ITU-T Workshop on Multimedia in NGN

Multimedia Applications in 4G WiMAX Network - Impacts and Optimization

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Nortel

NORTEL
Business made simple

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Abstract submitted

Abstract:
New multimedia services and applications are now becoming available or will soon emerge, Many new services we have not even imagined yet will become reality in the years to come. End users love the new services, and are eagerly anticipating new ones. And they expect operators and equipment manufacturers to perform their "magic": make it all work perfectly! But we know it isn't magic. Rather, it is the right products deployed in well engineered networks. It is operators and manufacturers who have to deal with the changes in the infrastructure that are required to deliver these new and exciting services to end users. In this presentation, we will examine the impact of new multimedia applications such as VoIP and video over 4G network such as Mobile WiMAX. We will look at the obstacles, the overheads, the network engineering, performance benchmarking, and techniques and ideas for optimization of both the end user's and the network operator's experience

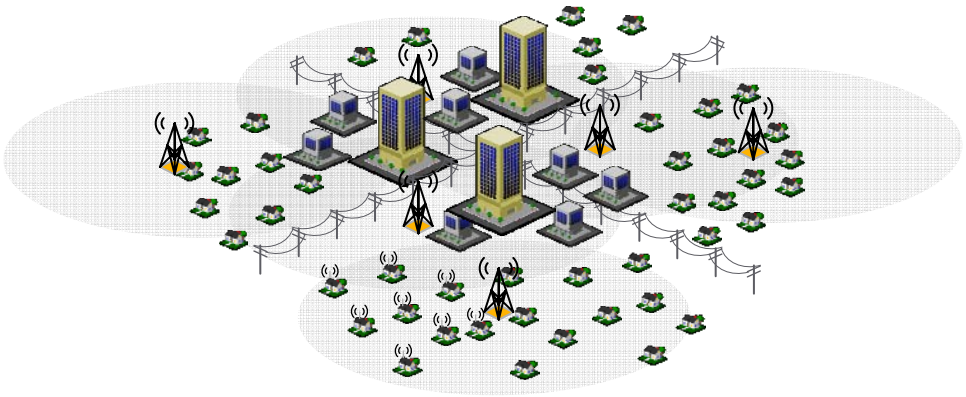
Topics

- WiMAX Market Overview
- WiMAX Architecture Overview
- Application Landscape and Challenges
- Application Enablers in WiMAX
- Video
- VoIP
- WiMAX Application QoE Enhancements

What is WiMAX?

The New Broadband Wireless Standard

Defined by IEEE and Industry, Globally endorsed



- 802.16-2004 (or 16d)
  - Predominantly Fixed
  - Deploying now
- 802.16-2005 (or 16e)
  - Portable / Mobile
  - Trials on-going, GA 4Q 2007

Key Drivers for WiMAX

Spectrum Allocation
WiMAX specific, 2-3 carriers /Country, TDD & FDD

Consumer Needs
Applications, Devices, Mobility

Markets & Segments
Emerging, Developed
Consumer & Enterprise

Why WiMAX?

Service Provider
New Business Model, TTM, Low Cost- High Performance

Strong Ecosystem
Competition, Innovation, Economical

Technology Innovation
OFDM,MIMO, All IP

vs. WiFi, 3G
Hotspot to everywhere
1/10th Cost $/bit

WiMAX Delivers Significant Value to Operators and End Users

The Next Generation Telecom World

PC
Cell

PC
Cell
PDA

PC
Cell
Laptop
PDA

PC
Cell
Laptop
PDA
Sensors
IP phone
Gaming
Security cameras

PC
Cell
Laptop
PDA
Sensors
IP phone
Gaming
Security cameras
iPhone

PC
Cell
Laptop
PDA
Sensors
IP Phone
Gaming
Security cameras
iPhone
Smart buildings
Home networks
⋮

# of network connections

# of people on network

The era of hyper-connectivity requires huge bandwidths

Wireless Options

Differentiating Wireless Technologies

	3G Cellular	WLAN / 802.11n	WiMAX / 802.16e
Coverage	Ubiquitous	Hotspot / Campus	Zone / Regional
QoS	Controlled	Shared Spectrum	Controlled
Mobility	Full, vehicular	Very limited	Fixed, portable, full mobility
Range	Miles	100-500 ft	Miles
User Speed	50–500 kbps	1-10 Mbps	1-10 Mbps
Architecture	Hierarchical	Flat, IP	Flat, IP

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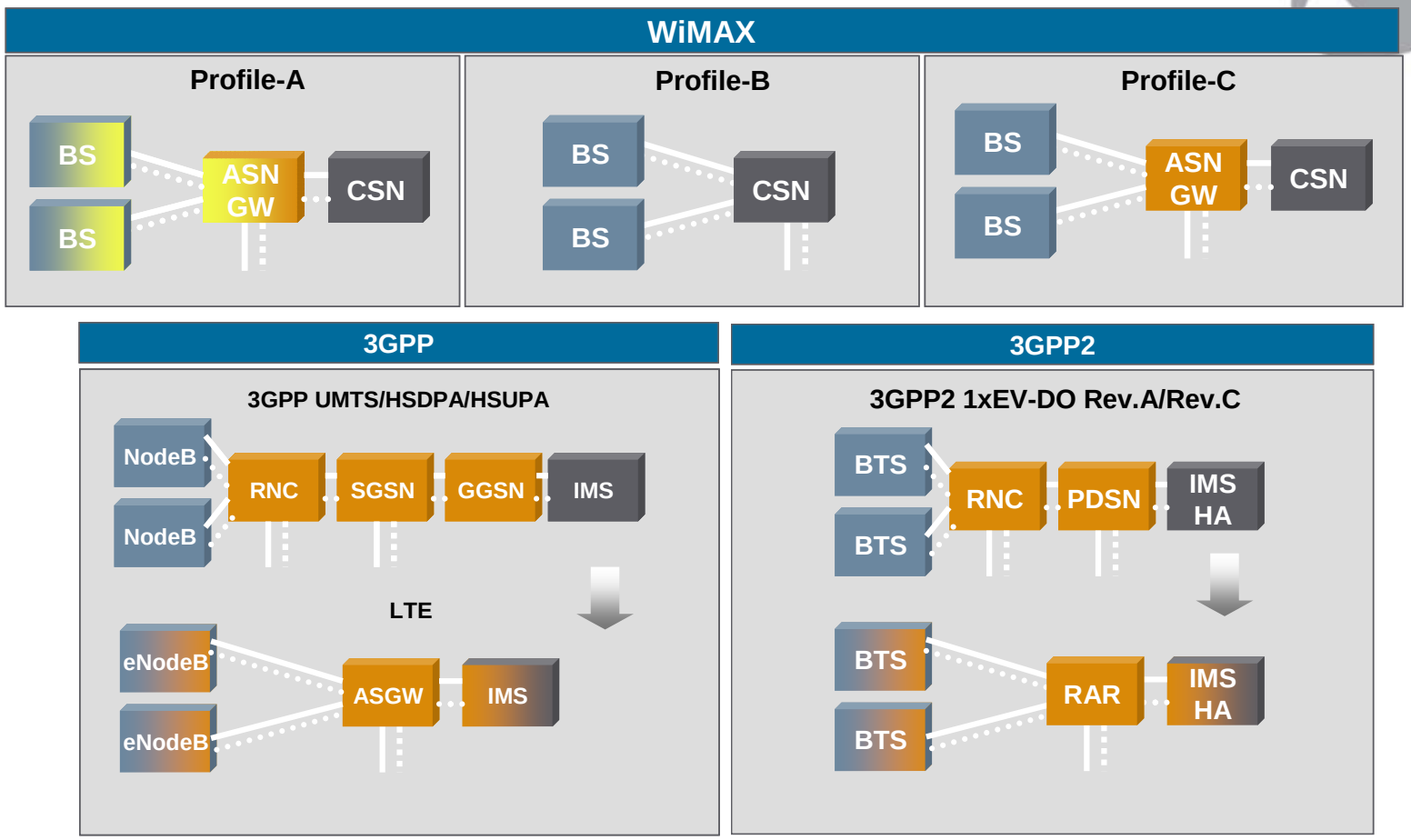
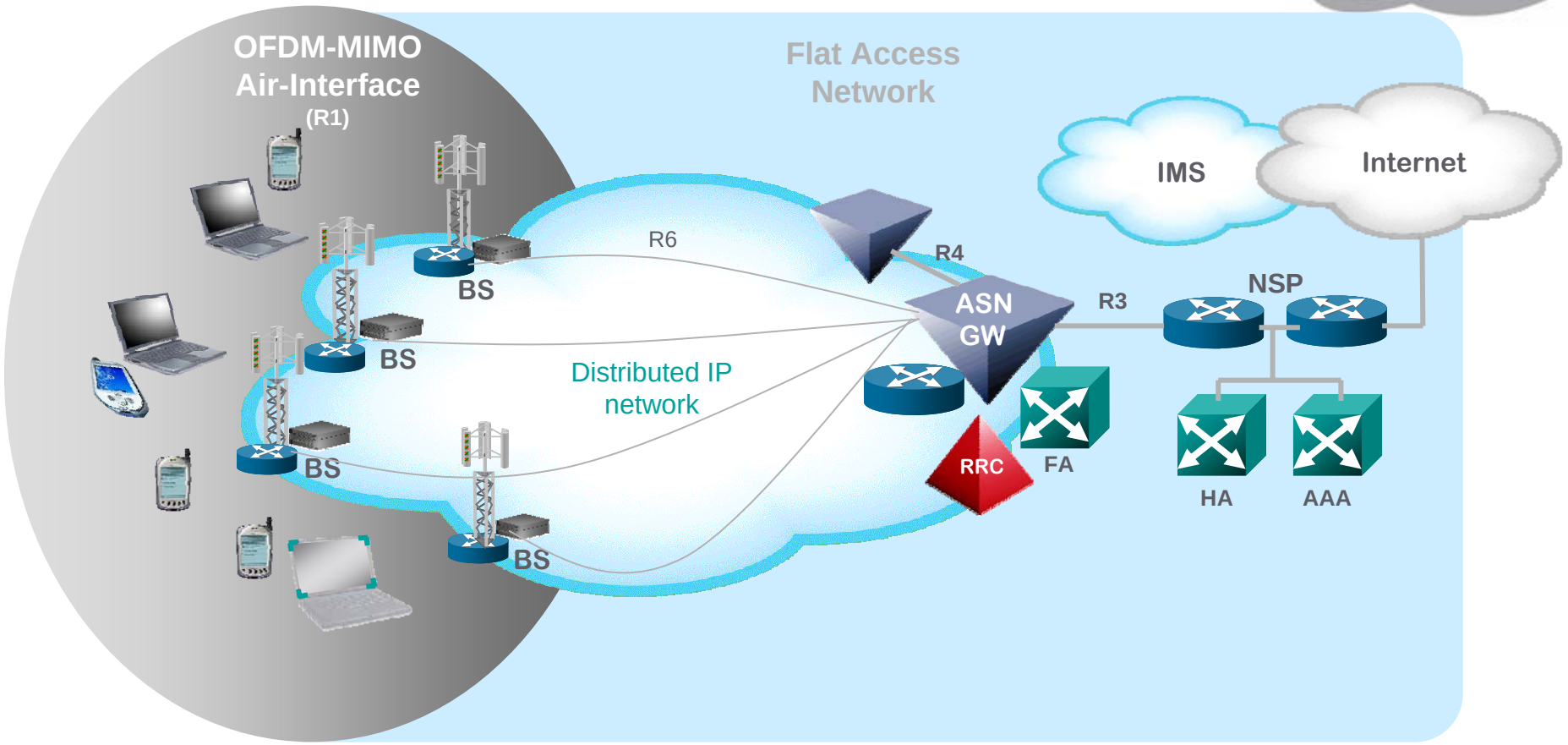
Next-Gen Networks Topology is Flat Network



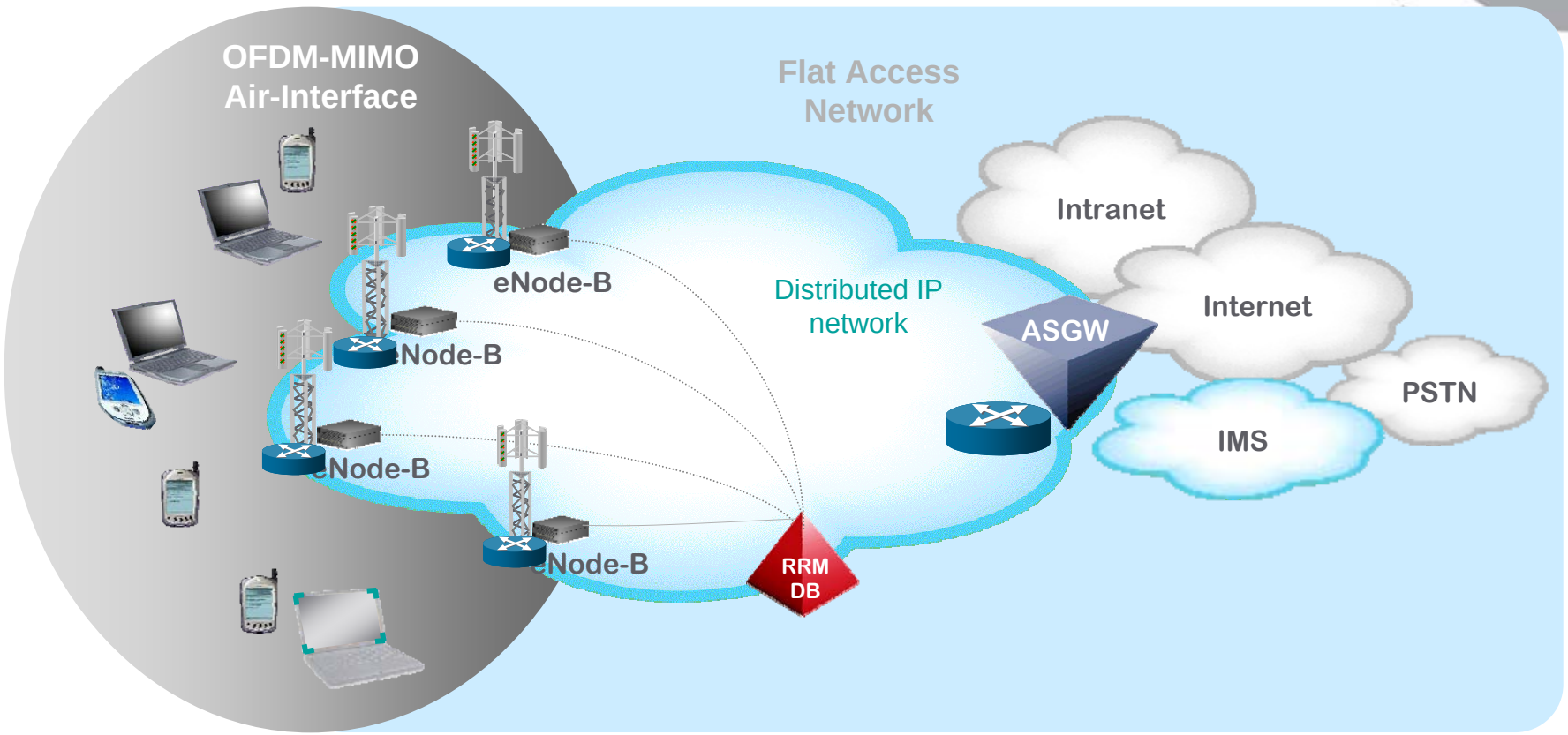
All standards converging to a similar Flatter IP-based architecture but distinct functional partitions

WiMAX Flat Network Architecture



Flatter Network Architecture Significantly Reduced Latency

LTE Flat Network Architecture



Simplified 2 Functional Entities on the User Plane eNode-B,ASGW

SGSN Control Plan → ASGW

RNC Control Plan → ASGW and eNode-B

“Edge” Similarities & Differences
ASGW vs RAR vs ASN-GW

> Similarities / opportunities for synergy
  - Common Layer 3 (& above) mechanisms
    - Bearer & subscriber control
    - Packet Inspection
    - QoS / Policy Enforcement
    - Security
    - Routing / forwarding
  - Mobile IP HA
  - Interfaces to IMS/MMD
  - OA&M

> Differences
  - Different Layer 2 “Access termination”
  - Different “RNC-type” functions on Edge platform
    - Macro-diversity
    - Mobility Management
    - RRM

A Common IP Services (L3) platform

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Explosion of Applications

>100 million mobile VoIP users by 2011 (On World Jun 06)

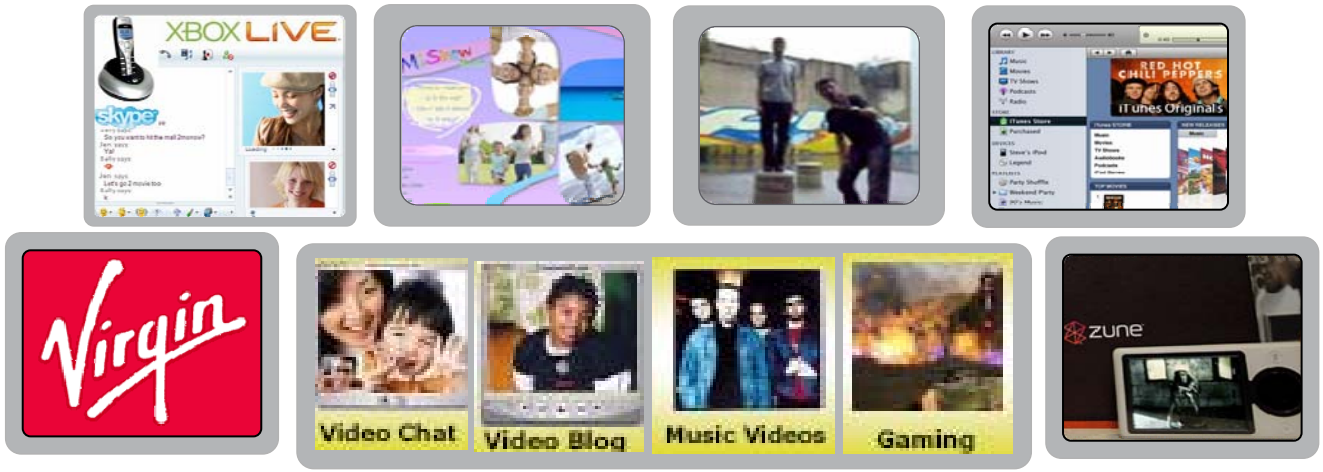
>Global wireless full track music download market to grow 8 fold from 2006 to 2011 to Euro 1.47bn (Screen Digest report, April 2007)

>1.3M text and voice messages are sent via Xbox Live every day (Microsoft 2006)

> In one month, the number of videos grew 20% to 6.1 million requiring 45 terabytes (WSJ Aug 06)

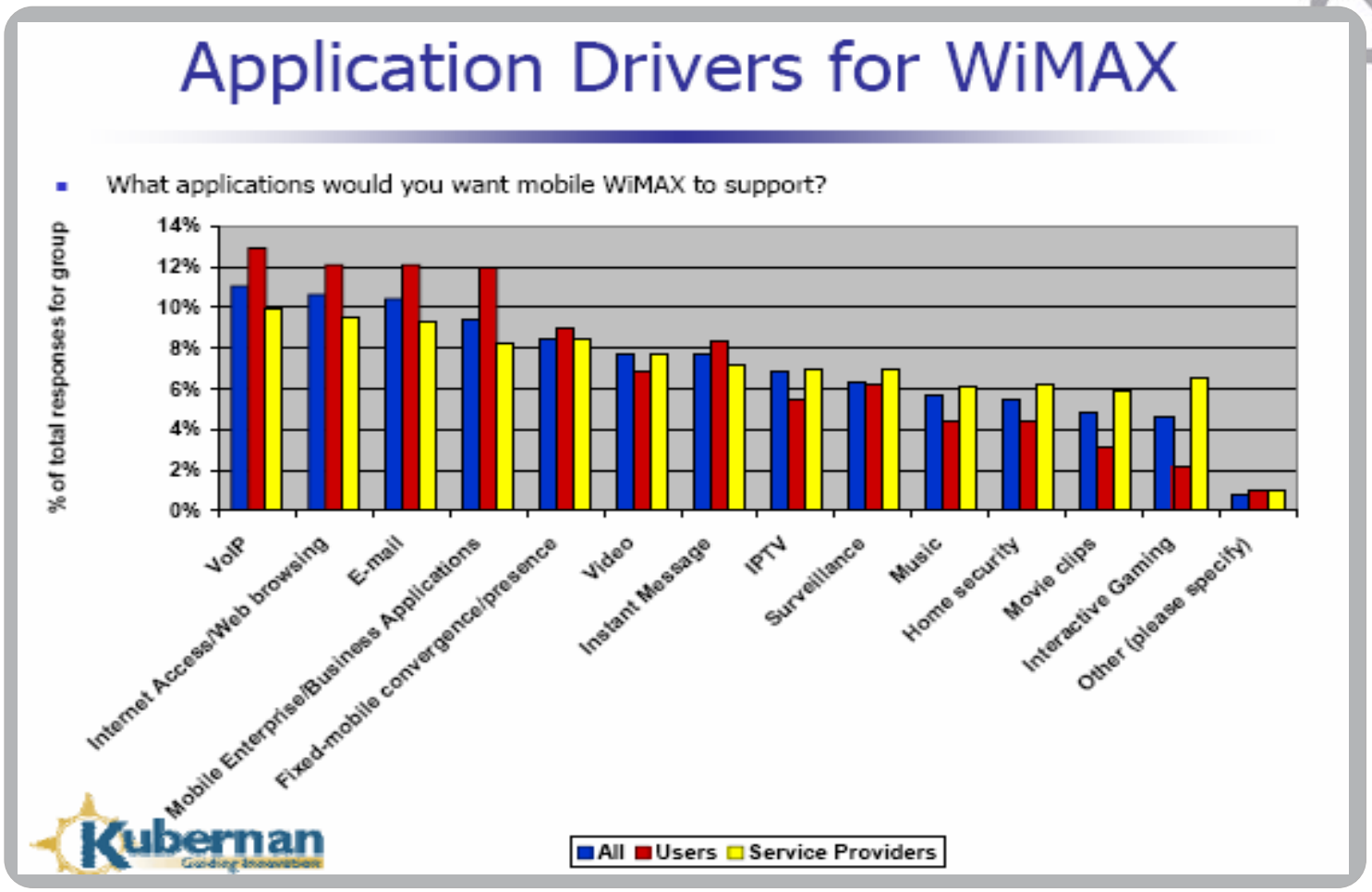
> Time spent watching YouTube since last year is 9,305 years! (WSJ August 06)

> 228 billion images captured by camera phones by 2010 (Infotrends Jan 06)



Bandwidth hungry applications require capacity

Webtorials Market Survey



WiMAX is expected to support both Voice and Data Applications

Application - Technical Challenges

VoIP Requirements	Technical Challenges	WiMAX Standard Effort
Capacity	Spectral Efficiency, Interference, Overhead	OFDMA, AMC, Sectorization
QoS	Multiplexing Services, Radio Resource Management, Air Transmission Reliability	16e MAC, Radio Link Scheduling, HARQ, AMC, 16e QoS
E2E IP Architecture	Adapting All-IP Architecture, E2E QoS	Standardization
Mobility	Latency, Session Continuity	Handover
Security	Privacy, Integrity, Access	Encryption, Authentication
NLOS Coverage	Multipath Fading, Interference	Diversity, Channel Coding
Cost	Cell Sites, Terminal Devices	Cellular Architecture, Standardization, IP Architecture
Power Consumption	Terminal Portability	Power-efficient Modulation, Power-saving Modes

Standard Compliance only Ensures Basic Interoperability

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WiMAX Multimedia Applications with QoS Parameters

Scheduling Types	Example Apps	QoS Attributes								
		Traffic Priority	Max Sustained Traffic Rate	Min Reserved Traffic Rate	Max Traffic Burst	Tolerated Jitter	Max Latency	Unsolicited Grant Interval	SDU Size	Unsolicited Polling Interval
UGS	VoIP w/o Silence Suppression			M		O	M	M	O	
ert-VR	VoIP w/ Silence Suppression	O	O	M	O	O	M	M		
rt-VR	Video	O	O	M	O		M			M
nrt-VR	FTP	O	O	M	O					
BE	Web Browsing	O	O							

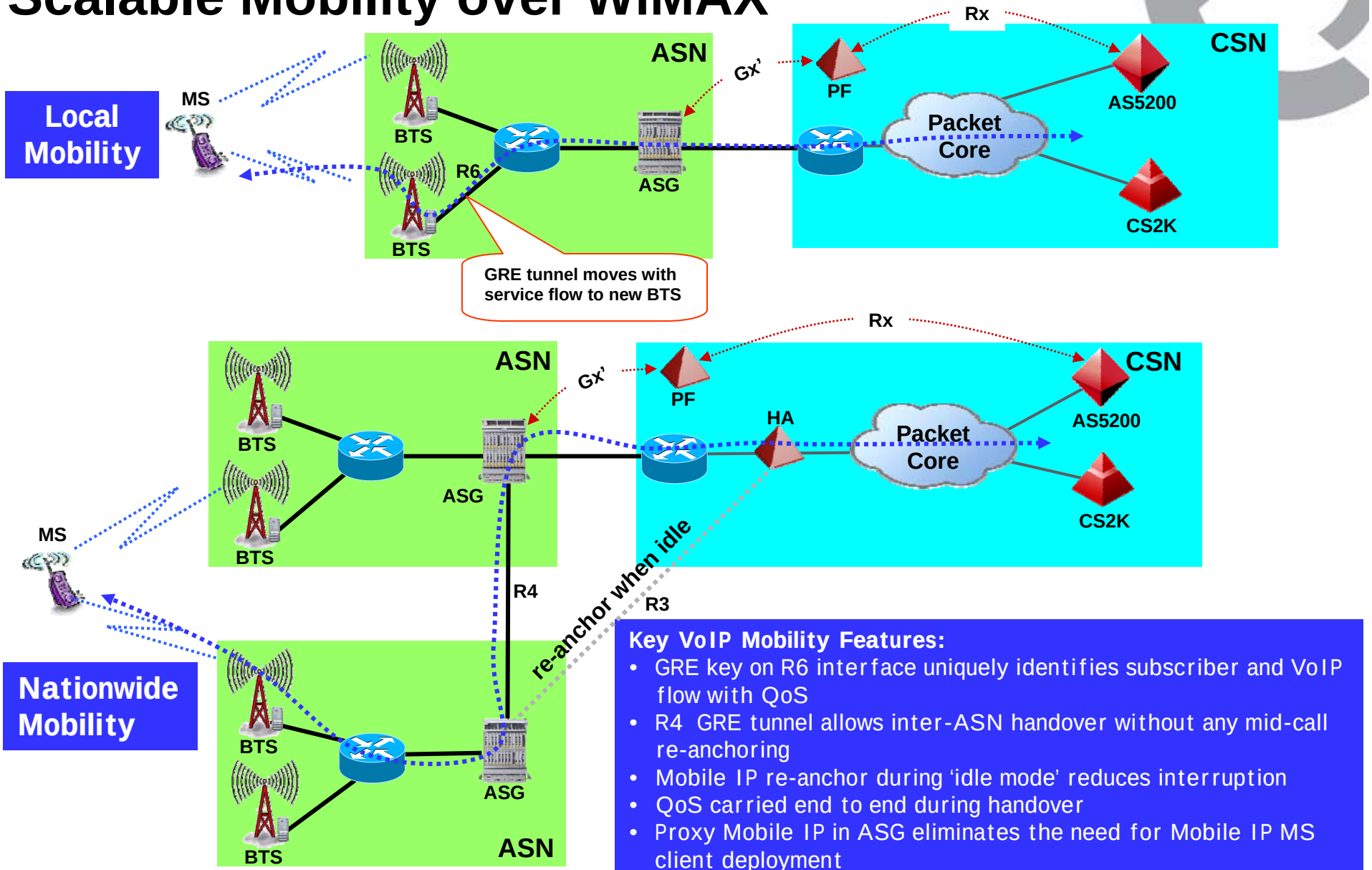
"The Fundamental premise of the WiMAX Standard (IEEE 802.16 MAC architecture) is QoS"

E2E WiMAX QoS to Application Mapping

Nortel	IETF	WiMAX			IP		Queuing Type	
NSC	ASC	Media Flow Type	TP	Class	DSCP		Queuing Type	Fwding Class
Customer	Customer Defined						SP or Wt	1
Premium	Telephony	Voice over IP	6	UGS/ertPS	EF	46	SP	2
	Real-time Interactive	Video Conversation	5	ertPS	CS4	32		
		Multi-player gaming		ertPS				
Network	Network Control				CS6	48	Weighted	3
Platinum	Multimedia Conferencing		4	rtPS	AF41	34	Weighted	4
	Signaling	Application signaling			CS5	40		
		Location-based services						
Gold	Broadcast Video	Streaming live TV	3	rtPS	CS3	24	Weighted	5
	Multimedia Streaming	Streaming VoD			AF31	26		
		Music & Photo Download (playout)						
Silver	Low Latency Data	Messags Robust Browser Secure Browser/ VPN	2	nrtPS	AF21	18	Weighted	6
Bronze	High Throughput Data	Music & Photo Download (store)	1	nrtPS	AF11	10	Weighted	7
	OAM	SNMP, etc.			CS2	16		
Standard	Standard	Text & Audio Books w/ Graphics	0	BE	DF/CS0	0	Weighted	8
		Data						
	Low Priority Data				CS1	8		

WiMAX QoS Maps to IP QoS

Scalable Mobility over WiMAX



Key VoIP Mobility Features:

- GRE key on R6 interface uniquely identifies subscriber and VoIP flow with QoS
- R4 GRE tunnel allows inter-ASN handover without any mid-call re-anchoring
- Mobile IP re-anchor during 'idle mode' reduces interruption
- QoS carried end to end during handover
- Proxy Mobile IP in ASG eliminates the need for Mobile IP MS client deployment

MIMO Powers Next Generation Mobility

Spectrum 5 + 5 MHz	EDGE	WCDMA 2003 - 04	HSPA 2005 - 07	Mobile WiMAX 2008 – 10
Typical Latency (Ping 32bytes)	750 ms	120 ms	60 ms	20 ms
Typical Max. Throughput per cell	0.32 Mbps	1 Mbps	10 Mbps	40 Mbps
Typical #users (*)	7	12	40	>100

(*) number of simultaneous users of 128kbps streaming in 5 + 5 MHz

OFDM-MIMO Performance "Triple Jump"
Latency, Throughput and Capacity

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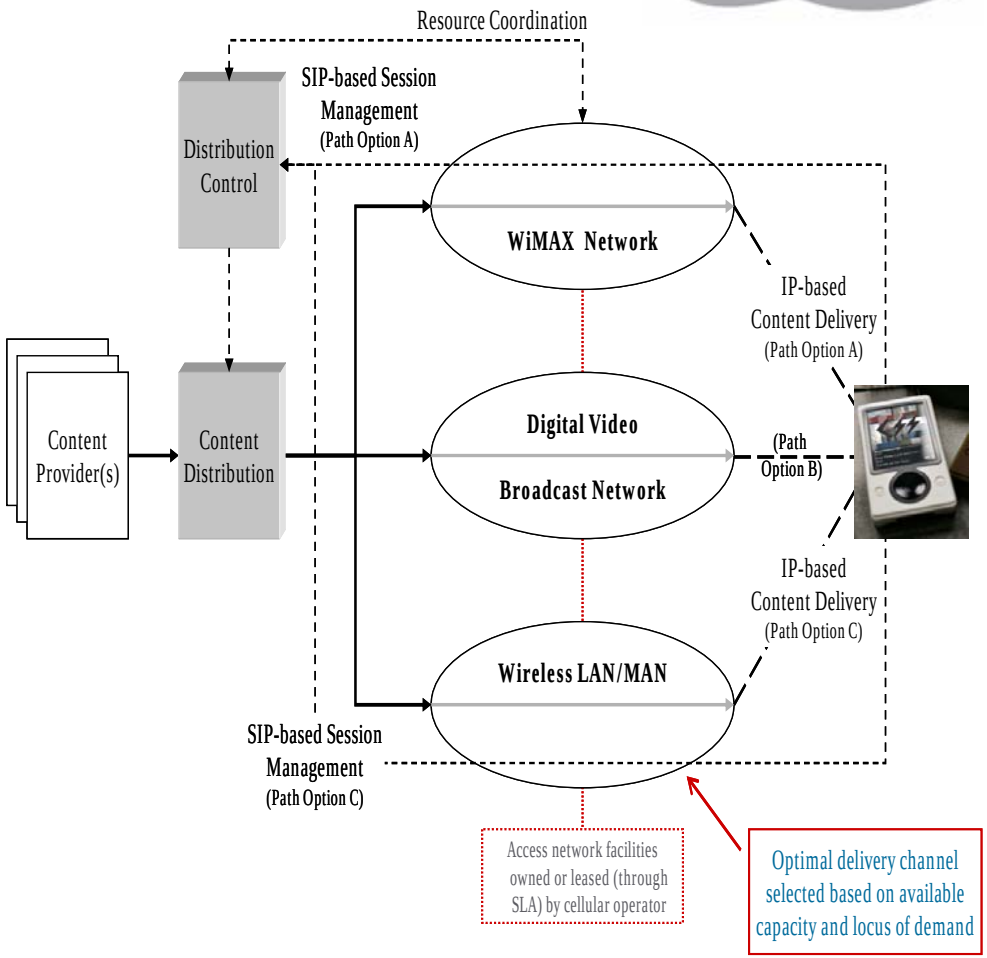
WiMAX Applications : Video

> **Video – one size does not fit all**

> **Multicast/Broadcast – Nortel is a key player in defining WiMAX standard**

> **Optimized Video Delivery**

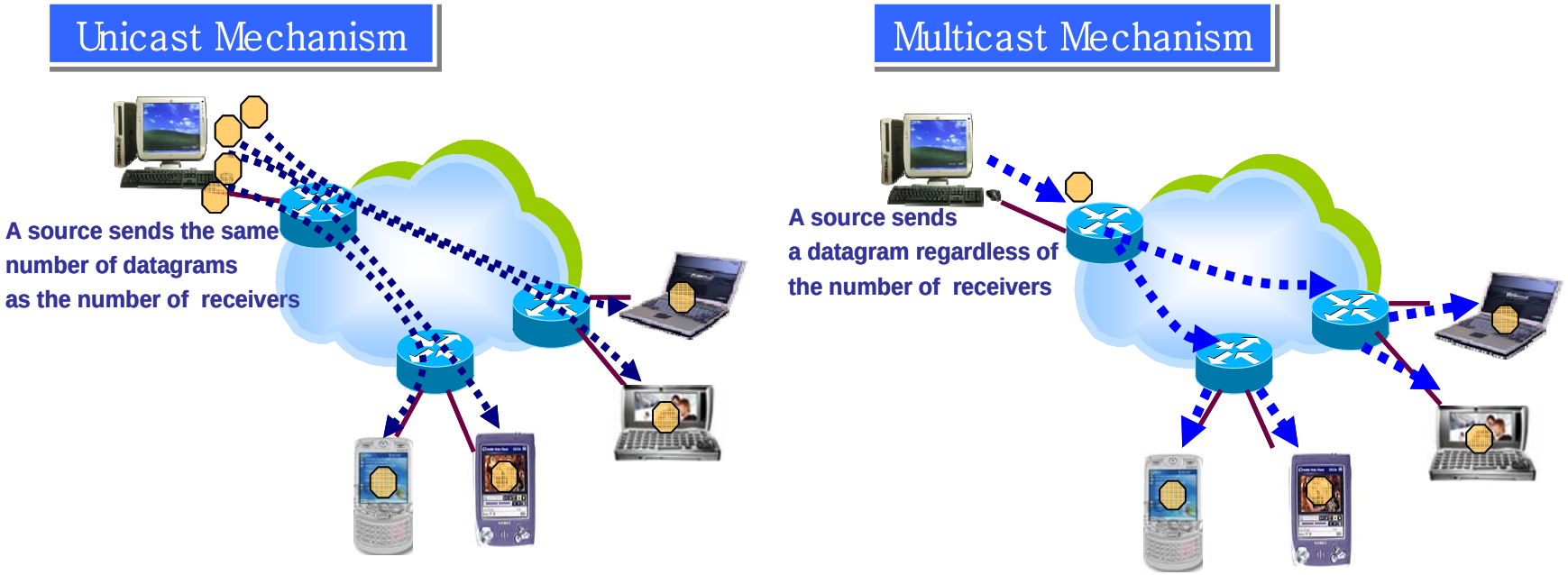
- Maximize video delivered & user experience
- Select right delivery mechanism
- Intelligent time shifting - use device memory
  - 4G bandwidth still precious
  - Off hours & traffic patterns to schedule
  - User preferences



Leading Broadcast Solutions Today → Time Shifting Solution

Concept of MBS

The Multicast Broadcast Service (MBS) feature refers to network's ability to provide flexible and efficient mechanisms of sending common (the same) information content to multiple users using **shared** radio resources.



MediaFlo, DVB-H and WiMAX MBS Comparison

Technology	Spectrally Efficient	Channels Per Transmitter	Infrastructure Cost @ 6 MHz Channel	Channel Switching Time	Power Consumption	Uplink Support	Dual Mode Device
MediaFlo	Yes	> 20 Channels, 6 MHz > ~ 300 Kbps each	1X (Reference)	~ 2 seconds	3.9 hours with 850 mAhr battery	No	Yes
DVB- H	Yes	> 9 Channels, 6 MHz > ~ 300 Kbps each	~ 2X	4.5 – 5 seconds	3 hours with 1550 mAhr battery	No	Yes
WiMAX MBS	Yes	> 40 Channels, 6 MHz > ~ 300 Kbps each	< 1X	< 350 ms	TBD	Yes	No

- **MediaFlo and DVB-H are comparable one-way video broadcasting technologies**
- **DVB-H is more standardized (plug-N-Play) while MediaFlo is based Qualcomm's proprietary solution**
- **Both MediaFlo and DVB-H require new network infrastructure as well as dual-mode handset devices if implemented within 3G/4G cellular networks**
- **WiMAX MBS (with MIMO) offers the highest throughput (for cellular tower based implementation)**
- **WiMAX MBS allows two-way communication (over both UL and DL) for interactive video applications**
- **WiMAX MBS standard is still in progress and presents ample opportunity to influence**

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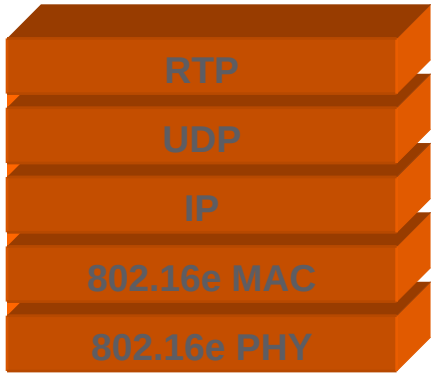
What it takes in the Network to support Carrier Grade Mobile VoIP?

E2E One-way Delay (ms)	Jitter (ms)	Packet Loss Rate	One-way RAN Delay (ms)
<150, preferred <250, limit	<20	<1%	~50



VoIPoWiMAX OSI Stack

> Speech Distortion Mitigation Techniques
- Choice of Good Codec
- Traffic Load Balancing – QoS Based Admission Control
- Controlling Delay & Jitter – E2E Delay Budget

> Congestion Control Techniques
- Good Scheduler
- Optimum use of Spectrum / Radio Resources –Dynamic QoS
- Priority for VoIP Packets over other applications

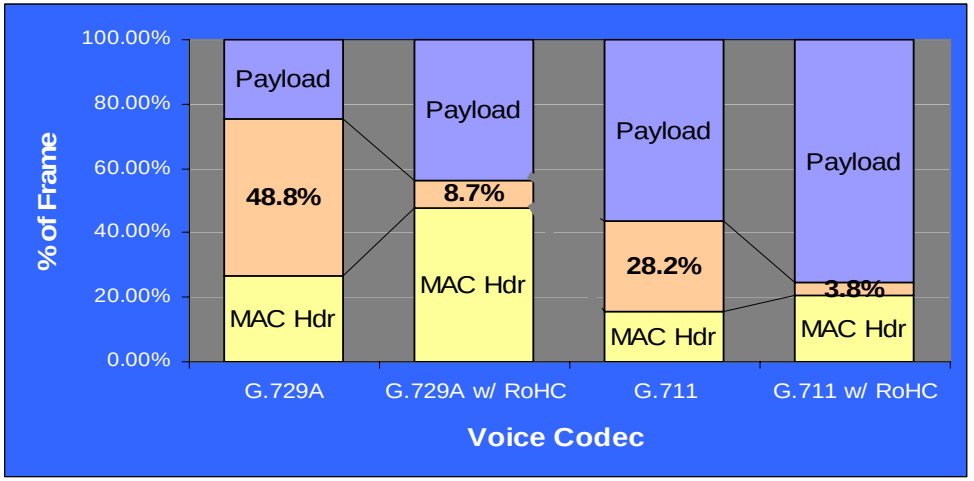
> Security – WiMAX Air Interface – PkmV2 Authentication, AES Encryption

Superior Voice End User QoE = f [Delay, Distortion, Sound level, Echo Level]

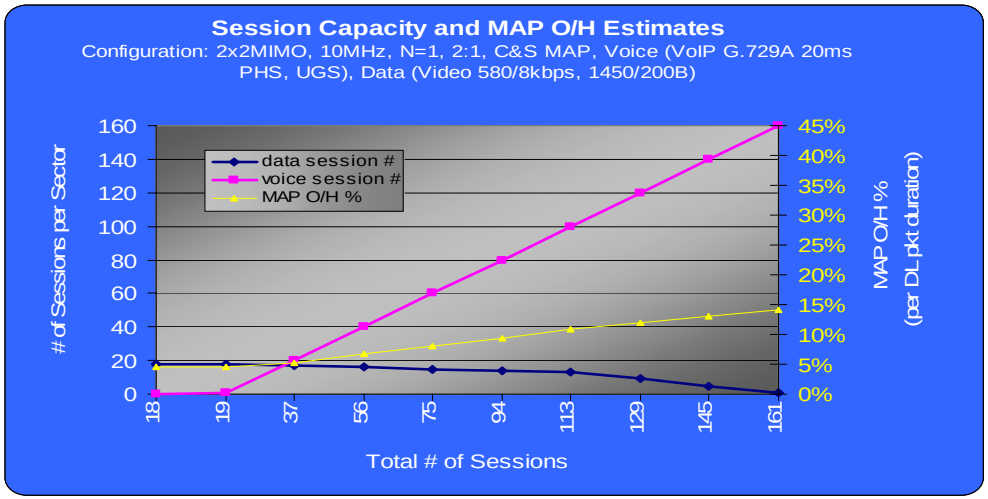
QoS, Network Capacity, Security and End-user QoE are Critical Success Factors for VoIP

Mobile VoIP – Overhead Reduction

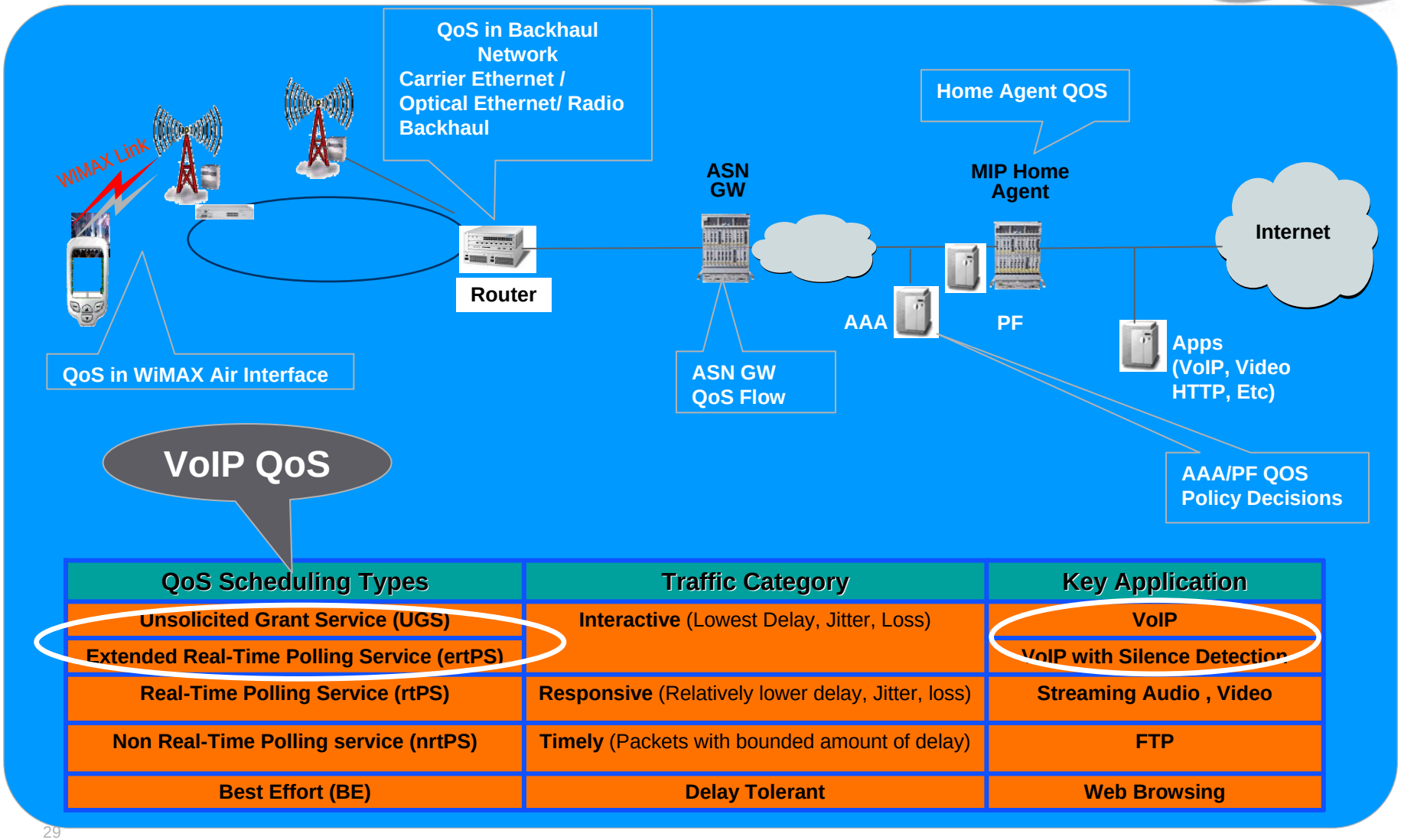
ROHC to reduce VoIP IP overhead by 90%



Compressed and sub-MAP Reduces 16e Overhead by >60%



Robust E2E QoS for VOIP



QoS Scheduling Types	Traffic Category	Key Application
Unsolicited Grant Service (UGS)	**Interactive** (Lowest Delay, Jitter, Loss)	VoIP
Extended Real-Time Polling Service (ertPS)		VoIP with Silence Detection
Real-Time Polling Service (rtPS)	**Responsive** (Relatively lower delay, Jitter, loss)	Streaming Audio , Video
Non Real-Time Polling service (nrtPS)	**Timely** (Packets with bounded amount of delay)	FTP
Best Effort (BE)	Delay Tolerant	Web Browsing

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WiMAX Multimedia Applications – Optimization

- End-to-end QoS solution
  - Consistent QOS treatment across all nodes in the network
    - Airlink, BTS, ASG, Backhaul marking to enable real-time application prioritization
  - Dynamic QOS Management
  - 802.16e and IP overhead compression for higher capacity
- Flexible mobility mechanisms to allow scalability
  - From Simple IP Metro-Area to Wide-Area Mobile IP handoff
  - Optimized inter-ASN handover with context transfer during ‘Idle Mode’
- Assured User Quality of Experience
  - Resource sensitive admission control
    - Management of multi-dimensional resources
    - Adaptive periodic feedback from the radio link conditions
    - Ability to fine tune various admission control parameters
  - Proactive admission control during handovers
  - Optimized inter-BTS and inter-ASN handoff with QoS context transfer
  - Overload avoidance detection

Summary

> WiMAX is a 4G technology well suited for multi-media applications
  - High Spectrum Efficiency, High Bandwidth
  - Seamless Mobility
  - Flat Network – reduced latency and complexity
  - Consistent E2E QoS
  - CPE varieties and favorable cost structure

> WiMAX 4G networks represents a major thread of evolution toward NGN
  - Voice and data convergence
  - Seamless access to internet
  - Increased data rate
  - All IP network