

# WI-FI TECHNOLOGY



**T1- BARCELONA AIRPORT**

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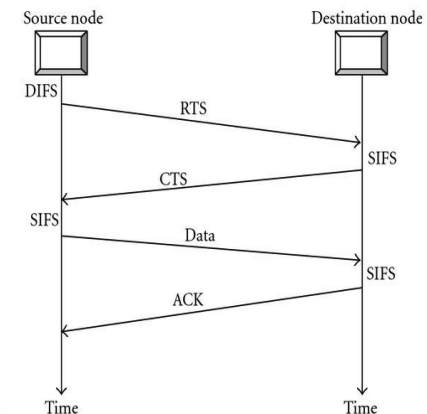
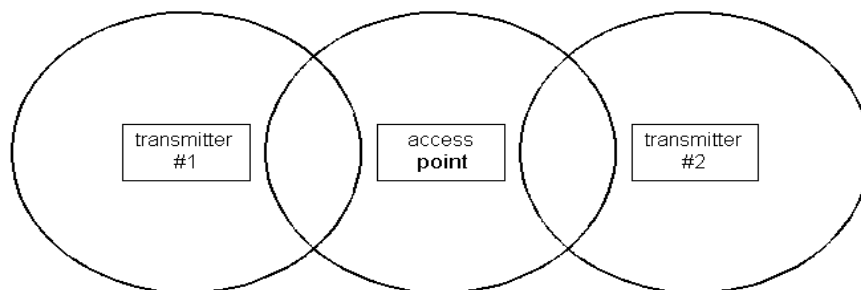


# WI-FI OVERVIEW

- 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

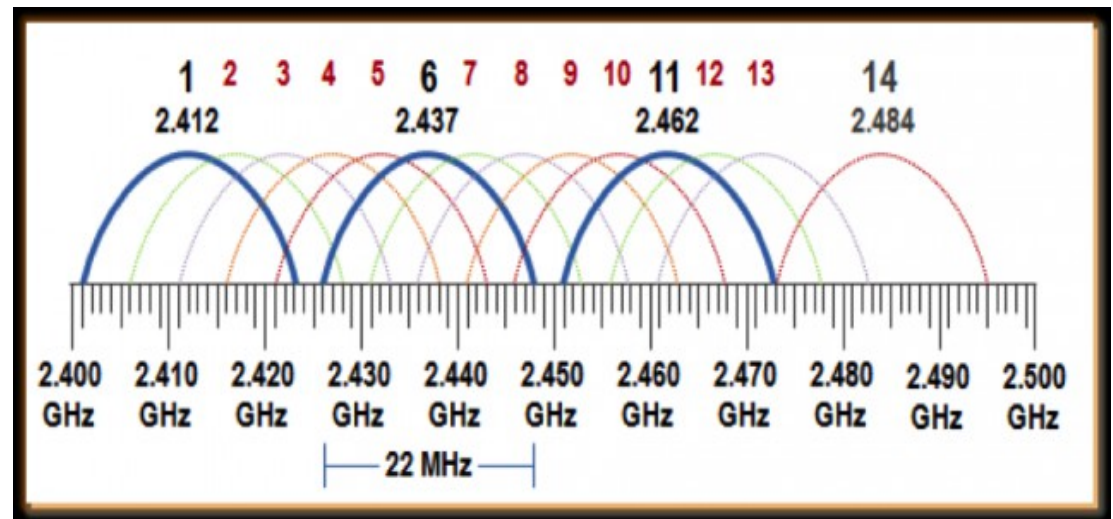
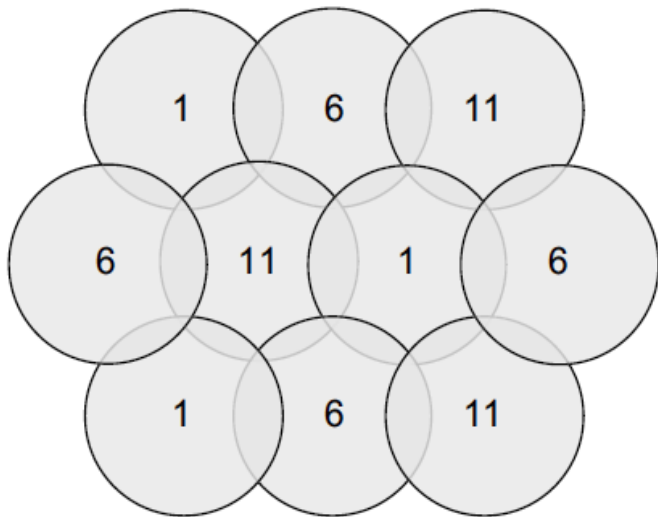
- CSMA/CA: nodes can transmit when the channel is "idle". Hidden node problem & 802.11 RTS/CTS solution:



# CHANNEL INTERFERENCES

## 802.11b/g/n:

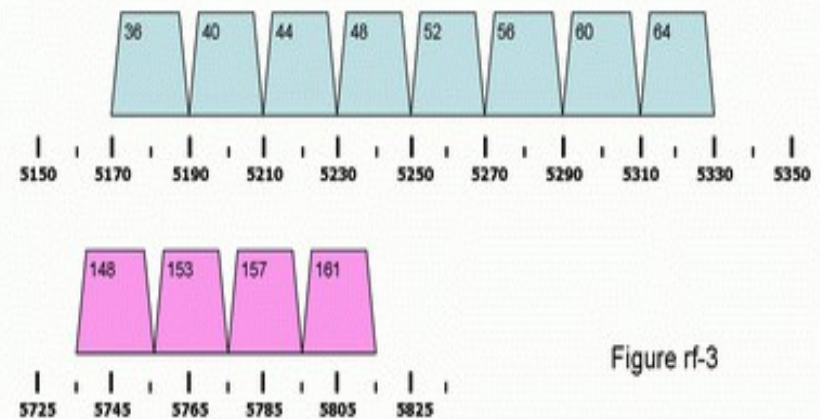
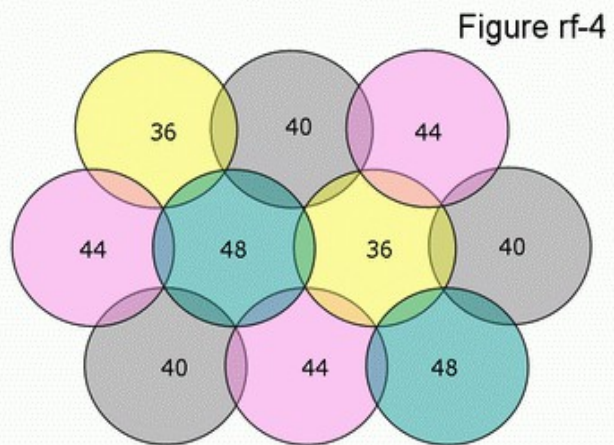
- ◆ 802.11b/g/n can transmit in the **2.4 GHz band** with a total of **13 available channels**.
- ◆ There are **three non-overlapping channels** with which to work in achieving isolation.



# CHANNEL INTERFERENCES

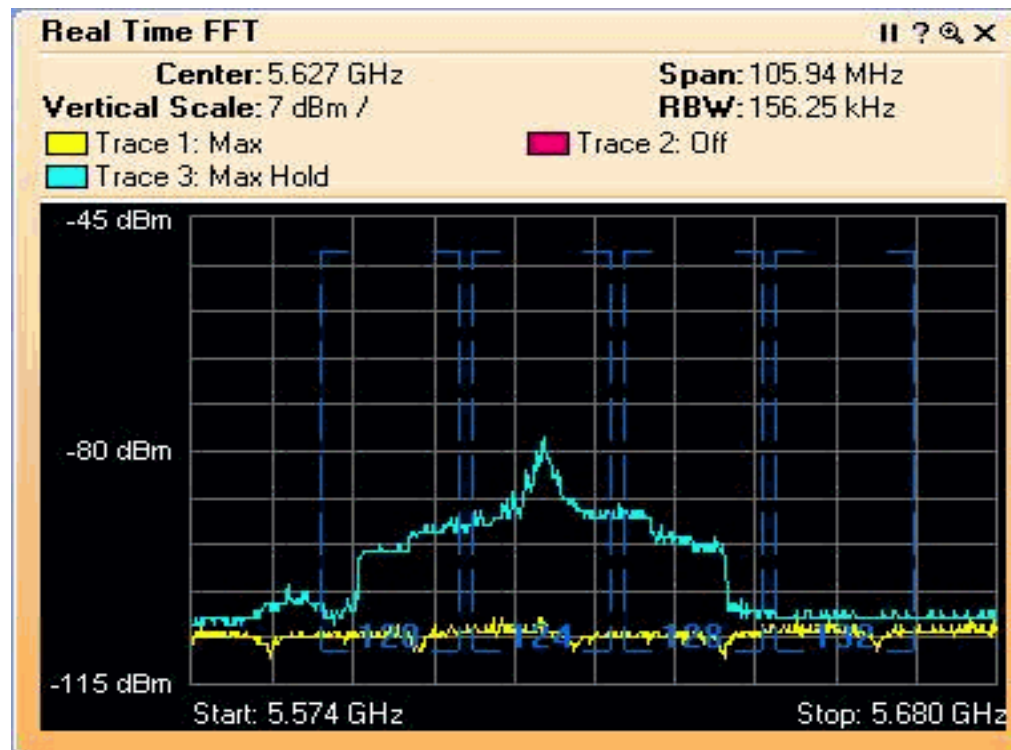
## 802.11a:

- ◆ 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

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

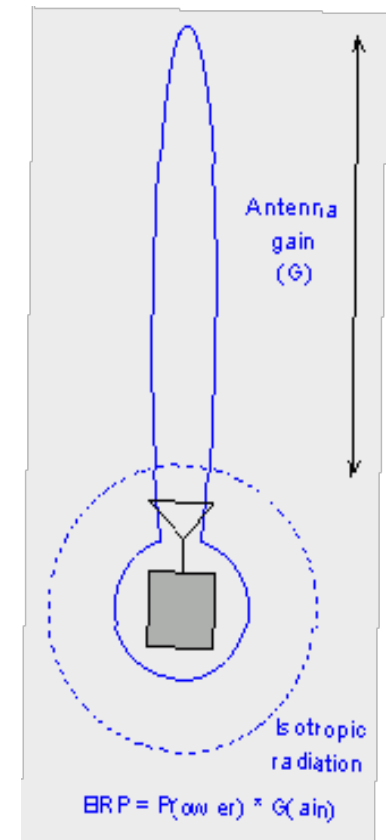
- dBd - decibels relative to a dipole reference antenna

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

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	

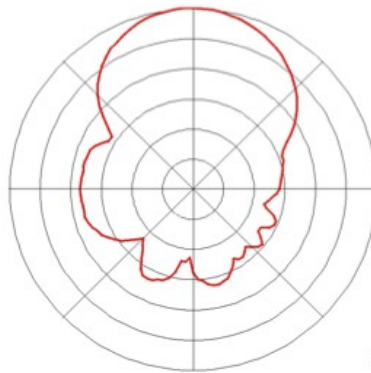


# ANTENNAS: INDOOR

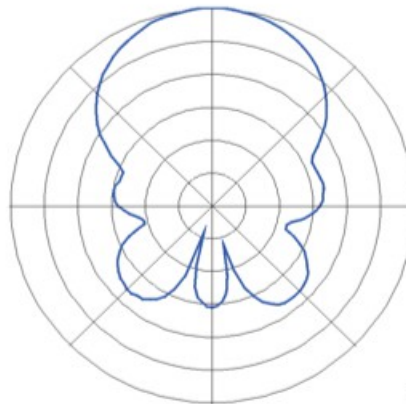
Directional antenna, IEEE 802.11a:



E-Plane Pattern



H-Plane Pattern

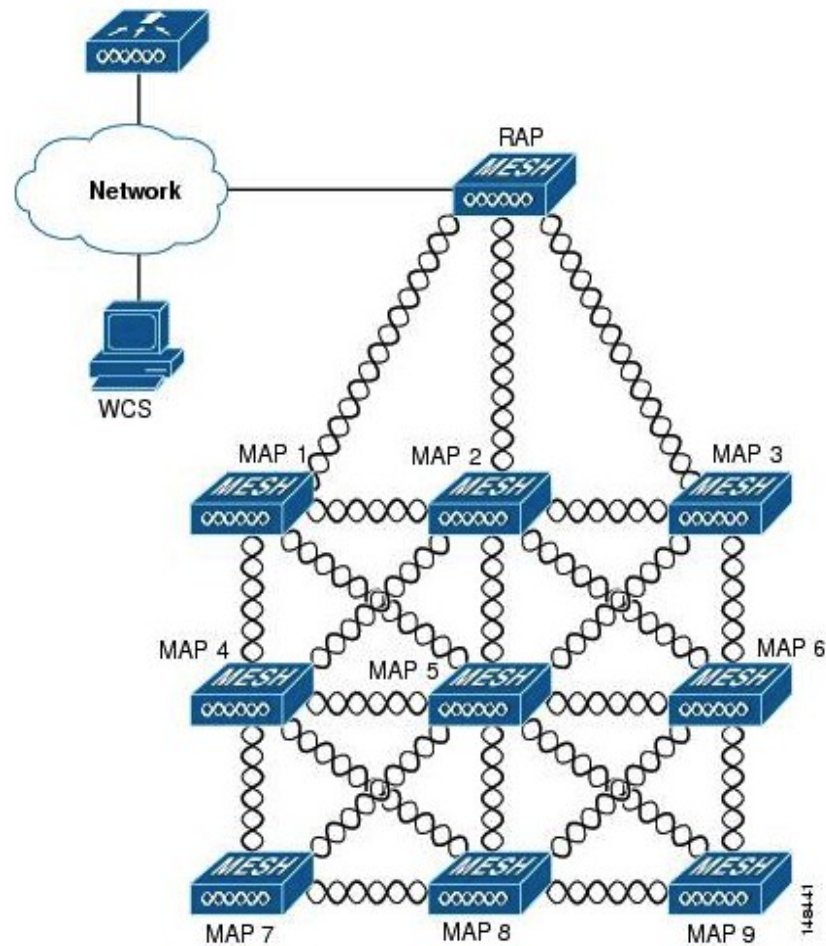


Antenna type	2 x 2 Patch array
Operating frequency range	5150–5850 MHz
Nominal input impedance	50Ω
Peak gain	9.5 dBi
Polarization	Linear, vertical
E-plane 3-dB beamwidth	43°
H-plane 3-dB beamwidth	50°
Sidelobe level	<−20 dBc
Front-to-back ratio	>20 dB
Cable length and type	36 in. (91.4 cm) Plenum rated, 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)

# ANTENNAS: OUTDOOR

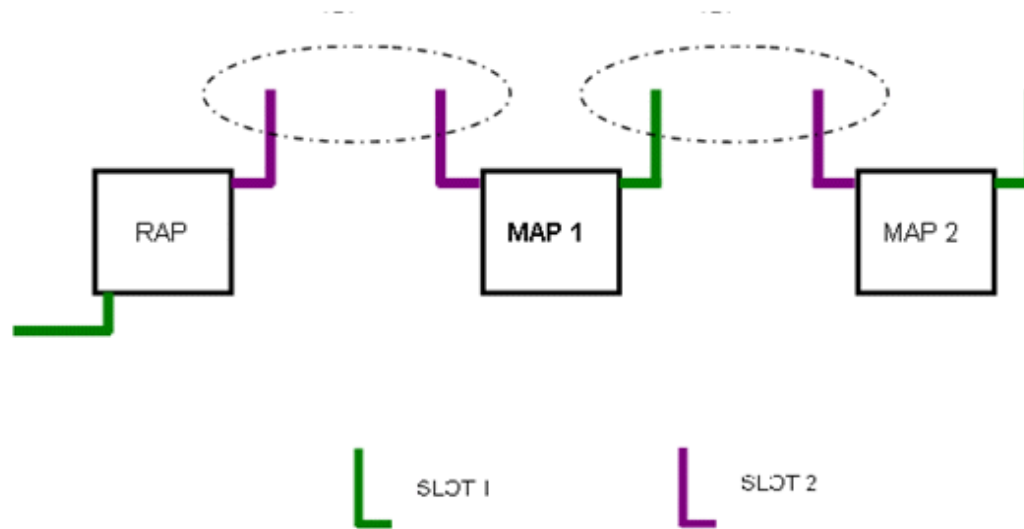
Mesh Network Hierarchy:

- **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

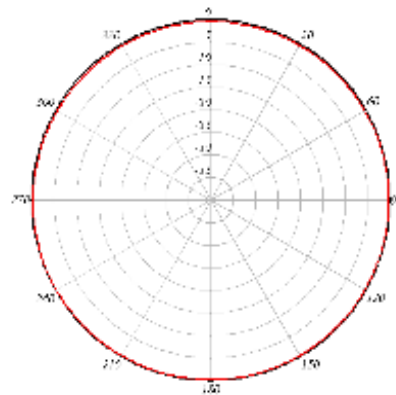
Slot 1: (11a, 5 GHz) (Access) – Omni/ Directional Antenna

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

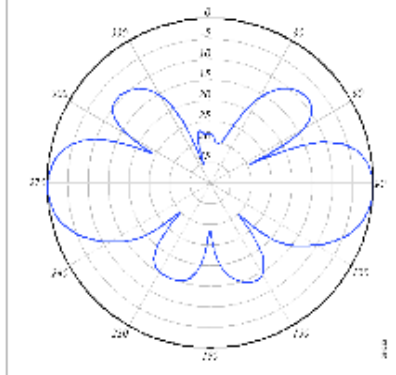
# ANTENNAS: OUTDOOR

Omnidirectional antenna, IEEE 802.11b/g:

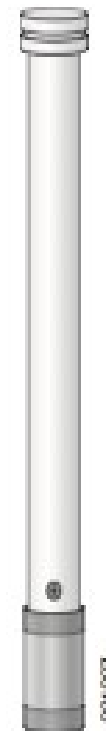
Azimuth Radiation Pattern



Elevation Radiation Pattern



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. (14.5 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



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# 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.

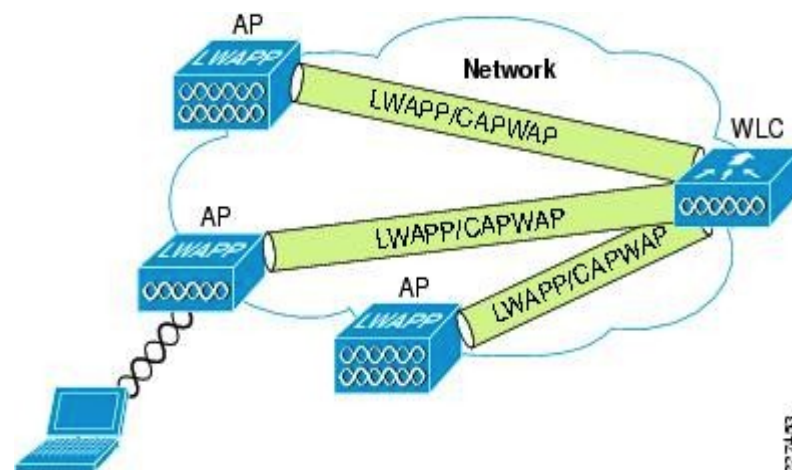


WPA 2		WPA (WI-FI Protected Access)	802.1x Authentication	Encryption	Security Type
AES	EAP-TLS (WPA)	EAP-TTLS (WPA)	EAP-FAST	CMIC (Cisco MIC)	WEP128
	EAP-FAST (WPA)	PEAP-MSCHAPv2 (WPA)	PEAP-GTC		TKIP (Cisco TKIP)
	LEAP (WPA)	WPA-PSK (Pre-Shared Key)	LEAP		

# CENTRALIZED ARCHITECTURE

## LWAPP / CAPWAP:

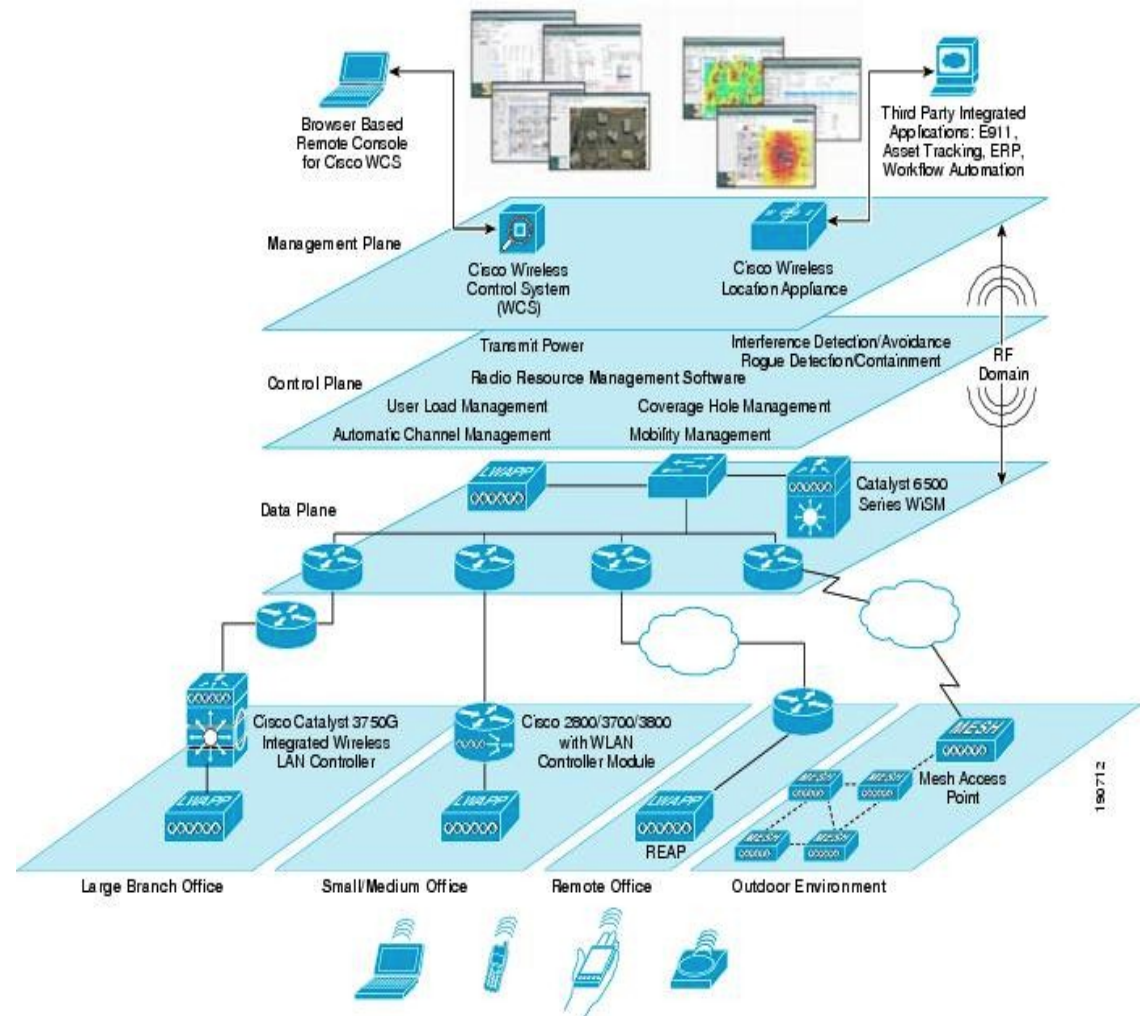
- Protocol that can control multiple Wi-Fi access points at once.
- Tunneling of WLAN client traffic to the WLAN controller.
- Collection of 802.11 data for overall WLAN system management.
- It reduces the amount of time spent on configuring, monitoring or troubleshooting a large network.



# CENTRALIZED ARCHITECTURE

## 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.

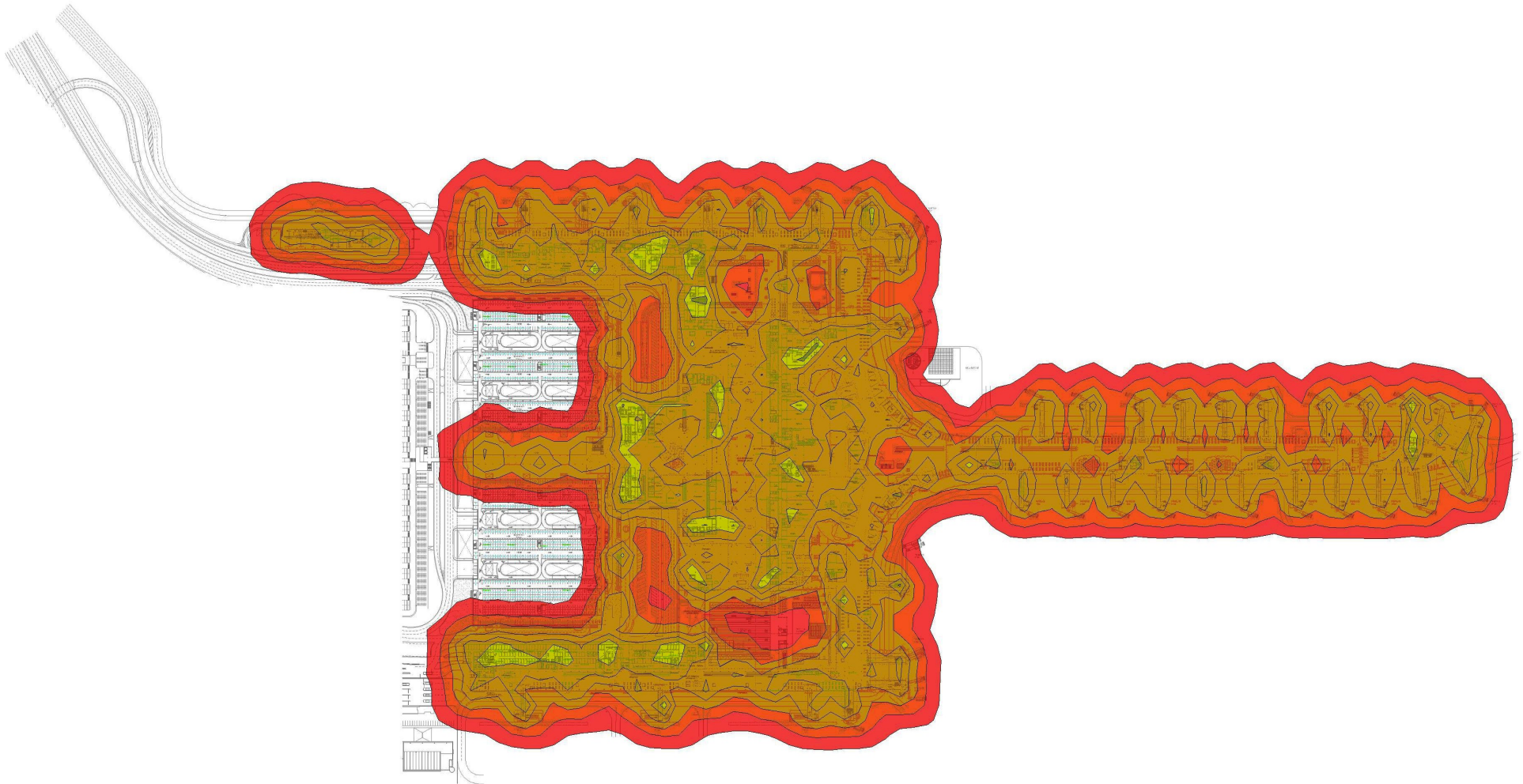




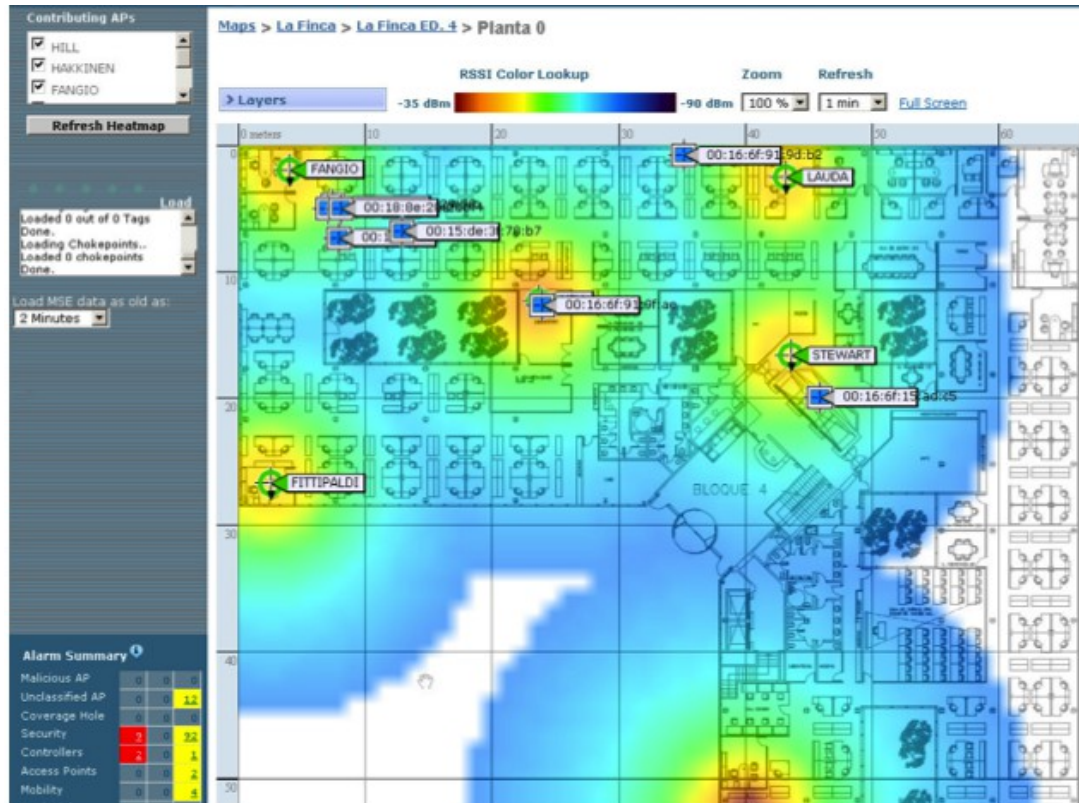
# WLAN PLANNING & DESIGN: SITE SURVEY

-80.0dBm

-20.0dBm



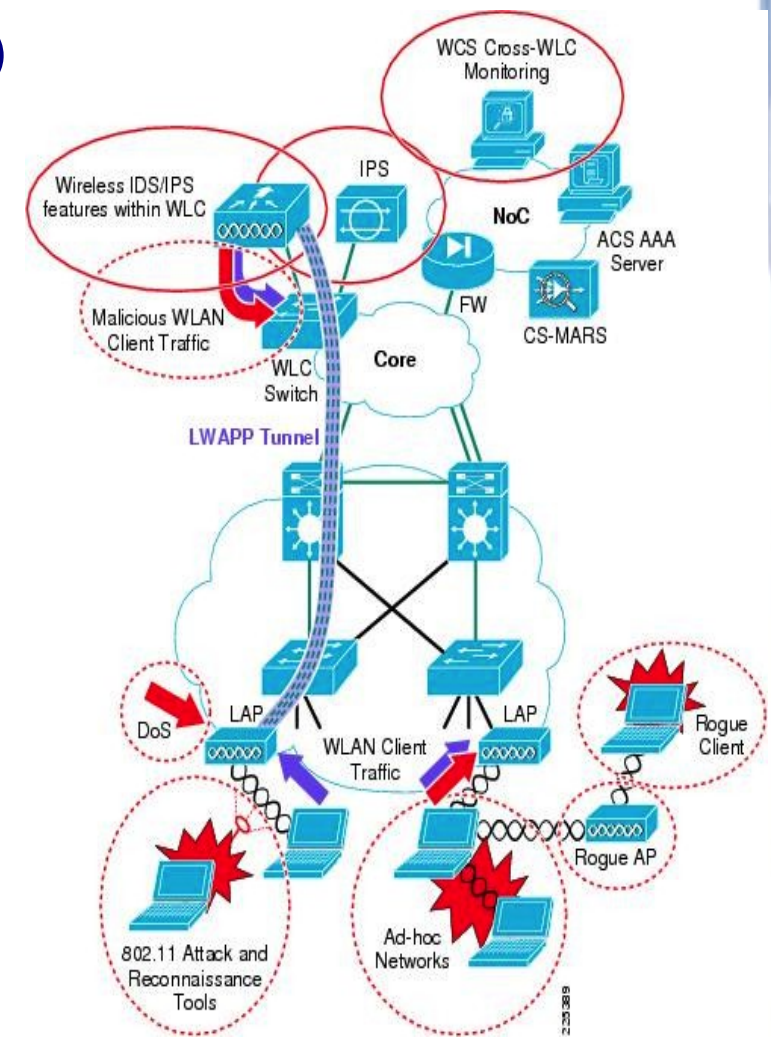
# NETWORK MONITORING & LOCALIZATION



# 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