Nomadic Communications Labs

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Security
And
Wireless Network

Wireless Security: Overview

- Open network
- Open network+ MAC-authentication
- Open network+ web based gateway
- WEP (wireless)
- IEEE 802.1x
- IEEE 802.11i & WPA

Wireless Security: Open Network

- **Open network**
  - This is not a real solution
  - The IP address could be assigned using a DHCP Server
  - Very simple to implement: does not require any special software (a DHCP client is available everywhere)
  - The access control is nearly impossible
  - The network is truly open (each clients and servers of the LAN is reachable)

Wireless Security: Open Network

- **Open network + MAC authentication**
  - Similar to the previous case, but the MAC-address of the wireless card of the user is verified
  - From the administrative point of view it’s quite complex the handling of the MAC addresses
  - It’s realy easy to spoof the MAC addresses
  - It’s not possible to have a guest user or different users categories

Wireless Security: Captive Portal

- **Open network + web based gateway**
  - A Level 3 gateway (router IP) between the WLAN and the wired network capture all the traffic, redirecting the user to a WEB page where he can insert his login and password
  - If the user is authenticated, his traffic (the whole or just some particular kind of it) will be authorized
  - It’s easy to handle a guest user
  - It’s required a browser, and the user has to open it to access every services (as printing, or access a network disk)

Wireless Security: Captive Portal

- **Open network + web based gateway**
  - There are a lot of implementation based on free software, like NoCat (http://nocat.net/), also embedded on AP: (WRT54G + openwrt, http://openwrt.org/)
  - But there are also many proprietary implementations (Cisco, Avaya, …)

Wireless Security: WEP

- **WEP**
  - Level 2 encryption between Clients and Access Point
  - The client has to know a string to access the Wireless Network
  - WEP is very easy to violate
  - The handling of the WEP keys is very complex

Wireless Security: 802.1x

- **IEEE 802.1x**
  - A level 2 solution to control the access at the wireless network
  - Different mechanisms for authentication have been developed (EAP-MD5, EAP-TLS, EAP-TTLS, PEAP)
  - It's a standard
  - Encrypt all the data, using dynamic keys
  - It's required a software (*supplicant*) installed on each client

Wireless Security: 802.1x

- 802.1x was standardized in June 2001
- The standard is available at the address: http://standards.ieee.org/getieee802/download/802.1X-2004.pdf

Wireless Security: 802.1x

- 802.1x defines 3 components to complete a sequence of authentication:
  - **Supplicant**: who wants to access the services (such as a mobile station) by providing the correct credentials to the authenticator
  - **Authenticator**: who takes care of applying the security policies (such as an Access Point), before leaving a supplicant access the services
  - **Authentication Server**: who verify (such ad a RADIUS server) if the supplicant is authorized to access the service through the authenticator

Wireless Security: 802.1x

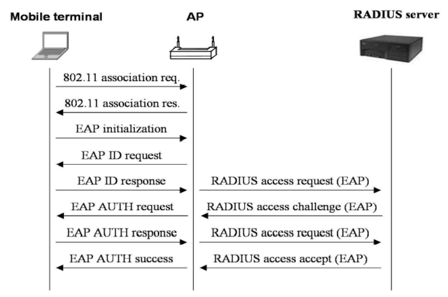
- 802.1x defines two points of connection for a client of a wireless network:
  - A "controlled" port and an "uncontrolled" port
- Before authentication, the supplicant communicates with the authentication server through the "uncontrolled" port

Wireless Security: 802.1x

- The client remains connected to the "uncontrolled" port until the authentication is completed
- After a successful authentication, the authentication server communicates to the authenticator to move the client on the "controlled" port
- A "controlled" port only accepts packets from authorized users

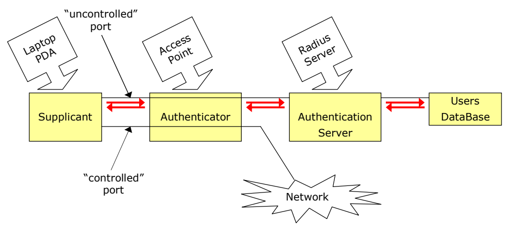
Wireless Security: 802.1x

- The authentication scheme is the following:



Wireless Security: 802.1x

- To better clarify:



Wireless Security: 802.1x

- The authentication scheme in the IEEE standard is described as follow:

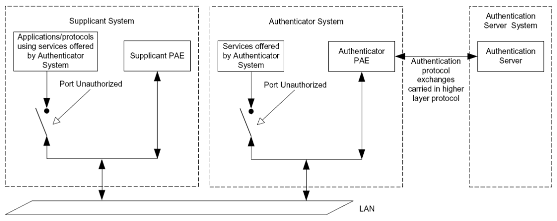

Supplicant System
Applications/protocols using services offered by Authenticator System
Supplicant PAE
Port Unauthorized
Authenticator System
Services offered by Authenticator System
Authenticator PAE
Port Unauthorized
Authentication protocol exchanges carried in higher layer protocol
Authentication Server System
Authentication Server
LAN

Figure 6-5—Authenticator, Supplicant, and Authentication Server roles

Wireless Security: EAP

- The EAP (Extensible Authentication Protocol) protocol has been defined in RFC 2284
- Provides an architecture in which more authentication mechanisms can be adopted
- Authentication mechanism for EAP:
  - EAP-MD5
  - EAP-TLS
  - EAP-TTLS
  - MS-CHAPv2
  - PEAP

Wireless Security: 802.11i & WPA

- IEEE 802.11i was ratified in June 2004, and fixes all WEP weaknesses
- The industry didn't have time to wait until the 802.11i standard was completed. So the Wi-Fi Alliance decided to created an interim solution based on draft 3 of the IEEE802.11i standard:

  WPA = Wi-Fi Protected Access
- One requirement was that existing 802.11 equipment could be used with WPA. WPA is basically TKIP (*Temporary Key Integrity Protocol)* + 802.1x

Wireless Security: 802.11i & WPA

- The authentication mechanism comes in two varieties: enterprise and consumer:
  - Enterprise:
    - It's possible to configure WPA to authenticate users, typically via a RADIUS server
    - During this process, the user obtains the primary master key (PMK), which is then used to set up the encryption algorithm used by TKIP
    - Because the PMK is derived as a result of the authentication process, there's no need for locally stored passwords
    - In addition, the authentication information is passed via an encrypted channel to protect it against eavesdroppers

Wireless Security: 802.11i & WPA

- Consumer:
  - The consumer environment offers little justification for an authentication server
  - WPA had to include some internal method to create the PMK used to initialize the TKIP encryption process
  - This solution is based on a pre-shared password that's previously configured in the access point and all nodes.

WEP Cracking

WEP: Wired Equivalent Privacy

- The aim declared of the **WEP** (Wired Equivalent privacy) key is (*Nomina sunt consequentia rerum*) providing *"a security level on the wireless channel equivalent to what one can expect in the case of wired networks"*
- Some have thought WEP as the sole mechanism for the access control
- Other as the solution of all the security problems

WEP: Wired Equivalent Privacy

- The shared key must be installed on the Access Point and on the client
- On the devices up to 4 keys are configurable but the standard does not specify how manage these keys: in the practice just one is used
- PROBLEM:
  - It is not possible install/update it
  - It is the same for all the users of the same AP

WEP: How it works

- WEP is based on the RC4 algorithm of the RSA
- It is a system of encryption based on a shared key
- The shared key is 40 bits (or 104 bits) long
- It is joined with an ***initialization vector*** (IV) 24 bits long
- In this way a seed of 64 bits (or 128 bits) is obtained for the RC4

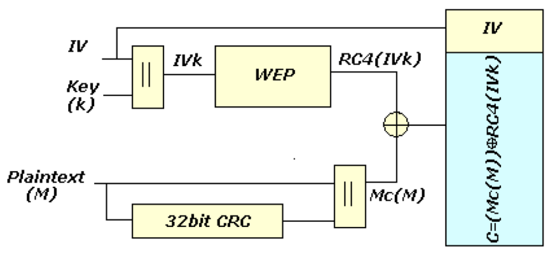
WEP: How it works

- To send a data packet:
  - Given the payload M, the 32 bits CRC c(M) is calculated and concatenated to M → M·c(M)
  - The k key is concatenated to the IV defined for the packet → IV·K
  - The RC4 algorithm is initialized using this packet and a sequence of bytes is produced → RC4(IV·k)
  - Now M·c(M) is xor-ed with RC4(IV·k) → C = (M·c(M))⊕RC4(IV·k)
  - The 3 bytes of the IV are transmitted as clear test (together with the index of the WEP key)

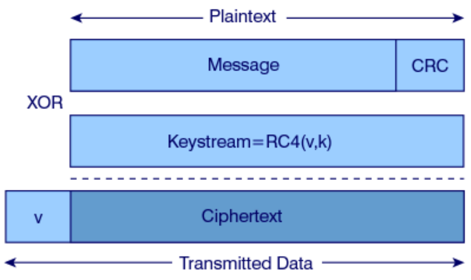
WEP: How it works

- The receiving side concatenates the IV received with the shared WEP key so that it can rebuild RC4(IV·k) → This is the reason for which the IV must be transmitted in clear text
- The receiving side decrypts the payload and if the CRC is equal then the packet is valid otherwise the packet is discarded

WEP: How it works



WEP: How it works



WEP: RC4

- Key Scheduling Algorithm
- RC4 uses a vector of status 256 octets long S[256] and two counters i, j
- Initialization of the status:
  - S [n] = n, i = 0, j = 0
  - In the temporary vector T of 256 octets inserts the IV·K key, repeating it if short
  - S is run exchanging the elements of the vector:

```
 for i = 0 to 255
     j = (j + S[i] + T[i mod 8]) mod 256
     swap (S[i], S[j])
```

WEP: RC4

- Pseudo Random Generation Algorithm. Generation of the keystream:
  - To generate an octet z of the keystream starting from the actual status (S, i, j):

```
  i = (i + 1) mod 256
  j = (j + S[i]) mod 256
  swap (S[i], S[j])
  t = (S[i] + S[j]) mod 256
  z = S[t]
```

  - At the beginning i=0, j=0 and discard T
  - The generation process continues until there is no more data

Weakness and
Vulnerability of WEP

WEP: Reuse of the coding

- If we use the same IV, the same byte sequence (keystream) is generated from RC4
- Encrypting two messages p1 and p2 we have:
  - $C1 = P1 \oplus RC4(IV \cdot k)$
  - $C2 = P2 \oplus RC4(IV \cdot k)$
  - $C1 \oplus C2 = P1 \oplus RC4(IV \cdot k) \oplus P2 \oplus RC4(IV \cdot k)$
    $= P1 \oplus P2$
- So with the xor of two ciphered messages we get the xor of the two messages as clear text

WEP: Reuse of the coding

- If one of the two messages is known, the other is obtained
- If we have many messages codified with the same keystream it is easy to go back to the original messages
- The protocols impose many similarities to the packets!
- So: do not reuse the keystream
- But: 24 bits of IV means 16.777.216 different keystream: TOO FEW!

WEP: Reuse of the coding

- The standard recommends (but it is not mandatory) that the IV should change in a random way after every transmitted packets
- Some cards generate the 24 bits of the IV using a counter set at zero every time they are initialized and then they increase the counter of 1
  - this increases the probability that the key is reused (the low IV values are more frequent and always transmitted at the beginning of a session)

WEP: Brute Force Attacks

- It can use a list of “easy” keys
- Analyzing the whole research space given
  - Requires up to 45 days with 40 bits
  - Not feasible for 104 bits keys
- Two packets are enough in general (to be sure that the CRC does not coincide by chance also with a wrong WEP key)

WEP: Attacks Based on Weak IV

- S. Fluhrer, I. Mantin, A. Shamir have shown that some weaknesses exist in the algorithm of generation of the keys in RC4 → *“Weakness in the Key Scheduling Algorithm of RC4”*
- The attack described in their article, besides being extremely fast, requires a time which increases linearly with the length of the WEP key!

WEP: Attacks Based on Weak IV

- The fact that a large part of the key (3 bytes) is transmitted in clear and make the cracking easier:
  - The first three iterations of the KSA are easily deducible for the fact that the first three digits of the key are well known (remembered: the IV is transmitted in clear)!
- It is possible to see that there is a probability of 5% than the values in S [0]-S [3] do not change after the first 3 iterations of the KSA

WEP: Attacks Based on Weak IV

- It has been demonstrated that the IV of a certain type are subject to be cracked:
  (B+3:255:x)
  where B is the byte of the secret key (the WEP key) that we are cracking
- Then for every byte of the key there are 256 Weak IV

WEP: Attacks Based on Weak IV

- The first values of the encrypted data is the SNAP (*Sub Network Attachment Point*) header. It is a standard (of layer 2) for the transmission of IP datagram on IEEE 802 network
- The not encrypted header is AA in hexadecimal
- The xor of the first encrypted data with AA, will provide the first byte of the PRGA
- This information allows rebuilding the first digit of the WEP key if we have a Weak IV of the type (3:255:x)

AV1

AV1 Pseudo Random Generation Alghoritm
Alessandro Villani, 5/27/2004

WEP: Attacks Based on Weak IV

- We analyze the first step of the algorithm to produce the first byte of the keystream:
  i = (i + 1) mod 256 → i = 1
  j = (j + S[i]) mod 256 → j = S[1]
  swap(S[i], S[j]) → swap(S[1], S[S[1]])
  t = (S[i] + S[j]) mod 256 → t = S[1] + S[S[1]]
  z = S[t] → z = S[S[1] + S[S[1]]]
- So the first byte is function of:
  S[1], S[S[1]] e S[S[1] + S[S[1]]]

WEP: Attacks Based on Weak IV

- The first two steps of the generation of the vector S with IV (3:255:x) are the following:
- i = 0, j = 0

S →	0	1	2	3	4
T →	3	255	x	W_1	

- i = 0, j = (j + S[i] + T[i mod 8]) = (0+S[0]+T[0]) = 0+0+3 = 3 → swap(S[0],S[3])

S →	3	1	2	0	4
T →	3	255	x	W_1	

WEP: Attacks Based on Weak IV

- i = 1, j = 3

S →	3	1	2	0	4
T →	3	255	x	W_1	

- i = 1, j = (j + S[i] + T[i mod 8]) = (3+S[1]+T[1]) = 3+1+255 = 3 → swap(S[1],S[3])

S →	3	0	2	1	4
T →	3	255	x	W_1	

WEP: Attacks Based on Weak IV

- At the next step j = (3 + S[2] + T[2]) = (3 + (2 + x)) that is j move forwards of x + 2 with x known
- Every IV behaves in different way depending on x, but we are able to rebuild the configuration of the vector S
- From here on the evolution of S depends on the key, and with a probability of 5% (as we said previously) the first 3 values of S do not change

WEP: Attacks Based on Weak IV

- Beyond the first byte of the key the operation gets complicated because it requires to go through the PRGA for several steps and so we could not be able to infer with a reasonable probability the exchanges of S
- Also other Weak IV families exist

WEP: Attacks Based on Weak IV

- Some producers of wireless cards have started building cards which avoid IV weak
- The space of IV available is further reduced (some thousands less)
- Observe that, to complete the attack, it is enough that only one client does not avoid the weak IVs

WPA Cracking

WPA

- Given the problem of WEP, IEEE started to work to the new standard: 802.11i
- WPA (released at the beginning of 2003) was intended as an intermediate solution till the final approval of 802.11i (2004)
- WPA supports many of the features of 802.11i (the design of the WPA protocol is based on the Draft 3 of 802.11i standard), but WPA in not an IEEE standard

WPA

- There are two variants of this protocol: enterprise and personal:
  - Enterprise: require an IEEE 802.1X authentication server, which will distributes different keys to different users
  - Personal: WPA utilizes the "pre-shared key" (PSK) mode, where all the computer will use the same passphrase

WPA

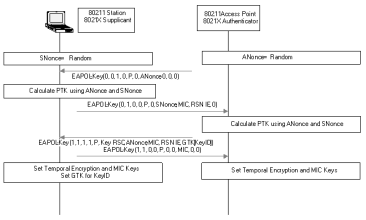
- The passphrase may be from 8 to 63 printable ASCII characters or 64 hexadecimal digits (256 bits)
- In PSK mode, security depends on the strength and privacy of the passphrase: the weak passphrases users typically select are vulnerable to password cracking attacks (off line attack based on dictionary)

WPA

- In WPA, every station is permitted to associate with the AP
- The AP has the option to start 802.1X authentication, exchanging Extensible Authentication Protocol (EAP) messages to verify user/server identities
- After authentication (if any), the AP start a four-way handshake to derive the keys for the session

WPA: 4 way handshaking

- The sheme of the 4 way handshacking is the following:



80211 Station
8021X Supplicant
80211Access Point
8021X Authenticator
SNonce= Random
ANonce= Random
EAPOLKey(0, 0, 1, 0, P, 0, ANonce0, 0, 0)
Calculate PTK using ANonce and SNonce
EAPOLKey (0, 1, 0, 0, P, 0, SNonce, MIC, RSN IE, 0)
Calculate PTK using ANonce and SNonce
EAPOLKey (1, 1, 1, 1, P, Key RSC, ANonce, MIC, RSN IE, GTK[KeyID])
EAPOLKey (1, 1, 0, 0, P, 0, 0, MIC, 0, 0)
Set Temporal Encryption and MIC Keys
Set GTK for KeyID
Set Temporal Encryption and MIC Keys

WPA: 4 way handshaking

- The AP sends a nonce-value to the STA (ANonce)
- The client now has all the attributes to construct the PTK (*Pairwise Transient Key* - 64 bytes)
- The STA sends its own nonce-value (SNonce) to the AP together with a MIC (*Message Integrity Code*)

WPA: 4 way handshaking

- The AP sends the GTK (*Groupwise Transient Key* – 32 bytes) with another MIC
- The STA sends a confirmation to the AP
- The GTK is used to decrypt multicast and broadcast traffic. This key has to be updated:
  - For the expiry of a preset timer
  - When a device leaves the network: this is to prevent the device from receiving any more multicast or broadcast messages from the AP

WPA: The Crack

- The four-way handshake occurs whenever you connect to a WLAN using WPA or WPA2. It also occurs periodically thereafter, whenever the AP decides to refresh transient keys
- If we use WPA-Enterprise, every session starts from a different PMK, delivered during 802.1X authentication
- In WLANs using WPA-Personal the station and AP must use the PSK!
- WPA-PSK crackers like aircrak, kisMAC, coWPAtty try to guess the PSK by capturing and analyzing the four-way handshake messages

WPA: The Crack

- A minimum PSK (8 lowercase letters) has 26^8 possible combinations (208.827.064.576), so trying all of those possible passphrases would take far too long
- Working from a dictionary file cuts that effort by just trying all 8-characters words! Huge password dictionaries are readily available for use with conventional password crackers like “John the Ripper”, and they can be fed into PSK crackers

WPA: The Crack

- Multi-pass hashing for every word in those files still takes time (depending on SSID and PSK length)
- But conventional password crackers to speed up the cracking use rainbow tables (long lists of pre-computed password hashes). Use default SSID and words in dictionary files
- For example coWPAtty use a variation on rainbow tables to speed PSK cracking by three orders of magnitude

Airsnort & AirCrack-ng: software for the cracking of WEP/WPA keys

Airsnort

- Several tools exist which allow to determine in an automatic way a WEP key
- One of these is Airsnort, downloadable to the address:
  http://airsnort.shmoo.com/
- It is a linux program available also for windows
- It requires the wireless card in monitor mode
- It works for instance with the cards Prism2, Orinoco and Cisco

Airsnort

- Once activated, the program captures the packets and simultaneously tries to crack the WEP key:
  - All the non data packets (except the beacon) are dropped
  - The packets not encrypted are dropped
  - The encrypted packets are selected and the ones considered not interesting are dropped
- The packets considered interesting are the Weak IV identified by Fluhrer, Mantin and Shamir (plus several *Weak IV* identified afterwards)

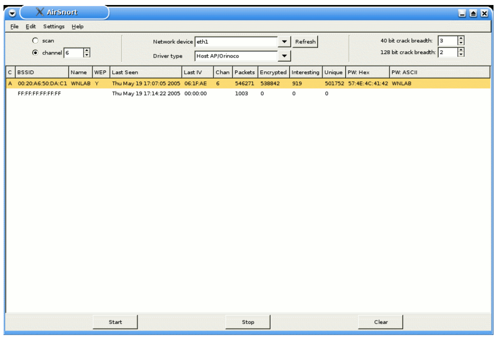
Airsnort

- Every 10 weak IV acquired, airsnort uses a probabilistic attack
- It is possible to define how deep the analysis of the tree of the various possibilities must be
- A value n of the parameter “breadth” indicates that the algorithm will try the n more probable values for each position of the key
- About 1000 weak IV for a key to 64 bits and about 2000 for a key to 128 bits are required

Airsnort

- Test of attack completed using:
  - An Access Point Avaya AP3
  - Two laptop to produce traffic
  - A laptop with a Netgear wireless card and Airsnort
- Set up a 64 bits WEP to, that is 40 key bits, that is 5 characters → WNLAB
- After about 15 minutes of acquisition with about 550.000 packets (540.000 encrypted) and 919 Weak IV, the key has been determined!

Airsnort



scan [✓ channel] 6
Network device: eth1
Driver type: Host AP/Orinoco
40 bit crack breadth: 3
128 bit crack breadth: 2

C	BSSID	Name	WEP	Last Seen	Last IV	Chan	Packets	Encrypted	Interesting	Unique	PW: Hex	PW: ASCII
A	00:20:A6:50:DA:C1	WNLAB	Y	Thu May 19 17:07:05 2005	06:1F:AE	6	546271	538842	919	501752	57:4E:4C:41:42	WNLAB
	FF:FF:FF:FF:FF:FF			Thu May 19 17:14:22 2005	00:00:00		1003	0	0	0		

Airsnort

- In the following table some runs of Airsnort:

Key length	No. of packets	Enchrypted packets	weak IV
40	283618	278860	120
40	546271	538842	919
40	283895	280098	100
40	283876	280057	102
40 AV5	702466	676083	252
104	285328	281596	104
104	285798	282076	850
104	575137	567385	933

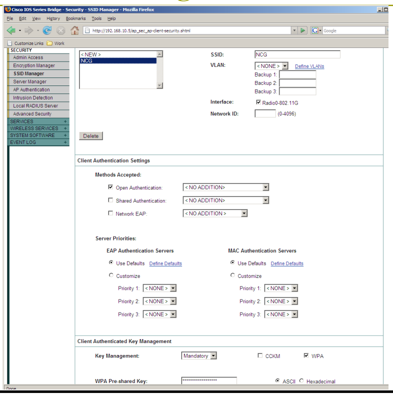
Slide 63

AV5 25/4/2006: AirSnort su auditor live CD
Alessandro Villani, 4/26/2006

WPA: AirCrack-ng

- We need to configure the CISCO AP to support WPA-PSK:
  - SSID Manager:
    - Client Authentication Key Management
      - Key Management → Mandatory
      - WPA → Check the box
      - WPA Pre-shared Key → Choose a simple string (not less than 8 chars)
  - Encryption Manager:
    - Encryption Modes
      - Cipher → TKIP

WPA: AirCrack-ng


Cisco IOS Series Bridge - Security - SSID Manager - Mozilla Firefox

http://192.168.10.5/ap_sec_ap-client-security.shtml

SSID: NCG
VLAN: < NONE >
Backup 1:
Backup 2:
Backup 3:
Interface: ☑ Radio0-802.11G
Network ID: (0-4096)

Client Authentication Settings

Methods Accepted:
☑ Open Authentication: < NO ADDITION>
☐ Shared Authentication: < NO ADDITION>
☐ Network EAP: < NO ADDITION >

Server Priorities:

EAP Authentication Servers: [✓ Use Defaults] Customize; Priority 1: < NONE >; Priority 2: < NONE >; Priority 3: < NONE >

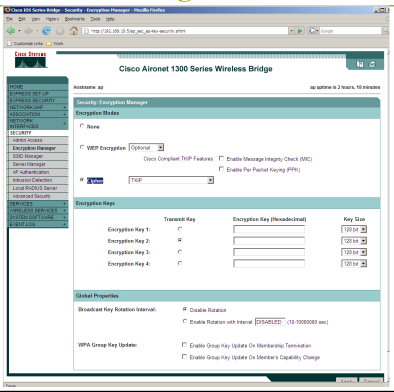
MAC Authentication Servers: [✓ Use Defaults] Customize; Priority 1: < NONE >; Priority 2: < NONE >; Priority 3: < NONE >

Client Authenticated Key Management

Key Management: Mandatory ☐ CCKM ☑ WPA

WPA Pre-shared Key: ****************** [✓ ASCII] Hexadecimal

WPA: AirCrack-ng


Cisco IOS Series Bridge - Security - Encryption Manager - Mozilla Firefox

http://192.168.10.5/ap_sec_ap-key-security.shtml

Cisco Aironet 1300 Series Wireless Bridge

Hostname ap — ap uptime is 2 hours, 18 minutes

Security: Encryption Manager

Encryption Modes

○ None

○ WEP Encryption Optional
Cisco Compliant TKIP Features: ☐ Enable Message Integrity Check (MIC) ☐ Enable Per Packet Keying (PPK)

● Cipher TKIP

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

WPA: AirCrack-ng

- To acquire data:
  - airodump-ng –channel X eth0 –w /root/dump
- Connect a client to the AP (we need to acquire the WPA handshake)
- Run the cracking tool:
  - aircrack-ng –a 2 –w DICT.TXT dump-01.cap

WPA: AirCrack-ng

- An example:

```
bt ~ # airodump-ng

 Airodump-ng 1.0 beta1 r857 - (C) 2006,2007 Thomas d'Otreppe
 Original work: Christophe Devine
 http://www.aircrack-ng.org

 usage: airodump-ng <options> <interface>[,<interface>,...]


CH  2 ][ Elapsed: 1 min ][ 2008-04-26 00:01 ][ WPA handshake: 00:11:92:90:BD:00

BSSID              PWR RXQ  Beacons    #Data, #/s  CH  MB  ENC  CIPHER AUTH ESSID

00:80:C8:B8:39:EB    0   0        3        0    0   1  22  WEP  WEP  <length:  0>
00:11:92:90:BD:00    0 100      770     1009    2   2   1. WPA  TKIP   PSK  NCG

BSSID              STATION            PWR   Rate  Lost  Packets  Probes

00:11:92:90:BD:00  00:15:00:3C:3B:1A    0   1- 1     0     1146  NCG
(not associated)   00:1E:4C:00:88:B2    0   0- 1     0        3

(not associated)   00:90:4B:64:4D:E7    0   0- 1     0        4
```

WPA: AirCrack-ng

- An example:

```
Opening dump.pcap-01.cap
Reading packets, please wait...
Read 2591 packets.

   #  BSSID              ESSID                     Encryption
   1  00:11:92:90:BD:00  NCG                       WPA (1 handshake)
   2  00:80:C8:B8:39:EB                            No data - WEP or WPA

Index number of target network ? 1
Opening dump.pcap-01.cap
Reading packets, please wait...
               Aircrack-ng 1.0 beta1
   [00:00:00] 0 keys tested (0.00 k/s)

               KEY FOUND! [ OVERVIEW ]

   Master Key     : 50 F0 E1 87 B6 9E BA 03 CA 93 C3 FB 1F 97 A2 92
                    C8 04 D5 E7 C2 EF 11 28 A2 08 D5 CC A1 11 22 F6

   Transcient Key : 1E 98 C0 6F BD A7 6F 2E 8E 49 B1 CF 1F CC 91 89
                    59 52 82 A7 BB C0 5E 09 44 07 26 4C 6D BA D3 7D
                    5B 3B 2A 77 7E 41 8C DC 37 3B 23 CA 17 2B E0 E3
                    36 B7 FB 72 73 B3 4D FD 11 B2 CD E5 C8 4A DA D9

   HEAPOL HMAC     : 0E 36 DA 0D A9 88 C2 29 94 10 08 E6 AE 1C A0 F8
```

WEP: AirCrack-ng

- Airsnort is no longer maintained
- You can use aircrack-ng also for WEP cracking!
- Aircrack-ng implement also the new set of crack named PTW
- This new attack reduce dramatically the number of packets required to crack a WEP key

The Report

WEP Cracking: possible task 1

- Change a WEP Key and verify the number of packets required to break it:
  - Set a simple (an ascii word) 64 bit WEP key
  - Set a complex (random hex) 64 bit WEP key
  - Set a simple (an ascii word) 128 bit WEP Key
  - Set a complex (random hex) 128 bit WEP key
- Use iperf to generate a lot of trafic
- Use a laptop with airsnort/aircrack to break the key
- Compare the number of packets required using PTW or IV based attack

WEP Cracking: possible task 1

- Some AP require that you insert the WEP key just as Hex
- Remember that there is a correspondence between ASCII chars and hex:

ASCII	A	B	…	Z	a	b	…	z
HEX	41	42	…	5A	61	62	…	7A

- There are a lot of sites to convert ASCII in HEX. Here an interesting one:
  - http://www.paulschou.com/tools/xlate/

WEP and IV: possible task 1.1

- Many wireless cards generate IV in a predictable way
- You can analyze the IV sequences for some wireless cards
- You have to work with two laptop:
  - One where you install the wireless card: verify the integrated wireless network card, but we have a lot of PCMCIA card. Ask for them!
  - The other in monitor mode to acquire and analyze the traffic

WEP and IV: possible task 1.1

- You have to:
  - Acquire some data generated from the laptop you intend to analyze (ping the AP)
  - Take a contiguous sequence of two or more packets
  - Look at the first 3 bytes that are the IV!
  - Restart the network card, to verify if the IV sequence start each time from the same value
  - Do a deep analysis of the IV trying to demonstrate if they are random number of sequence

WPA Cracking: possible task 2

- Change a WPA Key and verify the time required to break it:
  - Set a simple (ASCII dictionary word) 8 chars WPA key
  - Set a complex (random hex) 64 bit WPA key
  - Set a simple (ASCII dictionary word) WPA Key of length x with 8<x<64
  - Set a complex (random hex) WPA key of the same number of bits of before
  - Use a laptop with aircrack-ng to break the key
- N.B.: consider as unbreakable the key if you don’t find the key after one hour

WPA Cracking: possible task 2

- You can find dictionary files on the net. Here a link to an interesting site:
  - ftp://ftp.ox.ac.uk/pub/wordlists/
- Download the files
- Concatenate them (in linux) with the command `cat`
- Sort the new files (with the command `sort`)
- Remove repeated occurrence of the same word (with the command `uniq`)

WPA Cracking: possible task 2

- Some access point require a predefined length if you insert an HEX WPA Key
- In this case, for our tests, you can insert an ASCII WPA Key, choosing this key so that it is not a dictionary word
- As an example, for an 8 chars WPA key we can choose something like: Xa!.j(2W

WPA Cracking: possible task 2.1

- Verify the time required to break the same WPA key changing the vocabulary:
  - Use dictionary with different number of words
  - Use dictionary with different distributions of the lengths of the words
  - Build a dictionary with different mix of number/symbols/… mixed to the basic words. You can use for this task the password cracker "John the ripper": http://www.openwall.com/john/

WPA Cracking: possible task 3

- Complete a penetration test (and describe the successful attacks) on the wireless network of the faculty (`science-wify` or `unitn`). Example:
  - Spoof of IP/MAC addresses
  - Man in the Middle
- **BEWARE**:
  - Don't try any Denial of Services on the faculty wireless network!
  - Don't play with the data/information of the other users! Test the attacks using just your laptop/account!