

# WI-FI TECHNOLOGY



**T1- BARCELONA AIRPORT**

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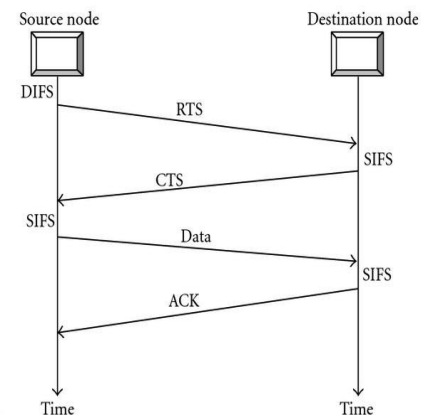
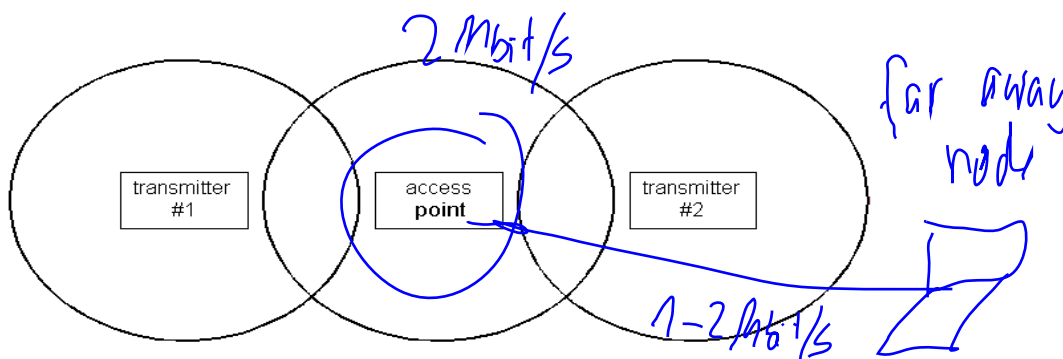
# WI-FI OVERVIEW

- Frequency, Modulation & Data Rates:

Standard	Frequency (Ghz)	Band (Ghz)	Modulation	Data Rates (Mbps)	Range Indoor (m)	Range Outdoor (m)
802.11	2.4	20	DSSS, FHSS	1,2	20	100
802.11a	5	20	OFDM	6,9,12,18,24,36,48,54	35	120
802.11b	2.4	20	DSSS	1,2,5.5,11	35	140
802.11g	2.4	20	OFDM, DSSS	6,9,12,18,24,36,48,54	38	140
802.11n	2.4/5	20	OFDM	7.2,14.4,21.7,28.9,43.3,57.8,65,72.2	70	250
		40		15,30,45,60,90,120,135,150	70	250

802.11b typical 50% overhead due to signalling  
lowest BW

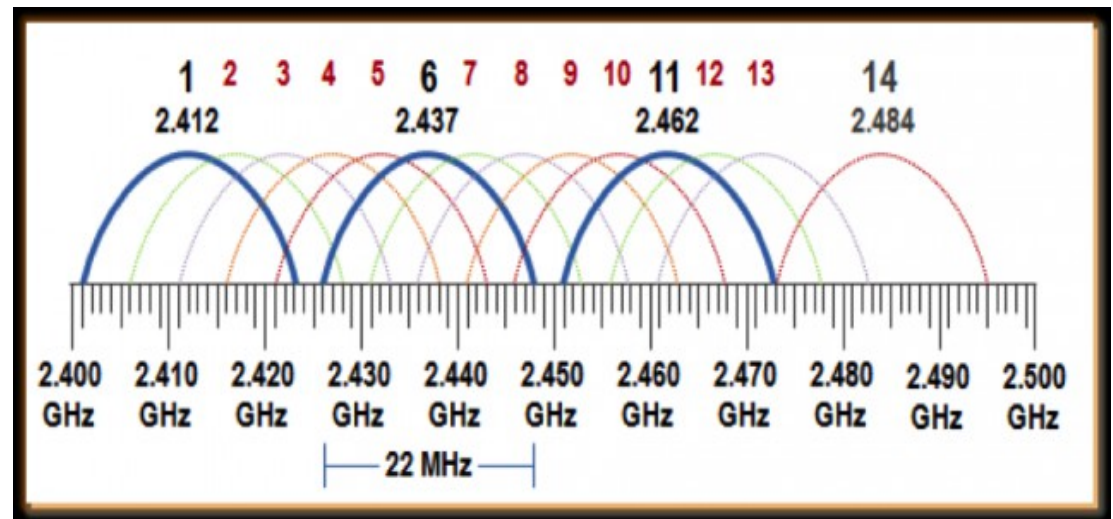
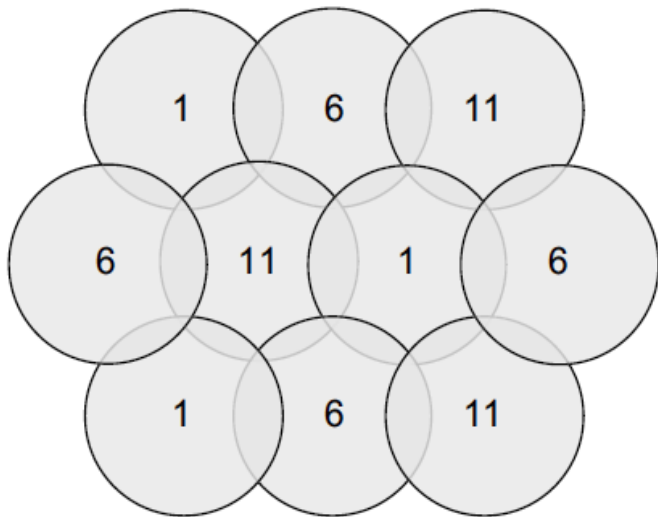
- CSMA/CA: nodes can transmit when the channel is "idle". Hidden node problem & 802.11 RTS/CTS solution:



# CHANNEL INTERFERENCES

## 802.11b/g/n:

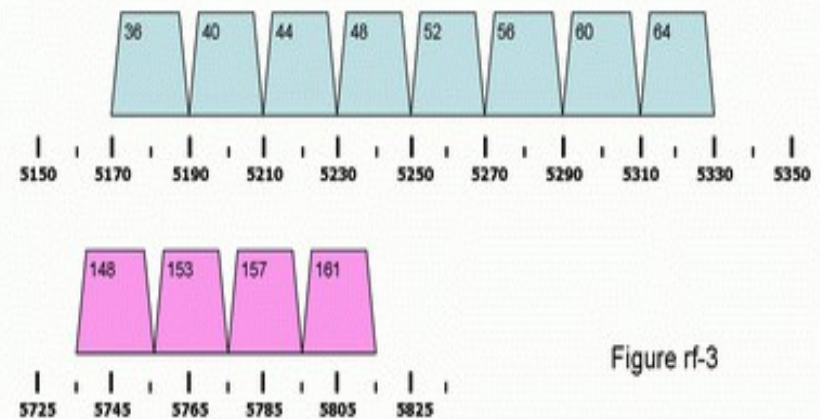
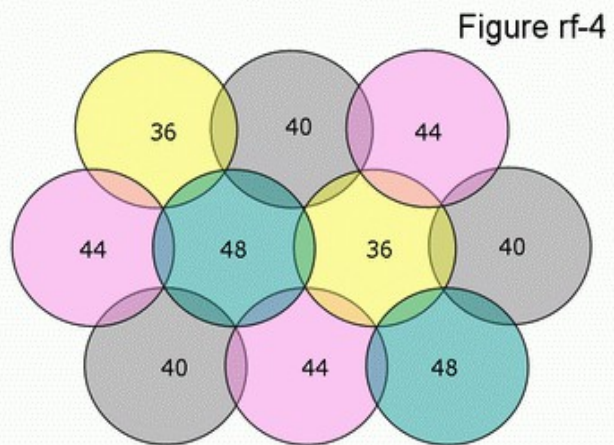
- ◆ 802.11b/g/n can transmit in the **2.4 GHz band** with a total of **13 available channels**.
- ◆ There are **three non-overlapping channels** with which to work in achieving isolation.



# CHANNEL INTERFERENCES

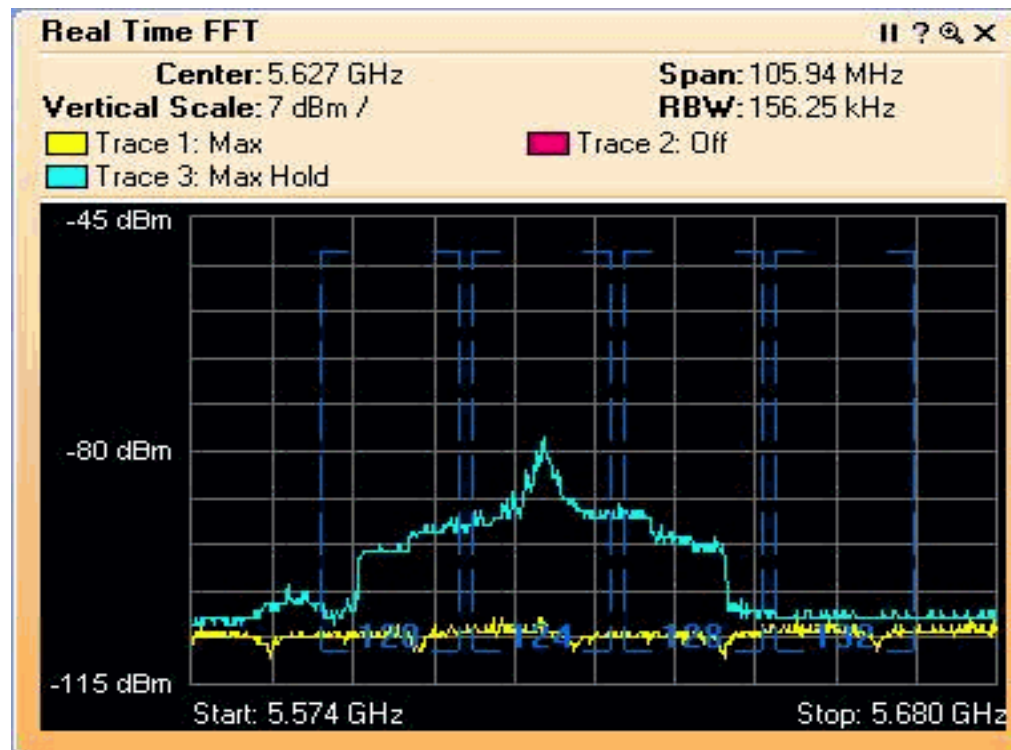
## 802.11a:

- ◆ 802.11a can transmit in the **5 GHz band** with a total of **12 non-overlapping channels**.
- ◆ Point-to-point links operates on the four channels: 149, 153, 157, and 161
- ◆ APs and client adapter cards operates on eight channels: 36, 40, 44, 48, 52, 56, 60, and 64



# OUTDOOR INTERFERENCES

- ◆ Outdoor Radar interferences: Spectrum analyzer for scanning radar signals across 802.11a outdoor channels before the deployment of mesh networks.



# ANTENNA: TYPICAL VALUES

## Gain:

- dBi - decibels relative to an isotropic reference antenna

$$G(dBi) = 10 * \text{Log} (G_{\text{Numeric}} / G_{\text{Isotropic}})$$

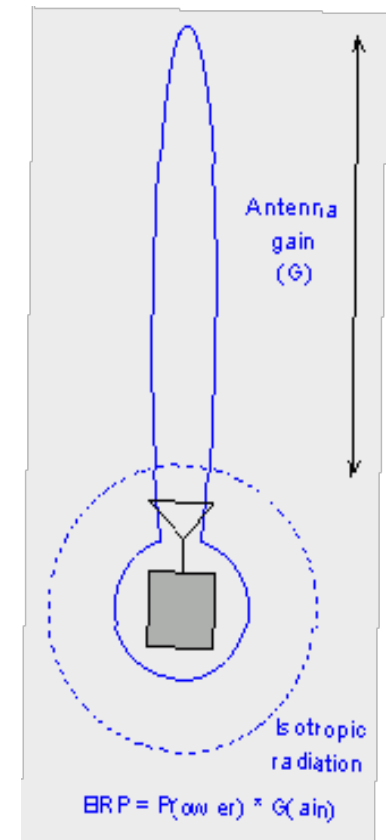
- dBd - decibels relative to a dipole reference antenna

$$G(dBd) = G(dBi) - 2.2 \text{ dBi}$$

Omnidirectional Wi-Fi Antennas: "rubber duck" design,  
with gain between 2 and 9 dBi.

Directional Wi-Fi Antennas: usually 12 dBi.

EIRP: Europe Max 20 dBm (Pt max = 17 dBm; Gmax = 3 dBi)



# ANTENNAS: INDOOR

Omnidirectional integrated antenna, IEEE 802.11a/b/g:



2.4 GHz, 3 dBi Azimuth Plane Radiation Pattern	5 GHz, 4.5 dBi Azimuth Plane Radiation Pattern	2.4 GHz, 3 dBi Elevation Plane Radiation Pattern	5 GHz, 4.5 dBi Elevation Plane Radiation Pattern
<b>Frequency Range</b>		<ul style="list-style-type: none"> <li>• 2.4–2.5GHz</li> <li>• 5.15–5.8 GHz</li> </ul>	
<b>Gain</b>		<ul style="list-style-type: none"> <li>• 2.4 GHz: 3 dBi</li> <li>• 5 GHz: 4.5 dBi</li> </ul>	
<b>Polarization</b>		Linear, Vertical	
<b>Azimuth 3dB Beamwidth</b>		Omnidirectional	
<b>Elevations 3dB Beamwidth</b>		50 degrees	
<b>Antenna Connector</b>		Integrated	
<b>Mounting</b>		Integrated	
<b>Antenna Type</b>		Omnidirectional	

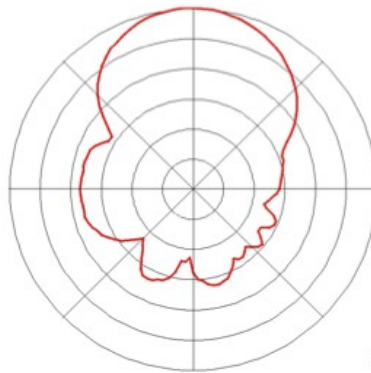


# ANTENNAS: INDOOR

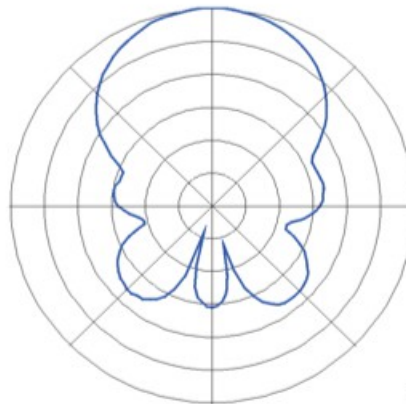
Directional antenna, IEEE 802.11a:



E-Plane Pattern



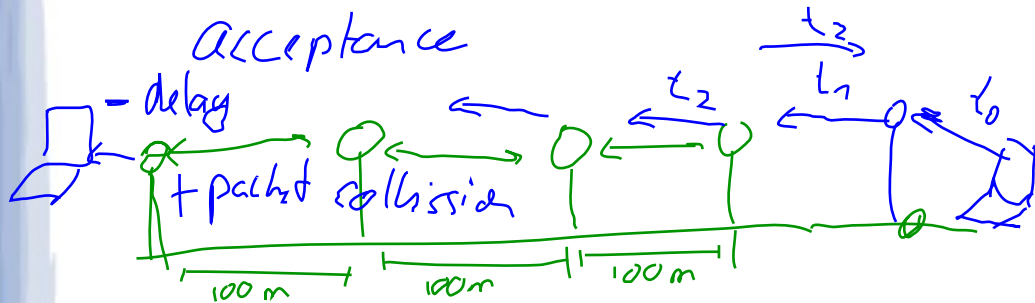
H-Plane Pattern



Antenna type	2 x 2 Patch array
Operating frequency range	5150–5850 MHz
Nominal input impedance	50Ω
Peak gain	9.5 dBi
Polarization	Linear, vertical
E-plane 3-dB beamwidth	43°
H-plane 3-dB beamwidth	50°
Sidelobe level	<−20 dBc
Front-to-back ratio	>20 dB
Cable length and type	36 in. (91.4 cm) Plenum rated, UV stable
Connector type	RP-TNC Male
Length	5.1 in. (12.9 cm)
Width	5.1 in. (12.9 cm)
Height	1.0 in. (2.5 cm)
Weight	10 oz. (0.2 kg)
Operating temperature range	−22°F to 158°F (−30°C to 70°C)
Storage temperature range	−40°F to 185°F (−40°C to 85°C)

End-to-end  
acceptance

# ANTENNAS: OUTDOOR

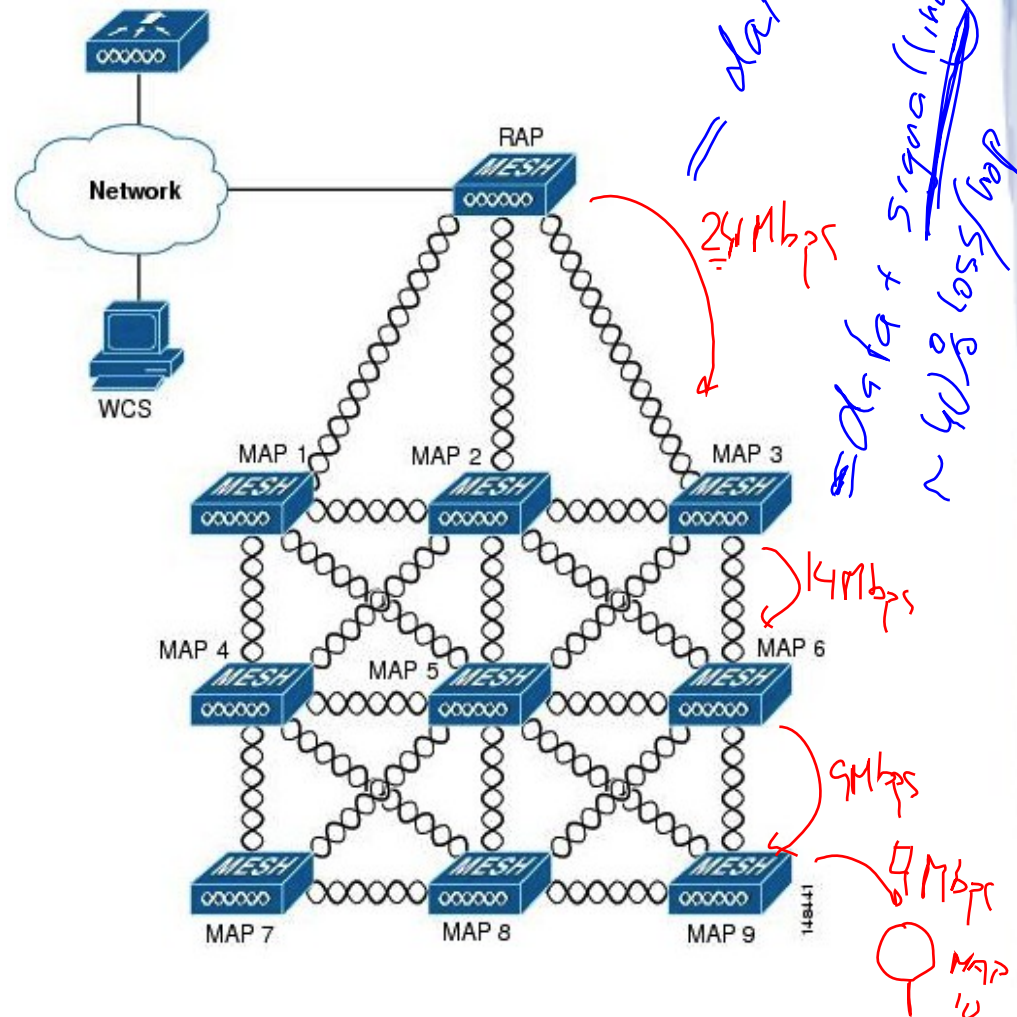


TCP

= data + signaling  
= data + signaling  
~ 40% loss/rp

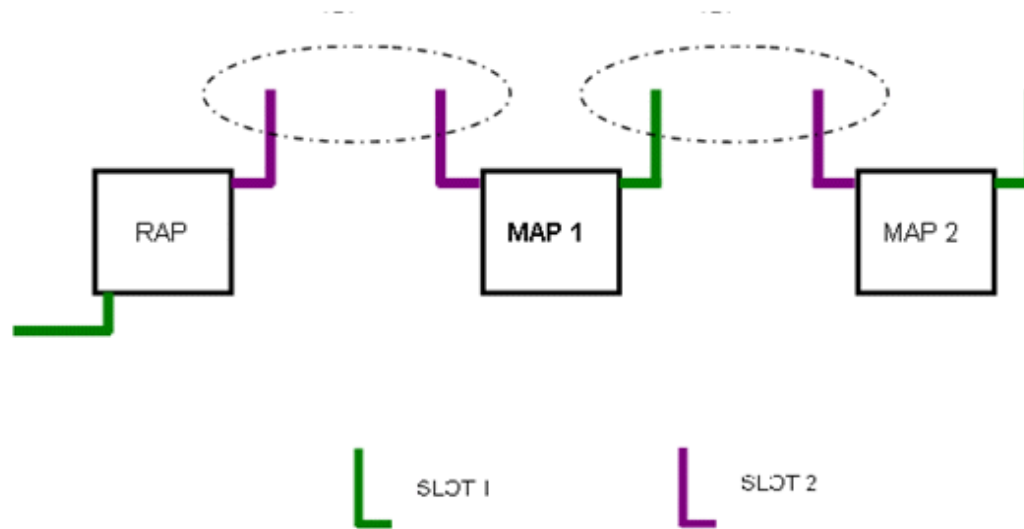
## Mesh Network Hierarchy:

- **Root AP:** RAPs have wired connections to the network.
- **Map AP:** MAPs have wireless connections among themselves and back to the RAP.



# ANTENNAS: OUTDOOR

It works as a **dual-radio system** with dual-band radios, IEEE 802.11a (5-GHz) and 802.11b/g (2.4-GHz) standards.



Slot 0: (11b/g, 2.4GHz) (Access) – Omni/Directional Antenna

Slot 1: (11a, 5 GHz) (Access) – Omni/ Directional Antenna

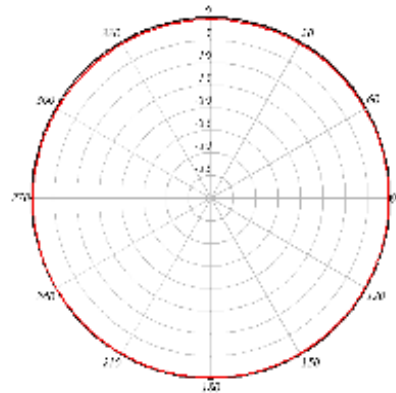
Slot 2: (11a, 5 GHz) (Backhaul) – Omni/Directional Antenna

# ANTENNAS: OUTDOOR

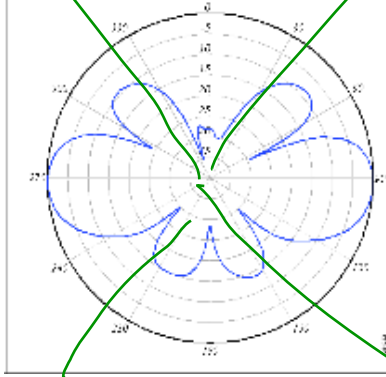
100 MHz = 3m

Omnidirectional antenna, IEEE 802.11b/g:

Azimuth Radiation Pattern



Elevation Radiation Pattern

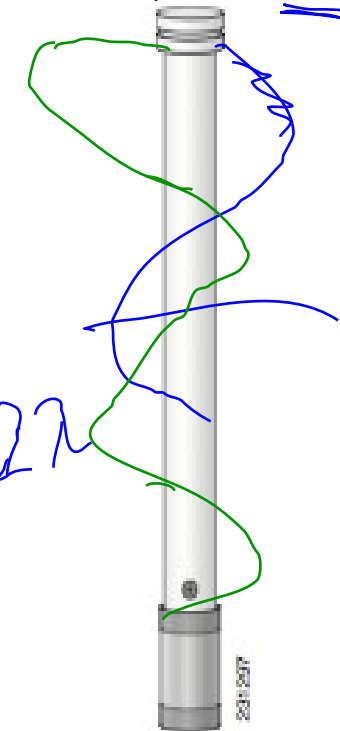


Handwritten green scribbles and the number '45' next to the Elevation Radiation Pattern plot.

Antenna type	Omnidirectional colinear array
Operating frequency range	2400–2484 MHz
1.7:1 VSWR bandwidth	2400–2484 MHz
Nominal input impedance	50Ω
Gain	5-dBi
Polarization	Linear, vertical
E-plane 3-dB beamwidth	30°
H-plane 3-dB bandwidth	Omnidirectional
Length	11.0 in. (27.9 cm)
Diameter	1.0 in. (2.5 cm)
Weight	6.0 oz. (160.0 g)
Connector type	N-Male
Operating temperature	-22°F - 158°F (-30°C - 70°C)
Wind rating	125 mph (201 kmh) 165 mph (265 kmh) gusts

Handwritten blue scribbles and calculations:  $2.4 \approx 12 \text{ cm}$

Handwritten blue scribbles and the number '22' next to the table.



Small vertical text on the antenna: 241-257

# SECURITY

- ◆ WEP: can be cracked in relatively no time & the WEP authentication protocol relies on DNS (man-in-the-middle attacks).
- ◆ WPA/WPA2: provides stronger data protection, and verifies network users through a server or setup password.

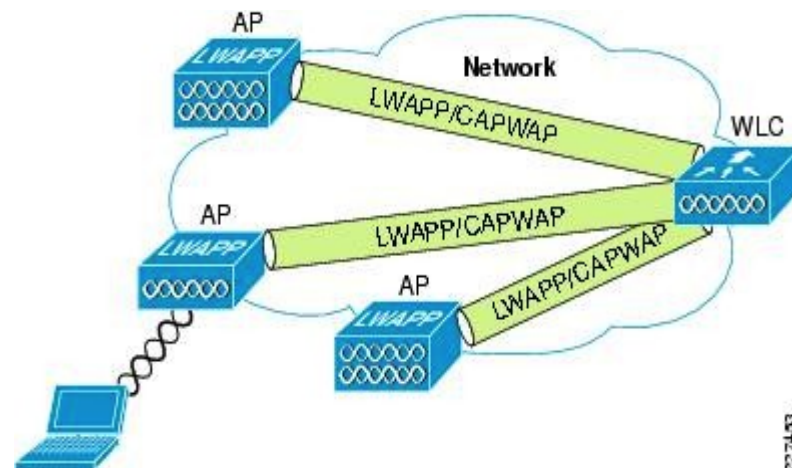


WPA 2		WPA (WI-FI Protected Access)	802.1x Authentication	Encryption	Security Type
AES	EAP-TLS (WPA)	EAP-TTLS (WPA)	EAP-FAST	CMIC (Cisco MIC)	WEP128
	EAP-FAST (WPA)	PEAP-MSCHAPv2 (WPA)	PEAP-GTC		TKIP (Cisco TKIP)
		LEAP (WPA)			
		WPA-PSK (Pre-Shared Key)			

# CENTRALIZED ARCHITECTURE

## LWAPP / CAPWAP:

- Protocol that can control multiple Wi-Fi access points at once.
- Tunneling of WLAN client traffic to the WLAN controller.
- Collection of 802.11 data for overall WLAN system management.
- It reduces the amount of time spent on configuring, monitoring or troubleshooting a large network.



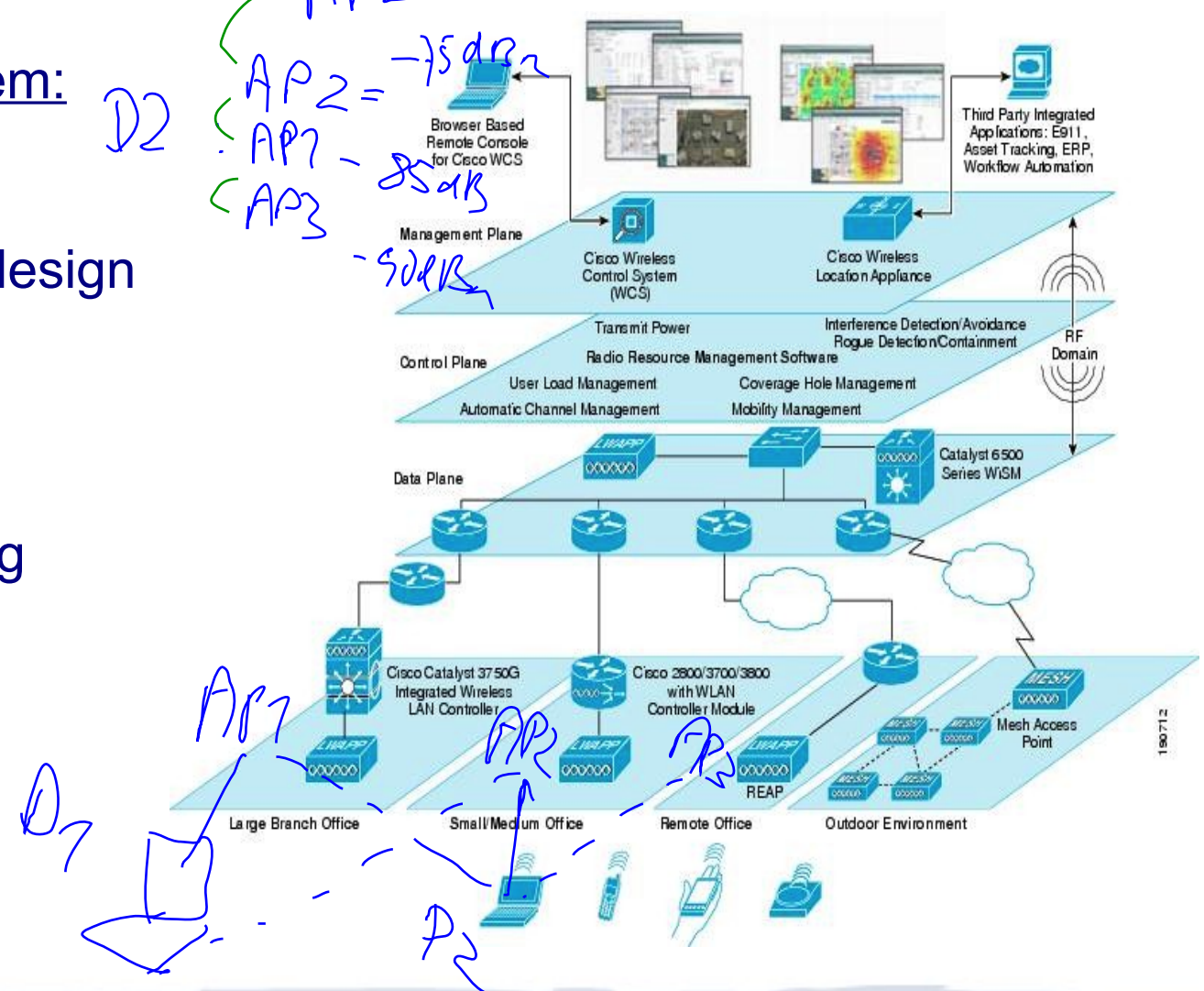
# CENTRALIZED ARCHITECTURE

Cisco Location "all neighbours"

D1  
 AP1 - 25 dBm  
 AP2 - 105 dBm  
 D2  
 AP2 = -75 dBm  
 AP1 - 25 dBm  
 AP3 - 50 dBm

## Wireless control system:

- WLAN planning & design
- Network monitoring
- Troubleshooting
- Localization tracking
- Secure access



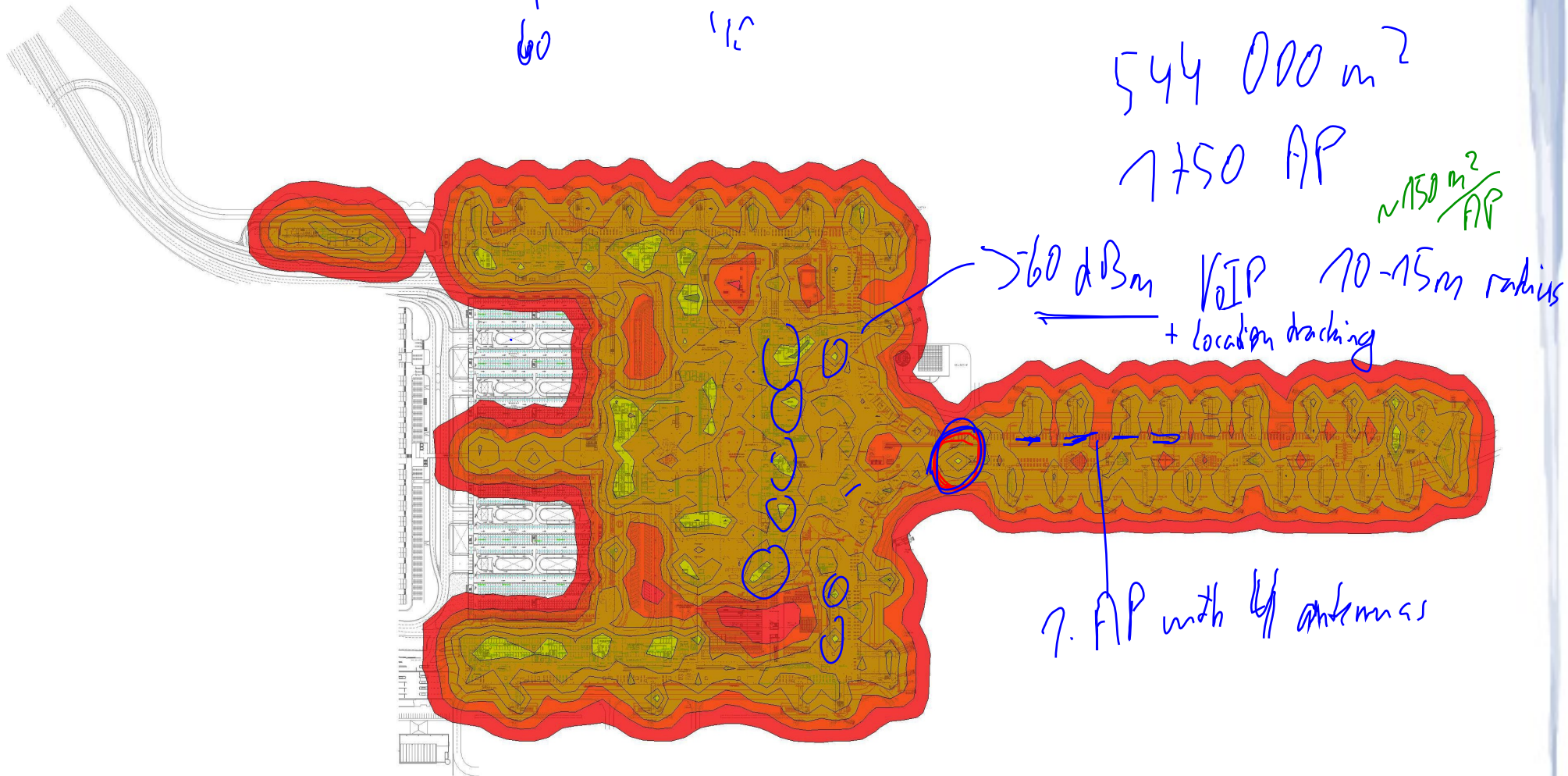
# WLAN PLANNING & DESIGN: BUILDING

- ◆ Barcelona Airport: Its structure has an area of 544,066 square meters and has a parking for aircraft of 600,000 m<sup>2</sup>.
- ◆ It was the biggest centralized WLAN deployment in Europe: 1750 Access Points.

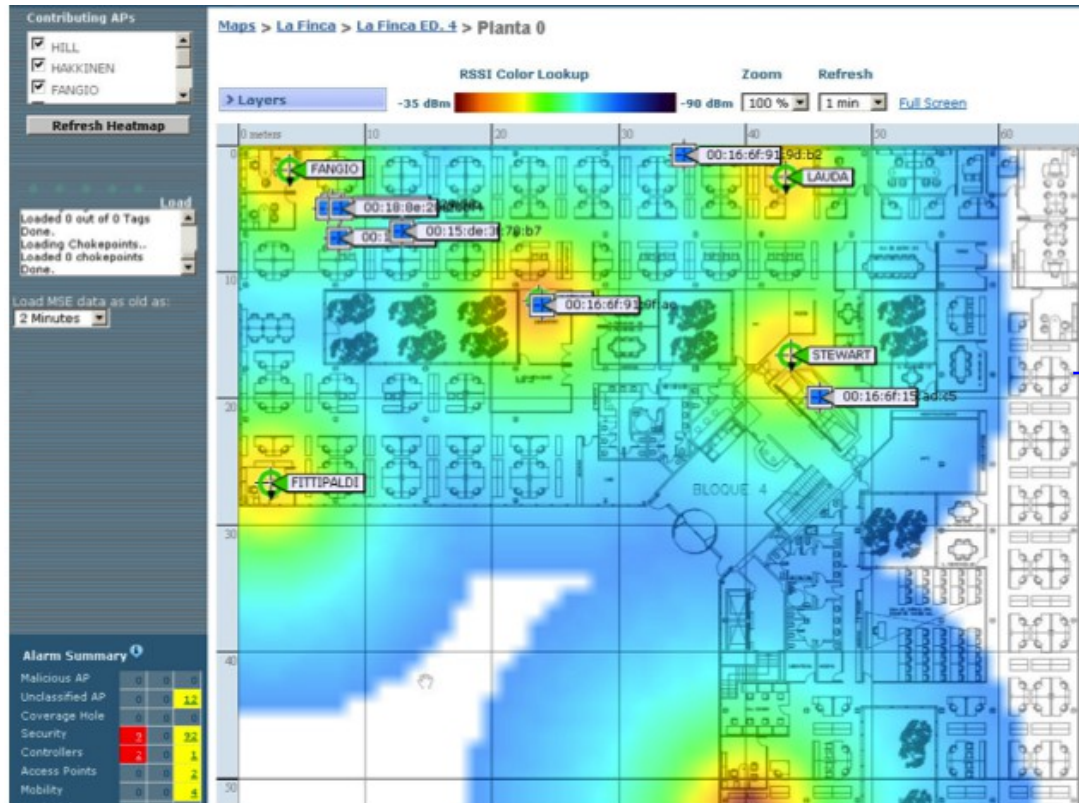




# WLAN PLANNING & DESIGN: SITE SURVEY



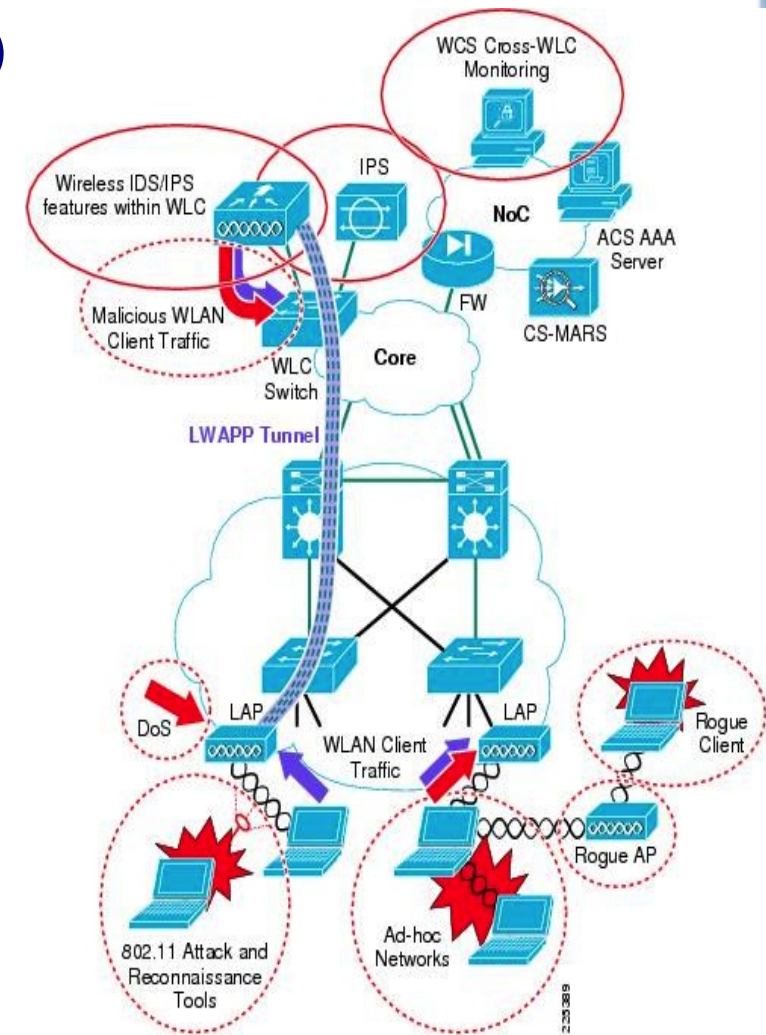
# NETWORK MONITORING & LOCALIZATION



# SECURE ACCESS

WIPS: (wireless intrusion prevention systems)

- **Rogue AP and Client** detection, location and containment.
- Detection & containment **802.11 DoS** and **802.11 attack tools**.
- Detection & containment of **excessive 802.11 associations** and authentications.
- Signature-based detection, identification and classification of **malicious traffic**.



END