Broadband WiMAX Update & Solution

(20 November 2007)

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Agenda

- WiMAX Value Proposition
- WiMAX Forum Update
- WiMAX Access - ASNG Architecture
- Cisco Broadband Architecture
- Broadband Wireless Solution Partners
- Service Enablement using Cisco IP-NGN
- Q & A

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Cisco's Mobility Vision
'Any Play Services'

Across Devices

Across Segments

Across Technologies

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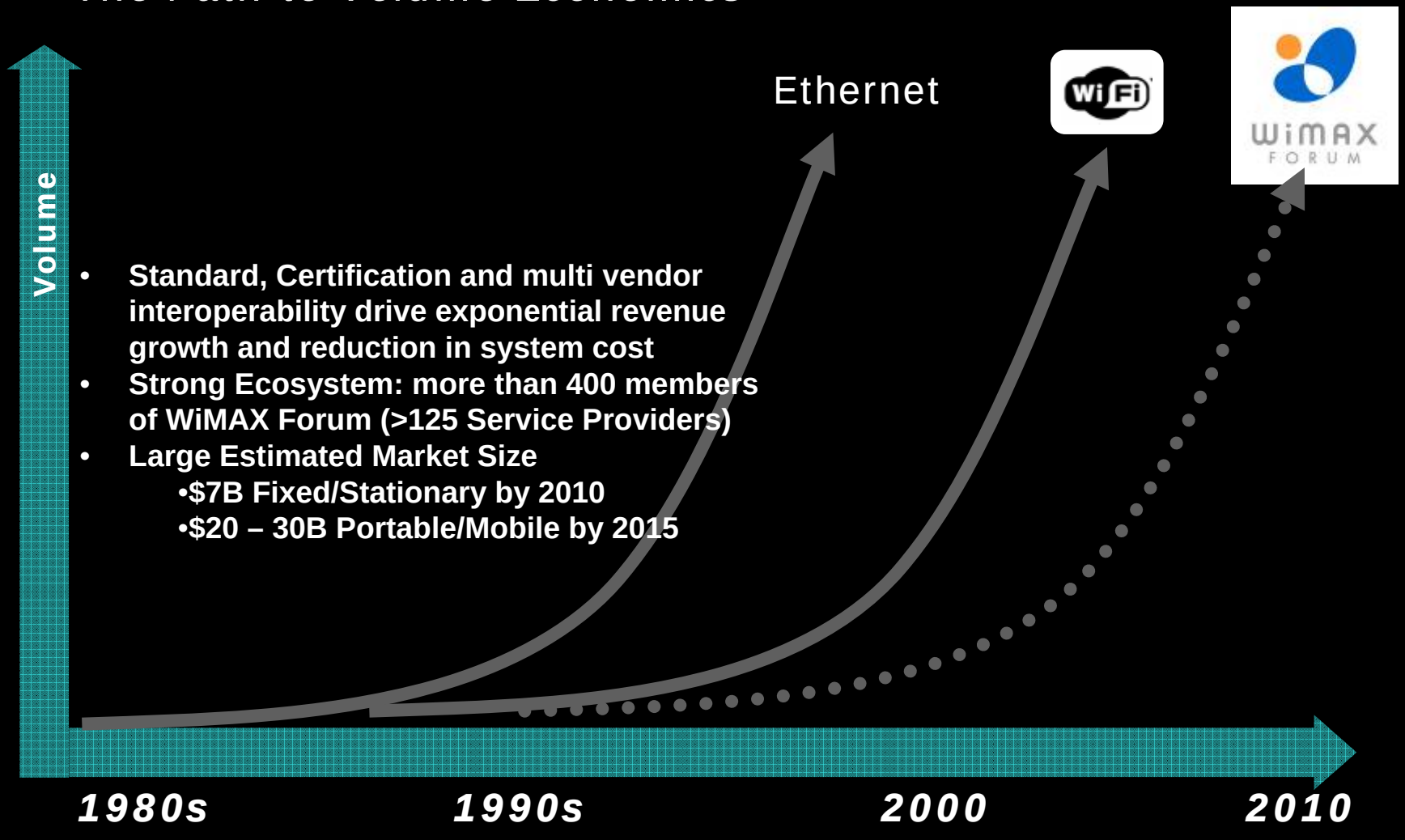
WHY WiMAX?

Following the same adoption curve …

The Path to Volume Economics



- **Standard, Certification and multi vendor interoperability drive exponential revenue growth and reduction in system cost**
- **Strong Ecosystem: more than 400 members of WiMAX Forum (>125 Service Providers)**
- **Large Estimated Market Size**
  - **$7B Fixed/Stationary by 2010**
  - **$20 – 30B Portable/Mobile by 2015**

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IMT-2000 Approval of WiMAX

- The ITU-R approved the WiMAX Forum's version of IEEE Standard 802.16 as an IMT-2000 technology’
- This significantly escalates opportunities to deliver mobile internet in the the 2.5-2.69 GHz band, for both rural and urban markets.
- This is the first time that a new air interface has been added to the IMT-2000 set of standards since the original technologies were selected nearly a decade ago.
- WiMAX technology currently has the potential to reach 2.7 billion people.

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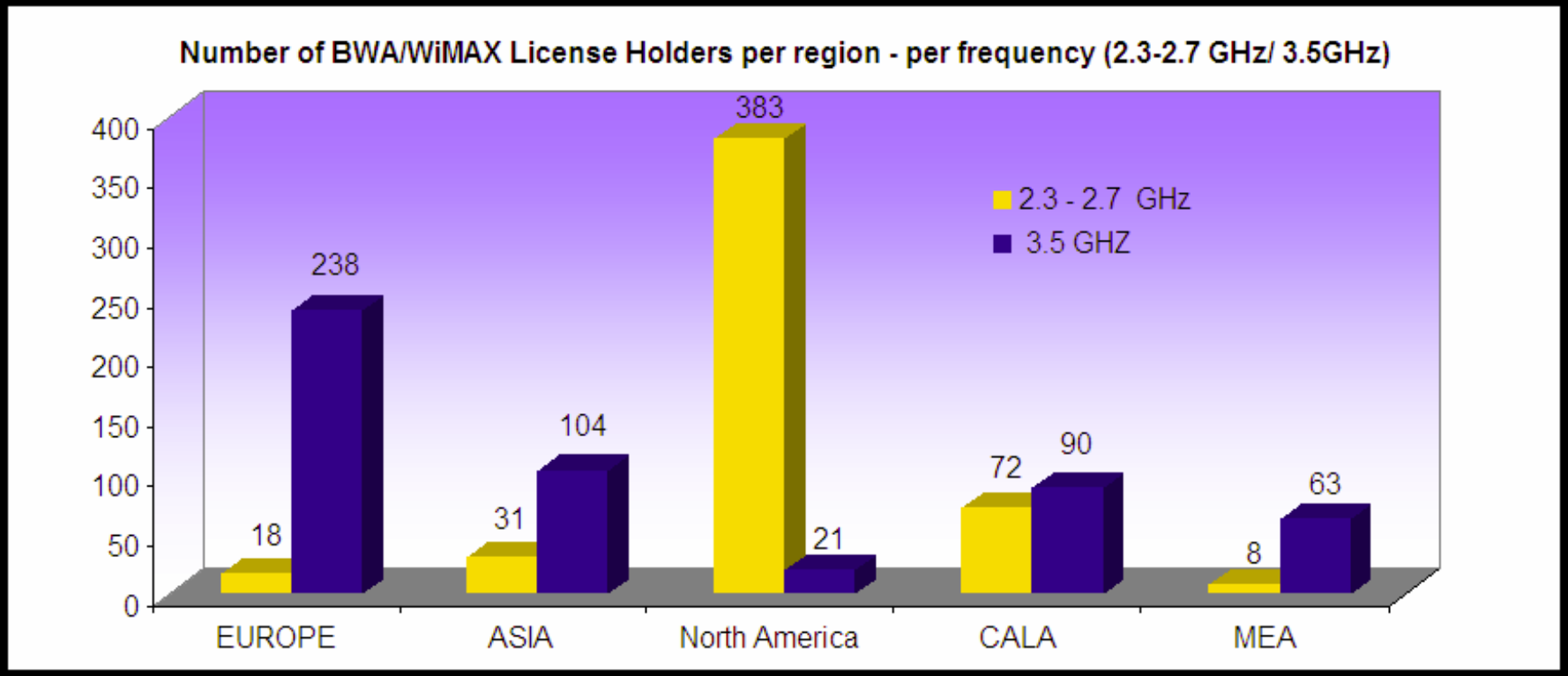
Reaching Critical Mass



2.7B people covered by WiMAX spectrum licenses today, estimated 4B as a result of ITU IMT-2000 inclusion

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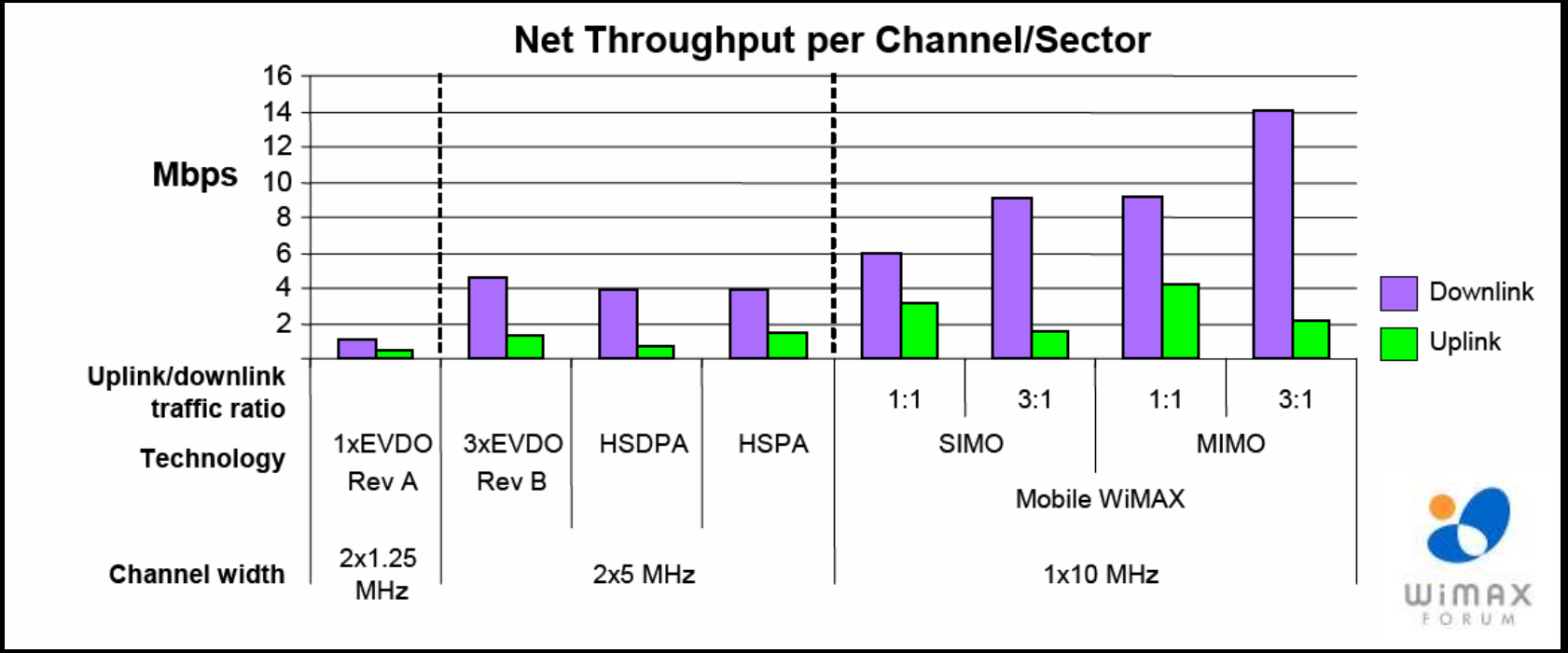
Broadband Wireless Market Adoption

Reason for WiMAX as preferred technology is simple…



- **Higher throughput per subscriber, lower latency, built for IP**
- **Business Case for 802.16 better than traditional 3G systems**
- **Models the successful "plug & play" scheme of Wi-Fi**
- **First licensed-RF technology to enable "personal wireless broadband"**
- **Taiwan picked WiMAX due to extraordinary expense of 3G**

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Why M-Taiwan – WiMAX Selection

Bottleneck of Mobile Data Services in Taiwan

	3G (now)	WiMAX (by M-Taiwan)
Data Rate	384Kbps	2Mbps
Revenue Model	•90% revenues come from voice service	•Most revenues come from data services
Device Loyalty	US$100-150 loyalty per unit shipment	All IP networking ➔ Lower technology complexity ➔ Less device loyalty

Challenge from Neighboring Countries

– South Korea and Singapore released WiBro/WiMAX spectrum in 2005 respectively

– Although the WiMAX spectrum in Taiwan wasn't released until July

2007, Taiwan ecosystem is affirmed of overtaking the other countries in spite of late launch.

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Why WiMAX ?

- **Responding to end-users' demand**

  - Over 50% people in Taiwan are looking forward to broadband wireless applications, such as mobile IPTV, ITS, and etc.

- **Taiwan plays an important role of ICT manufacturing**

  - Eg. The worldwide market share of WLAN is over 90%

- **International vendors are investing WiMAX**

  - Moto, Nokia, Alcatel-Lucent and many other vendors commit for 802.16e development

Downloading time for a DVD film (around 4.7GBytes)

1 Week

GPRS 2.5G

3.5 Days

EDGE 2.75G

1 Day

WCDMA 3G

6 Hours

HSDPA 3.5G

1 Hour

WiMAX

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The Real Opportunity

Country Transformation and 'Digital Inclusion'

Source: EIU, Telegeography, Point Topic, Cisco Analysis

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Country Transformation

IP Communication Technologies Drive Growth

Energy

Finance

Tourism

National ICT Agenda

National Economic and Social Development Agenda

Entrepreneurial

Education

Network as the Platform

Community

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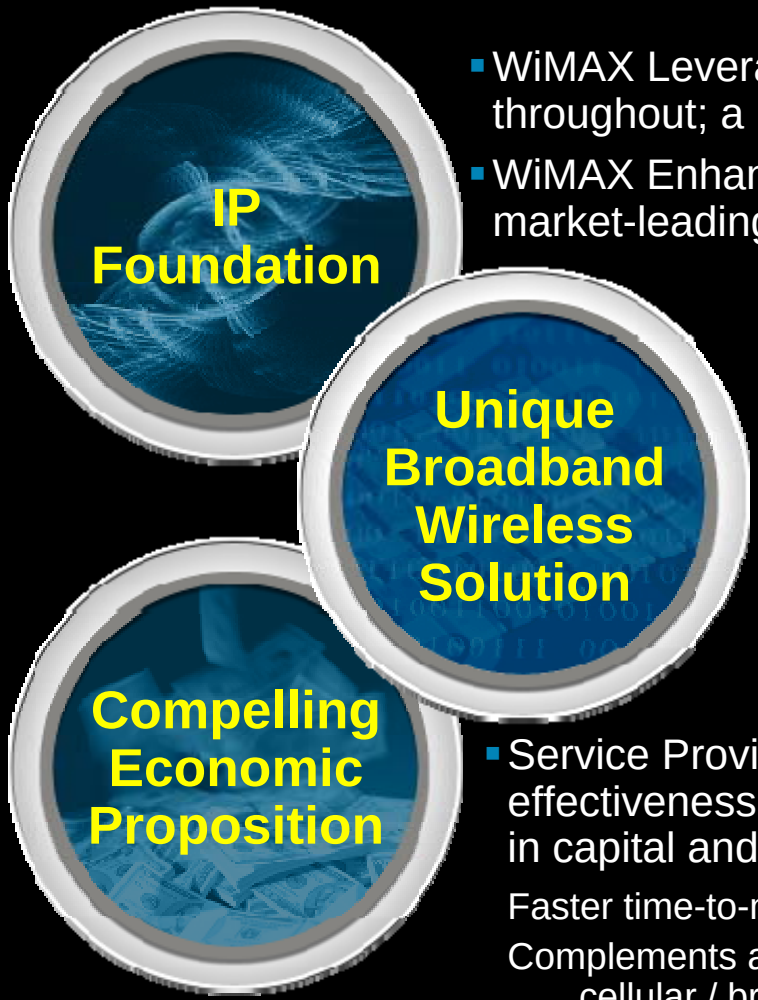
The Broadband Wireless Market

Why is WiMAX Important?



- WiMAX Leverages IP technologies throughout; a natural fit for Cisco
- WiMAX Enhances Cisco's existing market-leading WiFi and WiFi mesh solutions

WiMAX (802.16e-2005) enables a wide range of fixed and mobile 'any play' services to deliver the **Connected Life** experience

- Service Providers: Improved cost effectiveness with significant reductions in capital and operational expenditures
  - Faster time-to-market; no wires
  - Complements and extends existing cellular / broadband offerings
- Governments: An efficient means to enable 'Digital Inclusion'

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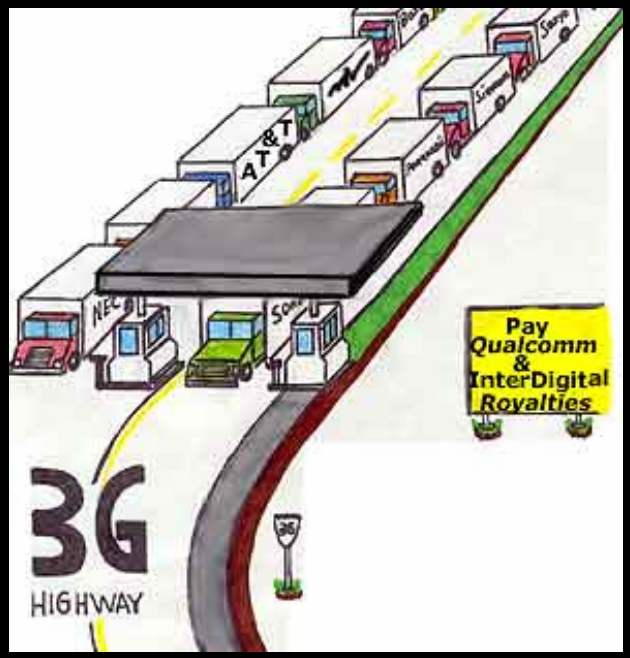
Why is Mobile WiMAX attractive to operators ?

- Intellectual Property Rights (IPR) problems with 3G (Qualcomm)
- Large ecosystem is developing including handset vendors
- Lots of mobile CAPEX up for grabs
- Spectrum is becoming available
- Will go all-IP e2e years ahead of 3G
- Leading the movement to “open” systems
- Is being incorporated into WiFi muni-mesh opportunities (Cisco Digital Cities Initiative)
- WiMAX Forum driving the technology forward (approaching 400 members)
- Will adopt OFDMA and MIMO well ahead of the 3G camps
- Emerging Market is seeing lots of activity



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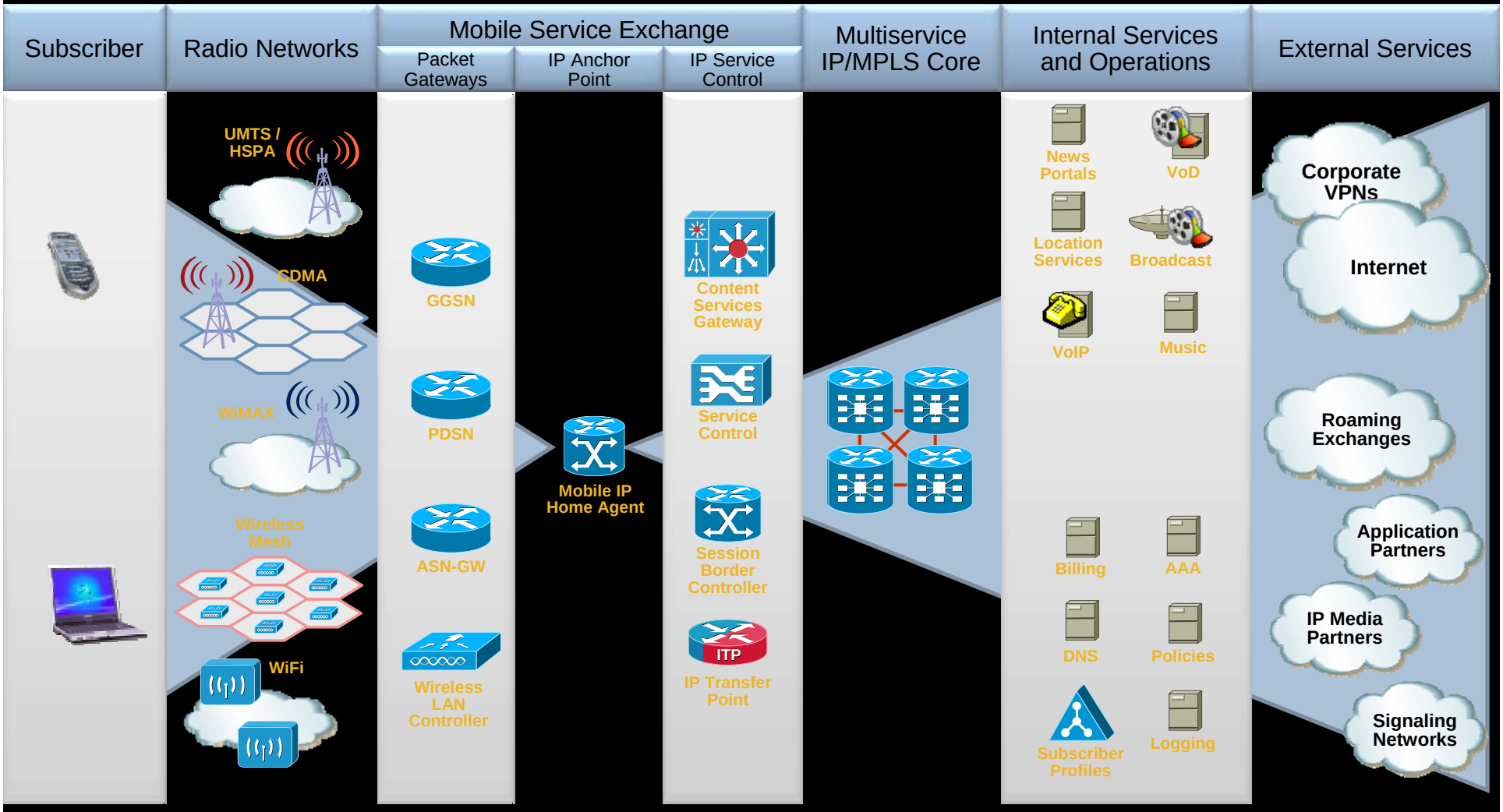
Cisco IP Next Generation Networks

IP Forms the Foundation for True Mobility for WiMAX



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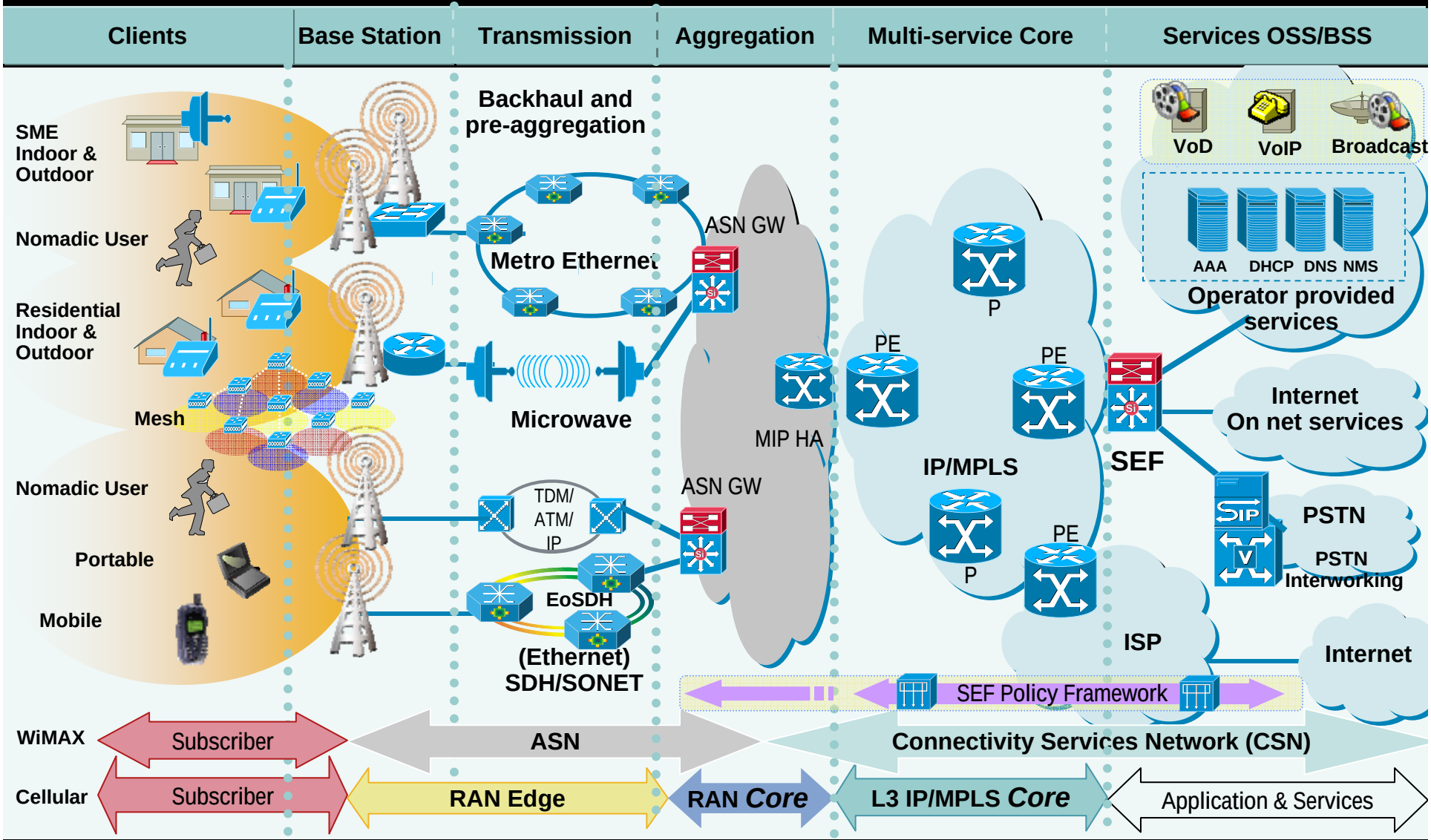
Cisco Broadband Wireless Strategy Overview

WiMAX is one of the Access Choices & Options Available…



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WiMAX Value Summary

- WiMAX value proposition is for operators to make money out of delivering services on the **new Internet model**
- WiMAX is free from the legacy wire line-cellular because it's roots are derived **from the Internet**
- WiMAX will match speeds of LTE (current proposal of 20 MHz now part of 1.5 Release.)
- WiMAX will have a cellular-based flavor of multicasting available via HSPA called Multimedia Broadcast Multicast Service or MBMS
- WiMAX embraces **QoS** controls and tools which allow operators to embrace multi-tier service pricing and level marketing.
- WiMAX is excellent where countries – locations have no existing infrastructure

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WiMAX Forum Approach
Intellectual Property Rights

- Basically a IT vs. Mobile industry approach to IPR.
- Significant problems with existing 3G approach to royalty payments in the mobile world
- Avoiding the pitfalls of CDMA/UMTS licensing as we move to OFDMA and MIMO and other advanced Antenna technologies.
- Spread IPR over large # of companies instead of having 1 company holding the lion-share.

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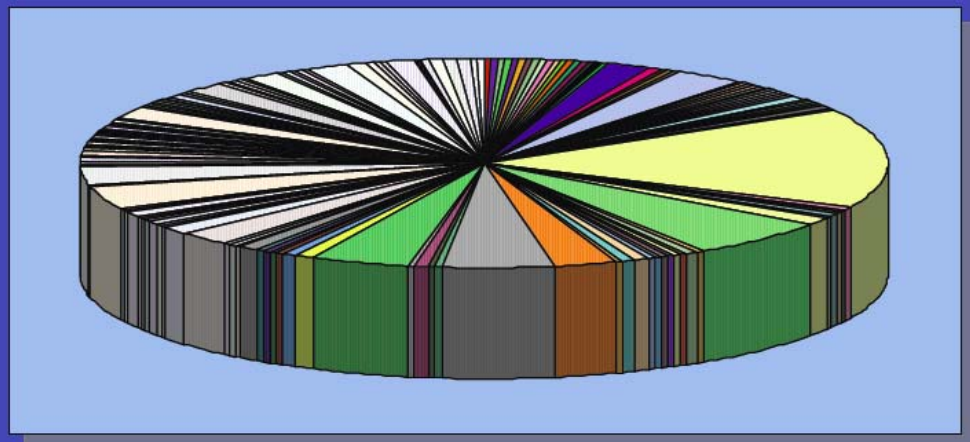
WiMAX IPR

- Dispersed distribution of ownership of US patents*
- No single company has a dominant IPR position.



1550 patents are distributed among 330 companies

Of the 23 Companies that hold more than 10 Patents…
74% are WiMAX Forum members, representing 82% of the patents held in concentrations of 11 or more patents per company

** Based on independent survey of relevant and potentially relevant patents/applications for United States*

Source: Schwegman, Lundberg, Woessner & Kluth
Oct 2006

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The WiMAX Forum – 519 Members

27%

137 Content Eco-systems

17%

87 Components Silicon Mfrs

31%

161 Service Providers

25%

127 System Vendors

•Deliver a trusted certification process

•Develop a framework for a high performance end to end IP mobile network architecture supporting all usage models

•Promote WiMAX as the leading business model to deliver global wireless broadband services

•WiMAX Forum contributes to foster a thriving ecosystem

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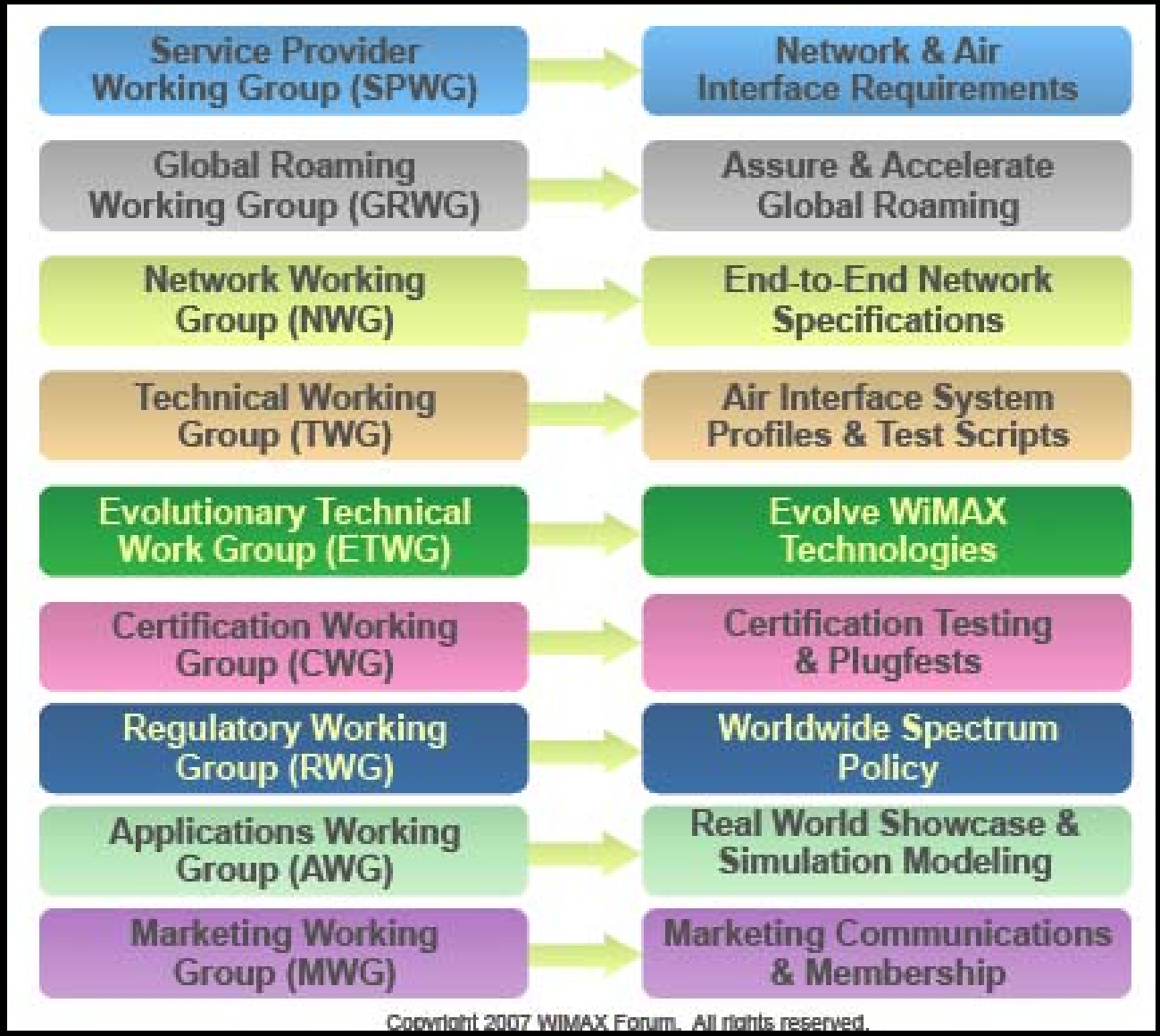
Nine WiMAX Forum Working Groups



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WiMAX forum's nine working groups

- **Applications Working Group:** Define applications over WiMAX™ that are necessary to meet core competitive offerings and that are uniquely enhanced by WiMAX technology.
- **Certification Working Group:** Handles the operational aspects of the WiMAX Forum Certified program.
- **Evolutionary Technical Working Group:** Maintains existing OFDM profiles, develops additional fixed OFDM profiles, and develops technical specifications for the evolution of the WiMAX Forum's OFDM based networks from fixed to nomadic to portable, to mobile.
- **Global Roaming Working Group:** Assures the availability of global roaming service for WiMAX networks in a timely manner as demanded by the marketplace.
- **Marketing Working Group:** Influences WiMAX technology adoption worldwide. Promotes WiMAX products, brands and standards, which form the basis for global interoperability of wireless broadband Internet anytime anywhere.
- **Network Working Group:** Creates higher level networking specifications for fixed, nomadic, portable and mobile WiMAX systems, beyond what is defined in the scope of 802.16.
- **Regulatory Working Group:** Influences worldwide regulatory agencies to promote WiMAX-friendly, globally harmonized spectrum allocations. *Chair: Tim Hewitt, BT*
- **Service Provider Working Group:** Gives service providers a platform for influencing BWA product and spectrum requirements to ensure that their individual market needs are fulfilled.
- **Technical Working Group:** The main goal of the TWG is to develop technical product specifications and certification test suites for the air interface based on the OFDMA PHY, complementary to the IEEE 802.16 standards, primarily for the purpose of interoperability and certification of Mobile Stations, Subscriber Stations and Base Stations conforming to the IEEE 802.16 standards.

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Mobile Certification in FY08

Release 1.0 Wave 1

Mandatory testing:
Key functionality, including QoS, AES, PKMv2, handoff, H-ARQ, power control, sleep and idle mode and header compression

Release 1.0 Wave 2

Mandatory testing: Additional test on handover, QoS, power saving and IPV6

Base Station

Optional Modules:
MIMO
Beamforming
Ethernet I/O
MBS

Mobile Station

Mandatory Testing:
MIMO
Beamforming
MBS

Optional:
Ethernet I/O

Backward Compatible More Features Tested

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Mobile Profiles for Taipei Plugfest

Plugfest Profiles	DESCRIPTION	SS	BS
1A	2.3-2.4 GHz, 8.75 MHz, TDD	5	3
3A	2.496-2.69 GHz, 5 MHz, TDD	20	10
3A	2.496-2.69 GHz, 10 MHz, TDD	24	19
5A	3.4-3.8 GHz, 5 MHz, TDD	2	1
5AL	3.4-3.6 GHz, 5 MHz, TDD	7	6
5BL	3.4-3.8 GHz, 7 MHz, TDD	3	2
Totals	6 Profiles	61	41

- Vendors have registered in a mix of 6 Certification Profiles
- • 34 Equipment Vendors and 8 test equipment vendors registered with 220+ participating Engineers which makes this Plugfest the largest one.
- • ***A 24% increase in participating companies and a 37% increase inattending engineers since the May 2007 Plugfest which demonstrates how WiMAX Technology is growing!***

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October 2007 Taipei Participants

Equipment Vendors		Test Equipment Vendors
Accton Technology	Institute for Information Industry	Aeroflex
Airspan Networks	Japan Radio	Agilent Technologies
Alcatel-Lucent	M/A - COM	Anite Telecoms
Alpha Networks	Marvel Semiconductor	AT4 wireless
Alvarion	Motorola	Azimuth Systems
Amicus Wireless	Navini Networks	Rohde & Schwarz
ApaceWave Technologies	NEC	Sanjole
ASUStek Computer	Nokia	Spirent
Beceem Communications	Nortel Networks	Samsung Electronics Corp.
Fujitsu	picoChip Designs Ltd.	Sanyo Electric Co. Ltd.
GCT Semiconductor	Posdata	Sequans Communications
Gemtek	Quanta Computer	Telsima
Huawei	Redline Communications.	Wavesat
Intel Corporation	Runcom Technologies Ltd	ZTE Corporation

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Four Plugfest Scheduled for FY08

- **Feb 10th – 17th -** .16e Plugfest – (MIMO, Beam Forming IO & SISO implementations) – New Delhi, India
- **May 4th – 11th -** .16e Plugfest – (MIMO, Beam Forming IO) - Vienna, Austria
- **Oct 12th – Oct 19th -** .16e Plugfest – (MIMO, Beam Forming IO) – Singapore
- **Nov 3rd – Nov 9th - NWIOT Plugfest** – Site TBD

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WiMAX Roaming Services

	Services	Network	Devices
2008	Internet Access Enterprise VPN	WiMAX WiMAX to Wi-Fi	Connection Cards USB Dongle PDAs
2009	Services w/QoS: - VoIP - Video Conferencing - Streaming Video and Music - Games	WiMAX WiMAX to 3G	Embedded Devices Phones

Home services available to Wimax users wherever they travel.

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Mobile Wimax Roadmap

Mobile WiMAX Rel 1.0 (802.16e)

Mobile WiMAX Rel 1.5 (802.16e)

Mobile WiMAX Rel 2.0 (802.16m)

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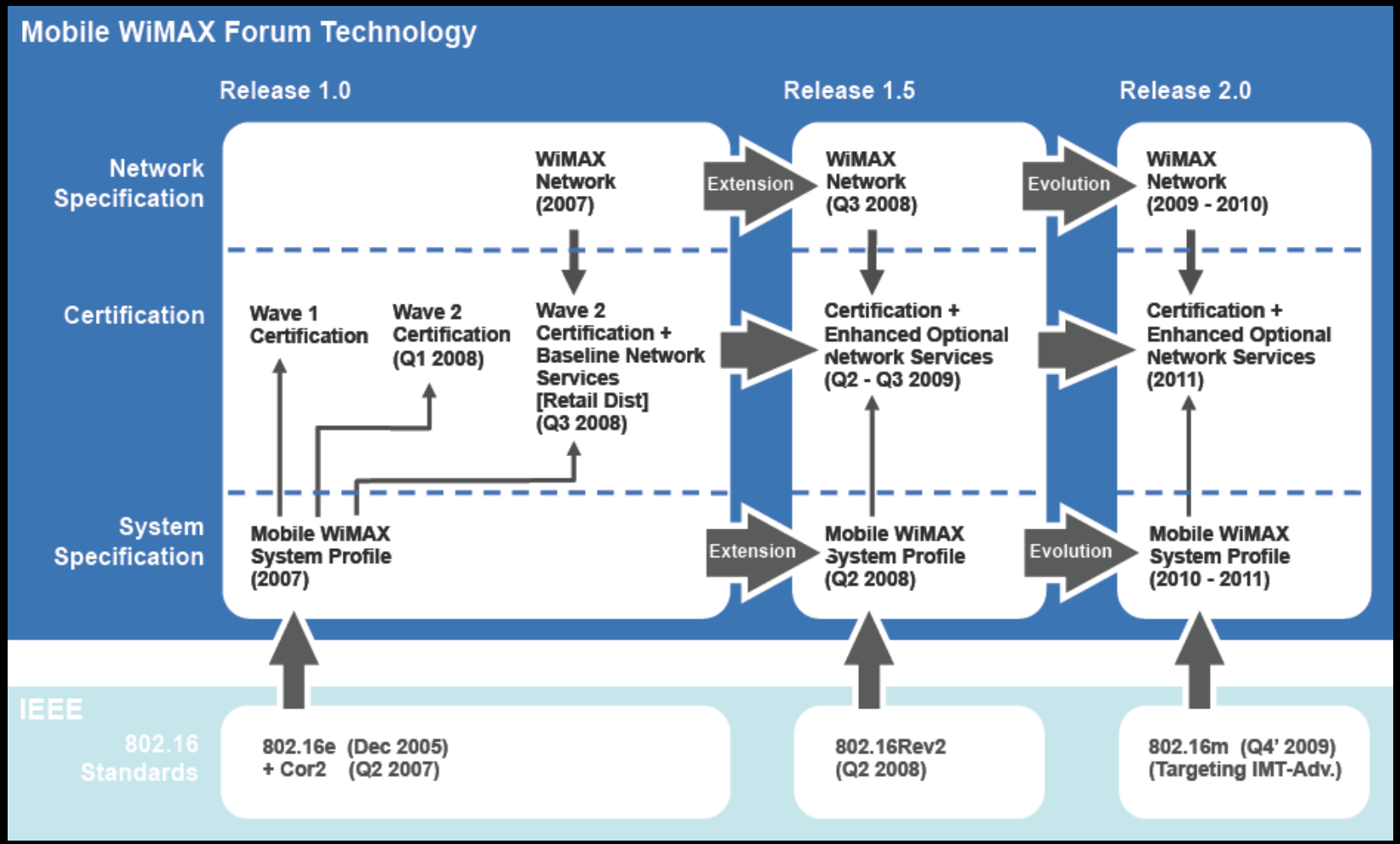
Mobile WiMAX Technology Evolution Vision



A fully backward compatible evolution on standards and products

Projections subject to change

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IEEE Standard Evolution to 16m

16m Standards Completion expected by end of 2009

Feature	IEEE 802.16m* (From Approved System Requirements)
RF Bands	Below 6 GHz, licensed
Duplexing Modes	TDD and FDD/HFDD
Channel Bandwidths	5, 10, 20, others optional BWs
Peak Data Rates (per sector)	DL: > 130 Mbps UL: > 56 Mbps (20 MHz, baseline antenna configuration)
Mobility	Up to 350 km/h (optimum performance < 15 km/h)
Latency	Link-Layer Access: < 10 ms Handoff: < 50 ms
MIMO Configuration	DL: 2x2, 2x4, 4x2, 4x4 MIMO UL: 1x2, 1x4, 2x2, 2x4, 4x4 MIMO
Peak Spectral efficiency (per sector)	Peak: DL > 6.5 bps/Hz UL > 2.8 bps/Hz
Average User Throughput Cell Edge User Throughput	> 2x Release 1.0
Number of VoIP Active Users	> 60 users/sector/FDD MHz > 30 users/sector/TDD MHz

***Minimum Requirements to be Exceeded by 16m**

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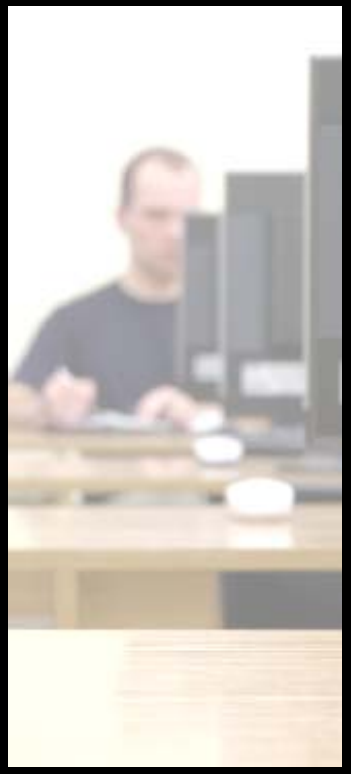
Mobile WiMAX Profile Release 1.0



Underlying Standards

- Air Interface: IEEE802.16e-2005
- Network: NWG Release 1.0/1.5

Specifications

- Channel BW: 8.75(Korea), 5, 10MHz
- Focus on TDD in

Modulation:

- DL: 64QAM, 16QAM, QPSK
- UL: 16QAM, QPSK
- Peak Data Rates Per Sector/Per Carrier:

Specifications Completed
Products 2007-8

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Mobile WiMAX Profile Release 1.x

Specifications 2008
Products 2009

Underlying Standards

Air Interface: IEEE802.16 REV2

Network: NWG Release 1.5

Enhancements

Extension to new Spectrum Bands

Enabling both TDD and (H)FDD with Maximum Commonality

Some Performance Improvement (Focus on Software Upgrades)

Enabling Network Release 1.5 Advanced Features

Applications

Higher VoIP Capacity

Enhanced LBS

Enhanced Multicast and Broadcast Services

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Mobile WiMAX Profile Release 2.0

Specifications 2010
Products 2011

Underlying Standards

Air Interface: IEEE802.16m

Network: NWG Release 2.0

Enhancements

Wider Band Channels (TDD & FDD in 5,10, 20MHz)

Multiple Carrier Support

Higher Spectrum Efficiency/Capacity

Higher Peak And Average User Data Rates

Integrated Relay

Improved Mobility And Lower Latency

Improved MIMO (focus on higher order and multiuser MIMO)

Enhanced Inter-tech Handoffs/Coexistence With 3G and WiFi

Improved Power Saving

Applications

Multi-hop relay deployments

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Documentation Outline

- **Network Rel 1.5 Requirements Status –approved changes**

  Simple IP, USI, MCBCS, Ethernet/VLAN, ND&S, SmartCard, IMS

- **Uploaded Release 1.5 today to forum data base**
- **Air Interface Rel 1.x Requirements Status**

  - Near-term evolution of mobile WiMAX profile based on 802.16-REV2

  - Requirements address alignment of Rel 1.x with network Rel 1.5

  - Rel 1.x document is in ballot review, with ongoing ballot comment resolution

  - Target completion: Dec 2007 (Santa Clara)

- **Network Rel 2.0 Requirements Status**

  - Release 2.0 Network Requirements (Target: Q308)

  - Multimedia Session Continuity Work Item

  - Network Management Requirements

  - Aligned with Air interface Release 2.0

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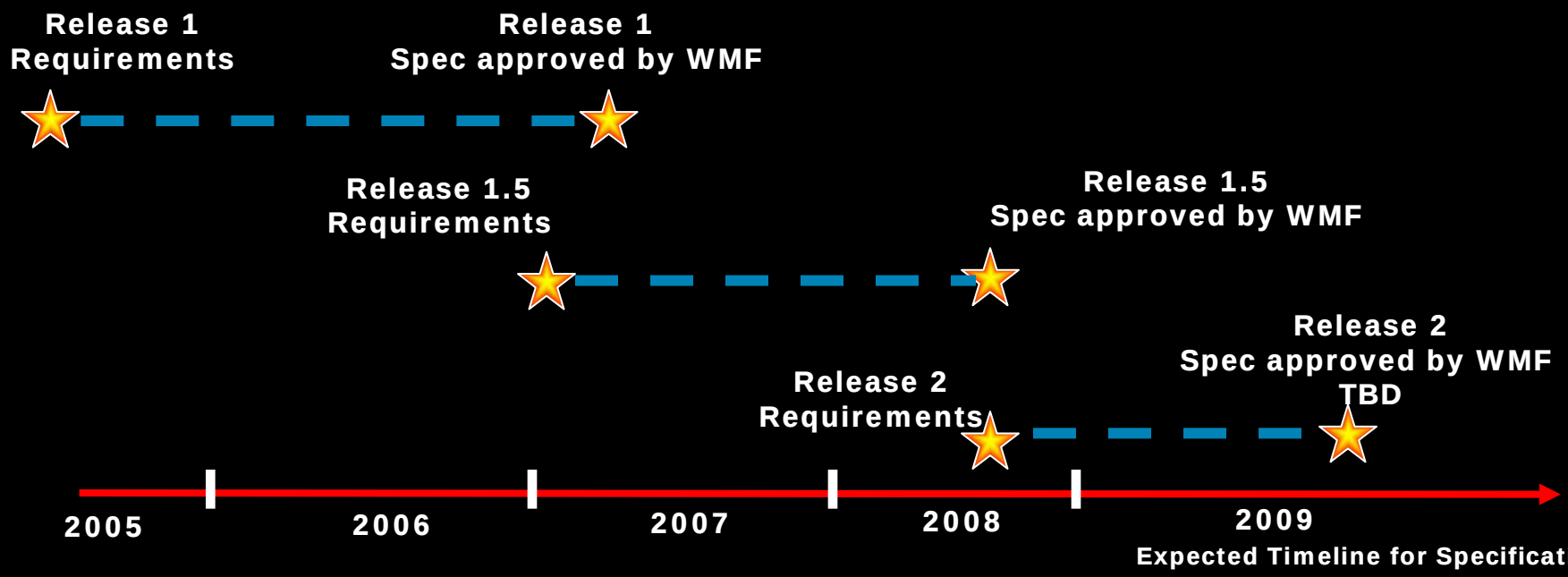
WiMAX Network Standards Roadmap



Expected Timeline for Specifications

Release 1:
- Mobile and stationary WiMAX base spec: ASN, CSN mobility, Sleep/Idle modes,
- IPv4 & IPv6 connectivity
- Pre-provisioned/static QoS,
- Optional RRM
- Network discovery/selection
- IP/Eth CS support
- Flexible credentials, pre- and postpaid accounting
- Roaming (RADIUS only)
- 3GPP I-WLAN compatible IWK
- Mobile Internet applications
- 3 ASN profiles
- Start of NWIOT (NCT/IIOT) specs

Release 1.5:
- IMS and PCC/Dynamic QoS
- Telephony VoIP with emergency services
- Lawful interception
- MCBCS
- Diameter based AAA
- OTA APDO and device management
- 3GPP SAE IWK, 3GPP2 IWK optimizations
- Ethernet services, VLAN, DSL IWK
- Multi-host support
- Location based services
- RoHC
- Normative R8
- Non-IMS/Universal Services Interface
- NWIOT Release 1.5 (NCT/IIOT) and enabling IOT for retails devices

Release 2:
- Multimedia Session Continuity
  - Seamless WiFi-WiMAX handover
  - 3GPP/2 IWK (optimized HO)
- Network Management
- Enhancements in
  - Roaming
  - MCBCS
  - Emergency Services
  - IMS Support
- Support for Relay (TBD)
- Second-gen. NWIOT framework

Last updated Oct 25, 2007

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Four Additional Certification Labs

- 4 additional labs across the globe in addition to Malaga, Spain
- Test vendors including Agilent, Anite, AT4, Azimuth, Innowireless, Tektronics, Rohde and Schwarz and Sanjole have developed test equipment to support our certification needs.
- The 4th Public, Mobile WiMAX PlugFest held October 13 - 20 in Taipei, was the largest successful Plugfest to date

  - 34 equipment vendors,

  - 8 test equipment vendors and

  - 220+ engineers!
- First official testing of Beamforming I/O
- Introduction of General Handoff and Hybrid ARQ Scenario
- Vendors had over 60 MIMO setups
- Vendors tested Collaborative MIMO and UL MIMO successfully – a first for our Mobile Plugfest.
- 200+ setups with different BS-MS achieved basic interoperability
- 125 setups achieved extended interoperability
- Several set ups achieved connectivity using Beamforming.

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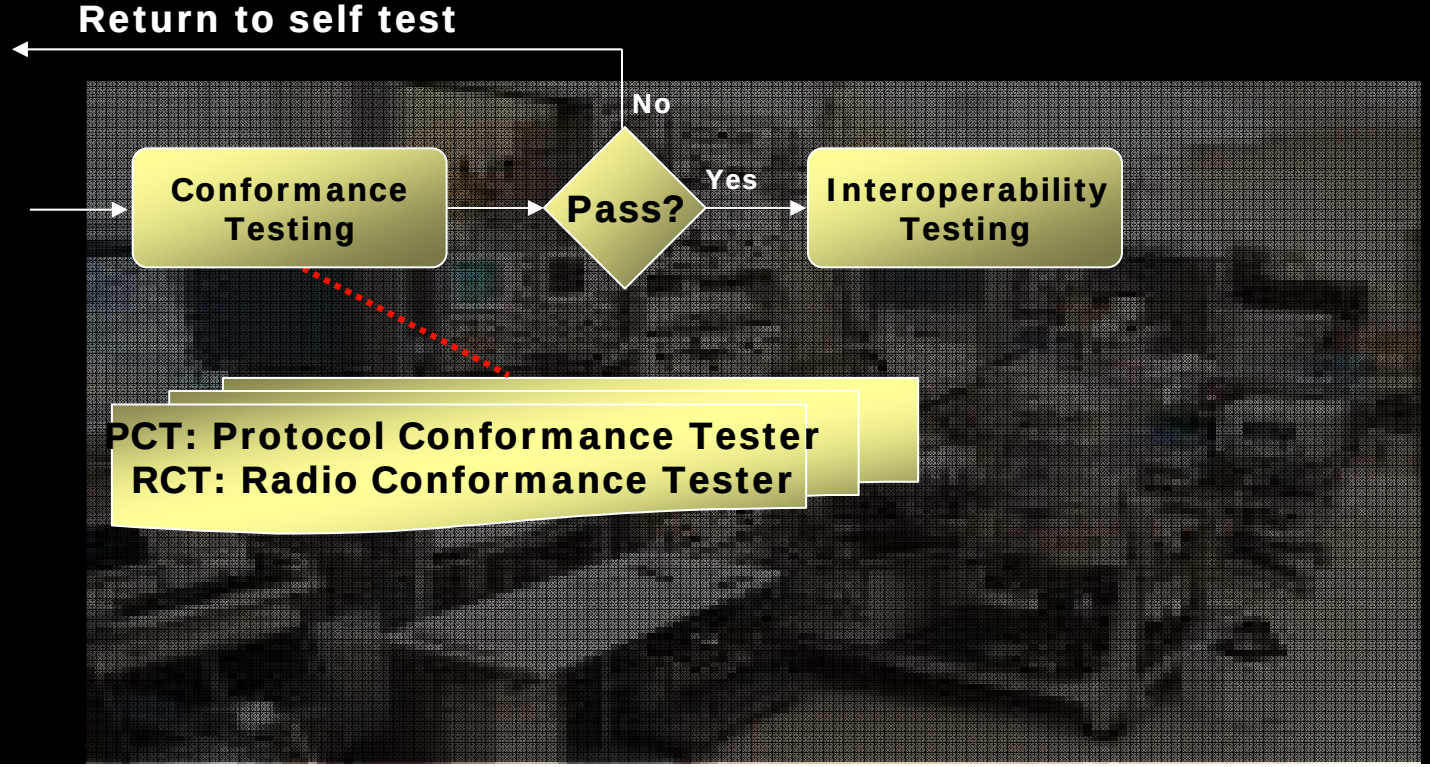
WiMAX Certification Process

- All tests must be performed at a certified WiMAX lab (CETECOM)
- Two steps to obtain WiMAX certified status

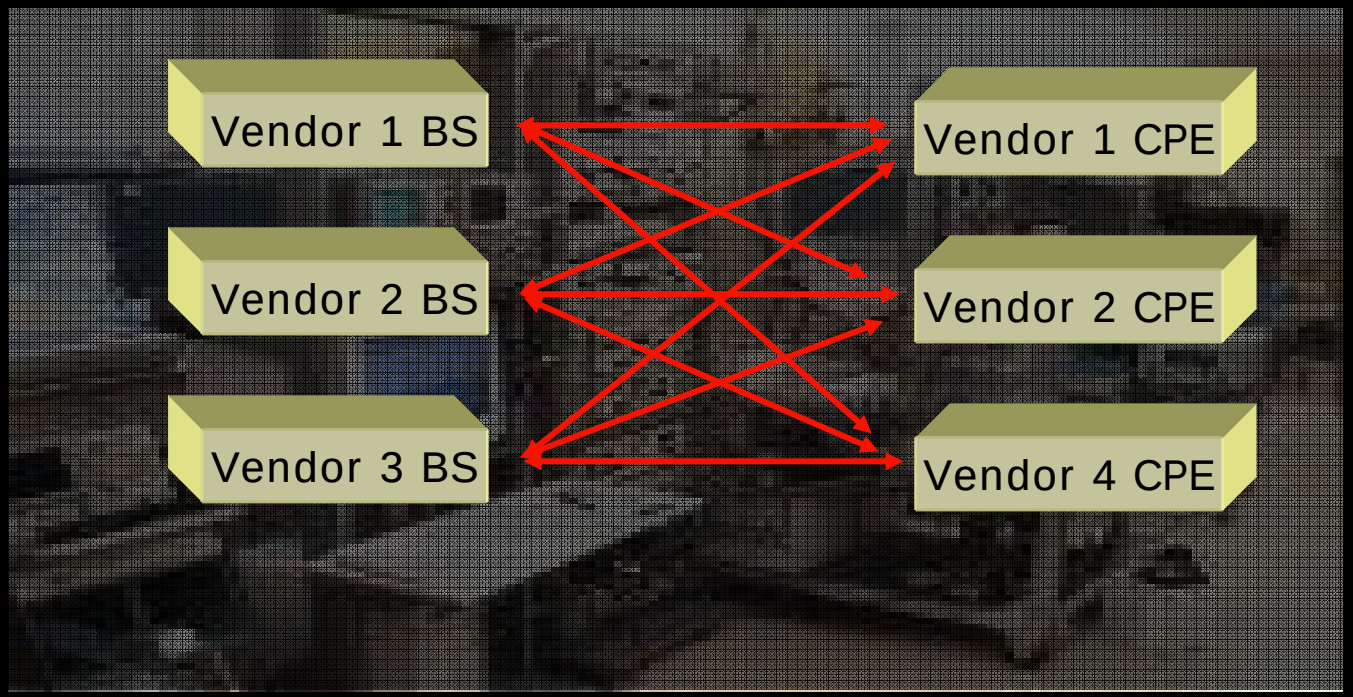
  Pass standard conformance tests (multiple waves/releases)

  Complete interoperability testing with two (3) other vendors



WiMAX Interoperability

- A minimum of three (3) vendors required
- Must test at least three (3) separate products



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2007-2008 NWG/NWIOT TG F2Fs

Oct 22 – 26, 2007, Taipei WiMAX Forum Member Conference

Dec 3 – 6, 2007, Santa Clara – SPWG F2F Air Interface

Dec 10 – 14, 2007, Tel Aviv Alvarion NWG F2F

- **NWIOT TG F2F December 10, 2007**
- **NWG Interim F2F December 11 – 14, 2007**

Jan 28 – Feb 1, 2008, Kona WiMAX Forum Member Conference

- **NWIOT TG F2F January 28, 2008**
- **NWG F2F January 29 – February 1, 2008**

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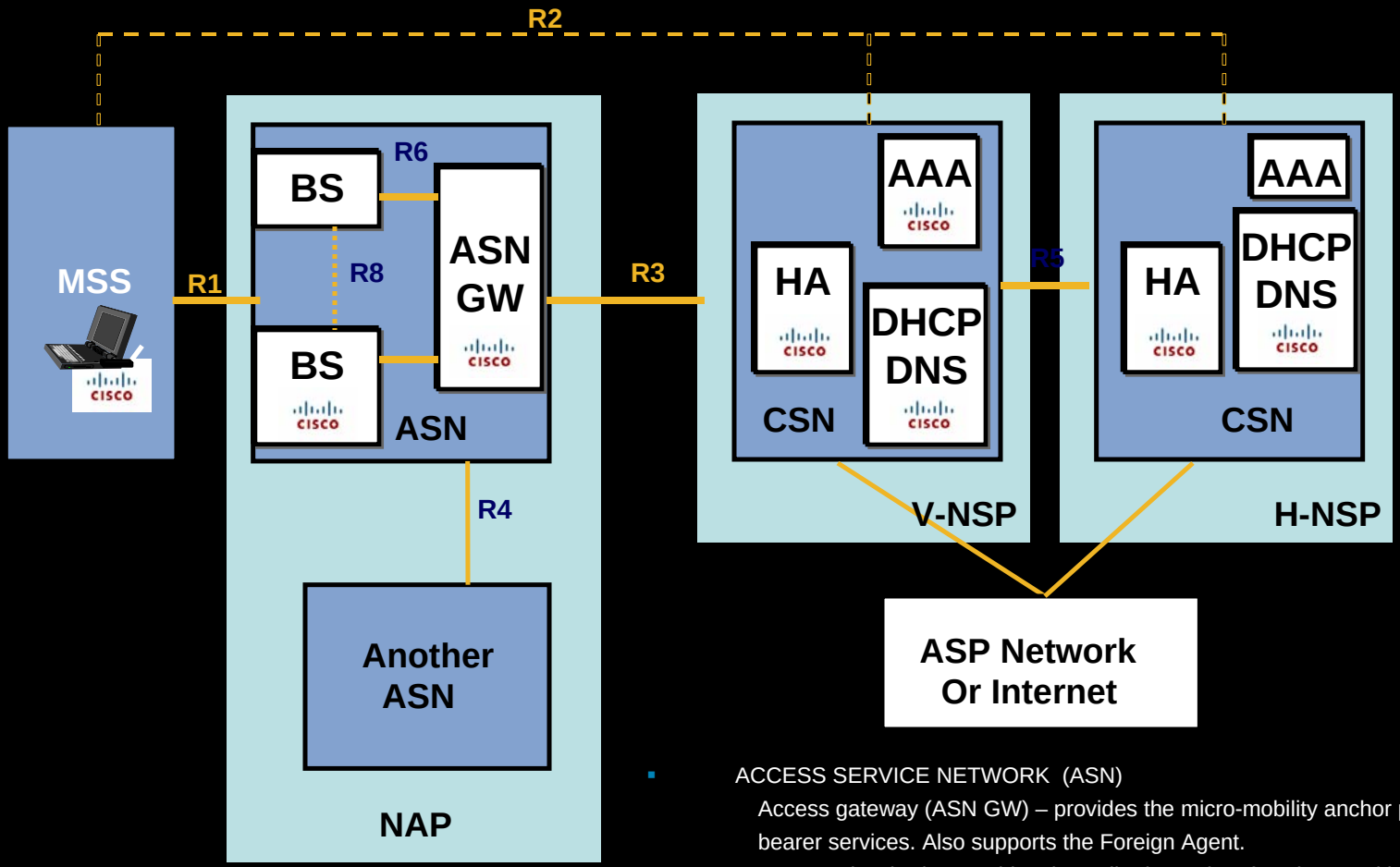
WiMAX End to End Network Reference Model



R1: 802.16e (MSS-ASN)

R2: MSS – CSN

R3: ASN GW – HA

R4: Inter-ASN

R5: CSN-CSN

R6: BS - ASNGW

R8: Inter BS

MSS – Mobile Subscriber Station

NAP – Network Access Provider

NSP – Network Service Provider

- ACCESS SERVICE NETWORK (ASN)
  - Access gateway (ASN GW) – provides the micro-mobility anchor point and supports bearer services. Also supports the Foreign Agent.
  - Base station (BS) – provides the radio dependent functions and has limited IP functionality
- CORE SERVICES NETWORK (CSN)
  - Home agent (HA) – provides the macro-mobility anchor point and supports bearer services , if roaming/mobility is desired.
  - Other Network Elements such as AAA, DHCP servers and more are also in the CSN.

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ASN Profiles

- **Three ASN Profiles have been specified in WiMAX as a tool to manage diversity in ASN node usage and implementation**
  - **Release 1 of NWG Specifications on WiMAX supports 3 ASN**
- **Profiles:**

  Profile A:

  • Centralized ASN Model with BS and ASN GW in separate platforms through R6 interface

  • Split RRM: RRA in BS and RRC in ASN-GW

  • Open interfaces for Profile A: R1, R6, R4, and R3

  Profile B:

  • Distributed ASN solution with the BS and ASN GW functionalities implemented in a single platform

  • Open interfaces Profile B: R4 and R3

  Profile C: Similar to Profile A, except for RRM being non-split and located in BS. A big departure from the way things used to be done in the mobile radio world.

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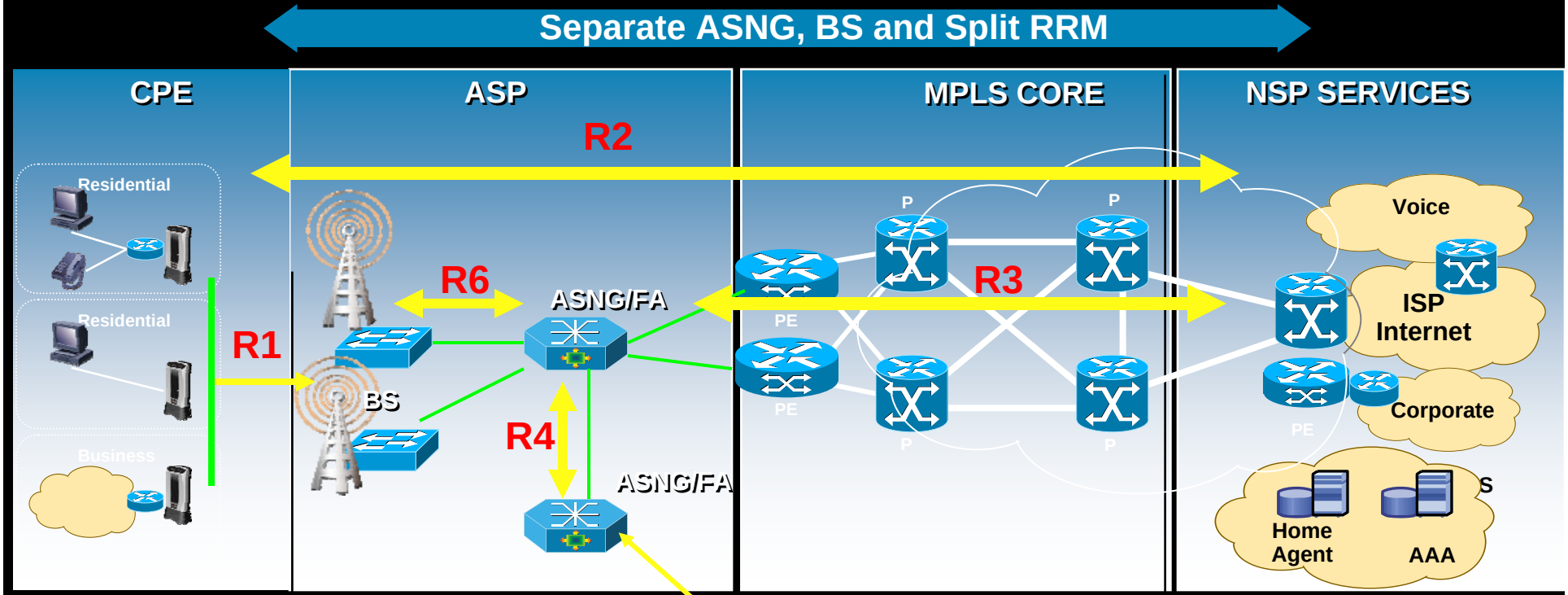
ASN Profile A -
removed from Standards



ASN Profile A

- HO
- Data Path 1 & 2
- Authentication Relay
- Paging Agent
- Key Receiver
- Context
- RRA
- SF Management

BS

R6

- HO
- Data Path 1 & 2
- Authenticator
- Key Distributor
- Context
- RRC
- SF Authorization
- DHCP Proxy/Relay
- MIP FA
- Location Register
- PMIP Client
- AAA Client
- Paging Controller

ASN-GW

R3

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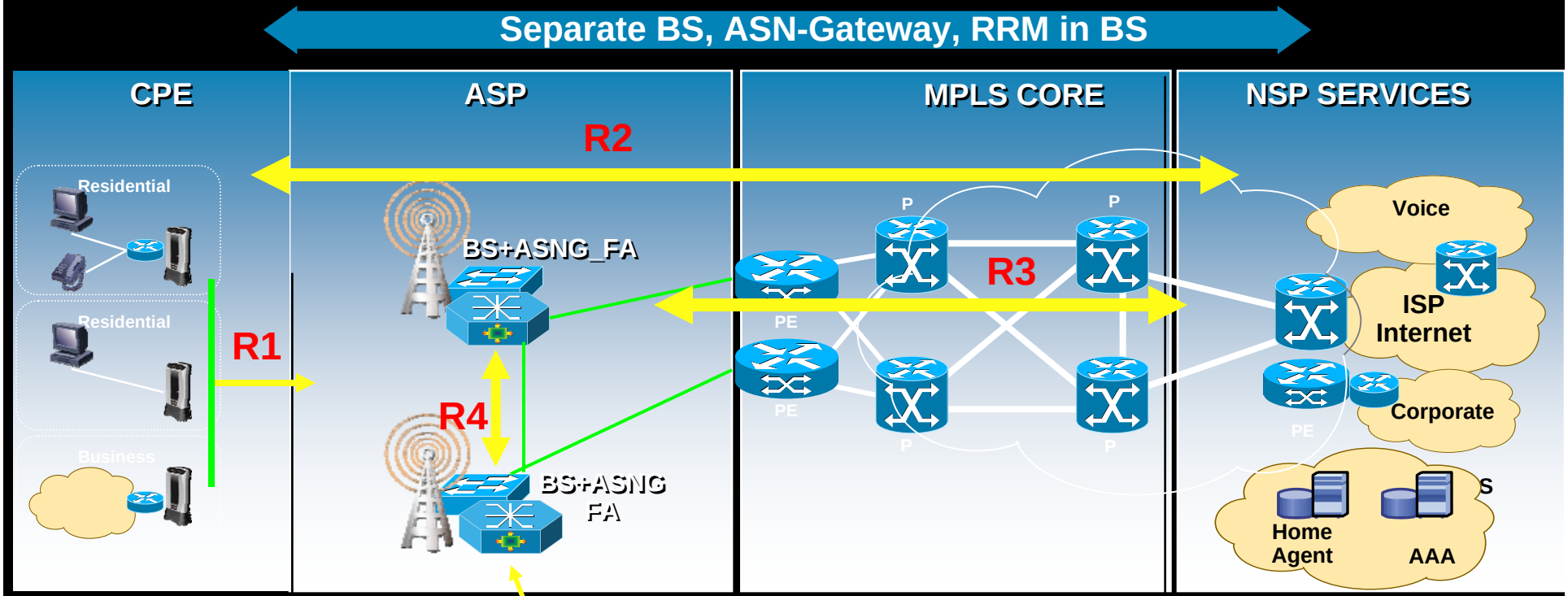
ASN Profile B –
no future development



R4

ASN Profile B

- HO
- Data Path 1 & 2
- Authenticator
- Key Rec. &Dist.
- Context
- RRA + RRC
- SF Auth & Mgt

- DHCP Proxy/Relay
- MIP FA
- Location Register
- PMIP Client/Assist
- AAA Client

R3

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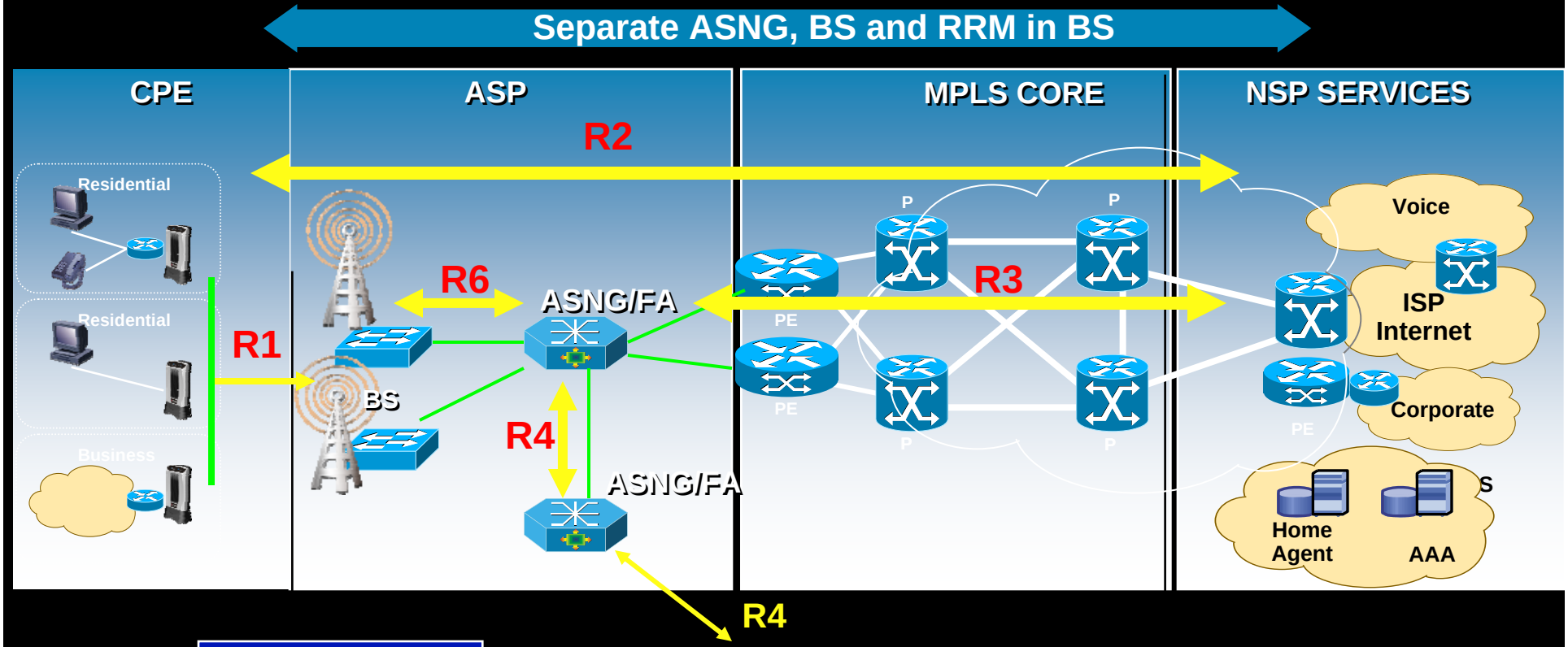
ASN Profile C -
approved and current development



ASN Profile C

- HO
- Data Path 1 & 2
- Authentication Relay
- Paging Agent
- Key Receiver
- Context
- RRA + RRC
- SF Management

R6

- HO
- Data Path 1 & 2
- Authenticator
- Key Distributor
- Context
- SF Authorization

- DHCP Proxy/Relay
- MIP FA
- Location Register
- PMIP Client
- AAA Client
- Paging Controller

R3

BS

ASN-GW

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Profile Comparison

ASN Profile	Description	Pro	Con
Profile A (Deprecated)	Centralized platform Separate BS and ASNGW Split RRM: RRA at BS and RRC at ASN-GW PHY and partly MAC in BTS Handover-Control (RRM) in ASN-GW. Routing and AAA/Paging in ASN-GW	Able to provide simplified pico-cell Able to provide soft handover Fewer backhauls for RRM messages	Difficult Interoperability between BS and ASNGW from different vendors Heavy workload at ASN-GW Fewer vendors
Profile B (No further Development)	Distributed platform Combined BS and ASNGW BS anchored by standard router Inter-BS control over Ethernet	Simple architecture Suitable for small-scale deployment	Difficult to customize IP and wireless functions for operators Expensive for large scale deployment
Profile C (Standards Track)	Distributed platform Separate BS and ASNGW All RRM functions in BS Handover-Control (RRM) in BS Routing and AAA/Paging in ASN-GW	Able to provide simplified pico-cell Open – multi -vendors can supply BS and ASNGW	Extra backhauls for RRM messages

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WiMAX 802.16 Service Flow
Model Definitions

- Packets are associated with a service flow, which is the central concept of the MAC protocol
- *Service flow* = an unidirectional flow of packets with a particular QoS
- Service flow has parameters like bandwidth, latency, jitter and other QoS-related variables
- When data comes to MAC layer, the convergence sublayer gives it an connection ID (CID)
- The service flow is mapped to this ID {CID,SFID}
- The Service Flow ID is fixed across Base-Stations. Each Base-Station maps a SFID to a new CID.
- Created on-demand or pre-provisioned
  - On-demand SF creation subject to authorization against permitted QoS parameters

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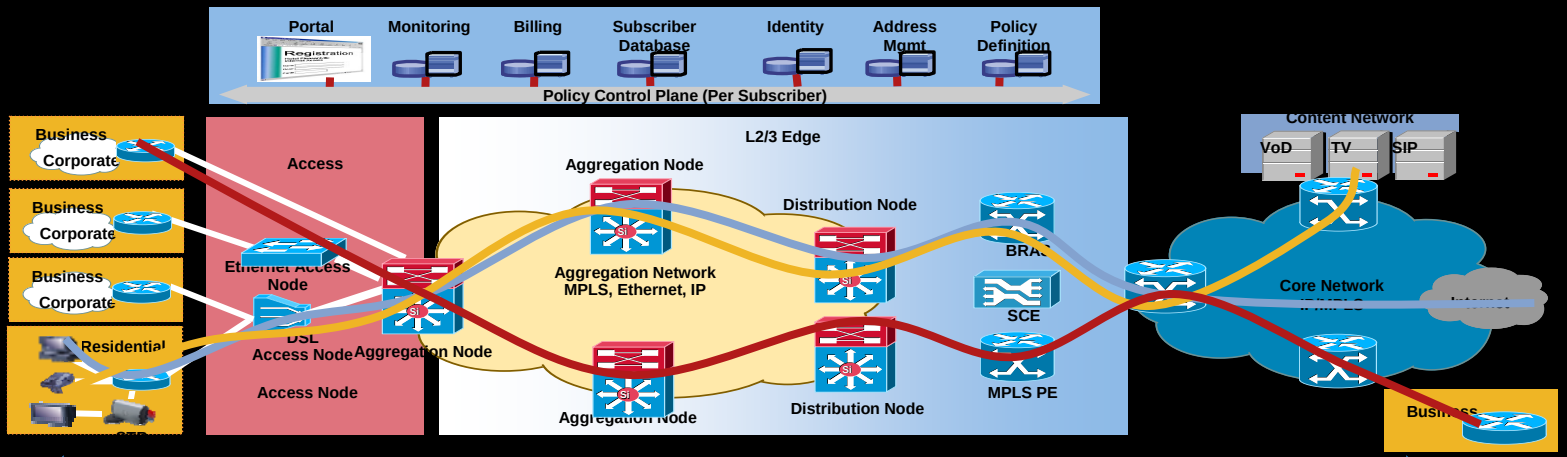
WiMAX Solution QOS
Architecture using IP-NGN



Consumer and Business Traffic Utilize Per-Subscriber or Per Service QoS Model in Access, Aggregation and Core

Traffic Class	Core /Edge/ Aggregation			Access	UNI		
	MPLS/IP			Ethernet	DSL, ETTX	DSL	**WiMAX**
	PHB	DSCP	MPLS EXP	802.1P	802.1P	ATM	**802.16**
Control Protocols Network Management	AF	48	6	(6)	(6)	VBR-nrt	**nrtPS**
Residential Voice	EF	46	5	5 and 7	5 or 7	VBR-rt	**rtPS**
Business Real-time	EF	56	7				
Residential TV and VoD	AF	32	4	4 and 3	4	VBR-nrt	**NA**
Residential D-Server Video	AF	24	3				
Business Critical In Contract Business Critical Out of Contract	AF	16 8	2 1	2 and 1	2 1	VBR-nrt	**nrtPS**
Residential HSI Business Best Effort	BE	0	0	0	0	UBR	**Best Effort**

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WiMAX QoS & Scheduling Schemes

Specifications & Applications…

QoS Category	Applications	QoS Specifications
UGS Unsolicited Grant Service	VoIP	•Maximum Sustained Rate •Maximum
rtVR Real-Time Variable Rate Service	Streaming Audio or Video	•Minimum Reserved Rate •Maximum Sustained Rate
ErtVR Extended Real-Time Variable Rate Service	Voice with Activity Detection (VoIP)	•Minimum Reserved Rate •Maximum Sustained Rate •Maximum
nrtVR Non-Real-Time Variable Rate Service	FTP File Transfer Protocol	•Minimum Reserved Rate •Maximum Sustained Rate
BE Best-Effort	Data, Web Browsing, etc.	•Maximum Sustained Rate

- **Service Flows**:

  Mechanism defined in Mobile WiMAX to provide QoS

  Uni-directional flow of packets associated with certain defined QoS parameters for traffic

- **Connections:**

  Unidirectional logical link between BS and CPE

  Each connection is associated with a service flow delivering the necessary QoS over the air interface

- **Packet Classifiers:**

  Each service flow also has packet classifiers associated with it to determine criteria used by the MAC layer to associate packets into service flows

- Mobile WiMAX scheduling based on QoS service Flows associated with each packet

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WiMAX Solution Security and Authentication
Framework Overview…

- **PKMv2 Framework**

  Mobile WiMax uses the Privacy and Key Management Protocol Version 2 (PKMv2) to manage all security, authentication and encryption schemes over the air interface

  PKMv2 manages AK security using PKM messaging between BS and CPE

- **Device and User authentication:**

  User authentication in Mobile WiMAX is done using EAP authentication schemes.

  Navini Mobile WiMAX solution supports EAP-TLS, EAP-TTLS and EAP-AKA etc

  Device authentication done using X.509 certificates in WiMAX CPE

- **Traffic Encryption:**

  Traffic encryption using 128 bit AES encryption scheme

  AES encryption keys derives from EAP authentication and transported over PKMv2 framework

- **Security context and associations:**

  All security and encryption contexts and associations maintained over mobility events and other network events

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Agenda

- WiMAX Value Proposition
- WiMAX Forum Update
- WiMAX Access - ASNG Architecture
- Cisco Broadband Architecture
- Broadband Wireless Solution Partners
- Q & A

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Cisco Broadband Wireless Solution

Fixed and Mobile WiMAX using Dot16d and/or Dot16e

- **Fixed WiMAX**
  - 802.16-2004 base stations (BS)
  - Layer 2 Interworking between BS and transport network
  - Transport based on 802.1q/ad or EoMPLS
  - Access Gateway (L2/L3 switch) provides IP address allocation, security policies (loose coupling with BS)
  - Intelligent Services and user identification function can be added via ISG
  - Immediate availability from WiMAX vendors (CPE and BS)

- **Fixed and Mobile WiMAX**
  - 802.16e-2005 base station
  - Layer 3 interworking between BS and transport network
  - Transport based R6 (GRE encapsulation)
  - ASN Gateway, authentication, QoS policy, DHCP, security, mobility (tight coupling with BS)
  - Fall 2007/Spring 2008 availability from WiMAX vendors, based on WiMAX forum certification timelines and volume quantities for BS and CPE

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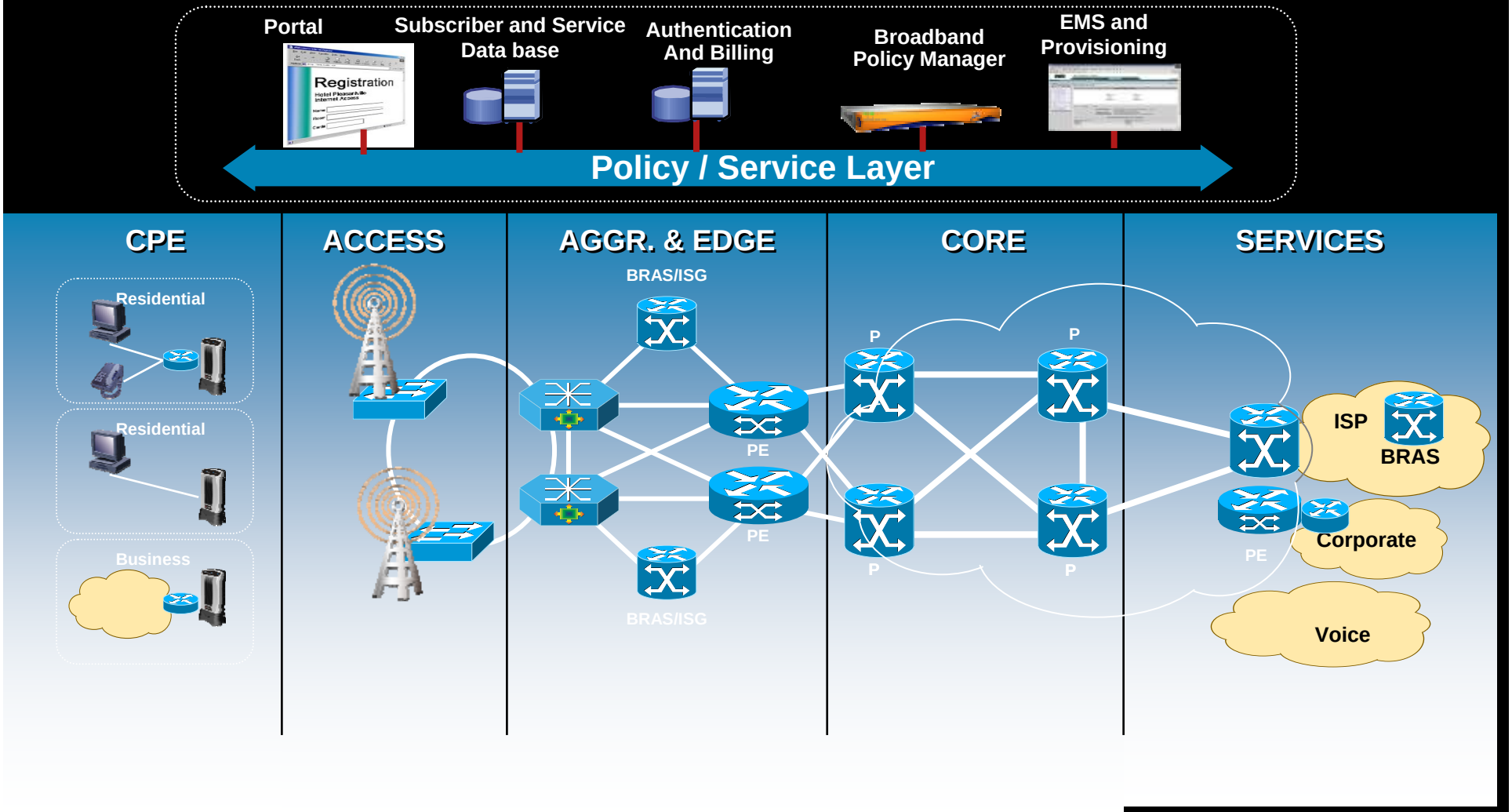
Solution Architectural Building blocks



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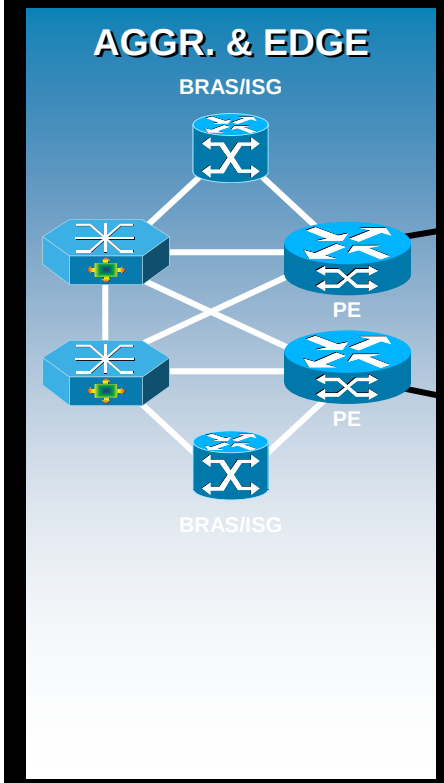
Aggregation and Edge Network



Distribution Node

- 7600
- Multi Access aggregation
- H-QoS
- EoMPLS Aggregation
- H-VPLS Switching
- MPLS PE
- DHCP Relay
- ASN Gateway module (Mobile WiMAX gateway)

BRAS/ISG

- 7200/7300/10K
- PPPoE/IPoE model
- Dynamic Subscriber Policy (RADIUS CoA)

MPLS PE

- 7600/12K
- MPLS PE
- EoMPLS/VPLS

Products

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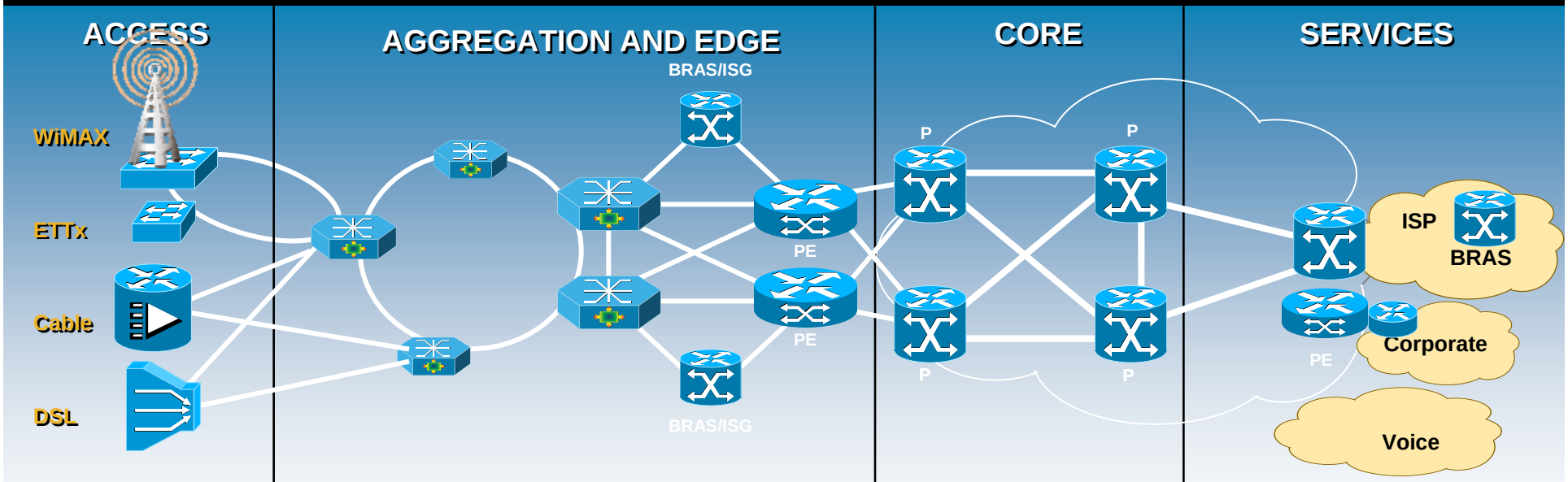
Cisco Broadband Wireless Solution

Multi Access Aggregation (including WiMAX)



- Solution utilizes any IP enabled access strategies (WiMAX, WiFi, ETTx, Cable, DSL, others…)
- Solution provides seamless and consistent services across all access types.
- Solution allows for Seamless Migration & Roaming using Cisco Mobile IP architecture

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Cisco ASN-gw

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Cisco ASN Gateway service module

- ASN-GW software will run on a service module in the 7600 Series Router
- Allows the system to rapidly scale by adding more service modules to meet traffic loads
- 7600 offers a variety of chassis configurations for different deployment scenarios
- A very robust and proven approach that has been used to support a variety of different applications in the mobile space
- A smaller “standalone”, 1RU high appliance based ASN-gw based on C7301 is available for Field/Demo trials

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Cisco ASNgw Overview

Architecture

→**Carrier Class Features**

- ASNgw Clustering using ASNgw-SLB
- Geographic Load Balancing & Scaling
- Stateful 1:1 Redundancy

- Deep Packet Inspection & Accounting
- Carrier-grade billing support using CSG2 (pre & postpaid)

C7600 based Service Module

Scaling

→**Carrier Class Performance**

- 8 Gbps per card using IMIX packet
- 100K Subscribers, 30% active, 70% idle
- Unlimited # of sessions per Subscribers

Software

→**Release 1 Features**

- Authentication/Security
- QoS
- Mobility (micro)
- IP address allocation
- Initial Network Entry of a user
- Service Flow creation for a user (with only pre-provisioned service flows)
- De-registration of a MS
- Support for unpredicted Hard Handoff
- Support for IP Convergence sublayer (CS) only

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ASNGW Roadmap (Sept 07)

RELEASE 1.0

EFT: 9 July 07 FCS: 14 Sep 07

Profile C → R6 (**IP-cs**), keepalive
C/U plane split

Profile B → FA (Standalone IOS)

Mobility

- Micro → Intra – ASNGW H.O
- Macro → MIPv4 in Ccoa

Authentication / Security (per domain)

- Unauthenticated / Emergency
- EAP
- Security Key Exchange
- Context Caching
- Per domain

Accounting (per domain)

- Post Paid
- Per Service Flow
- Advanced Billing, Pre-Paid, through CSG2

Address allocation

- DHCP Relay
- Option 82 (Remote, Circuit, VPN, Subscriber ID)
- Mutli-Host
- Overlapping address support

Static Pre-provisioning (per domain)

- QoS (ToS/DSCP,BE/NRT,RT/ER/UG, CBWFQ) rules
- Classifier rules
- Service flows (up to 4 --bi-directional--)

High Availability (7600)

- 1:1 card Intra and Inter chassis
  Stateful redundancy
- Load Balancing

NAP Sharing

- Connectivity/Domain
- VRF → MLS/VPN
- Tunneling Mechanism
- CSN Connectivity (GRE, MPLS,…)

NMS

- MIBS (systems & R6)

Hwr: 76xx /SAMI/ SUP720-3BXL
12.2(33).SRBxx

Hwr: 7301 (no SR or SLB support)

RELEASE 2.0 NC

PLAN CC: EC: EFT: Q1CY08
FCS: Q2CY08

Profile C → R6 (**Eth-cs**), Stage 3

Mobility

- Macro → CMIPv4/PMIPv4 (as per wimax)
  → in-line with HAR4.0

Enhancement VoIP Ph1

- Call Admission Control / Integration to Softswitch for Voice and Policy)
- PHS (Packet Header Suppression)

Enhancement QoS

- Dynamic QoS
- Rate limiting (Bidirectional bandwidth policing)

Dynamic Provisioning (Through AAA)

Push Services

- Idle/Paging/Location

Service Control / Awareness

- Hot Lining (CoA / PoD)
- PPP regen / L2tp
- per service flow VRF
- Client Network (NAP/NSP) Discovery
- Lawful Intercept
- Line Id (option 82)

NMS

MWTM support/ SNMP/ MIBs Enhancements (TBD)

Hwr: SUP32 (7604) / RSP720

RELEASE 3.0 NC

RADAR EFT: Q3CY08
FCS: Q4CY08 (radar)

Profile C → R6 (IPv6-CS/16ng ?)

Mobility

- Micro → R4
- Marco → Cmipv6/ NEtlmn?

Enhancement VoIP Ph2

- R4
- Low Latency Support / Bi-casting
- Gx+ Diameter

Address allocation

- AAA based IP address allocation
- Local pool

Single IP

Service Control / Awareness

- Broadcast / Multicast Services
- Auto Domain, ISG/SCE
- IPv6: IPv6-to-IPv4
- Prepaid Billing

NMS

- Provisioning through Network Management
- MWTM Enhancements (TBD)

Hwr: MCP

FCS = First Customer Ship **EFT = Early Field Trials** **EC = Execute Committed** **CC = Concept Committed** **NC = Not Committed**

HA Product - Roadmap

HA R4.0 (EC)

CC: Jan '07
EC: Feb '07
EFT: Oct '07
FCS: Dec '07
Platform: SAMI, (CC for 7301)

- Hot-lining: Support HSRP-HA, Support for new standard
- CPS rate increase to 900/processor
- CAC (Call Admission Control), Metrics affecting CAC, CLI for max bindings and DFP
- SIP roaming support (LNS)
- QoS: Support MQC feature set including traffic shaping
- **WiMAX: HA-AAA attribute support for WiMAX**
- Mobile IPv4 Host Configuration Extensions RFC4332
- Priority metric for local pool
- MAR Support, assignment of subnet to MAR
- Framed Pool
- MIP/LAC

HA R5.0 (NC)
Planning/Requirements Stages

CC: Q4 '07
EC: Q4 '07
EFT: Q2 '08
FCS: Q3 '08
Platform: SAMI, 7301

- MIPv6
- Additional VRF support
- MIB Enhancements
- Legal Intercept, CALEA
- Subscriber tracking
- Single Interface
- **WiMAX enhancements, support for Cisco ASN-GW R2**
- GRE Keying
- Simultaneous LNS and HA on a processor
- Dynamic Home Agent Assignment

HA Future (NC)
Radar

CC: Q3 '08
EC: Q3 '08
EFT: Q1 '09
FCS: Q1 '09
Platform: SAMI, MCP

- **Diameter Policy Interface**
- **Flow based QoS for Rev A/B**
- **MBMS**
- **L3 Geographical Redundancy**
- **L2TP Redundancy**
- **MAR Support, Dual Path Application Routing**
- **MIP Dual Anchor for fast Handoff**

FCS = First Customer Ship **EFT = Early Field Trials** **EC = Execute Committed** **CC = Concept Committed** **NC = Not Committed**

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WiMAX Services

Residential Services

- Internet Access
- Parental Control
- Residential Voice
- Walled Garden

Business Services

- Managed Services
- L2 VPN
- L3 VPN (MPLS)
- Internet access and presence
- Backhaul of Hotspots

Wholesale Services

- Internet Access
- Voice Services

Consumer Services

- Internet Access
- Voice Services

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Agenda

- WiMAX Value Proposition
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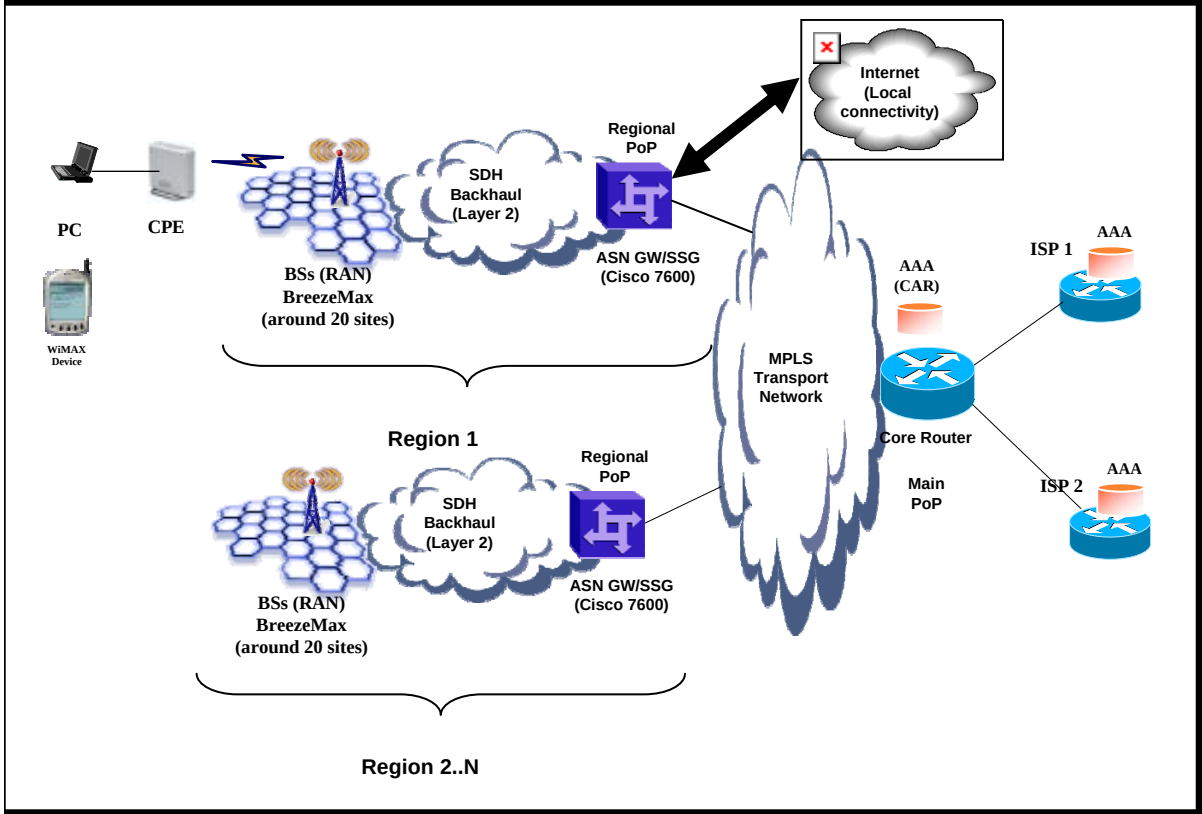
Broadband Wireless Solution Partner:
Alvarion



4Motion: Mobile WiMAX (802.16e) solution

- Fully complies with mobile WiMAX (IEEE 802.16e-2005)
- Employs an open, standard all-IP architecture enabling a Best-of-Breed multi-vendor solution
- Delivery of mobile and fixed video, voice, and data services
- Supports the full range of business, residential, and Personal Broadband services
- FCS expected Q1 2008

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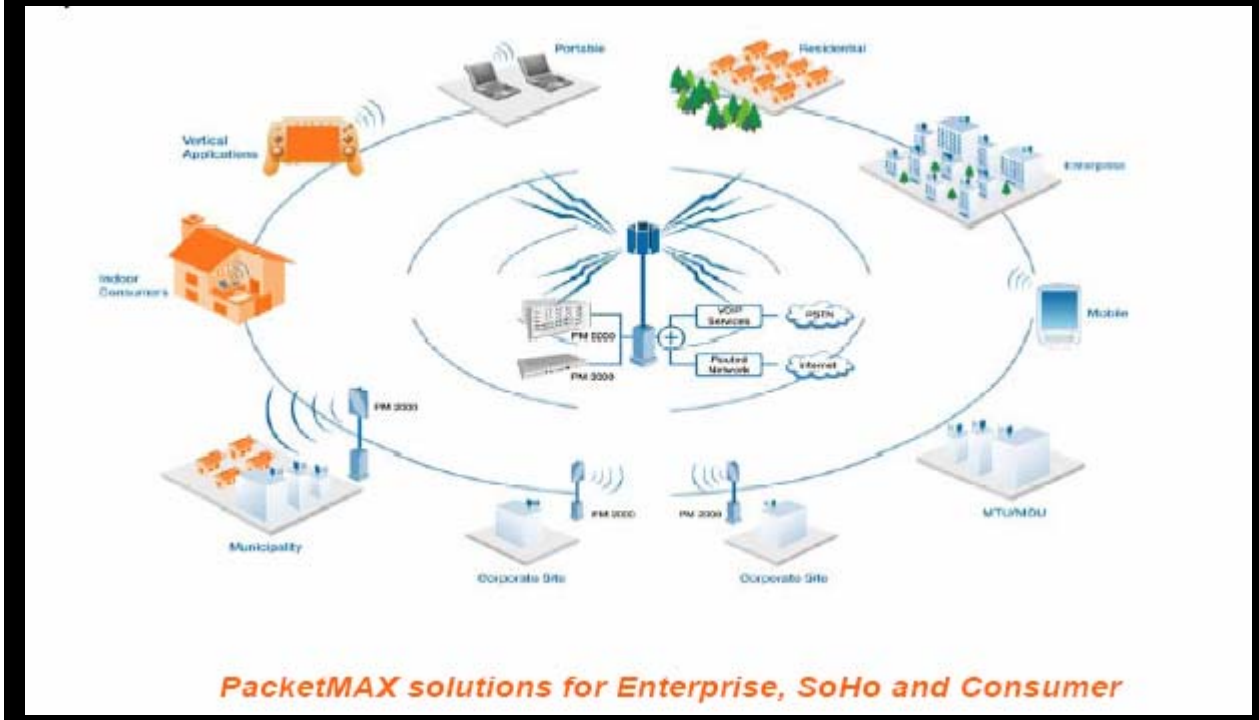
Broadband Wireless Solution Partner:
Aperto



PacketMAX solutions for Enterprise, SoHo and Consumer

PacketMAX architecture: 802.16e-2005 compliant base station offerings:

- **PacketMAX 5000** with WSC-e blade (wireless system controller) can accommodate both fixed and mobile subscribers
- **PacketMAX 4000** supports mobile WiMAX in a single sector "stackable" form factor
- **PacketMAX 3000** is optimized for fixed operation and can coexist in a mobile network
- **PacketMAX 2000** all-outdoor pico base station for mobile WiMAX

PacketMax CPE:

- **PacketMAX 100** series CPE are designed to suit the needs of a small office or home user.
- **PacketMAX 300** series CPE delivers the scalability and performance required by business grade users in an outdoor gateway form factor.
- **PacketMAX 500** series CPE provides a wireless alternative to DSL for indoor consumers.

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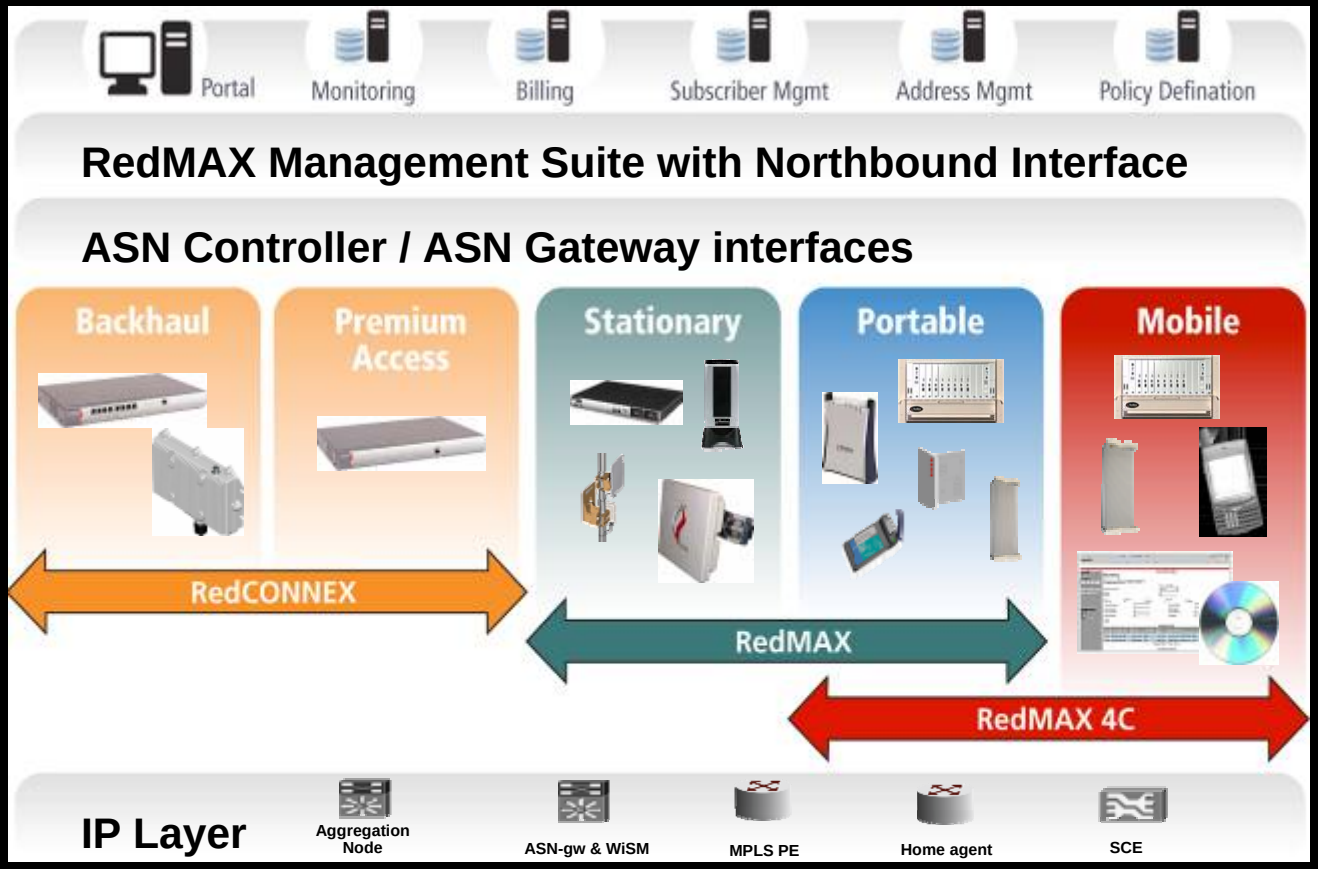
Broadband Wireless Solution Partner:
Redline



- Redline new RedMax 4C platform aimed at .16e-2005 Mobile Services.
- RedMax 4C includes MIMO and will be a Wave-2 Certified product.
- Redline demonstrated high per-sector occupancy rates, to enable better ROI for operators
- Redline is in discussion with Intel re: next-generation wave-2 CPE devices
- ASNgw IOT completion expected in August.
- FCS expected Jan/2008

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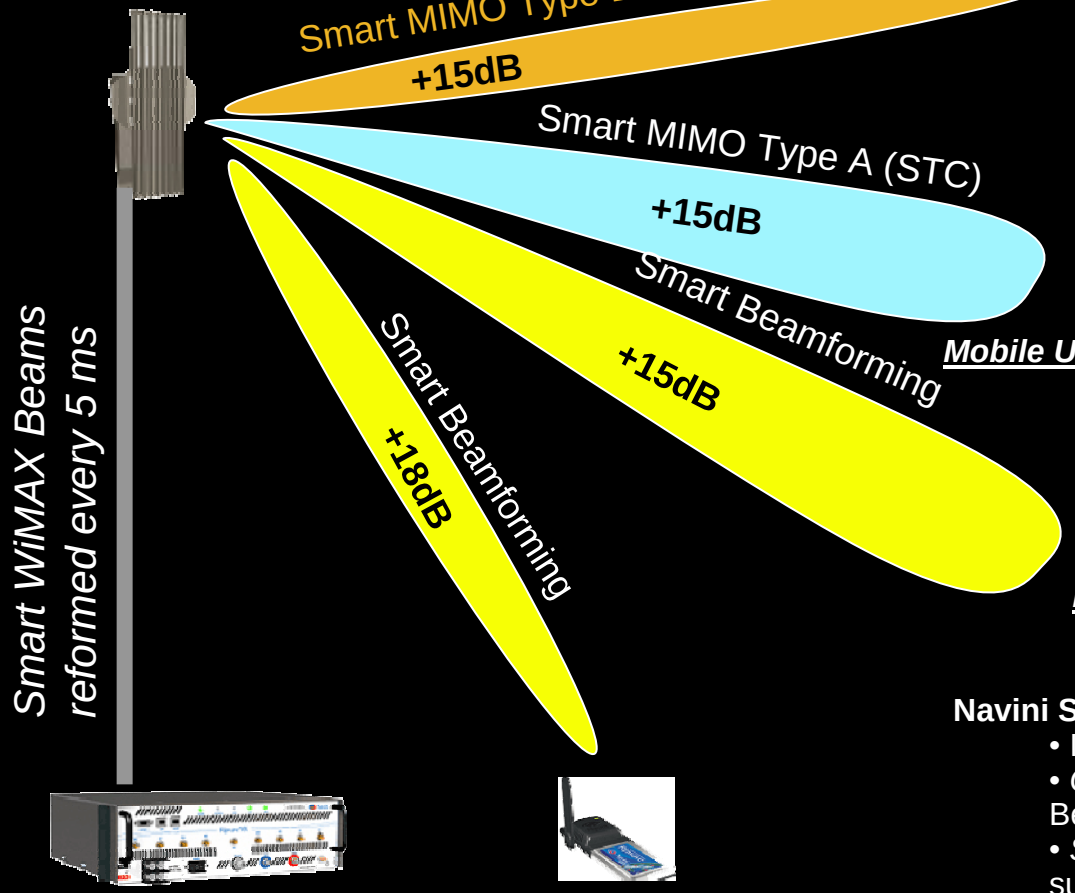
Broadband Wireless Solution Partner:
Navini



Stationary User with MIMO modem
(wave 2 modem with 2 antennas)

Mobile User with MIMO modem

Mobile User with Wave 1 modem

Stationary User with Wave 1 & 2 modem

Navini Smart WiMAX

- Integrates Beamforming, and MIMO *all in one system*
- *Combines* RF adaptations, using *both* MIMO and Beamforming simultaneously for any subscriber unit
- *Selects* the most effective MIMO adaptation on per subscriber basis
  - Mobile, portable, stationary
- *Switches* between MIMO type and Beamforming as required on timeslot basis
- FCS Expected for R6.2 in Q1/2008

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Why Navini?

Best-in-Class Innovation, Experience, Technology

Leading WiMAX Portfolio

- From base stations to modems
- Commercially deployed smart beam-forming technology
- Mobile WiMAX 802.16e-2005 compliant

Strong Value Proposition

- Yields OpEx and CapEx savings requiring up to 50% fewer sites
- Delivers higher peak data-rates and throughput – indoor and out
- 75 customers in 50 countries on 6 continents

Unmatched Innovation

- Advanced WiMAX RF capabilities
- Pioneering Smart Beam-Forming with MIMO; 13 patents, 49 more pending

Cisco Fit

- Shared IP-centric vision on mass market wireless broadband
- Geographically co-located (Richardson and Bangalore)
- Experienced people innovative culture

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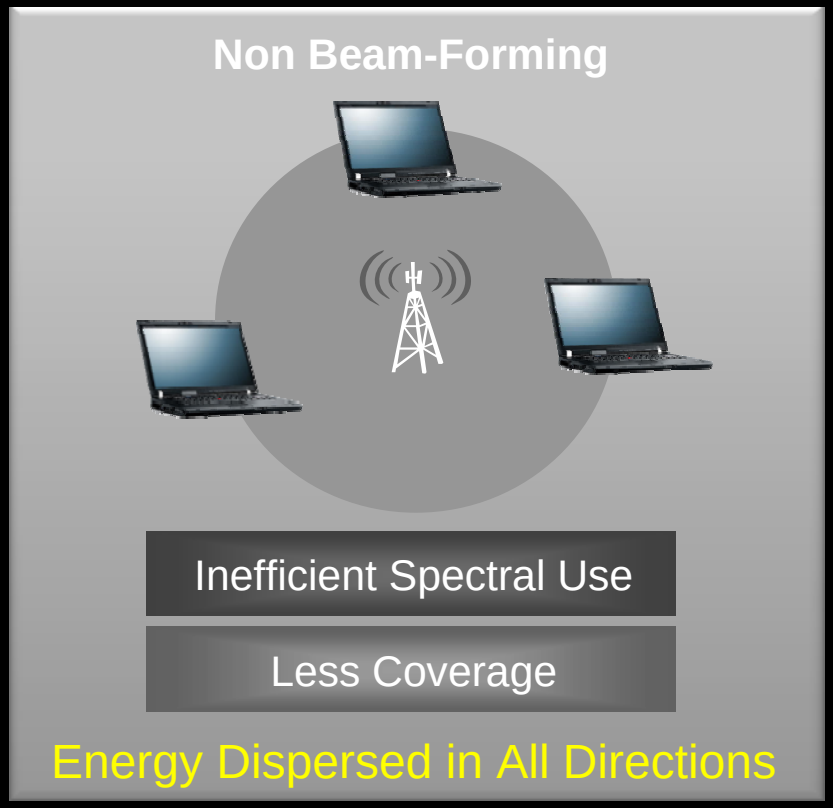
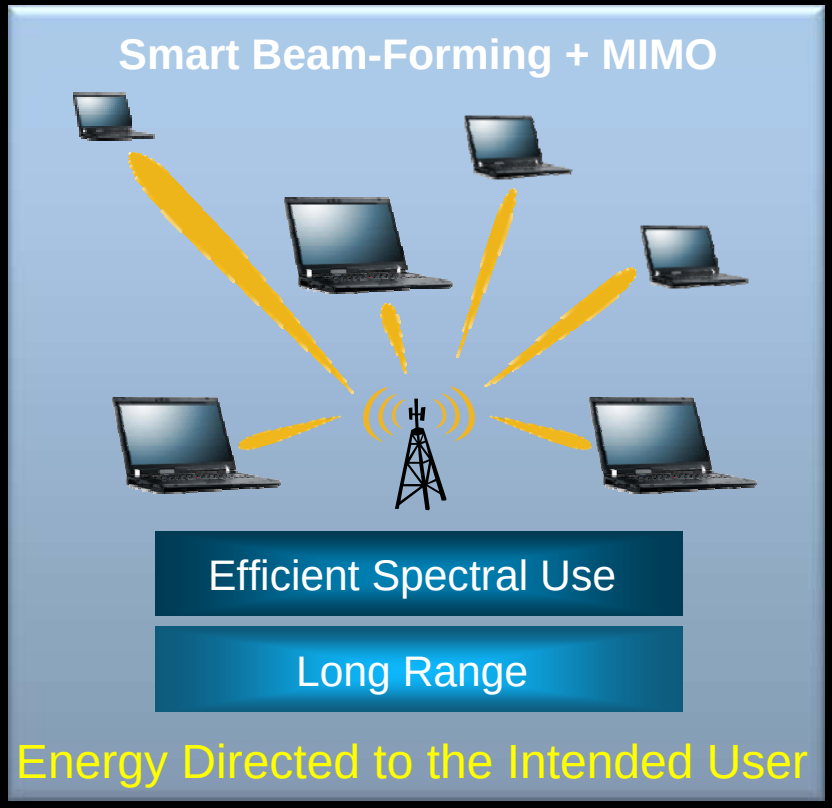
Navini Technical Leadership

The Only Commercially Deployed Smart Beam-Forming





Pioneering the Combination of Smart Beam-Forming with MIMO:

- Requires up to **50%** fewer sites than competition
- Yields up to **50%** savings in both OpEx and CapEx
- Enables the use of low powered consumer broadband devices (up to **4** times power reduction)
- Two to three times the network capacity
- Higher signal strength to both stationary and mobile users
- Enhanced indoor coverage / performance
- Improved roaming capabilities; fewer dropped signals

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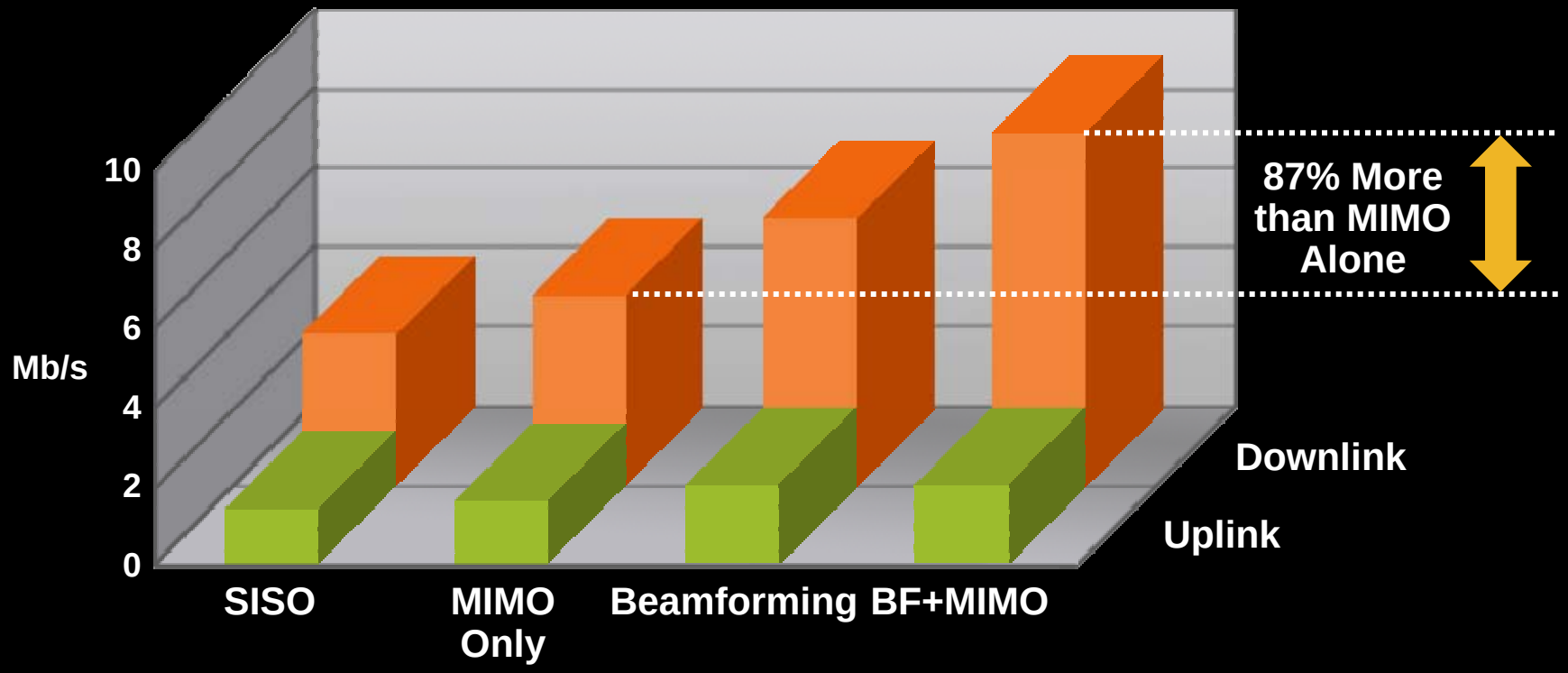
Navini's Leading WiMAX Performance

AAS: BeamForming + MIMO

Simulation based on:

- 21 Sector network
- 200 Users per sector
- 5 MHz OFDMA carrier
- N=3 Reuse
- 2:1 DL/UL Ratio
- 20kbps Min. at cell edge
- 2.5 GHz TDD
- 3GPP Mobility (SCM)



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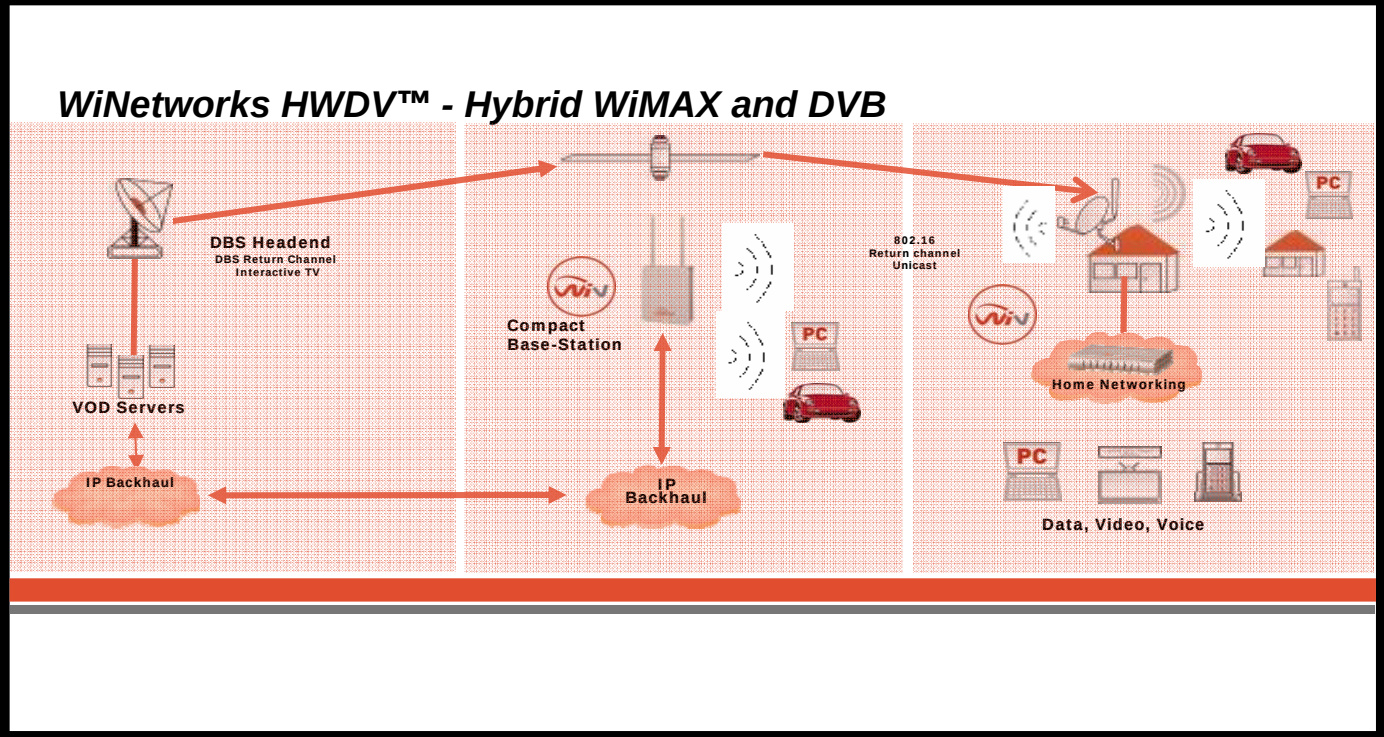
Broadband Wireless Solution Partner:
WiNetworks



- Mobile-WiMAX compliant based on IEEE 802.16e Mobile standard
- All outdoor installation - easy to install on walls, poles, power lines and cabinets
- Support of worldwide WiMAX deployments in the 1.X, 2.X and 3.X GHz bands
- Low cost of ownership - An ideal solution for entry-level deployment with a pay-as-you-grow build-out for rapid penetration into new market segments with minimal CAPEX
- Optimize link performance in NLOS conditions through STC/MRC and MIMO (2x2) radio technologies
- FCS expected Dec/2007 with Cisco ASN-gw R1.0

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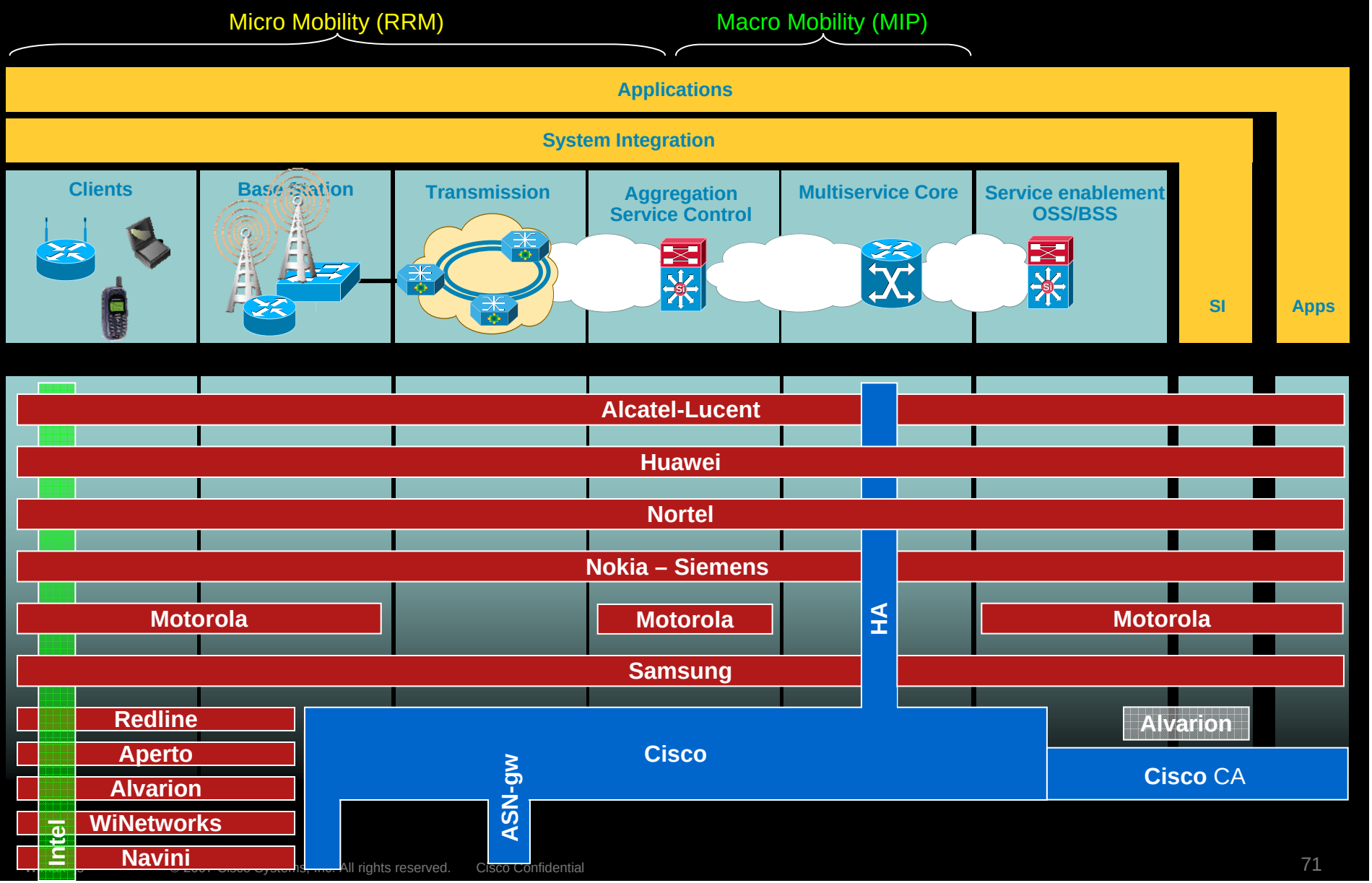
Cisco Broadband Wireless Market Overview

Partners & Competitors



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Agenda

- WiMAX Value Proposition
- WiMAX Forum Update
- WiMAX Access - ASNG Architecture
- Cisco Broadband Architecture
- Broadband Wireless Solution Partners
- Q & A

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Q & A

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