

WIMAX (802.16) Möglichkeiten und Perspektiven

ITG FG 5.2.4
Fachgruppentreffen
11. März 2004

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Inhalt

> Überblick

- IEEE 802.16, ...16a,...16REVd,...16e
- WiMAX Forum

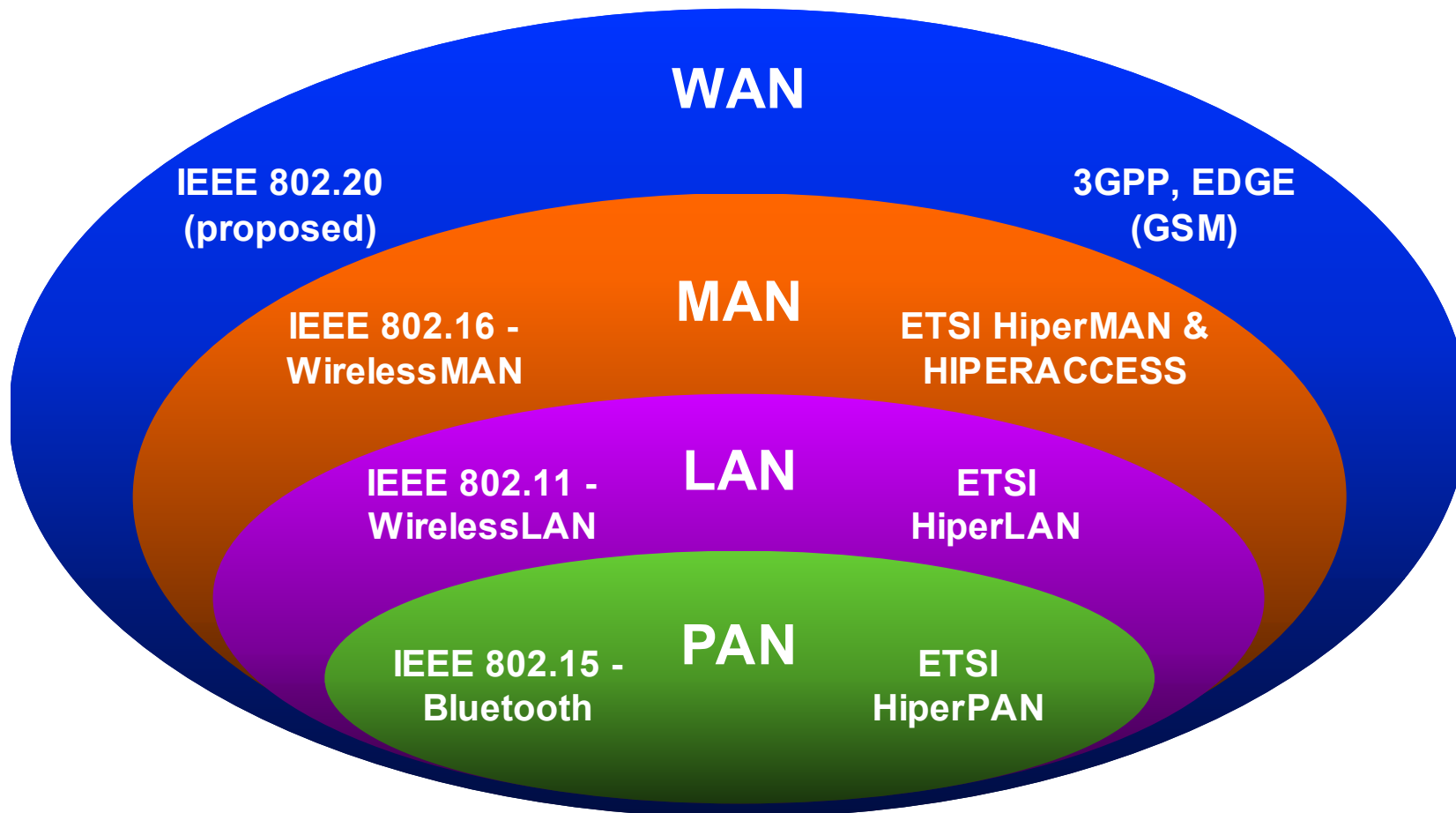
> Technische Charakteristika

- QoS, Sicherheit, ...
- Frequenzbereiche

> Einsatz-Möglichkeiten und Perspektiven

- Ländliche, städtische Bereiche
- Fixed, nomadic, mobile

IEEE802.16 Standardization Overview (1)



IEEE802.16 Standardization Overview (2)

> **802.16:**

- the original standard, published in April 2002
- defines a MAC layer and several physical layer specifications. The MAC supports frequency-division-duplex (FDD) and time-division-duplex (TDD), as well as real-time adaptive modulation and coding. Single-carrier modulation. The physical layer of the standard covers the spectrum from **10 to 66 GHz**, which includes the LMDS bands. The high frequencies limit the use to **line-of-sight (LOS)**.

> **802.16a:**

- a completed amendment that extends the physical layer to the **2 to 11 GHz** spectrum range (includes both licensed and unlicensed bands).
- the 802.16a standard also specifies three possible modulations: single carrier, OFDM and OFDMA. The lower frequencies allow **non-line of sight (NLOS)** formats, which can also be helped by OFDM's ability to handle multipath signals. Range can be up to 30 km, with cell footprints in the 4 to 6 km range. Total data rate can be up to 75 Mb/s in each 20MHz channel.

IEEE802.16 Standardization Overview (3)

> **802.16c:**

- profiles, conformance standards, and test suites for 802.16 (10-66GHz) implementations. The profiles are published, the conformance tests have concluded sponsor ballot.

> **802.16REVd:**

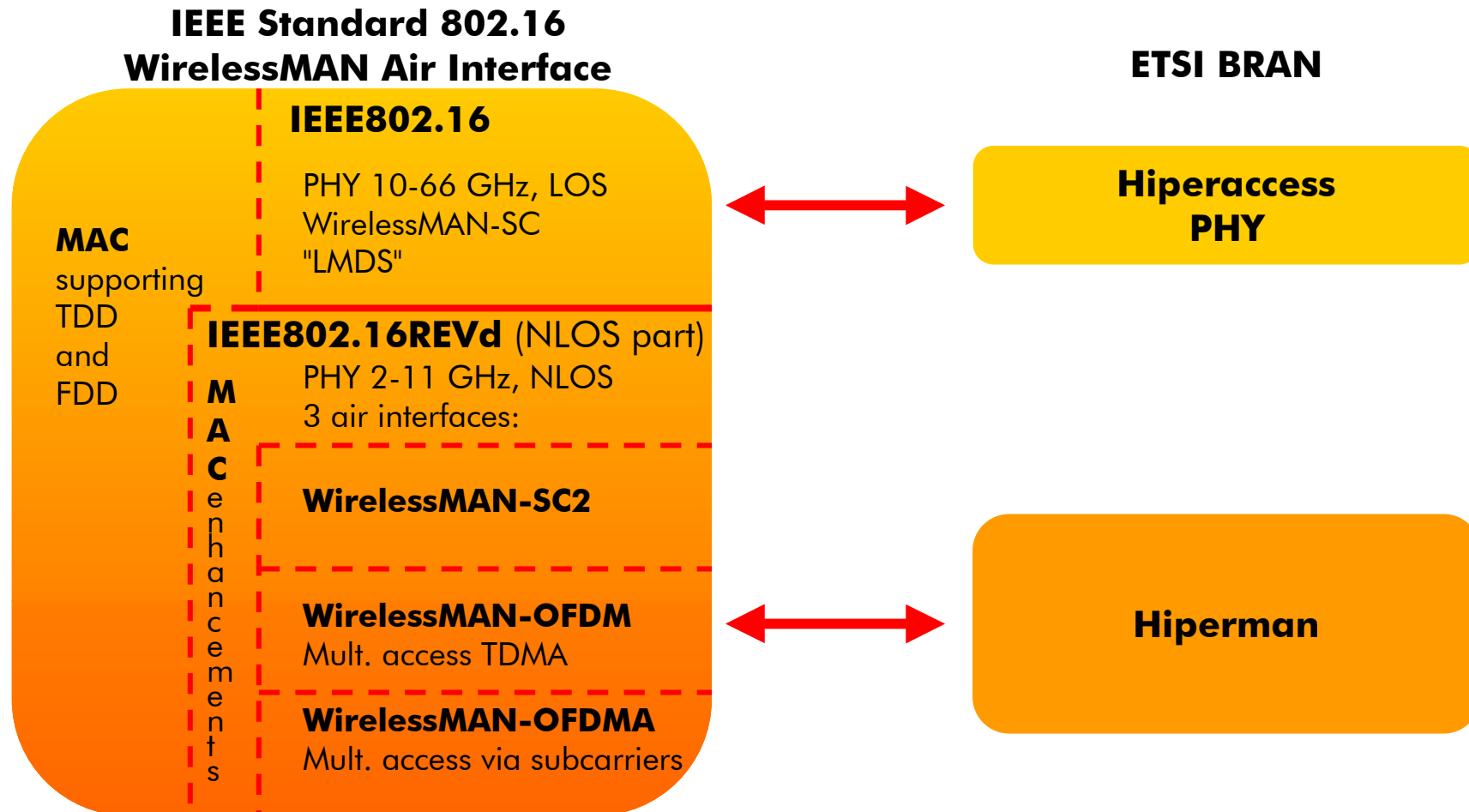
- full revision of 802.16 and 802.16a/d, covering the full LOS and NLOS range (2-66 GHz); currently in sponsor balloting process
- includes system profiles for 2-11GHz implementations

> **802.16e:**

- a nascent effort to extend the 802.16a standard for portability (mobile clients)
- Working group letter ballot launched on 15.01.2004

> For details see: <http://www.ieee802.org/16/milestones.html>

IEEE 802.16 <=> ETSI BRAN Correspondance



WiMAX Forum

- > WiMAX: both a label for a technology (from IEEE 802.16) and a interoperability certification forum
 - It is for 802.16REVd what WiFi is for 802.11 Certified™ Interoperability
- > Created in 2001 to help promote and certify the compatibility and interoperability of broadband wireless access equipment that conforms to the IEEE 802.16 and ETSI HiperMAN
- > Active participants: Airspan, Alvarion, Analog Devices, Aperto Networks, Ensemble Communications, Fujitsu, Intel, Nokia, Proxim, Redline, Siemens Mobile, Wavesat, ZTE ...
- > See: <http://www.wimaxforum.org>

IEEE802.16REVd: Technical Characteristics (1)

- > Non-line-of-sight (NLOS) and LOS environment
- > Licensed and license-exempt spectrum
- > Scalability due to flexible channel sizes:
1.25 MHz ~ 20 MHz, TDD, FDD, H-FDD
- > Physical layer technologies :
 - Single carrier
 - OFDM (dominant one, adopted by ETSI HiperMAN and WiMAX)
 - OFDMA
- > High spectral efficiency: up to 3.75 bps/Hz (Adaptative Modulation)
 - dimensioning in real NLOS case in the range of 2 bps/Hz (average)
- > Cell radius up to 30 km, but very dependant on the environment (NLOS, LOS, Urban, Rural)
 - NLOS up to 6 km

IEEE802.16REVd: Technical Characteristics (2)

- > Adaptive modulation support with frame-by-frame capacity allocation
- > Centralized resource allocation with TDM/TDMA scheduled DL/UL frames
- > Security features: modem authentication, individual encryption
- > QoS support
 - Unsolicited Grant Services (UGS) supports constant bitrate (CBR)
 - Real-time polling services (rtPS) supports variable data rate real-time services, e.g. MPEG video, VoIP
 - Non-real-time polling service (nrtPS) supports non-real-time variable size data packets, e.g. FTP
 - Best effort services (BE)

Frequency Bands below 10 GHz (1)

Band	2.3G	2.4G	2.6G		3.5G		5G
Bandwidth (MHz)	30	83.5	180		170 - 250		300 - 475
Europe		max. Tx power 100 mW	partly allocated for wireless access after 2007: foreseen for UMTS		widely licensed in blocks of 14 - 40 MHz		outdoor: 5470 - 5725 MHz max Tx power: 1 W EIRP
US	lic. in blocks of 5 MHz	max. Tx power 1 W	licensed in blocks of 6 MHz				outdoor: 5725 - 5825 MHz max. Tx power: 1 W EIRP
Canada	lic. in blocks of 15 MHz		licensed in blocks of 6 MHz		licensed in blocks of 25 MHz		
LAM							



not available for wireless access



licensed or unlicensed according to country regulations



licensed



unlicensed

Frequency Bands below 10 GHz (2)

> Licensed bands:

→ 3.5 GHz is the most important licensed band, but to serve all possible markets, both 2.6 and 3.5 GHz options will be needed

> Unlicensed bands:

- The 2.4 GHz is less suitable due to interference issues.
- The 5 GHz band is suitable for low density areas with only few potential interferers. The achievable QoS can be high, but always remains subject to unpredictable (legal) interference sources.

Comparison with other 802.xx Standards

	802.11a,b,g	802.16	802.16REVd	802.16e
Status	Complete	Dec 2001	In sponsor ballot	ETA Sept. 2003
Target App.	LAN	MAN	MAN	MAN
Range	Up to 300 ft. optimized for indoor LAN	Up to 5 miles Average Cell Radius 1-3 mi	Up to 25 miles Average Cell Radius 4-6 mi	Average Cell Radius 1-3 mi
Channel Conditions	LOS when outdoors	LOS	NLOS	NLOS
Spectrum	2.4 GHz & 5 GHz – Unlicensed	10-66 GHz Licensed	2-11 GHz Licensed and Unlicensed	2-6 GHz Licensed and Unlicensed
Mobility Support	Portable – Local Roaming	Fixed	Fixed	Pedestrian Mobility –Regional Roaming
Channelization	20 MHz	Scalable 1.5-20 MHz	Scalable 1.5-20 MHz	Scalable 1.5-5 MHz w/ sub-channels
Spectral Efficiency	< 2.7 bps/Hz	< 4.8 bps/Hz	< 3.75 bps/Hz	< 3 bps/Hz
Bit Rate	54 Mbps (20 MHz BW)	< 134 Mbps (28 MHz BW)	< 75 Mbps (20 MHz BW)	15 Mbps (5 MHz BW)

Source Intel

WiMAX Applications (1)

Extending existing services in...

- > White zone DSL areas
- > Rural and Sub-urban areas
- > Urban areas (city coverage)
- > Hot Spots



solving economical, technical and political issues in low density areas ('digital divide')



nomadic / portable broadband services

Introducing basic services in ...

- > developing countries (new service)
 - wireless telephony
 - IP services

WiMAX Applications (2)



**IP Services for
SMALL BUSINESS**



**T1 + LEVEL SERVICE
ENTERPRISE**



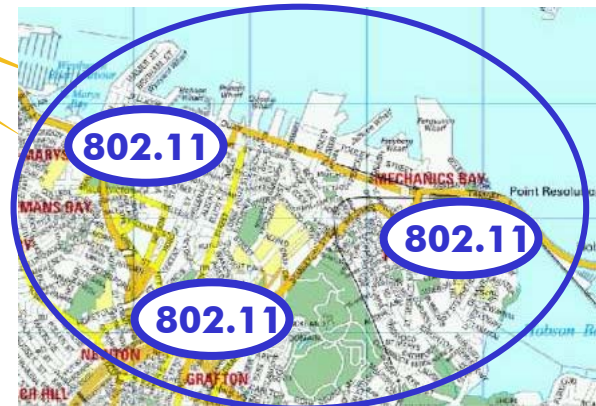
**BACKHAUL for
HOTSPOTS**



802.16REVd

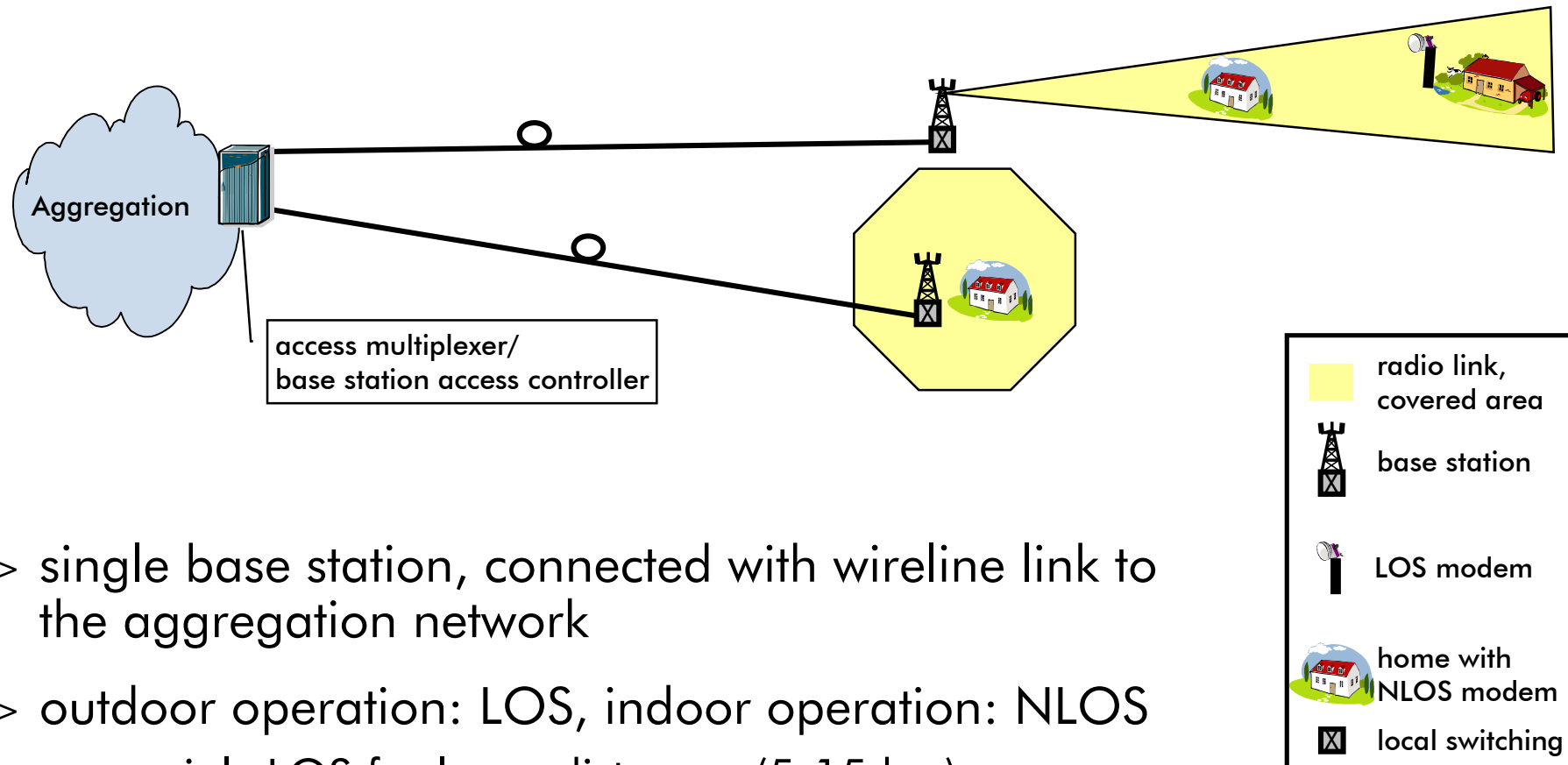


**WiMAX is for 802.16REVd
what WiFi is for 802.11
Certified™ Interoperability**



WiMAX

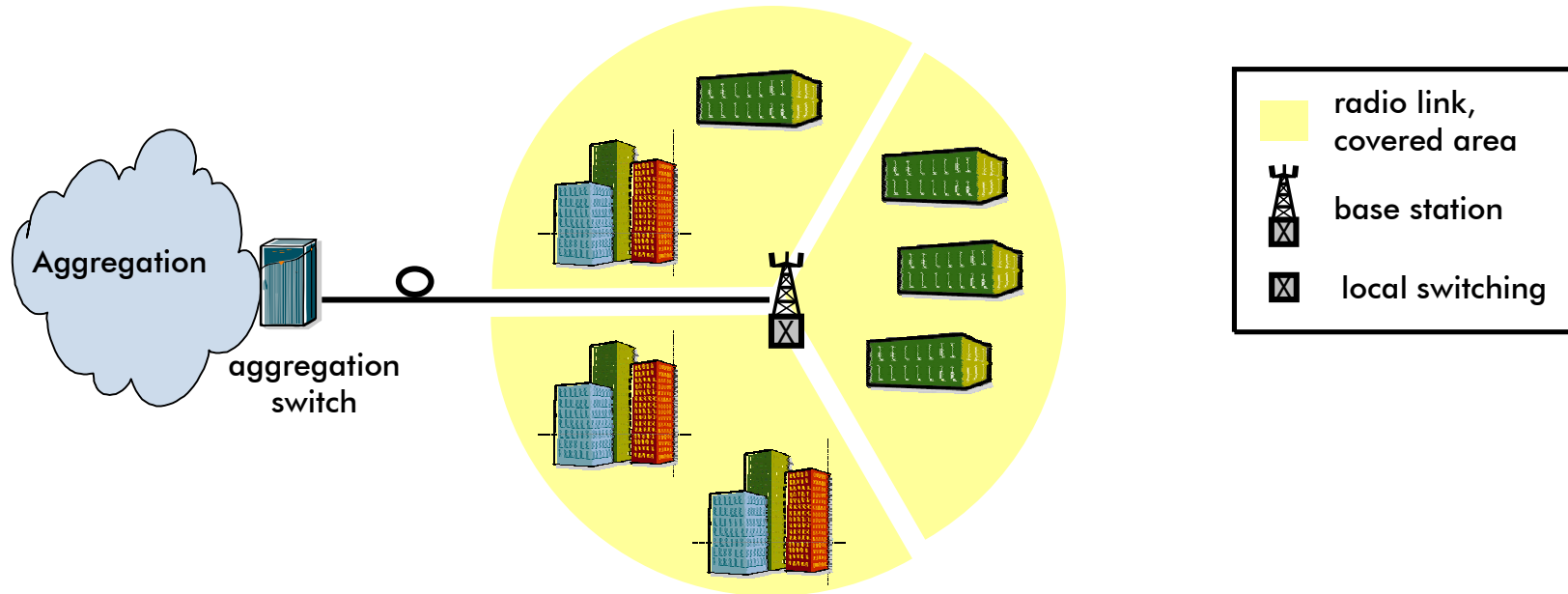
Single-Sector Base Station in Rural Environment



- > single base station, connected with wireline link to the aggregation network
- > outdoor operation: LOS, indoor operation: NLOS
 - mainly LOS for large distances (5-15 km)
 - NLOS is of importance e.g. for small villages

WiMAX

Multi-Sector Base Station in Urban Environment



> Characteristics:

- base station covers multiple sectors
- 3 to 6 sectors
(depending on user density and frequency reuse requirements)
- NLOS operation

WiMAX

Addressed Customers

Potential customers for broadband wireless access systems

- > Fixed Network ILECs
 - complementing wireline DSL
- > Mobile operators
 - complementing mobile access with high speed Internet
- > CLECs / Local authorities
 - creating/sponsoring new markets in the access area
- > Network and service operators in developing countries

WiMAX Network Integration

- > fixed networks
 - integration in DSL environment (for ILECs)
 - integration in metro networks (for CLECs)

- > mobile networks
 - integration similar to public WLAN

WiMAX

Nomadcity & Mobility

Nomadcity within WiMAX system

- > Covered by 802.16REVd
- > Non Real Time Service Continuity offered

Mobility within WiMAX system

- > 802.16e (not yet fixed)
- > Mobility issues handled on MAC layer, micromobility

Mobility in heterogeneous systems

- > Mobility issues handled on IP layer (mobile IP), macromobility
- > 802.21 handoff group:
developing standards to enable handover and interoperability between heterogeneous network type, including both 802 and non 802 networks

Summary

- > Family of standards: 802.16, .a, .REVd, .e
- > WiMAX forum to push interoperability
- > Fixed wireless access at data rates > 10 Mbit/s, range > 10 km
- > Important features: QoS, security, scalability
- > Deployment of WiMAX: rural, urban areas
- > Interoperation capability with fixed and mobile networks
- > Nomadicity covered by 802.16REVd ,
mobility to be covered by 802.16e (micromobility)

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