Wireless Networks 66554

Course instructor:

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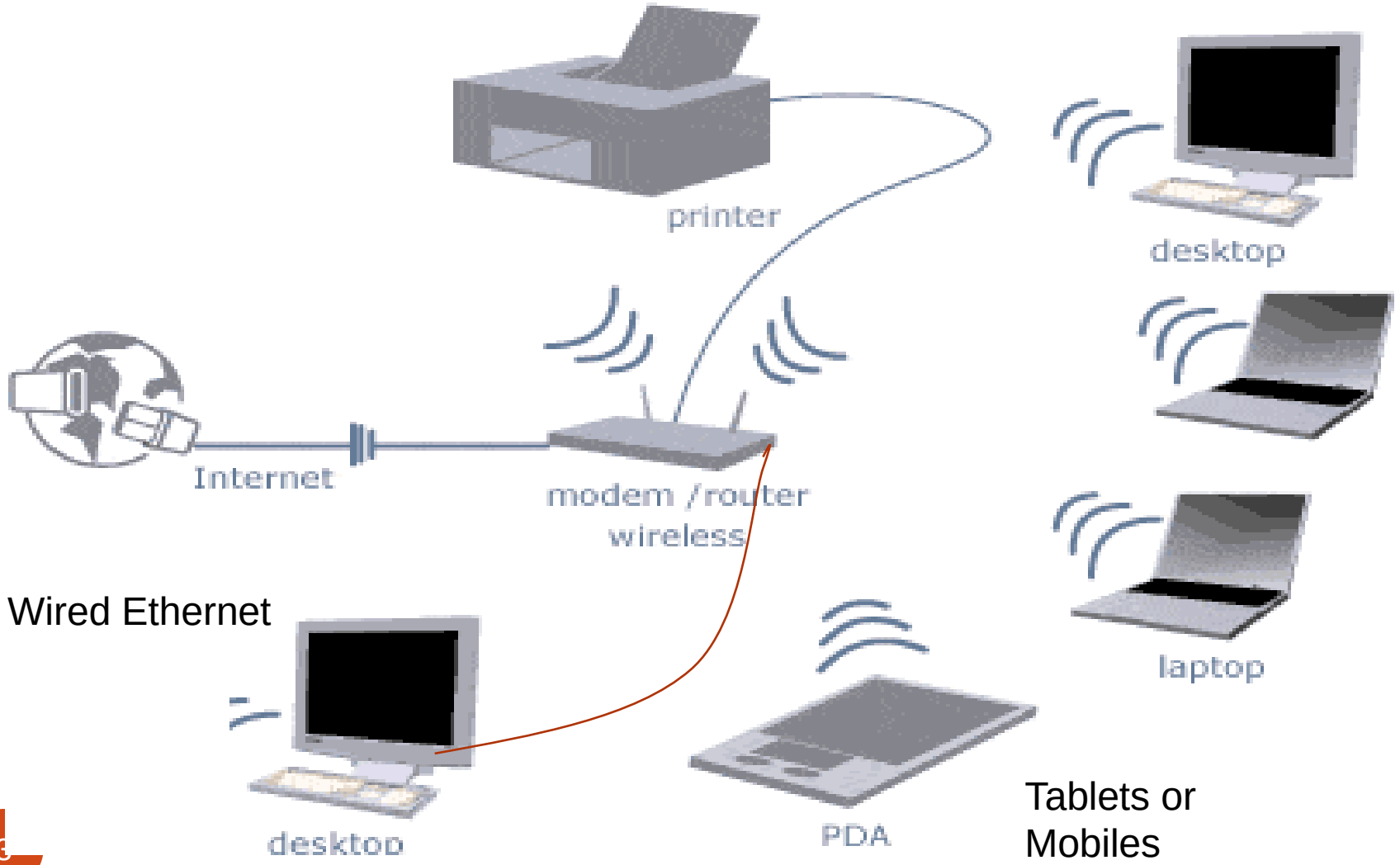
Wireless Networking

- Wireless technologies play an increasing role in all kinds of networks
  - Since 1990, the number of wireless options has increased, and the cost continues to decrease
  - Wireless networks can now be found in most towns and cities in the form of hot spots,
  - More home users have turned to wireless networks
- Wireless networks are often used with wired networks to interconnect geographically isolated LANs or groups of mobile users with stationary servers and resources on a wired LAN

Example: Wireless network at Home



Wireless Applications

Wireless applications:

- Ready access to data for mobile professionals
- Delivery of network access into isolated facilities or disaster-stricken areas
- Access in environments where layout and settings change periodically
- Improved customer services in busy areas, such as check-in or reception centers
- Network connectivity in structures where in-wall wiring would be impossible to install or too expensive
- Home networks where the installation of cables is inconvenient

Types of Wireless Networks

- Three main categories of wireless networks
  - Wireless Local Area Networks (WLANs)

    Wireless components act as part of an ordinary LAN
  - Extended WLANs

    use wireless components to increase LAN span
  - Mobile computing

    Mobile computing typically involves a third party (communications carrier) that supplies transmission reception devices to link the mobile part of a network with the wired part

Introduction

- What is a wireless network?
  - A technology that enables two or more entities to communicate without network cabling

What is a wireless LAN?

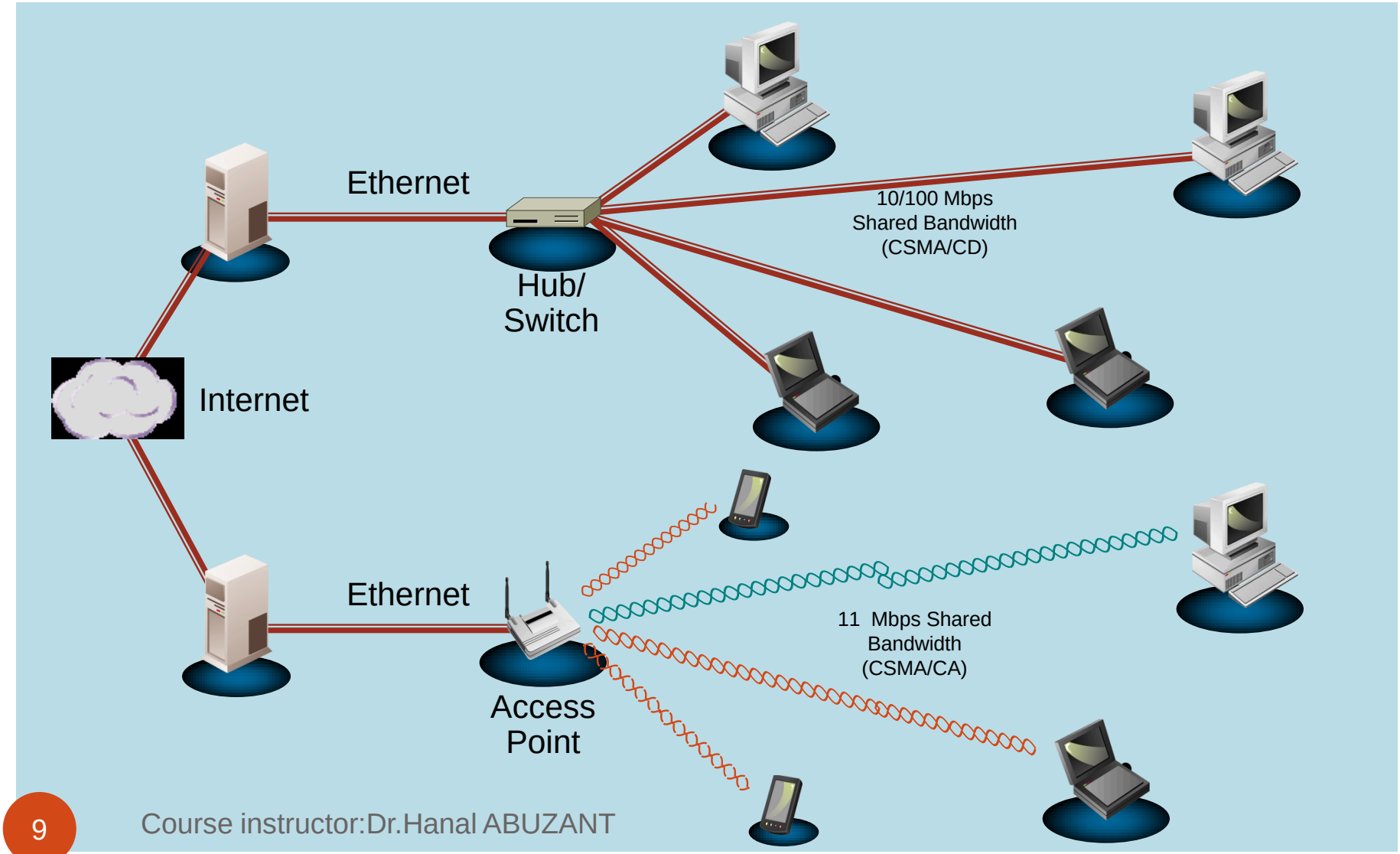
- **Wireless LAN (WLAN)** - provides all the features and benefits of traditional LAN technologies such as Ethernet and Token Ring, but without the limitations of wires or cables.

Wireless LAN Components

- NIC attaches to an antenna and an emitter, rather than to a cable
- An access point (AP) is installed to translate between the wired and wireless networks
  - An AP includes an antenna and a transmitter to send and receive wireless traffic, but also connects to the wired side of the network

Tarjeta NIC Inalámbrica
Wi-Fi 802.11 b/g/n 300 Mbps

Wireless vs. wired



Wireless LAN Transmission

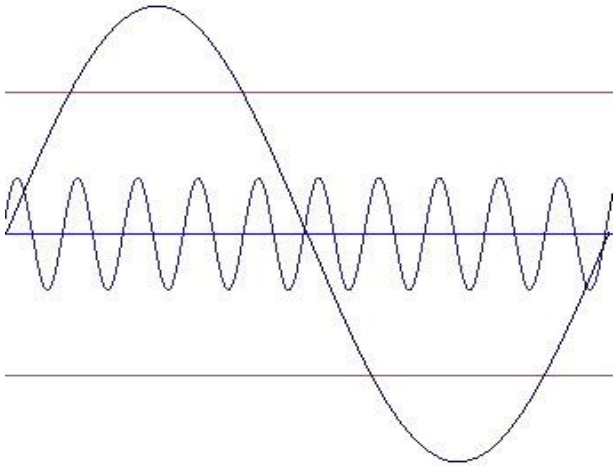
Wireless LANs send/receive signals

Broadcast through the air:

- Waves in the electromagnetic spectrum
- Frequency: cycles per second (measured in Hz)
  - Frequency affects the amount and speed of data transmission.

    e.g., electrical power 60 Hz

    telephone 0 – 3 kHz
  - Lower-frequency transmissions can carry less data more slowly over longer distances
  - Higher-frequency technologies often use tight-beam broadcasts and require a clear line of sight between sender and receiver



Wireless LAN Transmission Cont.

- Commonly used frequencies for wireless data communications
  - Radio —10 KHz (kilohertz) to 1 GHz (gigahertz)
  - Microwave —1 GHz to 500 GHz
  - Infrared — 500 GHz to 1 THz (terahertz)
- Wireless LANs make use of technologies for transmitting and receiving data

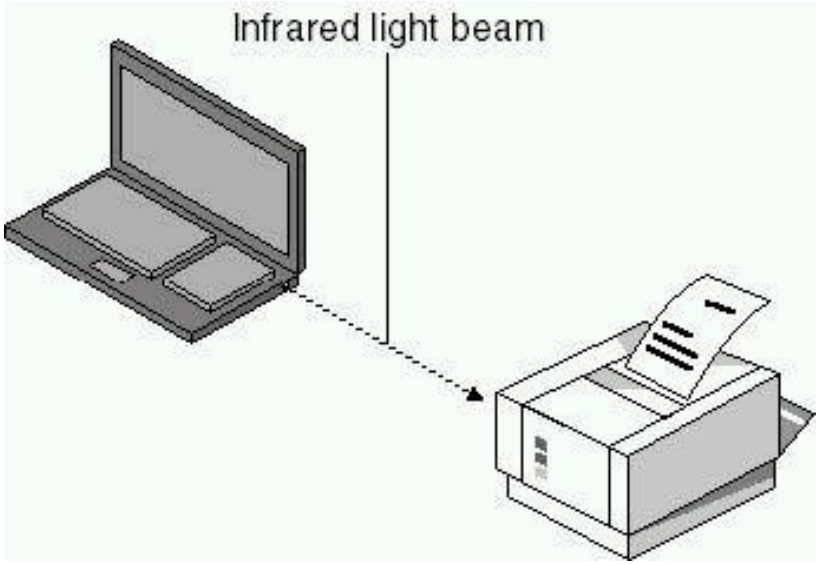
  Infrared, Laser, Spread-spectrum radio

Different Wireless Networks (WPAN)

- IrDA (Infrared Data Association)
  - Uses beams in the infrared light spectrum
- Bluetooth
  - Uses 2.45 gigahertz radio waves, but emits weak signals
    - Limits distance to 10 feet, but travels through walls
- Zigbee
  - Uses 2.45 gigahertz radio waves
  - Extremely long battery life (years on AA cell),
  - Low device data rate

Infrared LAN Technologies

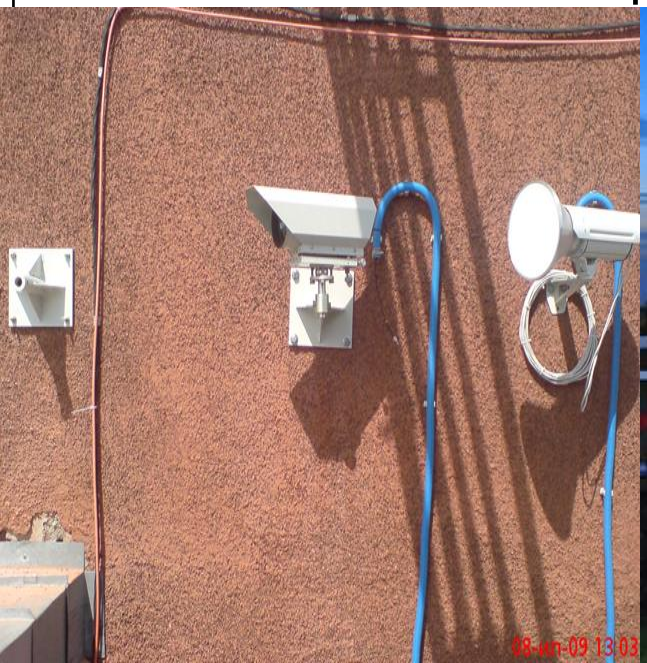
- Infrared light beams send signals between pairs of devices
- main types:
  - Line of sight networks
  - Reflective wireless networks
  - Scatter infrared networks

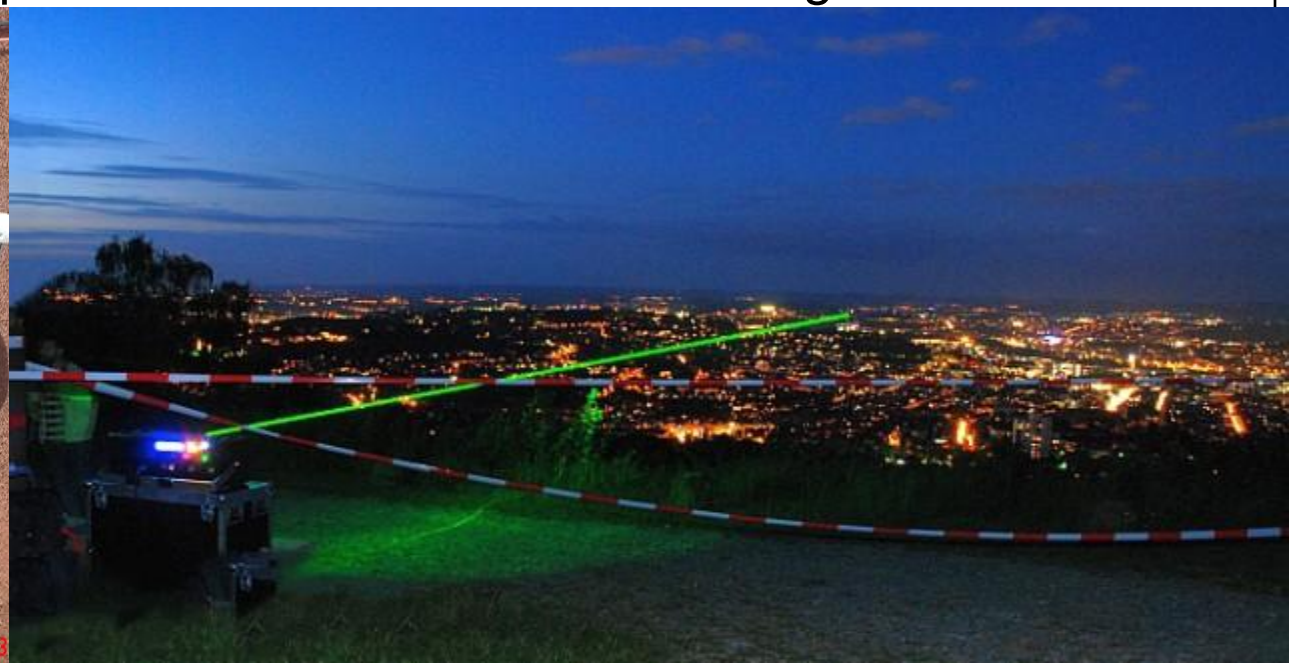


Laser-Based LAN Technologies

Laser-based transmissions also require a clear line of sight between sender and receiver

- Any solid object or person blocking a beam blocks data transmissions
- To protect people from injury and avoid excess radiation,
  - laser-based LAN devices are subject to many of the same limitations as infrared,
  - but aren't as susceptible to interference from visible light sources

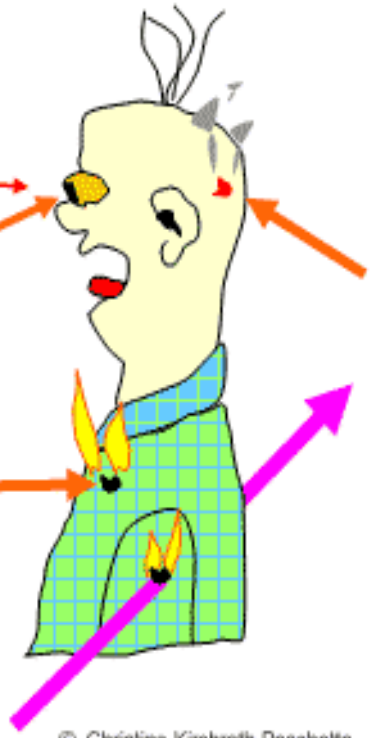


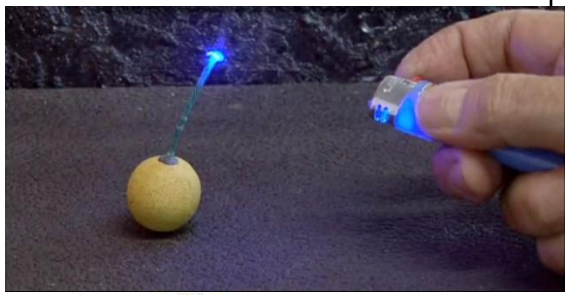


Laser Cons vs.Pos

Laser Safety Issues

- **Laser pointer, 3 mW**:
  rather bright; could quickly damage the retina,
  but: blinking reflex helps
- **Small Nd:YAG laser, 100 mW**:
  invisible – no blinking reflex!
  ⇒ rather dangereous for the eyes
- Larger **Nd:YAG laser, 10 W**:
  burns skin and clothes
- Small **Nd:YAG laser** für **Q-switched pulses**:
  very hazardous even for small average output power
- Industrial high power **Nd:YAG or CO_2 laser, 1-10 kW**:
  for welding; not beneficial for skin and eyes!



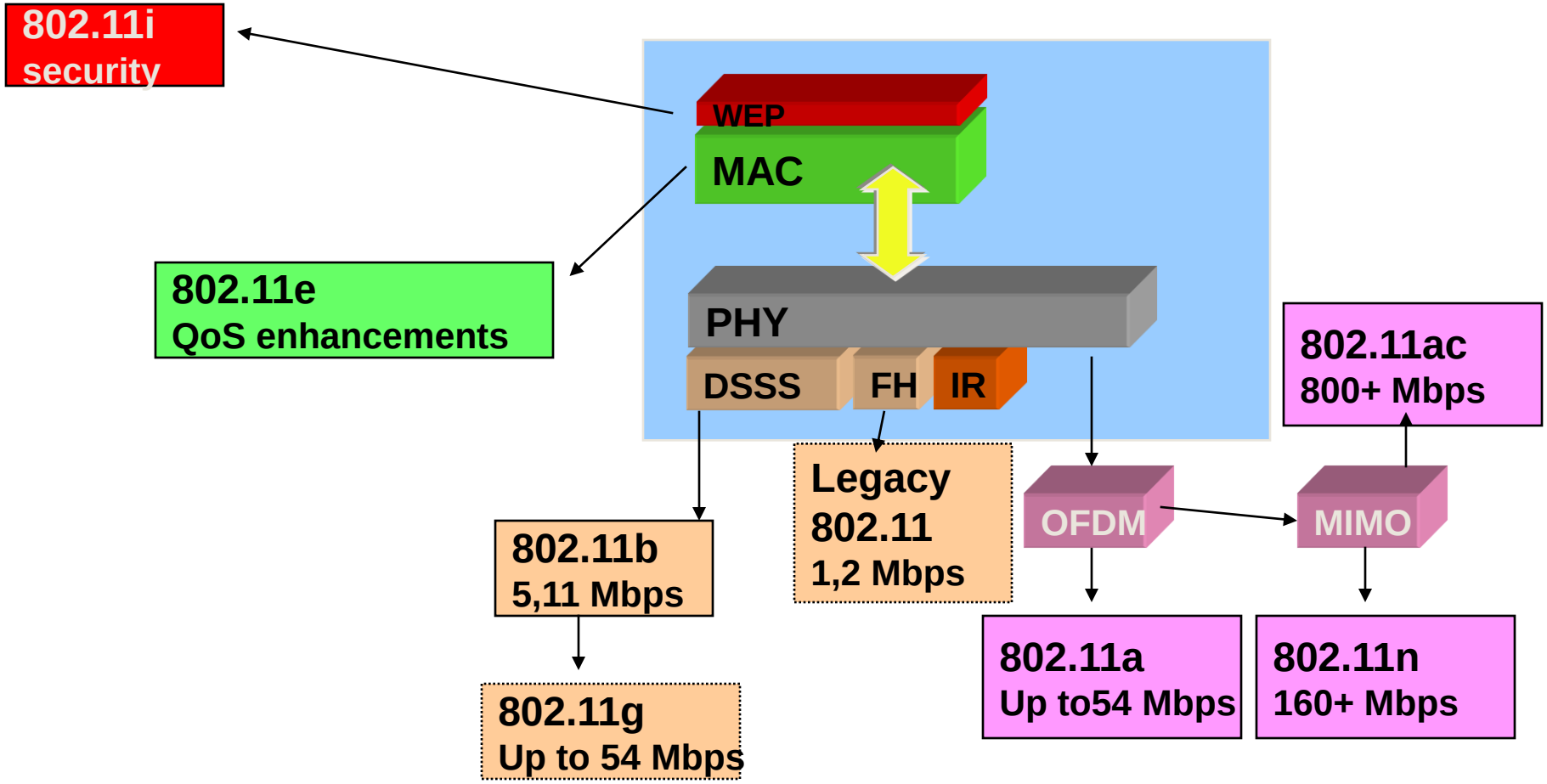


Laser Hazard Warning Signs Figure 4

Wireless Fidelity (Wi-Fi)

- Essentially, this technology is a variation of the IEEE 802.11 specification known as 802.11b
- Focuses on Direct-Sequence Spread Spectrum (DSSS)
  - High data rate (max of 160 Mbps)
  - In the case of interference, speed drops in halves (54, 22, 11 Mbps to 5.5 Mbps to 2 Mbps to 1 Mbps)

Examples of 802.11 variants



WLAN: IEEE 802.11b (1999)

- Data rate
  - 1, 2, 5.5, 11 Mbit/s, depending on SNR
- Transmission range
  - depending on antenna(i.e omni)
  - 300m outdoor, 30m indoor
  - Max. data rate ~10m indoor
- Frequency
  - Free 2.4 GHz ISM-band
- Security
  - Limited, WEP insecure, SSID
- Cost
  - 100$ adapter, 250$ base station, dropping (2000) to 10$,25$ in(2015)
- Availability
  - Many products, many vendors

- Connection set-up time
  - Connectionless/always on
- Quality of Service
  - Typ. Best effort, no guarantees
- Special
  - Advantage: many installed systems, lot of experience, available worldwide, free ISM-band, many vendors, integrated in laptops, simple system
  - Disadvantage:
    - high interference on ISM-band which can reduce speed rate:
      - Mobile devices
      - Bluetooth
      - **no QoS no service guarantees.**

WLAN: IEEE 802.11a (2001)

- Data rate
  - Up to 54 Mbit/s, depending on SNR
- Transmission range
  - 100m outdoor, 10m indoor
    - E.g., 54 Mbit/s up to 5 m, 48 up to 12 m, 36 up to 25 m, 24 up to 30m, 18 up to 40 m, 12 up to 60 m
- Frequency
  - Free 5.15-5.25, 5.25-5.35, 5.725-5.825 GHz ISM-band
- Security
  - Limited, WEP insecure, SSID
- Cost
  - 280$ adapter, 500$ base station (2000) to 30$,50$(2015)
- Availability
  - All products, all vendors
- Connection set-up time
  - Connectionless/always on
- Quality of Service
  - Typ. best effort, no guarantees
- Special Advantages/Disadvantages
  - Advantage:free ISM-band, available, simple system, uses less crowded 5 GHz band
  - Disadvantage: no QoS, not compatible with 802.11b

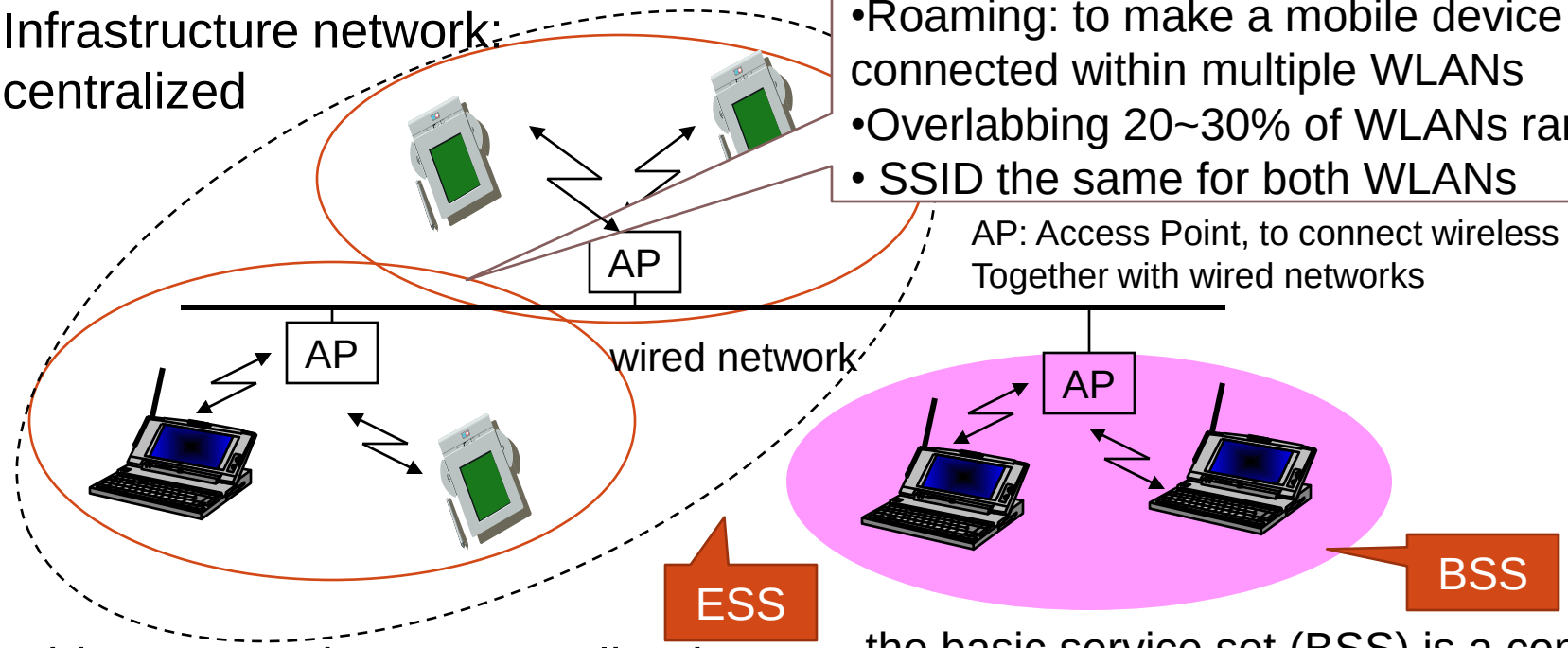
WLAN: IEEE 802.11g (2002)

- Data rate
  - Up to 54 Mbit/s, depending on SNR
- Transmission range
  - 100m outdoor, 10m indoor
    - E.g., 54 Mbit/s up to 5 m, 48 up to 12 m, 36 up to 25 m, 24 up to 30m, 18 up to 40 m, 12 up to 60 m
- Frequency
  - Free 2.4GHz ISM-band
- Security
  - Limited, WEP insecure, SSID
  - Now: more secured WPA/2
- Availability
  - All products, all vendors
- Connection set-up time
  - Connectionless/always on
- Quality of Service
  - Typ. best effort, no guarantees
- Special Advantages/Disadvantages
  - compatible with 802.11b

-The modulation technique achieves a 22 Mbps up to 54 Mbps data rates on the 2.4-GHz band.
- Combine the features of both standards a/b
  - **Disadvantage: no QoS**

IEEE802.11 networks

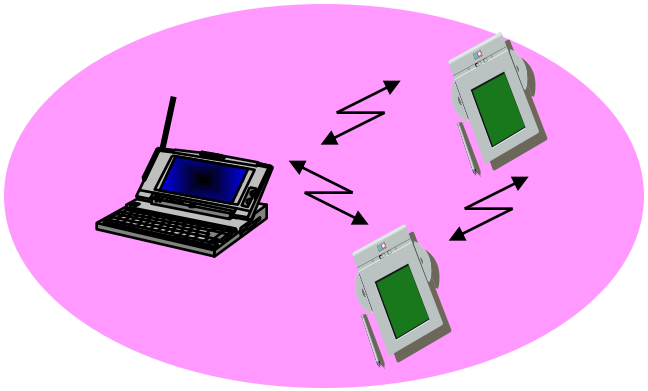
Infrastructure network: centralized



- Roaming: to make a mobile device connected within multiple WLANs
- Overlabbing 20~30% of WLANs ranges
- SSID the same for both WLANs

AP: Access Point, to connect wireless devices Together with wired networks

ad-hoc network: not centralized



the basic service set (BSS) is a component of the IEEE 802.11 WLAN architecture.

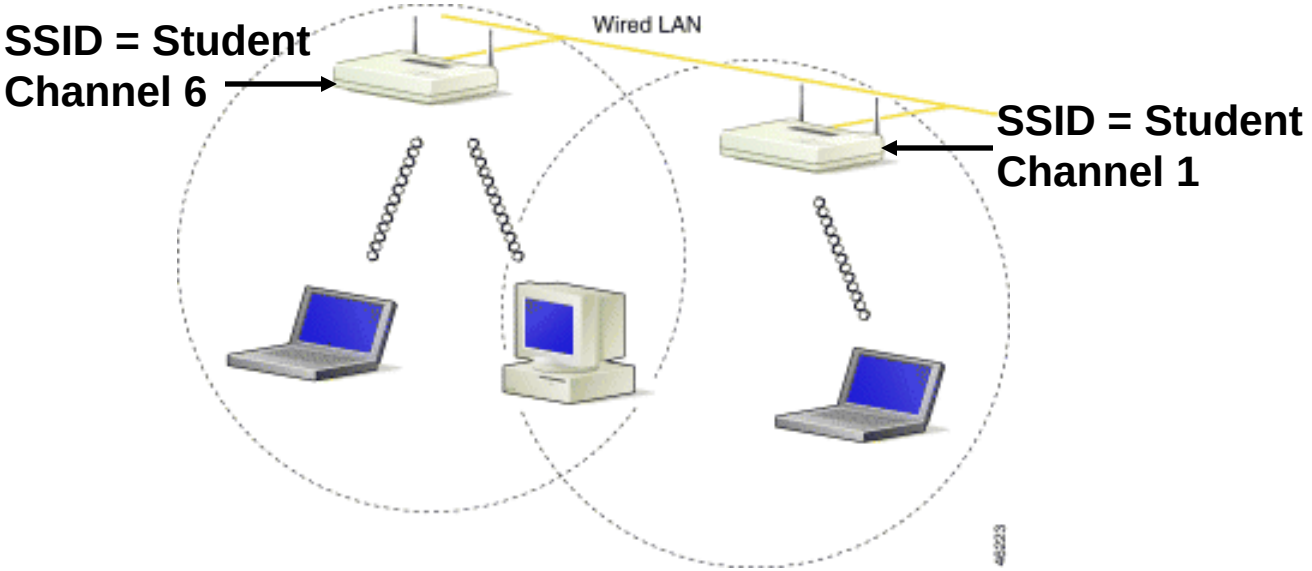
AP: SSID

- SSID is for ***s****ervice* ***s****et* ***id****entifier*.
- SSID is a case sensitive, 32 alphanumeric character
- each WLAN (AP) has a unique SSID
- SSID is attached to the header of packets sent over a wireless local-area network (WLAN)
- SSID differentiates one WLAN from another, so all access points and all devices attempting to connect to a specific WLAN must use the same SSID to enable effective roaming

AP: roaming

- to vary from AP to AP in a roaming (multiple AP) 802.11 network.
  - Channel is different for both AP
- To maximize bandwidth:
  - leave your APs to automatically select channel to use
  - you can manually pick channel:
    - different for both AP
    - non-overlapping channels
    - hopefully unoccupied channels to use.
  - transmissions to/from one AP to compete for bandwidth with transmissions to/from the other AP is undesired.

Roaming overlapping



- By arranging the access points so that the overlap in a coverage area is minimized (20-30%), a large area can be covered with minimal cost.

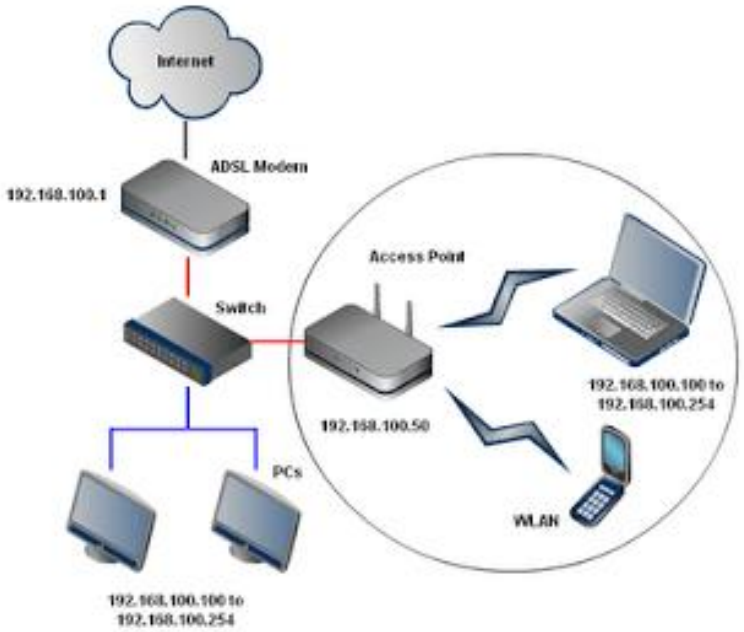
- The total bandwidth available to each wireless client device depends on the amount of data each mobile station needs to transfer and the number of stations located in each cell.

AP vs. wired

- use wired Ethernet as network backhaul.
- This saves the wireless bandwidth for the mobile devices that actually need it
- instead of wasting base stationary devices like APs .

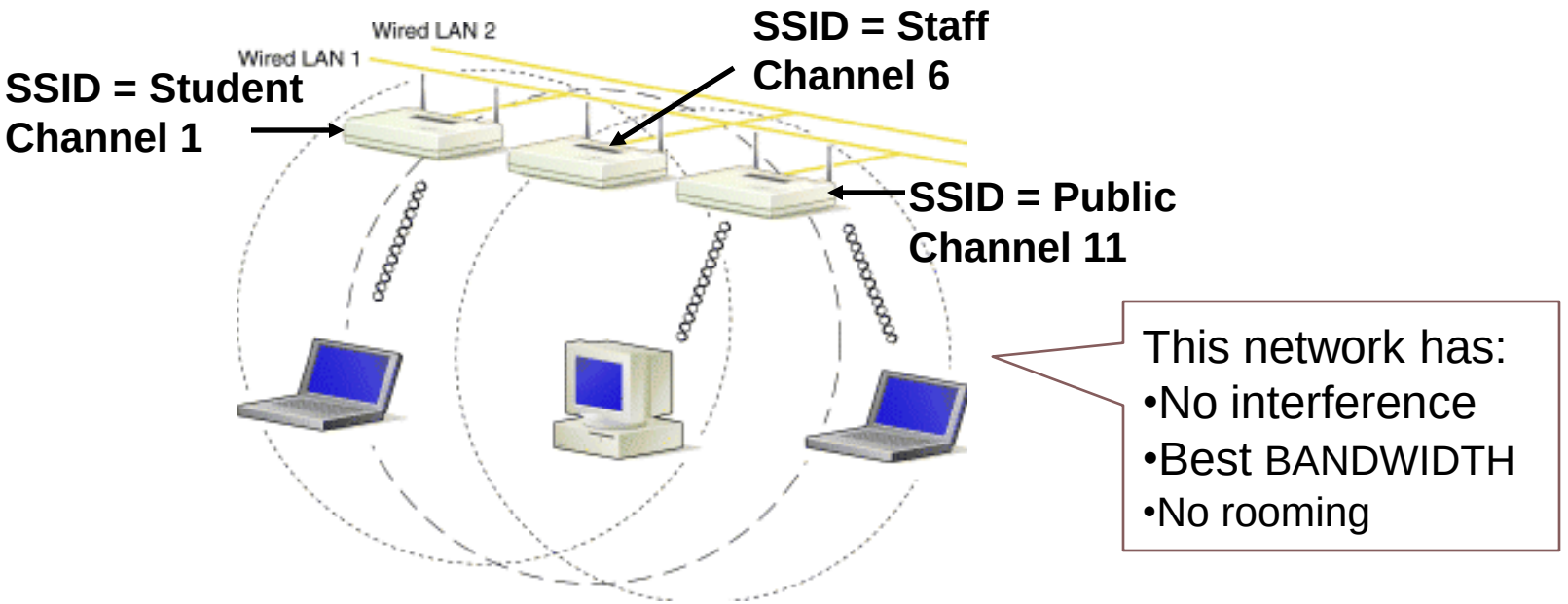
Wireless Access Point

- Supports
  - IEEE 802.3 (10BaseT)
  - IEEE 802.3 (100BaseTX)
  - IEEE 802.11b/a/g (Wireless)
- Built-in server capability
  - Obtains an IP and uses DHCP
- Built-in router capability
  - Routing to WAN (ADSL)
  - Routing to another LAN
- Built-in 4 ports switch
- Fully-configurable through simple web interface
- Acts as the Bridge between Wireless and Wired network
- Provides network connectivity over wireless media
- Range depends on structural RF gain of the antenna at the Access Point.



- To service larger areas, multiple APs may be installed with 20-30% overlap (Roaming)
  - A client is always associated with one AP and when the client moves closer to another AP, it associates with the new AP.

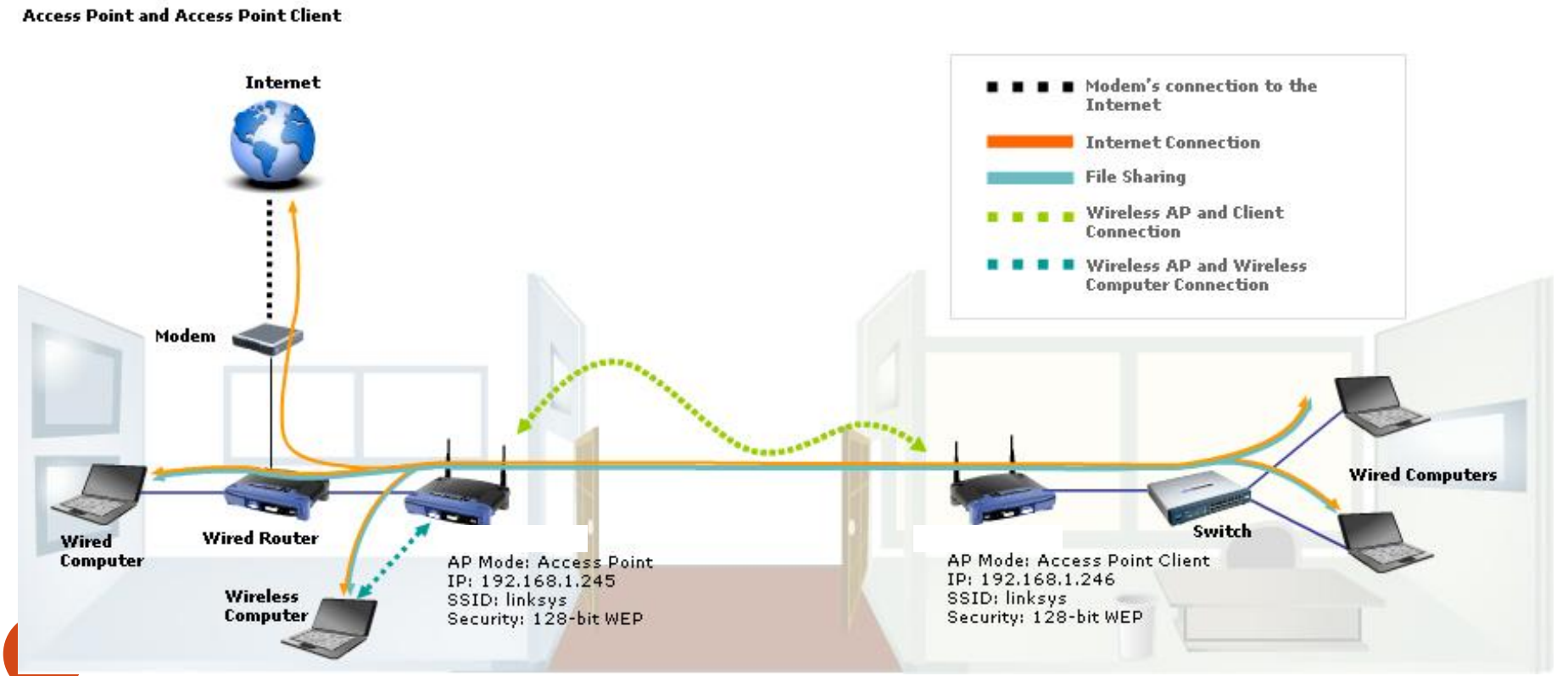
Multiple Overlapping Networks Coverage Option



- **Multiple networks can operate in the same vicinity.**
- The architecture provides multiple channels that can exist in the same area with virtually no interference to each other.
- In this mode, each system is configured with **different SSIDs** and **different channels**, which may (depending on configurations) prevent clients from roaming to access points of a different wireless network.

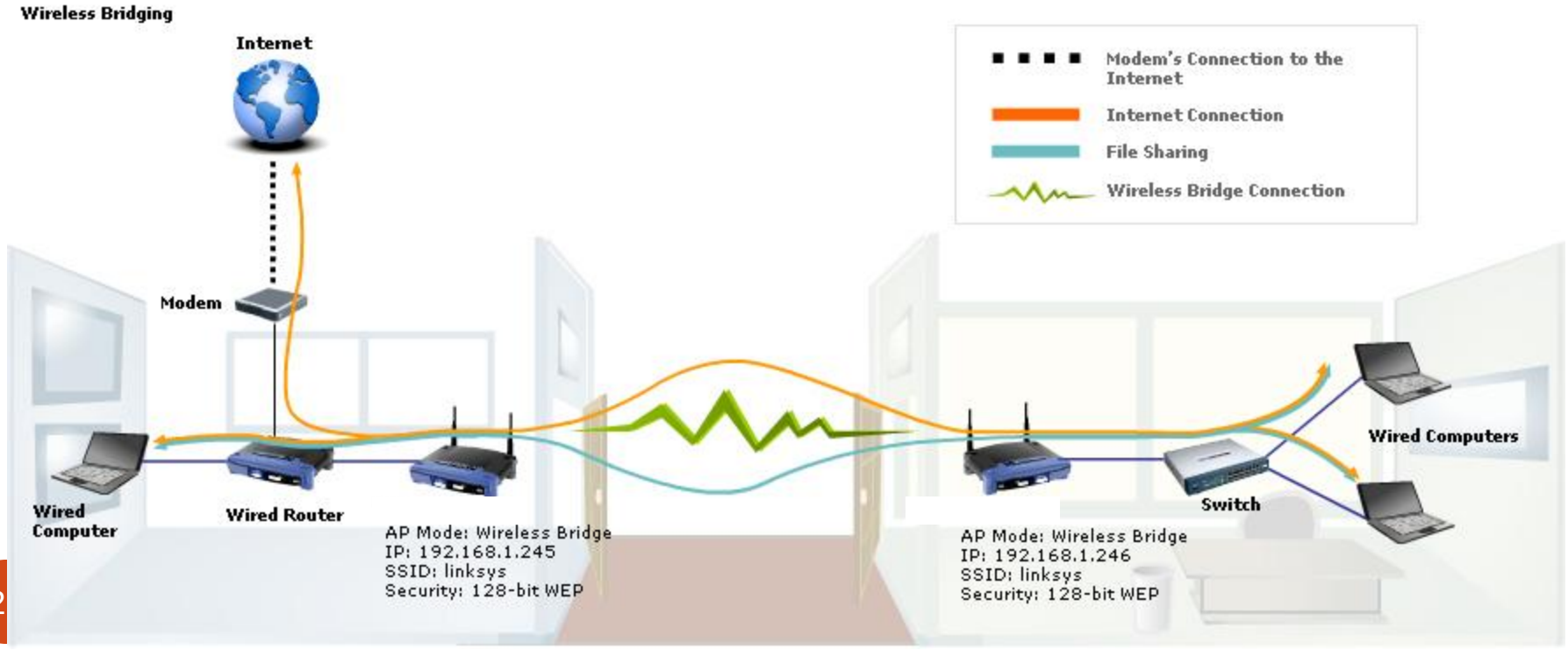
AP functionalities

- **(AP Client)**
  - Used to link two wired networks using two wireless AP without creating a bridge.
  - In this mode, the AP will no longer function as an access point (doesn't allow clients), therefore, you will need wires to use the AP and to configure it.
  - The AP client won't even be visible to other wireless devices
  - It is treated as a wireless mobile device not as an AP



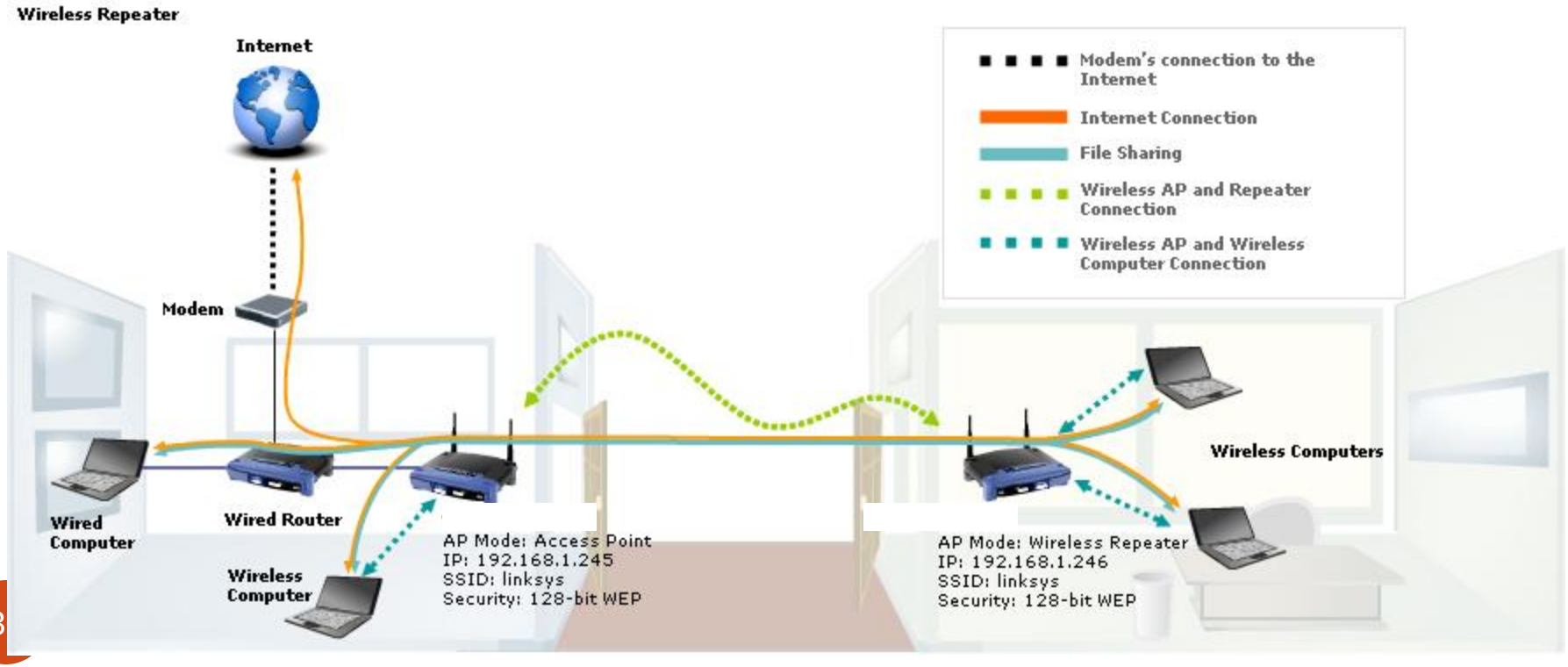
AP functionality and operation

- **(AP wireless Bridge)**
  - Used to link two wired networks using two wireless AP.
  - No mobile device connected to the AP wireless bridge
  - It can replace the wired backhaul



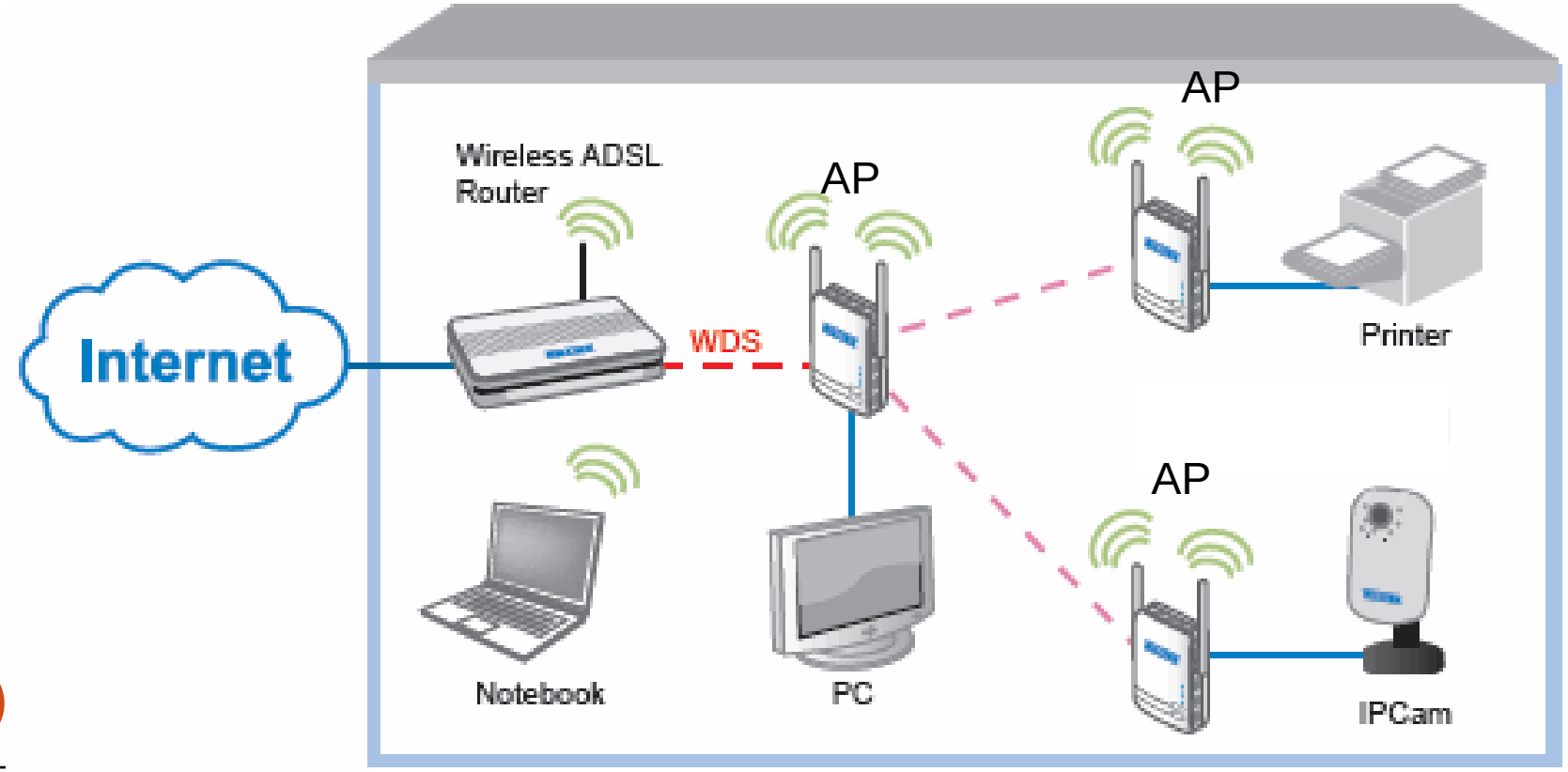
WLAN functionality and operation

- **Repeater**
  - The Wireless AP can also be used in Repeater mode, which lets you connect to your existing network and amplify it.
  - This enables you to extend the range of your wireless network
  - very useful if you have a weak connection in a room far away from your AP.
  - Repeater consumes a part of the bandwidth to transceive from/to wireless devices.



WLAN functionality and operation

- **WDS (Wireless Distribution System):**
  - A system enabling the wireless interconnection of AP
  - allows a wireless network to be expanded using multiple APs
  - without the traditional wired requirement
  - without having APs to be wired with themselves



WLAN functionality and operation

- AP with Repeating

WDS repeater & bridge function supports