

LTE, WLAN, BLUETOOTH AND FUTURE

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MOOC on M4D 2013

4G LTE



- LTE (Long Term Evolution) is the 4G wireless cellular standard developed by the 3GPP (3rd Generation Partnership Project) alliance
- 3GPP is the group which also oversaw the development of UMTS (Universal Mobile Telecommunication System) Standard
 - In that sense LTE is an Evolution of UMTS

LTE

- The corresponding evolution of the core network comprising of the GPRS/3G Packet core is termed as SAE (System Architecture Evolution)

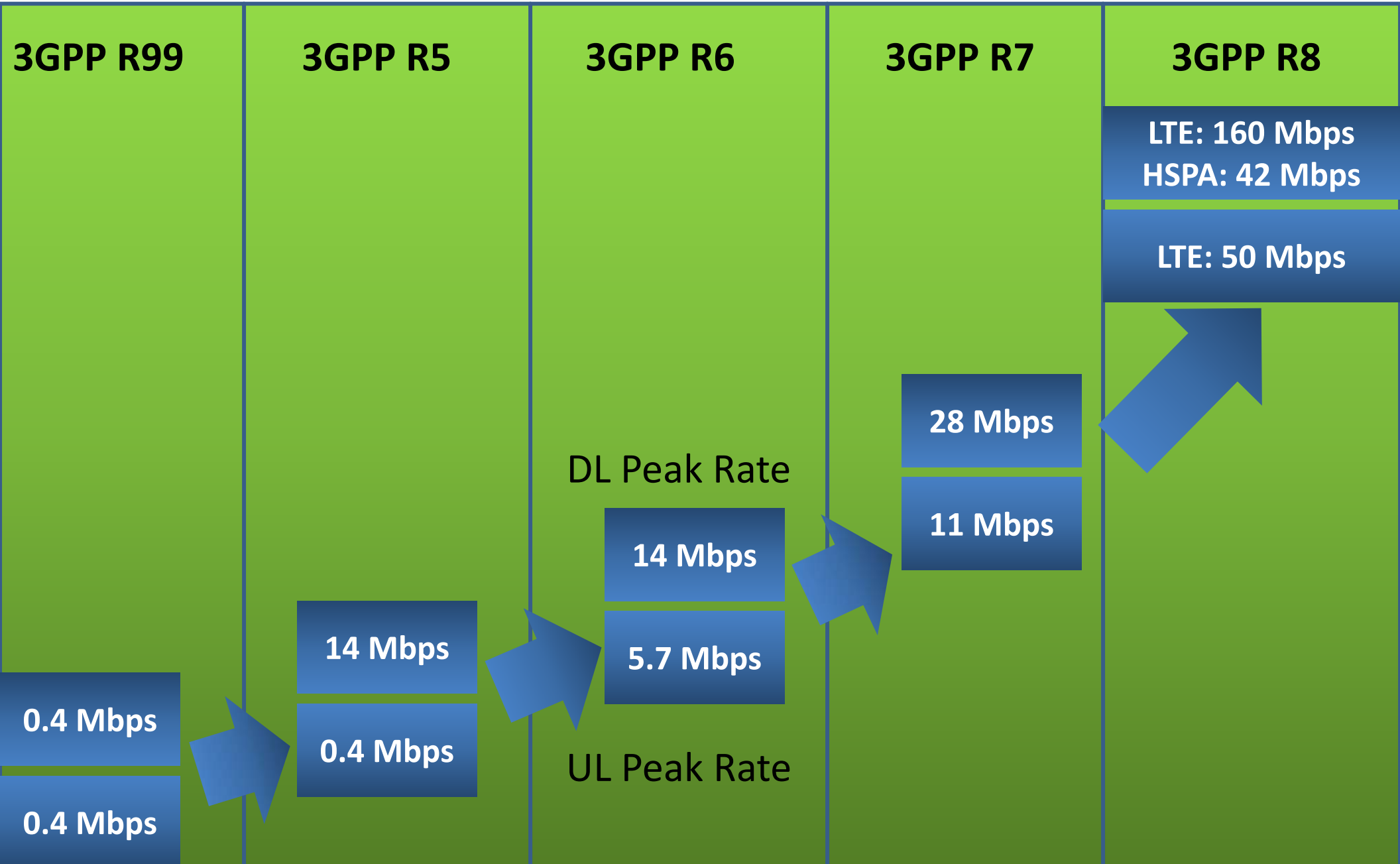
Aims of LTE

- LTE is mainly aimed at meeting the high demand for data access over wireless networks
- These include applications such as
 - Online Gaming with Multimedia
 - Mobile TV
 - Broadband content streaming such as videos, movies etc

LTE Timeline

2000	3GPP Release 99 Air Interface
2001	3GPP Release 4/ Deployed in Japan
2002	3GPP Release 5, IMS, HSDPA, Commercial Deployment in Europe
2004	3GPP Release 6, HSDPA, MBMS, Work started on LTE
2007	3GPP Release 7, HSPA+, VOIP
2008	Preliminary version with Release 8
2010	Targeted first deployment

Cellular Data Rate Evolution



LTE Features

- Based on OFDM (Orthogonal Frequency Division Multiplexing)
 - Built for High Speed broadband Wireless Access
- High spectral Efficiency – Up to 6 bits/ symbol (64 QAM)
- Very high data rates – Approximately 200- 300 Mbps in the downlink and 50-100 Mbps in the uplink
- Supports TDD (Time Division Duplexing) and Frequency Division Duplexing

LTE Features

- Bandwidth Scalability – 1.4 MHz to 20 MHz, depending on availability of spectrum
- Supports multiple and Advanced antenna processing.
 - In particular, MIMO can be used to achieve high data rates
- All interfaces and backhaul based on IP
 - Easy to integrate with existing internet based service infrastructure

LTE Features

- QoS Aspects – Ensures strict quality of service compliance with all services such as voice quality, video quality, delay and latency in video streaming etc
- Seamless roaming over existing 2G and 3G networks
 - Backward compatibility where 4G infrastructure does not exist

WILRELESS LAN – WIFI, 802.11 STANDARDS

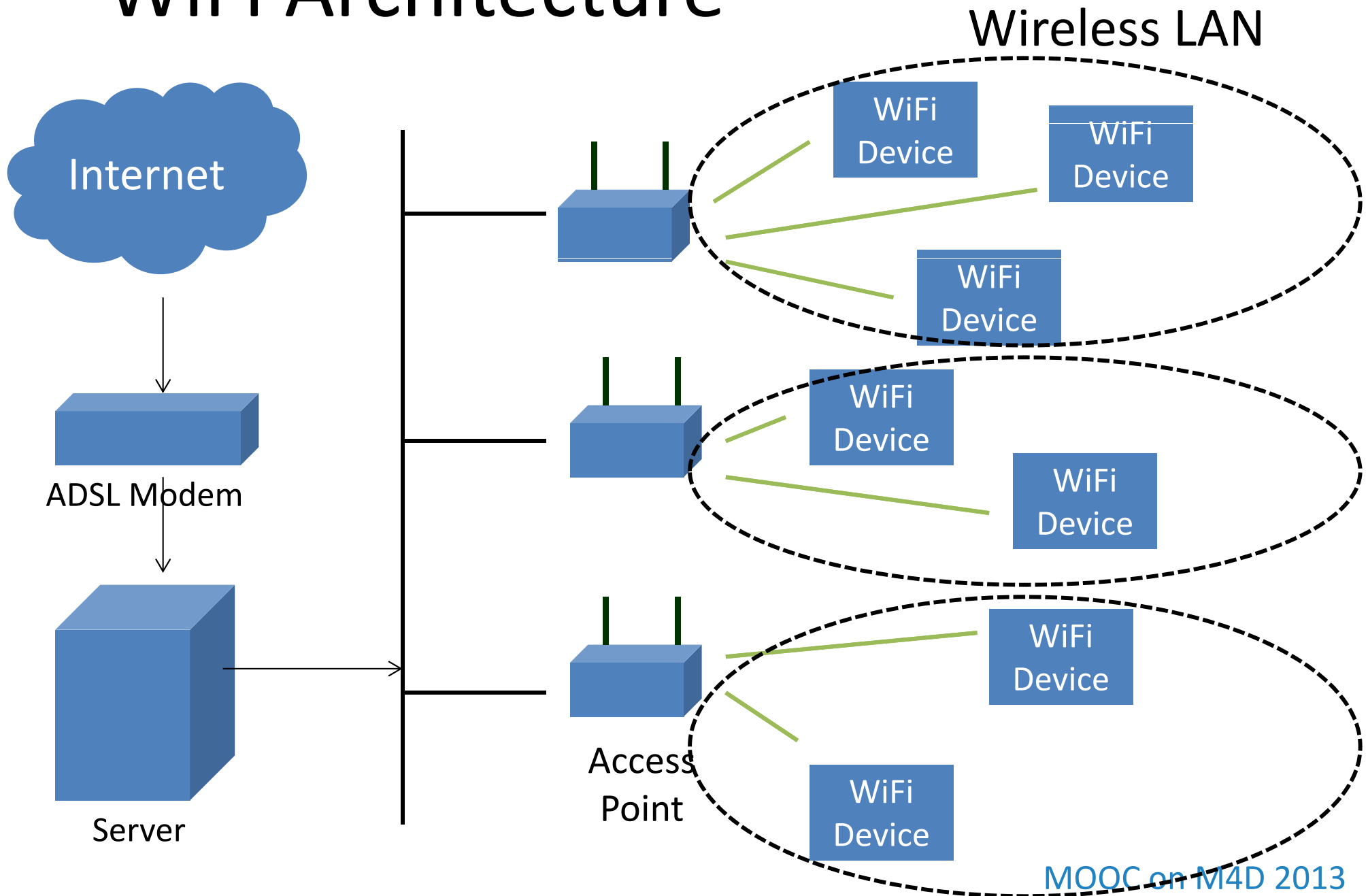


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Wireless LAN

- With LANs (Local Area Networks), primarily based on Ethernet, becoming popular in the late 90s, the stage was set for the development of wireless LANs
 - As the name implies, integration of LAN and wireless technologies
- Provide flexibility and mobility in indoor environment

WiFi Architecture



Wireless LAN

- Typically operate in ***Unlicensed*** bands such as
 - ISM (Industrial, Scientific, Medical) band
 - U-NII (Unlicensed National Information Infrastructure) band
- This unlicensed nature allows for development and deployment by multiple operators, vendors
 - Especially for educational and medical purposes

WLAN

- WLANs can provide connectivity in hotspot areas, homes, offices etc.
- Typical settings include
 - Coffee shops, airports, transit hubs, conferences
 - Universities, Schools, educational institutions
 - Offices, government institutions, Homes, community centres

802.11 Standards

- WLANs are predominantly dominated by 802.11x based devices also termed as WiFi.
- The development of 802.11 suite of standards was led by IEEE (Institute of Electrical and Electronics Engineers)
- Various 802.11 standards are summarized in the next slide along with the timeline

WLAN Technologies and Timeline

802.11 Standards	Year	Bandwidth	Data Rate	Technology
802.11a	1999	20 MHz	6-54 Mbps	OFDM (Orthogonal Frequency Division Multiplexing)
802.11b	1999	20 MHz	1-11 Mbps	DSSS (Direct Sequence Spread Spectrum)
802.11g	2003	20 MHz	6-54 Mbps	OFDM, DSSS
802.11n	2009	20, 40 MHz	~10 – 150 Mbps	OFDM
802.11 ac	2012	20-160 MHz	850 Mbps	OFDM

WLAN Advantages

- Advantages
 - Mobility, leads to higher efficiency and productivity
 - Cost effective ownership and installation (Compared to hard wired infrastructure)
 - Enables dynamic network reconfigurability (hardware software upgrades).

WLAN Equipment



- WLAN Adapter
- These provide an interface between the operating system and wireless radio signals
 - Typically PCMCIA, Card bus, PCI and USB.
- Allows laptops, desktops and other devices to connect to WLAN



WLAN Equipment

- Access point
- Equivalent of a LAN hub
- Connected with the network backbone
- Communicates with WLAN adapter through radio signal transmission from antenna

WLAN Equipment



- Access Point
- Range approximately 20-500 metres
- Supports approximately 15-100 users
- Multiple APs with overlapping coverage necessary for uninterrupted connectivity

WLAN Equipment

- WLAN Bridges
- Provide wireless connectivity between two WLAN networks
- Reduces the cost of deploying wired infrastructure

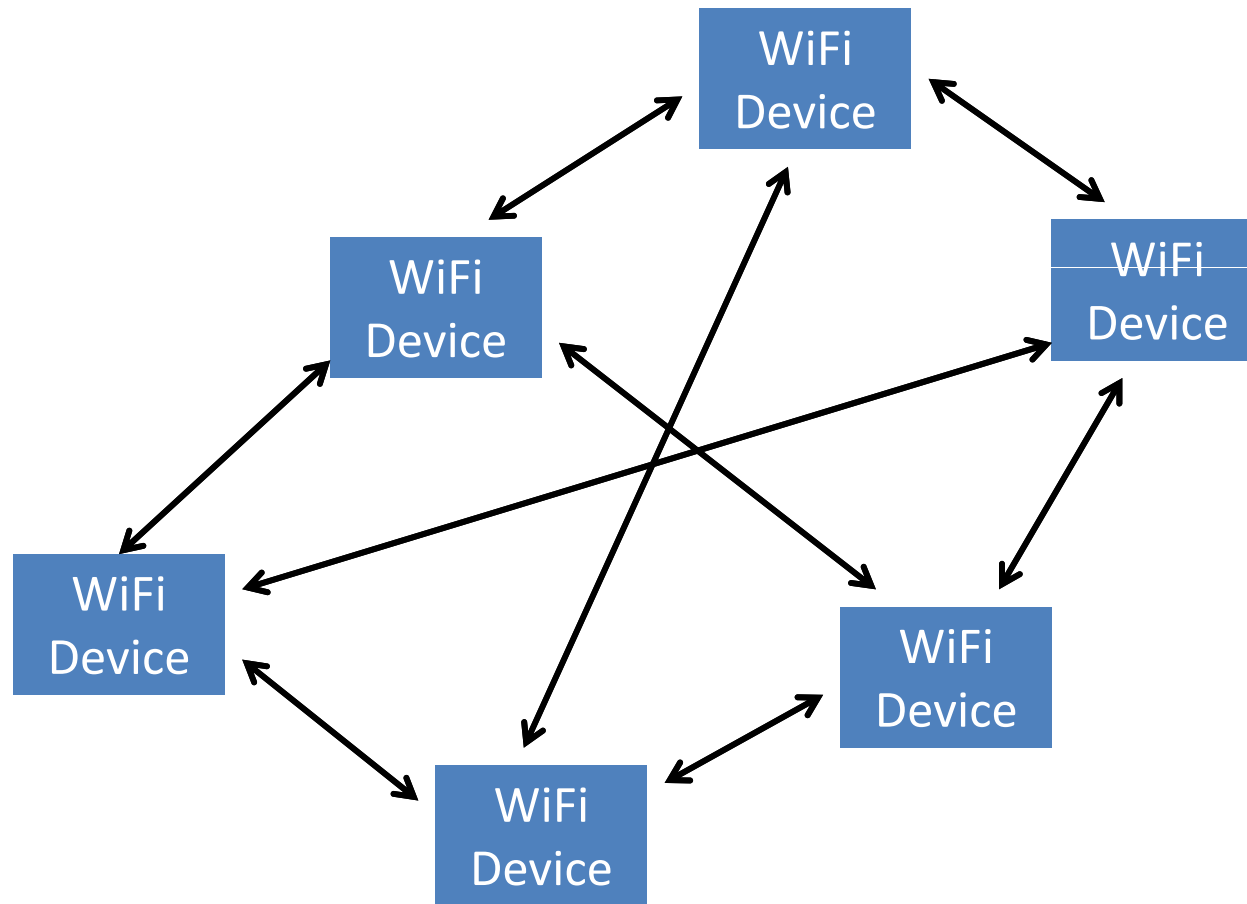
IEEE 802.11 Architecture

- Two types of 802.11 architecture
- Infrastructure Network
 - Several devices connect to an access point
 - Access point serves as point of contact between network and each device
- This is the most popular configuration

IEEE 802.11 Architecture

- Point-to-Point (Ad hoc Network)
 - Creates and supports mutual communication between different wireless clients
 - Does not require access points
 - Also, commonly known as a peer to peer network

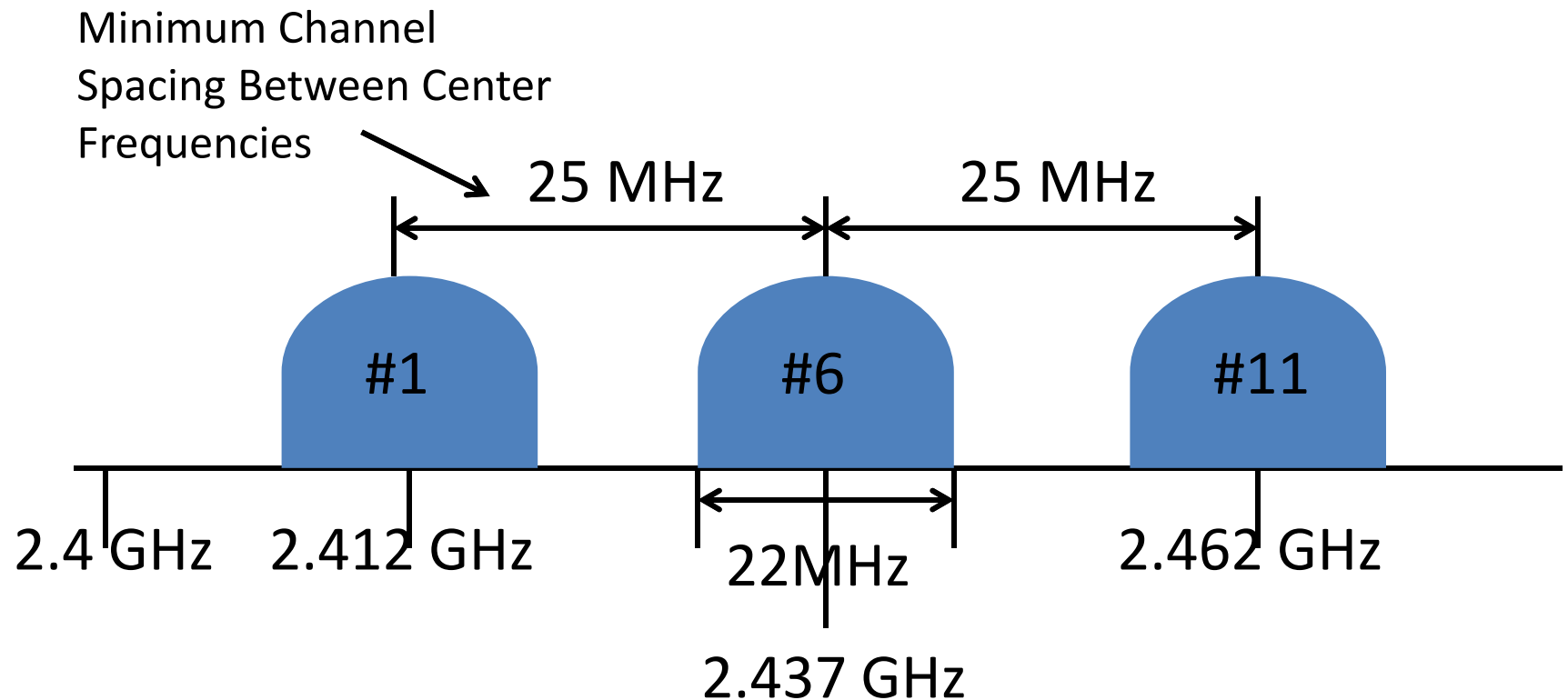
IEEE 802.11 Architecture



Ad hoc Network

802.11 Channel Spacing

- Channel Spacing looks as below
 - 22 MHz channels placed 25 MHz apart



WPAN BLUETOOTH



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WPAN



Bluetooth[®]

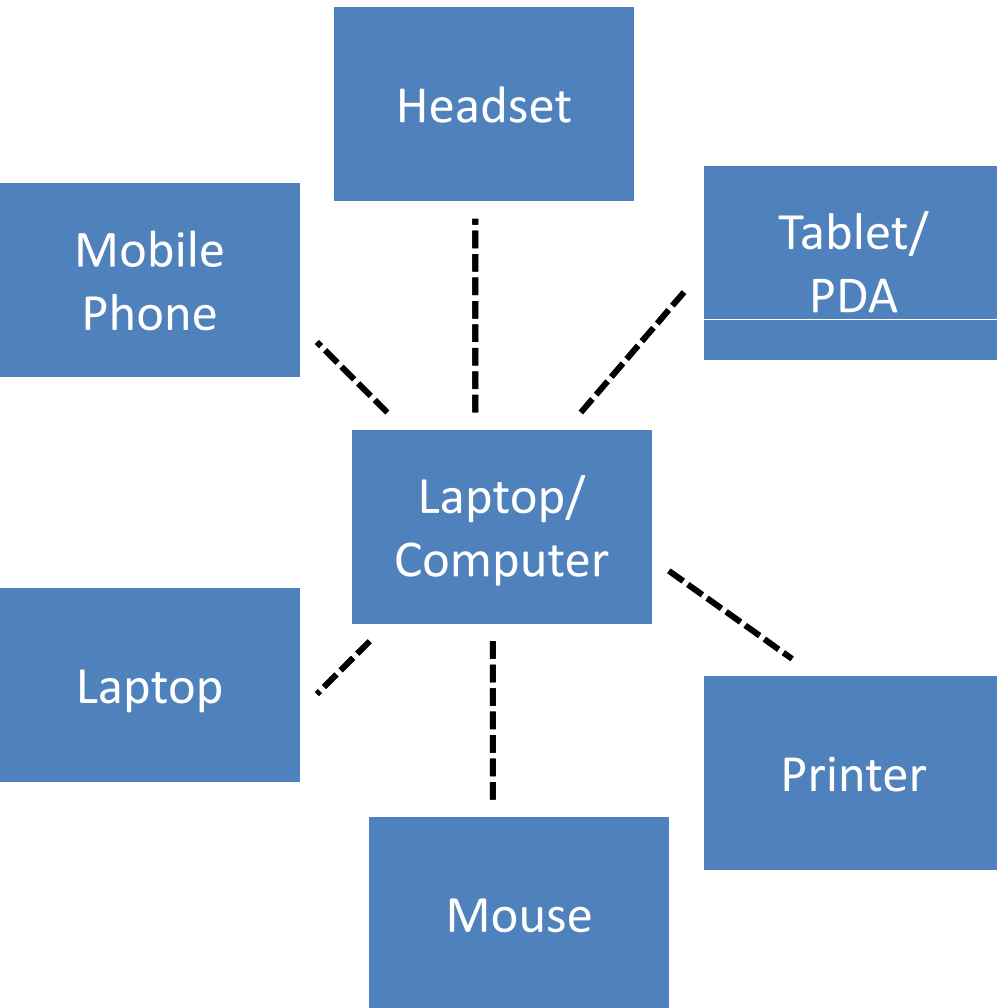
- WPAN stands for Wireless Personal Area Networks
- Bluetooth is one of the dominant WPAN standards
 - The technical number for Bluetooth is IEEE 802.15.1

Bluetooth



- Bluetooth is intended as a cable replacement technology
- Supports a small area ad hoc network (ie no fixed infrastructure)
- Connects devices such as,
 - PDAs, Printers, Cellphones, Storage Devices, Set-top boxes etc

Bluetooth Characteristics



- Low power consumption – Ideal for miniature devices
- Range 0 – 10 m – Small scale networks
- Rates – 20 – 100 Kbps approximately

Bluetooth Characteristics

- Size - ~ 1 inch
- Low cost ~ 10 – 100\$
- Multiple networks and multiple devices
 - Minimum Interference

FUTURE WIRELESS TECHNOLOGIES



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Future Wireless Technologies

- LTE Advanced – Advanced 4G Wireless Technology
- Scalable bandwidth up to 100 MHz
- Capable of Supporting data rates up to 3.3 Gbps

Future Wireless Technologies

- Cognitive Radio
- Interesting Radio paradigm based on Dynamic Spectrum Allocation
 - Enhances the efficiency compared to fixed spectrum allocation
- Based on components reconfigurable in software
 - Software Defined Radio