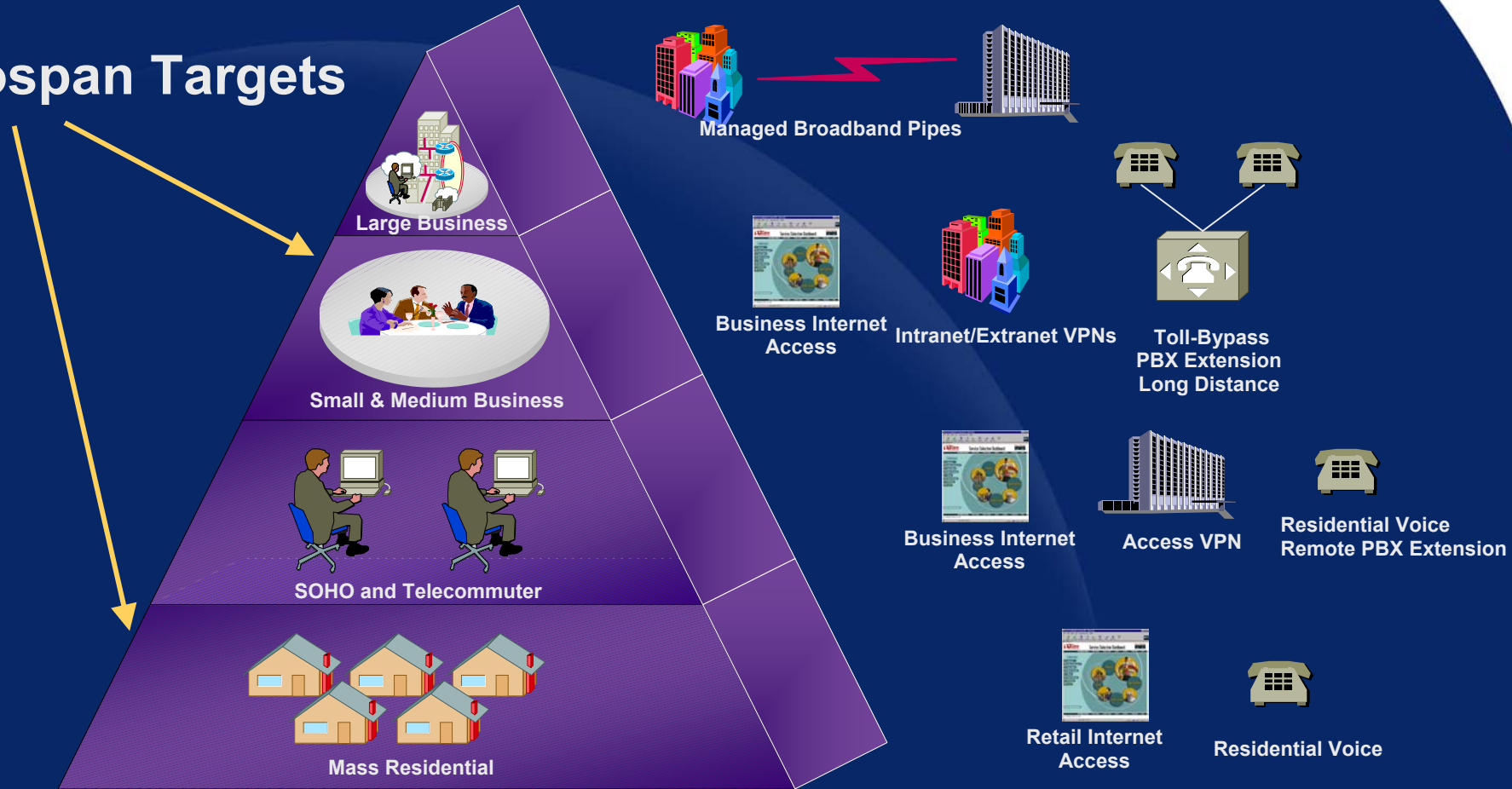


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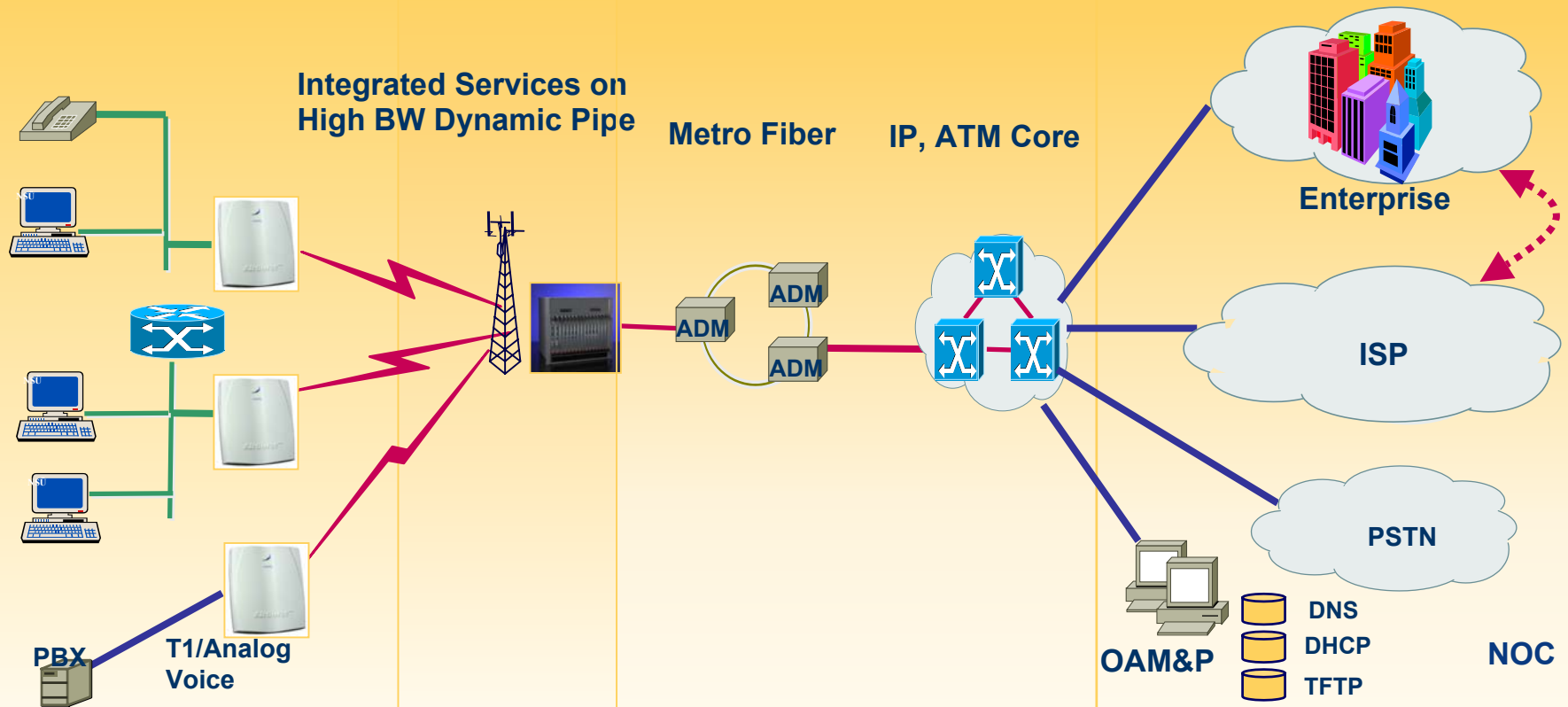
Fixed BB Wireless Access Market



Iospan Targets



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

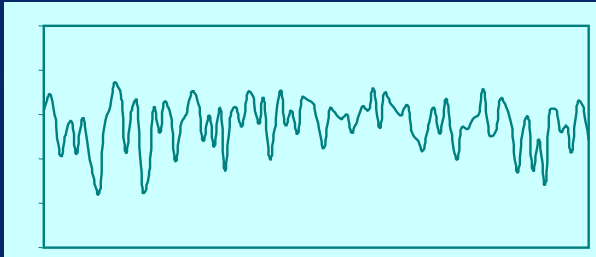


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Wireless Impairments

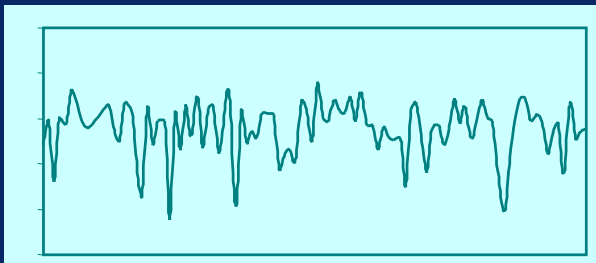
Fading

Space-Selective Fading



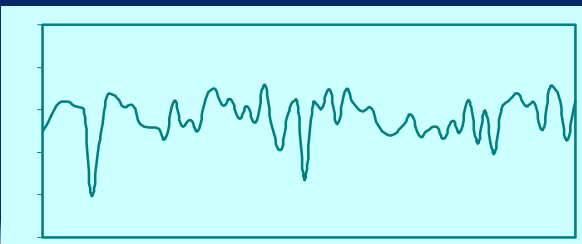
space \Rightarrow

Time-Selective Fading



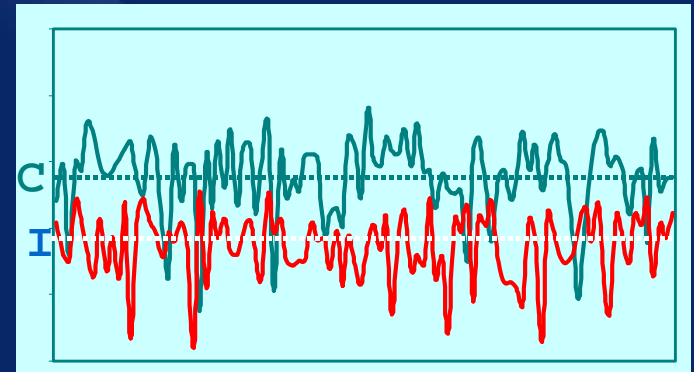
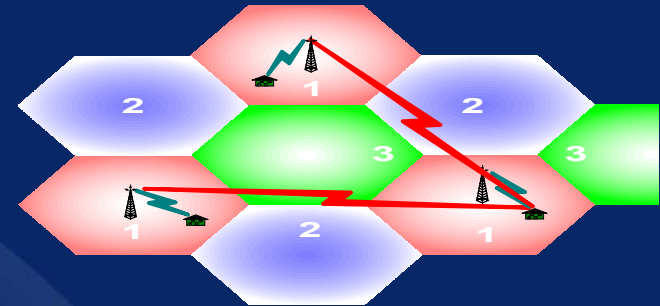
time \Rightarrow

Frequency-Selective Fading

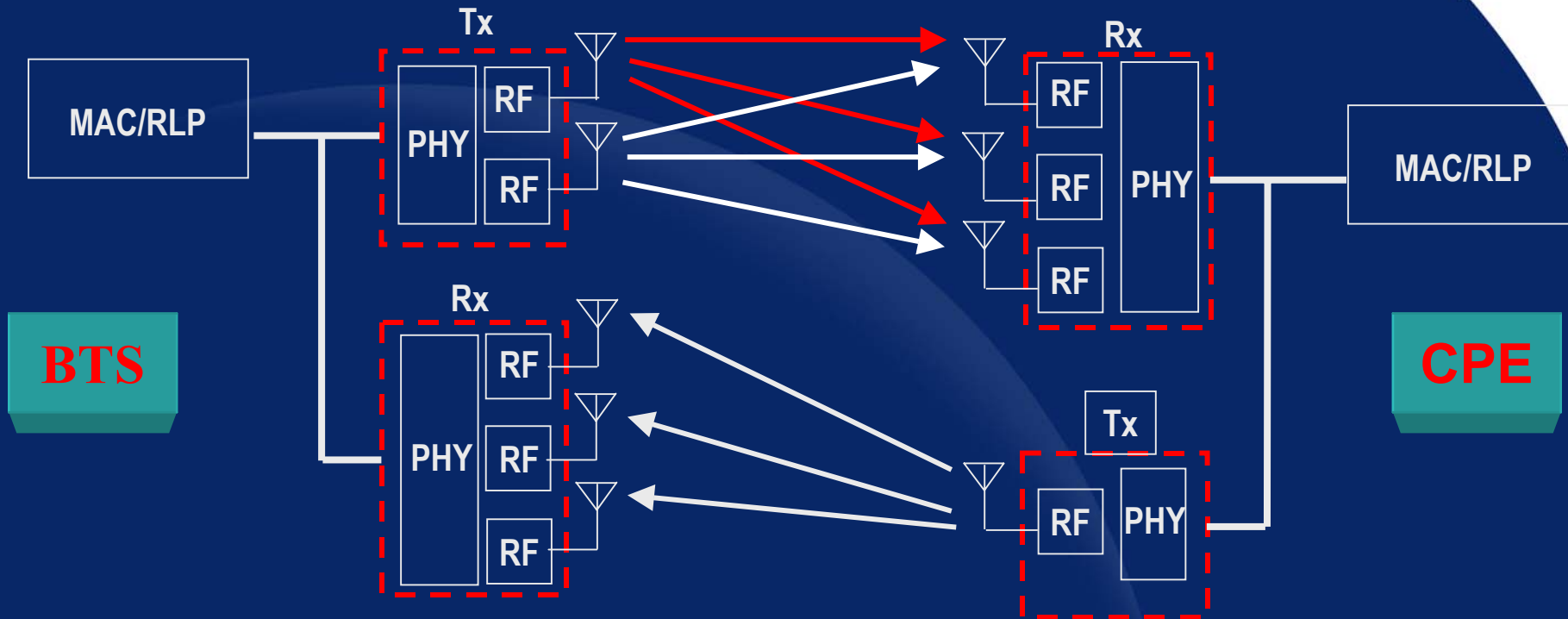


frequency \Rightarrow

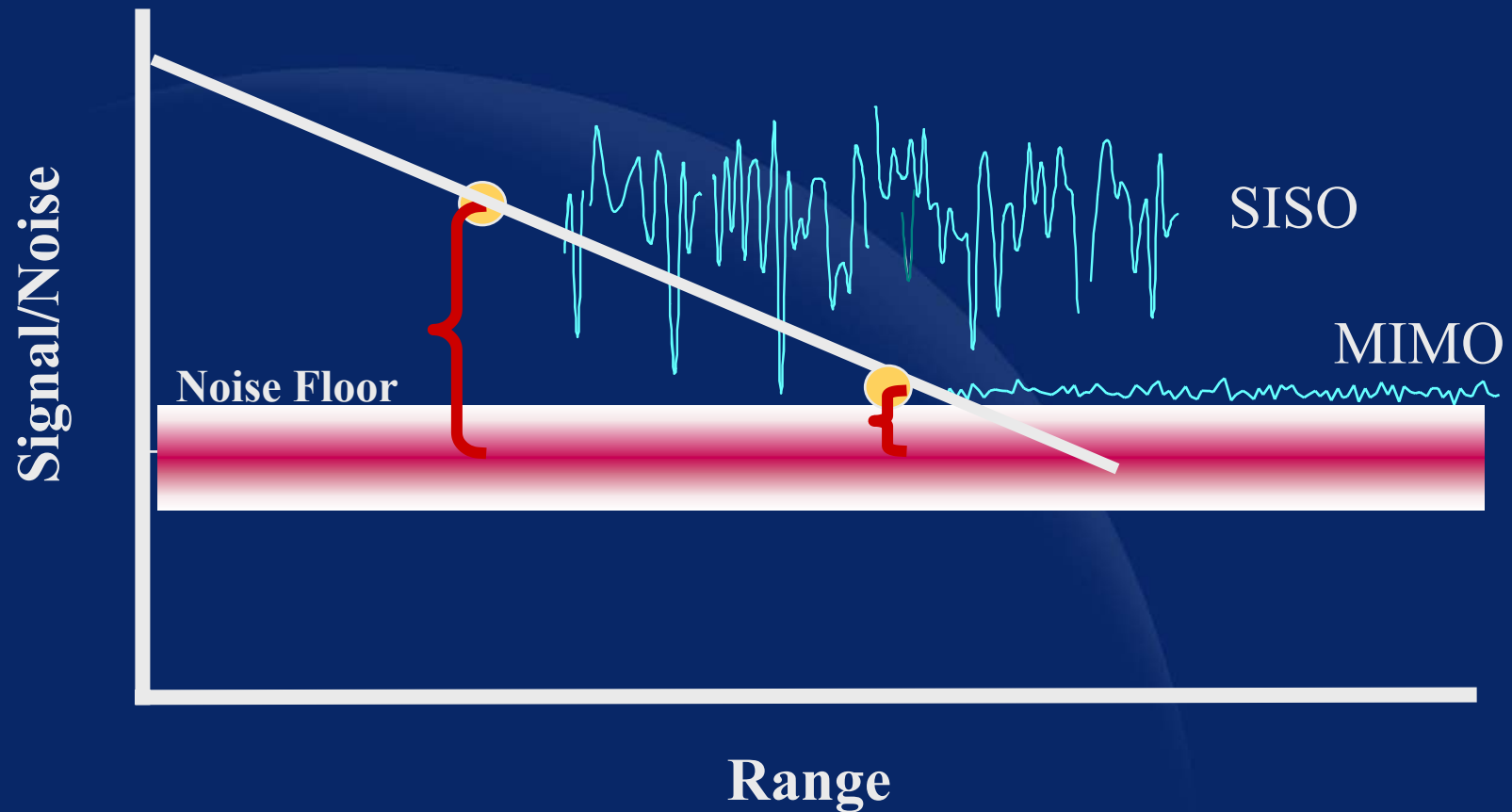
Co-Channel Interference



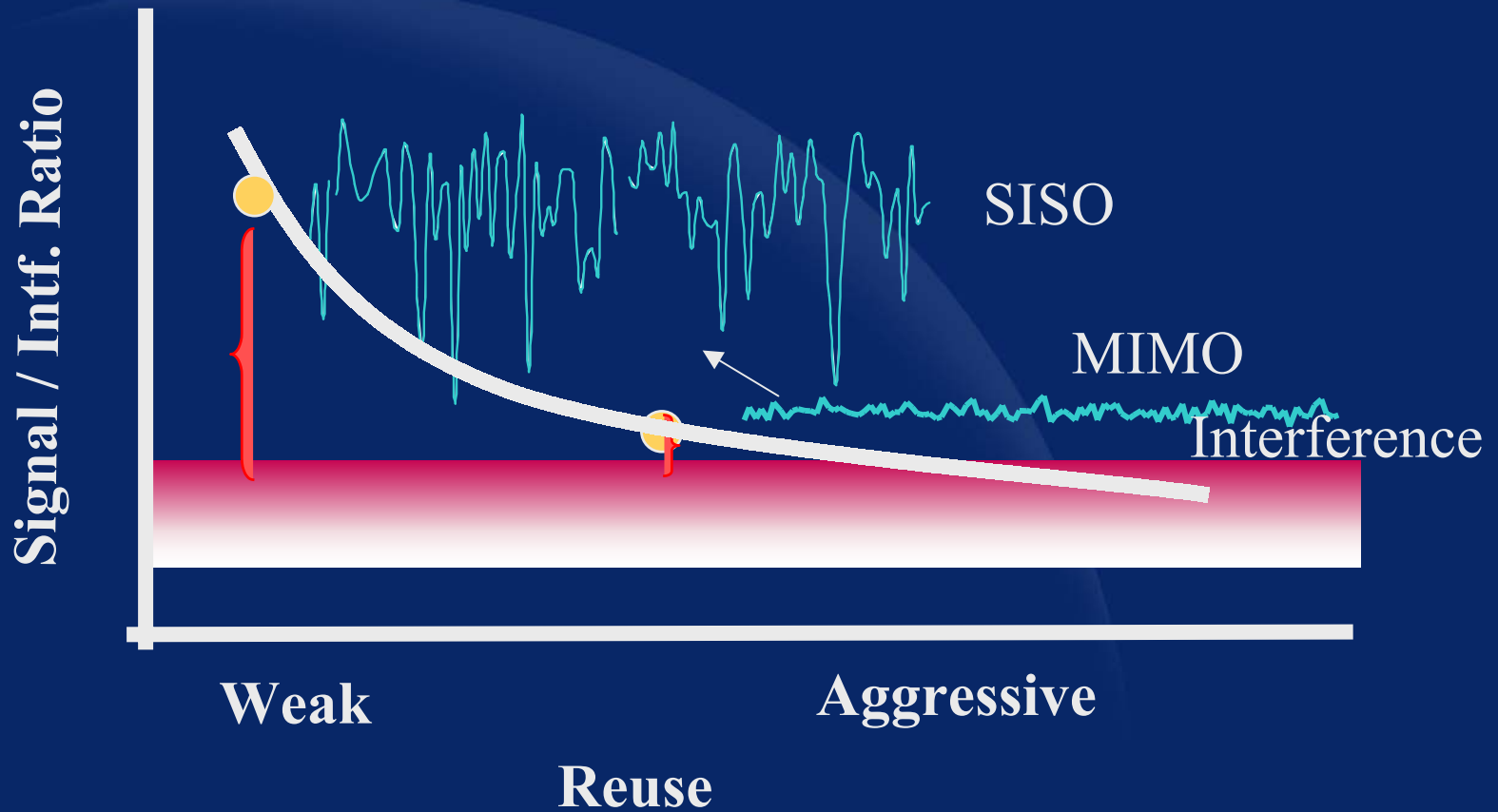
Spatial Processing System



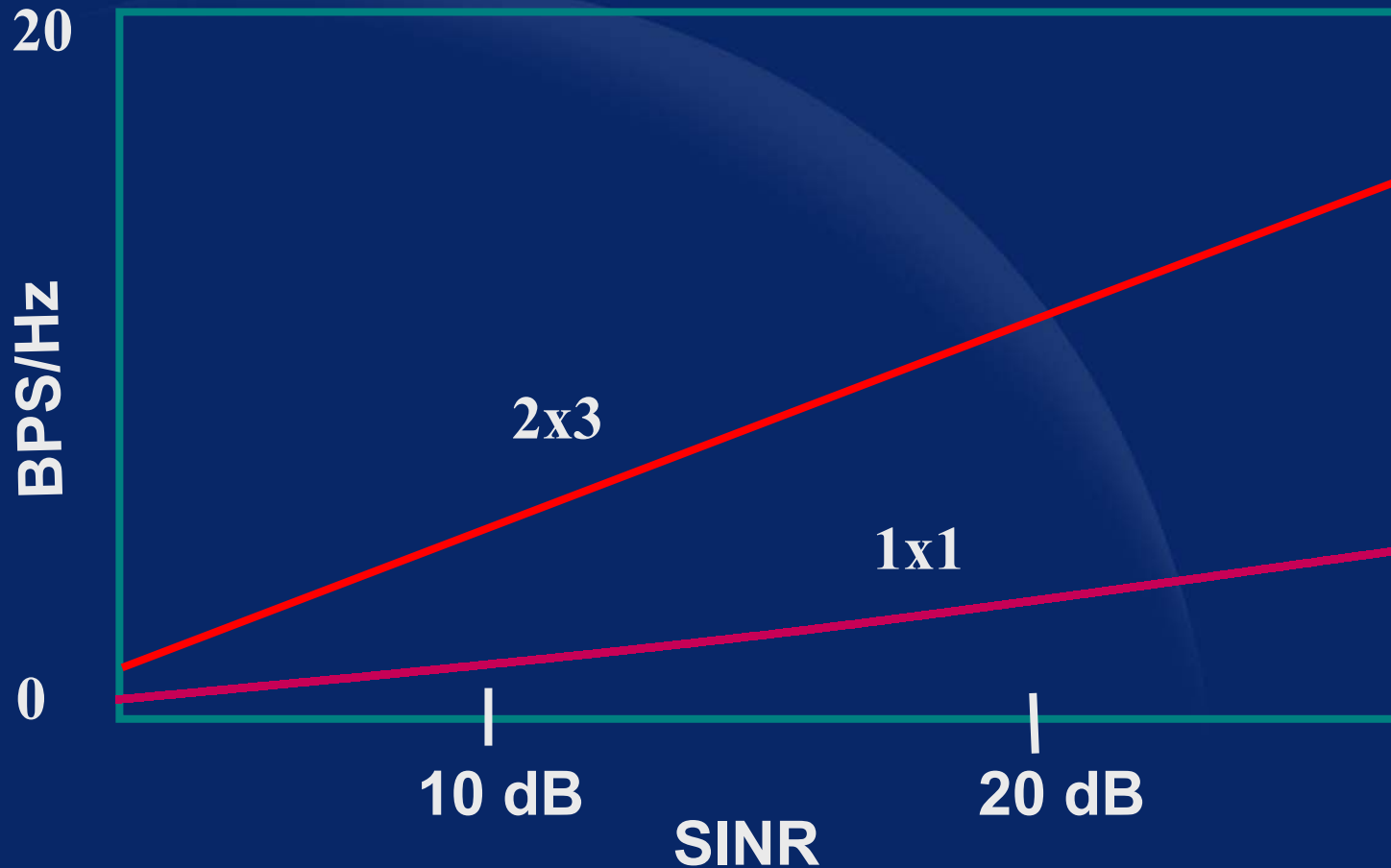
Diversity Enables Better Coverage



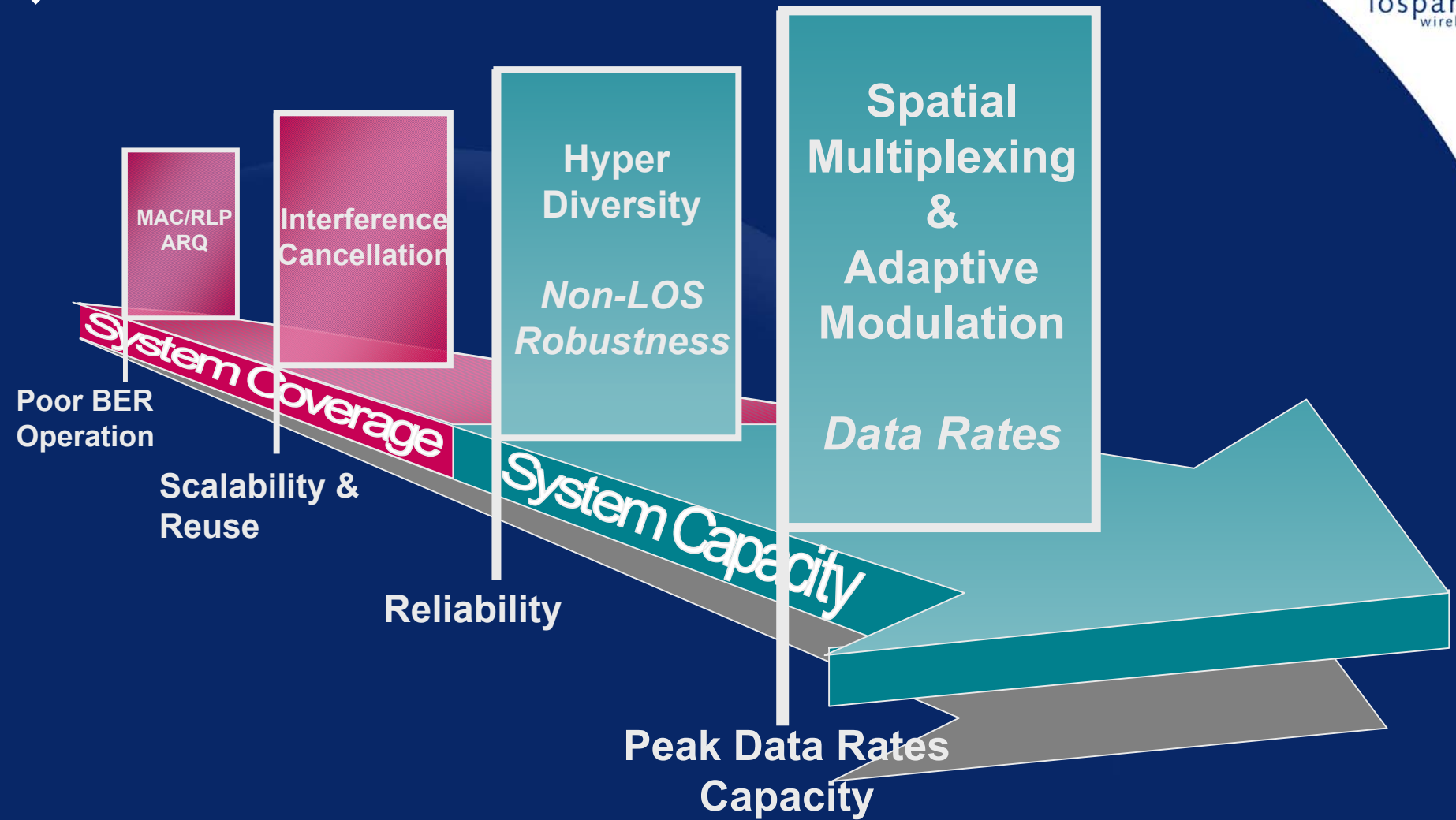
Diversity Enables Better Reuse



Spatial Multiplexing Increases Speed



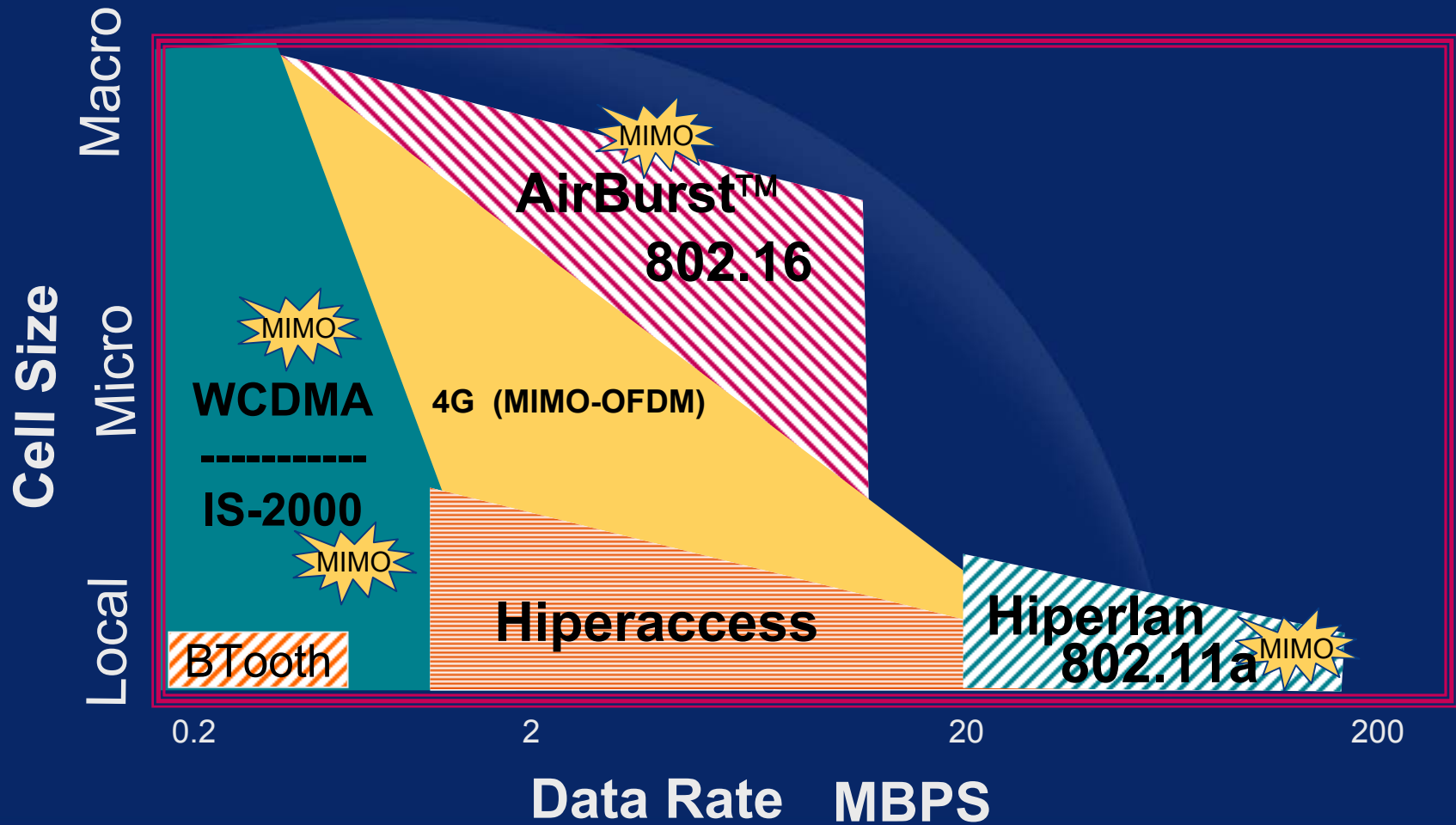
Building Blocks



◆ 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



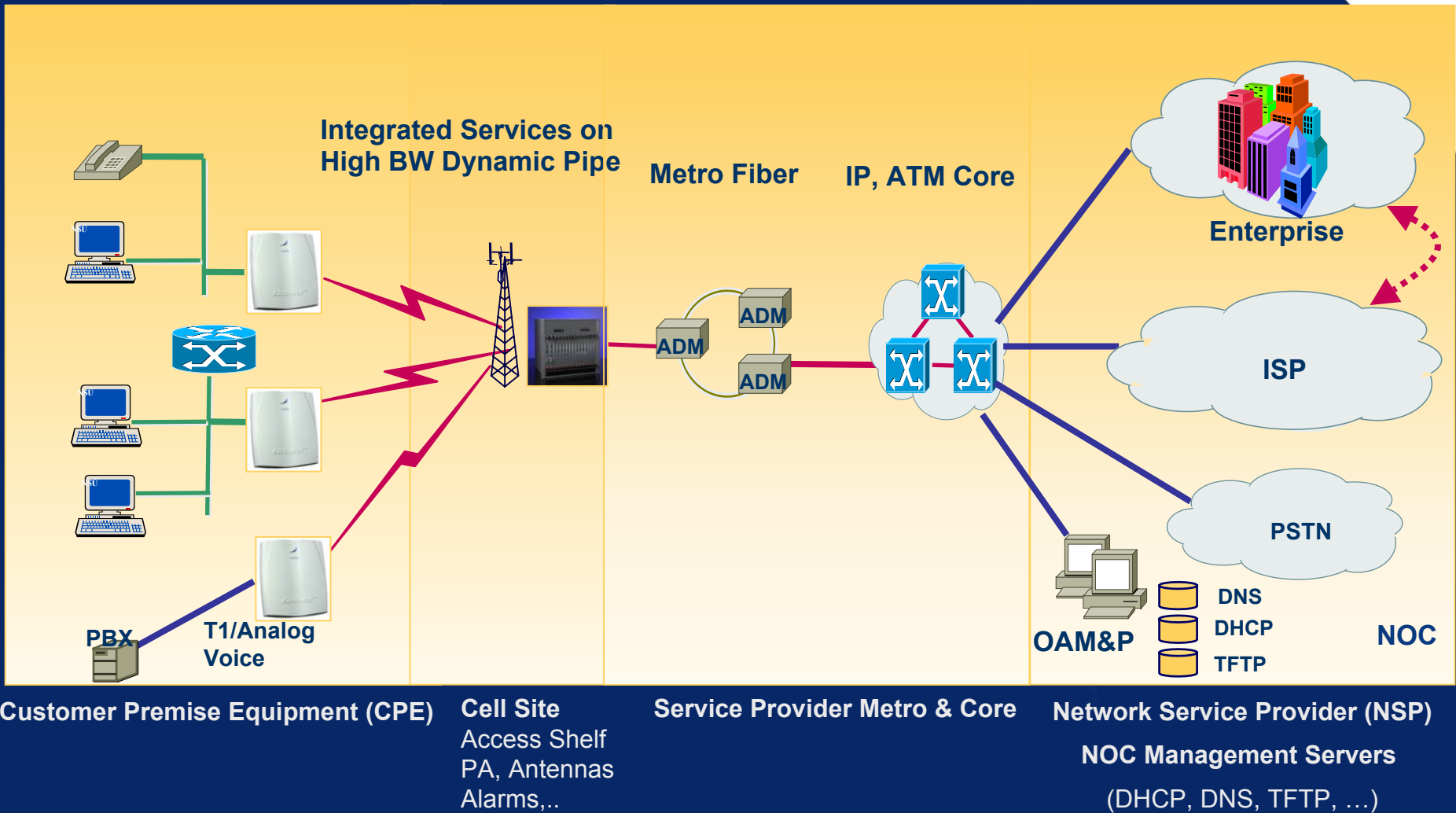


System Solution

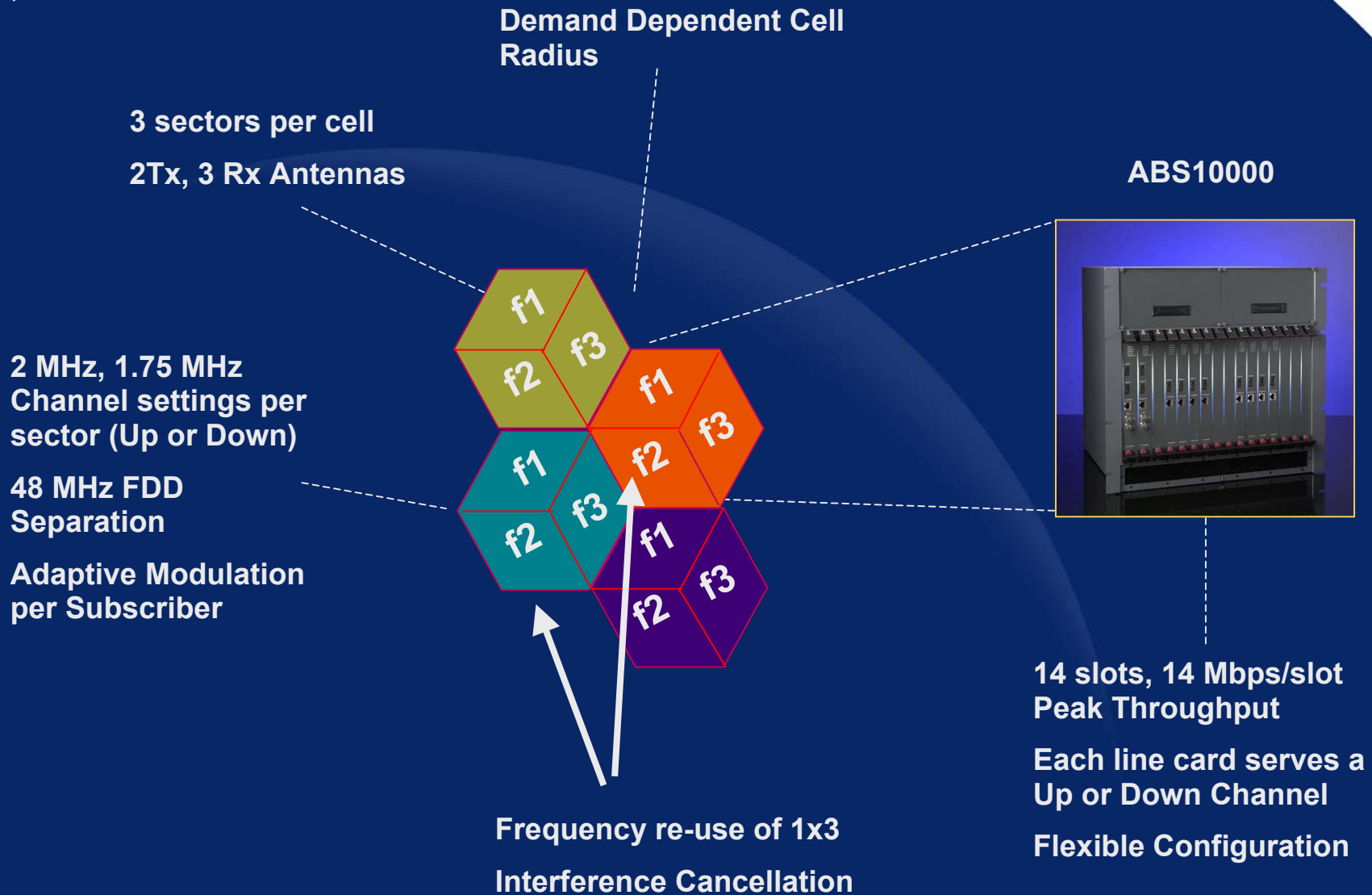


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AirBurst™ Network Architecture



Cellular Network Deployment



Airburst PHY and MAC Features



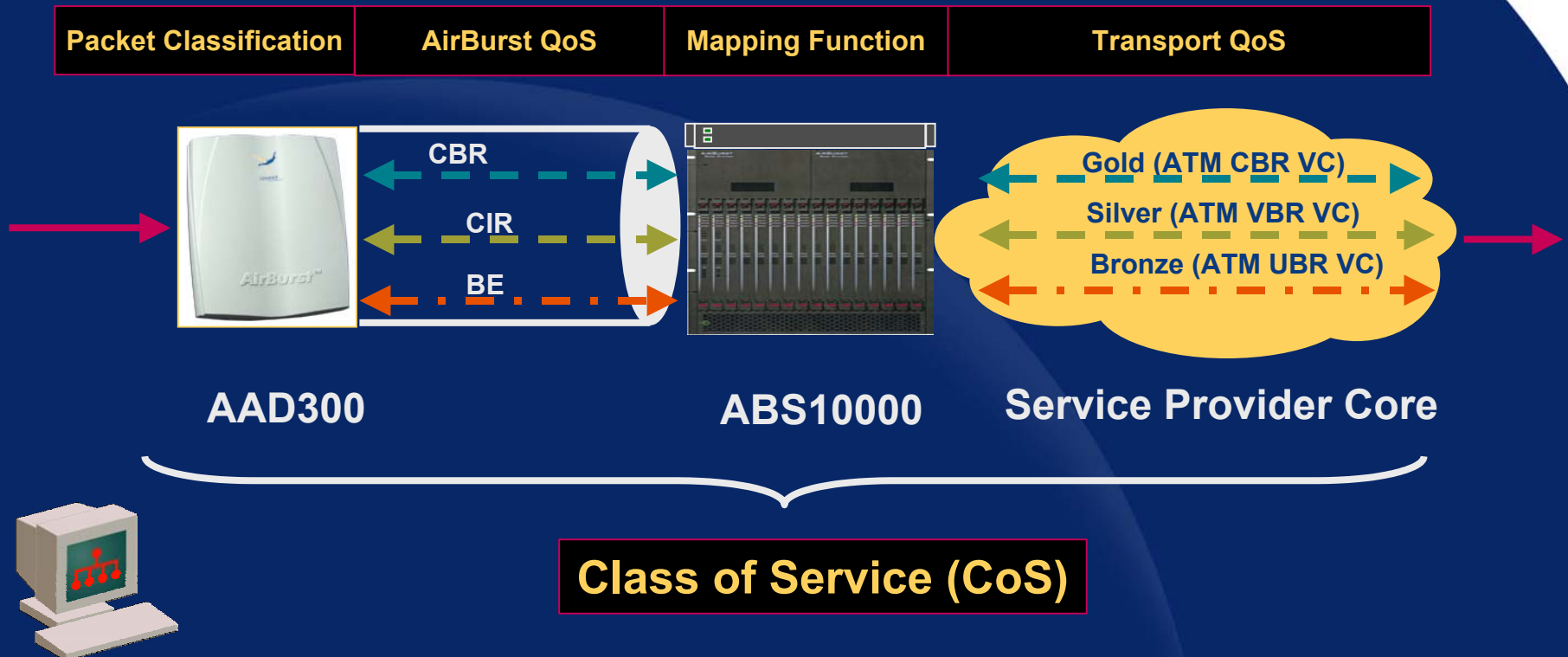
PHY

- ◆ **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



Subscriber Based Service Profiles
RES, SOHO, SME

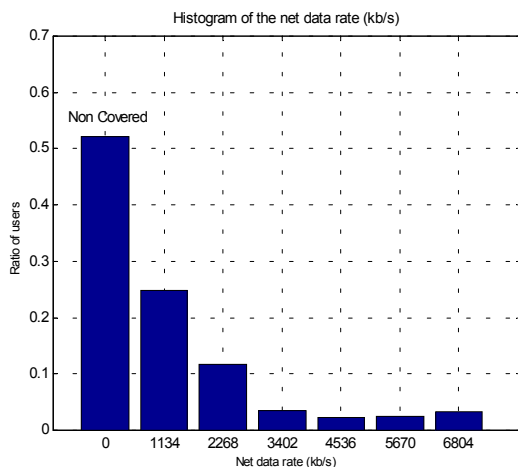
CBR Constant Bit Rate (Gold)
CIR Committed Information Rate (Silver)
BE Best Effort (Bronze)

Diversity: Throughput & Coverage

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

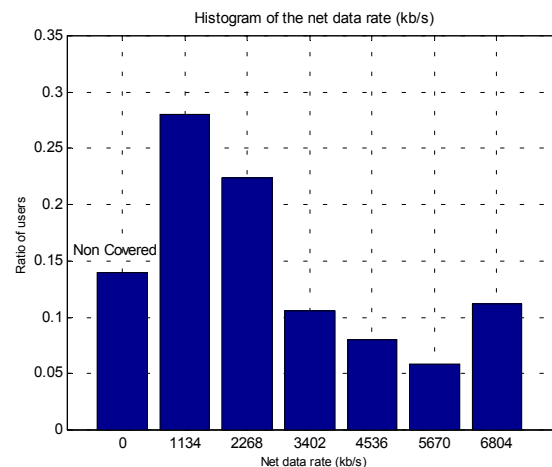
Example: cell radius = 6km

1x1 System (SISO)



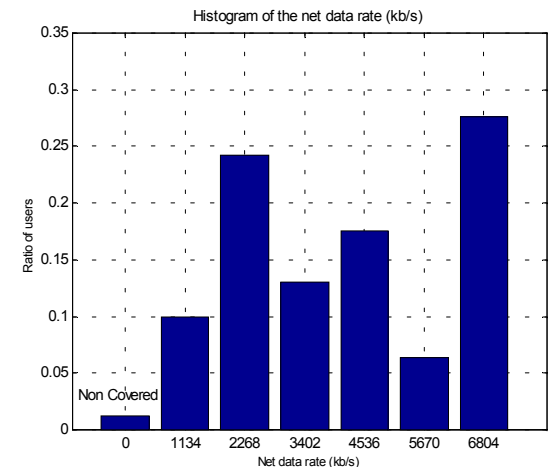
G1

1x2 System (SIMO)



G1.5

2x3 System (MIMO)



Mass Deployment

Airburst Performance Outline



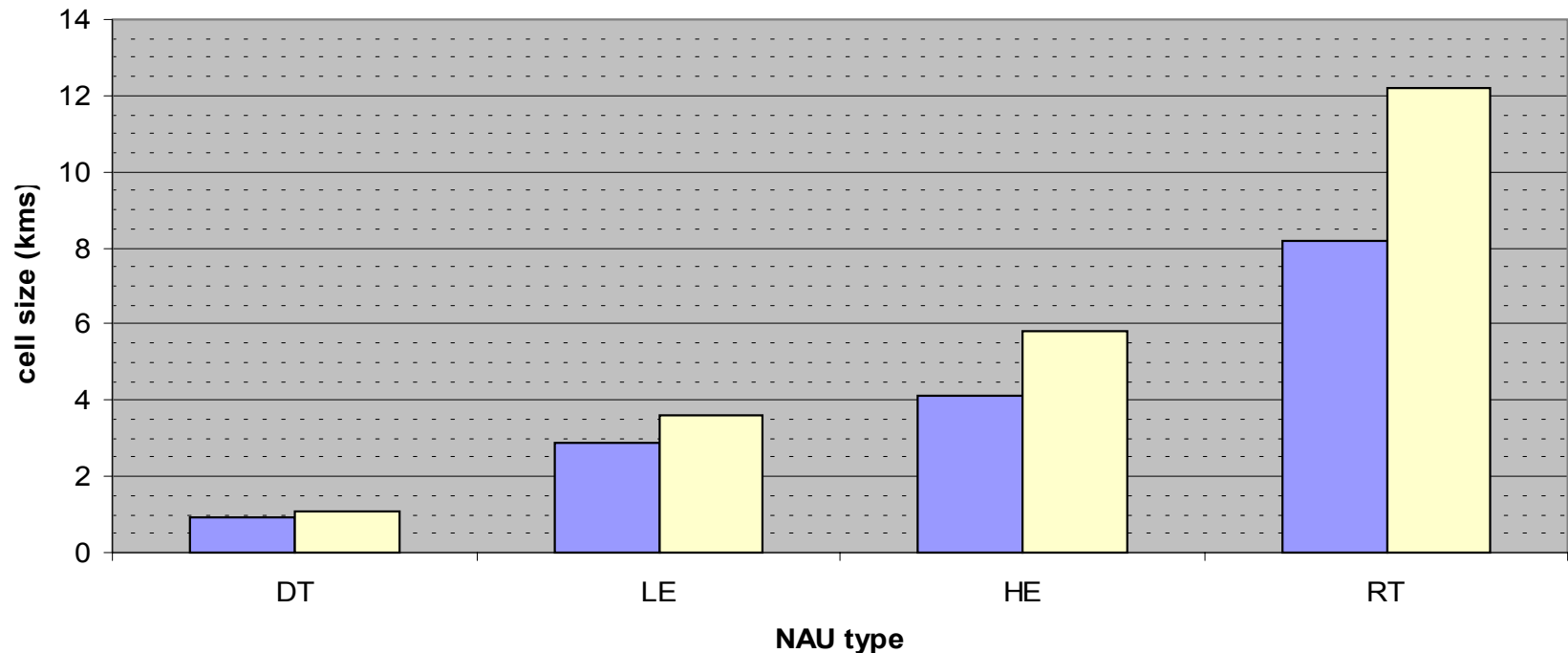
- ◆ **Fixed Wireless Access Channel Characterization**
- ◆ **PHY Level Performance**
 - ◆ Modem Set Points: Operating signal-to-noise-plus-interference ratio to meet PER and availability targets
- ◆ **Link Level Performance**
 - ◆ Link Adaptation Performance
- ◆ **System Level performance**
 - ◆ Coverage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

System Coverage

Random K factor and Delay Spread According to Models

Cell Size @ 90% coverage (kms)

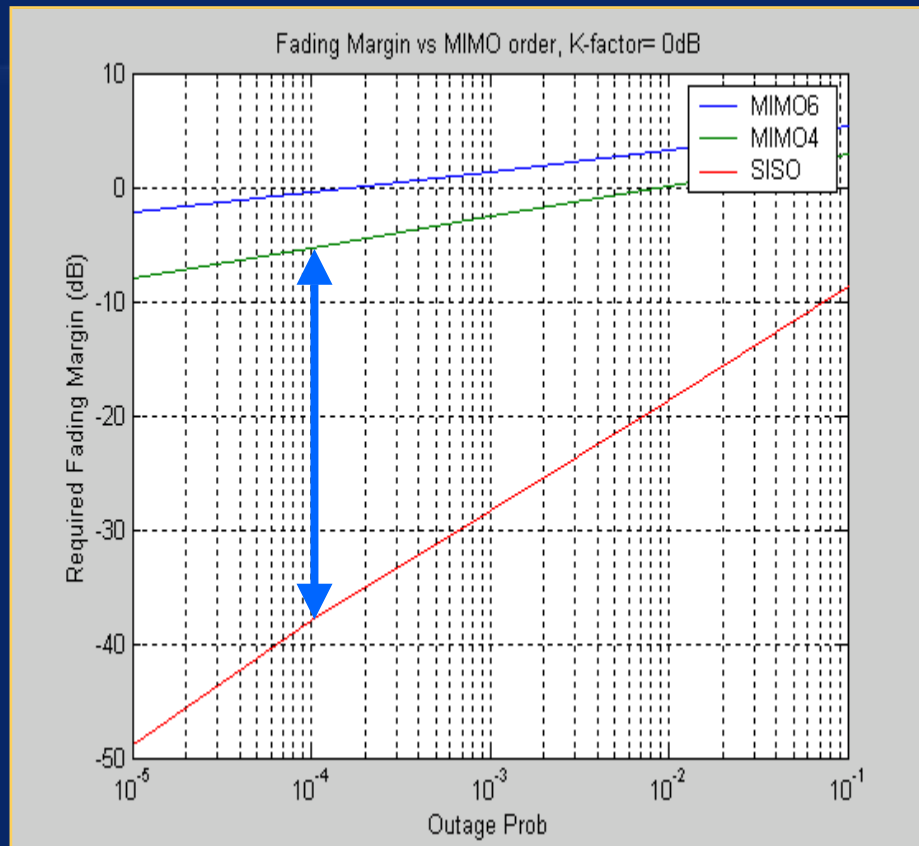
■ Micro-cell (15m BTS) ■ Macro-cell (30m BTS)



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



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AirBurst™ Base Station - ABS10000



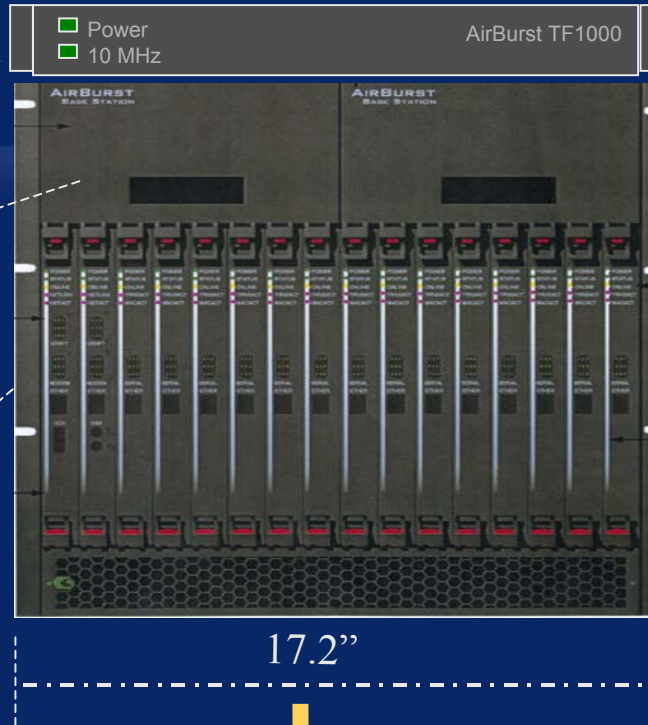
TF1000

RF Combine &
Timing

Redundant
Cooling

ABS10000

Channel Assembly



17.5"

17.2"

ABS10000 Chassis

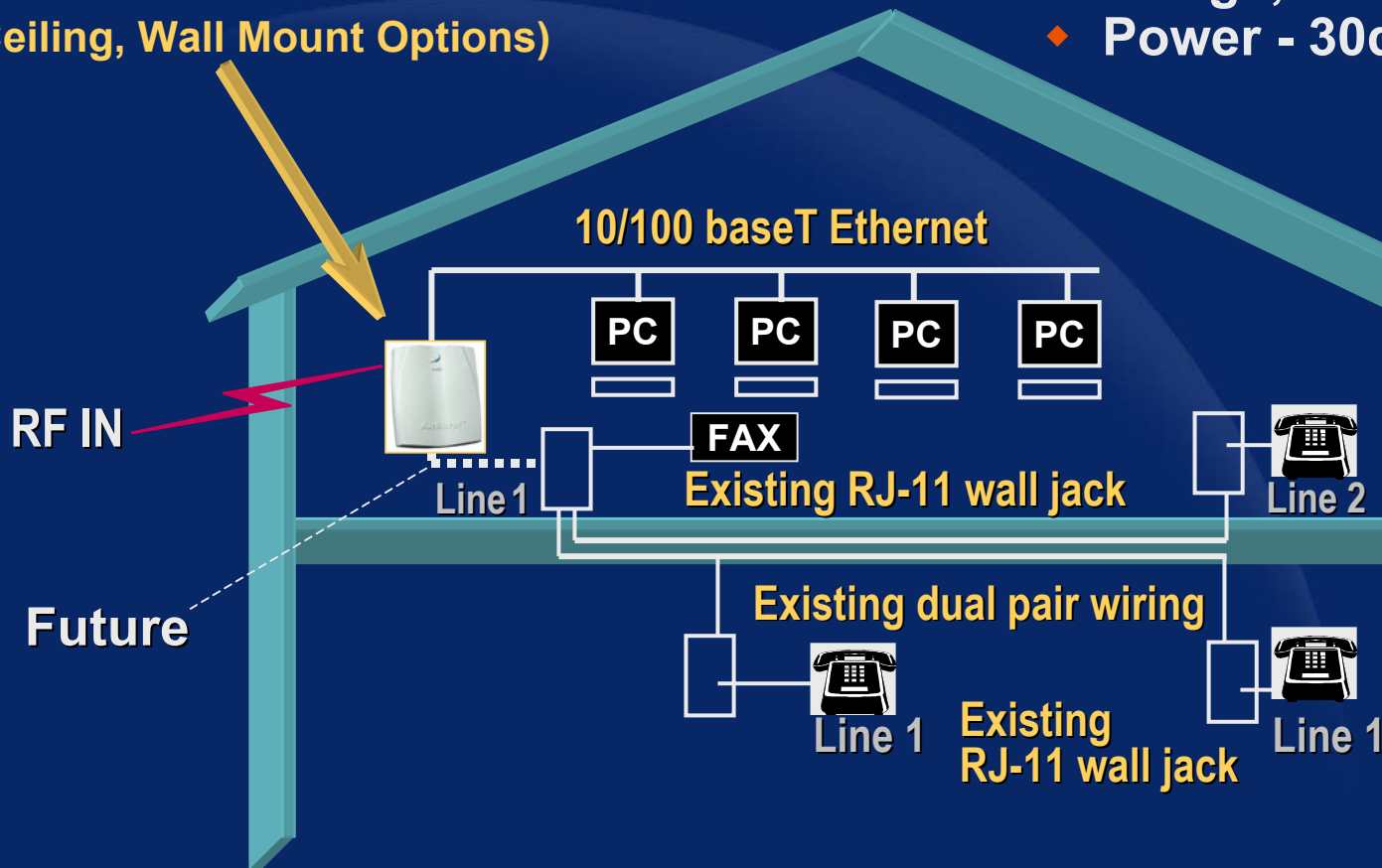
All Carrier Class Features - Future
Multiple Sector Modular Design
OC-3, DS3/E3 WAN Interface
Remote Diagnostics

AirBurst™ Access Device - AAD300

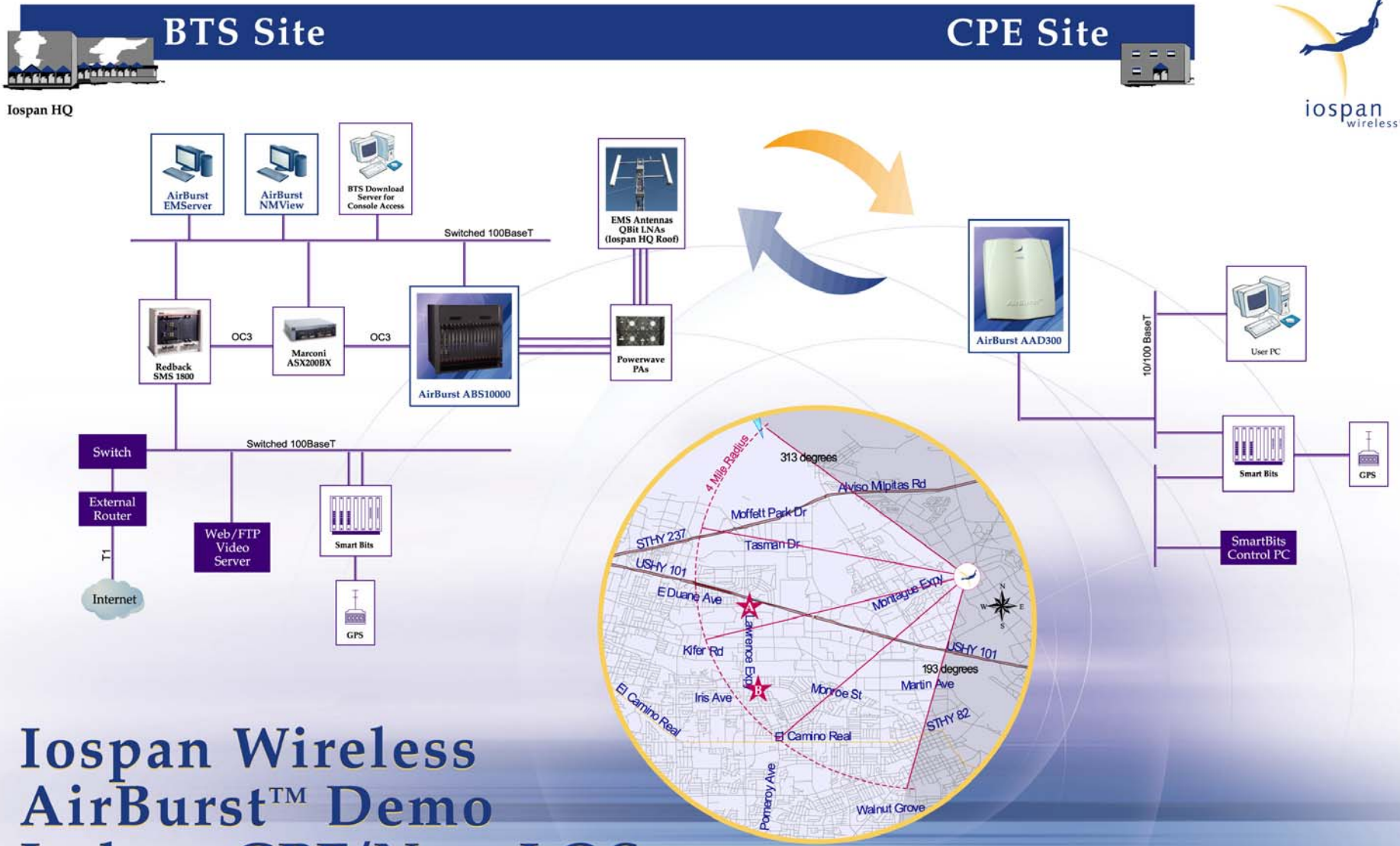


**Indoor Table Top
or Outdoor Under Eaves**
(Ceiling, Wall Mount Options)

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



Trial In-Progress



Iospan Wireless
AirBurst™ Demo
Indoor CPE/Non-LOS