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Wireless Security Myths and Realities

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Is This How You Think About Wireless?



The truth:

**Wireless is MORE
secure than wired**

(if you do it right)

Wired Network Security Questions

On your wired network...

Do you **authenticate** all users and devices?

Do you **encrypt** all traffic?

Do you **control access** to network resources based on user identity?

Wireless lets you do all of this – by design

The Myths...

Doing Nothing

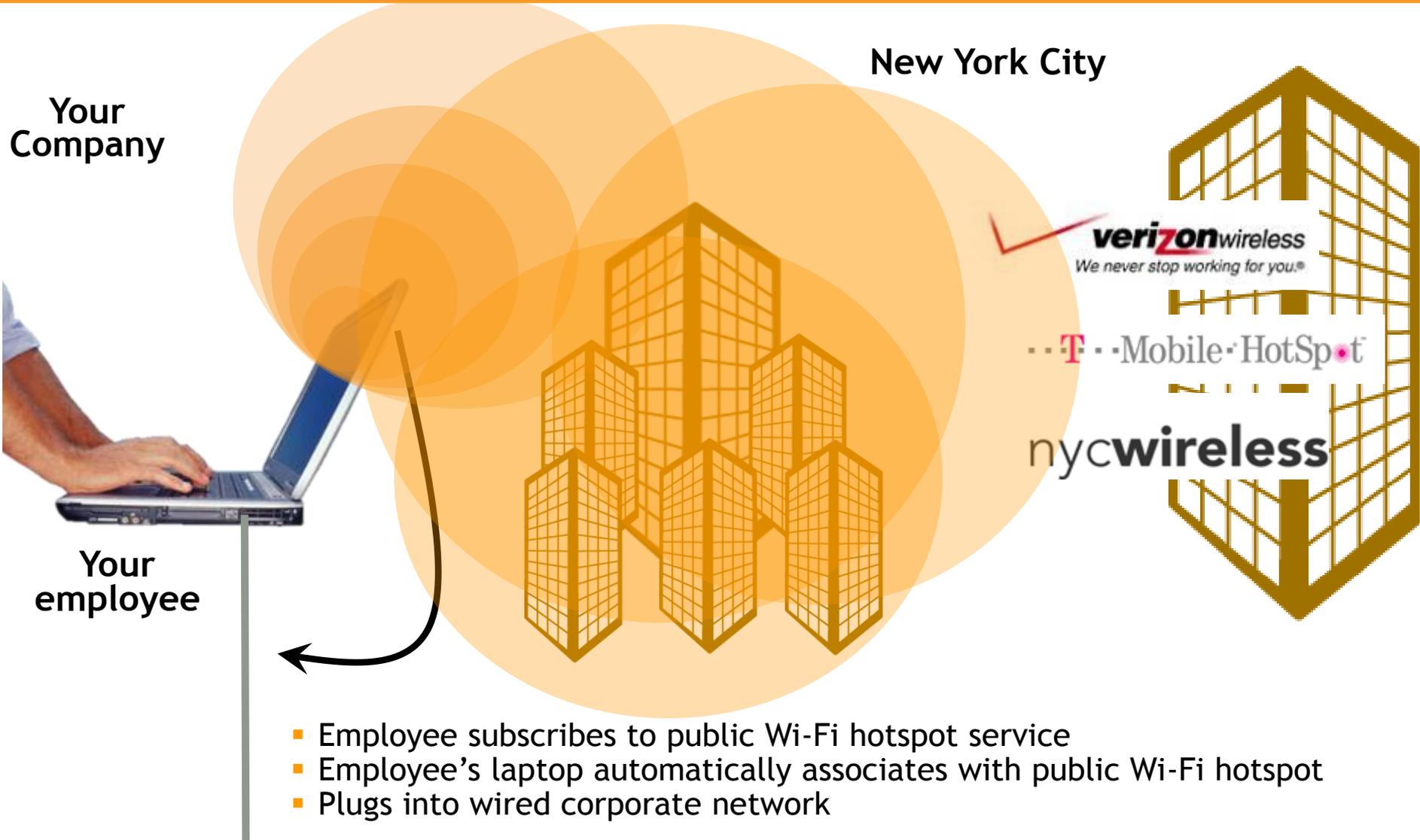
Wireless LAN equipment is cheap and easily available

- If the IT department doesn't deploy wireless, someone else will

Where is the “security perimeter” today?

How do you enforce “No Wireless” policies?

The Existence of Wireless LANs is a Security Threat



RF Engineering

Directional antennas?

Lowering transmit power?

Placing APs away from outside walls?

Set RF coverage to optimize user experience – not to control leakage



SSID Cloaking

- **Best practice?**
 - “Configure APs to not broadcast the SSID”
- **At best, this can *discourage* a bad guy**
- **At worst, this is downright dangerous**
- **The SSID is not the same as a password**

Discovering Cloaked SSIDs

```
linux:~# ./ssid_jack -h
```

Essid Jack: Proof of concept so people will stop calling an ssid a password.

```
Usage: ./ssid_jack -b <bssid> [ -d <destination mac> ] [ -c <channel number> ] [ -i  
ccc.gif <interface name> ]
```

-b: bssid, the mac address of the access point (e.g. 00:de:ad:be:ef:00)

-d: destination mac address, defaults to broadcast address.

-c: channel number (1-14) that the access point is on,
defaults to current.

-i: the name of the AirJack interface to use (defaults to
aj0).

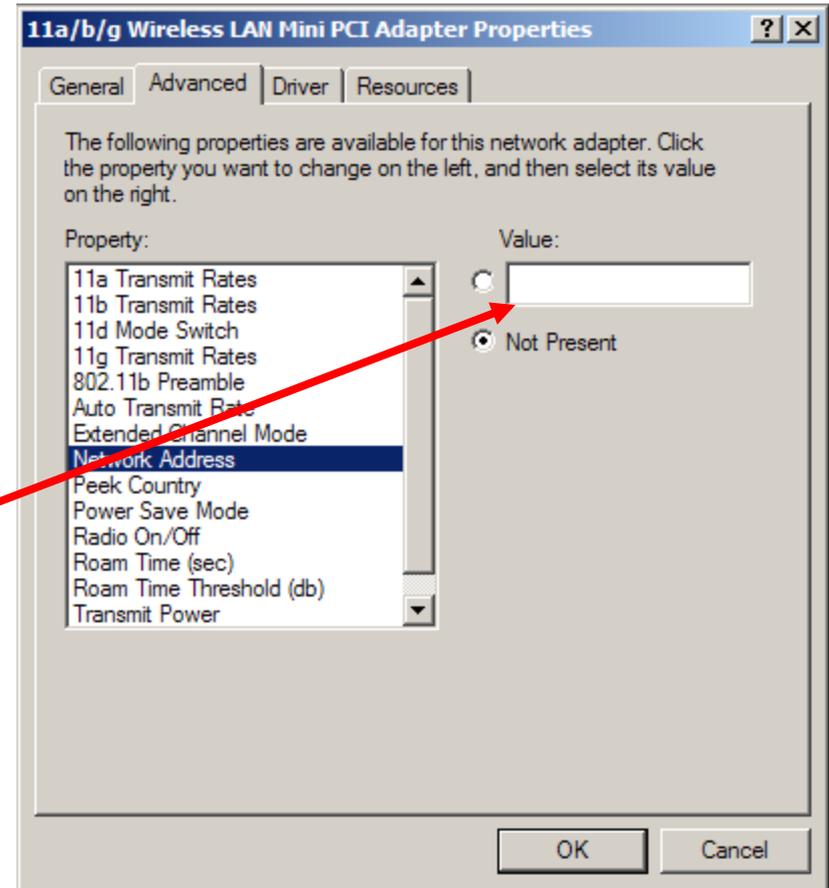
```
linux:~# ssid_jack -b 00:03:2d:de:ad: -c 11
```

Got it, the ssid is (escape characters are c style):

```
"s3kr1t_wl4n"
```

MAC Address Filtering

- **Some APs offer “MAC address filtering”**
- **Does not scale to large networks**
- **Trivial to defeat**



WEP

- **WEP stands for “Wired Equivalent Privacy”**
- **Part of original 802.11 specification**
- **Horribly broken**
 - Weak cipher
 - No anti-replay protection
 - Weak integrity
 - Vulnerable to very rapid cracking

Is WEP really that bad?

Yes.

Feds Hack Wireless Network in 3 Minutes

Posted by [CmdrTaco](#) on Tue Apr 05, '05 12:26 PM

from the [still-can't-balance-budget dept.](#)

[xs3](#) writes *At a recent ISSA (Information Systems Security Association) meeting in Los Angeles, a team of FBI agents demonstrated current WEP-cracking techniques and broke a 128 bit WEP key in about three minutes. Special Agent Geoff Bickers ran the Powerpoint presentation and explained the attack, while the other agents (who did not want to be named or photographed) did the dirty work of sniffing wireless traffic and breaking the WEP keys. This article will be a [general overview of the procedures used by the FBI team.](#)*"



Other things to Avoid...

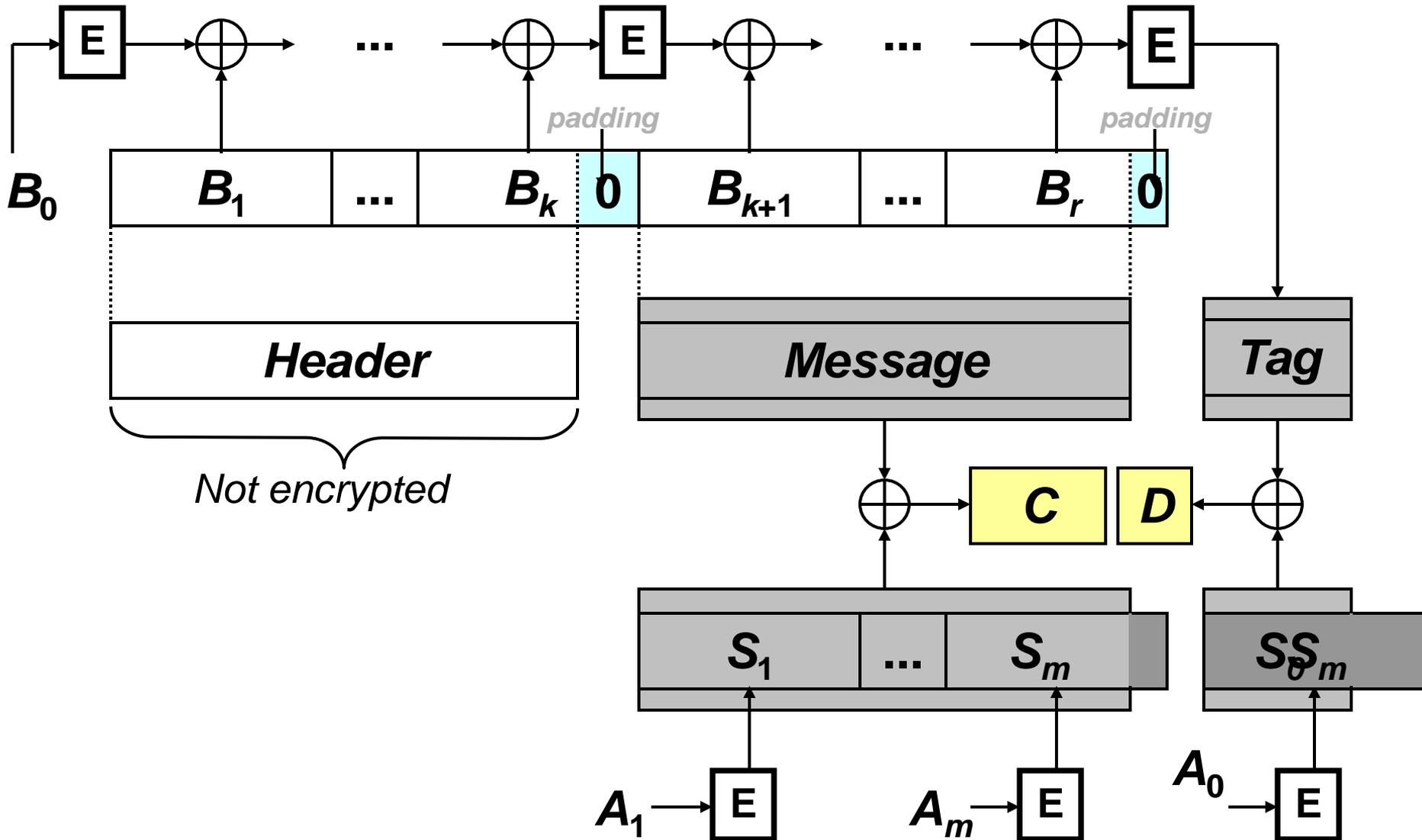
- **Cisco LEAP (vulnerable to dictionary attacks)**
- **EAP-FAST (doesn't securely provide mutual authentication)**
- **Use caution with WPA-Personal/WPA-PSK (more later...)**
- **“WEP Cloaking” (doesn't work)**
- **Proprietary “shielding” or “scrambling” (easy to defeat)**



The Reality...

A few basics...

AES-CCMP Block Diagram



Key Security Principles

Principle of Least Privilege

- Authentication, identity-based security, firewalls

Defense in Depth

- Authentication, encryption, intrusion protection, client integrity

Prevention is ideal, detection is a must

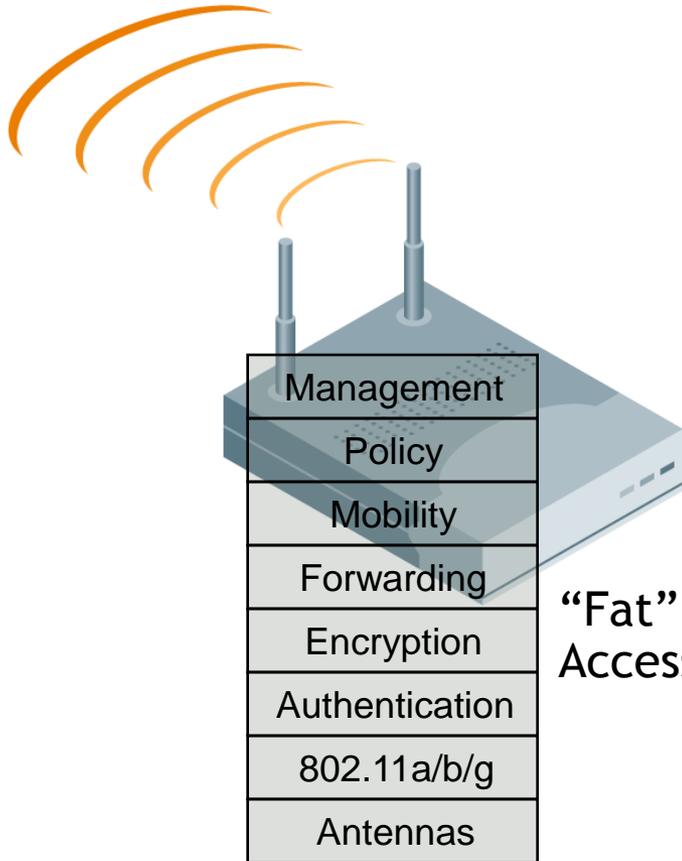
- Intrusion detection systems, log files, audit trails, alarms and alerts

Know Thy System

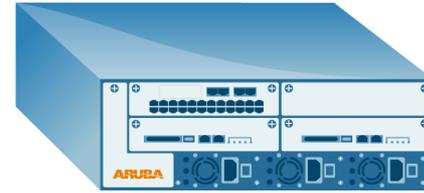
- Integrated management, centralization

Centralization is the First Step

Centralization solves security *and* TCO for WLANs



“Fat”
Access Points

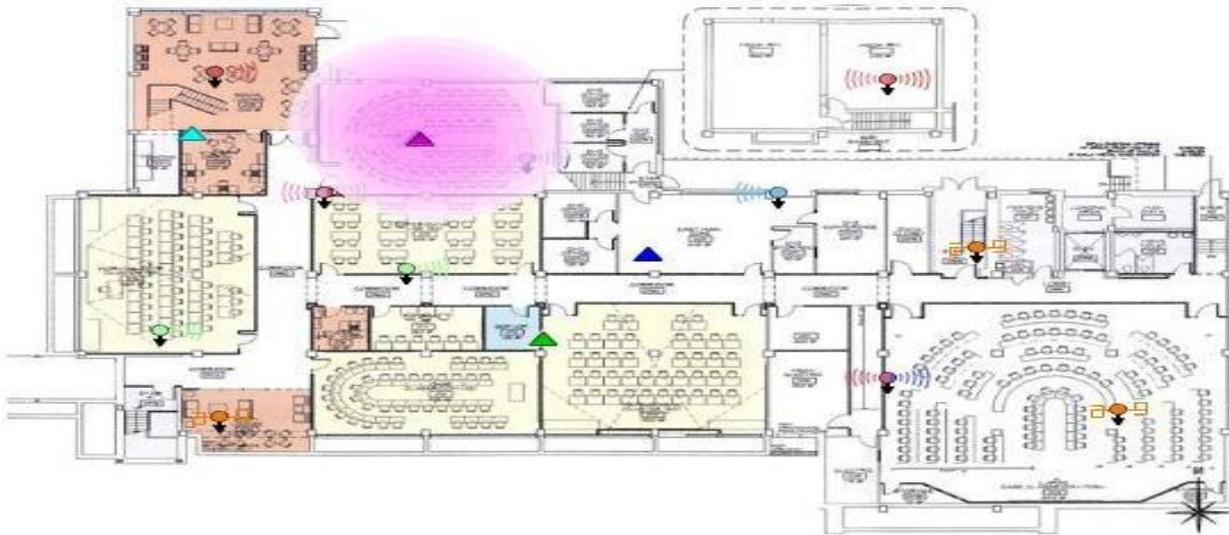


Centralized
Mobility Controller



“Thin”
Access Points

Controlling Rogue APs



1. AP detection

- See all APs

2. AP classification

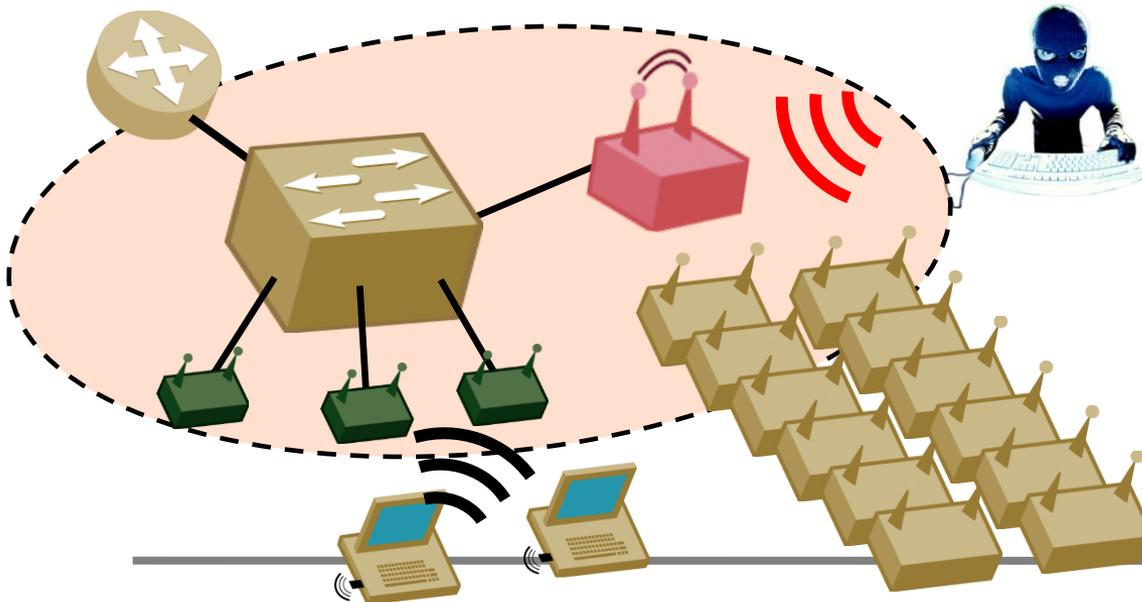
- Are they neighbors?
- Or are they a threat?

3. Rogue containment

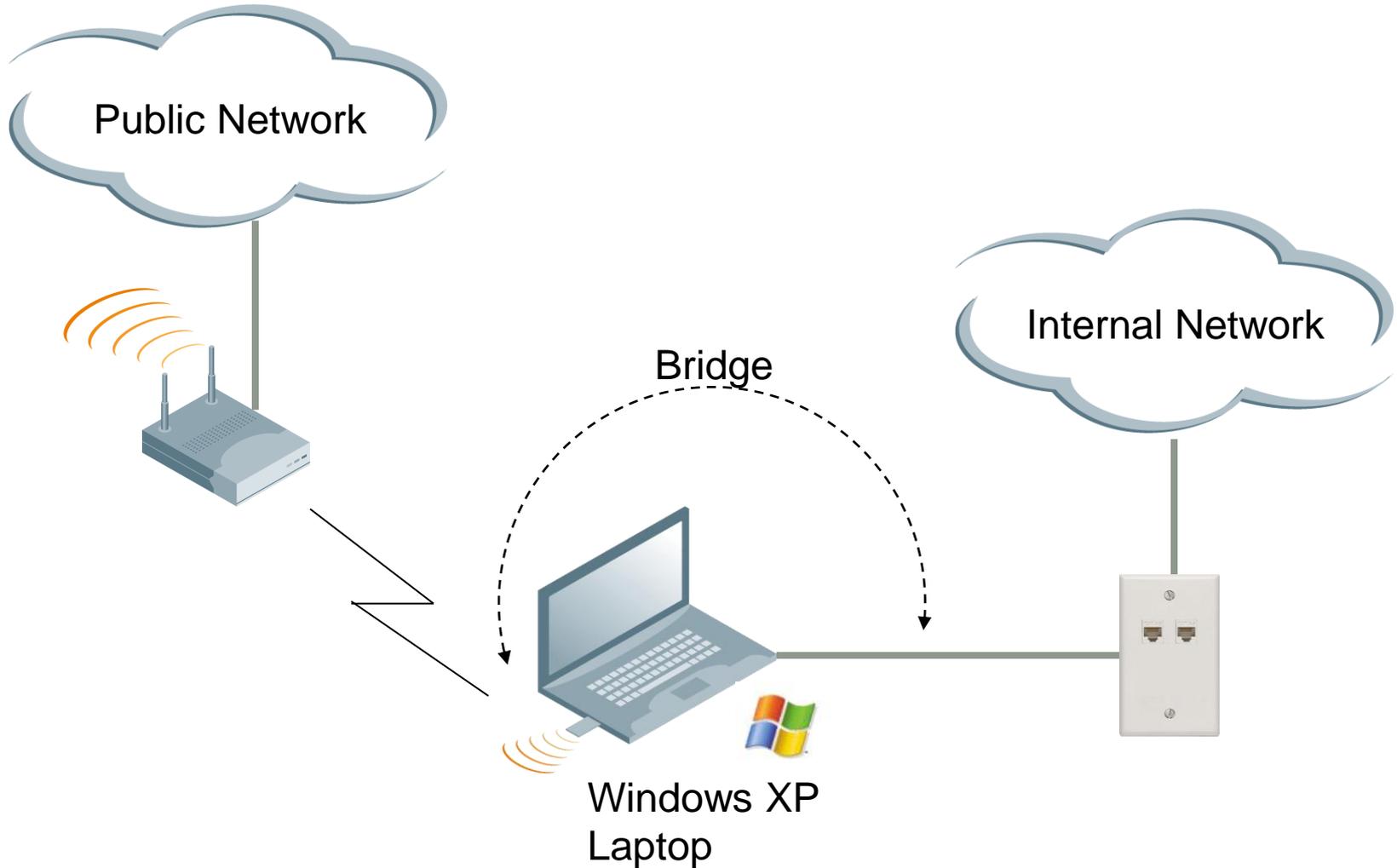
- Stop users from accessing rogue APs over the wire & over wireless
- Leave neighbors alone

4. Locate Rogue

- Find where it is and disconnect



Controlling Uncontrolled Wireless



Wireless Intrusion Detection/Protection

IDS: Node Rate Anomaly

Node=00:04:23:5c:e0:4a PktCount=51 RSSI=63

IDS: Node Rate Anomaly

An anomaly has been detected for a frame rate for a node. This could indicate a flood attack at/from the node.

IDS: Signature Match

SignatureName="Deauth-Broadcast"

Src=00:0b:86:80:34:40 Dst=ff:ff:ff:ff:ff:ff

Bssid=00:0b:86:80:34:40 Channel=6 RSSI=71

IDS: Signature Match

A match with one of the configured signatures has been detected.

IDS: Signature Match

SignatureName="Wellenreiter" Src=00:00:00:00:aa:01

Dst=ff:ff:ff:ff:ff:ff Bssid=00:00:00:00:aa:01 Channel=6 RSSI=58

IDS: Signature Match

A match with one of the configured signatures has been detected.

IDS: Signature Match

SignatureName="Null-Probe-Response"

Src=00:0b:86:80:34:40 Dst=00:04:23:5c:e0:4a

Bssid=00:0b:86:80:34:40 Channel=11 RSSI=57

IDS: Signature Match

A match with one of the configured signatures has been detected.

IDS: Sequence Number Anomaly

MAC=00:0b:86:80:34:40 RSSI=83 Seq1=107 Seq2=0

MismatchCnt=10

IDS: Sequence Number Anomaly

A sequence number anomaly has been detected for a node. This indicates MAC address spoofing, i.e., another machine is masquerading as this node.

IDS: Disconnect Station Attack

SrcMAC=00:0b:86:80:34:40 RSSI=56 DeauthSeq=163

NormalSeq=3593 MC=7 SC=10

IDS: Disconnect Station Attack

An attack to disconnect a station by spoofing either the Deauth, Auth, Disassoc or Reassoc frames, has been detected.

IDS: Channel Rate Anomaly

PacketCount=11

IDS: Channel Rate Anomaly

A frame rate anomaly is detected for a channel. This could indicate a flood attack on a channel.

IDS: Wireless Bridge Detected

Channel=6 Transmitter=00:00:00:00:00:01

Receiver=00:00:00:00:00:01

Destination=00:00:00:00:00:01 RSSI=57

IDS: Wireless Bridge Detected

AP-AP Communication has been detected.

IDS: Fake AP Flood Detected

Spurious APs=60

IDS: Fake AP Flood Detected

A number of spurious APs have been detected in the vicinity.

AP Impersonation

AP Impersonation

A man in the middle attack tool like Air Jack is impersonating an access point.

IDS: Signature Match

SignatureName="NetStumbler Version 7.3.0x"

Src=00:00:00:00:00:01 Dst=00:00:00:00:aa:01

Bssid=00:00:00:00:aa:01 Channel=6 RSSI=58

IDS: Signature Match

A match with one of the configured signatures has been detected.

IDS: Signature Match

SignatureName="NetStumbler Generic"

Src=00:00:00:00:00:01 Dst=00:00:00:00:aa:01

Bssid=00:00:00:00:aa:01 Channel=6 RSSI=53

IDS: Signature Match

A match with one of the configured signatures has been detected.

IDS: Signature Match

SignatureName="Linksys-defaultssid"

Src=00:00:00:00:aa:01 Dst=ff:ff:ff:ff:ff:ff

Bssid=00:00:00:00:aa:01 Channel=6 RSSI=54

IDS: Signature Match

A match with one of the configured signatures has been detected.

IDS: Signature Match

SignatureName="AirJack" Src=00:0b:86:80:34:40

Dst=ff:ff:ff:ff:ff:ff Bssid=00:0b:86:80:34:40 Channel=6 RSSI=74

IDS: Signature Match

A match with one of the configured signatures has been detected.

IDS: EAP Handshake Rate Anomaly

Channel=6 PktCount=10

IDS: EAP Handshake Rate Anomaly

A anomalous number of EAP handshakes have been seen on a channel. This could indicate that a station is under a DOS attack.

IDS: Ad-hoc Network Detected

Channel=11 Src=00:04:23:5c:e0:4a Dst=ff:ff:ff:ff:ff:ff

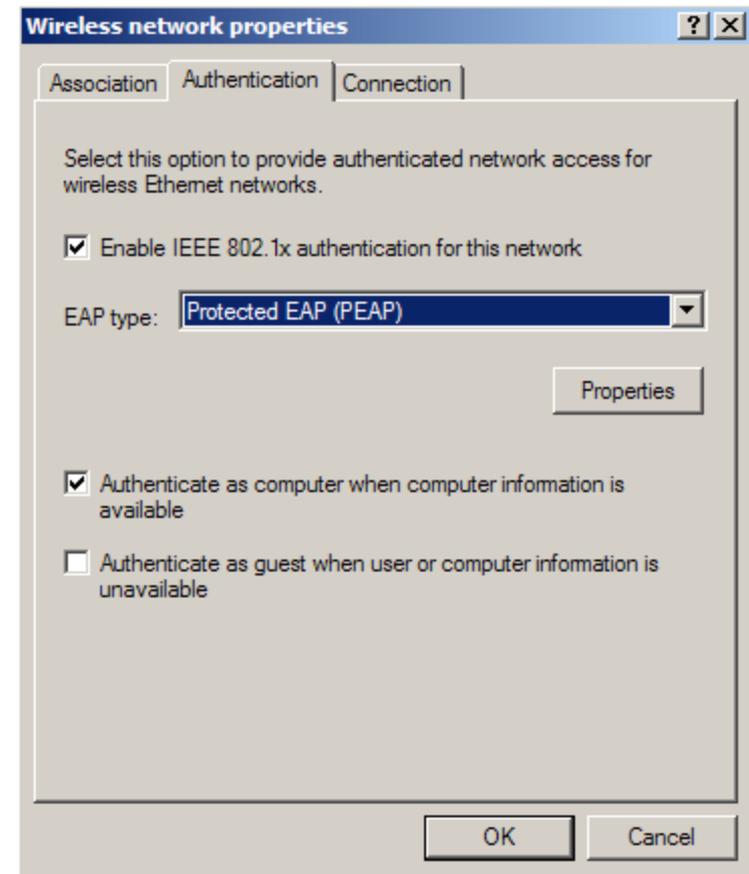
RSSI=6

IDS: Ad-hoc Network Detected

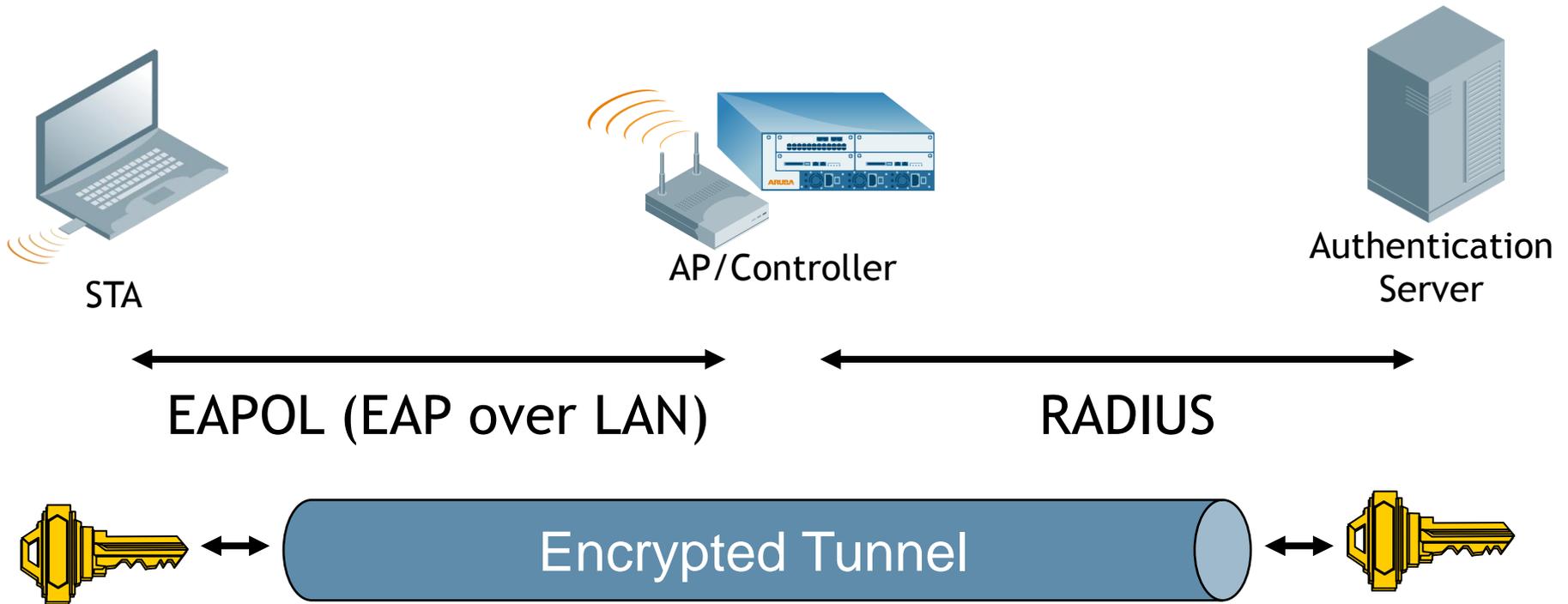
A station that is part of an Ad-hoc network has been detected. The SSID of the network and the BSS used is available.

Authentication with 802.1X

- **Authenticates users before granting access to L2 media**
- **Makes use of EAP (Extensible Authentication Protocol)**
- **802.1X authentication happens at L2 – users will be authenticated before an IP address is assigned**



Authentication with 802.1X: PEAP



802.1X Acronym Soup

PEAP (Protected EAP)

- Uses a digital certificate on the network side
- Password or certificate on the client side

EAP-TLS (EAP with Transport Level Security)

- Uses a certificate on network side
- Uses a certificate on client side

TTLS (Tunneled Transport Layer Security)

- Uses a certificate on the network side
- Password, token, or certificate on the client side

EAP-FAST

- Cisco proprietary
- Do not use – known security weaknesses

Encrypt the Data

If intruders can't read the data, there's no need to worry where it goes

- WEP
 - Simple to do, easy to crack
 - No key management
 - **Don't do it**
- TKIP (Temporal Key Integrity Protocol)
 - Works on legacy hardware (pre-2003)
 - First major flaw published in November 2008
 - Not currently recommended
- CCMP/AES
 - Encryption using AES
 - Considered state-of-the-art
 - FIPS 140-2 approved
 - Works on all modern hardware

Combining Authentication & Encryption: WPA

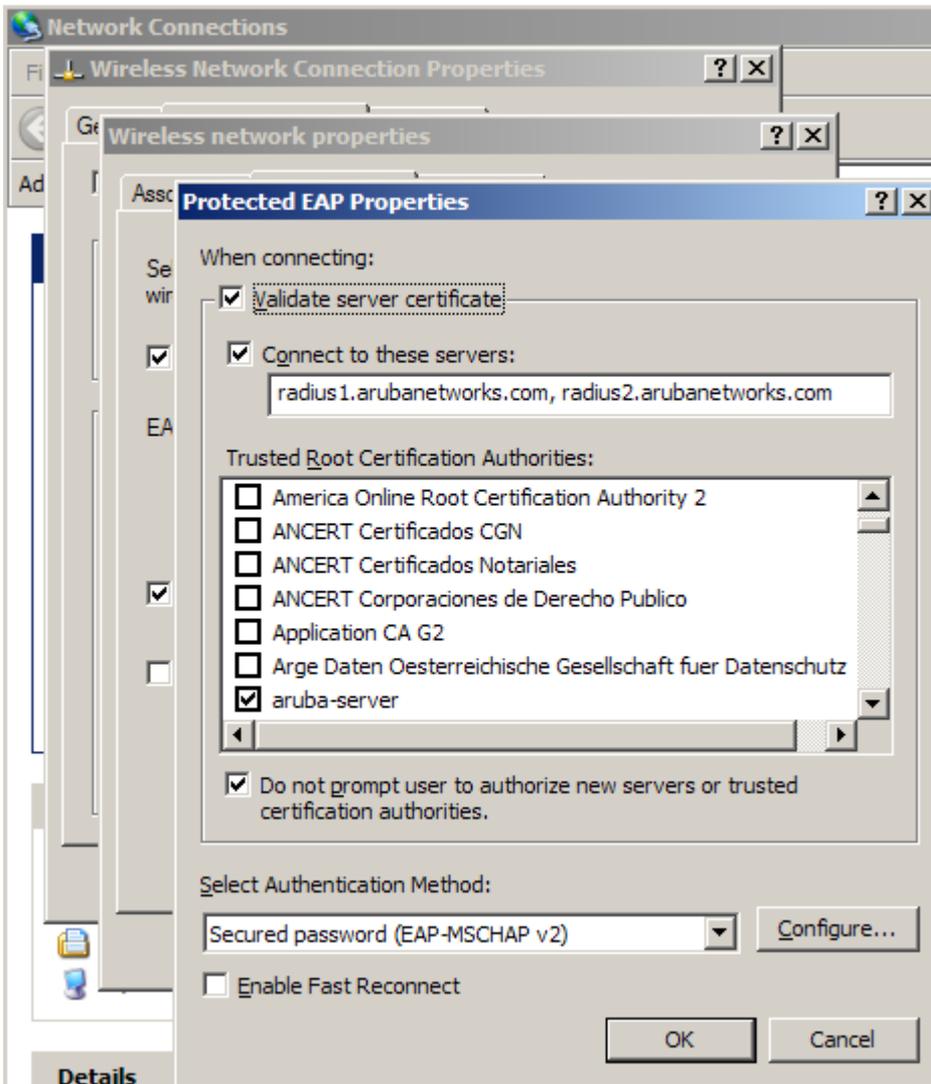
- **WPA == Wi-Fi Protected Access**
- **WPA**
 - Wi-Fi Alliance “standard” based on pre-802.11i
 - Includes TKIP for encryption
- **WPA2**
 - Wi-Fi Alliance “standard” based on ratified 802.11i
 - Includes TKIP and CCMP for encryption
- **For both:**
 - WPA-Enterprise == 802.1X for authentication, dynamic encryption keys
 - WPA-Personal == pre-shared authentication key – **careful!**



WPA-Personal? Be careful..

- **WPA Personal does not use 802.1X**
 - Pre-shared key
 - Easier
 - But less secure
- **Problem 1: Scalability**
 - Need to re-key any time an employee/user leaves the organization
- **Problem 2: Using weak keys**
 - WPA-PSK keys that are weak can be cracked (dictionary attack)

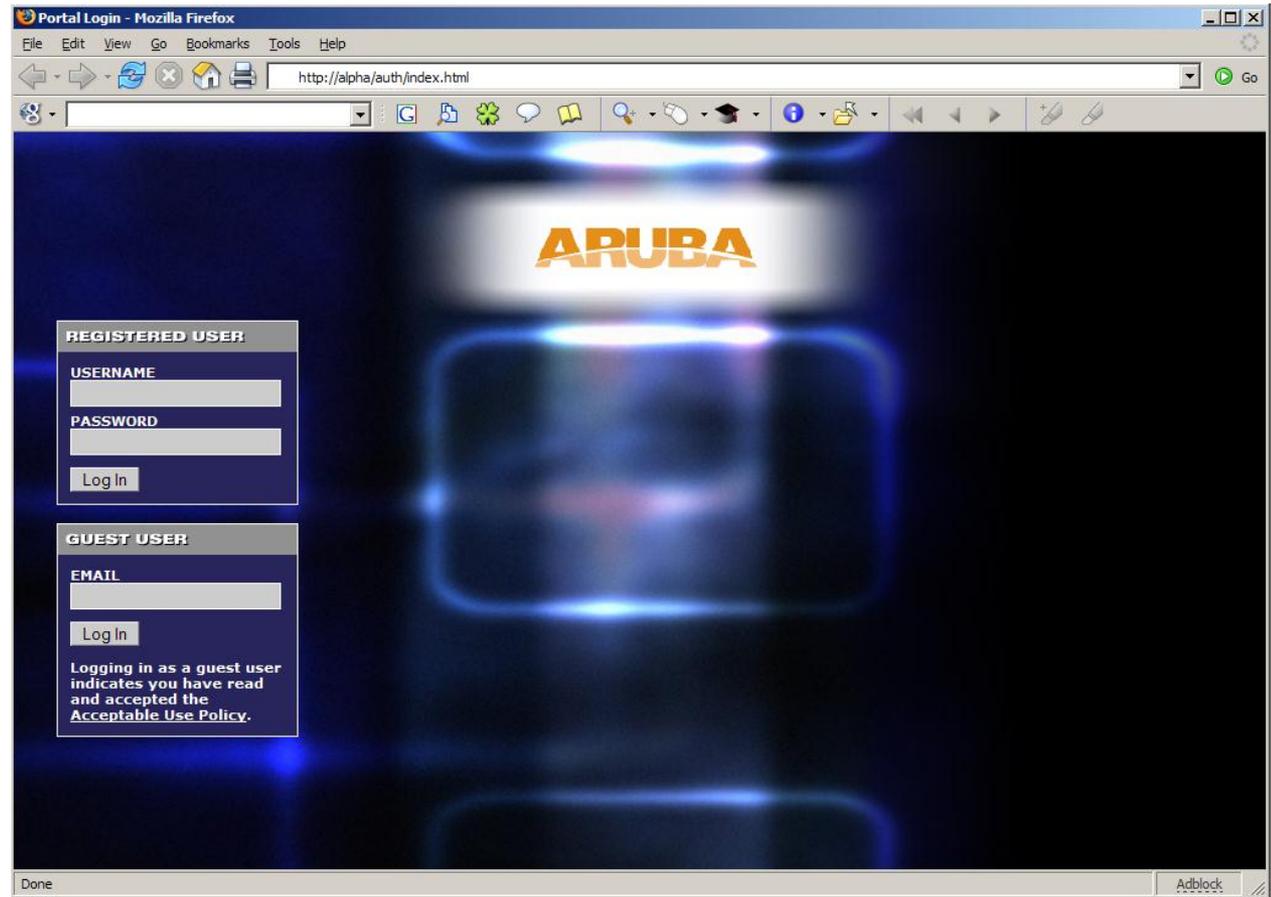
Configure WPA Properly



- **Configure the Common Name of your RADIUS server (matches CN in server certificate)**
- **Configure trusted CAs (an in-house CA is better than a public CA)**
- **ALWAYS validate the server certificate**
- **Do not allow users to add new CAs or trust new servers**
- **Enforce with group policy**

Captive Portals

- **Browser-based authentication**
- **SSL encrypted**
- **Permits registered user or guest access**
- **Typically used on open networks**
- **Use with caution!**

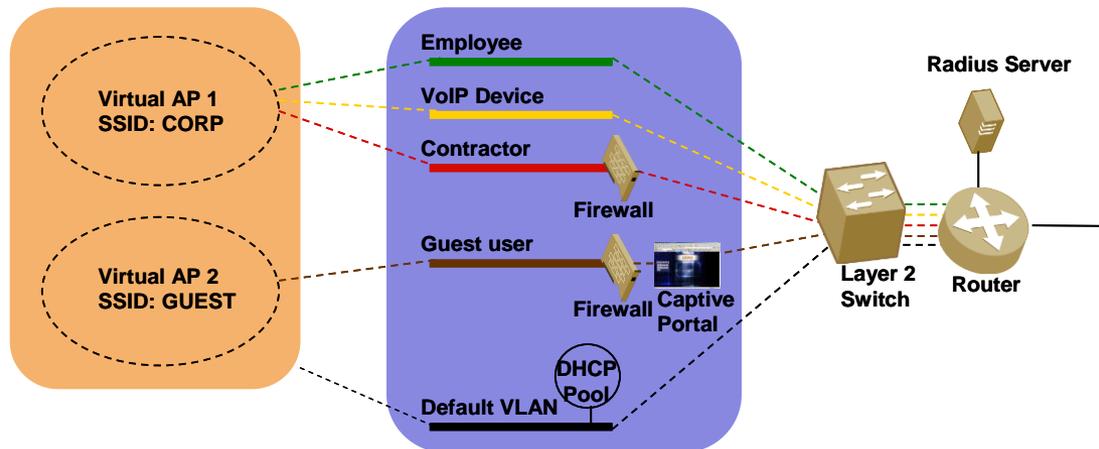


Authorize the Data

Most organizations do a decent job of authentication (who the user is), but a poor job of authorization (what the user is allowed to do)

Mobile networks are typically multi-use

Authentication provides you with user identity – *now use it!* Identity-aware firewall policies can restrict what a user can do, based on that user's needs



Why Worry About Authorization?

Where is the “network perimeter” today?



*We meet
again, 007!*

- Mobility brings us:
 - Disappearance of physical security
 - New mobile users, devices appearing everyday
 - Increased exposure to malware
- Assuming that “the bad guys are outside the firewall, the good guys are inside” is a recipe for disaster



Remember “NAC”?

Identity-Based Policy Control

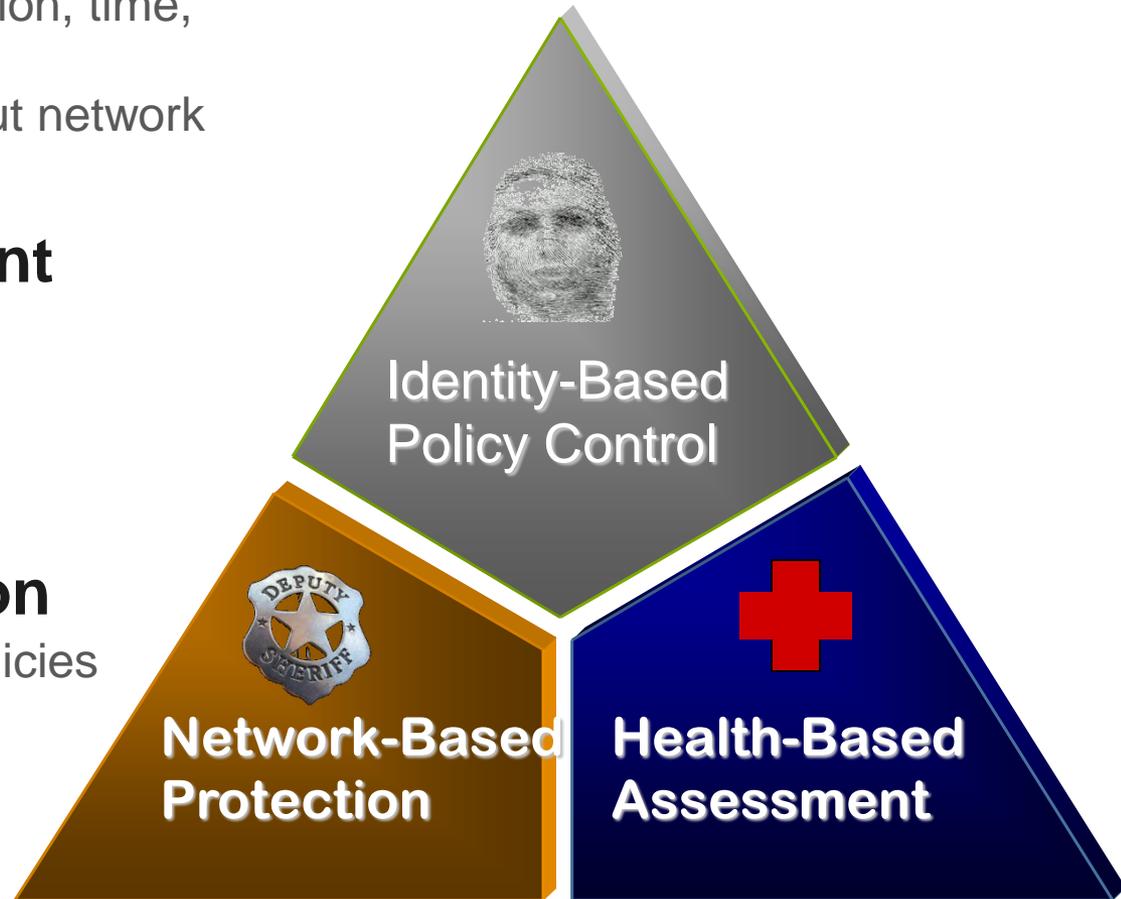
- Assess user role, device, location, time, application.
- Policies follow users throughout network

Health-Based Assessment

- Client health validation
- Remediation
- Ongoing compliance

Network-Based Protection

- Stateful firewalls to enforce policies and quarantine
- User/device blacklisting based on Policy Validation



Pay Attention to NIC Driver Software

- **Basic secure programming rule: Sanitize all user input**
- **“Fuzzing” attacks send random data to software inputs**
 - Stuff that comes in over the air is user input
- **802.11n is out there – lots of new driver software going into production**

MOKB-11-11-2006: Broadcom Wireless Driver Probe Response SSID Overflow

AA-2006.0090

AUSCERT Advisory

[OSX]

Public Exploit Code Available for AirPort Wireless Driver Vulnerability
6 November 2006

AusCERT Advisory Summary

Operating System: Mac OS X
Impact: Denial of Service
Access: Remote/Unauthenticated
Member content until: Monday, December 04 2006

OVERVIEW:

Public exploit code is available for a recently announced vulnerability [1][2] in the driver for Orinoco based AirPort cards.

“The Broadcom BCMWL5.SYS wireless device driver is vulnerable to a stack-based buffer overflow that can lead to **arbitrary kernel-mode code execution**. This particular vulnerability is caused by improper handling of 802.11 **probe responses containing a long SSID field**. The BCMWL5.SYS driver is bundled with new PCs from HP, Dell, Gateway, eMachines, and other computer manufacturers.

Abusing Preferred Network Lists...

Listens for probes in monitor mode
Becomes AP for all probed networks
Includes extensive support for fake services to manipulate client connectivity (XML)

– Fake SMB, FTP, HTTP

Bring Your Own eXploit (BYOX) model

“... a number of client-side exploits have been written, tested and demonstrated within this framework. Some may be included in a future release. Automated agent deployment is also planned.”

KARMA Example

```
[root@wirelessdefence karma-0.4]# bin/karma etc/karma.xml
Starting KARMA...
Loading config file etc/karma.xml
ACCESS-POINT is running
DNS-SERVER is running
DHCP-SERVER is running
POP3-SERVER is running
FTP-SERVER is running
[2006-01-20 22:43:58] INFO WEBrick 1.3.1
[2006-01-20 22:43:58] INFO ruby 1.8.4 (2005-12-24) [i386-linux]
[2006-01-20 22:43:58] INFO WEBrick::HTTPServer#start: pid=4962 port=80
HTTP-SERVER is running
CONTROLLER-SERVLET is running
EXAMPLE-WEB-EXPLOIT is running
Delivering judicious KARMA, hit Control-C to quit.
AccessPoint: 00:20:A6:54:3E:ED associated
DhcpServer: 00:20:a6:54:3e:ed (dell5150) <- 169.254.0.254
DNS: 169.254.0.254.1128: 22333 IN::A www.mysecretwebsite.com
FTP: 169.254.0.254 myusername/mypassword
```

Today's Wireless Gold Standard

- **Centralized wireless**
- **Keep clients updated – drivers too!**
- **Wireless intrusion detection**
 - Control uncontrolled wireless
 - Locate and protect against rogue APs
- **WPA-2**
 - Authentication using 802.1X and EAP-TLS
 - AES for link-layer encryption
- **Strong passwords**
 - SecureID or other token-card products
 - Strong password policies
- **Authorization with identity-aware firewalls**
 - Enforce principle of least privilege
 - Provide separation of user/device classes



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