Network Access Security – It's Broke, Now What?

June 15, 2010

Jeffrey L Carrell

Network Security Consultant | Network Conversions

SHARKFEST **'10**
Stanford University
June 14-17, 2010

Network Access Security – It's Broke, Now What?

- Access Problems on the Network
- How to Solve It
- How to Enhance It
- Now it Works
- Now it’s Broken

Network Access Security – It's Broke, Now What?

- The Issue: Open Access LAN Switch Ports
- Authentication of Users and End-point Devices on a LAN
- Enhanced Policy Decisions after Initial Authentication
- Network Access Control/Protection
- Components of a Secure Access System
- Demonstration of an 802.1X System

The Issue: Open Access LAN Switch Ports

- Are there open or available LAN Switch ports?
- Can the client device get an IP address?
- Can the client gain "any" access to network?

- If so, then there is the possibility of network attacks
  - attacks to network infrastructure devices (switches, APs)
  - attacks to network resources (servers, etc)
  - attacks to end-user computers
  - virus, trojan, and other malware distribution
  - use of network for malicious network attacks - inside and/or outside
  - data privacy exploits

Controlling Access to the Network

- Lock down LAN switch ports with configuration that requires all connections to the switch to authenticate
  - Users Authenticate
    - providing userid/password credentials
    - can be automated for single sign-on
  - Devices Authenticate
    - VoIP phones
    - Printers
    - Surveillance Cameras

Authentication of Users and End-point Devices on a LAN

- Authentication System for End-point Devices on a Local Area Network
  - IEEE 802.1X
- The Challenge - Adding VoIP Phones to the Secure Network
- RFC-4675
  - Enhancements to IEEE 802.1X

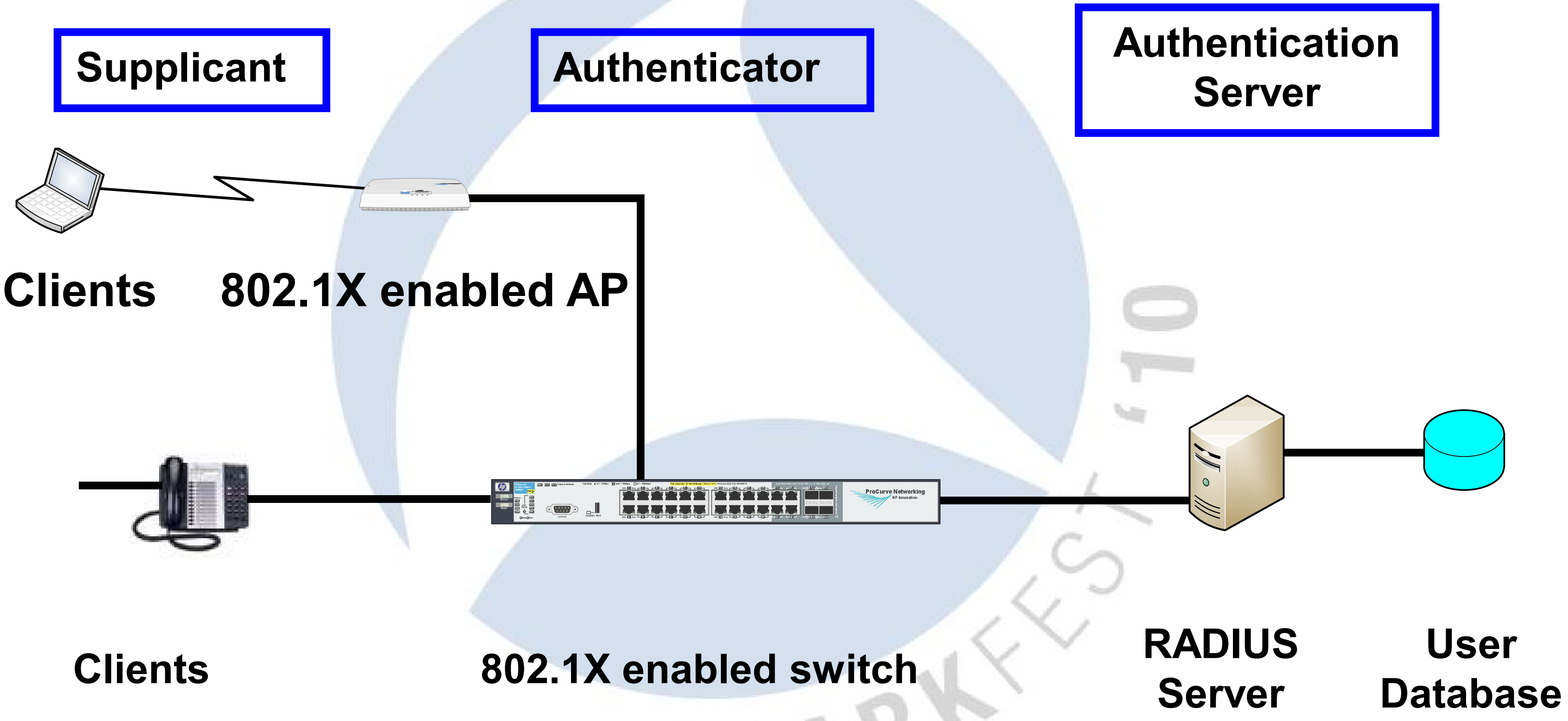
What is IEEE 802.1X?

- IEEE 802.1X is a standards based mechanism allowing users and end-point devices to authenticate in order to gain network access
- Foundation relies on the Remote Authentication Dial-In User Service (RADIUS) networking protocol for Authentication, Authorization and Accounting (AAA) management
- Devices communicate via the Extensible Authentication Protocol over LAN (EAP-OL) - a Layer 2 communication to the authenticator

Why IEEE 802.1X?

- 802.1X controlled switch ports block “normal” traffic by default until authentication is verified using a RADIUS server and EAP
- For specific user authentication, RADIUS server can provide VLAN ID (VID) to switch
- 802.1X does not specify what EAP type is used, as long as the supplicant and authentication server agree on an EAP method
- 802.1X is an IEEE standard and therefore provides interoperability between standards-based network access equipment, authentication servers, and client supplicants

Components of an 802.1X System



Supplicant

Authenticator

Authentication Server

Clients

802.1X enabled AP

Clients

802.1X enabled switch

RADIUS Server

User Database

Authentication Server

- Microsoft IAS (Windows Server 2000/2003)
- Microsoft NPS (Windows Server 2008)
- Juniper Networks Steel-Belted Radius (multiple server platforms)
- FreeRADIUS (many linux server platforms)
- Other RADIUS – conforming to RFC's
  - RFC 2284 PPP Extensible Authentication Protocol (EAP)
  - RFC 2865 Remote Authentication Dial In User Service (RADIUS)
  - RFC 2869 RADIUS Extensions

* not an exhaustive list

Authenticator

- 802.1X Enabled LAN Switch
- 802.1X Enabled Wireless Access Point

- (generally requires enterprise-class devices)

Supplicant

- Microsoft – WinXP, Vista, Win7
- Apple – Mac OS X 10.4+
- Juniper Networks – Odyssey Access Client (Windows, Red Hat Linux)
- Open Source - Open1X (Windows, Linux)
- Network Printers (built-in)
- VoIP Phones (built-in)
- LAN Switch (built-in)
- Wireless Access Point (built-in)

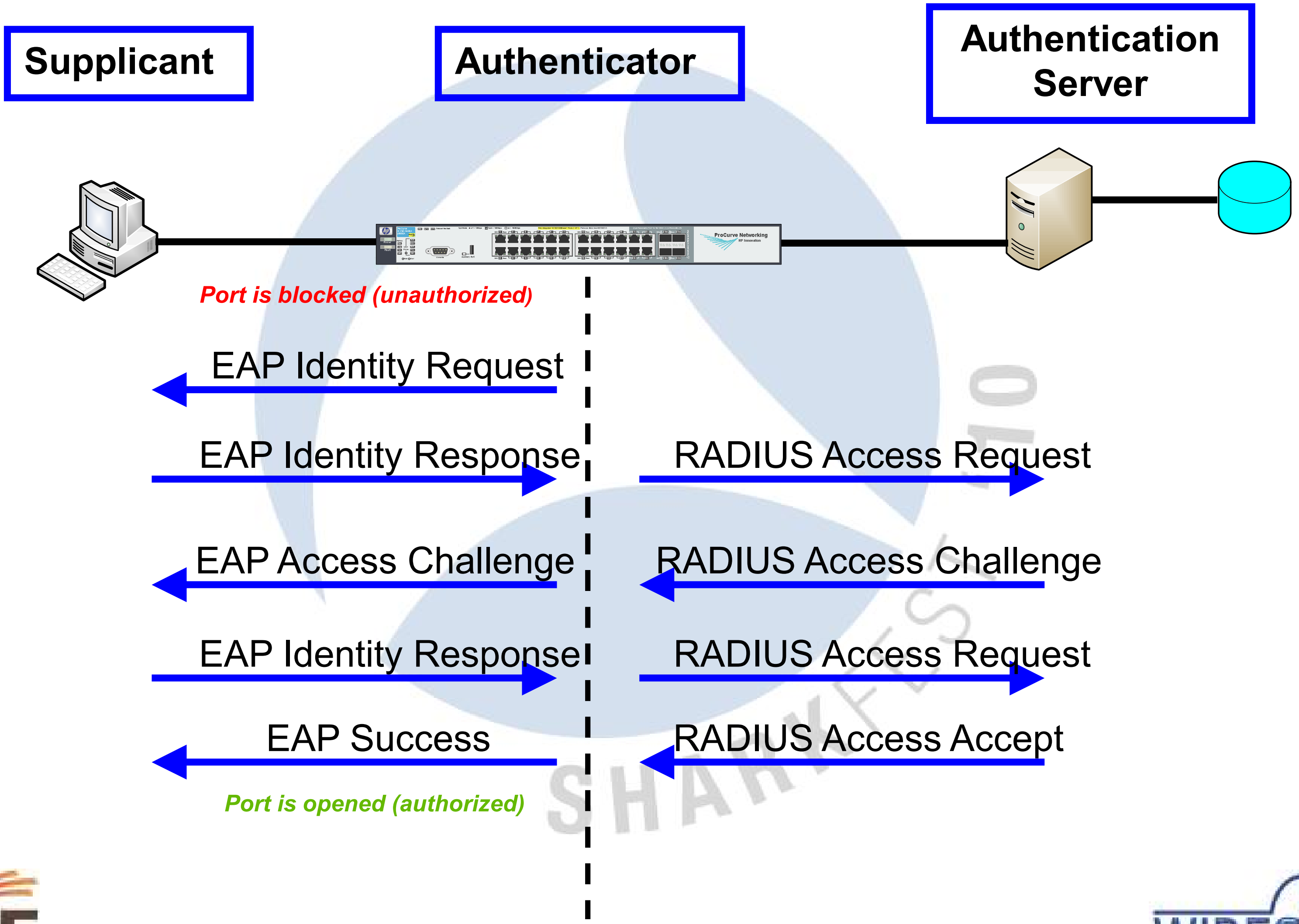
- Client MUST be configured for the same EAP type supported on the Authentication Server

* not an exhaustive list

EAP types

- EAP-MD5
  - least secure
  - most commonly supported on VoIP phones
- Protected EAP (EAP-PEAP)
  - more secure, can use digital certificate on end-point
- EAP-Tunneled TLS (EAP-TTLS)
  - more secure, can use digital certificate on end-point
- EAP-Transport Layer Security (EAP-TLS)
  - most secure, requires digital certificate on end-point

802.1X Communications Flow



Switch Port States in 802.1X

- A port that has been configured to require 802.1X authentication has two states:
  - Unauthorized—no authorized client has connected to the port, or client has failed authentication
  - Authorized—connected client has supplied valid credentials and has been authenticated
- When a port is in the unauthorized state, only EAP traffic is allowed
- When a port is in the authorized state, traffic is forwarded normally

VLAN Assignment of Switch Port

- RADIUS can send attributes to the switch which could define a specific VLAN the port is assigned to based on the user credentials
- If RADIUS doesn’t provide VLAN attributes, switch port could be assigned to “authorized VID”
- If RADIUS doesn’t provide VLAN attributes and the “authorized VID” is not defined, then the switch opens the port using the statically assigned VID of that port

* for the duration of that authorized users’ session

The Challenge - Adding VoIP Phones to the Secure Network

- Some manufacturers' VoIP phones support 802.1X with a built-in supplicant, but generally only a few in their product lines
  - if so, then a matching RADIUS remote access policy can be configured to support the VoIP phone
- Without RFC-4675, dynamic 802.1Q (tag) VID assignment from RADIUS is not possible
- If the VoIP phone doesn't have a supplicant, difficult to support 802.1X authentication
  - some LAN switch manufacturers support alternate 802.1X authentication methods, such as MAC Auth & WEB Auth

RFC-4675
Enhancements to 802.1X

- RADIUS can specify tag ports (for VoIP phones)
- RADIUS can specify VLAN name to switch

- Is supported on:
  - FreeRADIUS v2.0.0+

- May require LAN switch software upgrade

Configuring a Microsoft Server Based System for 802.1X

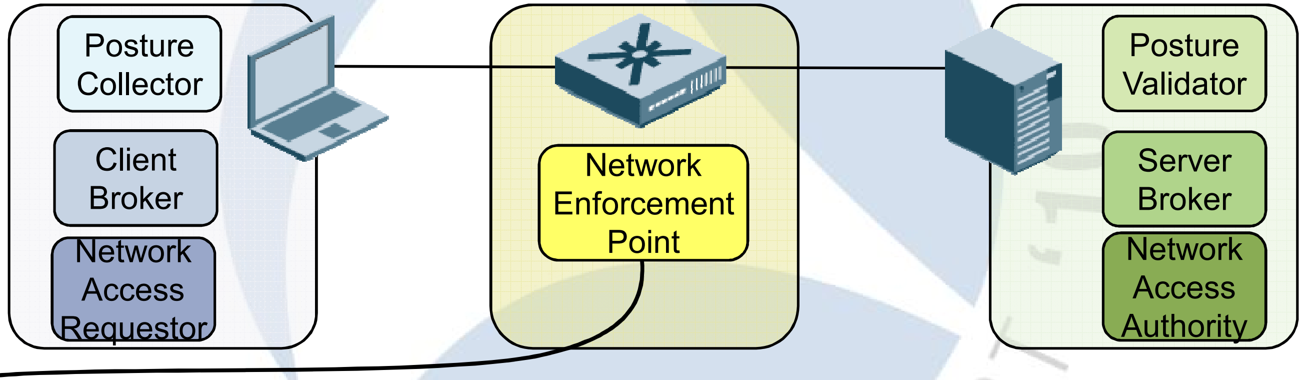
- Active Directory
  - userID(s) must have “remote access permission” enabled
- IAS/NPS
  - define each authenticator as RADIUS client
  - define remote access policies for users
- LAN Switch and/or AP
  - configure RADIUS server definition
  - configure specific ports/WLANs to support 802.1X
- Client Supplicant
  - configure EAP type used for authentication

Enhanced Policy Decisions after Initial Authentication

- A mechanism to apply additional policy based rules to validate a user's level of access into the network
- Executes after initial 802.1X authentication
- Policy components may include:
  - where is the user/device in the network
  - when is the user/device on the network
  - integrity of the computer or device

TCG/Microsoft/IETF Architectures

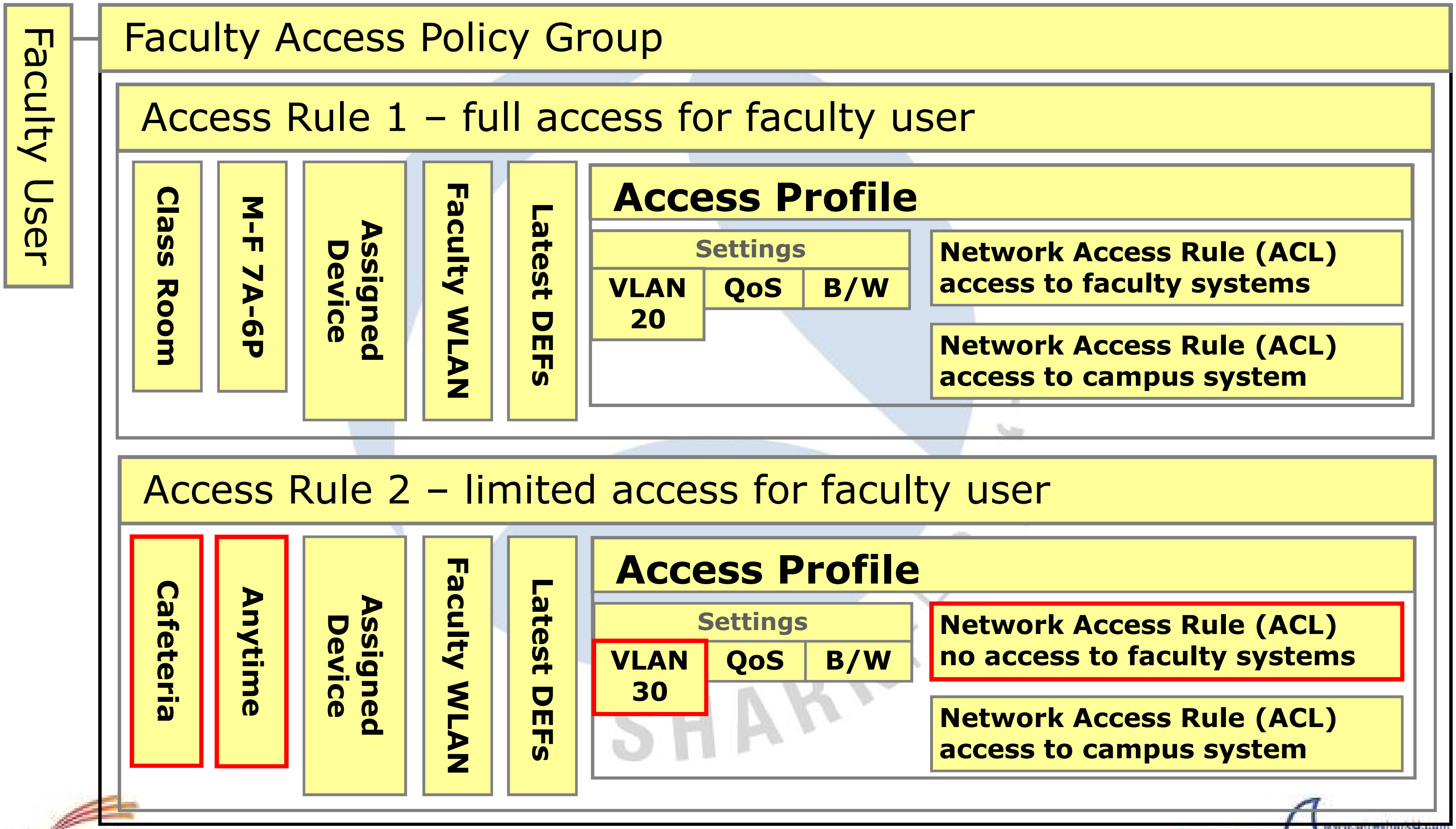
What is it?	TCG TNC	Microsoft	IETF NEA
Posture Collector Third-party software that runs on the client and collects information on security status and applications, such as "is A/V enabled and up-to-date?"	Integrity Measurement Collector	System Health Agent	Posture Collector
Client Broker "Middleware" that runs on the client and talks to the Posture Collectors, collecting their data, and passing it down to Network Access Requestor. In product form, this is generally bundled with the Network Access Requestor.	TNC Client	NAP Agent	Posture Broker Client
Network Access Requestor Software that connects the client to network. Examples might be 802.1X supplicant or IPSec VPN client. Used to authenticate the user, but also as a conduit for Posture Collector data to make it to the other side.	Network Access Requestor	NAP Enforcement Client	Posture Transport Client



What is it?	TCG TNC	Microsoft	IETF NEA
Network Enforcement Point Component within the network that enforces policy, typically an 802.1X-capable switch or WLAN, VPN gateway, or firewall.	Policy Enforcement Point	NAP Enforcement Server	Intermediary Devices
Posture Validator Third-party software that receives status information from Posture Collectors on clients and validates the status information against stated network policy, returning a status to the Server Broker.	Integrity Measurement Verifier	System Health Validator	Posture Validator
Server Broker "Middleware" acting as an interface between multiple Posture Validators and the Network Access Authority.	TNC Server	NAP Administration Server	Posture Broker Server
Network Access Authority A server responsible for validating authentication and posture information and passing policy information back to the Network Enforcement Point.	Network Access Authority	Network Policy Server	Posture Transport Server

this slide from Interop iLabs NAC Team - used with permission

Enhanced Policy Decisions
Example Policy



Faculty User

Faculty Access Policy Group

Access Rule 1 – full access for faculty user

Class Room

M-F 7A-6P

Assigned Device

Faculty WLAN

Latest DEFs

Access Profile

Settings

VLAN 20 | QoS | B/W

Network Access Rule (ACL) access to faculty systems

Network Access Rule (ACL) access to campus system

Access Rule 2 – limited access for faculty user

Cafeteria

Anytime

Assigned Device

Faculty WLAN

Latest DEFs

Access Profile

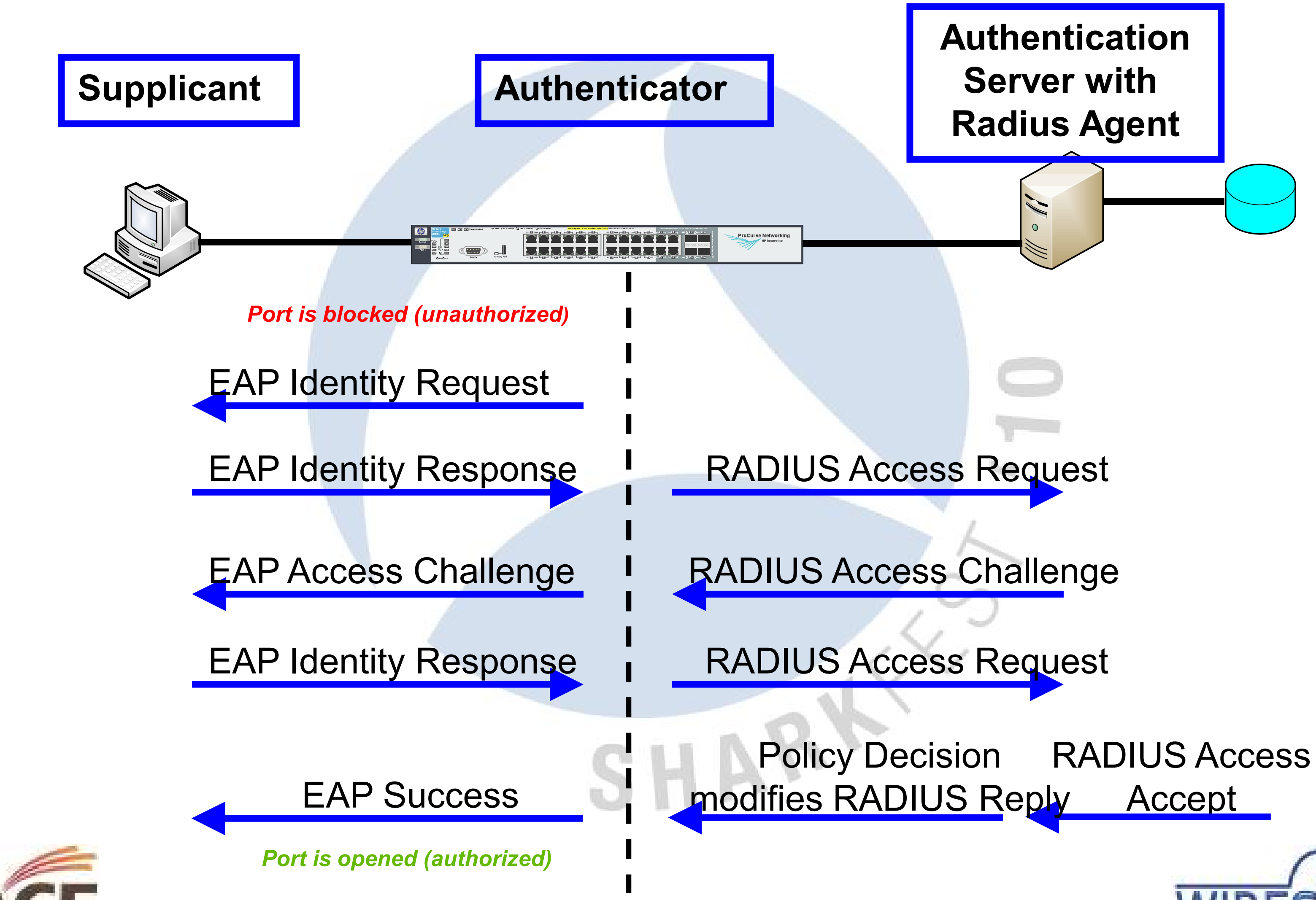
Settings

VLAN 30 | QoS | B/W

Network Access Rule (ACL) no access to faculty systems

Network Access Rule (ACL) access to campus system

Enhanced Policy Decisions Communications Flow



Supplicant

Authenticator

Authentication Server with Radius Agent

Port is blocked (unauthorized)

EAP Identity Request

EAP Identity Response

RADIUS Access Request

EAP Access Challenge

RADIUS Access Challenge

EAP Identity Response

RADIUS Access Request

Policy Decision modifies RADIUS Reply

RADIUS Access Accept

EAP Success

Port is opened (authorized)

Network Access Control/Protection

- Before authentication and possible policy decision *
- Provides Endpoint Integrity Assessment
  - Verify OS updates & hot fixes/service packs
  - Verify security applications are running and up-to-date
- Provides Endpoint Integrity Enforcement
  - Quarantines access for remediation to NAC/NAP policy compliance
  - Restrict access for non-compliance

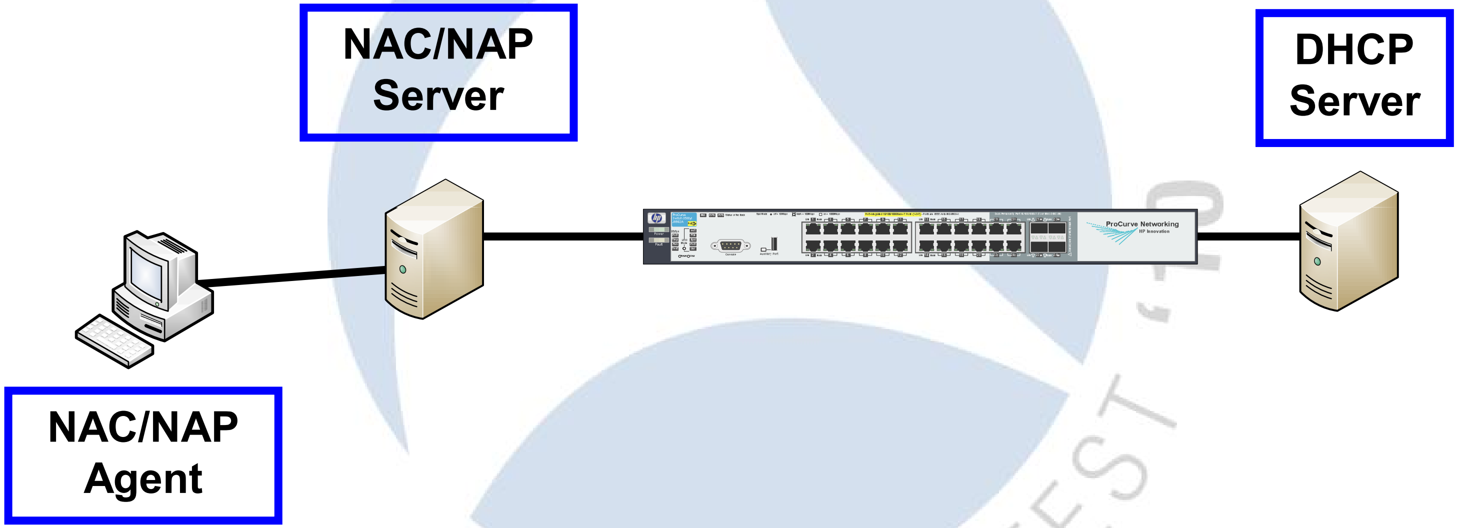
* Some NAC/NAP Systems include these functions

Network Access Control/Protection

- 3 Primary client testing options
  - Agent – least user interaction
  - ActiveX – requires user to launch browser
  - Agentless – limited function
- 3 Types of Endpoint Integrity Assessment Tests
  - Inline – NAC/NAP server in the flow of traffic
  - DHCP – NAC/NAP server intercepts DHCP request
  - 802.1X – authentication required

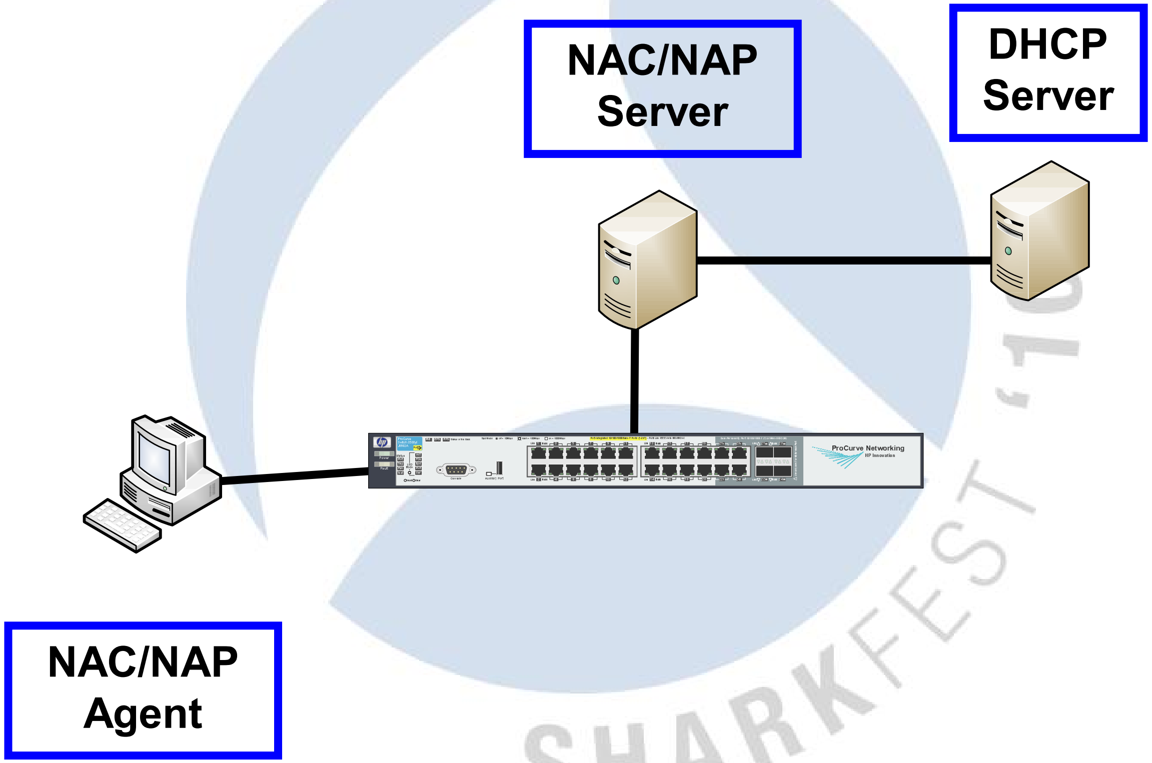
Endpoint Integrity Assessment Test – Inline

- NAC/NAP server in the flow of traffic



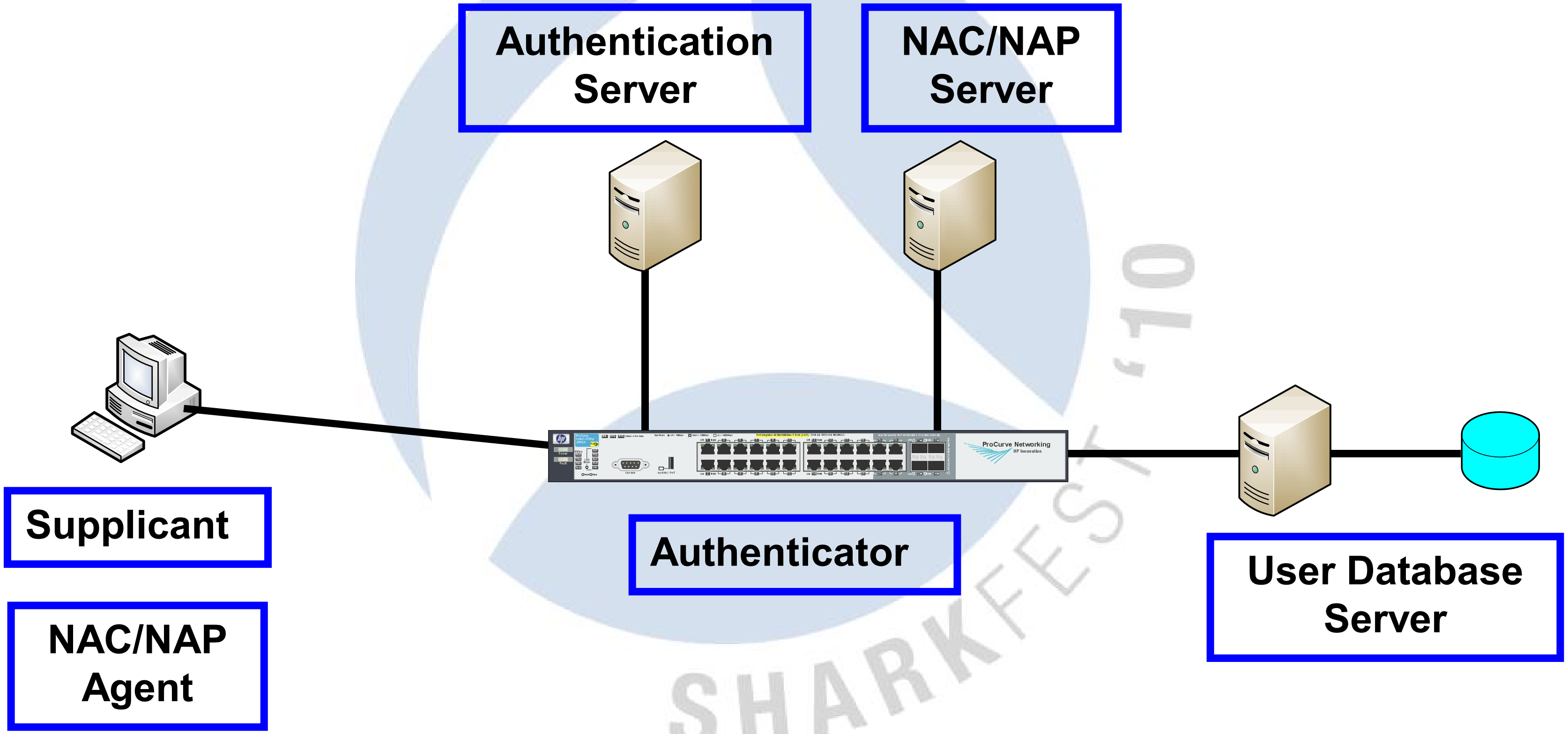
Endpoint Integrity Assessment Test – DHCP

- NAC/NAP server intercepts DHCP request



Endpoint Integrity Assessment Test – 802.1X

- Authentication required



Authentication Server

NAC/NAP Server

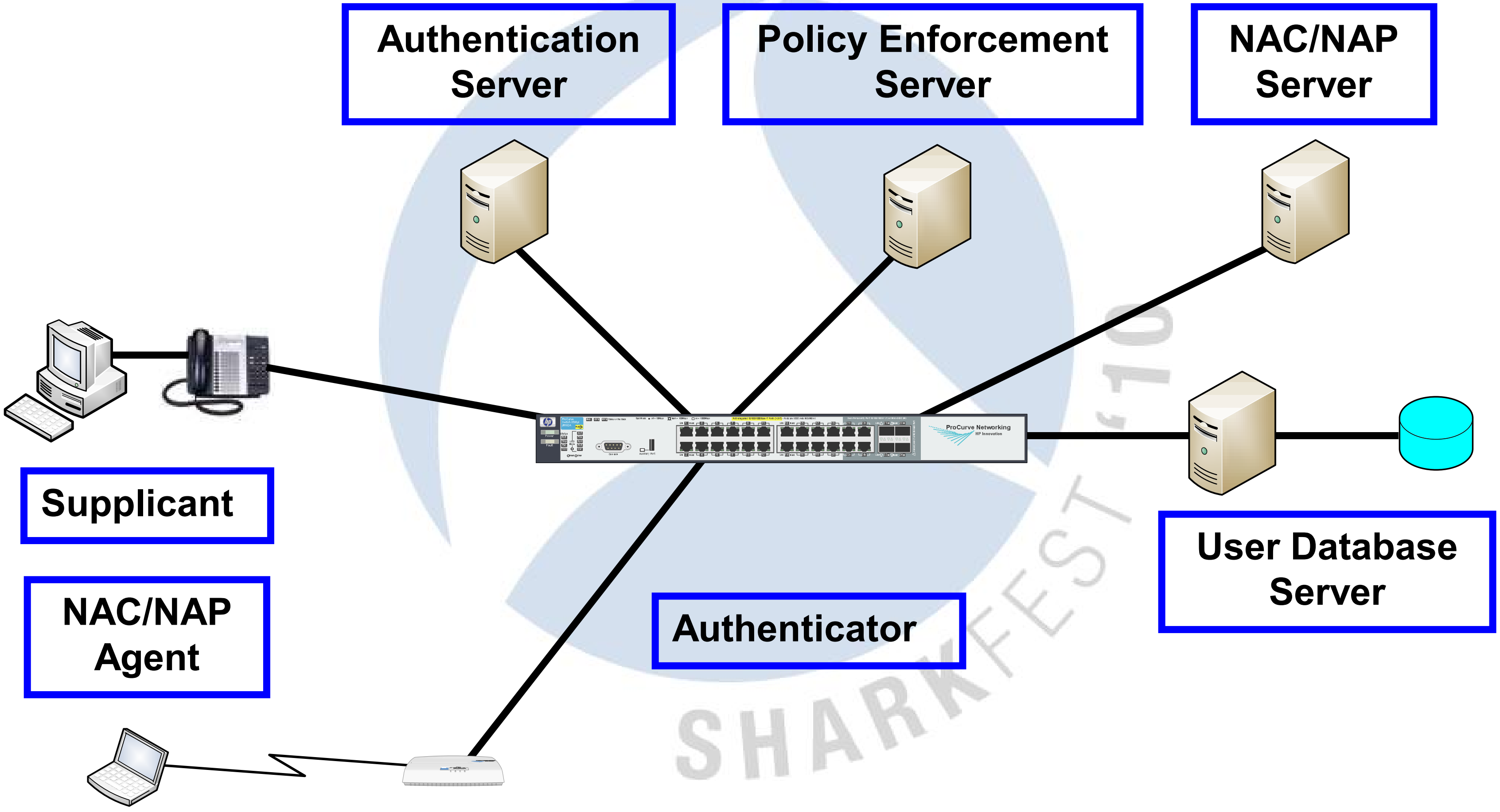
Supplicant

NAC/NAP Agent

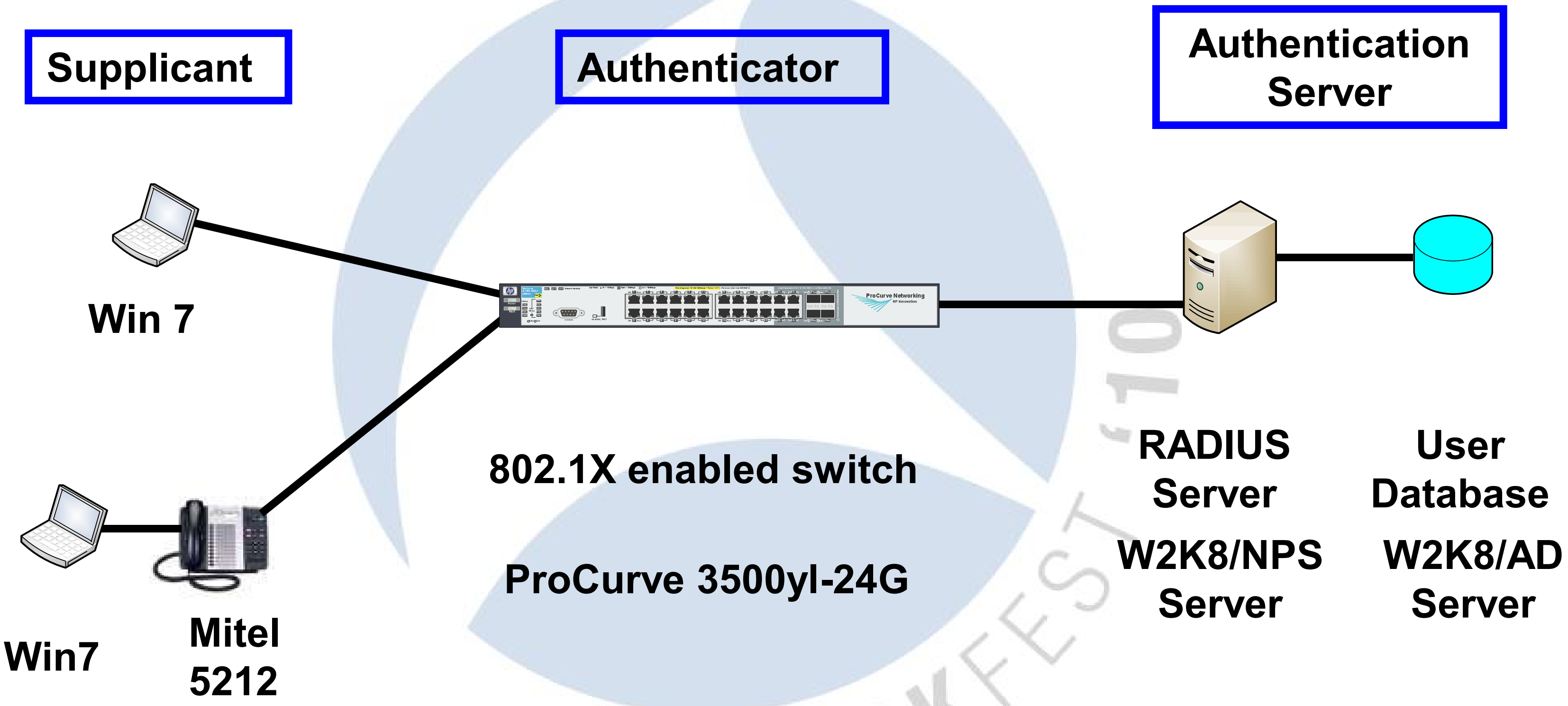
Authenticator

User Database Server

Components of a Secure Access System



Demonstration of an 802.1X System



Supplicant

Authenticator

Authentication Server

Win 7

Win7

Mitel 5212

802.1X enabled switch

ProCurve 3500yl-24G

RADIUS Server

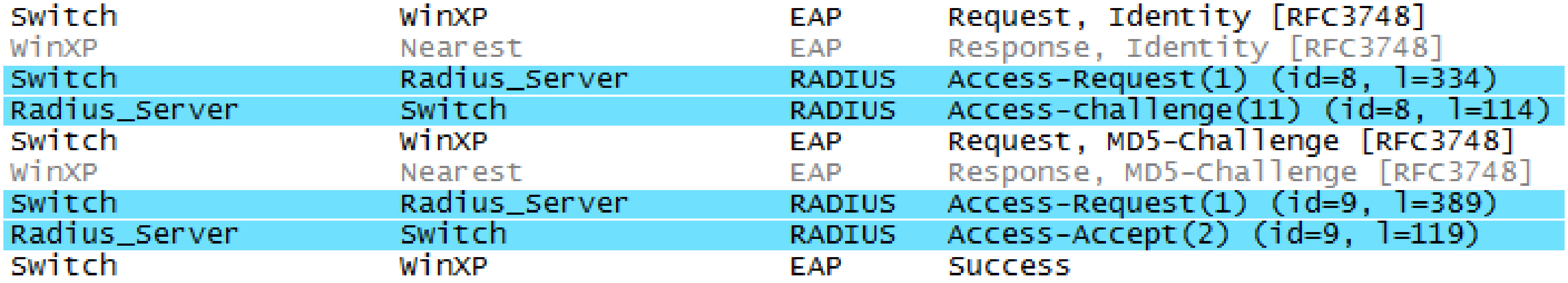
W2K8/NPS Server

User Database

W2K8/AD Server

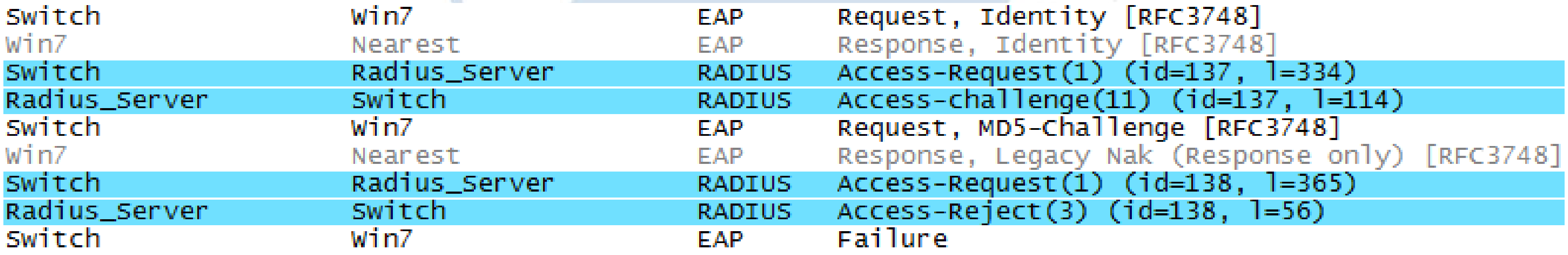
Of Course We Have Captures!

- Successful client authentication



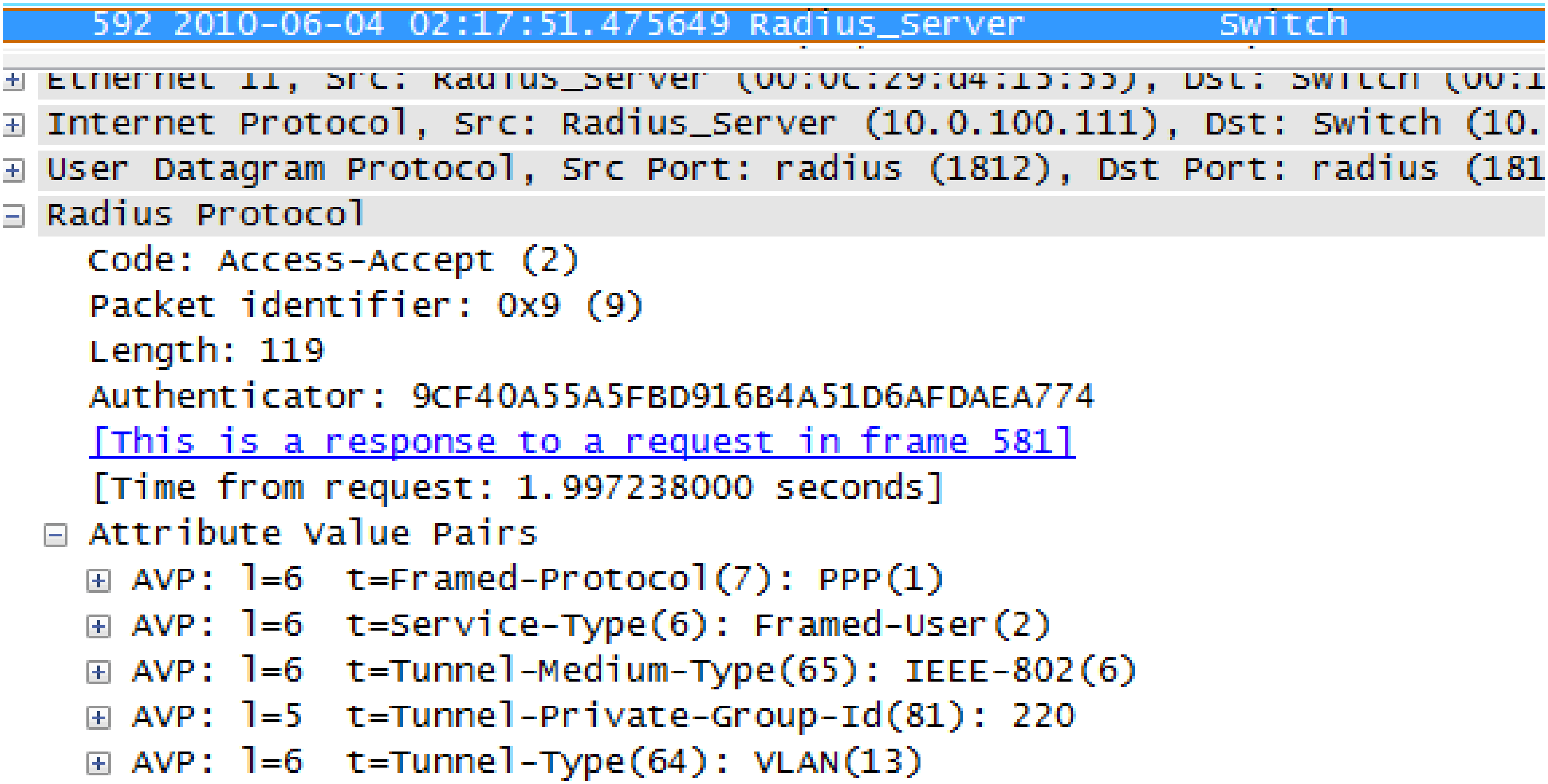
```
Switch                 WinXP                  EAP       Request, Identity [RFC3748]
WinXP                  Nearest                EAP       Response, Identity [RFC3748]
Switch                 Radius_Server          RADIUS    Access-Request(1) (id=8, l=334)
Radius_Server          Switch                 RADIUS    Access-challenge(11) (id=8, l=114)
Switch                 WinXP                  EAP       Request, MD5-Challenge [RFC3748]
WinXP                  Nearest                EAP       Response, MD5-Challenge [RFC3748]
Switch                 Radius_Server          RADIUS    Access-Request(1) (id=9, l=389)
Radius_Server          Switch                 RADIUS    Access-Accept(2) (id=9, l=119)
Switch                 WinXP                  EAP       Success
```

- Failed client authentication



```
Switch                 Win7                   EAP       Request, Identity [RFC3748]
Win7                   Nearest                EAP       Response, Identity [RFC3748]
Switch                 Radius_Server          RADIUS    Access-Request(1) (id=137, l=334)
Radius_Server          Switch                 RADIUS    Access-challenge(11) (id=137, l=114)
Switch                 Win7                   EAP       Request, MD5-Challenge [RFC3748]
Win7                   Nearest                EAP       Response, Legacy Nak (Response only) [RFC3748]
Switch                 Radius_Server          RADIUS    Access-Request(1) (id=138, l=365)
Radius_Server          Switch                 RADIUS    Access-Reject(3) (id=138, l=56)
Switch                 Win7                   EAP       Failure
```

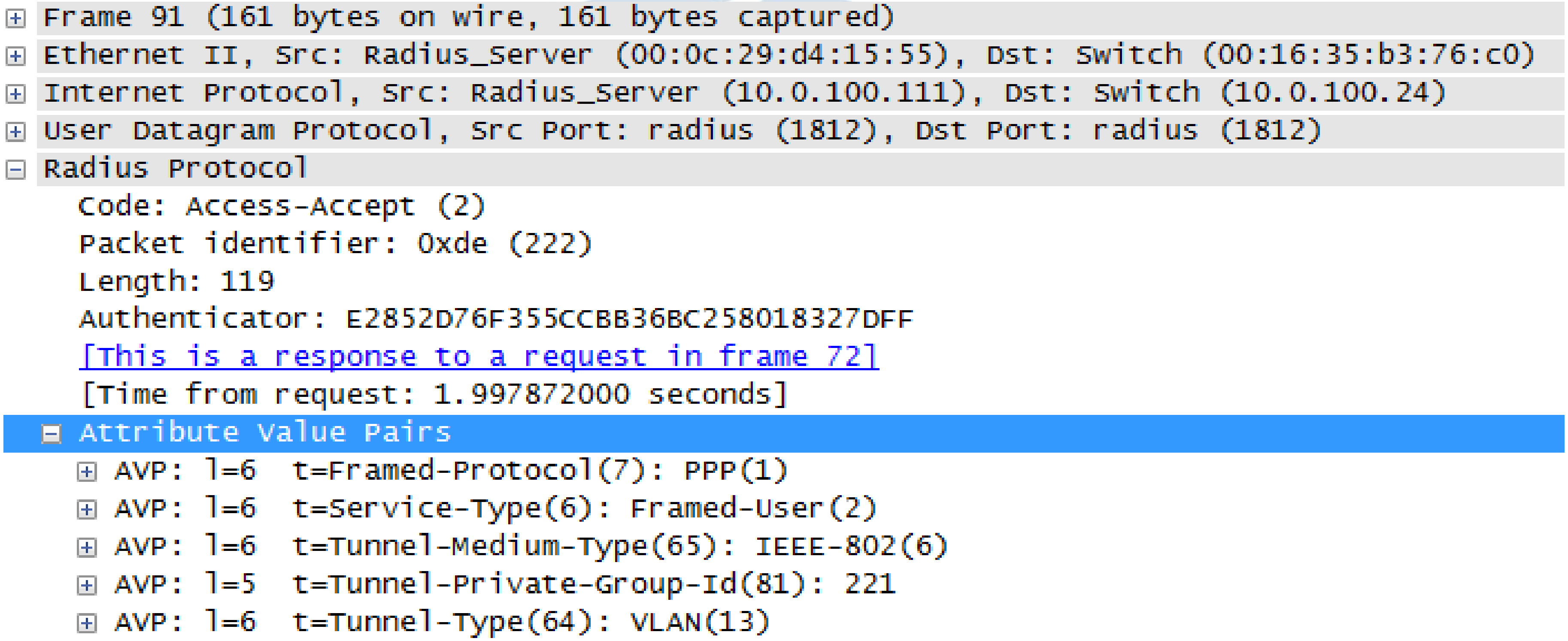
Successful Client Authentication, w/VLAN Assignment



```
    592 2010-06-04 02:17:51.475649 Radius_Server          Switch
⊞ Ethernet II, Src: Radius_Server (00:0c:29:d4:15:55), Dst: Switch (00:1
⊞ Internet Protocol, Src: Radius_Server (10.0.100.111), Dst: Switch (10.
⊞ User Datagram Protocol, Src Port: radius (1812), Dst Port: radius (181
⊟ Radius Protocol
    Code: Access-Accept (2)
    Packet identifier: 0x9 (9)
    Length: 119
    Authenticator: 9CF40A55A5FBD916B4A51D6AFDAEA774
    [This is a response to a request in frame 581]
    [Time from request: 1.997238000 seconds]
  ⊟ Attribute Value Pairs
    ⊞ AVP: l=6  t=Framed-Protocol(7): PPP(1)
    ⊞ AVP: l=6  t=Service-Type(6): Framed-User(2)
    ⊞ AVP: l=6  t=Tunnel-Medium-Type(65): IEEE-802(6)
    ⊞ AVP: l=5  t=Tunnel-Private-Group-Id(81): 220
    ⊞ AVP: l=6  t=Tunnel-Type(64): VLAN(13)
```

Successful Client Authentication, but Fail on Switch

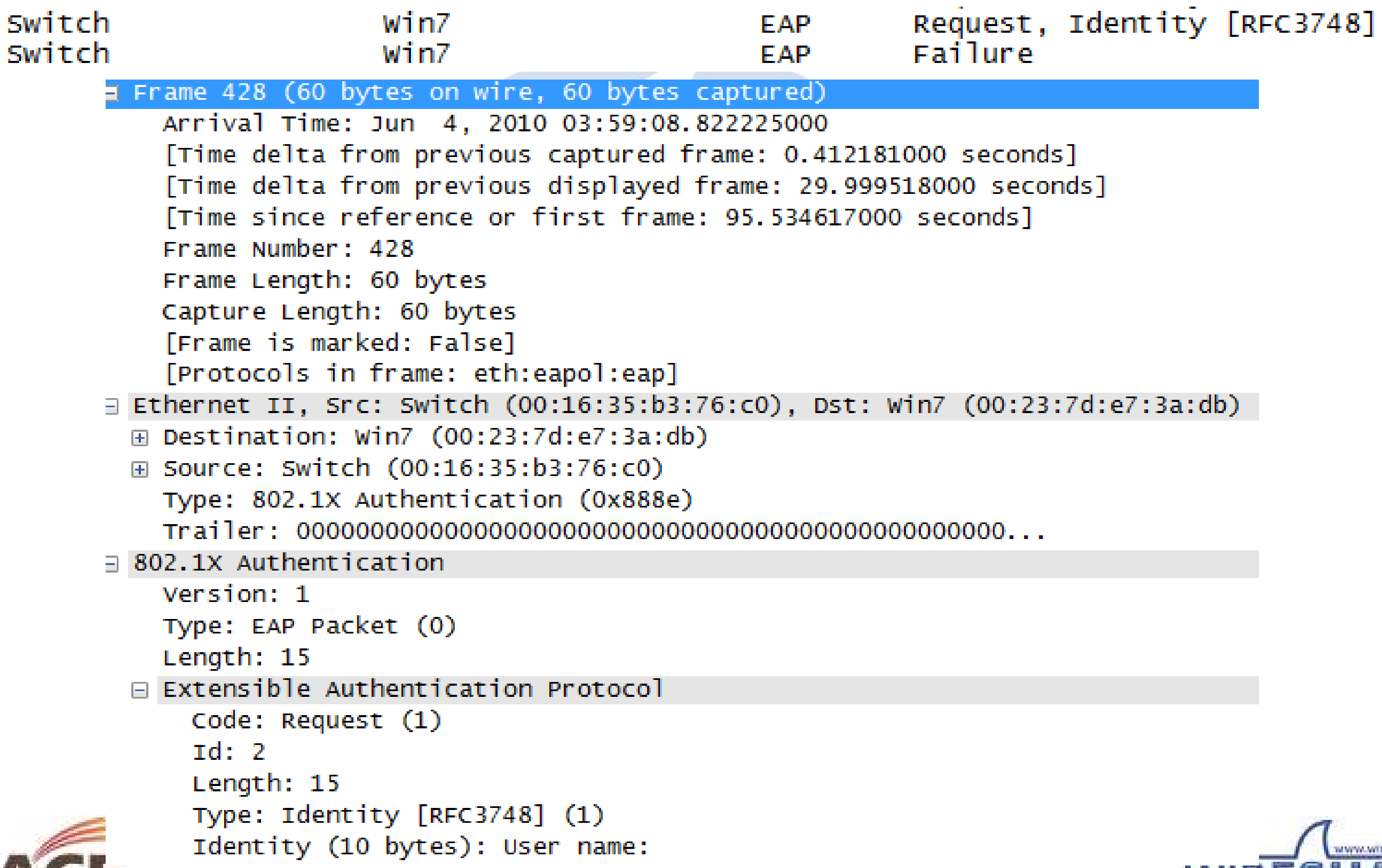
- RADIUS provided VID, switch did not have that specific VID configured



```
⊞ Frame 91 (161 bytes on wire, 161 bytes captured)
⊞ Ethernet II, Src: Radius_Server (00:0c:29:d4:15:55), Dst: Switch (00:16:35:b3:76:c0)
⊞ Internet Protocol, Src: Radius_Server (10.0.100.111), Dst: Switch (10.0.100.24)
⊞ User Datagram Protocol, Src Port: radius (1812), Dst Port: radius (1812)
⊟ Radius Protocol
    Code: Access-Accept (2)
    Packet identifier: 0xde (222)
    Length: 119
    Authenticator: E2852D76F355CCBB36BC258018327DFF
    [This is a response to a request in frame 72]
    [Time from request: 1.997872000 seconds]
  ⊟ Attribute Value Pairs
    ⊞ AVP: l=6  t=Framed-Protocol(7): PPP(1)
    ⊞ AVP: l=6  t=Service-Type(6): Framed-User(2)
    ⊞ AVP: l=6  t=Tunnel-Medium-Type(65): IEEE-802(6)
    ⊞ AVP: l=5  t=Tunnel-Private-Group-Id(81): 221
    ⊞ AVP: l=6  t=Tunnel-Type(64): VLAN(13)
```

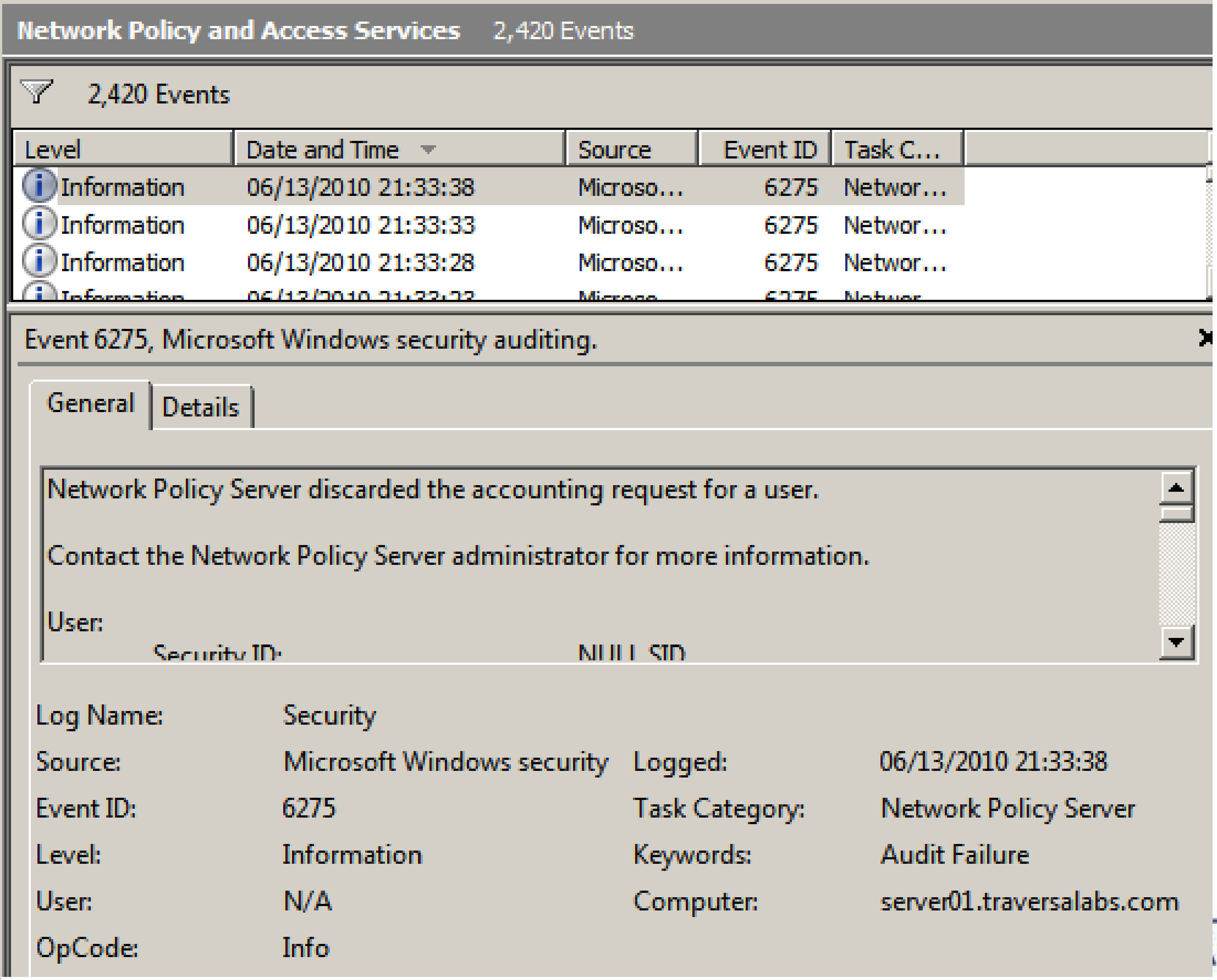
Fri Jun 04 13:44:29 2010: <12> Jun 4 13:44:28 10.0.100.24 02400 dca: 8021X client, RADIUS-assigned VID validation error. MAC 00226481699E port 17 VLAN-Id 0 or unknown.

Unsuccessful Authentication: no Supplicant Enabled on Client



```
Switch                  Win7                    EAP      Request, Identity [RFC3748]
Switch                  Win7                    EAP      Failure
⊟ Frame 428 (60 bytes on wire, 60 bytes captured)
    Arrival Time: Jun  4, 2010 03:59:08.822225000
    [Time delta from previous captured frame: 0.412181000 seconds]
    [Time delta from previous displayed frame: 29.999518000 seconds]
    [Time since reference or first frame: 95.534617000 seconds]
    Frame Number: 428
    Frame Length: 60 bytes
    Capture Length: 60 bytes
    [Frame is marked: False]
    [Protocols in frame: eth:eapol:eap]
⊟ Ethernet II, Src: Switch (00:16:35:b3:76:c0), Dst: Win7 (00:23:7d:e7:3a:db)
  ⊞ Destination: Win7 (00:23:7d:e7:3a:db)
  ⊞ Source: Switch (00:16:35:b3:76:c0)
    Type: 802.1X Authentication (0x888e)
    Trailer: 00000000000000000000000000000000000000000000000...
⊟ 802.1X Authentication
    Version: 1
    Type: EAP Packet (0)
    Length: 15
  ⊟ Extensible Authentication Protocol
      Code: Request (1)
      Id: 2
      Length: 15
      Type: Identity [RFC3748] (1)
      Identity (10 bytes): User name:
```

Fail-Client Configured for Incorrect EAP Type



Network Policy and Access Services 2,420 Events

2,420 Events

Level	Date and Time	Source	Event ID	Task C...
Information	06/13/2010 21:33:38	Microso...	6275	Networ...
Information	06/13/2010 21:33:33	Microso...	6275	Networ...
Information	06/13/2010 21:33:28	Microso...	6275	Networ...
Information	06/13/2010 21:33:23	Microso...	6275	Networ...

Event 6275, Microsoft Windows security auditing.

Network Policy Server discarded the accounting request for a user.

Contact the Network Policy Server administrator for more information.

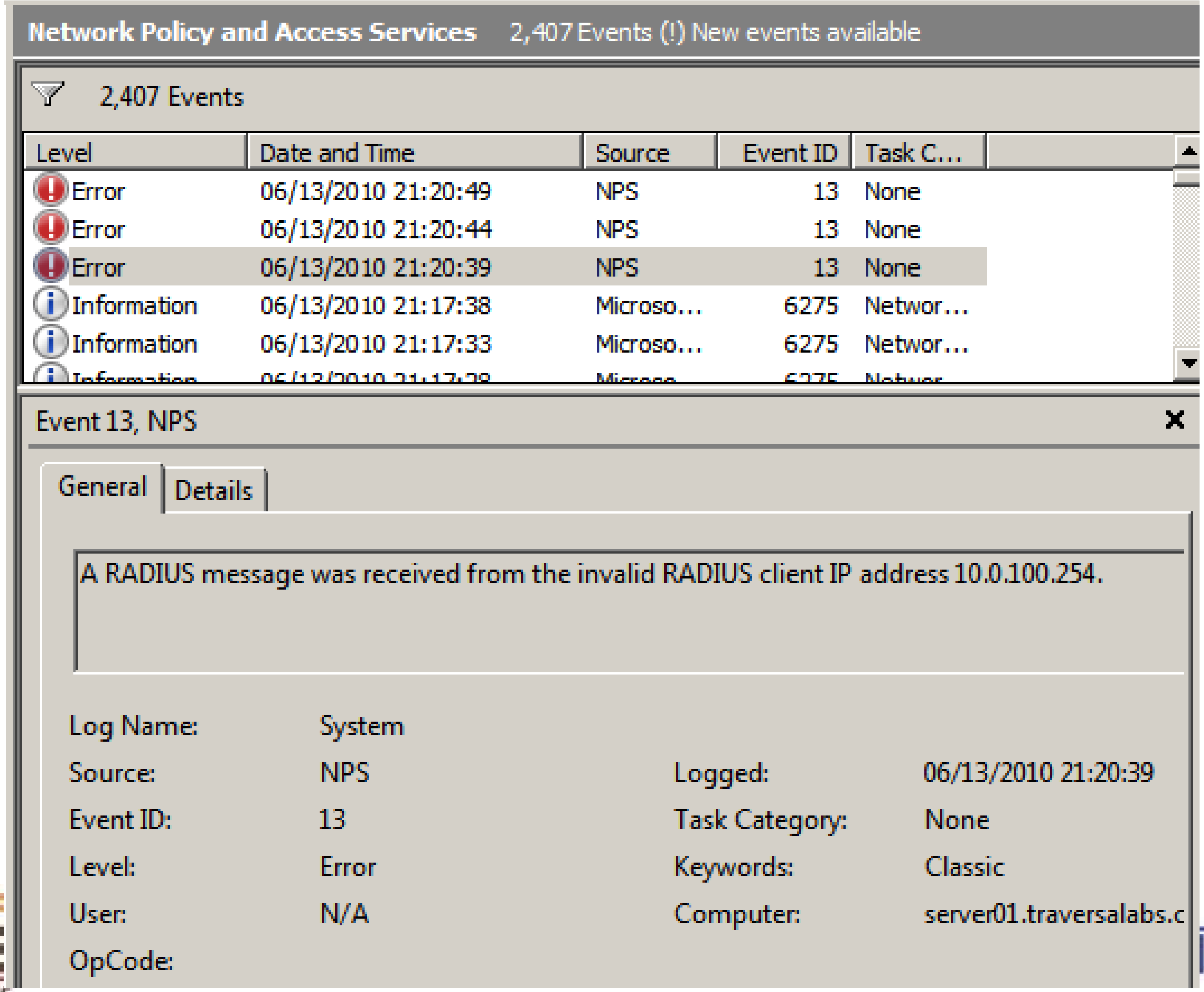
User:
Security ID: NULL SID

Log Name:	Security		
Source:	Microsoft Windows security	Logged:	06/13/2010 21:33:38
Event ID:	6275	Task Category:	Network Policy Server
Level:	Information	Keywords:	Audit Failure
User:	N/A	Computer:	server01.traversalabs.com
OpCode:	Info		

Fail-Client Configured for Incorrect EAP Type

```
Level               Date and Time         Source                Event ID              Task Category
Information         06/13/2010 21:33:38   Microsoft-Windows-Security-Auditing         6275
                    Network Policy Server  "Network Policy Server discarded the accounting request for a user.

Contact the Network Policy Server administrator for more information.

User:
                    Security ID:                                                      NULL SID
                    Account Name:                                                     procurve
                    Account Domain:                                                   -
                    Fully Qualified Account Name:               -

Client Machine:
                    Security ID:                                                      NULL SID
                    Account Name:                                                     -
                    Fully Qualified Account Name:               -
                    OS-Version:                                                       -
                    Called Station Identifier:                                        -
                    Calling Station Identifier:                                       00-23-8B-72-99-D8

NAS:
                    NAS IPv4 Address:                           10.0.1.2
                    NAS IPv6 Address:                           -
                    NAS Identifier:                                                   ProCurve_3524G
                    NAS Port-Type:                                                    -
                    NAS Port:                                                         13

RADIUS Client:
                    Client Friendly Name:                       ProCurve_3524G_a
                    Client IP Address:                                                10.0.100.254

Authentication Details:
                    Proxy Policy Name:                          -
                    Network Policy Name:                        -
                    Authentication Provider:                                          -
                    Authentication Server:                      server01.traversalabs.com
                    Authentication Type:                        -
                    EAP Type:                                                         -
                    Account Session Identifier:
                    30303742303030303030313437
                    Reason Code:                                                      49
                    Reason:                                                                              The
connection attempt did not match any connection request policy.
"
```

Fail-No Client Defined in RADIUS for this Authenticator



Network Policy and Access Services 2,407 Events (!) New events available

2,407 Events

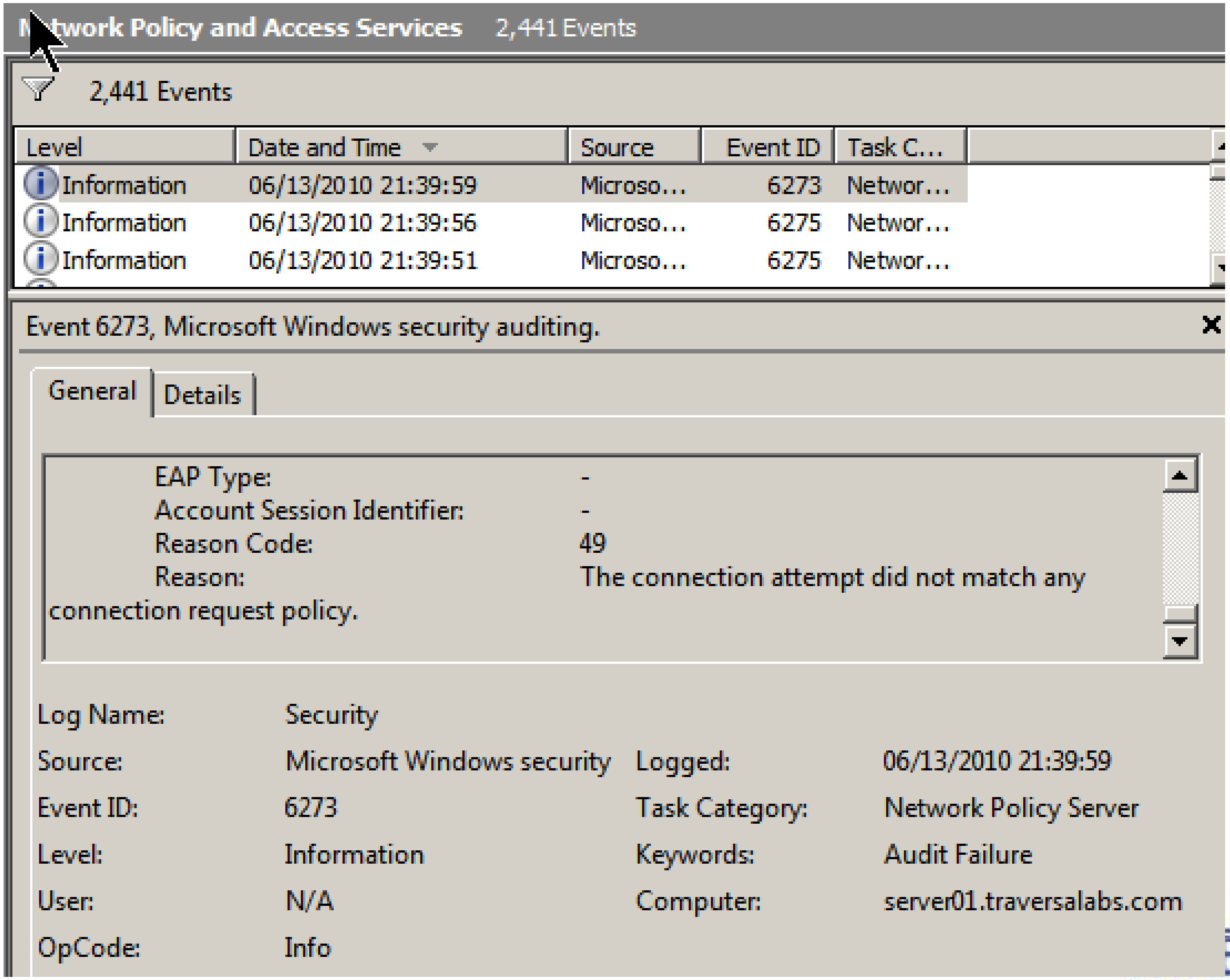
Level	Date and Time	Source	Event ID	Task C...
Error	06/13/2010 21:20:49	NPS	13	None
Error	06/13/2010 21:20:44	NPS	13	None
Error	06/13/2010 21:20:39	NPS	13	None
Information	06/13/2010 21:17:38	Microso...	6275	Networ...
Information	06/13/2010 21:17:33	Microso...	6275	Networ...
Information	06/13/2010 21:17:28	Microso...	6275	Networ...

Event 13, NPS

A RADIUS message was received from the invalid RADIUS client IP address 10.0.100.254.

Log Name:	System		
Source:	NPS	Logged:	06/13/2010 21:20:39
Event ID:	13	Task Category:	None
Level:	Error	Keywords:	Classic
User:	N/A	Computer:	server01.traversalabs.c
OpCode:			

Fail-no Radius
Connection Policy Match



Network Policy and Access Services 2,441 Events

2,441 Events

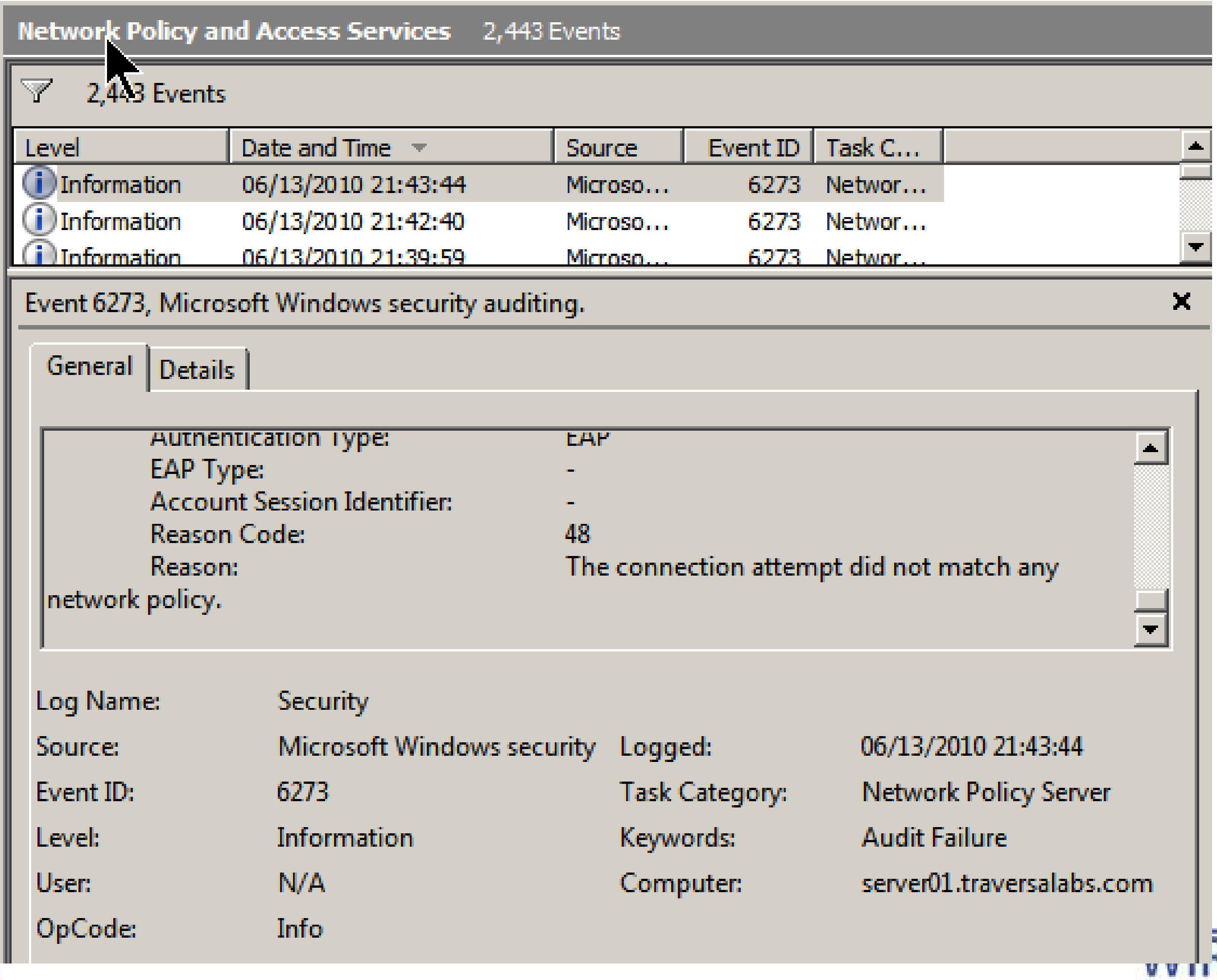
Level	Date and Time	Source	Event ID	Task C…
Information	06/13/2010 21:39:59	Microso…	6273	Networ…
Information	06/13/2010 21:39:56	Microso…	6275	Networ…
Information	06/13/2010 21:39:51	Microso…	6275	Networ…

Event 6273, Microsoft Windows security auditing.

```
            EAP Type:                               -
            Account Session Identifier:             -
            Reason Code:                            49
            Reason:                                 The connection attempt did not match any
connection request policy.
```

Log Name:	Security		
Source:	Microsoft Windows security	Logged:	06/13/2010 21:39:59
Event ID:	6273	Task Category:	Network Policy Server
Level:	Information	Keywords:	Audit Failure
User:	N/A	Computer:	server01.traversalabs.com
OpCode:	Info		

Fail-no Radius
Network Policy Match



Network Policy and Access Services 2,443 Events

2,443 Events

Level	Date and Time	Source	Event ID	Task C...
Information	06/13/2010 21:43:44	Microso...	6273	Networ...
Information	06/13/2010 21:42:40	Microso...	6273	Networ...
Information	06/13/2010 21:39:59	Microso...	6273	Networ...

Event 6273, Microsoft Windows security auditing.

```
            Authentication Type:                 EAP
            EAP Type:                            -
            Account Session Identifier:          -
            Reason Code:                         48
            Reason:                              The connection attempt did not match any
network policy.
```

Log Name:	Security		
Source:	Microsoft Windows security	Logged:	06/13/2010 21:43:44
Event ID:	6273	Task Category:	Network Policy Server
Level:	Information	Keywords:	Audit Failure
User:	N/A	Computer:	server01.traversalabs.com
OpCode:	Info		

Captures Isn’t All

- So, where can you look to troubleshoot if the captures don’t tell the whole story?
  - – Look at RADIUS logs
    - Event Viewer in W2K0/3/8
  - – Look at switch logs
  - – Look at client Logs
    - Event Viewer

Network Access Security – It's Broke, Now What?

Thank You for Attending!

Jeffrey L Carrell
Network Security Consultant
jeff.carrell@networkconversions.com

www.thenetworksandbox.com