NAC@ACK

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&
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Agenda

- Part 1 – Introduction (very short)
  - Some marketing buzz on Cisco NAC
- Part 2 – NAC Technology
  - All you need to know about NAC (in order to hack it)
- Part 3 – Security Analysis
  - Delving into the security flaws of Ciscos’ NAC solution
- Part 4 – Approaching NAC@ACK
  - The stony road towards a working exploit
- Part 5 - Showtime
Part 1 - Introduction
Why is Cisco selling Cisco NAC?

- Because customers are willing to pay for it ,-)
- But why are customers willing to pay for it?
- Because Cisco makes some pretty cool promises… see next slide
NAC Business Benefits

Dramatically improves security

- Ensures endpoints (laptops, PCs, PDAs, servers, etc.) conform to security policy
- Proactively protects against worms, viruses, spyware, and malware; focuses operations on prevention, not reaction

Extends existing investment

- Enables broad integration with multivendor security and management software
- Enhances investment in network infrastructure and vendor software
- Combining with Cisco Security Agent enables "trusted QoS" capabilities that classify mission-critical traffic at the endpoint and prioritize it in the network

Increases enterprise resilience

- Comprehensive admission control across all access methods
- Prevents non-compliant and rogue endpoints from impacting network
- Reduces OpEx related to identifying and repairing non-compliant, rogue, and infected systems

Comprehensive span of control

- Assesses all endpoints across all access methods, including LAN, wireless connectivity, remote access, and WAN
The idea behind Cisco NAC

- Grant access to the network based on the grade of compliance to a defined (security) policy. **So it is first of all a compliance solution and not a security solution.**

- **Security Policy can usually be broken down to:**
  - Patch level (OS & Application)
  - AV signatures & scan engine up to date
  - No „unwanted“ programs (e.g. l33t t00ls)
  - Desktop Firewall up & running

- If a client is non-compliant to the policy [and is not whitelisted somewhere – think network-printers], restrict access.

2. Access Device queries the client for an agent and relays information to a backend policy server.

3. Policy Server checks received information against defined rules and derives an appropriate access-level.

Part 2 – NAC Technology
What is Cisco NAC?

NAC over 802.1x work principle:

1. CTA sends authentication and host security information to the switch (using 802.1x).
2. The switch sends the authentication information to ACS.
3. ACS begins authentication work. It interacts with the directory server, confirming user permissions.
4. ACS checks the Windows Service Pack, Hotfix, CSA version, etc.
5. ACS interacts with third-party anti-virus policy servers, confirming the user's health status.
6. According to AD and anti-virus policy servers' feedback information, determine whether the computer is healthy or not. If healthy, assign to VLAN 100, if not healthy, assign to isolation VLAN. Add the user's ACL.
7. The CTA software sends the authentication result to the terminal.
8. CTA checks the computer's status, whether healthy or unhealthy, whether it passes the certification.
9. CSA obtains the computer's status from CTA and decides whether to limit the application, and records in the system log, and sends it to MARS.
A „big overview“ picture…

- Endpoint Security Software
- Security App
- Plug-ins
- CTA
- EAPoUDP EAPoLAN
- RADIUS
- Cisco Secure ACS
- 3rd-party Policy Server
- Home Credential Authorization Protocol
- Cisco Trust Agent or Cisco Security Agent
- Router or Switch or ASA
- AAA Server
- Network Access Device
- AV-Server
- NAC enabled Security App (e.g. AV)
- AV-Server

ERNW
Wir leben IT-Security.
There are 3 different NAC flavours...

- **NAC-Layer3-IP**
  - Access-restrictions are implemented as IP-ACLs
  - NAD is a Layer-3 device (e.g. a Router or a VPN-Concentrator/Firewall).
  - The communication takes place using PEAP over EAP over UDP (EoU).

- **NAC-Layer2-IP**
  - Access-restrictions as IP-ACLs on a VLAN-interface of a switch.
  - The communication takes place using PEAP over EAP over UDP (EoU)

- **NAC-Layer2-802.1x**
  - Uses 802.1x port control to restrict network access
  - Obviously the device enforcing these restrictions is a switch.
  - EAP-FAST is used in conjunction with 802.1x.
  - This is the only NAC flavour where the client is:
    - authenticated before being allowed on the network
    - restricted from communicating with its local subnet
(Some) Features…

<table>
<thead>
<tr>
<th>Feature</th>
<th>NAC-L2-802.1x</th>
<th>NAC-L2-IP</th>
<th>NAC-L3-IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger</td>
<td>Data Link / Switchport</td>
<td>DHCP / ARP</td>
<td>Routed Packet</td>
</tr>
<tr>
<td>Machine ID</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>User ID</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Posture</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VLAN Assignment</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>URL Redirection</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Downloadable ACLs</td>
<td>Cat65k only</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Yet another agent: Cisco Trust Agent

- The Cisco Trust Agent (CTA) is the main component of the NAC framework installed on the clients.

- Its‘ tasks are to collect „posture data“ about the client and forward it to the ACS via the NAD.

- It has a plug-in interface for 3rd party vendors‘ NAC-enabled applications.

- It has a scripting interface for self-written scripts.
CTA architecture

- The CTA comes with two plug-ins by default:
  - Cisco:PA
  - Cisco:Host
Posture Information

- The information collected are Attribute-Value-pairs categorized by
  - Vendor: ID based on IANA SMI assignment
  - Application-Type: see next slide
  - Credential Name: e.g. “OS Version”
  - Value-Format: String, Date, etc.

- For all plug-ins & scripts this information is collected in a plaintext “.inf-file”.

## Application Types in Cisco NAC

<table>
<thead>
<tr>
<th>Application-Type ID</th>
<th>Application-Type Name</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PA</td>
<td>Posture Agent</td>
</tr>
<tr>
<td>2</td>
<td>Host / OS</td>
<td>Host information</td>
</tr>
<tr>
<td>3</td>
<td>AV</td>
<td>Anti Virus</td>
</tr>
<tr>
<td>4</td>
<td>FW</td>
<td>Firewall</td>
</tr>
<tr>
<td>5</td>
<td>HIPS</td>
<td>Host IPS</td>
</tr>
<tr>
<td>6</td>
<td>Audit</td>
<td>Audit</td>
</tr>
<tr>
<td>32768 – 65536</td>
<td></td>
<td>Reserved for “local use” (custom plug-ins or scripts)</td>
</tr>
</tbody>
</table>
## Credentials for Cisco:PA & Cisco:Hosts

<table>
<thead>
<tr>
<th>Application-Type</th>
<th>Attribute Number</th>
<th>Attribute Name</th>
<th>Value-Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posture Agent</td>
<td>3</td>
<td>Agent-Name (PA-Name)</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Agent-Version</td>
<td>Version</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>OS-Type</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>OS-Version</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>User-Notification</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>OS-Kernel</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>OS-Kernel-Version</td>
<td>Version</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Service Packs</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Hot Fixes</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Host-FQDN</td>
<td>String</td>
</tr>
</tbody>
</table>
Posture Tokens...

- For each plug-in/Application/script an “Application Posture Token” (APT) is derived by the ACS through the configured policy.
- This token is one out of:
  - Healthy, Checkup, Quarantine, Transition, Infected, Unknown (see next slide for definitions of these tokens)
- From all APTs a “System Posture Token” (SPT) is derived – this corresponds to the APT which will grant the least access on the network to the client.
- The SPT is associated with access-restrictions on the ACS (e.g. downloadable ACL, URL-Redirection).
Posture Tokens – well defined

- **“Healthy”:** fully compliant with the admission policy for the specified application.

- **“Checkup”:** partial but sufficient compliance with the admission policy, no need to restrict access, a warning to the user may be issued.

- **“Transition”:** either during boot-time, when not all necessary services have been started or during an audit-process for clientless hosts, temporary access-restrictions may be applied.

- **“Quarantine”:** insufficient compliance with the admission policy, network access is usually restricted to a quarantine/remediation segment.

- **“Infected”:** active infection detected, usually most restrictive network access even up to complete isolation.

- **“Unknown”:** a token can not be determined or no CTA installed on client. This may lead to partial access (guest-vlan & internet-access for example).
Sample inf-File for Trendmicro AV

```
[main]
dll=tmbapp.dll
PluginName=tmbapp.dll
VendorID=6101
VendorIDName=TrendMicro, Inc
AppName=av

[av]

AppType=3
AppTypeName=Antivirus
AttributeList=attr1, attr2, attr3, attr4, attr5, attr6, attr7, attr8, attr9, attr10, attr11, attr12, attr13, attr14
attr1=1, Unsigned32, Application-Posture-Token
attr2=2, Unsigned32, System-Posture-Token
attr3=3, String, Software-Name
attr4=4, Unsigned32, Software-ID
attr5=5, Version, Software-Version
attr6=6, Version, Scan-Engine-Version
attr7=7, Version, Dat-Version
attr8=8, Time, Dat-Date
attr9=9, Unsigned32, Protection-Enabled
attr10=10, String, Action
attr11=32768, String, OSCE-Srv-Hostname
attr12=32769, OctetArray, Client-GUID
attr13=32770, Ipv4Address, Client-IP
attr14=32771, OctetArray, Client-MACddd
```

The name of the plug-in. In case of a script this would be ctscriptPP.dll and the vendor-id would be “Cisco” for scripts.

Official Credentials

Private Credentials from the Vendor
Sample Policy on Cisco ACS

External User Databases

Rule Configuration

- Adding Rule Elements
- Editing Rule Elements
- Deleting a Rule Element
- Deleting a Rule

Use this page to create or modify a rule by creating and modifying the one or more rule elements that make up the rule. Each rule element consists of an attribute, an operator, and a value. Cisco Secure ACS uses the operator to compare the attribute received in the posture validation request to the value.

For each posture validation request that a rule is applied to, all rule elements must be true in order for a rule to be match the posture validation request.

Adding Rule Elements

For each rule element you want to add:

1. From the Attribute list, select an attribute.
2. From the Operator list, select the applicable operator. The operators available vary depending upon the attribute you selected.
3. Type a value for comparison to the attribute selected.
And the resulting SPT on a NAD

```
Mar 2 13:26:15.243: %EOU-6-AUTHTYPE: IP=192.168.67.24  AuthType=EAP
nad#
nad#show eou all

+-------------------------------+-------------------+-----------+----------------+--------------+
<table>
<thead>
<tr>
<th>Address</th>
<th>Interface</th>
<th>AuthType</th>
<th>Posture-Token</th>
<th>Age(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.67.34</td>
<td>FastEthernet3/1</td>
<td>CLIENTLESS</td>
<td>unknown</td>
<td>0</td>
</tr>
<tr>
<td>192.168.67.24</td>
<td>FastEthernet3/1</td>
<td>EAP</td>
<td>healthy</td>
<td>0</td>
</tr>
</tbody>
</table>

nad#
```
General Communication Flow

1. Challenge
2. Credentials
3. Credentials
4. Comply?
   - OS patched: healthy
   - CSA enabled: healthy
   - AV out of date: quarantine
5. Access Rights: Quarantine
6. Enforce: Quarantine
7. Notification: “Quarantine”
Transport Mechanisms…

- **NAC-Layer2-802.1x**
  - Uses 802.1x
  - Uses EAP-FAST as EAP method
  - Uses EAP-TLV to transport posture information

- **NAC-Layer2-IP**
  - Uses EAP over UDP (Port 21862 on client & NAD)
  - Uses PEAPv1 as EAP method without inner authentication
  - Uses EAP-TLV to transport posture information

- **NAC-Layer3-IP**
  - Uses EAP over UDP (Port 21862 on client & NAD)
  - Uses PEAPv1 as EAP method without inner authentication
  - Uses EAP-TLV to transport posture information
NAC-L3-IP Communication Flow

API / Process Posture Request / AV
- EAPoU Hello
- EAPoU Identity
- EAPoU / PEAP / Start
- EAPoU / AV + PA Posture
- EAPoU / AV + PA Posture
- EAPoU / APT+SPT+AV Notification
- EAPoU / APT+SPT+AV Notification + PA User Notification
- EAPoU / PEAP / Close
- EAPoU Result

API / Process Posture Notification / APT+SPT +AV Notification
- RADIUS Identity
- RADIUS / PEAP / Start
- RADIUS / AV + PA Posture
- RADIUS / AV + PA Posture
- RADIUS / APT+SPT+AV Notification + PA User Notification
- RADIUS / PEAP / Close
- RADIUS / EAP Result + Access Policy

Host

IPC
PP
DLL
PA

EAPoUDP
PEAP
EAP-TLV / Posture & Posture-Notification
RADIUS

ACS
Extensible Authentication Protocol

- EAP is a “request-response” Protocol:
  - Exchange of “identity” and “authentication” information between a supplicant and an AAA server.
- EAP supports a multitude of authentication schemes:
  - EAP-MD5
  - EAP-MSCHAP
  - ...
- EAP has to be “enhanced” for “policy based access restrictions” (aka NAC)
  - EAP-TLV: Attribute-Type-Length-Value-Pair
  - Status Query: new method to get query the state of a client
  - EAPoUDP: EAP Transport over IP (instead of over Layer2 as e.g. 802.1x)
Encapsulation for L2-IP & L3-IP
PEAPv1 Frame Format
EAP-TLV Vendor Frame Format

- **Code**: 1 Byte, 1 = Request, 2 = Response
- **Packet Length**: 2 Bytes
- **Reserved**: 2 Bytes
  - Value: 0
- **Length of Value Field**: 2 Bytes
- **Value**
- **Identifier**: 1 Byte
- **Type**: 1 Byte
  - = 33 EAP-TLV
- **Mandatory Flag**: 1 Bit
  - 1: Mandatory
- **TLV Type**: 14 Bits
  - 7: Vendor Spec. TLV
- **Vendor ID**: 4 Bytes

NAC @ACK by Michael Thumann & Dror-John Roecher

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Part 3 – Security Analysis
### Flawed by Design 1: Client Authentication

<table>
<thead>
<tr>
<th></th>
<th>NAC-Layer 3 IP</th>
<th>NAC Layer 2 IP</th>
<th>NAC Layer 2 802.1x</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Client Authentication</strong></td>
<td><strong>No intrinsic Client Authentication.</strong> In VPN scenarios there is a “VPN Authentication” which might be considered a “mitigating control”.</td>
<td><strong>No intrinsic Client Authentication</strong> – and no means of “adding” such on top.</td>
<td>Client Authentication based on 802.1x/EAP-FAST</td>
</tr>
<tr>
<td><strong>Restriction of access on local subnet.</strong></td>
<td>It is not possible to restrict access to the local subnet via NAC.</td>
<td>It is not possible to restrict access to the local subnet via NAC.</td>
<td>Access to local subnet can be denied through “port shutdown” via NAC.</td>
</tr>
</tbody>
</table>
Flawed by Design

- So 1st design flaw is:

  **Authorization without Authentication**

- This is clearly breaking a “secure by design” approach [for a security product] and is not conforming to “Best Current Practices”
Epimenides was a Cretan (philosopher) who made one statement: "All Cretans are liars."

Same paradox applies to Cisco NAC as well:
- The goal is to judge the “compliance”-level of (un)known & untrusted clients.
- This is achieved by asking the (un)known & untrusted client about itself.
- How can the ACS be sure that the client is a Cretan philosopher (a liar)?
Posture Spoofing Attack

- We define “posture spoofing” as an attack where a legitimate or illegitimate client spoofs “NAC posture credentials” in order to get unrestricted network access.
Insider: An insider is a legitimate user of a NAC-protected network. The client has a working installation of the CTA and valid user/machine-credentials for the network. Additionally the inside attacker has the certificate of the ACS installed in its certificate store and if 802.1x is being used, this attacker has valid EAP-FAST-Credentials (PAC).

The insider simply wants to bypass restrictions placed on his machine (e.g. no “leet tools” allowed and NAC checks list of installed programs).
Attackers Definition - Outsider

- **Outsider**: An outsider is not a legitimate user of the NAC-protected network and wants to get unrestricted access to the network. The outsider has no valid user/machine-credentials and no working CTA installation.
Attack Vectors

- **Code an “alternative” NAC client**
  - Definitely possible
  - Will not work on 802.1x with EAP-FAST for outsider.
  - Currently “development in process” 😊

- **Replace plug-ins with self-written ones**
  - Definitely possible (be patient for ~50 more slides *just kidding*)
  - Works for the “insider” but not for the “outsider”.
  - Less work than the “alternative client”

- **Abuse the scripting interface**
  - Not verified yet – limitations on “Vendor-ID” and “Application-ID” apply and not (yet) known if these are enforced or can be circumvented
  - If possible – the easiest way 😊
# Feasible Attack Vectors

<table>
<thead>
<tr>
<th></th>
<th><strong>Insider</strong></th>
<th><strong>Outsider</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>NAC-L2-802.1x</td>
<td>DLL/Plug-In replacement&lt;br&gt;Scripting Interface&lt;br&gt;CTA replacement</td>
<td>None as to our current knowledge.</td>
</tr>
<tr>
<td>NAC-L2-IP</td>
<td>DLL/Plug-In replacement&lt;br&gt;Scripting Interface&lt;br&gt;CTA replacement</td>
<td>CTA replacement</td>
</tr>
<tr>
<td>NAC-L3-IP</td>
<td>DLL/Plug-In replacement&lt;br&gt;Scripting Interface&lt;br&gt;CTA replacement</td>
<td>CTA replacement</td>
</tr>
</tbody>
</table>
Part 4 – Approaching NAC@AK
The ugly stuff – working with a structured approach *sigh

- Step 1: Define what you need to know in order to get it working.
- Step 2: Sketch an attack-tree showing steps towards the goal.
- Step 3: Evaluate the components of the attack-tree for feasibility. Get the “tools” & know the “techniques” you need.
- Step 4: Pursue the feasible steps from step 3.
- Step 5: loop to step (1) until you get it working ,-)
Want to know

- **Everything relating to...**
  - Communication flow
  - Packet format
  - Data-structures
  - Used Crypto
  - Used libraries
  - Existing interfaces
  - Program flow
  - Used Authentication
  - ...
Attack Tree
Tools & Techniques

- **Reverse Engineering**
  - Reverse Engineering aims at uncovering the constructional elements of a product. IDAPro 😊 … and Hex-Rays

- **Packet Sniffing**
  - You all know that - Wireshark/Ethereal

- **Packet Differing**
  - Extracting common and differing parts of two packets.

- **Debugging / API-Monitoring / Function-Hooking**
  - Through attaching a debugger or api-monitor to the running process, it is possible to actually see the contents of the stack while the program is running.

- **Built-in capabilities**
  - Logging / Debugging capabilities of the product – Cisco is usually _very_ good at that!

- **RTFM**
  - Read Read Read – often then vendor will tell you a lot about the product.
Big “want to have”: Cleartext Packets...

- Communication is encrypted using TLS... packet capture shows encrypted packets.
- Not possible to get cleartext dump with tools (SSLProxy, etc.) – TLS over UDP not supported by tools.

- RTFM: Client Log can be enabled and it can dump cleartext payload of packets *g
Excerpt from a CTA logfile:

65 16:23:13.343 04/26/2006 Sev=PktDump/13 CTAVSTLV/0x64300016 Request message dump:
000700D1000000009800200C9000000090001001000100080000000000000000000010000200
08000000000000090000100A9000700A14865727A6C69636856E20476C7565636B77756E73
6368202D20496872205043206B6F66E6E7461206572666F6C77756963682061757468656E74
696697A69657274207765726656E20756E420656E7473707269636874206465722053656375
26974792050696F6C6963792E2049687265204E5747A7765726B7A7567616E67207769726420
6E696368742065696E6765736368726E66E6B7421800300020001

66 16:23:13.359 04/26/2006 Sev=Info/4 PAPplugin/0x63200001 Application Posture Result = Healthy


68 16:23:13.359 04/26/2006 Sev=Debug/7 CT EapHandlePacket exit

69 16:23:13.359 04/26/2006 Sev=Warning/2 PAPplugin/0xA3200012 CTAPP received UserMsg Notification: Content = Herzlichen Glückwunsch - Ihr PC konnte erfolgreich authentifiziert werden und entspricht der Security Policy. Ihre Netzwerkzugang wird nicht eingeschränkt!
Packet Sniffing & Diffing

<table>
<thead>
<tr>
<th>No.</th>
<th>Time</th>
<th>Source</th>
<th>Destination</th>
<th>Protocol</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>00 40 96 a7 48 5d 00 14</td>
<td>F3 96 F7 c8 08 00 45 00</td>
<td>.A.M... ....E.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0010</td>
<td>04 2c 20 4a 00 00 00 fe 13</td>
<td>67 8f c0 00 01 42 00 a8</td>
<td>...g.g..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0020</td>
<td>se 55 66 65 66 04 08</td>
<td>bf 00 00 01 04 f4 04 14</td>
<td>AqkU...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0030</td>
<td>eb 6e 64 54 c6 8d 00 02</td>
<td>00 01 03 09 f0 00 00 00</td>
<td>.Dr..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0040</td>
<td>69 6c 61 6e 26 6c 61 6f</td>
<td>63 61 6c 6c 63 61 67</td>
<td>illa, loc al\Certi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0050</td>
<td>6e 72 6f 6c 6c 45 52</td>
<td>4e 52 2d 54 65 67</td>
<td>Tmpl eXeMe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0060</td>
<td>32 30 41 41 25 32 30 34</td>
<td>72 61 69 6e 69 66</td>
<td>67 2e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0070</td>
<td>61 72 6c 30 30 00 00 00</td>
<td>06 08 0c 0f 03 00 00</td>
<td>cr10.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0080</td>
<td>30 02 06 63 68</td>
<td>74 70 0a 3a 0a 02</td>
<td>77 36 2e 7e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0090</td>
<td>6f 7a 69 6c 61</td>
<td>2e 6c</td>
<td>6f 63 61 6c 6f 7a 69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00a0</td>
<td>74 45 6e 72 76 6f 6c 61</td>
<td>6e 63 61 6c 63 61 67</td>
<td>6a, loc al\Certi</td>
<td></td>
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</tr>
<tr>
<td>00b0</td>
<td>6c 61 6c 61 6e</td>
<td>2e 6c 6f 63 61 6c 61 6c 63 61 67</td>
<td>Tmpl eXeMe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00c0</td>
<td>65 73 74 25 32 30 34</td>
<td>41 25 32 30 34 72 61 69 6e</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00d0</td>
<td>69 6e 67 2e 69</td>
<td>73 21 30 00 00 00 00</td>
<td>09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00e0</td>
<td>07 0e 00 02 06 63 68</td>
<td>6f 63 61 6c 6f 7a 69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00f0</td>
<td>6b 2e 4d 7a 69 6c 61</td>
<td>6e 63 61 6c 6f 7a 69</td>
<td>6a, loc al\Certi</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C:\Daten\MyExploits\NAC\Reversing and Docs\nac-captures\Healthy-1\2

C:\Daten\MyExploits\NAC\Reversing and Docs\nac-captures\Healthy-1\3

NAC @ACK by Michael Thumann & Dror-John Roecher

August 1st 2007
RE of the CTA – 1: Used Crypto

<table>
<thead>
<tr>
<th>Address</th>
<th>Length</th>
<th>Type</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>0000000E</td>
<td>C FIPS routines</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>0000000E</td>
<td>C OCSP routines</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>00000010</td>
<td>C engine routines</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>0000000A</td>
<td>C func(%lu)</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>00000009</td>
<td>C lib(%lu)</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>0000001C</td>
<td>C \crypto\engine\tb_digest.c</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>0000001B</td>
<td>C \crypto\engine\eng_init.c</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>00000029</td>
<td>C Stack part of OpenSSL 0.9.7g 11 Apr 2005</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>00000017</td>
<td>C \crypto\stack\stack.c</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>00000019</td>
<td>C \crypto\buffer\buffer.c</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>00000027</td>
<td>C RSA part of OpenSSL 0.9.7g 11 Apr 2005</td>
</tr>
<tr>
<td>&quot;.&quot;</td>
<td>.rdata:1...</td>
<td>00000017</td>
<td>C \crypto\rsa\rsa_lib.c</td>
</tr>
</tbody>
</table>

Used crypto (btw: this version is vulnerable)
RE of CTA – 1: Core Function
RE of CTA – 2: Core Function

EapTlvHandlePacket
Function Hooking into EapTlvHandlePacket
RE of Plug-In 1: Exported Functions
RE of Plug-In 2: Exported Functions

; Exported entry 1. processPostureNotification

; int cdecl processPostureNotification(char *NotifyBuffer,int Status)
public processPostureNotification
processPostureNotification proc near

NotifyBuffer= dword ptr 4
Status= dword ptr 8

mov eax, dword_10027880
push esi
mov ecx, [eax+8]
mov edx, [eax+4]
push ecx
push edx
call sub_10018000
mov edx, [esp+0CH+4]
add esp, 8
push edx
mov edx, [esp+0CH+4]
call sub_10018000
mov edx, [eax+4]
add esp, 8
push edx
mov edx, [esp+0CH+4]
call sub_10018000
mov edx, [eax+4]
call sub_10018000
mov esi, eax
pop esp
ret

processPostureNotification endp

; Exported entry 2. processPostureRequest

; int cdecl processPostureRequest(char *Request,int ID,char *AttributeList,int *pNumber)
public processPostureRequest
processPostureRequest proc near

pRequest= dword ptr 4
ID= dword ptr 8
pAttributeList= dword ptr 0CH
pNumber= dword ptr 10H

mov eax, dword_10027880
push esi
mov ecx, [eax+8]
mov edx, [eax+4]
push ecx
push edx
call sub_10018000
mov edx, [esp+0CH+4]
add esp, 8
push edx
mov edx, [esp+0CH+4]
call sub_10018000
mov edx, [eax+4]
call sub_10018000
mov esi, eax
pop esp
ret

processPostureRequest endp

; Exported entry 3. queryPostureStatusChange

; int cdecl queryPostureStatusChange()
public queryPostureStatusChange
queryPostureStatusChange proc near

mov eax, dword_10027880
push esi
mov ecx, [eax+8]
mov edx, [eax+4]
push ecx
push edx
call sub_10018000
mov ecx, dword_10027880
add esp, 8
mov ecx, [eax+4]
call sub_10018000
mov ecx, [eax+4]
call sub_10018000
mov esi, eax
pop esp
ret

queryPostureStatusChange endp
Hex-Rays Decompiler

```
mov ecx, [esp+813Ch+hostshort]
push ecx
mov edx, [esp+8134h+hostlong]
and ecx, 0FFFFh ; Logical AND
push edx
push ecx
mov eax, [esp+8138h+hostlong+2]
push edx
mov edx, [esp+8130h+hostlong+3]
and eax, 0FFFFFFh ; Logical AND
push eax
and edx, 0FFFFFFh ; Logical AND
push edx
call mt_log_data ; Call Procedure
push 20h ; unsigned int
call ??EAVAPX16@@U ; operator new(uint)
add esp, 28h ; Add
mov [esp+8134h+var_8114h], eax
test eax, eax ; Logical Compare
mov [esp+8134h-__EHRec$staten], 0
je short loc_4042C6 ; Jump if zero (ZF=1)
```

```
BYTE __EHRec$[12]; // [esp+8130h] [bp-60h]RR

timeout.tv_sec = 0;
timeout.tv_usec = 500000;
readfds.fd_array[0] = s;
readfds.fd_count = 1;
if ( select_data(&readfds, 0, 0, &timeout) < 0 )
    { v0 = -mt_recv_data(s, &buf, 32768, (int)hostlong, (int)hostshort), v0 = v5, v5 = -0 )
        { result = 2147483648;
    } else
        { mt_log_data(7, 1661992965, "Received a packet from address %u.%u.%u.%u, port %x%x", SHIF33(hostlong[0]));
            v0 = operator new(Ox20h);
            v12 = 0;
            *(DWORD *)&__EHRec$[8] = 0;
            if ( v6 )
                v1 = sub_405090();
            else
                v1 = 0;
            *(DWORD *)&__EHRec$[8] = -1;
            v2 = incomingPacketDump(hostlong, hostshort, &buf, v0);
            v3 = v2;
            if ( v2 )
                { v2 = 2147483613
                    { if ( *(BYTE *)&v1 & 0x0F) == 2 )
                        { sub_404550((u_long)hostlong, hostshort, v1);
                            mt_log_data(3, -1552232497, "Send MK message to %u.%u.%u.%u (port %x) ", SHIF30(hostlong[0]));
                        }
                    } else
                        { if ( *(BYTE *)&v1 & 0x0F) == 2 )
                            v8 = sub_404550((u_long)hostlong, hostshort, v1);
                        else
                            v3 = sub_404550(hostlong, hostshort, v1);
                        }
                    }
```
Hex-Rays Decompiler

- First Decompiler that produces more than crap
- Build by Ilfak Guilfanov (think IDAPro 😊)
- Actually in Beta State (but already impressing)
- Will be released as commercial Addon for IDA
- Planned: API to support Decompiler Plugins like Vulnerability Analyzer and others
- Planned: Type and Function Prototype Recovery
- Planned: Assembler Knowledge not needed anymore
- Further Information at www.hexblog.com
- Thanks to Ilfak for the Beta Version 😊
Quick Summary…

- A lot of stuff learned so far…
  - What is used
  - How it works
  - How it interoperates
  - Where to start hacking it

- So now its…
Showtime Setup

w/o CTA
192.168.81.90/27
(presentation notebook)

w/ CTA
192.168.81.70/27
(attacking VM)

192.168.81.66
EAPoUDP

192.168.81.33
NAD

192.168.81.34
ACS

RADIUS
Thank’s for your patience

Time left for `questions & answers` ?

You can always drop us a note at:
droecher@ernw.de
mthumann@ernw.de