BSc in Computer Engineering
CMP4204
Wireless Technologies

Lecture 09

WiMAX, HiperLAN and HiperWAN

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1. Worldwide Interoperability for Microwave Access (WiMAX)

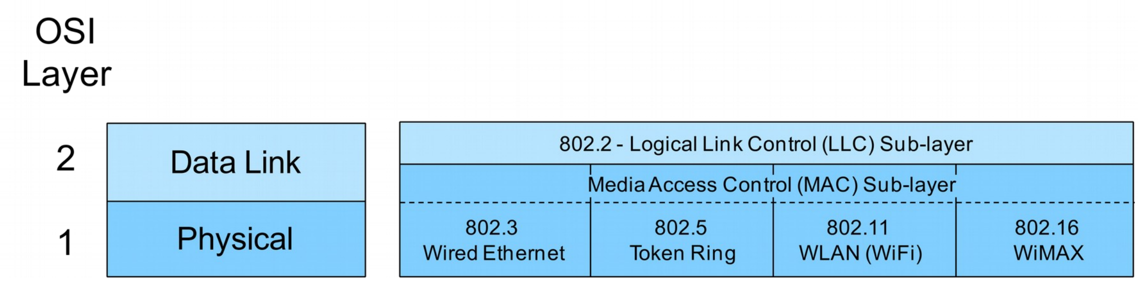

Illustration 1: WiMAX in the OSI Physical and Data Link Layer

IEEE Standard 802.16-2001, completed in October 2001 and published on 8 April 2002 defines the WirelessMAN PHY and MAC air interface specification for wireless Metropolitan Area Networks (MAN).

This standard, approved in 2001, addresses frequencies from 10 to 66 GHz. This is new spectrum currently available worldwide but at which the short wavelengths introduce significant deployment challenges. The 2–11 GHz bands are addressed in an amendment project 802.16a. These were rolled up into 802.16.2-2004 (802.16d) which defined the design and deployment of Fixed Broadband Wireless Access (FBWA).

1.1. 802.16d Fixed Broadband Wireless Access

802.16d addresses specifically the coexistence among FBWA systems operating in 23.5–43.5 GHz frequencies, the coexistence of FBWA systems with Point To Point (PTP) systems operating in 23.5–43.5 GHz frequencies and the coexistence among FBWA systems operating in 2–11 GHz licensed bands.

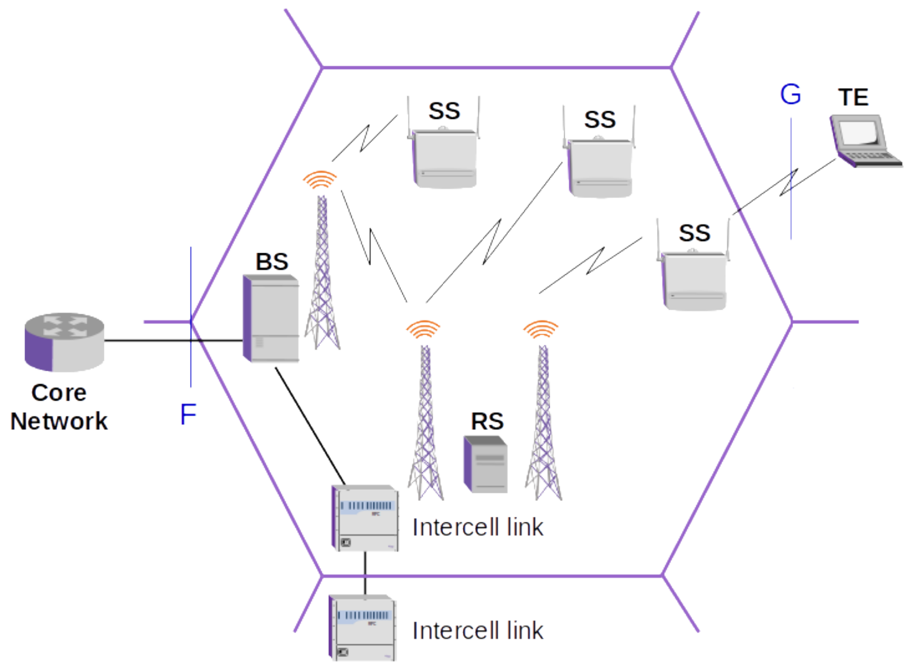

Illustration 2: FBWA Cell Architecture

In Illustration 2 the relationship between the various elements in the FBWA can be seen. Each FBWA system bust contains a Base Station (BS) and Subscriber Stations (SS) Cells. Intercell connectors can be achieved by using either wireless, fibre optic or copper facilities to interconnect two or more BS units. In systems that are more complex BS can be connected to the SS by use of a Repeater Station (RS). This is typical for SS that are out of range or have no Line of Sight (LoS) to their respective BS.

The FBWA network has two interface reference points labelled as F and G. The F interface is the connection to the core network, which is typically IP or ATM while the G interfaces between SS are generally wired Ethernet or 802.11 WiFi.

1.2. 802.16e Mobile WiMAX

Another working group called IEEE 802.16e had created a mobility WiMAX amendment published as 802.16e-2005. It provided enhancements to IEEE Std 802.16-2 2004 to support SS moving at vehicular speeds and thereby specifies a system for combined fixed and mobile broadband wireless access. This involved support for higher layer handover between base stations. Operation is limited to licensed bands suitable for mobility below 6 GHz.

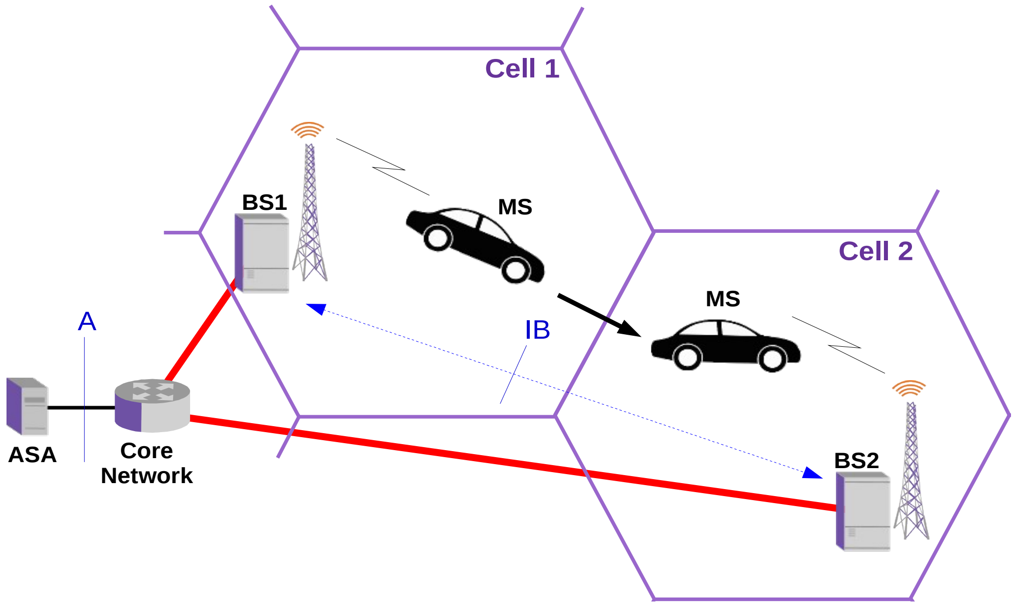

Illustration 3: Mobile WiMAX operation

In Illustration 3 two BS are connected to an operator backbone. BS 1 is the serving BS for an MS. BS 2 is the neighbouring BS in the next cell on the path. If the MS moves closer to BS 2 the MS is handed over to the nearer BS. The interfaces shown in Illustration 3 are ‘IB’ for the inter BS messaging. The ‘A’ interface for authentication and authorisation functions and the ‘U’ interface defines the physical and MAC operations.

While mobile WiMAX can deliver 70 Mb/s in theory, in reality, it is more like 30 Mb/s and then it can only do so over short distances from the BS. If the SS is at a longer distance from the BS then the throughput will drop as the bit error rate increases. Typical throughput at the cell edge is 1 - 4 Mb/s. Another important point is that 802.16e is not backwards compatible with 802.16d systems.

1.2.1 802.16m WiMAX2

802.16m, dubbed WiMAX2 WirelessMAN-Advanced Air Interface provided a future path for operators using 802.16e. It is backwards compatibility with 802.16e as well providing a data rate 100 Mb/s using multiple channels using advanced Multiple In, Multiple Out (MIMO) antenna technology. WiMAX2 was approved by International Telecommunication Union – Radiotelecommunications (ITU-R) as an International Mobile Telecommunications – Advanced (IMT-Adv) technology.

Using 4X4 MIMO in the urban microcell scenario with only a single 20 MHz Time Division Duplex (TDD) channel available system wide, the 802.16m system can support both 120 Mb/s DownLink (DL) and 60 Mb/s UpLink (UL) per site simultaneously.

1.3. WiMAX/Long Term Evolution (LTE)

LTE, the 4G mobile broadband technology backed by major cellular network equipment providers and operators, battled with WiMAX for the 4G technology of choice and in reality it was a short battle. It is well documented how the large equipment vendors backed LTE over WiMAX.

LTE had a distinct advantage over WiMAX, which was enhanced by where network operators were in the business cycle of their 3G systems investments.

Additionally the addition of Time Division LTE (TD-LTE) is a natural competitor to WiMAX by offering carriers virtually the same technology and performance but with access to a larger market, with more vendors and roaming opportunities. Many existing WiMAX operators have started or are planning the transition to TD-LTE or even to FDD LTE.

1.4. WiMAX migration to LTE

1.4.1 BS to eNodeB migration

Despite the similarity in the underlying technology between WiMAX and LTE, not all WiMAX base stations can be upgraded to TD-LTE, particularly the early WiMAX base stations. Many vendors have software or software with minimal hardware upgrades to LTE, bearing in mind both use OFDM, MIMO and have IP interfaces. upgrading to FDD LTE however is more difficult because of the use of paired spectrum.

1.4.2 Core network integration

Both WiMAX and LTE use an all-IP core network, upgrades are possible, but may entail the replacement of some core elements.

1.4.3 Multimode SS

Vendors have produced User Equipment that is multimode, that is to say it supports both WiMAX and LTE so when a migration happens customers will not need hardware swaps.

1.5. WiMAX future - LTE

As 4G is rolling out there is obviously a choice to be made between WiMAX2 and LTE for many carriers. While there are a number of high profile WiMAX deployments worldwide, the vendors have chosen LTE and major carriers have committed to LTE over WiMAX.

2. HiperLAN and HiperMAN

HiperLAN was a development in the European Telecommunications Standards Institute (ETSI) at roughly the same time as the IEEE were developing 802.11 as a Wireless Local Area Network (WLAN). HiperLAN's design was for a high data rate of 23.5 Mb/s, which was double that of the 802.11 11 Mb/s at the time. The standard was approved in 1996.

The standard covered a Physical layer and the Media Access Control part of the Data link layer like 802.11. It also has a sublayer called Channel Access and Control (CAC) sublayer to deal with access requests for channels.

At the PHYsical layer HiperLAN uses Frequency Shift Keying (FSK) and Gaussian Minimum Shift Keying (GMSK), a Phase Modulation (PM) modulation method.

- HiperLAN features:
- Range 50 m
- Nomadic (slow) mobility (1.4 m/s)
- Supports asynchronous and synchronous traffic
- Bit rate - 23.2 Mb/s
- Frequency range- 5.15-5.3 GHz and the 17.1-17.3 GHz spectrum.

2.1. HiperLAN/2

HiperLAN/2 functional specification was accomplished February 2000. Version 2 was designed as a fast wireless connection. HiperLAN/2 used the 5 GHz band with a data rate of up to 54 Mbit/s data rate.

The physical layer of HiperLAN/2 is very similar to IEEE 802.11a wireless local area networks. However, the media access control was Dynamic Time Division Multiple Access (TDMA), while Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is used in 802.11.

On the physical layer Binary Phase Shift Key (BPSK), Quadrature Phase Shift Keying (QPSK), 16 Quadrature Amplitude Modulation (QAM) (16QAM) or 64QAM modulations were used.

2.2. HiperMAN

High Performance Radio Metropolitan Area Network (HiperMAN) was another standard created by ETSI to provide a wireless network communication in the 2 –11 GHz bands and was seen as an alternative to IEEE 802.16 WiMAX.

2.3. Failure in the Market

HiperLAN failed to attract market interest due to competition from IEEE 802.11 and it never received much commercial implementation. IEEE 802.11a incorporated much of the HiperLAN/2 PHY specification.

Like HiperLAN loosing out to IEEE 802.11 standard, HiperMAN lost out to IEEE 801.16 WiMAX, which you have just seen is itself loosing out to LTE.

3. Self-test Quiz

1. Define the differences between WiMAX 802.16d and 802.16e.
2. What advances were promised with the release of IEEE 802.16m ?
3. What is the future pathways for WiMAX operators towards 4G ?
4. What is HiperLAN and HiperWAN, why do you think they failed in the market ?

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