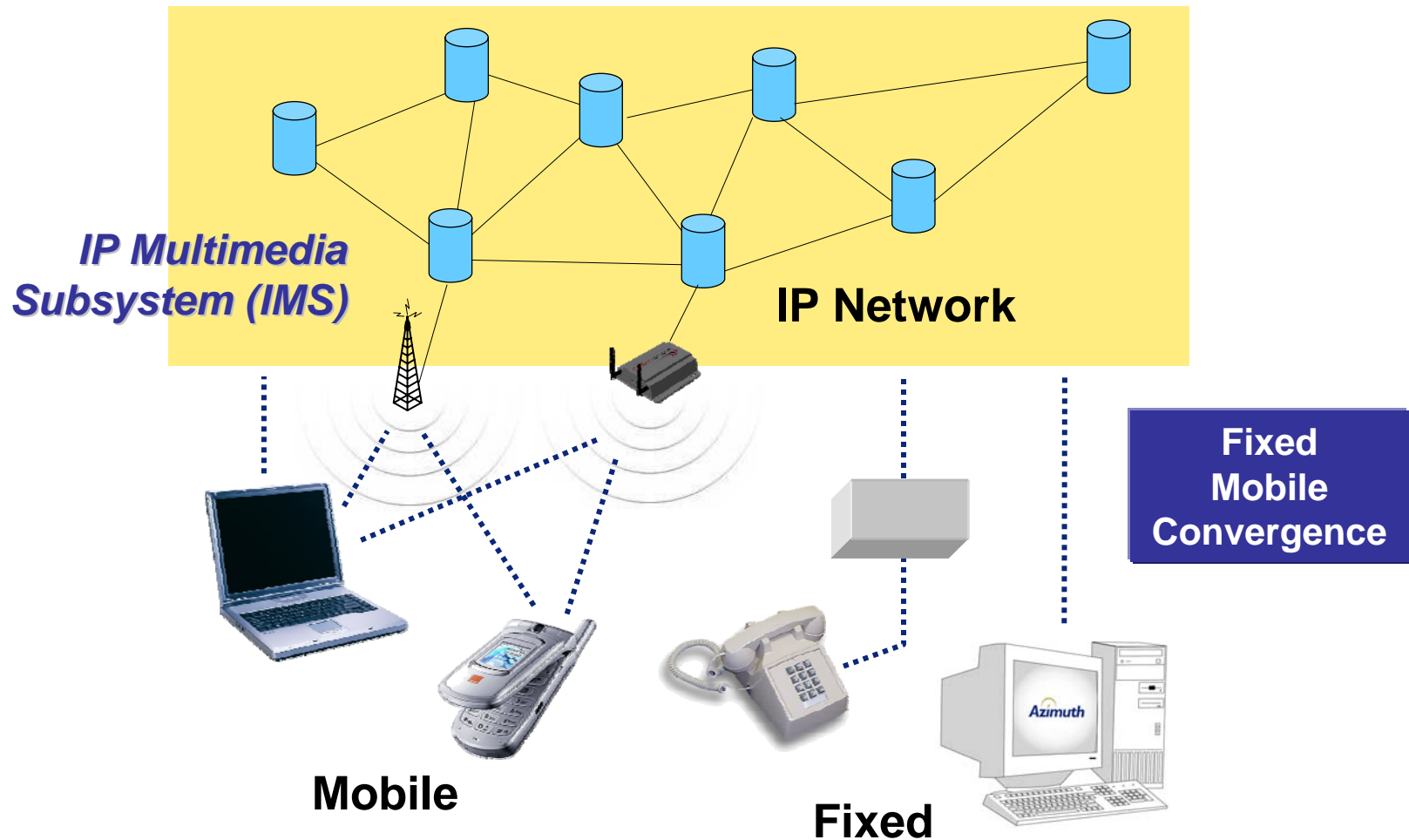# A Glimpse at the Wireless Data Communications Standards

Fanny Mlinarsky

8 August 2007

IMS Infrastructure for FMC

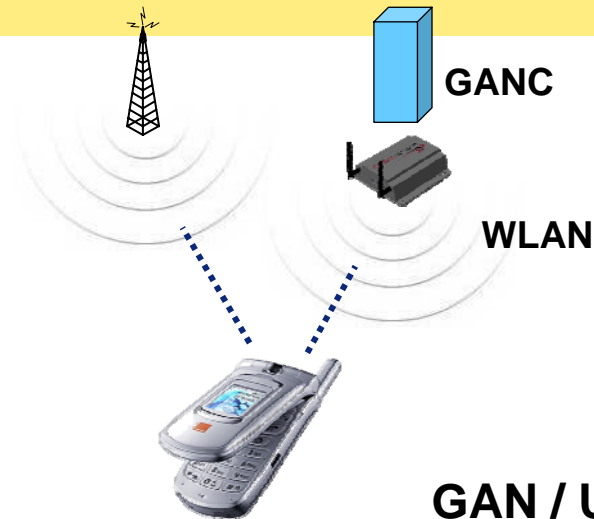*IP Multimedia Subsystem (IMS)*

IP Network

Fixed
Mobile
Convergence

Mobile

Fixed

Standards for FMC

- ❑ **3GPP- IMS**
  - ➢ GAN/UMA *2G*
  - ➢ VCC *3G/4G*
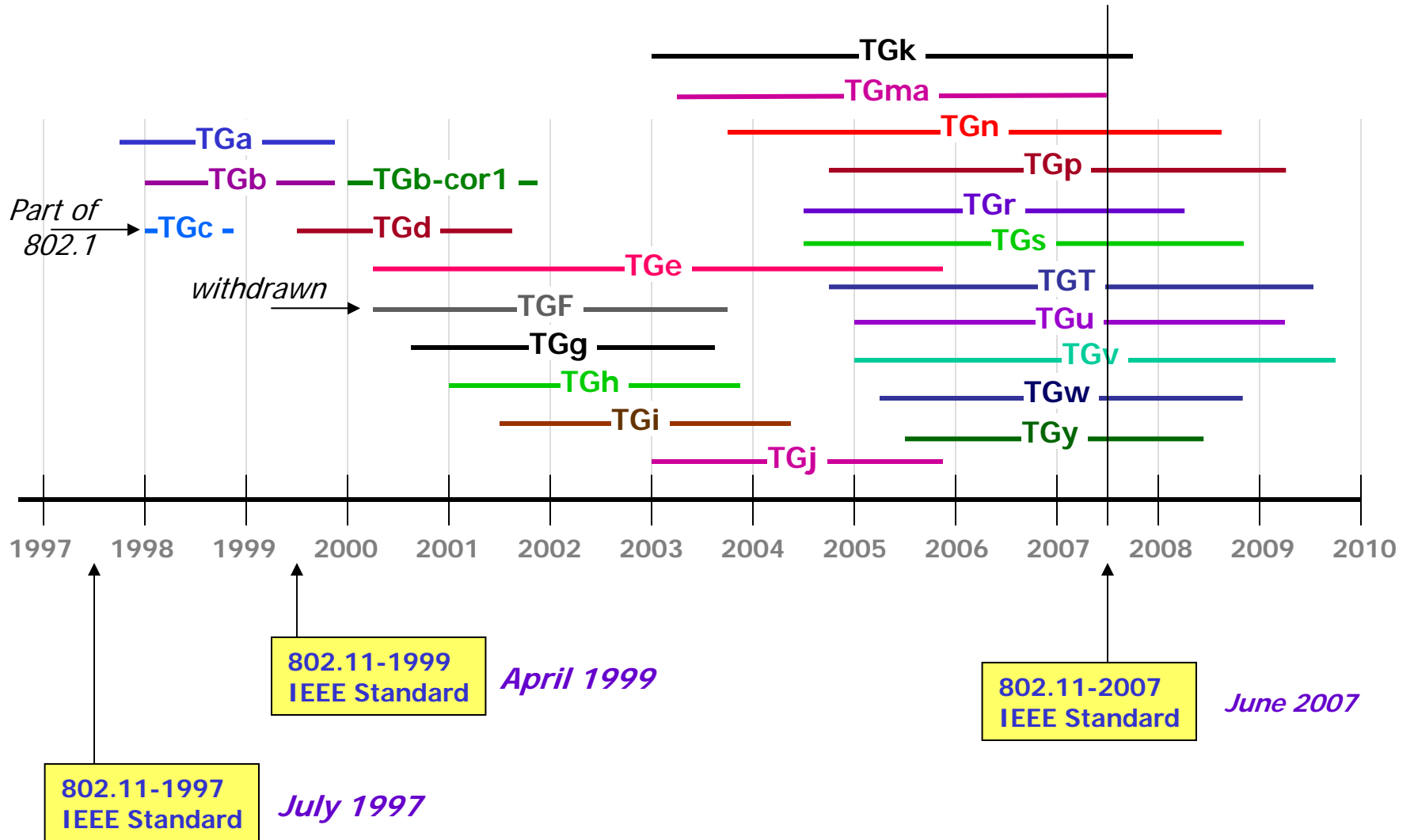 - ➢ I-WLAN (no handoff)
- ❑ **IEEE**
  - ➢ 802.11n, k, u, v, y, s
  - ➢ 802.16e, m
  - ➢ 802.21

GAN = generic access network
UMA = unlicensed mobile access
VCC = Voice Call Continuity
I-WLAN = Interworking-WLAN
IMS = internet multimedia subsystem

GAN / UMA
GSM Infrastructure

GANC

WLAN

GAN / UMA
GSM/WiFi phones

IEEE 802.11 Timeline

TGk

TGma

TGa

TGb — TGb-cor1

TGn

TGp

Part of 802.1 → TGc

TGd

TGr

TGs

TGe

TGT

withdrawn → TGF

TGu

TGg

TGv

TGh

TGw

TGi

TGy

TGj

1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

802.11-1999 IEEE Standard *April 1999*

802.11-2007 IEEE Standard *June 2007*

802.11-1997 IEEE Standard *July 1997*

IEEE 802.11 Active Task Groups

- TGk – Radio Resource Measurements

- TGn – High Throughput

- TGp – Wireless Access Vehicular Environment (WAVE/DSRC)

- TGr – Fast Roaming

- TGs – ESS Mesh Networking

- TGT – IEEE 802 Performance

- TGu – InterWorking with External Networks

- TGv – Wireless Network Management

- TGw – Protected Management Frames

- TGy – 3650-3700 MHz Operation in USA

- DLS – Direct Link Setup Study Group

http://grouper.ieee.org/groups/802/11

802.11n Summary

- Minimum of 100 Mbps throughput at the MAC SAP interface – with no 802.11 overhead;
  - data rate reaches 600 Mbps with 4 spatial streams in 40 MHz channels
- PHY improvements
  - Spatial Multiplexing, Beamforming, up to 4x4 MIMO, 40 MHz channels
- MAC improvements
  - Frame aggregation, block acknowledgements
- Battery life improvements for handsets
  - Sleep mode with scheduled packet delivery

Real implementations use up to 2 spatial streams and the following configurations:

2x2, 2x3, 3x3
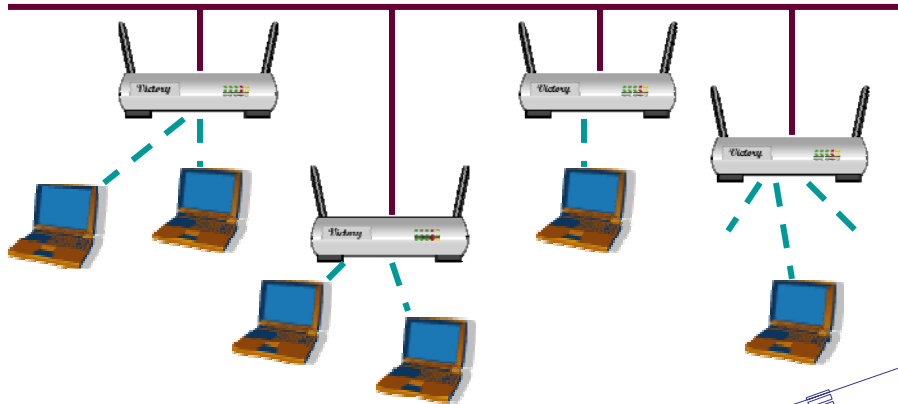
Extra transmitters or receivers implement diversity

Victory
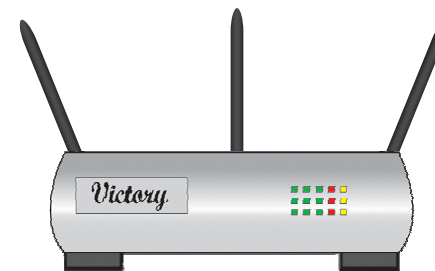
802.11s Mesh for Municipal Outdoor Networks

Wired connection to each AP
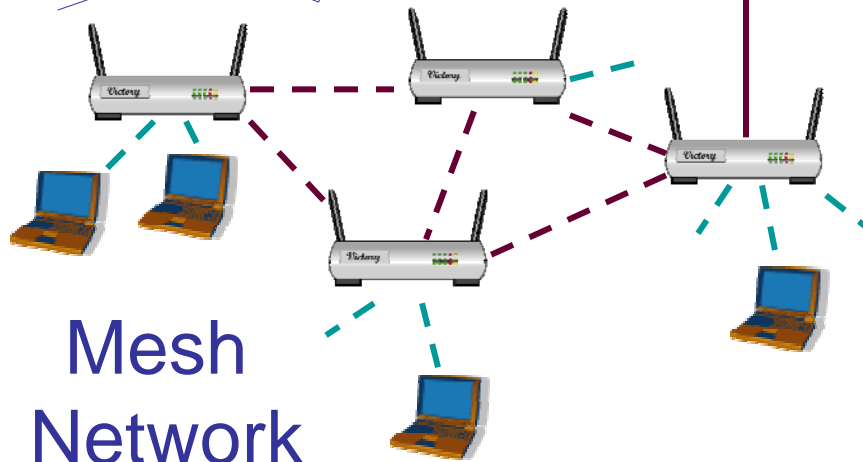
Traditional WLAN

Mesh Portal

Wired links

Mesh links

Client links

Mesh Network

Lightly Regulated Band for Contention-based Networks

octoScope

- March 2005 FCC offered 50 MHz at 3650 to 3700 MHz for *contention-based protocol*

- 802.11y meets FCC requirement; 802.16h is working to comply

- 21st century regulation geared for digital communications
  - multiple services to share the band in an orderly way

❖ **300 Million licenses one for every person or company**

❖ **$300 per license for 10 years**

❖ **Registered stations (base stations): 1 W/MHz, ~15 km**

❖ **Unregistered stations (handsets, laptops): 40 mW/MHz, 1-1.5 km**

802.11k,v,w for Enterprise-grade Performance and Management

- ❑ 802.11k – Radio Resource Measurements
  - ➢ Protocol to map the network, measure signal levels and traffic levels at every device
  - ➢ Assist with fast handoff for voice handsets
  - ➢ Determine whether network segments have sufficient QoS performance for mission-critical services such as VoIP
  - ➢ Monitor Enterprise WLAN from a central point

- ❑ 802.11v – Wireless Network Management
  - ➢ Protocols for location protocol, load sharing, fast handoff management, power conservation for handsets, device location

- ❑ 802.11w – Protected Management Frames
  - ➢ Encrypt 802.11 k,v management frames to protect from attackers

TGk

TGv

TGw

2003   2004   2005   2006   2007   2008   2009   2010
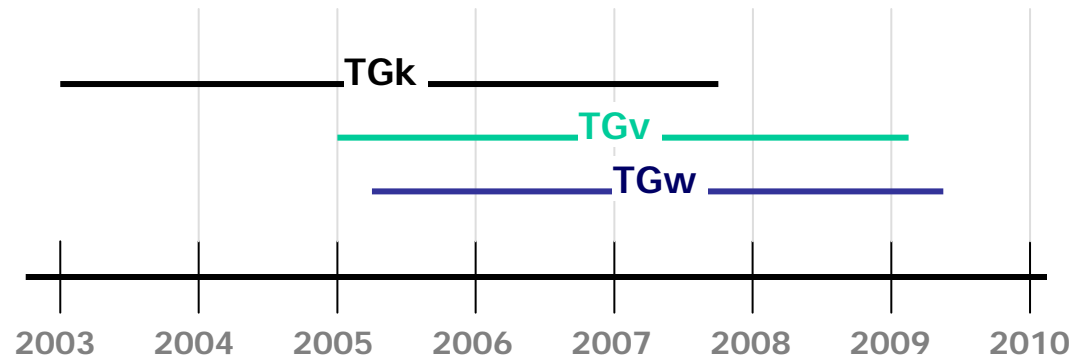
802.11u and 802.21

- 802.11u - InterWorking with External Networks
  - Goal: Interworking with external networks, including other 802 based networks such as 802.16 and 802.3 and 3GPP based IMS networks
  - Network discovery, emergency call support (e911), roaming, location and availability
  - Network discovery capabilities include information on service provider, QoS capabilities
  - SSP (service subscription provider) – carrier or operator; SSPN is their network

- 802.21 is developing MIH (media independent handover)
  - GAS (generic advertising service) defines a way for a station to access the Advertising Server that has information about 802.11 and 802.16 networks
  - Information on SSPN, its corresponding SSID, radio, available services, etc.
  - 802.11u provides a means for a station to access the 802.21 information server to find all the information in one place.

IEEE 802.16 Overview

- Network Management Task Group
  - P802.16g, Management Plane Procedures & Services
  - P802.16i, Mobile Management Information Base
  - P802.16k, 802.16 Bridging (for 802.1d)

- 802.16h, License-Exempt Task Group
  - Developing PAR (project authorization request)
  - A joint meeting next week with 802.11 TGy and 802.19

- 802.16j, Mobile Multihop Relay
  - developing PAR

- 802.16m, AMT Advanced Air Interface
  - developing PAR

http://grouper.ieee.org/groups/802/16

ITU-T Framework

Pervasive connectivity
WLAN - WMAN - WWAN

ITU-T – United Nations telecommunications standards organization

Accepts detailed standards contributions from 3GPP, IEEE and other groups

IEEE 802.11 – WLAN (wireless local area network)

IEEE 802.16 – WMAN (wireless metropolitan area network)

3GPP – WWAN (wireless wide area network, cellular)

ITU International Mobile Telecommunications

- ❑ **IMT-2000**
  - ➢ Global standard for third generation (3G) wireless communications
  - ➢ Provides a framework for worldwide wireless access by linking the diverse systems of terrestrial and satellite based networks.
  - ➢ Data rate limit is approximately 30 Mbps
 - ➢ Detailed specifications contributed by 3GPP, 3GPP2, ETSI and others

- ❑ **IMT-Advanced**
  - ➢ New generation framework for mobile communication systems beyond IMT-2000 where Deployment around 2010 to 2015
  - ➢ Data rates to reach around 100 Mbps for high mobility and 1 Gbps for nomadic networks (i.e. WLANs)
  - ➢ IEEE 802.16m working to define the high mobility interface
  - ➢ IEEE 802.11 VHT SG (very high throughput study group) working to define the nomadic interface

WiMAX IP-OFDMA

Basis for IP-OFDMA
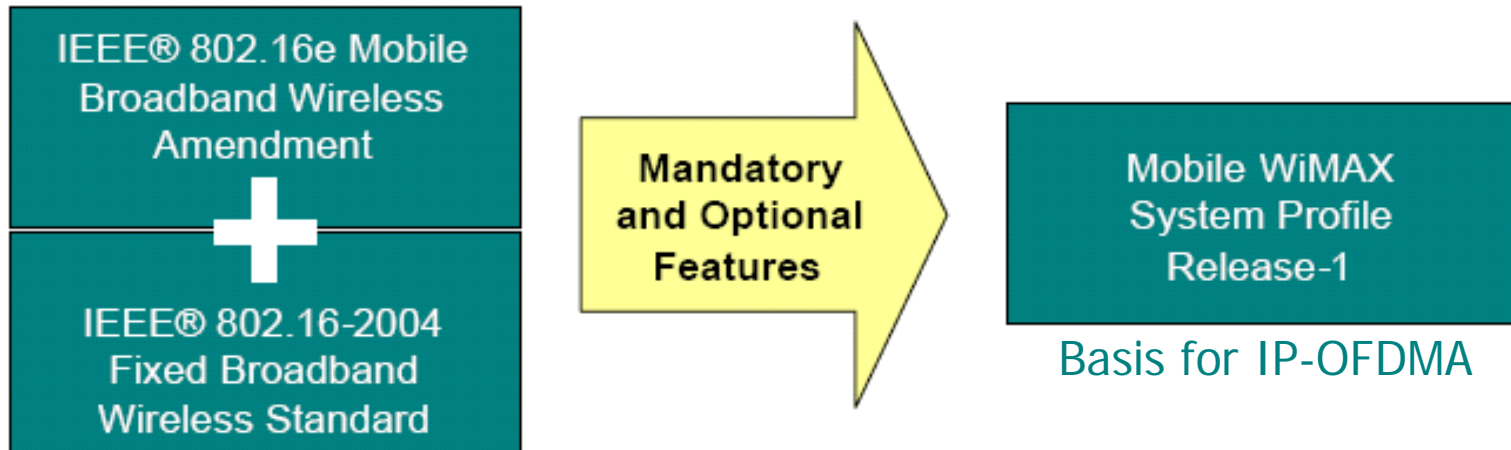
- ❑ The IEEE 802.16e-2005 Wireless MAN standard is based on the concept of scalable OFDMA* (S-OFDMA).
  - ➢ A range of bandwidths to accommodate available spectrum

- ❑ WiMAX Forum Release-1
  - ➢ Based on 802.16e-2005
  - ➢ 1.25, 5, 7, 8.75, 10 and 20 MHz channel bandwidths
  - ➢ Initial profiles are 5 and 10 MHz
  - ➢ Licensed worldwide spectrum allocations include 2.3, 2.5, 3.3 and 3.5 GHz bands

* Orthogonal Frequency Division Multiple Access

WiMAX Smart Antenna Technologies

- **Beamforming**
  - Use multiple-antennas to spatially shape the beam to improve coverage and capacity

- **Spatial Multiplexing (SM)**
  - Multiple streams are transmitted over multiple antennas
  - Multi-antenna receivers separate the streams to achieve higher throughput
  - In uplink single-antenna stations can transmit simultaneously

- **Space-Time Code (STC)**
  - Transmit diversity such as Alamouti code is supported to reduce fading
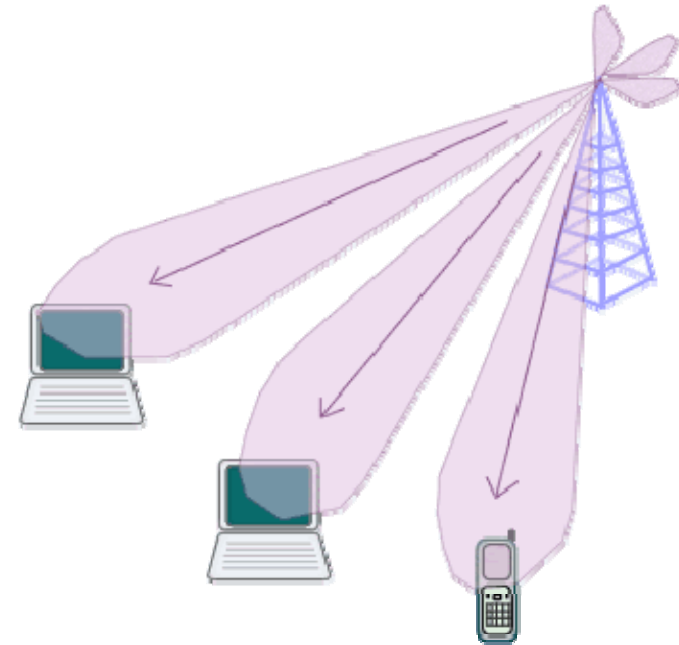
2x2 MIMO SM increases the peak data rate two-fold by transmitting two data streams.

IEEE 802.16d vs. 802.16e

	802.16d 2004	**802.16e 2005**
Cell radius	7 km NLOS 30 km LOS	5 km NLOS 30 km LOS
Bit Rate	Up to 10 Mbps / 3.5 MHz	Up to 15 Mbps / 5 MHz
Bandwidth	3.5, 7 MHz	5, 7, 10 MHz
Band	2.5, 3.5, 5.8 GHz	
Signaling	OFDM, 256 subcarriers	SOFDMA, 2048 subcarriers
Mobility	Fixed, nomadic	High mobility 60 km/h

3GPP Long Term Evolution

- LTE (Long Term Evolution) being developed as a 4G technology competing with 802.16

  - 100 Mbps uplink; 50 Mbps downlink
  - 5 km cells; 30 km with some degradation
  - Channels 1.25, 1.6, 2.5, 5, 10, 15, 20 MHz

- MIMO-based; smart antenna

- No products yet

IEEE 802 Wireless Workshop at Pulvermedia FMC Show

- http://www.pulver.com/fmc

- Wednesday September 5
  - 9:00 a.m. to 3:20 p.m.

- Tutorial on the 802.11, 802.16 and 802.21 Wireless standards that enable Fixed Mobile Convergence

- How these standards are evolving to support voice and video applications

- Wi-Fi and WiMAX technologies and solutions

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