



# WiMAX and 802.16 Standards

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## Abbreviations and acronyms

- CEPT = European Conference of Postal and Telecommunications Administrations
- BWA = Broadband Wireless Access
- CLP = Cell Loss Priority
- EIRP = Effective Isotropic Radiated Power
- ETSI = European Telecommunications Standards Institute
- LMDS = Local Multipoint Distribution Service
- MMDS = Multichannel Multipoint Distribution Service
- LOS = Line Of Sight
- NLOS = Non Line Of Sight
- PMP = Point-to-Multipoint
- MP-MP = Multipoint-to-Multipoint or Mesh



## Abbreviations and acronyms

- PDU = Protocol Data Unit
- CS = Covergence Sublayer
- BS = Base Station
- SS = Subscriber Station
- RS = Repeater Station
- FDD = Frequency Division Duplexing
- TDD = Time Division Duplexing
- TDM = Time Division Multiplexing
- TDMA = Time Division Multiplexing Access



# WiMAX and standards 802.16

- Association with about 100 manufacturers promoting 802.16 standard
- Possible standard to implement Wireless Local Loop
- Wireless Metropolitan Area Network which coexist with WiFi networks
- IEEE Wireless MAN Standards:
  - 802.16-2001
    - Point-to-multipoint topologies
    - 10-66 GHz bands
  - 802.16a-2003
    - Point-to-multipoint and mesh topologies
    - 2-11 GHz bands
    - NLOS (Non Line Of Sight) function supported
  - 802.16e approved 28 February 2006
    - Support mobility functions for Subscriber Stations at speed of vehicle





# WiMAX and frequency planning

- WiMAX bands:
  - **licensed bands** are the frequencies assigned by the country Telecommunication Minister or equivalent with different cost rate depending by the countries.
    - 802.16-2001 can use only licensed bands (10-66 GHz)
  - **license-exempt bands** are free frequencies that normally is not necessary to pay money for the use, depend on countries law or rules. The free frequencies are different in different countries or state.
  - 802.16a-2003 (2-11 GHz) can use licensed bands or license-exempt bands (between 5 e 6 GHz)



# Frequency planning from 2 to 5 GHz

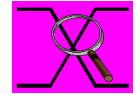
Frequency bands (GHz) (licensed unless noted)	Allowed channel spacing	Reference	
2.305–2.320 2.345–2.360	1 or 2 x (5 + 5 MHz) or 1 x 5 MHz (Can be aggregated in any combinations) Interference Protection to DARS	USA CFR 47 part 27 (WCS) See FCC Docket IB95-91 for potential (increased) interference from DARS repeaters.	
2.150–2.162 2.500–2.690	125 kHz to (n x 6) MHz Single or multiple, contiguous or non-contiguous and combinations. Interference Protection to video and ITFS users	USA CFR 47 part 21.901 (MDS) USA CFR 47 part 74.902 (ITFS, MMDS)	
2.150–2.160 2.500–2.596 2.686–2.688	1 MHz – (nx6) MHz (1 or 2-way) 25 kHz-(n x 25 kHz) "return" Contiguous channels preferred	Canada SRSP-302.5 (MCS) MDS service allocated to adjacent sub-bands (incl. separate "return" channels)	
2.400–2.483.5 (license-exempt)	Frequency Hopping or Direct Sequence Spread Spectrum etc.	CEPT/ERC/REC 70-03 USA CFR 47 Part 15, subpart E [B19]	
3.400–4.990	3.410–4.200	1.75–30 MHz paired with 1.75 MHz to 30 MHz Symmetric only. (50 MHz or 100 MHz separation)	Rec. ITU-R F.1488 Annex II ETSI EN 301 021[B18], CEPT/ERC Rec. 14-03 E, CEPT/ERC Rec. 12-08 E
	3.400–3.700	n x 25 MHz (single or paired) (50 MHz or 100 MHz separation if paired)	Rec. ITU-R F.1488 Annex I CITEL PCC.III/REC.47 (XII-99) Canada SRSP-303.4 (BWA)
	3.650–3.700	Rulemaking in progress	USA FCC Docket WT00-32
	4.940–4.990	Rulemaking in progress	USA FCC Dockets WT00-32 and ET-98-237



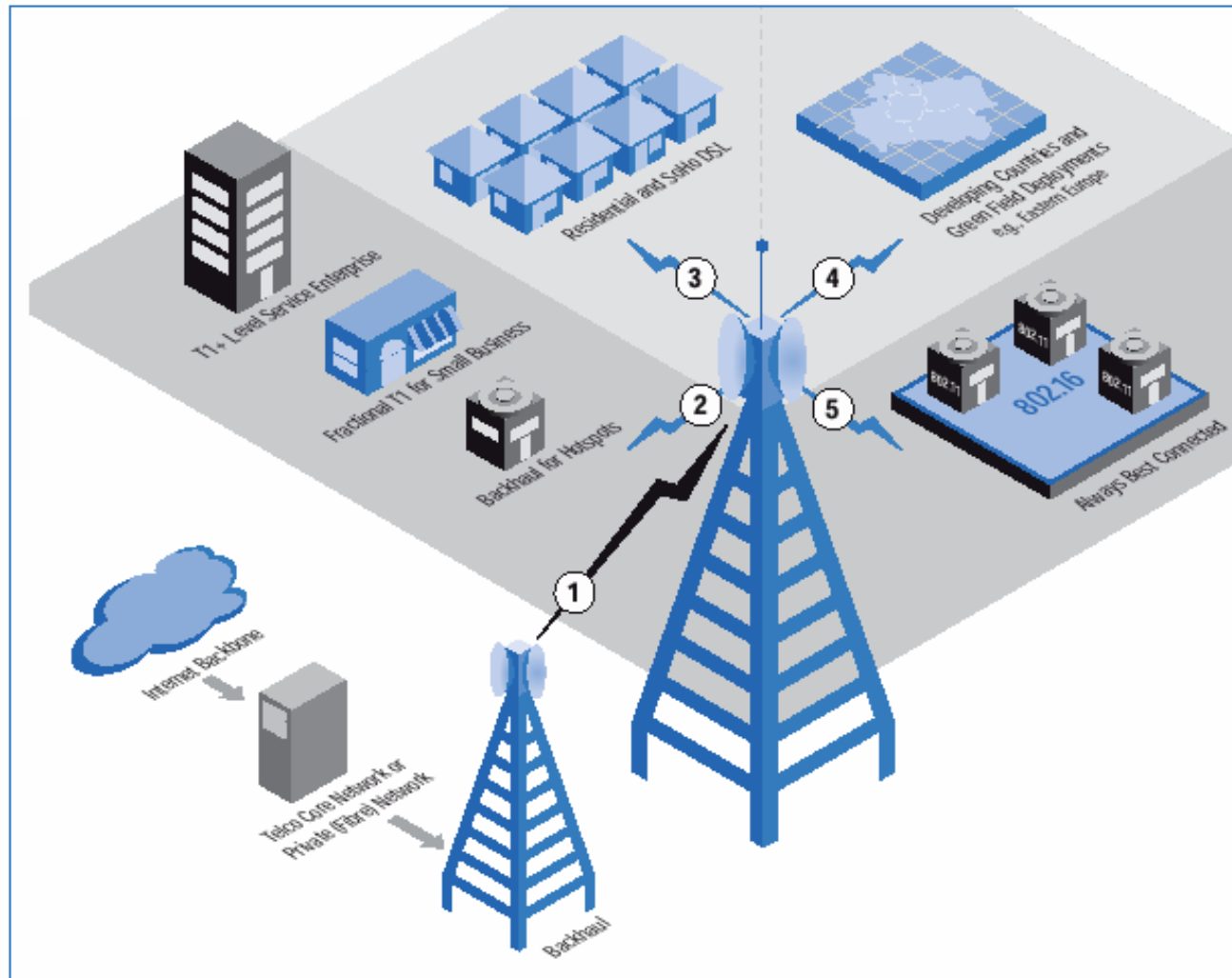
# Frequency planning from 5 to 11 GHz

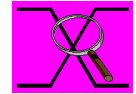
Frequency bands (GHz) (licensed unless noted)		Allowed channel spacing	Reference
5.150–5.850 (license-exempt)	5.150–5.350	n x 20 MHz (HIPERLAN) Restricted to Indoor Use	CEPT/ERC/REC 70-03
	5.470–5.725	n x 20 MHz (HIPERLAN)	
	5.250–5.350	100 MHz Max. Restricted to Indoor Use	USA CFR 47 Part 15, subpart E [B19] USA CFR 47 Part 15, subpart C [B19]
	5.250–5.350	100 MHz Max	
	5.725 –5.850	125 MHz Max	
10.000–10.680	3.5 to 28 MHz paired with 3.5 to 28 MHz. Symmetric only 350 MHz separation	CEPT/ERC/REC. 12-05 ETSI EN 301 021 [B18]	



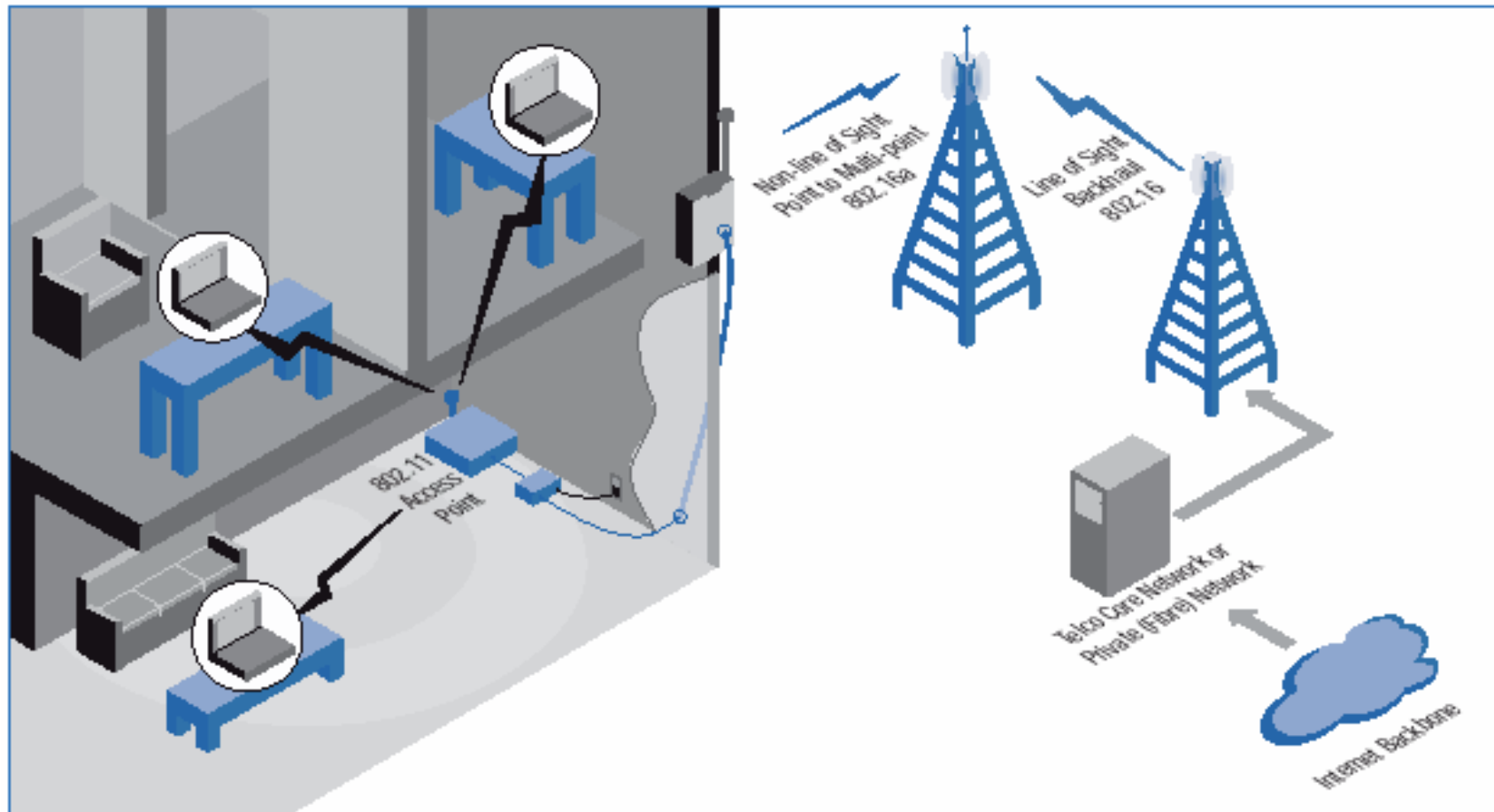


# WiMAX and metropolitan area coverage



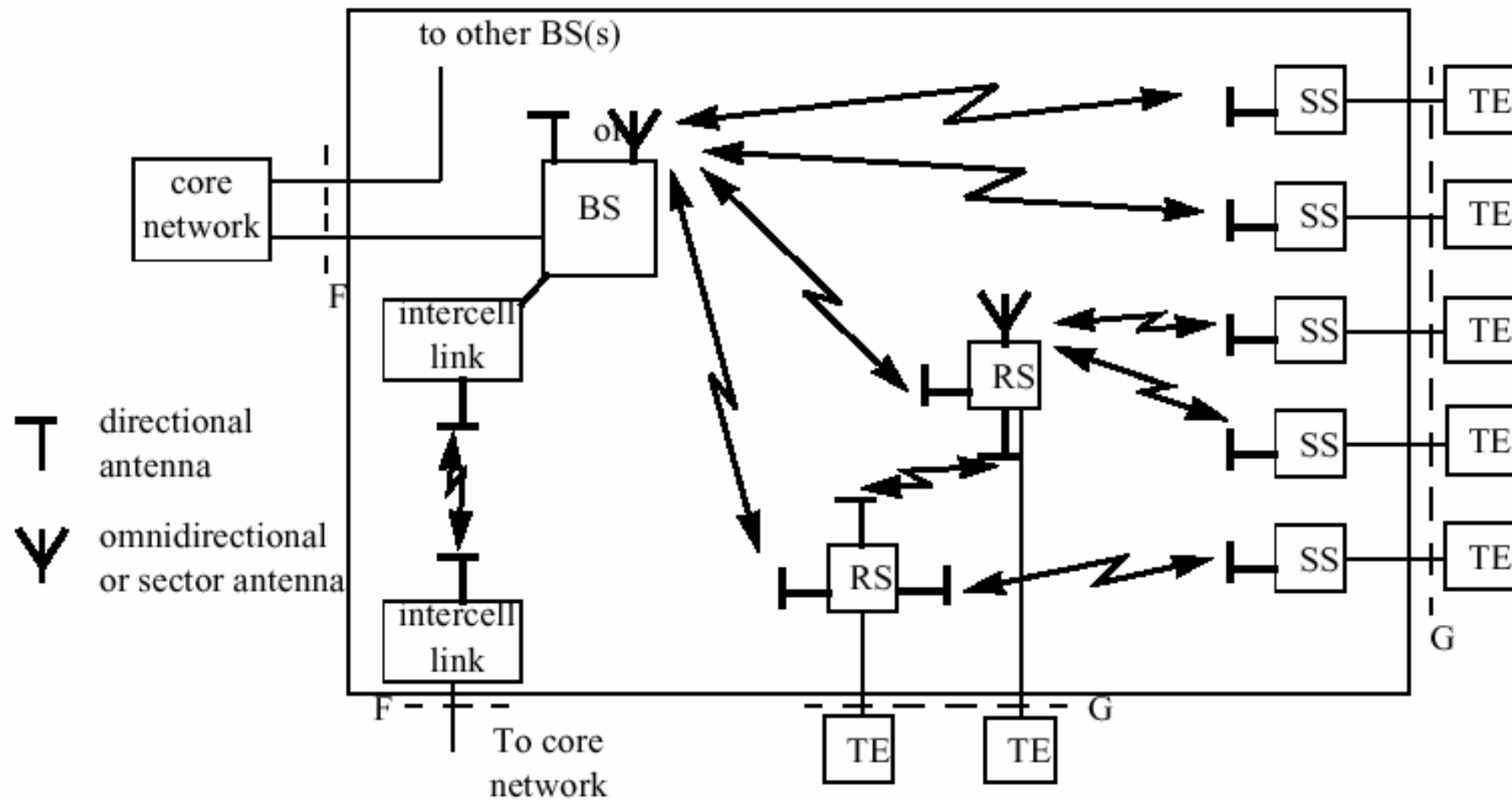


# WiMAX and 802.11b,g





# WiMAX 802.16 network elements and Broadband Wireless Access Systems Reference diagram



BS = Base Station; SS = Subscriber Station; TE = Terminal Equipment; RS = Repeater Station



## Basic network elements

### ■ Base Station (BS):

- A generalized equipment set providing connectivity, management, and control of the subscriber station.
  - Cover a limited area
  - The function is similar to the Access Point in Wireless LAN (Wifi) environment, but can transport different kinds of frames

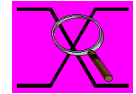
### ■ Subscriber Station (SS):

- A generalized equipment set providing connectivity between subscriber equipment and a base station. The SS send and receive frame to/from BS and the BS is responsible of connection between SS
  - This equipment permit to Terminal Equipment (example PC), connected via Ethernet or Wifi connection, to reach other Terminal Equipment via Wimax network



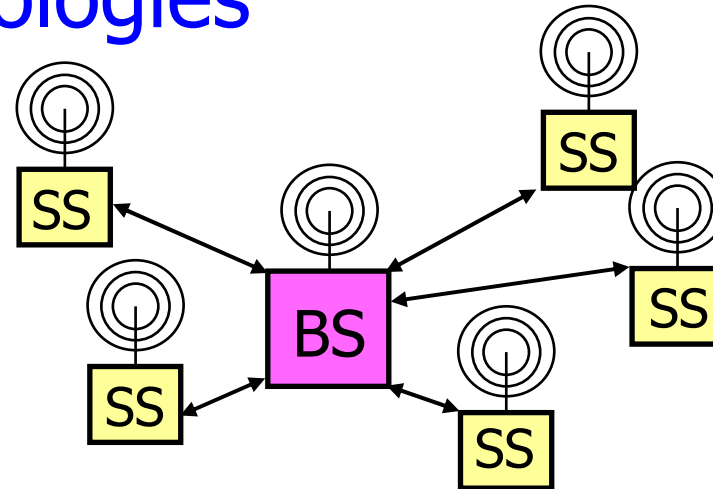
## Basic network elements

- Terminal Equipment (TE):
  - A wide variety of apparatus at customer premises, providing end user services and connecting to subscriber station (SS) equipment via one or more interfaces.
    - A PC can be considered Terminal Equipment
- Repeater Station (RS):
  - A station other than the base station (BS) that includes radio communication equipment facing two or more separate directions. Traffic received from one direction may be partly or wholly retransmitted in another direction. Traffic may also terminate and originate at the RS.
  - May connect a Terminal Equipment

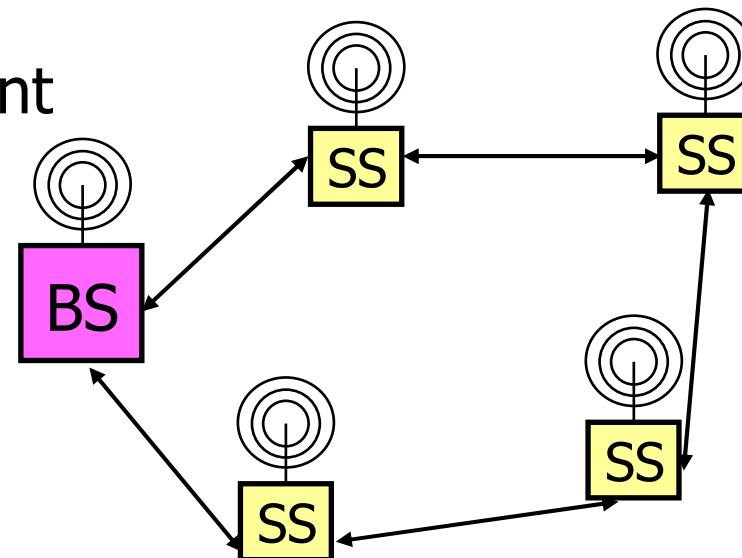


## Connections topologies

### ■ Point-to-MultiPoint

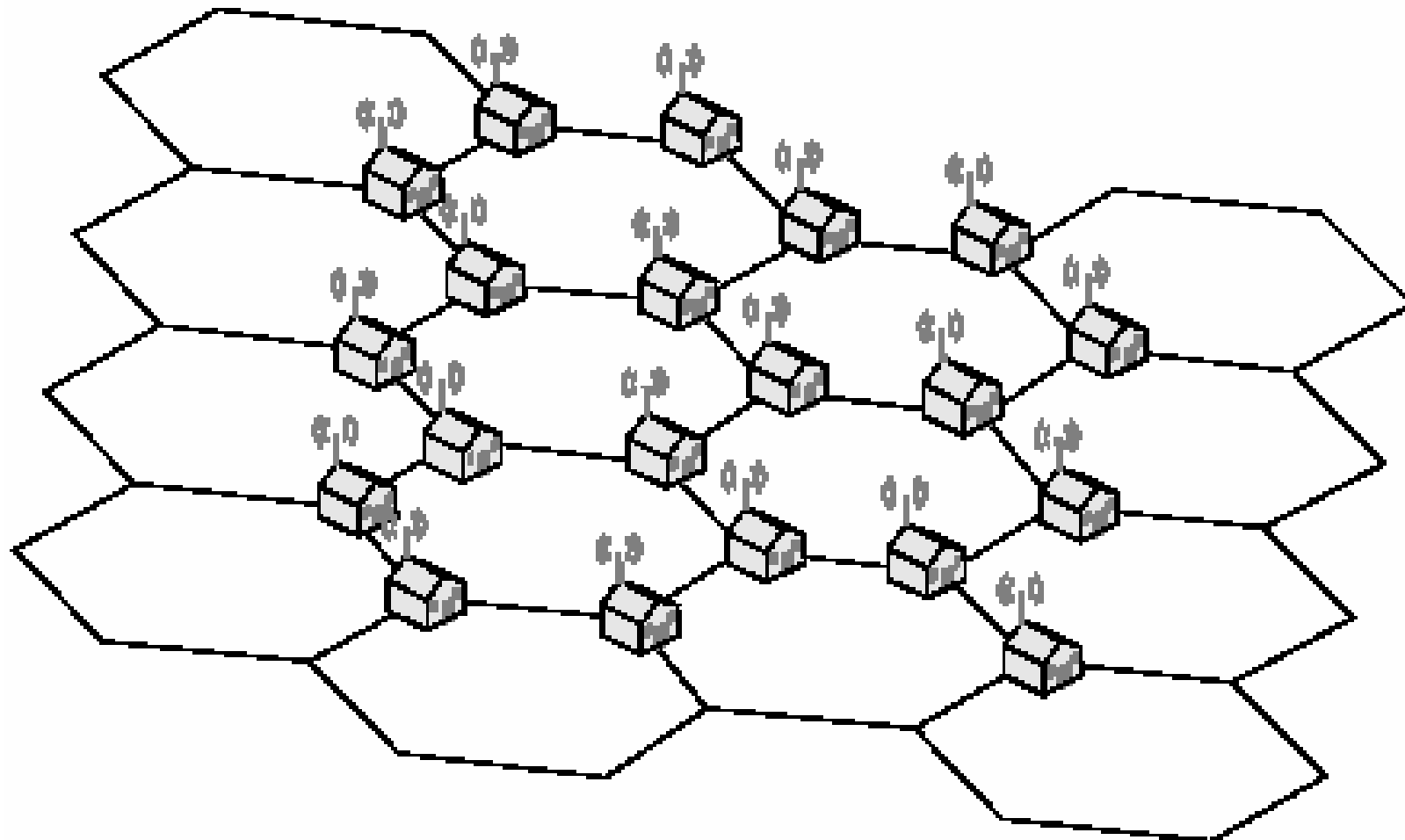


### ■ Mesh or Multipoint-to-Multipoint





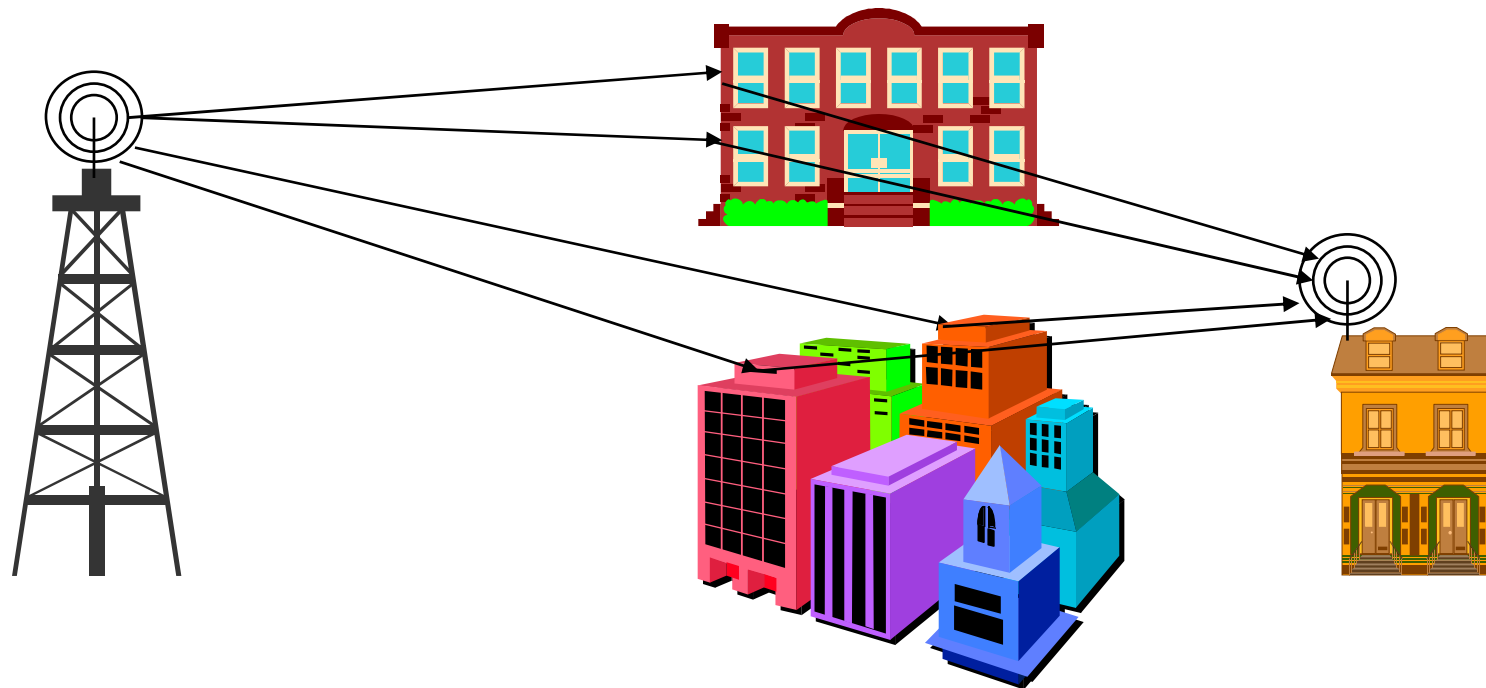
# WirelessHUMAN Mesh deployment model





## Non Line Of Sight (NLOS)

- Function of Multi-Path rebuilding signal for NLOS
- Supported only in 802.16a standard







**Table 1—Summary of the guidelines for geographical and frequency spacing**

<b>Dominant interference path (Note 1)</b>	<b>Scenario</b>	<b>Spacing at which interference is below target level (generally 6 dB below receiver noise floor)</b>
PMP BS to PMP BS	Adjacent area, same channel	60 km (Note 5)
Mesh SSs to PMP BS	Adjacent area, same channel	12 km (Note 2)
PMP BS to PMP BS	Same area, AdjCh	1 guard channel (Notes 3 and 5)
Mesh SSs to PMP SS	Same area, AdjCh	1 guard channel (Note 4)

**NOTES**

1—The dominant interference path is the path that requires the highest guideline geographical or frequency spacing.

2—The 12 km value is based on a BS at a typical 50 m height. For other values, the results change to some extent, but are always well below the 60 km value calculated for the PMP-PMP case.

3—The single guard channel spacing is based on both interfering and victim systems using the same channel size. Where the transmissions in neighboring blocks employ significantly different channel bandwidths, then it is likely that a guard frequency equal to one equivalent channel of the widest bandwidth system will be adequate. However, analysis suggests that, under certain deployment circumstances, this may not offer sufficient protection and that a guard frequency equal to one channel at the edge of each operator's block may be required.

4—The single guard channel spacing for mesh to PMP is based on both interfering and victim systems using the same channel size. This may be reduced in some circumstances. Where the transmissions in neighboring blocks employ significantly different channel bandwidths, it is likely that a guard frequency equal to one equivalent channel of the widest bandwidth system will be adequate. However, analysis suggests that, under certain deployment circumstances, this may not offer sufficient protection and that a guard frequency equal to one channel at the edge of each operator's block may be required.

5—In a case of harmonized FDD band plans and/or frequency reassignable TDD systems, the BS-to-BS case ceases to be dominant.