IEEE Standard 802.16 for Global Broadband Wireless Access

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Purpose:
To inform the Working Group concerning an address on IEEE 802.16 given by the Working Group Chair at ITU Telecom World 2003, Geneva, October 12-18, 2003. An accompanying manuscript is available as IEEE C802.16-03/14.
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Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

IEEE Standard 802.16 for Global Broadband Wireless Access

ITU Telecom World Forum 2003

Geneva, Switzerland

14 October 2003

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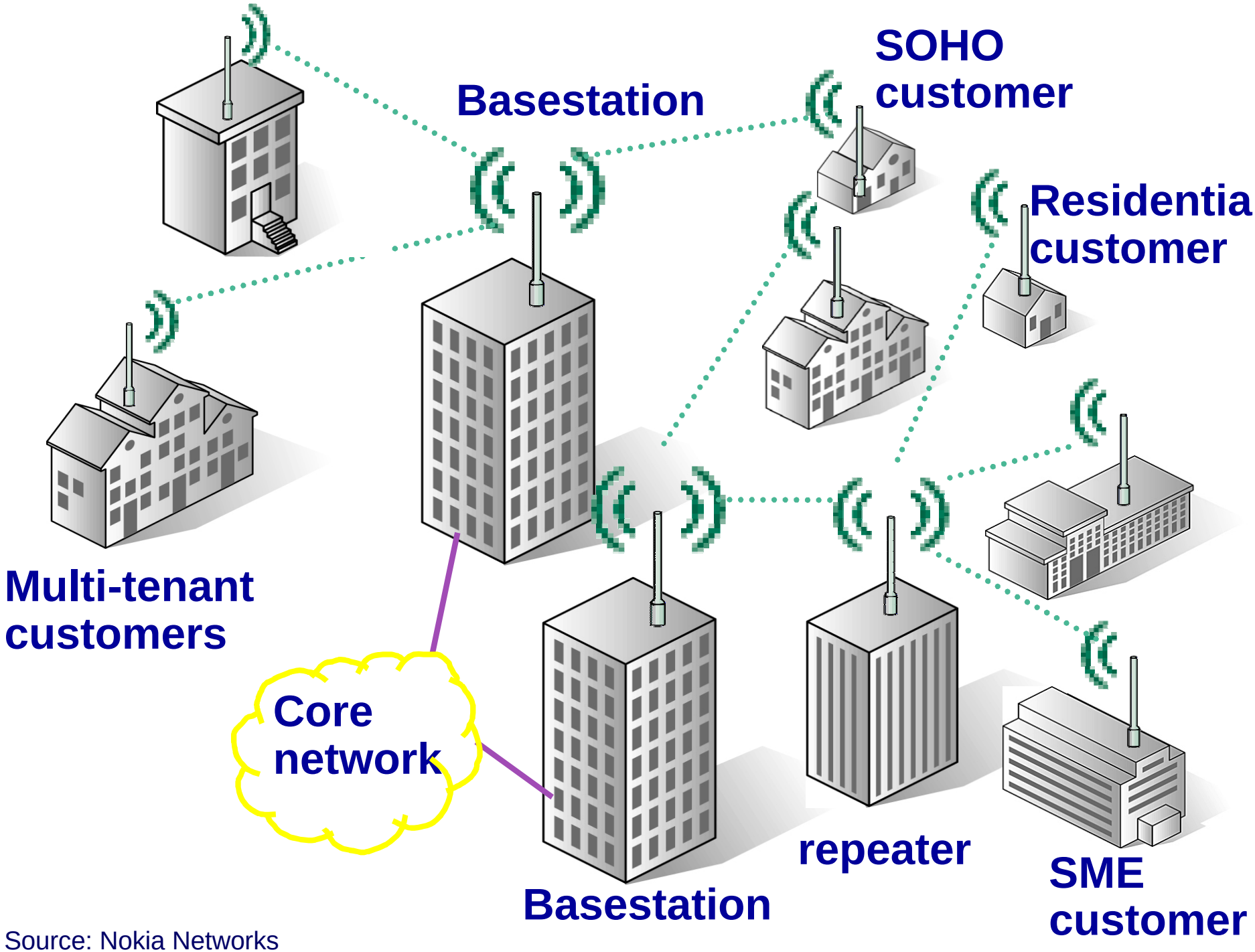
Chair, IEEE 802.16 Working Group

http://WirelessMAN.org

WirelessMAN: Wireless Metropolitan Area Network



Source: Nokia Networks

IEEE 802.16
Wireless MAN: not a LAN

- Base Station (BS) connected to public networks
- BS serves Subscriber Stations (SSs)
  - SS typically serves a building (business or residence)
    - Standard is evolving to support mobile SS
  - provide SS with first-mile access to public networks
- Compared to a Wireless LAN:
  - Carrier-class
  - Multimedia QoS
    - Scheduled services (request/grant); bandwidth on demand
  - Many more users
  - Much higher data rates
  - Much longer distances

802.16 Last Mile Market Segments

- Market still early stage
- Dramatic product improvements since 1st gen
- 802.16a standard opens door for volume components
- Cooperation & promotion amongst vendors is key

T1/E1 LEVEL SERVICE for ENTERPRISE

FRACTIONAL T1/E1 for SMALL BUSINESS

RESIDENTIAL/SOHO BROADBAND

WIRELESS BACKHAUL for Hotspots

19

Source: Intel

The World Wants Access

- All over the world:
  - Users want access to networks
    - More choice, better service, better value
  - Network operators want access to customers

- Broadband Wireless Access flourishes where:
  - Users want more choice in access
  - Network operators need to reach customers quickly and economically

The World Wants Standards

- Standards are at the forefront of world trade
  - World Trade Organization rules accelerating process
- In all fields of telecommunications, the world wants standards.
- Broadband Wireless Access is not isolated from this trend.
- Even stationary systems require standards:
  - Ethernet
  - DOCSIS

IEEE 802 Standards

The LAN/MAN Standards Committee

Wired:

- **802.3 (Ethernet)**

Wireless:

- **802.11: Wireless LAN**
  - **Local Area Networks**
- **802.15: Wireless PAN**
  - **Personal Area Networks {inc. Bluetooth (802.15.1)}**
- **802.16: WirelessMAN**
  - **Metropolitan Area Networks**

IEEE 802.16 History

- **Project Development: 1998-1999**
- **Meet every two months:**
  - **Session #1: July 1999**
  - **...**
  - **Session #28: Nov 2003**

- ***Open process and open standards***

Properties of IEEE Standard 802.16

- Broad bandwidth (to 134 Mbit/s in 28 MHz channel)
- Point-to-multipoint topology, with mesh extensions
- Supports multiple services simultaneously with full QoS
  - Efficiently transport IPv4, IPv6, ATM, Ethernet, etc.
- Bandwidth on demand (frame by frame)
- MAC designed for efficient use of spectrum
- Comprehensive, modern, and extensible security
- Time-Division or Frequency-Division Duplex
- Supports multiple frequency allocations up to 66 GHz
  - ODFM and OFDMA for non-line-of-sight applications
- Link adaptation: Adaptive modulation and coding
  - Subscriber by subscriber, burst by burst, uplink and downlink
- Support for adaptive antennas and space-time coding
- Extensions to mobility coming next

Frequency Bands for Wireless MAN (licensed and license-exempt)

2.4 GHz

2.5 GHz

3.5 GHz

5-6 GHz

10.5 GHz

28 GHz

38 GHz

42 GHz

etc.

The World Wants 802.16 WirelessMAN™ Standards

- Have had attendees from 22 countries (Australia, Brazil, Canada, China, Finland, France, Germany, Greece, Israel, Italy, Japan, Korea, Netherlands, Norway, Pakistan, Russia, Singapore, Spain, Sweden, Taiwan, UK, USA)
- 2002 meetings in:
  - Finland
  - Korea
  - Canada twice (Vancouver and Calgary)
  - U.S. twice (Hawaii and St. Louis)
- Coordinated European efforts in ETSI

IEEE 802.16 and ETSI

- Over 50 liaison letters between 802.16 and ETSI
  - (European Telecom Standards Institute)

- ETSI BRAN (HIPERACCESS and HIPERMAN)
  - Healthy cooperation
  - Harmonized HIPERMAN with IEEE 802.16 OFDM

BWA/802.16 Interest within China

"IEEE 802.16a Broadband Wireless Access (BWA) Standard Development and Internet Application": conference sponsored by BUPT and MII on 24 August 2001 in Beijing "on the specific topic of whether to use 802.16a as the Chinese national standard for fixed broadband wireless access at 3.5 GHz"

WiMAX Forum

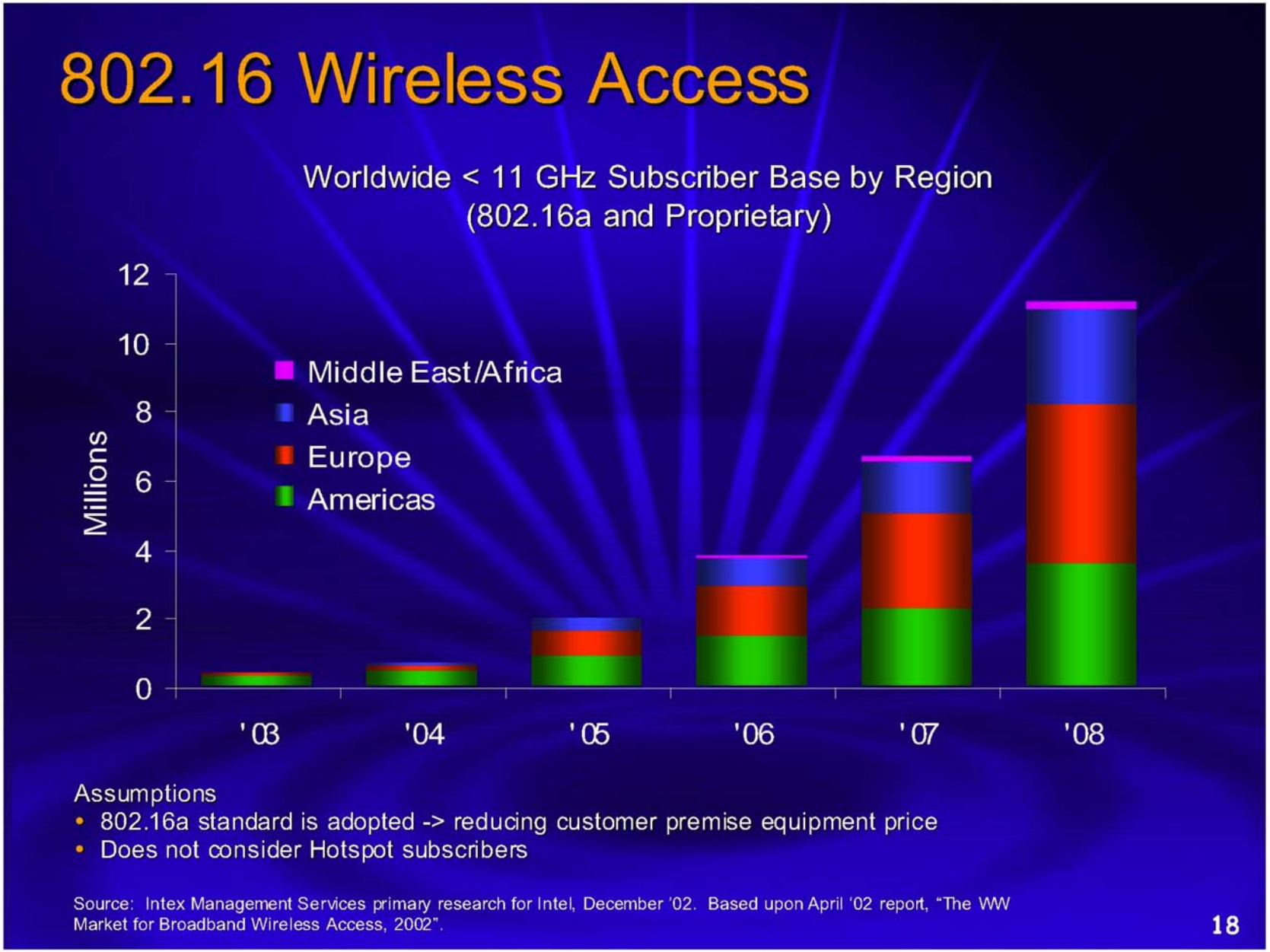
- **WiMAX: Worldwide Interoperability for Microwave Access**
- **Mission:** ***To promote deployment of BWA by using a global standard and certifying interoperability of products and technologies.***

- **Principles:**
- **Support IEEE 802.16 standard**
- **Propose and promote access profiles for IEEE 802.16 standard**
- **Certify interoperability levels both in network and the cell**
- **Achieve global acceptance**
- **Promote use of broadband wireless access overall**

WiMAX Members

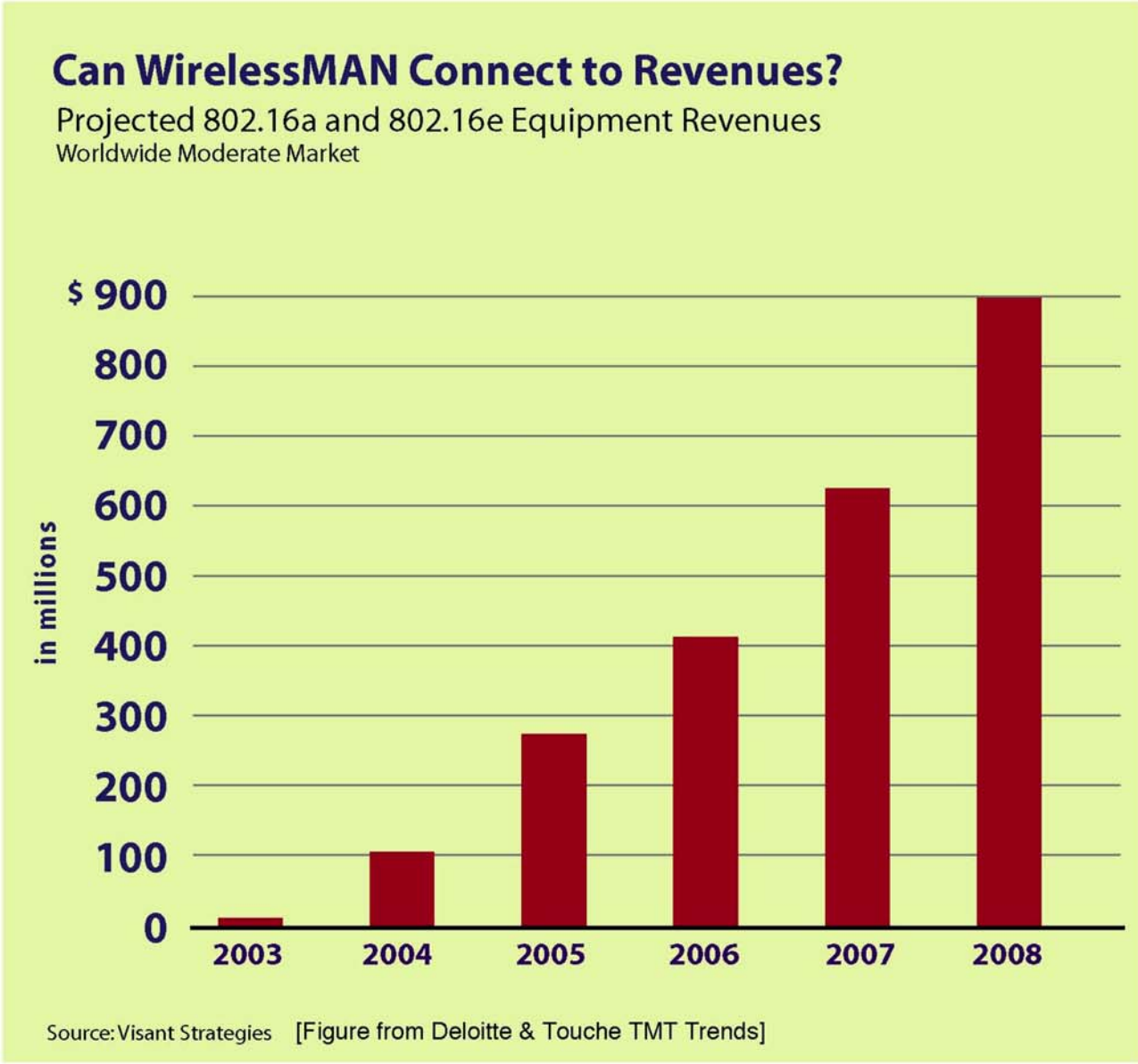
- Airspan Networks
- Alvarion Ltd.
- Andrew Corp.
- Aperto Networks
- Atheros
- Compliance Certification
- Ensemble Communications
- Fujitsu Microelectronics
- Hughes Network Systems
- Intel Corporation
- Nokia
- NEWS IQ Inc
- OFDM Forum
- Powerwave
- Proxim Corporation
- Redline Comms.
- RF Integration
- SI Wave Corp.
- SI Works
- SR Telecom
- Telnecity Group
- Towerstream
- TurboConcept
- Wavesat Telecom
- Wi-LAN Inc.
- Winova Wireless

IEEE 802.16 Growth Projections



Source: Intel

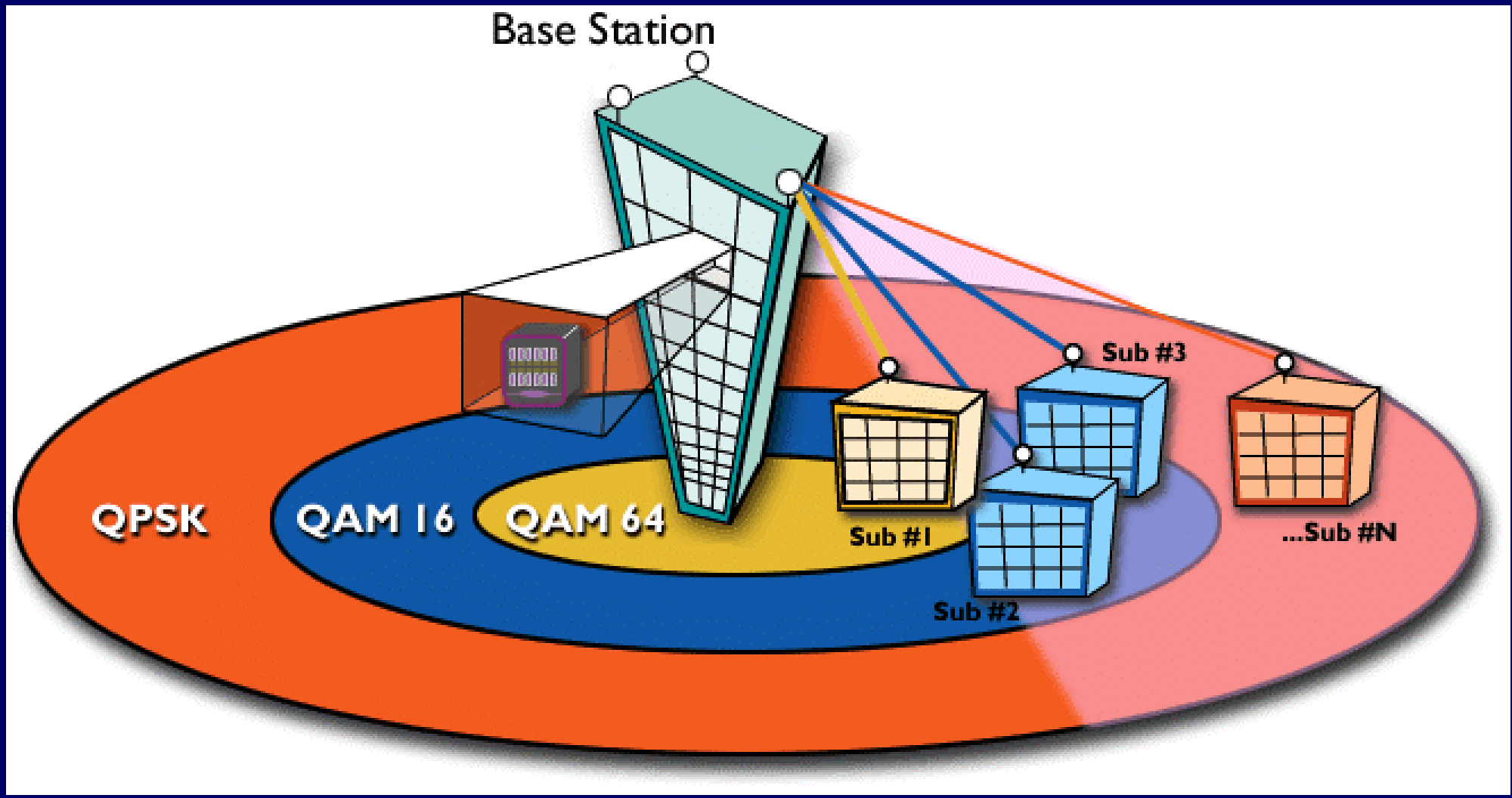
IEEE 802.16 Revenue Projections



IEEE 802.16 MAC: Overview

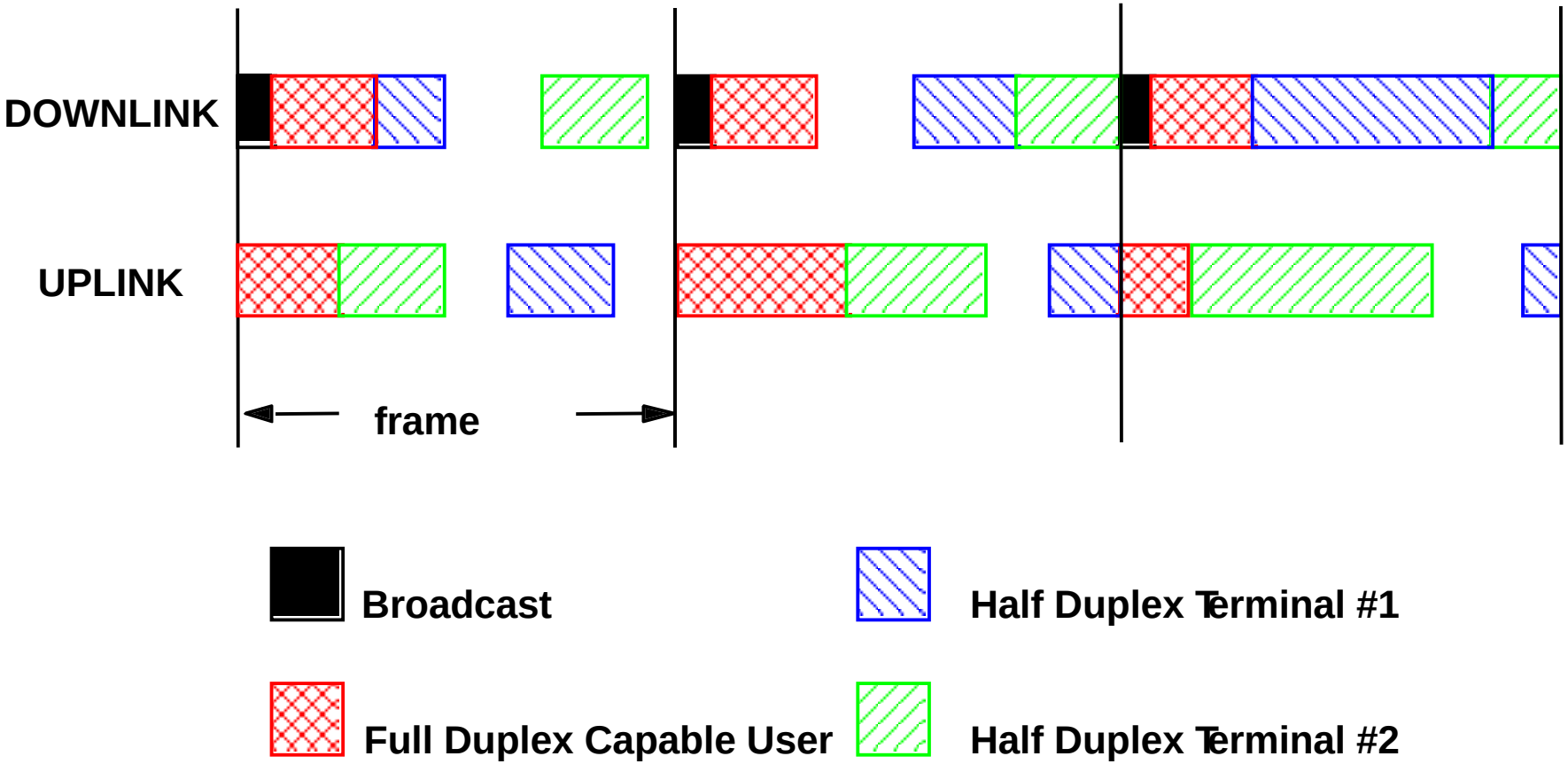
- Point-to-Multipoint
- Metropolitan Area Network
- Connection-oriented
- Supports difficult user environments
  - High bandwidth, hundreds of users per channel
  - Continuous and burst traffic
  - Very efficient use of spectrum
- Protocol-Independent core (ATM, IP, Ethernet, …)
- Balances between stability of contentionless and efficiency of contention-based operation
- Flexible QoS offerings
  - CBR, rt-VBR, nrt-VBR, BE, with granularity within classes
- Supports multiple 802.16 PHYs

Link Adaption



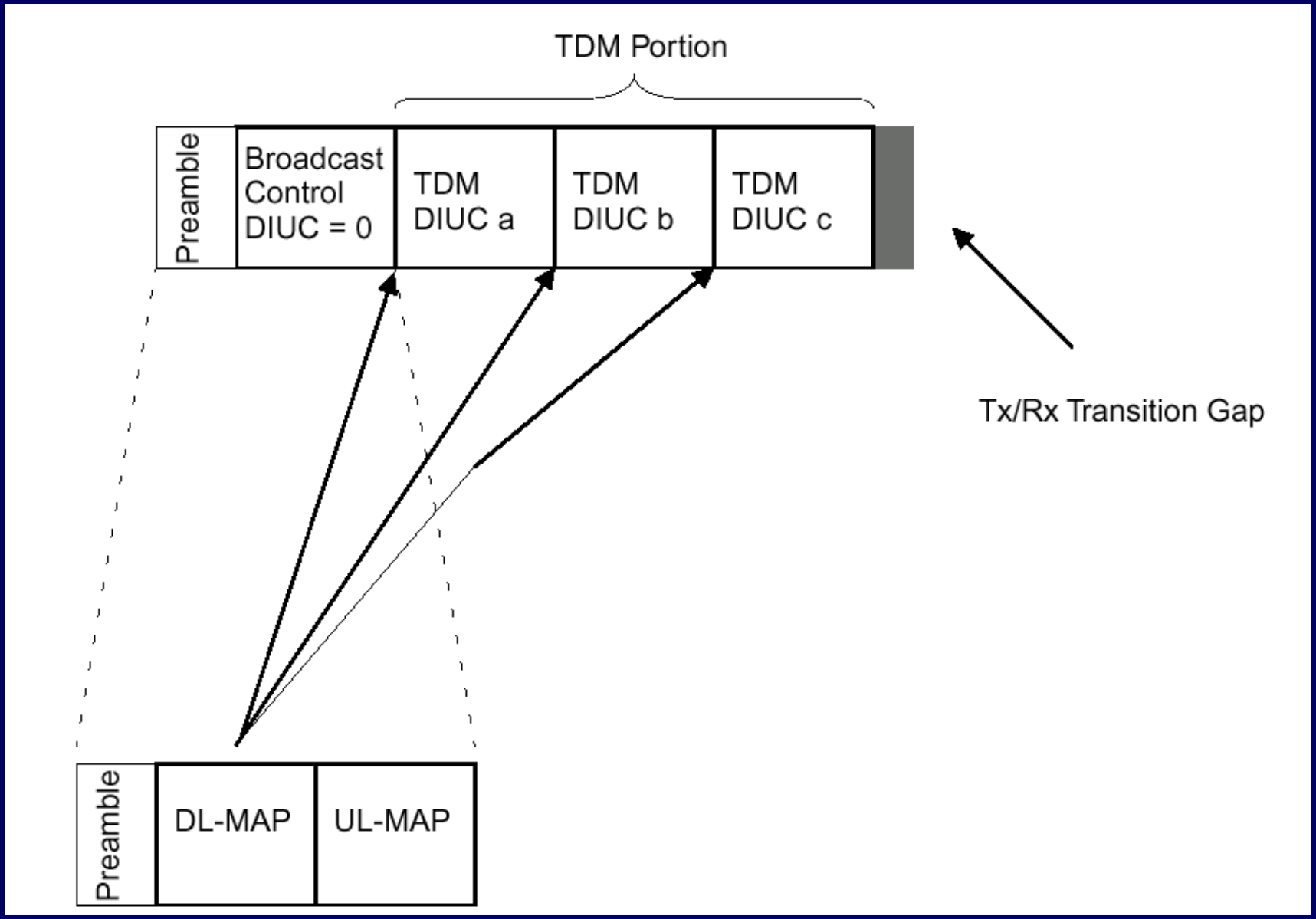
(burst-by-burst adaptivity not shown)

Burst FDD Framing



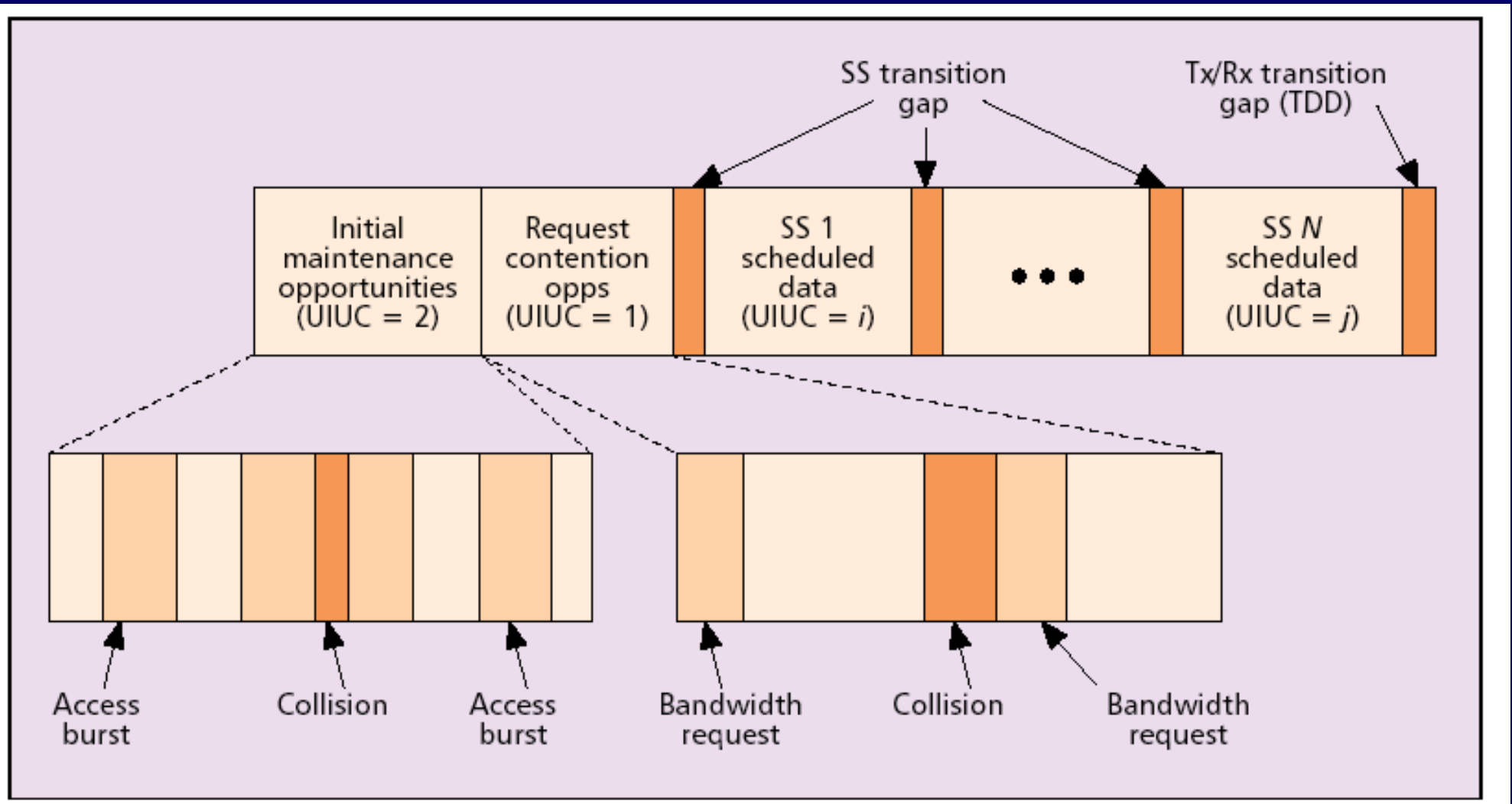
Allows scheduling flexibility

TDD Downlink Subframe



DIUC: Downlink Interval Usage Code

Typical Uplink Subframe (TDD or FDD)



802.16 Projects: 10-66 GHz

Air Interface

IEEE Standard
802.16
Publ: Apr 2002
- MAC
- 10-66 GHz PHY

802.16c (Profiles)
Publ: Jan 2003

Conformance

802.16/Conf01
(PICS)
Publ: Aug 2003

P802.16/Conf02
Passed 1st ballot;
Done in 2003 (?)

P802.16/Conf03
Draft in ballot

P802.16/Conf04
future

Coexistence

IEEE Standard
802.16.2
Publ: Sep 2001

802.16 Projects: 2-11 GHz

Air Interface

802.16a
- 2-11 GHz PHY

Publ: April 2003

P802.16-REVd
Revision
- In Ballot
- Done early 2004 (?)

P802.16e
- Mobile Extension
- Start: Dec 2002
- Draft to Ballot: Nov 2003

Conformance

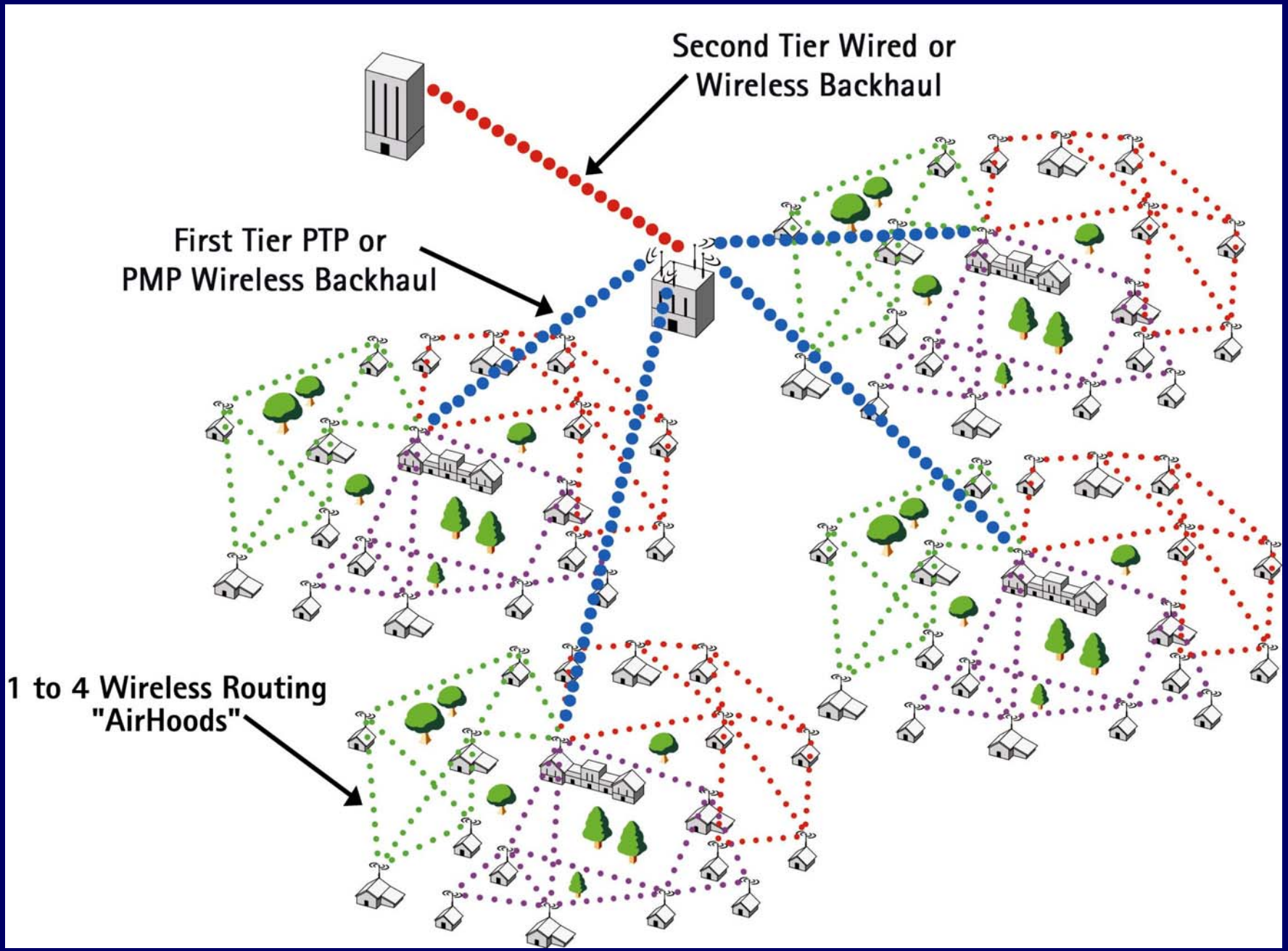
Coexistence

802.16.2-REVa
Revision
- 2-11 GHz
- Done 2003 (?)

802.16a PHY Alternatives: Different Applications, Bandplans, and Regulatory Environments

- OFDM (WirelessMAN-OFDM Air Interface)
  - 256-point FFT with TDMA (TDD/FDD)
- OFDMA (WirelessMAN-OFDMA Air Interface)
  - 2048-point FFT with OFDMA (TDD/FDD)
- Single-Carrier (WirelessMAN-SCa Air Interface)
  - TDMA (TDD/FDD)
  - BPSK, QPSK, 4-QAM, 16-QAM, 64-QAM, 256-QAM
  - Most vendors will use Frequency-Domain Equalization

Mesh-based WirelessMAN



Source: Nokia Networks

What's Next ?

- Revision of IEEE Std 802.16
- Possible extensions:
  - mesh enhancements
  - Special point-to-point mode
- Mobility: IEEE Project 802.16e
- Compliance documentation

- New 802 Handoff Study Group

Grow as you Go

- Fixed wireless
  - Can deploy one cell at a time
  - As customer base grows, add cells
- Might be able to justify initiation solely for backhaul
  - Then grow to serve other customers
- Move toward mobile support
  - Once systems are deployed
  - Once mobile terminals are cheaper

Free IEEE 802 Standards

- **Since May 2001, IEEE 802 standards have been available for free download.**
  - **beginning six months after publication**

- **See:**

http://WirelessMAN.org

Recent News

6 October 2003

- **Wavesat Wireless Announces OFDM Chip implementation of IEEE 802.16 Standard**

7 October 2003

- **Redline Communications Debuts its IEEE 802.16 Compliant Broadband Wireless System at ITU Telecom World 2003**

9 October 2003

- **CNET UK Technology Awards: "Most Promising Technology of the Year" award to "WiMAX, the IEEE 802.16 Air Interface Standard for fixed broadband wireless access"**

IEEE 802.16 Summary

- addresses worldwide needs
- open in development and application
- engineered as optimized technical solutions
- compliance & interoperability tests are coming
- vendor differentiation without compromising interoperability

- evolving for expanded opportunities
  - mobility is the next major enhancement

IEEE 802.16 Resources

IEEE 802.16 Working Group on Broadband Wireless Access

info, documents, tutorials, email lists, etc:

http://WirelessMAN.org