Trusted Network Connect (TNC)

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First European Summer School on Trusted Infrastructure Technologies
September 2006
Agenda

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  ... a dead end street?
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Motivation

- organisational conditions call for action, e.g. Sarbanes Oxley Act (SOX), Basel II Accord
- new and more sophisticated IT-based attacks...
- ... example...
  - an attacker wants to compromise a server...
    ... which is behind a hard to break firewall ...
  - thus, take the more clever approach:
    - first, compromise the client (much easier)...
      ... and stay hidden on the client...
    - wait for the client to authenticate itself to the server
    - (mis)use the authenticated connection for attacking the server
      ... and still stay hidden ...
IT security today

- more or less isolated security solutions for specific problems, e.g.
  - firewalls to protect the corporate network against attacks from the outside
  - virus scan engines to find malicious code
  - filter software against spam
  - IDS for alerting in case of suspicion of intrusion
  - …
... a dead-end street?

- The internal network has to be more opened, due to strong increase of the need for electronic business with partners.
  - decreases the effectiveness of central firewall systems
- Growing need for public zones in LANs including the acceptance and integration of foreign endpoints
  - consultants, students, guests, ...
  - endpoints are often under user‘s control
- New computing paradigms, e.g. Grid computing
  - raising new security issues
- Sophisticated attacks target at client software to (e.g.) compromise servers over the Web (s.a.)
- It’s hard to track network wide security incidents.
Vision...

- ... of a modern, effective IT security architecture
- features
  - distributed
    - with respect to the higher importance of endpoint security
    - security begins at the edge of the network
    - checking of endpoints (integrity and authenticity) before joining the network and periodically thereafter
  - integrated
    - "Security goes inline": Integration into network devices (eg. switches, access points)
  - cooperative
    - interaction of technologies and tools
  - open
    - open specification and standards allow communication between entities from different vendors
  - central, integrated management
Benefits

- “distributed” incl. endpoints
  - strong prevention against malware attacks
- “integrated”
  - comprehensive coverage for network endpoints regardless of access type, network infrastructure, and communications protocol
  - flexible handling of non-compliant endpoints
- “cooperative”
  - detection of complex attacks by bringing together events and alarms from different sites
- “open”
  - multi-vendor compatibility and interoperability
    - leverages existing network infrastructure
- „central, integrated management“
  - enterprise-wide deployment
  - enforcement of a uniform security policy for different levels (user, group, access point, ...)

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How to prepare for the future?

- Don‘t focus security on the central firewall system between internal and external networks exclusively, but...
- ... take into account distributed security measures at the edge of your network.
- Integrate endpoint security (integrity / authenticity checking) into security architecture, based on a uniform security policy.
- Prefer open standards against proprietary solutions.
Trusted Network Connect (TNC) Overview

- an open, non-proprietary standard that enables the application and enforcement of security requirements for endpoints connecting to the corporate network
  - enables customer choice of security solutions and infrastructure
  - adopts existing standards whenever possible
  - received thorough and open technical review
  - support for multi-vendor interoperability
- more than 60 participating companies
  - include those with expertise in firewalls and anti-virus products; switches, routers and hubs; systems management; and operating systems
TNC: Features (1)

- Platform Authentication
  - Platform Credential Verification
  - Integrity Check Handshake
- Endpoint Policy Compliance (Authorisation)
  - establishing a level of ‘trust’
  - examples:
    - ensuring the presence, status, and software version of mandated applications
    - completeness of virus-signature databases, intrusion detection and prevention system applications
    - the patch level of the endpoint’s operating system and applications
  - input to the authorisation decision for gaining access to the network
TNC: Features (2)

- **Access Policy**
  - endpoint machine and/or its user authenticates and discloses their security posture before connecting to the network
  - leveraging a number of existing and emerging standards, products, or techniques

- **Assessment, Isolation and Remediation**
  - systems not meeting security policy requirements can be isolated or quarantined
  - remediation (if possible), e.g. upgrading software or virus signature database
TNC: Entities

- **Access Requestor (AR)**
  - requests access to a protected network
  - typically the endpoint, e.g. notebook, desktop, ...

- **Policy Decision Point (PDP)**
  - performing the decision-making regarding the AR’s request, in light of the access policies.
  - typically a network server

- **Policy Enforcement Point (PEP)**
  - enforces the decisions of the PDP regarding network access
  - typically a switch or access point
TNC: Architecture

![Diagram of TNC Architecture]

TNC: Basic Message Flow

TNC: Assessment, Isolation, Remediation (1)

- Assessment phase
  - IMVs perform the verification of the AR following the policies and if necessary delivers remediation instructions to the IMCs

- Isolation phase
  - if AR
    - is authenticated and recognised to have some privileges but
    - has not passed the integrity-verification by the IMV
  - then PDP
    - may return instructions to the PEP to redirect the AR to an isolation environment where the AR can obtain integrity-related updates.
TNC: Assessment, Isolation, Remediation (2)

- Remediation phase
  - AR obtaining corrections to its current platform configuration and other policy-specific parameters
  - bringing it inline with the PDP’s requirements for network-access
TNC: Provisioning and Remediation Layer

TNC: Provisioning and Remediation Entities

- Provisioning & Remediation Applications (PRA)
  - communicates with the IMC and provides it with specific types of integrity information, e.g. latest AV signature files
  - could be implemented as part of the IMC

- Provisioning & Remediation Resources (PRR)
  - represents the various sources of integrity information needed to update the AR, e.g. enterprise servers, vendor services (e.g. FTP server), CDs/DVDs containing the update parameters
TNC: Supporting Technologies

- Network access technologies
  - 802.1x, VPN, PPP
- Message transport technologies
  - Protected EAP methods
    - EAP-TLS, EAP-TTLS, PEAP, EAP-FAST, ...
    - TLS und HTTPS
- PDP technologies
  - RADIUS
  - Diameter
TNC: Benefits (1)

- Potentially very high security risks arising from compromised endpoints will be beaten down to a minimum, e.g.
  - employees connect their mobile devices at home to the open Internet
  - resulting in malware being inadvertently downloaded onto the device
  - when connected to the corporate network, the device becomes a distributor of the malware to other devices on the enterprise network
TNC: Benefits (2)

- With TNC verifiers
  - may ascertain the security state of a given platform or device and
  - thus, have the ability to decide
    - when it is safe to extend the enterprise boundary to a connecting platform
    - based on the integrity information reported by the platform and by the proof-of-identity supplied by the platform
TNC: Implementation at FHH (1)

- Two master thesis, both starting Feb. 06
  - Development of client and server software for checking trustworthiness of network endpoints
    - main goal: implementation of TNCC and TNCS
  - Adapting software for automatic integrity checking of endpoints
    - main goal: implementation of IMCs and IMVs
TNC: Implementation at FHH (2)

- Technologies used for Network Access Layer:
  - 802.1x
  - Ethernet-based LAN (no WLAN)
  - RADIUS

- Technologies used during development
  - C++ as programming language
  - Eclipse with CDT-plugin as IDE
  - Xerces for parsing TNCCS-messages and IMC-IMV-messages
  - xWidgets for TNCC User Interface
  - FreeRadius server

- Platforms:
  - Windows XP: TNC Client
    - Cygwin as runtime-environment
  - SuSE Linux 9.3: TNC Server
TNC: Implementation at FHH (3)

Architecture

Communication via EAP-TNC
TNC: Implementation at FHH (4)

- Developed IMCs / IMVs:
  - IMCRegistry / IMVRegistry:
    - reads out Windows Registry entries
    - IMV checks whether specific security-relevant entries are present
    - Registry entries to be checked are configurable on server-side
  - IMCHostScanner / IMVHostScanner:
    - checks for open ports on Access Requestor
    - port numbers to be checked are configurable on server-side
  - IMCSecurityCenter / IMVSecurityCenter:
    - checks parameters from Windows Security Center and detects if anti-virus software and firewall are installed and up-to-date
  - IMCClamWin / IMVClamWin:
    - checks if ClamWin (open source anti-virus software) is installed and up-to-date
**TNC: Implementation at FHH (5)**

- **TNCC User interface**
  - enables transparency of actions to user
  - gives control to user about handshake
TNC: Implementation at FHH (6)

- Detailed Logging enables reproduction of actions

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TNC Client started
IMCs loaded
IMCs initialized
Connection to PEP established
Starting initial Handshake for IMC ClamWin

**** Received Message from IMC IMC ClamWin (ID: 2, MessageType: ffff0020):
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<FHH.IMC.ClamWin version="1.0">
  <ClamWin installed="false"/>
</FHH.IMC.ClamWin>

**************************************************************************
Round finished for IMC ClamWin
1. round (IMCs->IMVs, Outgoing data):

Size of Batch: 1520
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<TNCCS-Batch BatchId="0" Recipient="TNCS", ...>
  <IMC-IMV-Message>
    <Type>FFFF0020</Type>
    <Base64>PD94bWwgdmVyc2lvbj0iMS4wI…</Base64>
  </IMC-IMV-Message>…
TNC: Implementation at FHH (7)

◆ Experiences:
  ➢ good specification documents from TCG
  ➢ difficult task: implementing Network Access with Windows
  ➢ usual problems of C++ development 😊

◆ Limitations:
  ➢ no encrypted EAP-TNC messages
  ➢ no Remediation Phase (Start TNC Client once again! 😊)
  ➢ no TPM support
  ➢ only simple policy specification on TNC Server
TNC with TPM: Features (1)

◆ Protected Capabilities
  ➢ a set of commands with exclusive permission to access „Shielded Locations“
  ➢ examples for TPM usage in TNC
    ➢ protect and report aggregations of integrity measurements that are stored inside the TPM’s Platform Configuration Registers (PCR)
    ➢ store cryptographic keys used to authenticate reported measurements
TNC with TPM: Features (2)

◆ Integrity Measurement and Storage
  ➢ obtaining metrics of platform characteristics that affect the integrity (trustworthiness) of a platform
  ➢ storing those metrics
  ➢ putting digests of those metrics in PCRs.

◆ Integrity Reporting
  ➢ attesting to the contents of integrity storage, i.e. stored measurement log
  ➢ signed using the private key held (e.g. AIK-certificate) located in shielded locations in the TPM
TNC with TPM: Features (3)

◆ Attestation
  ➢ vouching for the accuracy of information, such that a relying party can use the attestation to decide whether it trusts the remote platform

◆ Evaluation and Decision Making
  ➢ allows delegation of evaluation to a 3rd party
  ➢ outcome not limited to binary results

◆ Enforcement and Response
  ➢ evaluating platform may in fact be a PEP or may return responses to another platform
TNC with TPM: Architecture

TNC with TPM: Entities

- in general the same entities as without TPM
- one additional entity: Privacy Certification Authority
  - issues AIK certificates to trusted platforms
  - trusted by both parties
  - needed if AR and PEP/PDP have different „owners“
TNC with TPM: Components

◆ Platform Trust Services (PTS)
  ➢ exposes trusted platform capabilities to TNC components, including
    ➢ protected key storage, asymmetric cryptography, random numbers, platform identity, platform configuration reporting and integrity state tracking

◆ TCG Software Stack (TSS)
  ➢ enables applications to use higher level interfaces for communication with the TPM support functions, including
    ➢ unlimited key storage (off-chip protected), key caching, higher-level interface abstraction
TNC with TPM: Benefits

- TPM provides a strong hardware-protected root-of-trust.
- This is needed to ensure malware and improperly configured software cannot report an erroneous status.
- The use of the TPM prevents a system from lying about what the platform is running so others can determine if the endpoint has the desirable integrity.
TNC: (some) challenges and questions

- How good does TNC work in real (complex) network environments?
- How can TNC environments be effectively managed and security policies be effectively enforced?
- What are benefits, side effects and impacts of TNC, regarding different operating scenarios?
- What scenarios are suited for operating TNC with / without TPM?
- What are security / privacy issues of TNC with / without TPM?

- Is TNC able to become a de facto standard?
- Does TNC really make the world more secure?
- ...
Conclusions

◆ A distributed, integrated, cooperative and open security architecture can leverage security significantly.

◆ TNC seems to be more than a well suited starting basis, due to
  ➢ its use of the TCG Platform-Authentication approach as a critical part of achieving true trusted network connections
  ➢ its openness and broad vendor support

◆ There are several challenges and questions...
  ➢ ... some further research and development efforts seem to be required
References

- [www.trustedcomputinggroup.org](http://www.trustedcomputinggroup.org)
  - home of the Trusted Computing Group
- [www.trustedcomputinggroup.org/groups/network/](http://www.trustedcomputinggroup.org/groups/network/)
  - home of the Trusted Network Connect Sub Group (TNC-SG)
- [www.trustedcomputinggroup.org/specs/TNC/](http://www.trustedcomputinggroup.org/specs/TNC/)
  - TNC-SG specs, e.g.