Nomadic Communications Labs

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Configuration of CISCO AP
1200 Series

AP 1200: Features

- This AP supports:
  - Multiple SSID (up to 16). For each one it is possible to choose:
    - If transmitting in broadcast the SSID (guests mode)
    - The method of authentication
    - The maximum number of customers
    - VLAN: a VLAN for each SSID
  - Authentication Methods:
    - MAC Address
    - 802.1x
    - WPA

AP 1200: Initial Configuration

- Configuration using serial port
  - 9600 baud
  - 8 data bits
  - Parity none
  - stop bit 1
  - flow control no

AP 1200: Initial Configuration

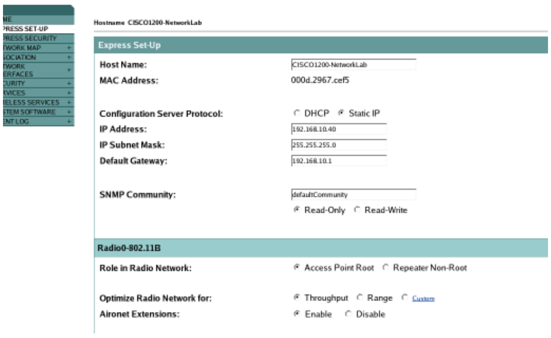
- "Standard" CISCO commands:
  - `enable`
  - *`Password`* → `Cisco`
  - `configure` *`[terminal]`*
  - `ip default-gateway 192.168.10.1`
  - `interface BVI 1`
  - `ip address 192.168.10.40 255.255.255.0`
  - `exit`
  - `Ctrl-z`
  - `copy running-config startup-config`
  - `reload`

AP 1200: Initial Configuration

- To display the initial configuration:
  - `Enable`
  - `Password: Cisco`
  - `show running-config`

AP 1200: WEB Interface

- After the first configuration via CLI:



Hostname CISCO1200-NetworkLab

Express Set-Up

Host Name: CISCO1200-NetworkLab

MAC Address: 000d.2967.cef5

Configuration Server Protocol: ○ DHCP ● Static IP

IP Address: 192.168.10.40

IP Subnet Mask: 255.255.255.0

Default Gateway: 192.168.10.1

SNMP Community: defaultCommunity

● Read-Only ○ Read-Write

Radio0-802.11B

Role in Radio Network: ● Access Point Root ○ Repeater Non-Root

Optimize Radio Network for: ● Throughput ○ Range ○ Custom

Aironet Extensions: ● Enable ○ Disable

AP 1200: Firmware Update

- The Firmware is downloadable from the CISCO WEB Site:
  - http://tools.cisco.com/support/downloads/go/Redirect.x?mdfid=278875243
  - You have to register at least as guest user
  - The current version is: c1200-k9w7-tar.123-8.JEC2.tar
  - The AP firmware can be updated via tftp or via http

AP 1200: Wireless Configuration

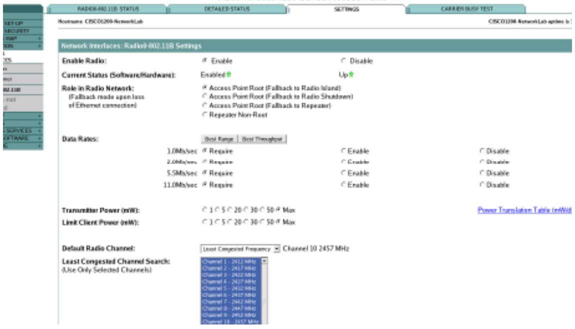
- Role in a Wireless Network:
  - Root/Repeater
- Power:
  - You can limit the power of the AP radio
  - It is also possible to limit the power (in transmission) of the client stations (CISCO extensions)

AP 1200: Wireless Configuration

- Speed:
  - Basic (Require in WEB Interface): unicast and multicast traffic, used from the highest to the lowest. At least one rate must be set to basic. Note that if the client doesn’t support a Basic rate, it can not associate to the AP
  - Enabled: Unicast traffic only
  - Disabled: This speed is not usable

AP 1200: Wireless Configuration

- Configuration of the basic parameters



Hostname CISCO1200-NetworkLab

CISCO1200-NetworkLab uptime is

Network Interfaces: Radio0-802.11B Settings

Enable Radio: ● Enable ○ Disable

Current Status (Software/Hardware): Enabled Up

Role in Radio Network: (Fallback mode upon loss of Ethernet connection)
● Access Point Root (Fallback to Radio Island)
○ Access Point Root (Fallback to Radio Shutdown)
○ Access Point Root (Fallback to Repeater)
○ Repeater Non-Root

Data Rates: Best Range | Best Throughput

1.0Mb/sec	● Require	○ Enable	○ Disable
2.0Mb/sec	● Require	○ Enable	○ Disable
5.5Mb/sec	● Require	○ Enable	○ Disable
11.0Mb/sec	● Require	○ Enable	○ Disable

Transmitter Power (mW): ○ 1 ○ 5 ○ 20 ○ 30 ○ 50 ● Max

Power Translation Table (mW/d

Limit Client Power (mW): ○ 1 ○ 5 ○ 20 ○ 30 ○ 50 ● Max

Default Radio Channel: Least Congested Frequency Channel 10 2457 MHz

Least Congested Channel Search: (Use Only Selected Channels)
Channel 1 - 2412 MHz
Channel 2 - 2417 MHz
Channel 3 - 2422 MHz
Channel 4 - 2427 MHz
Channel 5 - 2432 MHz
Channel 6 - 2437 MHz
Channel 7 - 2442 MHz
Channel 8 - 2447 MHz
Channel 9 - 2452 MHz
Channel 10 - 2457 MHz

AP 1200: Wireless Configuration

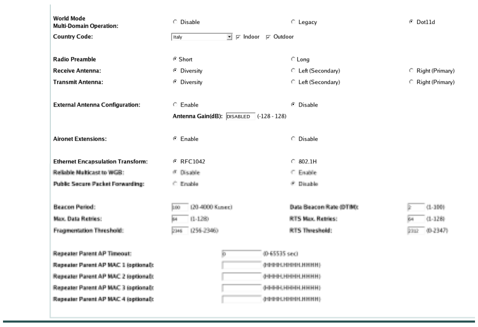
- World Mode:
  - Clients can receive “national” information about setting. Legacy for CISCO compatibility, 802.11d new standards
- Antenna:
  - Diversity: both antennas are used and the one that receives the best signal is chosen
- Encapsulation:
  - To manage the non 802.3 packages, these have to be encapsulated. Interoperability with others: RFC1042; 802.1H optimized for CISCO

AP 1200: Wireless Configuration

- RTS:
  - Choose low values if not all of the stations are within sensing range of each other
- Fragmentation:
  - Choose low values if the area is disturbed or with low transmission quality
- CISCO Extension:
  - Used to support special features

AP 1200: Wireless Configuration

- Configuration of the basic parameters



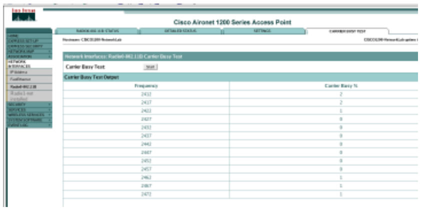
World Mode Multi-Domain Operation:	○ Disable	○ Legacy	● Dot11d
Country Code:	Italy ▾ ☑ Indoor ☑ Outdoor		
Radio Preamble	● Short	○ Long	
Receive Antenna:	● Diversity	○ Left (Secondary)	○ Right (Primary)
Transmit Antenna:	● Diversity	○ Left (Secondary)	○ Right (Primary)
External Antenna Configuration:	○ Enable	● Disable	
	Antenna Gain(dB): DISABLED (-128 - 128)		
Aironet Extensions:	● Enable	○ Disable	
Ethernet Encapsulation Transform:	● RFC1042	○ 802.1H	
Reliable Multicast to WGB:	● Disable	○ Enable	
Public Secure Packet Forwarding:	○ Enable	● Disable	

Beacon Period:	100 (20-4000 Kusec)	Data Beacon Rate (DTIM):	2 (1-100)
Max. Data Retries:	64 (1-128)	RTS Max. Retries:	64 (1-128)
Fragmentation Threshold:	2346 (256-2346)	RTS Threshold:	2312 (0-2347)

Repeater Parent AP Timeout:	0 (0-65535 sec)
Repeater Parent AP MAC 1 (optional):	(HHHH.HHHH.HHHH)
Repeater Parent AP MAC 2 (optional):	(HHHH.HHHH.HHHH)
Repeater Parent AP MAC 3 (optional):	(HHHH.HHHH.HHHH)
Repeater Parent AP MAC 4 (optional):	(HHHH.HHHH.HHHH)

AP 1200: Wireless Configuration

- Channel Selection:
  - It is possible to make the AP choose the channel automatically
  - It is possible to set it manually
  - It is possible to do a survey to determine the state of the channels in the area



Cisco Aironet 1200 Series Access Point

Network Interfaces: Radio0-802.11B Carrier Busy Test

Carrier Busy Test Start

Carrier Busy Test Output

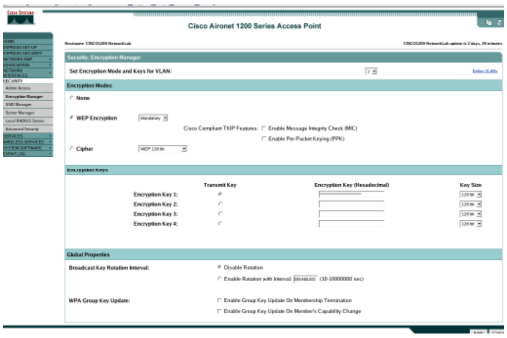
Frequency	Carrier Busy %
2412	2
2417	2
2422	1
2427	0
2432	0
2437	0
2442	0
2447	0
2452	0
2457	0
2462	1
2467	1
2472	1

AP 1200: SSID and Authentication

- SSID:
  - You have to define an SSID. Default “tsunami”
  - Guest SSID: is the SSID advertised
- Authentications:
  - Open: all the devices are allowed to authenticate with the AP
  - Shared: there is an exchange of a message plain or encrypted. Unsafe
  - EAP: the safest mode
- Authentication based on MAC:
  - Open authentication → “With MAC Authentication”

AP 1200: SSID and Authentication

- Definition of Cryptography



Cisco Aironet 1200 Series Access Point

Hostname CISCO1200-NetworkLab

CISCO1200-NetworkLab uptime is 2 days, 49 minutes

Security: Encryption Manager

Set Encryption Mode and Keys for VLAN: 3

Encryption Modes

○ None

● WEP Encryption Mandatory

Cisco Compliant TKIP Features: □ Enable Message Integrity Check (MIC)

□ Enable Per Packet Keying (PPK)

○ Cipher WEP 128 bit

Encryption Keys

	Transmit Key	Encryption Key (Hexadecimal)	Key Size
Encryption Key 1:	●	**************************	128 bit
Encryption Key 2:	○		128 bit
Encryption Key 3:	○		128 bit
Encryption Key 4:	○		128 bit

Global Properties

Broadcast Key Rotation Interval: ● Disable Rotation

○ Enable Rotation with Interval: DISABLED (10-10000000 sec)

WPA Group Key Update: □ Enable Group Key Update On Membership Termination

□ Enable Group Key Update On Member's Capability Change

AP 1200: Configuration via CLI

- All the configurations via HTTP are possible via CLI
  - `show running-config`

```
interface Dot11Radio0
 no ip address
 no ip route-cache
 !
 encryption vlan 3 key 1 size 128bit 7 501B2057424875554B78965D207B
transmit-key
 encryption vlan 3 mode wep mandatory
 !
 ssid CREATE-NET-TEST
    vlan 4
    authentication open mac-address mac_methods
    accounting acct_methods
    mobility network-id 4
    information-element ssidl advertisement
 !
 ssid WILMA-LAB
    vlan 3
    authentication open mac-address mac_methods
    accounting acct_methods
    mobility network-id 3
    information-element ssidl advertisement
 !
 ssid WILMA-LAB-TEST
    vlan 5
    authentication open mac-address mac_methods
    accounting acct_methods
    guest-mode
    mobility network-id 5
```

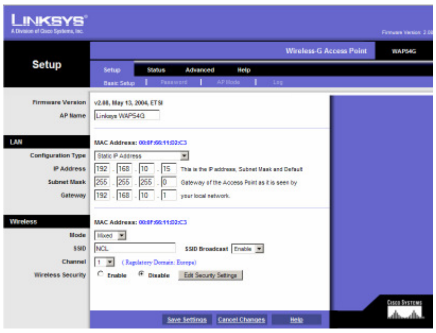
Configuration of LinkSys AP
WAP54G

WAP54G: Firmware Update

- The Firmware is downloadable from the LinkSys WEB Site:
  - http://www.linksysbycisco.com/US/en/support/WAP54G
  - The AP firmware can be updated via http

WAP54G: WEB Interface

- We can configure it via WEB interface:



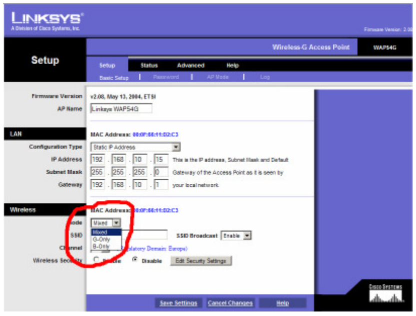
Firmware Version: v2.08, May 13, 2004, ETSI
AP Name: Linksys WAP54G

MAC Address: 00:0F:66:11:02:C3
Configuration Type: Static IP Address
IP Address: 192 . 168 . 10 . 15
Subnet Mask: 255 . 255 . 255 . 0
Gateway: 192 . 168 . 10 . 1
This is the IP address, Subnet Mask and Default Gateway of the Access Point as it is seen by your local network.

MAC Address: 00:0F:66:11:02:C3
Mode: Mixed
SSID: NCL
SSID Broadcast: Enable
Channel: 1 (Regulatory Domain: Europe)
Wireless Security: ○ Enable ● Disable Edit Security Settings

WAP54G: WEB Interface

- From the main page you can change the B/G/mixed mode:



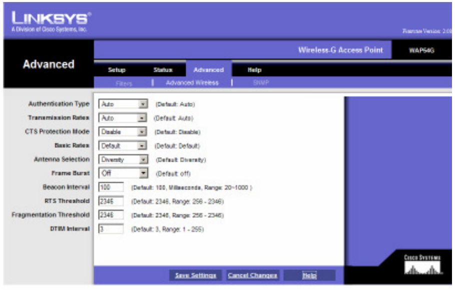
Firmware Version v2.08, May 13, 2004, ETSI
AP Name Linksys WAP54G

MAC Address: 00:0F:66:11:02:C3
Configuration Type Static IP Address
IP Address 192 . 168 . 10 . 15 This is the IP address, Subnet Mask and Default
Subnet Mask 255 . 255 . 255 . 0 Gateway of the Access Point as it is seen by
Gateway 192 . 168 . 10 . 1 your local network.

MAC Address: 00:0F:66:11:02:C3
Mode Mixed (Mixed / G-Only / B-Only)
SSID SSID Broadcast Enable
Channel (Regulatory Domain: Europe)
Wireless Security ○ Enable ● Disable Edit Security Settings

WAP54G: WEB Interface

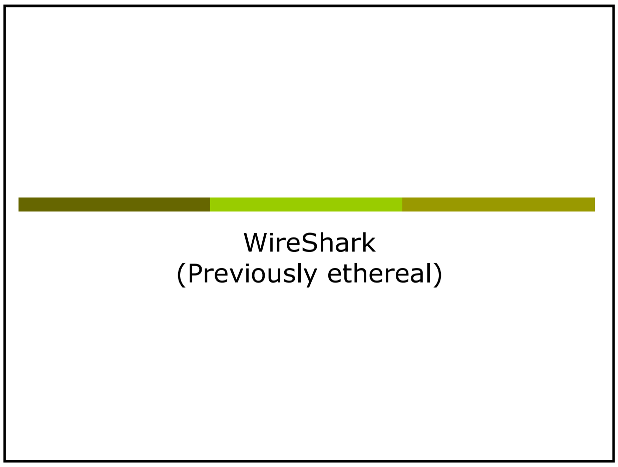
- In the Advanced page, Advanced Wireless tab, you can modify a lot of parameters:



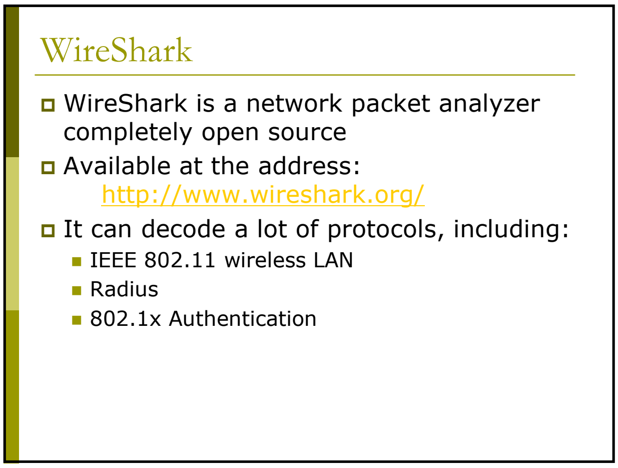
Authentication Type Auto (Default: Auto)
Transmission Rates Auto (Default: Auto)
CTS Protection Mode Disable (Default: Disable)
Basic Rates Default (Default: Default)
Antenna Selection Diversity (Default: Diversity)
Frame Burst Off (Default: off)
Beacon Interval 100 (Default: 100, Milliseconds, Range: 20~1000)
RTS Threshold 2346 (Default: 2346, Range: 256 - 2346)
Fragmentation Threshold 2346 (Default: 2346, Range: 256 - 2346)
DTIM Interval 3 (Default: 3, Range: 1 - 255)

WAP54G: WEB Interface

- For this AP you can change:
  - The Fragmentation Threshold
  - The Transmitting speed
  - The RTS Threshold
  - The mode (B/G/Mixed)

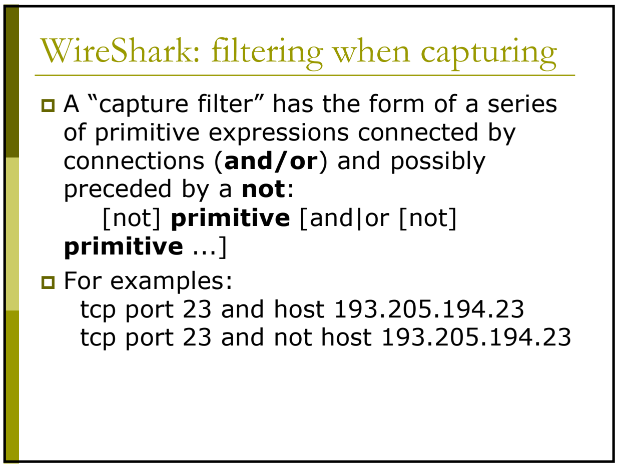


WireShark
(Previously ethereal)



WireShark

- WireShark is a network packet analyzer completely open source
- Available at the address:
  http://www.wireshark.org/
- It can decode a lot of protocols, including:
  - IEEE 802.11 wireless LAN
  - Radius
  - 802.1x Authentication



WireShark: filtering when capturing

- A "capture filter" has the form of a series of primitive expressions connected by connections (**and/or**) and possibly preceded by a **not**:
  [not] **primitive** [and|or [not] **primitive** ...]
- For examples:
  tcp port 23 and host 193.205.194.23
  tcp port 23 and not host 193.205.194.23

WireShark: filtering when capturing

- **Some of the most used primitives:**
- **[src|dst] host <host>**
  - This primitive allows to filter on the basis of the IP address or the name of the host
- **ether [src|dst] host <ehost>**
  - This primitive allows to filter on the basis of the ethernet address of the host
- **[src|dst] net <net> [{mask <mask>}|{len <len>}]**
  - This primitive allows to filter on the basis of the network addresses
- **[tcp|udp] [src|dst] port <port>**
  - This primitive allows to filter on the basis of the TCP and UDP port numbers
- **ip|ether proto <protocol>**
  - This primitive allows to filter on the basis of the protocols specified at Ethernet or IP level

Promiscuous Mode
and
Monitor Mode

Promiscuous Mode

- To make *sniffing* on a network device it is required that the filter based on the MAC address in the destination field applied to the incoming packets is deactivated: promiscuous mode
- In most cases the control is not hardcoded and therefore it is possible to disabled it acting on the driver

Monitor Mode

- For many 802.11 wireless cards, besides the *Promiscuous Mode*, it is possible to use another mode: the *Monitor Mode*
- This mode allows to make sniffing in a completely passive way: we can see all what is on the wireless channel without having to join to the WLAN (it is not possible to transmit, but the card can be used more efficiently for listening)
- The possibility of using a card in Monitor Mode depends on the driver

Monitor Mode

- A (not complete) list of cards, with the corresponding linux driver which support the Monitor Mode, is available at the address:

  http://www.kismetwireless.net/documentation.shtml

802.11 Frames

802.11 Frame

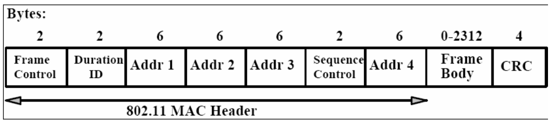
- The Monitor Mode (plus applications like WireShark or Kismet) allows us to analyze the frames of a 802.11 communication
- 802.11 defines several types of frame which stations (NIC and AP) use to communicate among them and to manage and check the wireless link

802.11 Frame

- Each frame has a control field that defines the version of the 802.11 protocol, the type of frame, and several flags like if WEP is active, if the management power is active, ...
- Every frame contains MAC addresses of the source and destination station, a frame number, the frame body and a frame check (for error control)

802.11 Frame

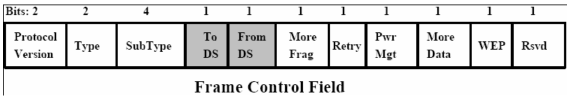
- Frame format:



Bytes: 2	2	6	6	6	2	6	0-2312	4
Frame Control	Duration ID	Addr 1	Addr 2	Addr 3	Sequence Control	Addr 4	Frame Body	CRC

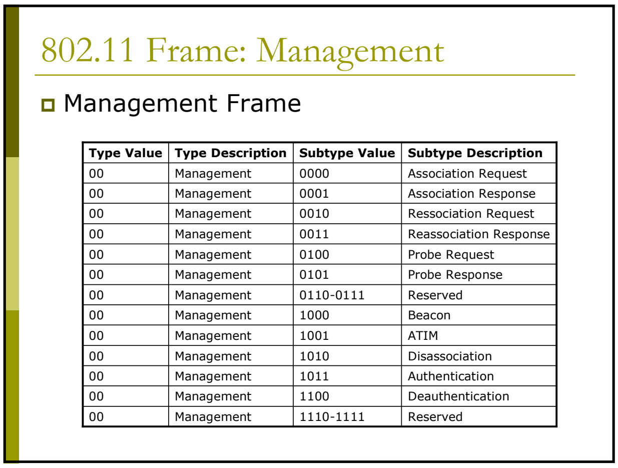
802.11 MAC Header

- The Frame Control Field is:



Bits: 2	2	4	1	1	1	1	1	1	1	1
Protocol Version	Type	SubType	To DS	From DS	More Frag	Retry	Pwr Mgt	More Data	WEP	Rsvd

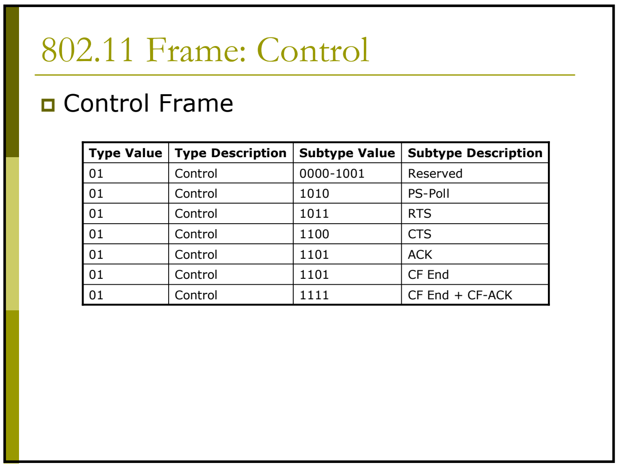
Frame Control Field



802.11 Frame: Management

- Management Frame

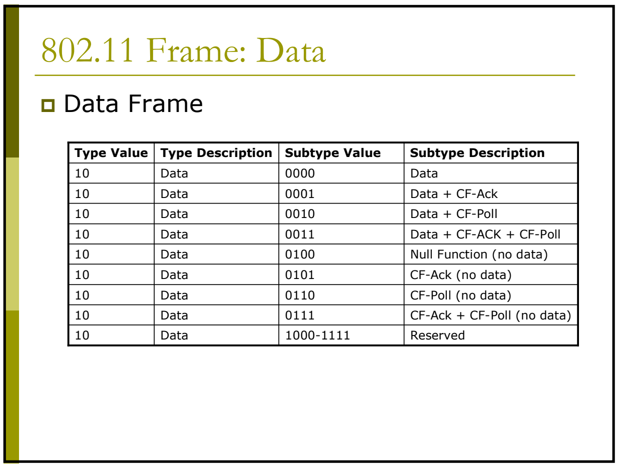
Type Value	Type Description	Subtype Value	Subtype Description
00	Management	0000	Association Request
00	Management	0001	Association Response
00	Management	0010	Ressociation Request
00	Management	0011	Reassociation Response
00	Management	0100	Probe Request
00	Management	0101	Probe Response
00	Management	0110-0111	Reserved
00	Management	1000	Beacon
00	Management	1001	ATIM
00	Management	1010	Disassociation
00	Management	1011	Authentication
00	Management	1100	Deauthentication
00	Management	1110-1111	Reserved



802.11 Frame: Control

- Control Frame

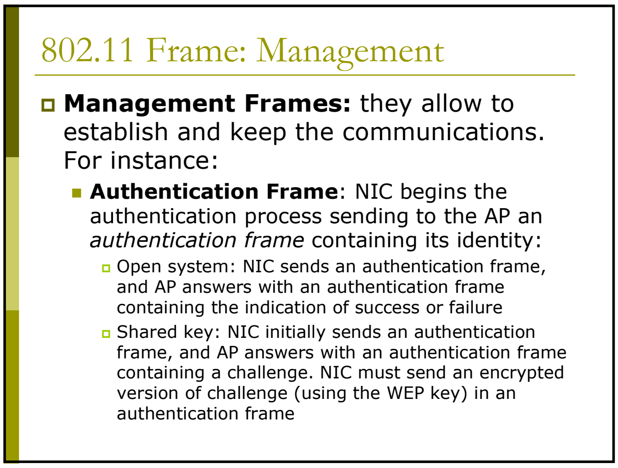
Type Value	Type Description	Subtype Value	Subtype Description
01	Control	0000-1001	Reserved
01	Control	1010	PS-Poll
01	Control	1011	RTS
01	Control	1100	CTS
01	Control	1101	ACK
01	Control	1101	CF End
01	Control	1111	CF End + CF-ACK



802.11 Frame: Data

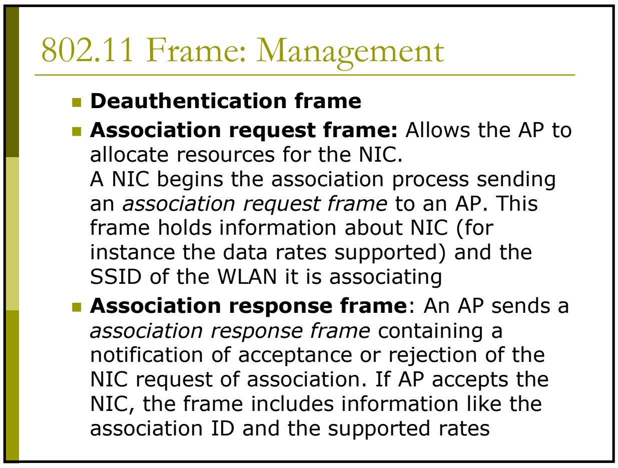
- Data Frame

Type Value	Type Description	Subtype Value	Subtype Description
10	Data	0000	Data
10	Data	0001	Data + CF-Ack
10	Data	0010	Data + CF-Poll
10	Data	0011	Data + CF-ACK + CF-Poll
10	Data	0100	Null Function (no data)
10	Data	0101	CF-Ack (no data)
10	Data	0110	CF-Poll (no data)
10	Data	0111	CF-Ack + CF-Poll (no data)
10	Data	1000-1111	Reserved



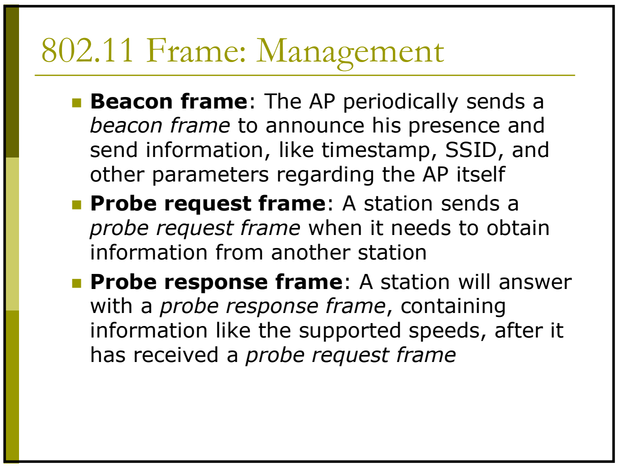
802.11 Frame: Management

- **Management Frames:** they allow to establish and keep the communications. For instance:
  - **Authentication Frame**: NIC begins the authentication process sending to the AP an *authentication frame* containing its identity:
    - Open system: NIC sends an authentication frame, and AP answers with an authentication frame containing the indication of success or failure
    - Shared key: NIC initially sends an authentication frame, and AP answers with an authentication frame containing a challenge. NIC must send an encrypted version of challenge (using the WEP key) in an authentication frame



802.11 Frame: Management

- **Deauthentication frame**
- **Association request frame:** Allows the AP to allocate resources for the NIC.
  A NIC begins the association process sending an *association request frame* to an AP. This frame holds information about NIC (for instance the data rates supported) and the SSID of the WLAN it is associating
- **Association response frame**: An AP sends a *association response frame* containing a notification of acceptance or rejection of the NIC request of association. If AP accepts the NIC, the frame includes information like the association ID and the supported rates



802.11 Frame: Management

- **Beacon frame**: The AP periodically sends a *beacon frame* to announce his presence and send information, like timestamp, SSID, and other parameters regarding the AP itself
- **Probe request frame**: A station sends a *probe request frame* when it needs to obtain information from another station
- **Probe response frame**: A station will answer with a *probe response frame*, containing information like the supported speeds, after it has received a *probe request frame*

802.11 Frame: Control

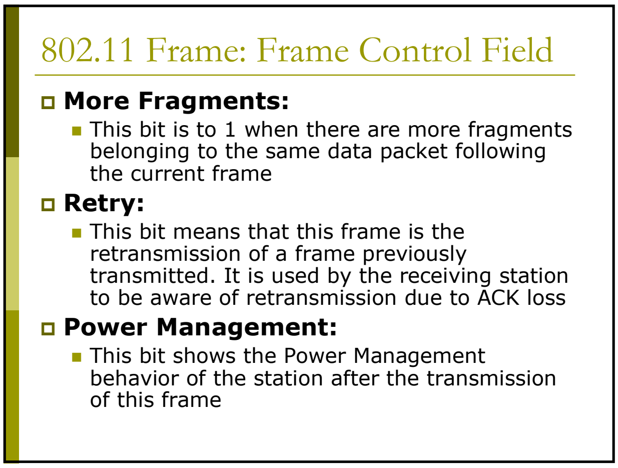
- **Control Frames:** used in the delivery of frames date among the stations. For instance:
  - **Request to Send (RTS) frame**
  - **Clear to Send (CTS) frame**
  - **Acknowledgement (ACK) frame**: after the arrive of a dates frame, the receiving station will use a error checking process and will send an *ACK frame* to the transmitting station if there are not mistakes. If the transmitting station does not receive an ACK after a certain time it will resend the data frame

802.11 Frame: Data

- **Data Frames**: The data frame contains inside the frame body the packets from the highest levels, as web pages, control information for the printers, ...,

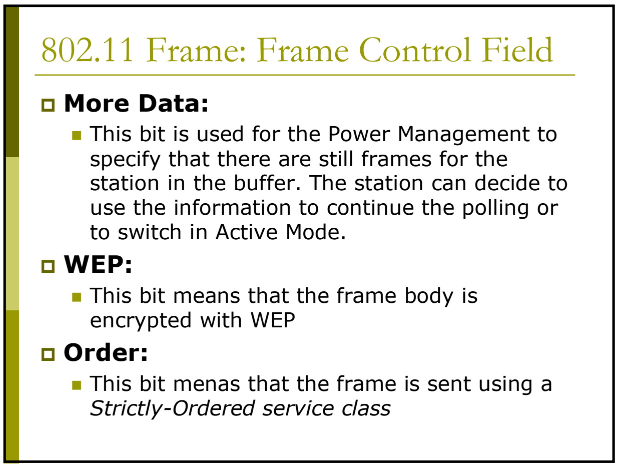
802.11 Frame: Frame Control Field

- **ToDS:**
  - This bit is set to 1 when the frame goes to the AP for the forwarding to the DS (*Distribution System*)
  - The bit is set to 0 in all other cases
- **FromDS:**
  - This bit is set to 1 when the frame is received from the DS
  - The bit is set to 0 in all other cases, i.e., for frames that do not leave the BSS



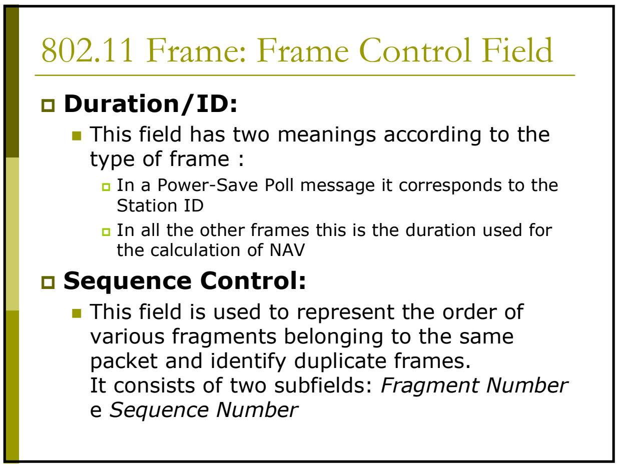
802.11 Frame: Frame Control Field

- **More Fragments:**
  - This bit is to 1 when there are more fragments belonging to the same data packet following the current frame
- **Retry:**
  - This bit means that this frame is the retransmission of a frame previously transmitted. It is used by the receiving station to be aware of retransmission due to ACK loss
- **Power Management:**
  - This bit shows the Power Management behavior of the station after the transmission of this frame



802.11 Frame: Frame Control Field

- **More Data:**
  - This bit is used for the Power Management to specify that there are still frames for the station in the buffer. The station can decide to use the information to continue the polling or to switch in Active Mode.
- **WEP:**
  - This bit means that the frame body is encrypted with WEP
- **Order:**
  - This bit menas that the frame is sent using a *Strictly-Ordered service class*



802.11 Frame: Frame Control Field

- **Duration/ID:**
  - This field has two meanings according to the type of frame :
    - In a Power-Save Poll message it corresponds to the Station ID
    - In all the other frames this is the duration used for the calculation of NAV
- **Sequence Control:**
  - This field is used to represent the order of various fragments belonging to the same packet and identify duplicate frames.
    It consists of two subfields: *Fragment Number* e *Sequence Number*

Frame 802.11: Frame Control Field

- **Address Fields:**
  - A frame can contain up to 4 addresses based on the value of ToDS and FromDS bits:
    - **Address-1** it is always the receiver address.
      If ToDS is set to 1 then it is the address of AP, otherwise it is the address of the final station
    - **Address-2** it is always the transmitter address.
      If FromDS is set to 1 then it is the address of AP, otherwise it is the address of the final station
    - **Address-3** If FromDS is set to 1, Address-3 is the original source address, if ToDS is set to 1 then Address 3 is the destination address, otherwise it is the address of the AP in IBSS
    - **Address-4** is used when a Wireless Distribution System is used and the frame is transmitted by an AP to another

802.11 Frame: MAC Header

- **Address Fields:**

To DS	From DS	Address 1	Address 2	Address 3	Address 4
0	0	DA	SA	BSSID	N/A
0	1	DA	BSSID	SA	N/A
1	0	BSSID	SA	DA	N/A
1	1	RA	TA	DA	SA

- **SA = Source MAC Address**
- **DA = Destination MAC Address**
- **TA = Transmitter MAC Address**
- **RA = Receiver MAC Address**
- **BSSID = AP MAC Address or Random MAC in Ad-Hoc**

802.11 Frame: Frame Format

- **CRC**: it is a field of 32-bits for the error checking, Cyclic Redundancy Check (CRC)

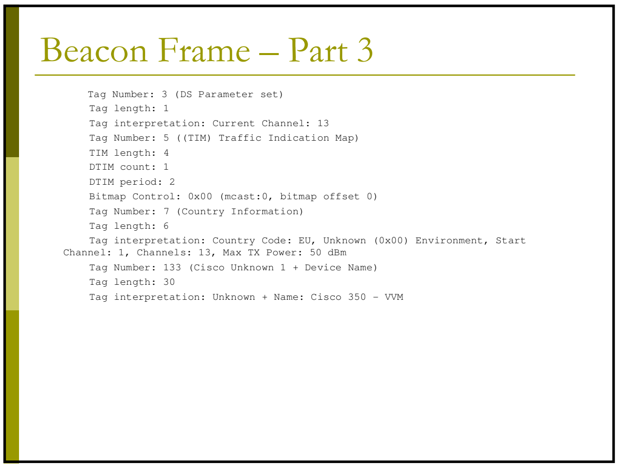
Beacon and Probe Frame

Beacon Frame – Part 1

```
Frame 1 (98 bytes on wire, 98 bytes captured)
    Arrival Time: Apr  7, 2005 23:30:17.202927000
    Time delta from previous packet: 0.000000000 seconds
    Time since reference or first frame: 0.000000000 seconds
    Frame Number: 1
    Packet Length: 98 bytes
    Capture Length: 98 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Beacon frame (8)
    Frame Control: 0x0080 (Normal)
        Version: 0
        Type: Management frame (0)
        Subtype: 8
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 0
    Destination address: ff:ff:ff:ff:ff:ff (Broadcast)
    Source address: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    BSS Id: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Fragment number: 0
    Sequence number: 1394
```

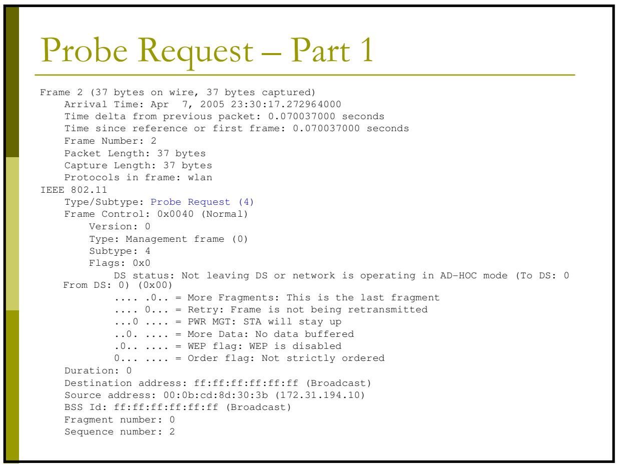
Beacon Frame – Parte 2

```
IEEE 802.11 wireless LAN management frame
    Fixed parameters (12 bytes)
        Timestamp: 0x000000007AC11AC
        Beacon Interval: 0.102400 [Seconds]
        Capability Information: 0x0021
            .... .... .... ...1 = ESS capabilities: Transmitter is an AP
            .... .... .... ..0. = IBSS status: Transmitter belongs to a BSS
            .... .... .... 00.. = CFP participation capabilities: No point coordinator
    at AP (0x0000)
            .... .... ...0 .... = Privacy: AP/STA cannot support WEP
            .... .... ..1. .... = Short Preamble: Short preamble allowed
            .... .... .0.. .... = PBCC: PBCC modulation not allowed
            .... .... 0... .... = Channel Agility: Channel agility not in use
            .... .0.. .... .... = Short Slot Time: Short slot time not in use
            ..0. .... .... .... = DSSS-OFDM: DSSS-OFDM modulation not allowed
    Tagged parameters (62 bytes)
        Tag Number: 0 (SSID parameter set)
        Tag length: 5
        Tag interpretation: WILMA
        Tag Number: 1 (Supported Rates)
        Tag length: 4
        Tag interpretation: Supported rates: 1.0(B) 2.0(B) 5.5(B) 11.0(B) [Mbit/sec]
```



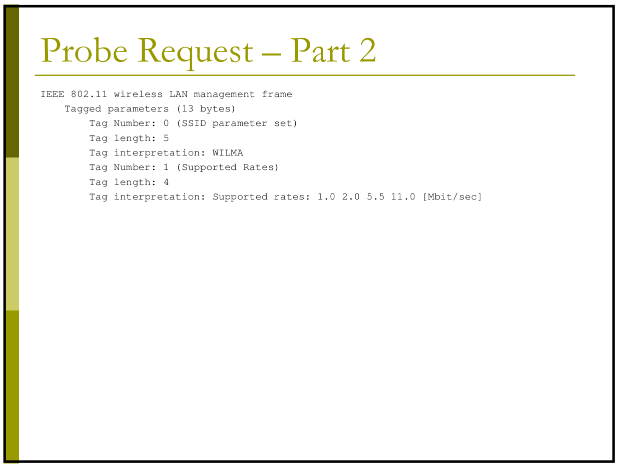
Beacon Frame – Part 3

```
        Tag Number: 3 (DS Parameter set)
        Tag length: 1
        Tag interpretation: Current Channel: 13
        Tag Number: 5 ((TIM) Traffic Indication Map)
        TIM length: 4
        DTIM count: 1
        DTIM period: 2
        Bitmap Control: 0x00 (mcast:0, bitmap offset 0)
        Tag Number: 7 (Country Information)
        Tag length: 6
        Tag interpretation: Country Code: EU, Unknown (0x00) Environment, Start
    Channel: 1, Channels: 13, Max TX Power: 50 dBm
        Tag Number: 133 (Cisco Unknown 1 + Device Name)
        Tag length: 30
        Tag interpretation: Unknown + Name: Cisco 350 - VVM
```



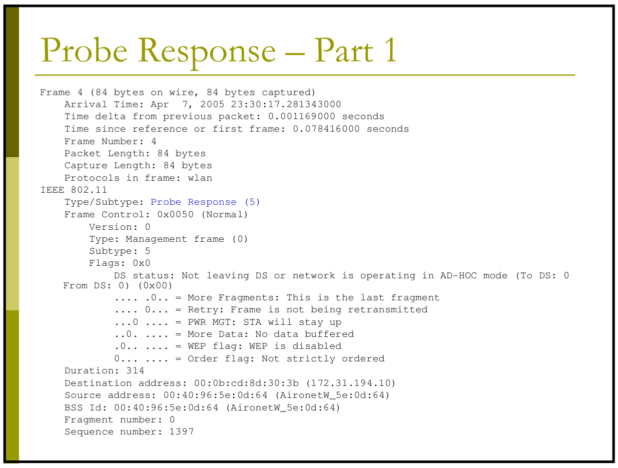
Probe Request – Part 1

```
Frame 2 (37 bytes on wire, 37 bytes captured)
    Arrival Time: Apr  7, 2005 23:30:17.272964000
    Time delta from previous packet: 0.070037000 seconds
    Time since reference or first frame: 0.070037000 seconds
    Frame Number: 2
    Packet Length: 37 bytes
    Capture Length: 37 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Probe Request (4)
    Frame Control: 0x0040 (Normal)
        Version: 0
        Type: Management frame (0)
        Subtype: 4
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 0
    Destination address: ff:ff:ff:ff:ff:ff (Broadcast)
    Source address: 00:0b:cd:8d:30:3b (172.31.194.10)
    BSS Id: ff:ff:ff:ff:ff:ff (Broadcast)
    Fragment number: 0
    Sequence number: 2
```



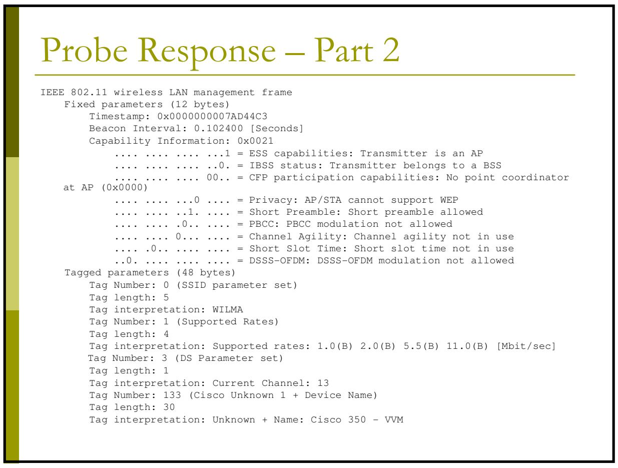
Probe Request – Part 2

```
IEEE 802.11 wireless LAN management frame
    Tagged parameters (13 bytes)
        Tag Number: 0 (SSID parameter set)
        Tag length: 5
        Tag interpretation: WILMA
        Tag Number: 1 (Supported Rates)
        Tag length: 4
        Tag interpretation: Supported rates: 1.0 2.0 5.5 11.0 [Mbit/sec]
```



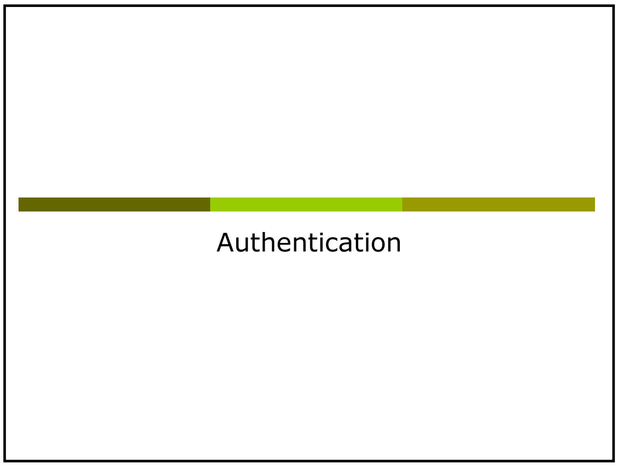
Probe Response – Part 1

```
Frame 4 (84 bytes on wire, 84 bytes captured)
    Arrival Time: Apr  7, 2005 23:30:17.281343000
    Time delta from previous packet: 0.001169000 seconds
    Time since reference or first frame: 0.078416000 seconds
    Frame Number: 4
    Packet Length: 84 bytes
    Capture Length: 84 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Probe Response (5)
    Frame Control: 0x0050 (Normal)
        Version: 0
        Type: Management frame (0)
        Subtype: 5
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 314
    Destination address: 00:0b:cd:8d:30:3b (172.31.194.10)
    Source address: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    BSS Id: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Fragment number: 0
    Sequence number: 1397
```

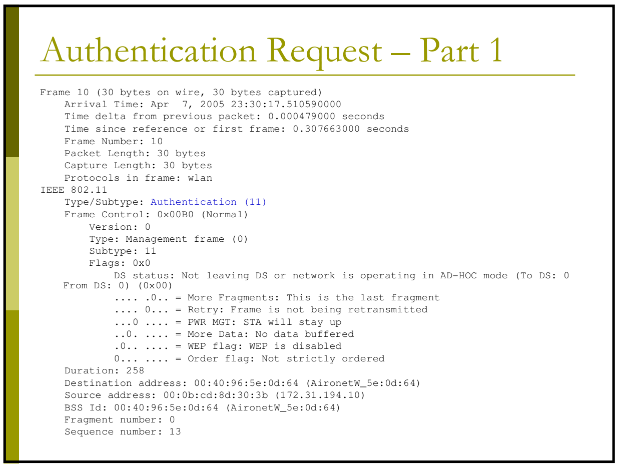


Probe Response – Part 2

```
IEEE 802.11 wireless LAN management frame
    Fixed parameters (12 bytes)
        Timestamp: 0x000000007AD44C3
        Beacon Interval: 0.102400 [Seconds]
        Capability Information: 0x0021
            .... .... .... ...1 = ESS capabilities: Transmitter is an AP
            .... .... .... ..0. = IBSS status: Transmitter belongs to a BSS
            .... .... .... 00.. = CFP participation capabilities: No point coordinator
    at AP (0x0000)
            .... .... ...0 .... = Privacy: AP/STA cannot support WEP
            .... .... ..1. .... = Short Preamble: Short preamble allowed
            .... .... .0.. .... = PBCC: PBCC modulation not allowed
            .... .... 0... .... = Channel Agility: Channel agility not in use
            .... .0.. .... .... = Short Slot Time: Short slot time not in use
            ..0. .... .... .... = DSSS-OFDM: DSSS-OFDM modulation not allowed
    Tagged parameters (48 bytes)
        Tag Number: 0 (SSID parameter set)
        Tag length: 5
        Tag interpretation: WILMA
        Tag Number: 1 (Supported Rates)
        Tag length: 4
        Tag interpretation: Supported rates: 1.0(B) 2.0(B) 5.5(B) 11.0(B) [Mbit/sec]
        Tag Number: 3 (DS Parameter set)
        Tag length: 1
        Tag interpretation: Current Channel: 13
        Tag Number: 133 (Cisco Unknown 1 + Device Name)
        Tag length: 30
        Tag interpretation: Unknown + Name: Cisco 350 - VVM
```

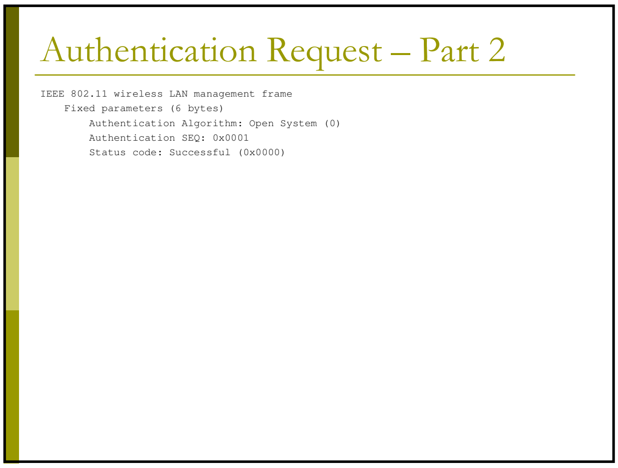


Authentication



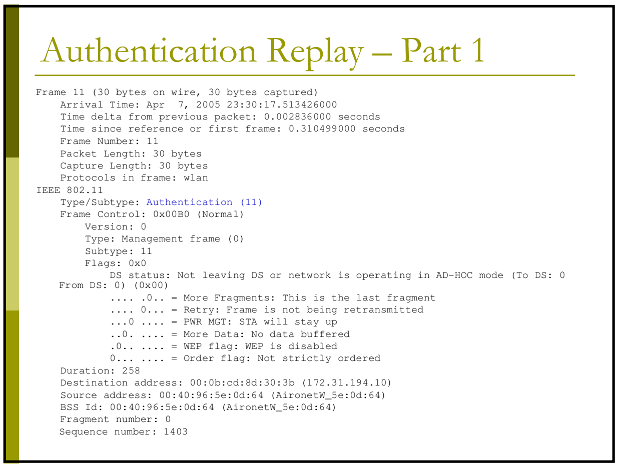
Authentication Request – Part 1

```
Frame 10 (30 bytes on wire, 30 bytes captured)
    Arrival Time: Apr  7, 2005 23:30:17.510590000
    Time delta from previous packet: 0.000479000 seconds
    Time since reference or first frame: 0.307663000 seconds
    Frame Number: 10
    Packet Length: 30 bytes
    Capture Length: 30 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Authentication (11)
    Frame Control: 0x00B0 (Normal)
        Version: 0
        Type: Management frame (0)
        Subtype: 11
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 258
    Destination address: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Source address: 00:0b:cd:8d:30:3b (172.31.194.10)
    BSS Id: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Fragment number: 0
    Sequence number: 13
```



Authentication Request – Part 2

```
IEEE 802.11 wireless LAN management frame
    Fixed parameters (6 bytes)
        Authentication Algorithm: Open System (0)
        Authentication SEQ: 0x0001
        Status code: Successful (0x0000)
```



Authentication Replay – Part 1

```
Frame 11 (30 bytes on wire, 30 bytes captured)
    Arrival Time: Apr  7, 2005 23:30:17.513426000
    Time delta from previous packet: 0.002836000 seconds
    Time since reference or first frame: 0.310499000 seconds
    Frame Number: 11
    Packet Length: 30 bytes
    Capture Length: 30 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Authentication (11)
    Frame Control: 0x00B0 (Normal)
        Version: 0
        Type: Management frame (0)
        Subtype: 11
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 258
    Destination address: 00:0b:cd:8d:30:3b (172.31.194.10)
    Source address: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    BSS Id: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Fragment number: 0
    Sequence number: 1403
```

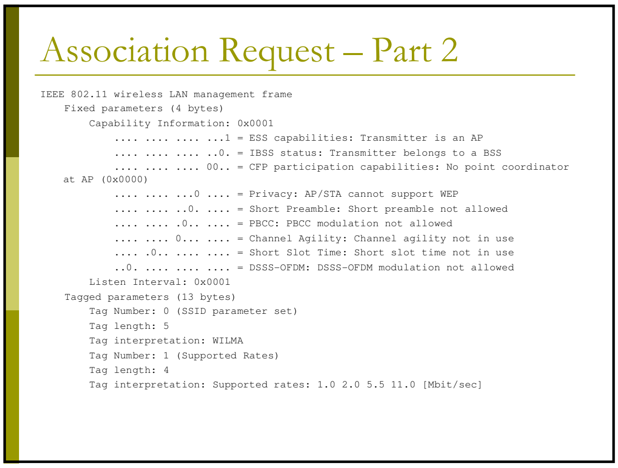
Authentication Replay – Part 2

```
IEEE 802.11 wireless LAN management frame
    Fixed parameters (6 bytes)
        Authentication Algorithm: Open System (0)
        Authentication SEQ: 0x0002
        Status code: Successful (0x0000)
```

Association

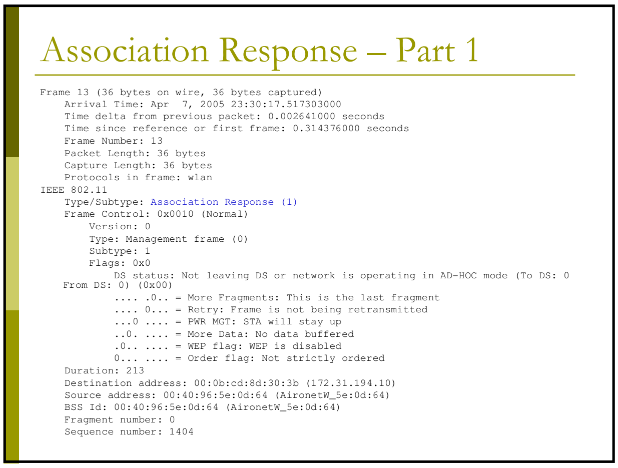
Association Request – Part 1

```
Frame 12 (41 bytes on wire, 41 bytes captured)
    Arrival Time: Apr  7, 2005 23:30:17.514662000
    Time delta from previous packet: 0.001236000 seconds
    Time since reference or first frame: 0.311735000 seconds
    Frame Number: 12
    Packet Length: 41 bytes
    Capture Length: 41 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Association Request (0)
    Frame Control: 0x0000 (Normal)
        Version: 0
        Type: Management frame (0)
        Subtype: 0
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0 
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 258
    Destination address: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Source address: 00:0b:cd:8d:30:3b (172.31.194.10)
    BSS Id: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Fragment number: 0
    Sequence number: 14
```



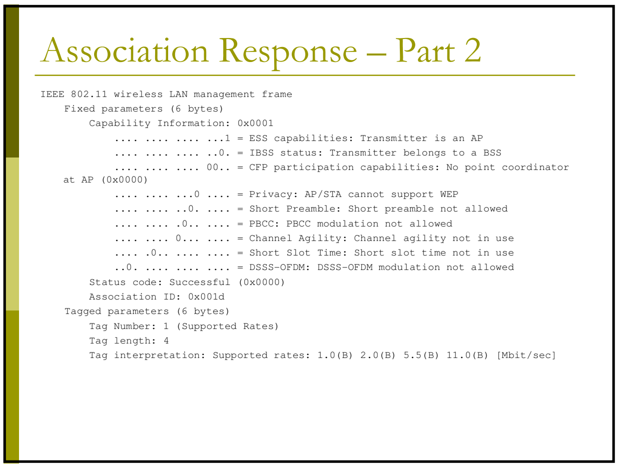
Association Request – Part 2

```
IEEE 802.11 wireless LAN management frame
    Fixed parameters (4 bytes)
        Capability Information: 0x0001
            .... .... .... ...1 = ESS capabilities: Transmitter is an AP
            .... .... .... ..0. = IBSS status: Transmitter belongs to a BSS
            .... .... .... 00.. = CFP participation capabilities: No point coordinator
    at AP (0x0000)
            .... .... ...0 .... = Privacy: AP/STA cannot support WEP
            .... .... ..0. .... = Short Preamble: Short preamble not allowed
            .... .... .0.. .... = PBCC: PBCC modulation not allowed
            .... .... 0... .... = Channel Agility: Channel agility not in use
            .... .0.. .... .... = Short Slot Time: Short slot time not in use
            ..0. .... .... .... = DSSS-OFDM: DSSS-OFDM modulation not allowed
        Listen Interval: 0x0001
    Tagged parameters (13 bytes)
        Tag Number: 0 (SSID parameter set)
        Tag length: 5
        Tag interpretation: WILMA
        Tag Number: 1 (Supported Rates)
        Tag length: 4
        Tag interpretation: Supported rates: 1.0 2.0 5.5 11.0 [Mbit/sec]
```



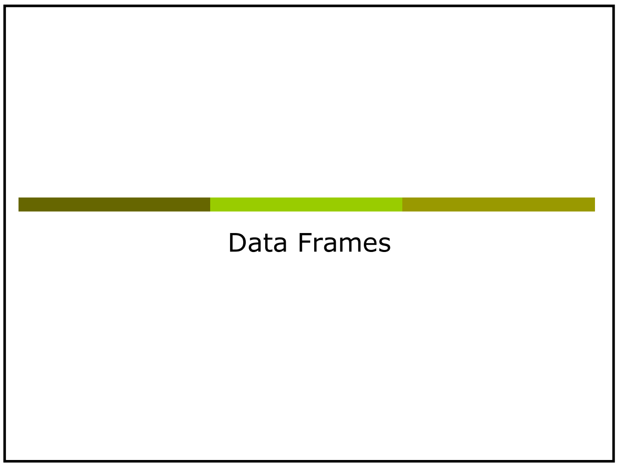
Association Response – Part 1

```
Frame 13 (36 bytes on wire, 36 bytes captured)
    Arrival Time: Apr  7, 2005 23:30:17.517303000
    Time delta from previous packet: 0.002641000 seconds
    Time since reference or first frame: 0.314376000 seconds
    Frame Number: 13
    Packet Length: 36 bytes
    Capture Length: 36 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Association Response (1)
    Frame Control: 0x0010 (Normal)
        Version: 0
        Type: Management frame (0)
        Subtype: 1
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 213
    Destination address: 00:0b:cd:8d:30:3b (172.31.194.10)
    Source address: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    BSS Id: 00:40:96:5e:0d:64 (AironetW_5e:0d:64)
    Fragment number: 0
    Sequence number: 1404
```

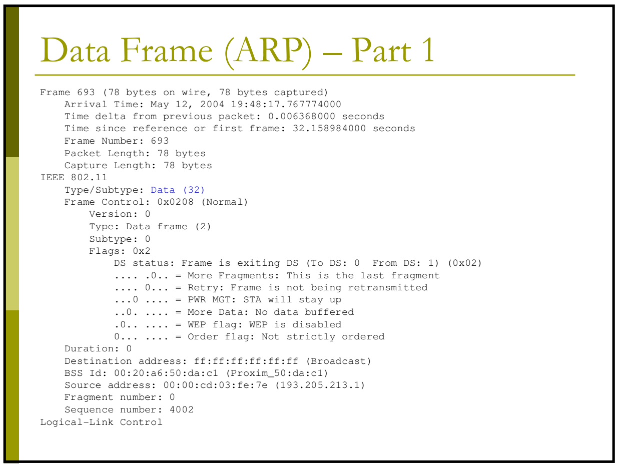


Association Response – Part 2

```
IEEE 802.11 wireless LAN management frame
    Fixed parameters (6 bytes)
        Capability Information: 0x0001
            .... .... .... ...1 = ESS capabilities: Transmitter is an AP
            .... .... .... ..0. = IBSS status: Transmitter belongs to a BSS
            .... .... .... 00.. = CFP participation capabilities: No point coordinator
    at AP (0x0000)
            .... .... ...0 .... = Privacy: AP/STA cannot support WEP
            .... .... ..0. .... = Short Preamble: Short preamble not allowed
            .... .... .0.. .... = PBCC: PBCC modulation not allowed
            .... .... 0... .... = Channel Agility: Channel agility not in use
            .... .0.. .... .... = Short Slot Time: Short slot time not in use
            ..0. .... .... .... = DSSS-OFDM: DSSS-OFDM modulation not allowed
        Status code: Successful (0x0000)
        Association ID: 0x001d
    Tagged parameters (6 bytes)
        Tag Number: 1 (Supported Rates)
        Tag length: 4
        Tag interpretation: Supported rates: 1.0(B) 2.0(B) 5.5(B) 11.0(B) [Mbit/sec]
```

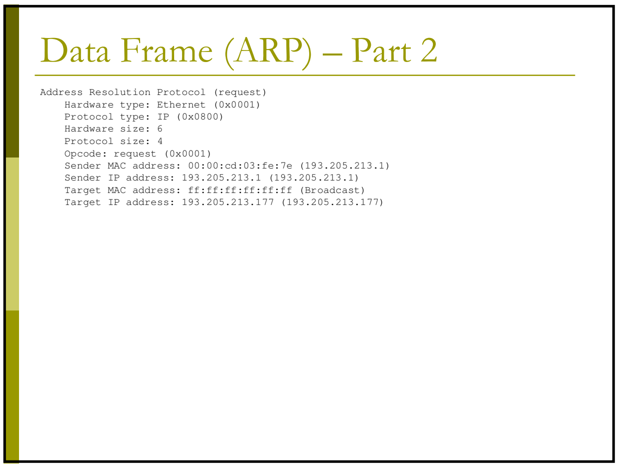


Data Frames



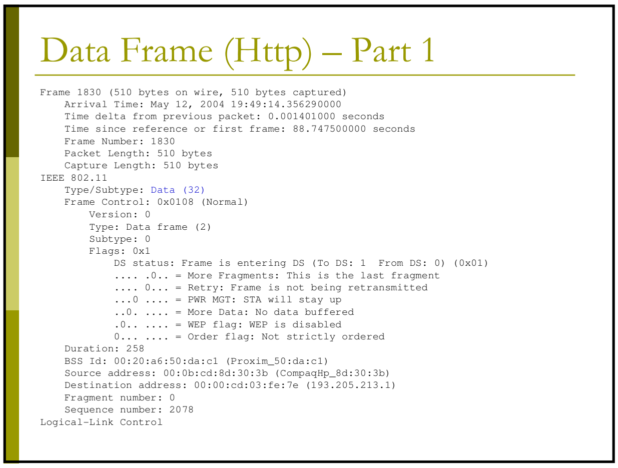
Data Frame (ARP) – Part 1

```
Frame 693 (78 bytes on wire, 78 bytes captured)
    Arrival Time: May 12, 2004 19:48:17.767774000
    Time delta from previous packet: 0.006368000 seconds
    Time since reference or first frame: 32.158984000 seconds
    Frame Number: 693
    Packet Length: 78 bytes
    Capture Length: 78 bytes
IEEE 802.11
    Type/Subtype: Data (32)
    Frame Control: 0x0208 (Normal)
        Version: 0
        Type: Data frame (2)
        Subtype: 0
        Flags: 0x2
            DS status: Frame is exiting DS (To DS: 0  From DS: 1) (0x02)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 0
    Destination address: ff:ff:ff:ff:ff:ff (Broadcast)
    BSS Id: 00:20:a6:50:da:c1 (Proxim_50:da:c1)
    Source address: 00:00:cd:03:fe:7e (193.205.213.1)
    Fragment number: 0
    Sequence number: 4002
Logical-Link Control
```



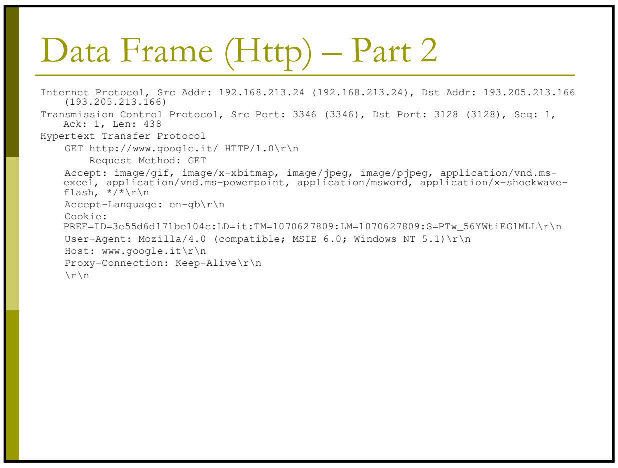
Data Frame (ARP) – Part 2

```
Address Resolution Protocol (request)
    Hardware type: Ethernet (0x0001)
    Protocol type: IP (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (0x0001)
    Sender MAC address: 00:00:cd:03:fe:7e (193.205.213.1)
    Sender IP address: 193.205.213.1 (193.205.213.1)
    Target MAC address: ff:ff:ff:ff:ff:ff (Broadcast)
    Target IP address: 193.205.213.177 (193.205.213.177)
```



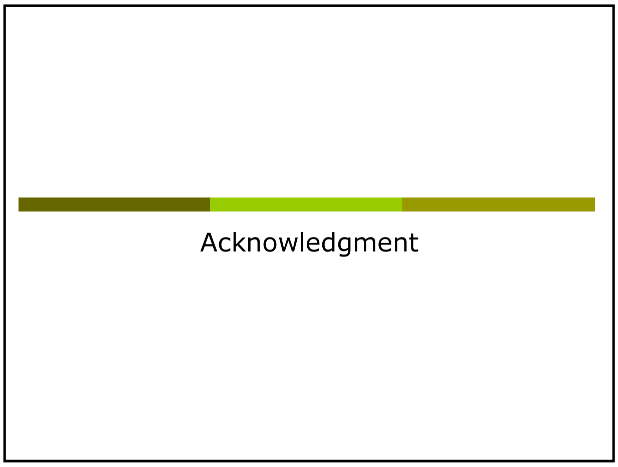
Data Frame (Http) – Part 1

```
Frame 1830 (510 bytes on wire, 510 bytes captured)
    Arrival Time: May 12, 2004 19:49:14.356290000
    Time delta from previous packet: 0.001401000 seconds
    Time since reference or first frame: 88.747500000 seconds
    Frame Number: 1830
    Packet Length: 510 bytes
    Capture Length: 510 bytes
IEEE 802.11
    Type/Subtype: Data (32)
    Frame Control: 0x0108 (Normal)
        Version: 0
        Type: Data frame (2)
        Subtype: 0
        Flags: 0x1
            DS status: Frame is entering DS (To DS: 1  From DS: 0) (0x01)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 258
    BSS Id: 00:20:a6:50:da:c1 (Proxim_50:da:c1)
    Source address: 00:0b:cd:8d:30:3b (CompaqHp_8d:30:3b)
    Destination address: 00:00:cd:03:fe:7e (193.205.213.1)
    Fragment number: 0
    Sequence number: 2078
Logical-Link Control
```



Data Frame (Http) – Part 2

```
Internet Protocol, Src Addr: 192.168.213.24 (192.168.213.24), Dst Addr: 193.205.213.166
    (193.205.213.166)
Transmission Control Protocol, Src Port: 3346 (3346), Dst Port: 3128 (3128), Seq: 1,
    Ack: 1, Len: 438
Hypertext Transfer Protocol
    GET http://www.google.it/ HTTP/1.0\r\n
        Request Method: GET
    Accept: image/gif, image/x-xbitmap, image/jpeg, image/pjpeg, application/vnd.ms-
    excel, application/vnd.ms-powerpoint, application/msword, application/x-shockwave-
    flash, */*\r\n
    Accept-Language: en-gb\r\n
    Cookie:
    PREF=ID=3e55d6d171be104c:LD=it:TM=1070627809:LM=1070627809:S=PTw_56YWtiEG1MLL\r\n
    User-Agent: Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1)\r\n
    Host: www.google.it\r\n
    Proxy-Connection: Keep-Alive\r\n
    \r\n
```

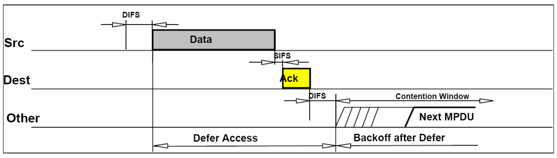


Acknowledgment

Control Frame: ACK

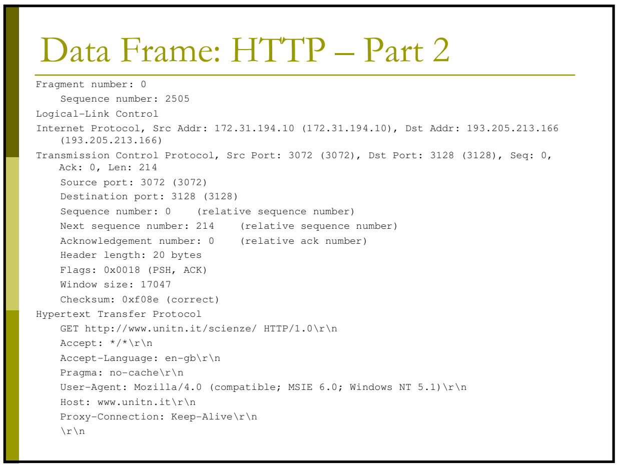
- All the unicast traffic frames must receive an ACK frame
- A *date frame* will use NAV to reserve the channel for the *data frame*, his ACK and SIFS (Short Inter Frame Space)
- With this NAV, the sender ensures to the receiver of the data frame the possibility of sending ACK

Control Frame: ACK



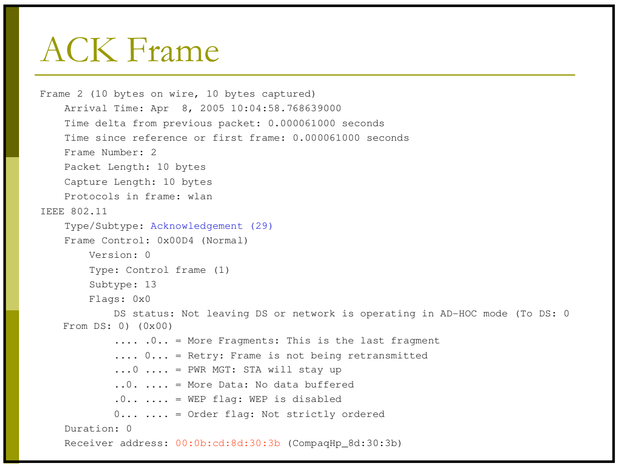
Data Frame: HTTP – Part 1

```
Frame 1 (286 bytes on wire, 286 bytes captured)
    Arrival Time: Apr  8, 2005 10:04:58.768578000
    Time delta from previous packet: 0.000000000 seconds
    Time since reference or first frame: 0.000000000 seconds
    Frame Number: 1
    Packet Length: 286 bytes
    Capture Length: 286 bytes
    Protocols in frame: wlan:llc:ip:tcp:http
IEEE 802.11
    Type/Subtype: Data (32)
    Frame Control: 0x0108 (Normal)
        Version: 0
        Type: Data frame (2)
        Subtype: 0
        Flags: 0x1
            DS status: Frame is entering DS (To DS: 1  From DS: 0) (0x01)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 213
    BSS Id: 00:20:a6:50:da:ca (Proxim_50:da:ca)
    Source address: 00:0b:cd:8d:30:3b (CompaqHp_8d:30:3b)
    Destination address: 00:0b:db:73:2b:16 (DellEsgP_73:2b:16)
```



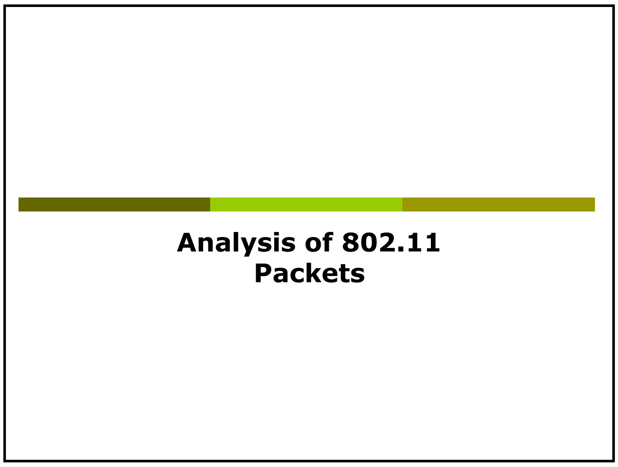
Data Frame: HTTP – Part 2

```
Fragment number: 0
    Sequence number: 2505
Logical-Link Control
Internet Protocol, Src Addr: 172.31.194.10 (172.31.194.10), Dst Addr: 193.205.213.166
    (193.205.213.166)
Transmission Control Protocol, Src Port: 3072 (3072), Dst Port: 3128 (3128), Seq: 0,
    Ack: 0, Len: 214
    Source port: 3072 (3072)
    Destination port: 3128 (3128)
    Sequence number: 0    (relative sequence number)
    Next sequence number: 214    (relative sequence number)
    Acknowledgement number: 0    (relative ack number)
    Header length: 20 bytes
    Flags: 0x0018 (PSH, ACK)
    Window size: 17047
    Checksum: 0xf08e (correct)
Hypertext Transfer Protocol
    GET http://www.unitn.it/scienze/ HTTP/1.0\r\n
    Accept: */*\r\n
    Accept-Language: en-gb\r\n
    Pragma: no-cache\r\n
    User-Agent: Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1)\r\n
    Host: www.unitn.it\r\n
    Proxy-Connection: Keep-Alive\r\n
    \r\n
```



ACK Frame

```
Frame 2 (10 bytes on wire, 10 bytes captured)
    Arrival Time: Apr  8, 2005 10:04:58.768639000
    Time delta from previous packet: 0.000061000 seconds
    Time since reference or first frame: 0.000061000 seconds
    Frame Number: 2
    Packet Length: 10 bytes
    Capture Length: 10 bytes
    Protocols in frame: wlan
IEEE 802.11
    Type/Subtype: Acknowledgement (29)
    Frame Control: 0x00D4 (Normal)
        Version: 0
        Type: Control frame (1)
        Subtype: 13
        Flags: 0x0
            DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0
    From DS: 0) (0x00)
            .... .0.. = More Fragments: This is the last fragment
            .... 0... = Retry: Frame is not being retransmitted
            ...0 .... = PWR MGT: STA will stay up
            ..0. .... = More Data: No data buffered
            .0.. .... = WEP flag: WEP is disabled
            0... .... = Order flag: Not strictly ordered
    Duration: 0
    Receiver address: 00:0b:cd:8d:30:3b (CompaqHp_8d:30:3b)
```



Analysis of 802.11 Packets

BackTrack

- We will use a Linux Live distribution: BackTrack
  - http://www.remote-exploit.org/backtrack.html
- It has all the tools we need for wireless sniffing and monitoring, and we don't need to install any program on the laptop or ask for root passwd

BackTrack: Startup

- Currently we can use two different versions: *V3.0 Final* or *V:4.0 Beta*
- For *Version 3.0 Final*
  - Boot from CD (`BT3 Graphics mode`)
- For *Version 4.0 Beta*
  - Boot from DVD (`Text mode`)
  - Login as root:
    - Login: `root`
    - Password: `toor`
  - Start the graphics mode:
    - `startx`

BackTrack: iwconfig

- To get the Wireless Network Card parameters:
  - `iwconfig`
- The result is something like:

```
eth0      IEEE 802.11b  ESSID:“science-wifi"
          Mode:Managed  Frequency:2.462 GHz  Access Point: 00:40:96:5E:0D:64
          Bit Rate:11 Mb/s   Tx-Power=20 dBm   Sensitivity=8/0
          Retry limit:7   RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:off
          Link Quality=46/100  Signal level=-73 dBm  Noise level=-88 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:34   Missed beacon:0
```

BackTrack: iwconfig

- To put the wireless Network Card in monitor mode (listening the channel 7):
  - `iwconfig eth0 mode monitor channel 7`
- If we give the iwconfig command again, the result is something like:

```
eth0      unassociated  ESSID:off/any
  Mode:Monitor  Frequency=2.442 GHz  Access Point: Not-Associated
  Bit Rate:0 kb/s   Tx-Power=20 dBm   Sensitivity=8/0
  Retry limit:7   RTS thr:off   Fragment thr:off
  Encryption key:off
  Power Management:off
  Link Quality:0  Signal level:0  Noise level:0
  Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
  Tx excessive retries:0  Invalid misc:51   Missed beacon:0
```

Tools for the analysis of the performances of a network

IPERF

- Several tools exist for the performances measurement of a network each one with different purposes:
  - Iperf:
    - http://dast.nlanr.net/Projects/Iperf/
  - d-itg:
    - http://www.grid.unina.it/software/ITG/
  - Netperf:
    - http://www.netperf.org/netperf/NetperfPage.html

IPERF: Setup

- Iperf has a many options:
- Issue the command `iperf -- help` for the full list
- The most interesting one:
  - `-u`: use UDP instead of TCP (SUGGESTED)
  - `-s`: run iperf in server mode
  - `-c`: run iperf in client mode
  - `-b`: the offered load in bit/sec
  - `-d`: run a bidirectional test simultaneously
  - `-r`: run a bidirectional test individually

IPERF: Setup

- To run IPERF as server (IP Address `192.168.10.30`):
  - `iperf -u -s`
- To run IPERF as a client:
  - `iperf -c 192.168.10.30 -u -b20M -i 5 -t 40`
  - Where:
    - -i 5 means a report any 5 seconds
    - -t 40 means a simulation 40 seconds long
    - -u means UDP transfer mode
    - -b 20M means 20Mbit/sec offered load (bandwidth for iperf)

Analysis of the performances of a Wireless network

IPERF: the test

- We want to measure how the performances vary changing some parameters of the configuration of the AP
- After every modification of a parameter run N times IPERF (N>20, runtime>20sec each):
  - Analyze the data set and remove any point clearly wrong (but you have to describe the procedure you adopted)
  - Compute average, standard deviation, …
  - It is of interest also the best result!

IPERF: the test

- For our APs, you can try to:
  - Change the threshold for RTS/CTS
  - Change the threshold for fragmentation
  - Change the speed used
  - Change UDP Packet Size
  - …

IPERF: Examples

- For example for a CISCO AP:

Speed 11 Mb/sec	**Speed 1 Mb/sec**
10.0 sec, 2.75 MBytes→ 2.30 Mbits/sec	10.4 sec, 872 KBytes→ 684 Kbits/sec
10.0 sec, 3.20 MBytes→ 2.67 Mbits/sec	

- Therefore approximately:
  - Speed ratio: 11/1 = 11
  - Performance ratio: 2.49 / 0.684 = 3.64

IPERF: Suggestion

- There is no point to use a –b parameters too high
- For instance, if the speed configured on the AP is 11, then you can use –b11M during the iperf tests, and so on

IPERF: Suggestion

- For Fragmentation: choose the threshold so that you have:
  - No – fragmentation
  - 2 fragments
  - 3 fragments
  - …
- For CTS/RTS threshold, you have just to enable/disable it

IPERF: The Report

- All the groups have to test all the speeds available (both b & g), one client, uplink, downlink
- Add to you report one or more of the following
  - Measure the maximum throughput with 2, 3 … clients
  - RTS/CTS
  - Fragmentation
  - UDP Packet Size
  - TCP instead of UDP
  - …

IPERF: AP Cisco

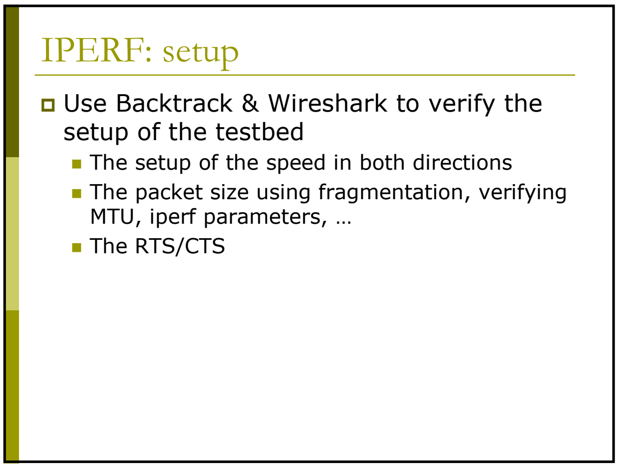
- Cisco 1310:
  - IP: 192.168.10.5
  - SSID: NCG
  - Login: empty
  - Passwd: `Cisco`
  - Channel: 7
- Cisco 1230B:
  - IP: 192.168.10.10
  - SSID: NCB
  - Login: empty
  - Passwd: `Cisco`
  - Channel: 13

IPERF: LinkSys

- LinkSys WAP54G:
  - IP: 192.168.10.15
  - SSID: NCL
  - Login: empty
  - Password: `admin`
  - Channel: 1

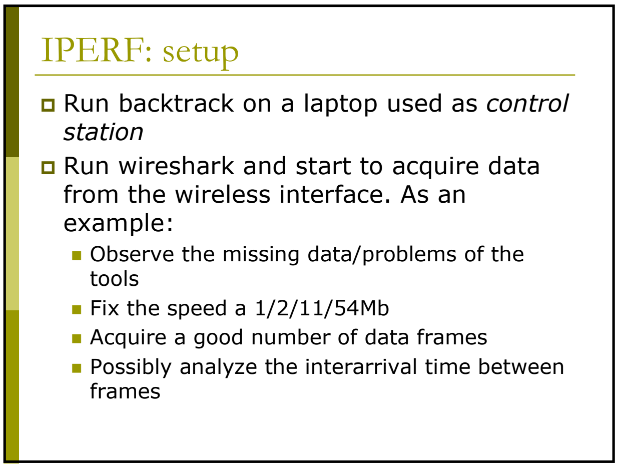
IPERF: setup

- Server: 192.168.10.30
- Login: `root`
- Passwd: `students`
- Connect all the device (the 3 AP and the laptop-server) to the switch
- Startup of services:
  - `/etc/init.d/networking restart`
  - `/etc/init.d/dhcp3-server restart`
  - `iperf -u -s`



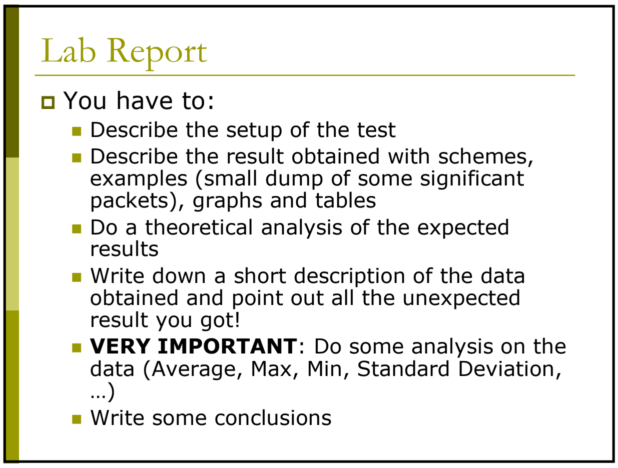
IPERF: setup

- Use Backtrack & Wireshark to verify the setup of the testbed
  - The setup of the speed in both directions
  - The packet size using fragmentation, verifying MTU, iperf parameters, …
  - The RTS/CTS



IPERF: setup

- Run backtrack on a laptop used as *control station*
- Run wireshark and start to acquire data from the wireless interface. As an example:
  - Observe the missing data/problems of the tools
  - Fix the speed a 1/2/11/54Mb
  - Acquire a good number of data frames
  - Possibly analyze the interarrival time between frames



Lab Report

- You have to:
  - Describe the setup of the test
  - Describe the result obtained with schemes, examples (small dump of some significant packets), graphs and tables
  - Do a theoretical analysis of the expected results
  - Write down a short description of the data obtained and point out all the unexpected result you got!
  - **VERY IMPORTANT**: Do some analysis on the data (Average, Max, Min, Standard Deviation, …)
  - Write some conclusions

Lab Report

- We will put on the website some good reports of the previous years
- We will put online a latex template