High Speed Wireless Services Using Two Way MMDS System

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Snapshot of the Next Century

	1994	2010
	$26 Trillion	$48 Trillion
	$4 Trillion	$16.6 Trillion
	4.3%	2.5%
	$5.607 Billion	$7.32 Billion
	$607 Million	$1.4 Billion
	$34 Million	$1.3 Billion
Number of PC's - World Wide	$150 Million	$278 Million
Number of PC's - Desktop	$132 Million	$230 Million
Number of PC's - Mobile	$18 Million	$47 Million

Source: ***Business Week, November 18, 1994***

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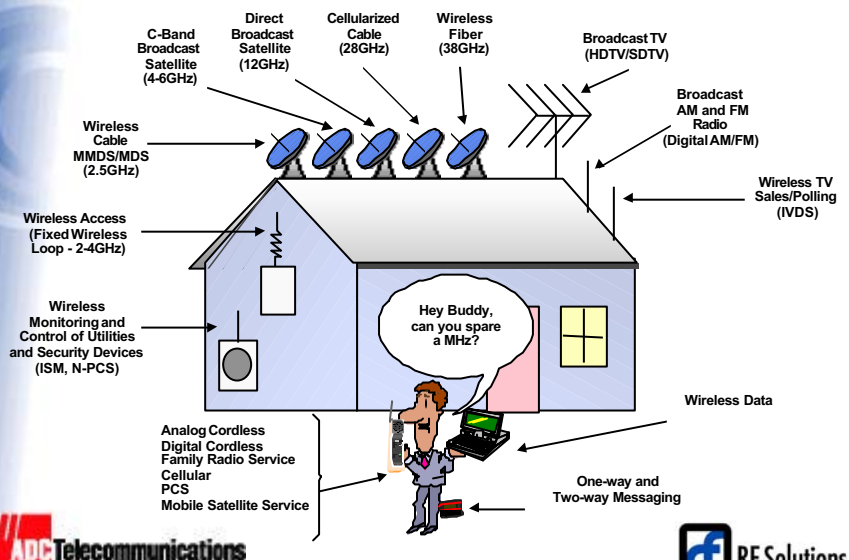
Many Wireless Alternatives



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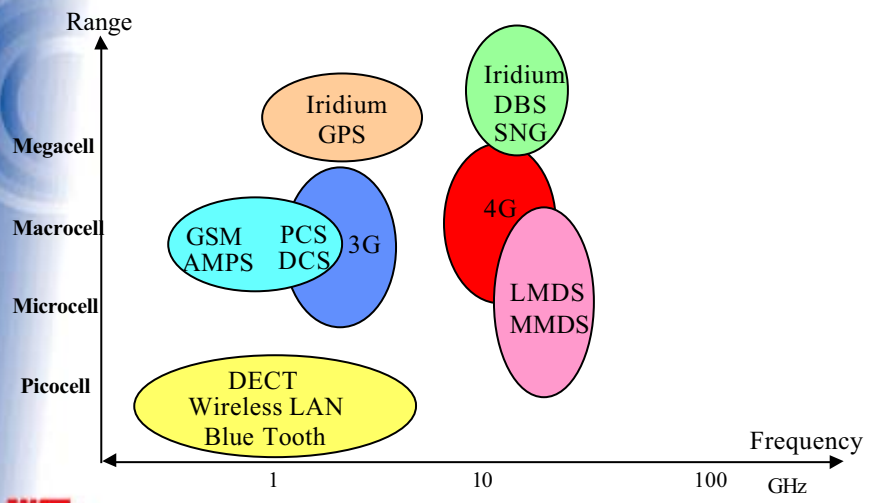
Wireless Standards



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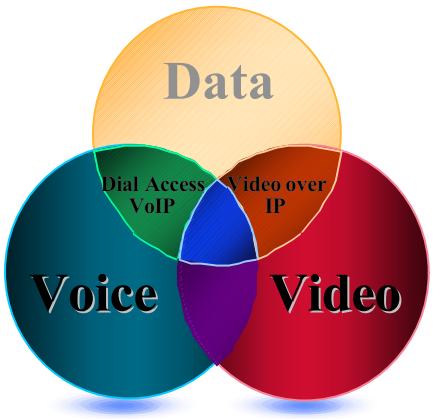
Convergence

Broadband Packet-Based Services!

- Broadband data
  - VPNs
- Voice over IP
  - PBX trunking
  - POTS
- Video
  - Push services
  - Conferencing



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Broadband Access and Transport Mission

Multiservice Delivery to Businesses and Residences - Software and Hardware Solutions

ADC Products	Applications	Last-Mile Networks	Service Users
Soneplex Cellworx Teledata Kentrox	xDSL Optical Transport Digital Loop Carrier Enterprise Access	Telephone	
Homeworx DV5000, HWX, ISX Pathworx	Cable Telephony/Data Optical Transport Coaxial Amplifier	Cable TV	
CellSpan	Broadband Wireless	Wireless	

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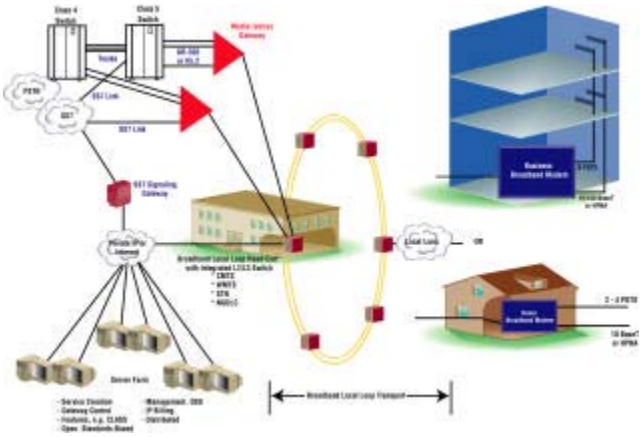
BROADBAND LOCAL LOOP ARCHITECTURE



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Comparison of Various Broadband Technologies

Perameter	ISDN	xDSL	Cable Modem	MMDS	LMDS
Deployment cost	high	high	high	low to very low	medium
Deployment time	medium	medium	medium	low	low
CPE cost	medium	medium	low	low-medium	high
Data rate	128 Kbs	1-6 Mbs	>1 Mbs	0.2-2 MMbs	1-10 Mbs
Bandwidth available			5-42 MHz - up	78 MHz-MMDS/MDS	1100 MHz-A
Bandwidth available				132 MHz -ITFS	150 MHz-B
Total Capacity	high	high	medium	Medium	high
Coverage area / cell	near central office	near CO	large	50-100Km	2-6 Km
Symmetry	yes	may be	no	may be	yes
Other Advantages				technology ready today	
Suitable application		businesses near CO (central office)	Business/Residential	Business/Residential	Business
Suitable application				International	International backhaul
Suitable application					
Other issues		not good far from CO		freq. Coordination with ITFS	

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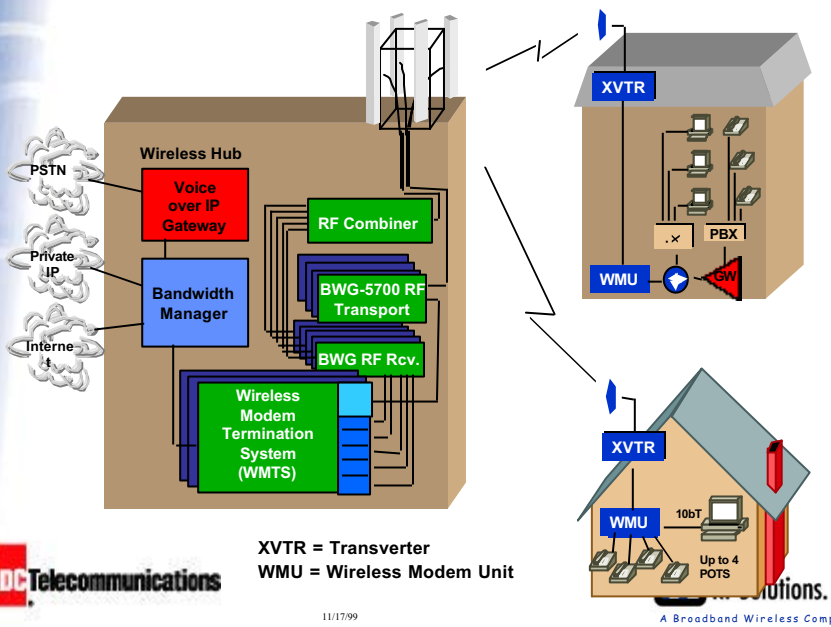
Fixed Wireless System Architecture



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XVTR = Transverter
WMU = Wireless Modem Unit

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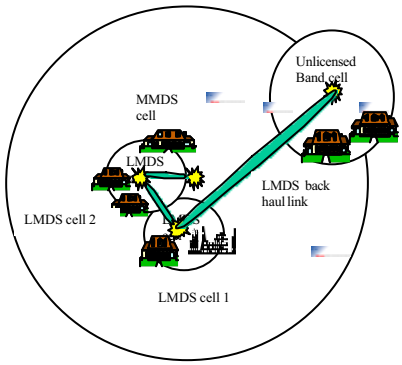
Combined Use of MMDS, LMDS And Unlicensed Bands for Broadband Services



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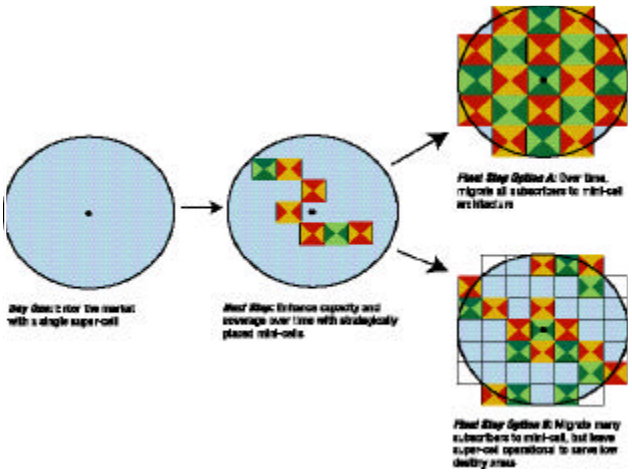
MMDS Network Migration



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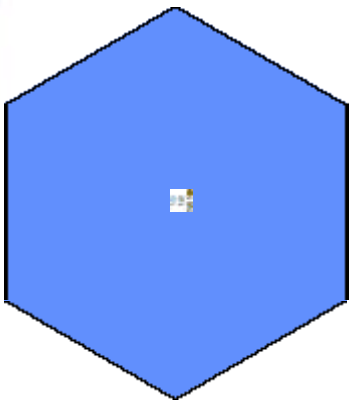
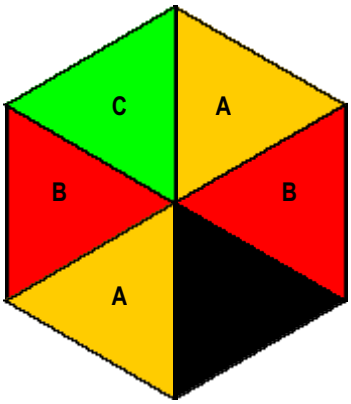
Super-cell Coverage Deployment



Downstream -
Omni



Upstream -
6 Sectors

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System Considerations

- Coverage area
- Take rate / applications- data, VOIP, video, video conferencing etc.
- Interference, neighbors, ITFS channels etc.
- Symmetry u/s, d/s
- number of cells
- sectorization
- frequency planning - u/s, d/s channels, sub channels,frequency reuse
- Headend modem - modulation, FEC, symbol rate etc. Head end - channels, no of receivers, sectorization
- Antenna - Headend , transverter, specs.- front to back, side lobes,
- frequency hopping, space diversity
- transverter specs.-Po, TR on / off,
- modem performance - symbol rate, equalizer, FEC,
- modem transverter integration

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Super-cell Capacity Example

- 7 D/S 6MHz Channels:
  - 1 x 64QAM
  - 4 x 16QAM
  - 2 x QPSK
- Aggregate D/S throughput per cell: 113Mbps
- Total Offered Traffic
  - Daytime - 105.6Mbps
  - Nighttime - 78.6Mbps
- 2 U/S 6MHz Channels:
  - 6 x 1.6MHz
  - 6 x 400kHz
- Aggregate U/S throughput per cell: 27Mbps
- Total Offered Traffic
  - Daytime - 17.2Mbps
  - Nighttime - 10.2Mbps

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Common Deployment Scenarios

- Not all subscribers will have a pristine receive signal
  - Foliage and Terrain blockage
  - Reflections from stationary or moving objects
  - Self-interference from other sectors or cells
  - Not all subscribers will be close to the hub
- Some sectors may have a large number of business users, while another may be made up of mostly residences
- Some sectors or cells may have a high density of subscribers, others may be low density
- Different numbers and combinations of RF channels will be available in each market

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Next Generation Wireless Modem Termination System (WMTS)

- Carrier class reliability
- Integrated QoS to support voice and data services
- Configuration flexibility to address changing MMDS spectrum requirements
- Distributed FPGA MAC architecture for market/cell specific configuration selection
- Overall scalability/flexibility/density to fit broadband wireless applications

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Wireless Modem Units (WMU): Desktop Data WMU

- 10BaseT Ethernet
- QoS supported by external policy-based bandwidth manager
  - Hardware ready for Integrated QoS upgrade
- SNMP-based agent
- Automatic carrier and modulation acquisition with CellSpan WMTS
- Voice support through external VoIP MTA
- Dynamic bandwidth allocation

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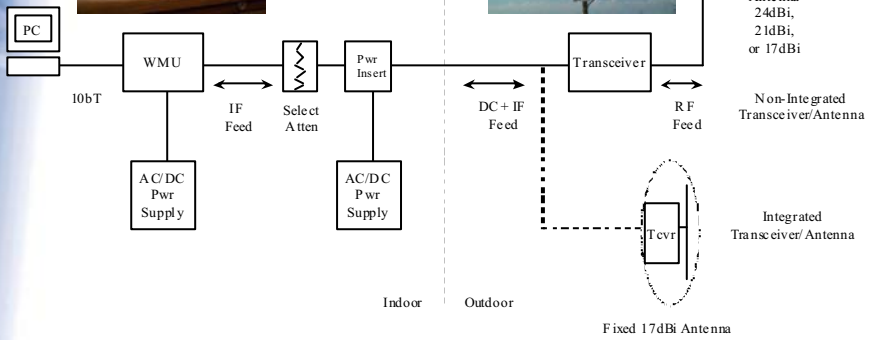
CPE Block Diagram and picture



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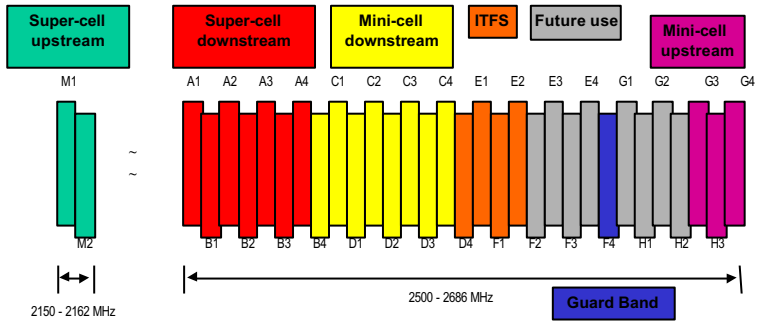
Frequency Plan Example



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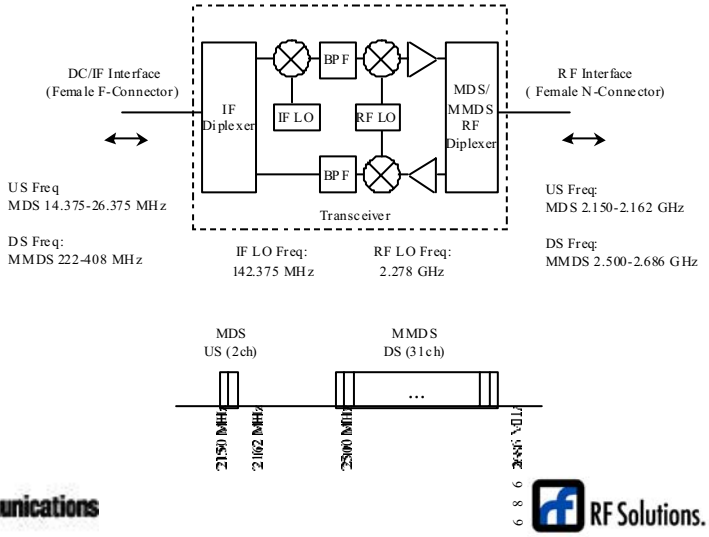
Transceiver (MDS US) Block Diagram



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MMDS Deployments

- Completed a number of successful deployments with large cell architectures
- Better installation procedures and hardware improvements are making deployments easier
- Strong interest in MMDS network deployment from large operators like Sprint, MCI, Bell South etc.
- High capacity sectorized cellular architectures being investigated

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Next Generation Technologies

Challenges

- Not all subscribers will have a pristine receive signal
- Capacity and coverage
- Many CPE configurations, flexible bandwidth
- Less interference
- Lower cost

Solutions

- Adaptive Antennas
  - DSP
- Software Radios
  - DSP
  - A/D Conversion
  - Wide Bandwidth designs
- Transmitter Development
  - High P/A
  - Linearization (DSP)
- Integration
  - Electronic Filtering
  - MEMs Switches

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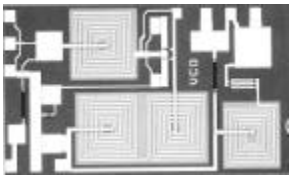
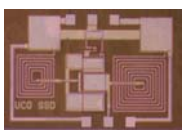
Quantum MMIC Technology

- Reduction of Passive Devices
- High Speed A/D Conversion
- Wide bandwidth topologies
- Low Noise Topologies
- Frequency Agile Active Filtering





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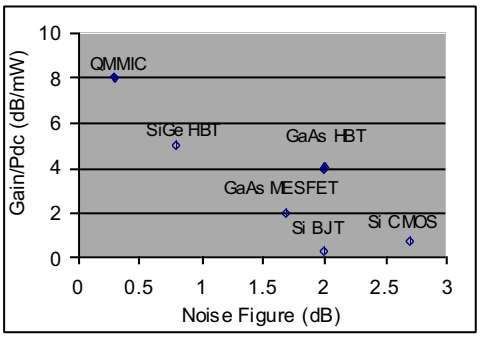
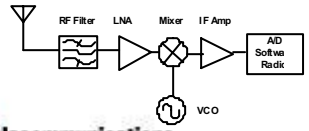
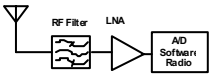
Quantum MMIC Technology

- Enabling Technology for Software Radio







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Conclusions

- Convergence of Broadband Standards
- MMDS/LMDS will offer megabit services to businesses and residences
- Last Mile Race Requires High Data Rate
- Technology Advancements: Component to System will be Required

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