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Trusted Network Connect → Basis

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if(is) internet security.

Contents

- Aim and outcomes of this lecture
- Introduction
- Network Access Control
- Trusted Network Connect
- Summary

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TNC Basis
→ Aims and outcomes of this lecture

Aims

- To introduce the topics Network Access Control (NAC) and Trusted Network Connect (TNC)
- To explore the general idea of Network Access Control (NAC) and Trusted Network Connect (TNC)
- To analyze the goals of Network Access Control (NAC) and Trusted Network Connect (TNC)
- To assess the concerns of Network Access Control (NAC) and Trusted Network Connect (TNC)

At the end of this lecture you will be able to

- Understand what the basic idea of Network Access Control (NAC) and Trusted Network Connect (TNC) is.
- Know something about the approach of Network Access Control (NAC) and Trusted Network Connect (TNC).
- Understand the need of Network Access Control (NAC) and Trusted Network Connect (TNC).

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Introduction
→ What are the problems? (1/2)

Networks

- Still increasing networking in and between companies
- Worldwide communication

  → use of public networks (Internet) which lead into multiple threats
- Growing demand for security critical applications with increasing need for trustworthy communication
  - B2B transactions, home banking and many more

Company networks

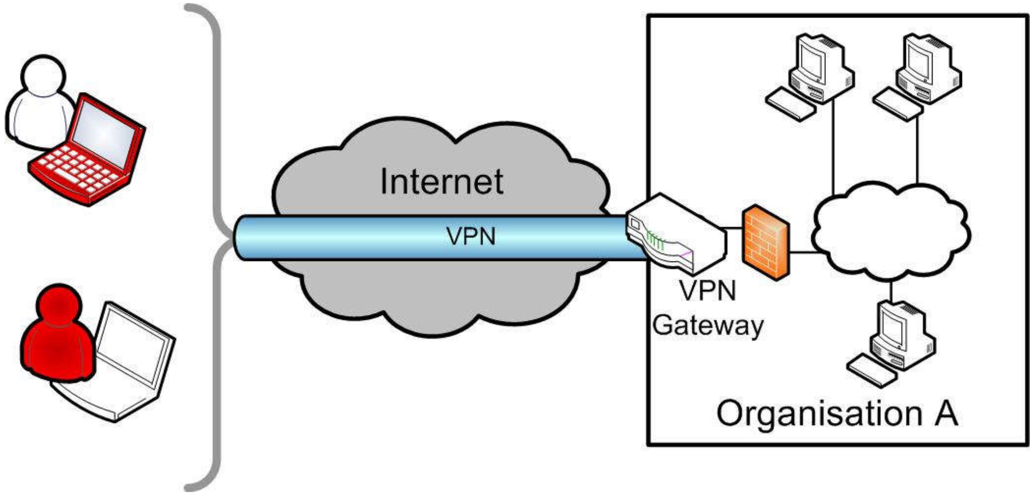
Employees „carry“ security threats into the companies

- as field workers (directly or over VPN connections)
- as users who ***use notebooks at home*** and ***allow family members to access to it***
- …

- **Field workers** use their computer systems in many environments with ***various security requirements*** (e.g. insurance agents).

Introduction
→ What are the problems? (2/2)

- **Network access protected mainly by**
  - User authentication
  - Firewalls,
  - VPNs, …



- **But**
  - **No integrity checks** of connecting or connected **computer systems!**
  - No difference between **trustworthy** and **not trustworthy** computer systems!

- **Consequences**
  - Network connections are **not trustworthy**

    → Lack of trustworthy communication

    → High probability of successful attacks!

Introduction
→ Need for new approaches

- **There’s a need for new technologies which**
  - make an access decision as early as possible depending on the integrity (Trustworthiness) of any accessing device
  - **permit access** to computer systems with **trusted configuration**
  - **deny access** to computer systems with **untrusted configuration**

Approach

Network Access Control (NAC)

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Network Access Control
→ Functions (1/2)

- **User Authentication**
  - User Authentication
    (e.g. password / challenge-response /certificates management)
  - e.g. VPN and IEEE 802.1x

- **Configuration Assessment**
  - Configuration measurement **before** network access
    - e.g. installed software like Antivirus Scanner and Firewall
  - Compare the measurements to policies of the network to access

  ➔ Integrity check of the computer system
  - Re-assess accepted computer systems in regular intervals

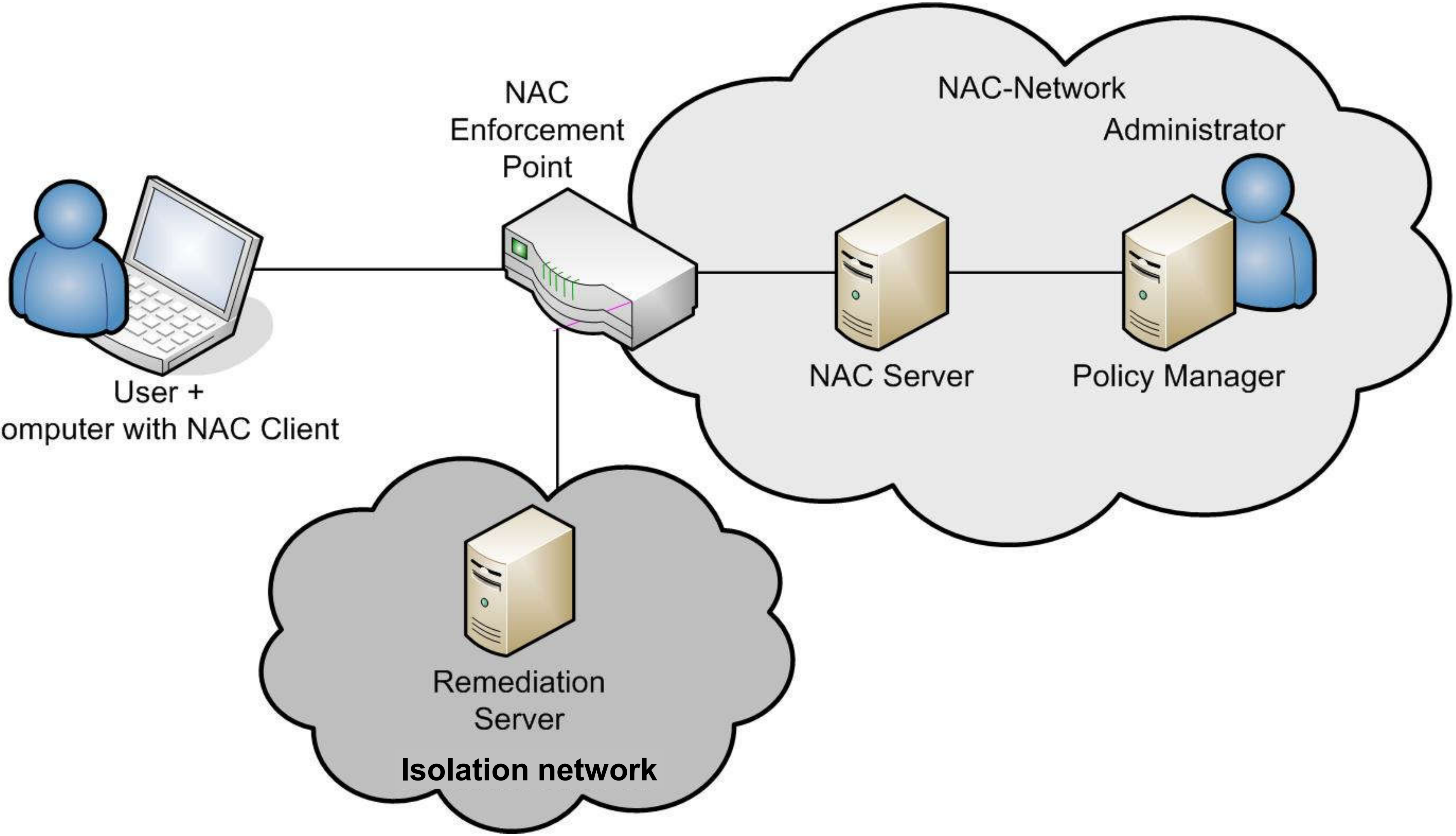
- **Policy Enforcement**
  - Enforce policies to non compliant (untrusted) computer systems

Network Access Control
→ Functions (2/2)

- **Isolation**
  - Isolate non compliant computer systems in “Isolation networks”
  - Instead of “access deny”
  - Limited network access only
    - e.g. internet, update and remediation server

- **Remediation**
  - Allow non compliant computer systems to achieve a policy compliant configuration
  - e.g., by updating their software to match the given Endpoint Policy Compliance
    - new signatures for anti malware scanners, OS patches, …
  - Access allow after re-assessment

Network Access Control
→ Topology

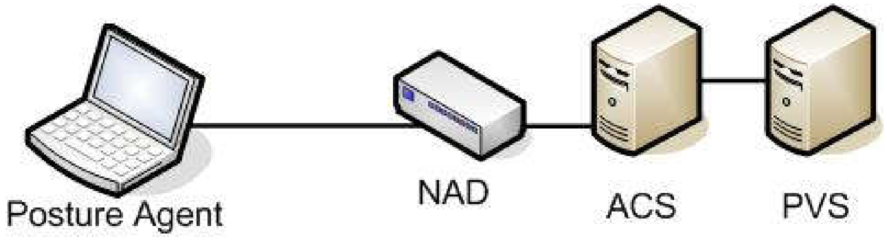


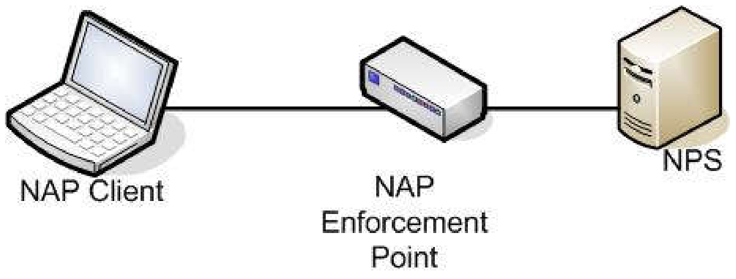
Network Access Control
→ Solutions

- **NAC solutions already available on the market**

- **The most prominent solutions**
  - Cisco Network Admission Control (Cisco NAC)
  - Microsoft Network Access Protection (Microsoft NAP)

- **And many more …**
  - Juniper Unified Access Control
  - StillSecure Safe Access
  - …



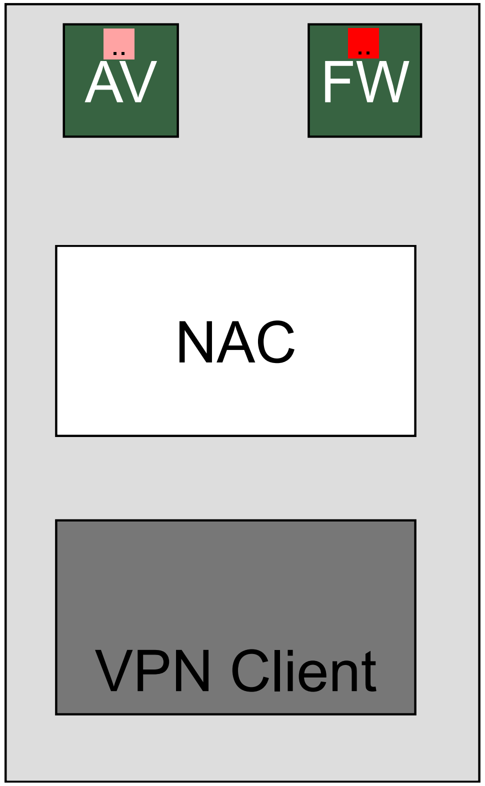


Network Access Control
→ Limitations of current solutions (1/3)

Lack of trust in the measurements

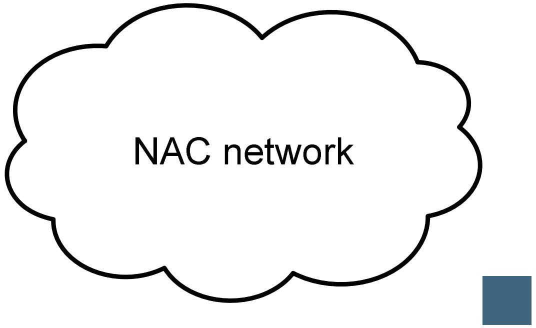
The “lying endpoint problem”

- Caused by current OS without isolation of components
- Measured components can get compromised
- NAC components can get compromised too
  - Shown on Cisco CTA at BlackHat conference 2007
- **Paradox**: Achieve more trustworthiness based on measurements which are not trustworthy?



Lack of trust in NAC enabled networks

- User can’t control collected data
- Possible privacy issues



Network Access Control
→ Limitations of current solutions (2/3)

- **No standards, no compatibility by design**
- **First approaches**
  - Client sided compatibility of Cisco NAC and MS NAP
  - Microsoft opened their NAP-Client-Server-Protocol „SoH“
  - Compatibility of „smaller“ solutions to Cisco NAC, NAP or TNC
    - e.g. StillSecure Safe Access
- **Two approaches for standardization**
  - **TCG: Trusted Network Connect (TNC)**
  - IETF: Network Endpoint Assessment (NEA)
    - **Goal:** Standardize the Client-Server-Protocolls

Network Access Control
→ Limitations of current solutions (3/3)

- **Platform independence**
  - Support for every common OS is essential
  - Support of every IT devices (cars, TV, cell phone, …) is required
  - Current NAC solutions support primarily Microsoft products
  - Need for exception management
    - e.g. MAC whitelist (which is not safe!!!)

Network Access Control
→ Other names

- Endpoint Security
- Health System for IT Systems
- …

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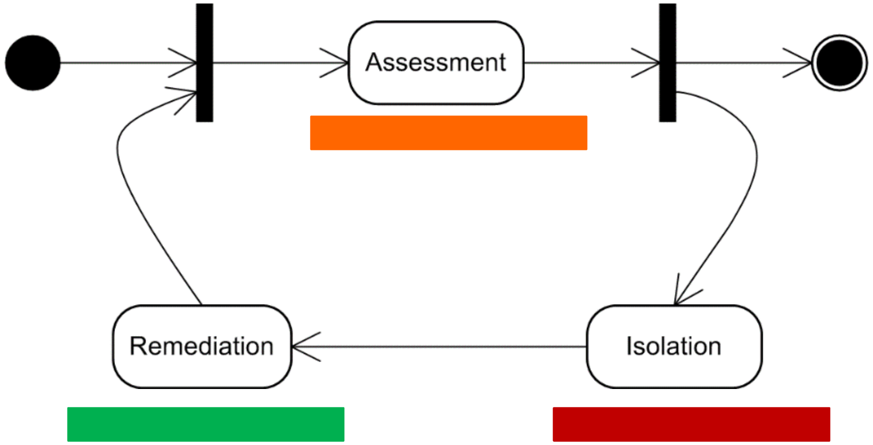
Trusted Network Connect
→ Overview

- **Open Architecture for NAC**
  - Specified by the TNC Subgroup of the TCG
  - All specifications are publicly available
    - Enables multi-vendor interoperability
  - Supports existing technologies (802.1x, EAP)

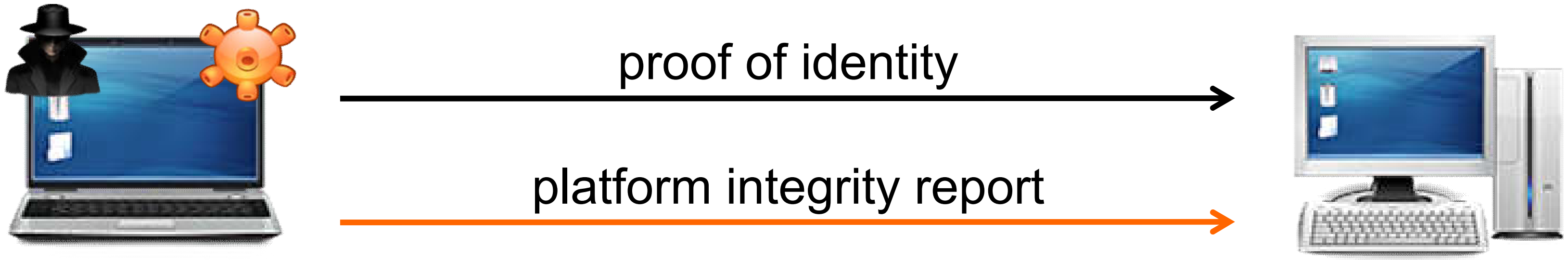
- **TNC Handshake consists of 3 phases**
  - **Assessment Phase**
    - TNC Platform Authentication
      - identity + integrity of platform
  - **Isolation Phase**
    - Quarantine non-healthy endpoints
  - **Remediation Phase**
    - Fixes problems and makes endpoint healthy again



Trusted Network Connect
→ Overview

- **TNC shall enhance existing network authentication protocols with Trusted Computing concepts [TNC2007]**

- **TNC enables verification of endpoint integrity additional to user/machine authentication**
  - e.g., a user is only allowed to connect to a network via specific machines that are in a certain, probably secure configuration



proof of identity

platform integrity report

platform's integrity may be compromised by, e.g., viruses, Trojans, etc.

TC concept ensures authentic reporting of platform integrity information

may decide whether peer is trustworthy based on reported integrity information

Trusted network Connect
→ Goals of TNC I

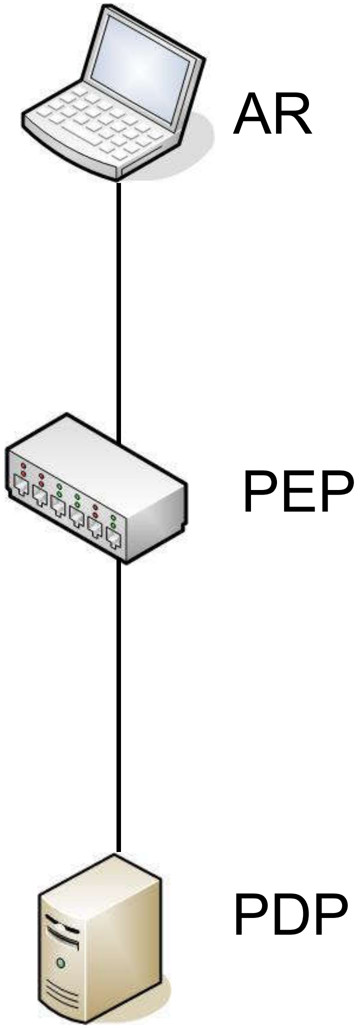
- **Interoperability of network access solutions of different vendors**
- **Platform-Authentication**
  - Platform Credential Authentication
    - Proof of the identity of a platform
    - e.g., via AIK certificates
  - Integrity Check Handshake of access requestor’s platform
    - Verification of the integrity of a platform
    - e.g., via remote attestation (Trusted Computing – TCG)

Trusted network Connect
→ Goals of TNC II

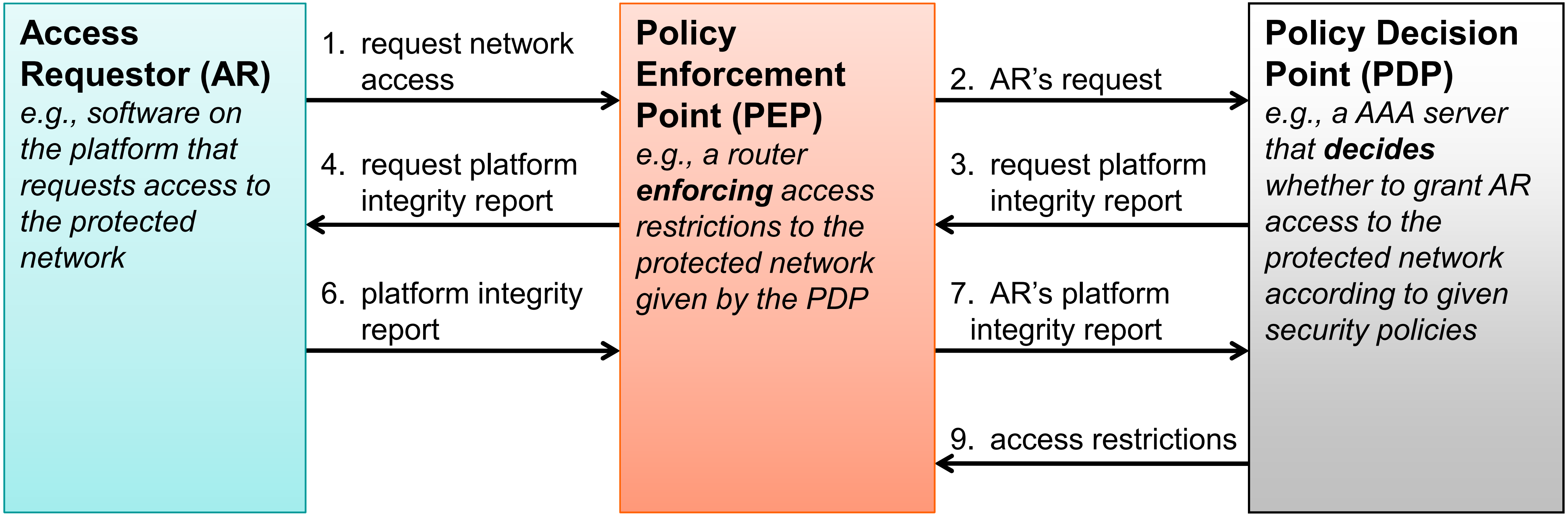
- **Endpoint Policy Compliance**
  - Assignment of a "level of trust" to the access requestor's platform, e.g., according to the presence, integrity and version of software installed on AR's platform
  - e.g., a platform is allowed to access certain network services only if the latest patches for the operating system, virus scanner are installed and the personal firewall in the right configuration.
- **Access Policy**
  - Ensuring authentication of the access requestor and the
  - disclosure of the access requestor's security posture before granting access to the network

Trusted network Connect
→ Topology

- **Access Requestor (AR)**
  - computer system with TNC client for system measurement
  - establishes the connection to the network
  - e.g. TNC enabled VPN-Client or IEEE 802.1x supplicant
- **Policy Enforcement Point (PEP)**
  - receives access request at the networks entry point
  - enforces the access decisions made by the PDP
  - e.g. TNC enabled VPN server or 802.1x switch
- **Policy Decision Point (PDP)**
  - decides whether to grant AR access to the protected network
  - according to given security policies
  - e.g. AAA Server (RADIUS)



Trusted network Connect
→ Basic Message Flow



Access Requestor (AR)
e.g., software on the platform that requests access to the protected network

Policy Enforcement Point (PEP)
*e.g., a router **enforcing** access restrictions to the protected network given by the PDP*

Policy Decision Point (PDP)
*e.g., a AAA server that **decides** whether to grant AR access to the protected network according to given security policies*

1. request network access
2. AR's request
3. request platform integrity report
4. request platform integrity report
6. platform integrity report
7. AR's platform integrity report
9. access restrictions

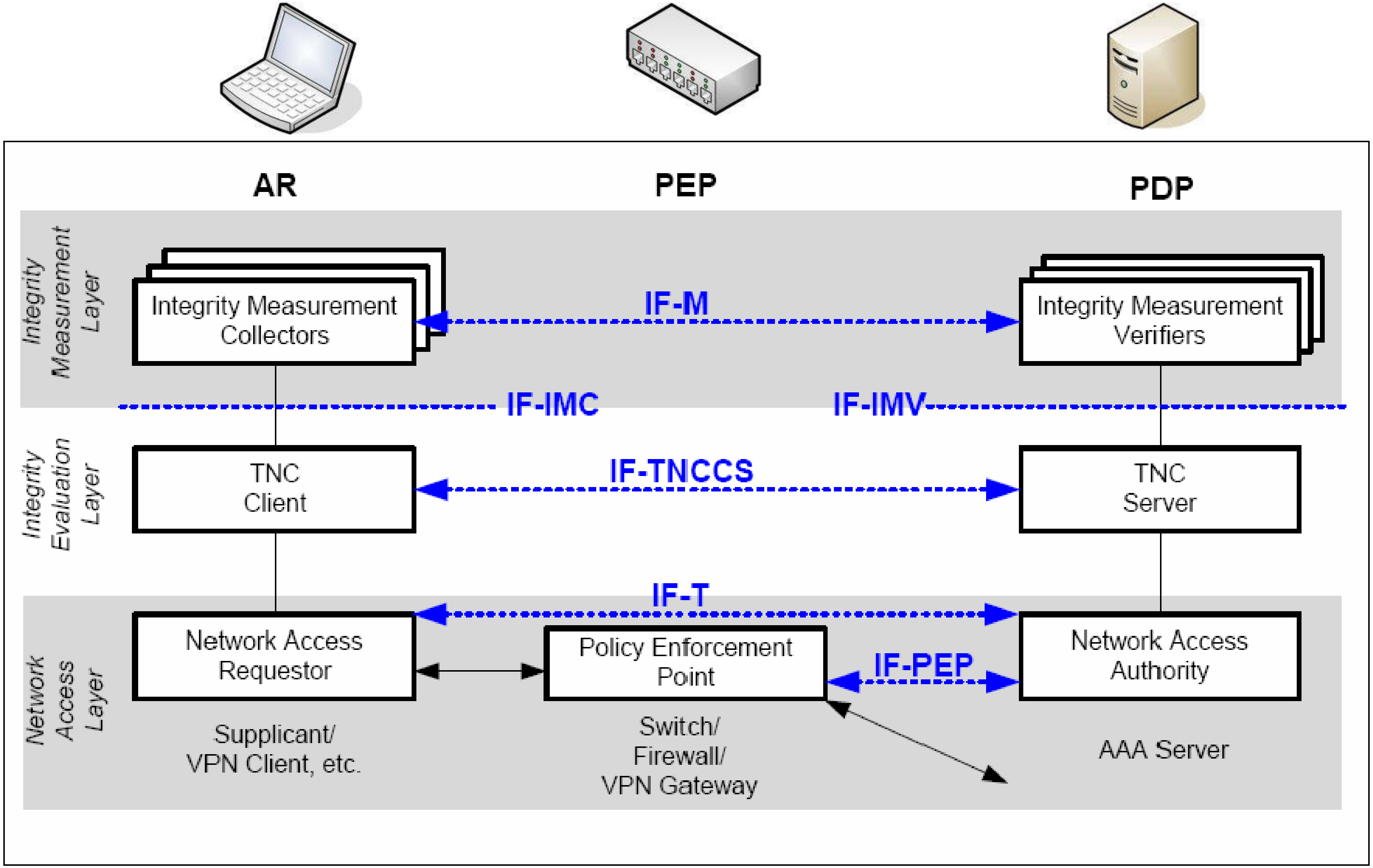
5. performs integrity measurements

10. enforces access restrictions given by PDP

8. verifies AR's platform integrity report and decides according to a given security policy and AR's platform configuration which level of access should be granted to AR

AAA stands for "Authentication, Authorization and Accounting"
(well known AAA protocol implementations are RADIUS or DIAMETER)

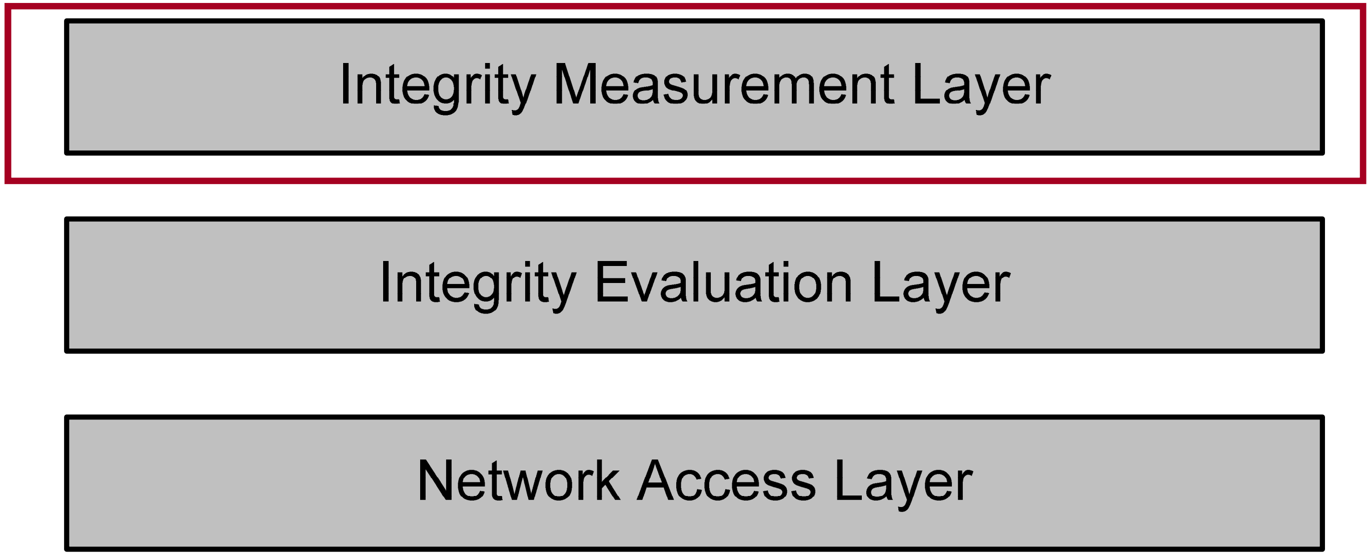
Trusted Network Connect
→ Architecture: Entities and Interfaces


AR
PEP
PDP
Integrity Measurement Layer
Integrity Measurement Collectors
IF-M
Integrity Measurement Verifiers
IF-IMC
IF-IMV
Integrity Evaluation Layer
TNC Client
IF-TNCCS
TNC Server
IF-T
Network Access Layer
Network Access Requestor
Policy Enforcement Point
IF-PEP
Network Access Authority
Supplicant/ VPN Client, etc.
Switch/ Firewall/ VPN Gateway
AAA Server

[TNC Architecture for Interoperability Specification version 1.3 revision 6]

Trusted Network Connect
→ TNC Layers (1/3)

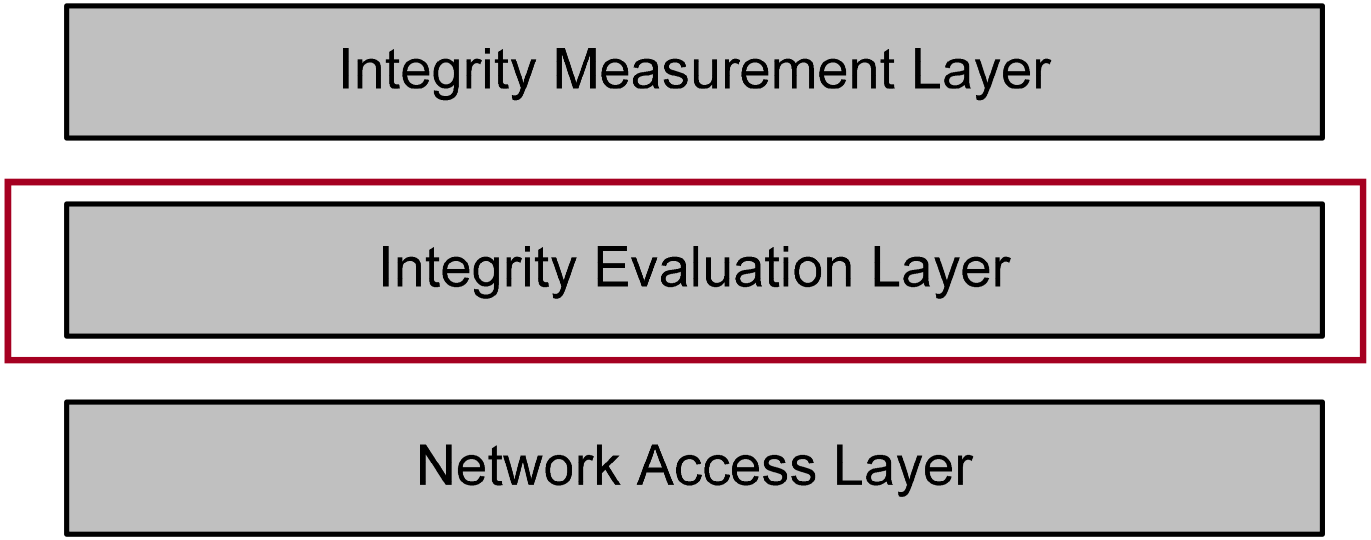
Integrity Measurement Layer (IML)



- **Functions handled on this layer**
  - Record current integrity state by collecting measurements
  - Request further measurements
  - Create “IMV action recommendations”
    - Which are sent to the TNCS (TNC Server)

Trusted Network Connect
→ TNC Layers (2/3)

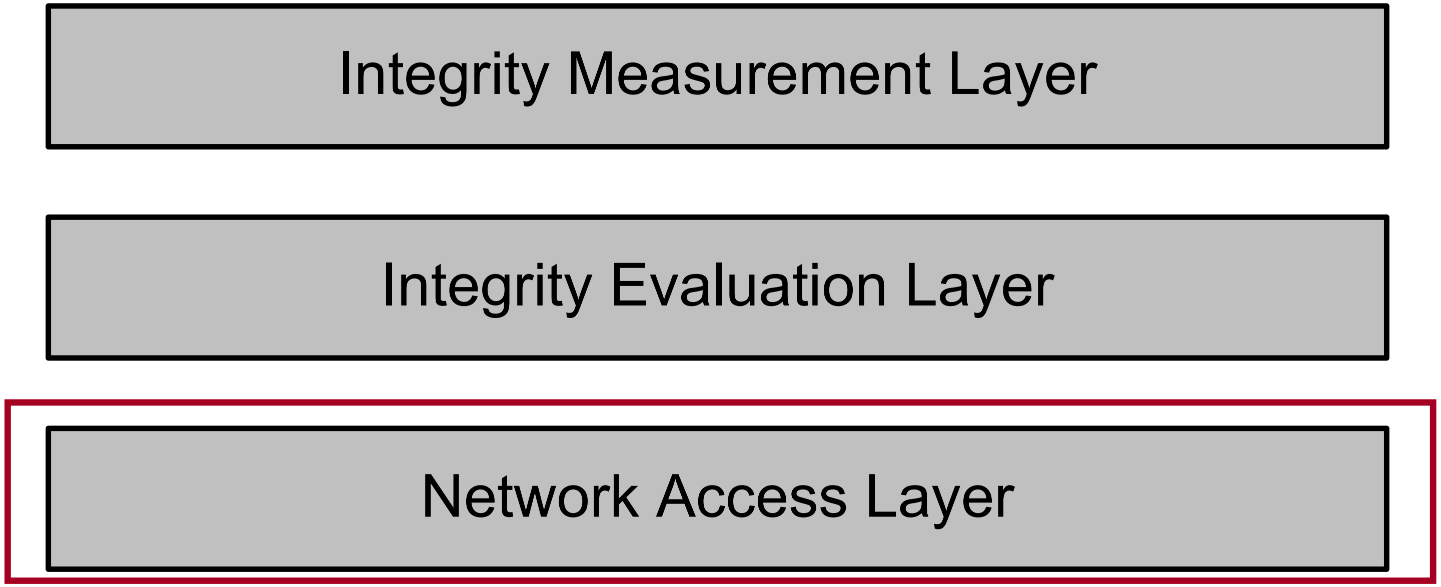
Integrity Evaluation Layer (IEL)



- **Functions handled on this layer**
  - Collect IMC measurements
  - Handle communication between IMCs and IMVs (logical)
  - Collect each “IMV action recommendation” received from the IML
  - Create a “TNCS recommendation“ based on the IMV action recommendations
    - Send to the Network Access Layer

Trusted Network Connect
→ TNC Layers (3/3)

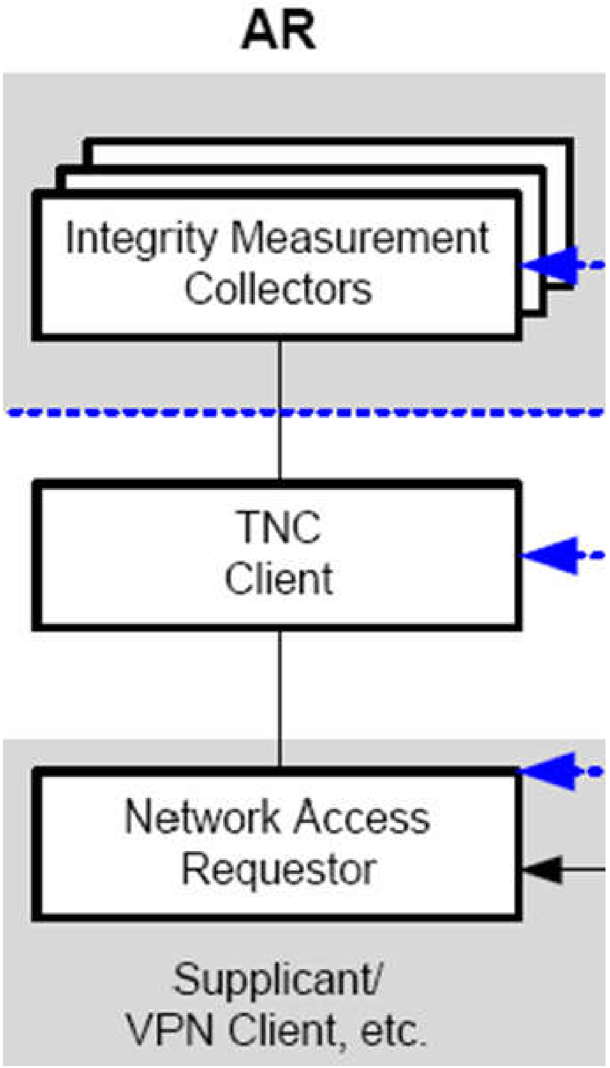
Network Access Layer (NAL)



- **Functions handled on this layer**
  - Establish, perform and close the communication
  - Receive, create and execute access decisions
  - Support existing technologies (like VPN or 802.1s)
    - e.g. VPN clients/VPN gateways

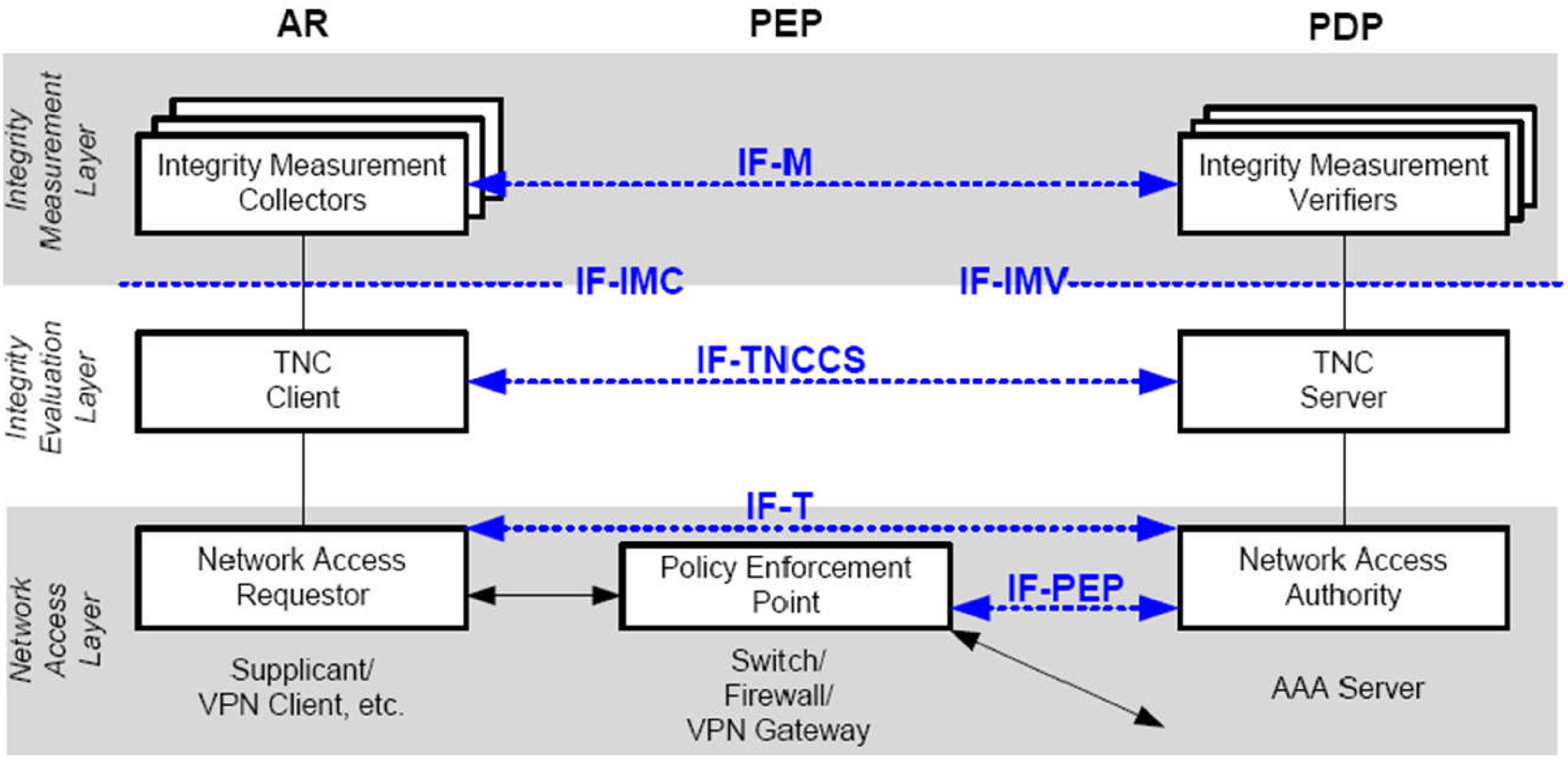
Trusted Network Connect
→ Components: Access Requestor (AR)

- **Network Access Requestor (NAR)**
  - Establishes network access
  - Quantity: Multiple
    - one for each supported network access technology (e.g. VPN)
- **TNC Client (TNCC)**
  - Software component which manages the integrity measures of the IMCs
  - Quantity: 1
- **Integrity Measurement Collector (IMC)**
  - Software which measures security related parameters of applications
  - Quantity: Multiple
    - e.g. one for each security application like antivirus, personal firewall, OS patch level, …


AR
Integrity Measurement Collectors
TNC Client
Network Access Requestor
Supplicant/ VPN Client, etc.

Trusted Network Connect
→ Components: Policy Enforcement Point (PEP)

- **Policy Enforcement Point (PEP)**
  - Controls the access to a TNC enabled network and enforces access decisions
  - Asks the PDP whether access is granted or not



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TNC Server
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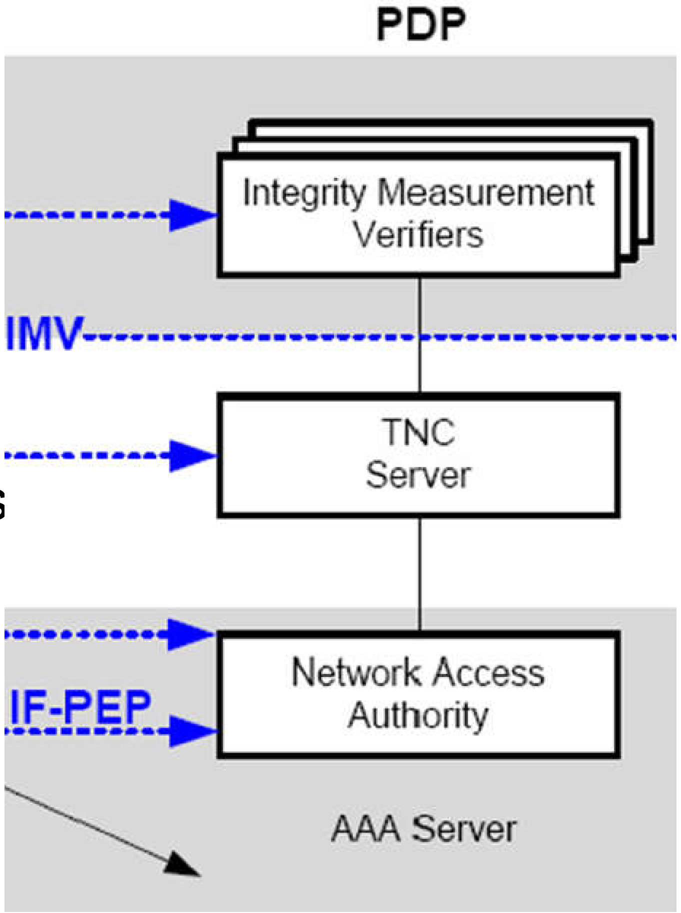
Network Access Layer
Network Access Requestor
Policy Enforcement Point
IF-PEP
Network Access Authority
Supplicant/ VPN Client, etc.
Switch/ Firewall/ VPN Gateway
AAA Server

Trusted Network Connect
→ Components: Policy Decision Point (PDP)

- **Integrity Measurement Verifier (IMV)**
  - Components which compare the received measurements to the policies
  - Creates an **IMV action recommendation**
  - Quantity: Multiple

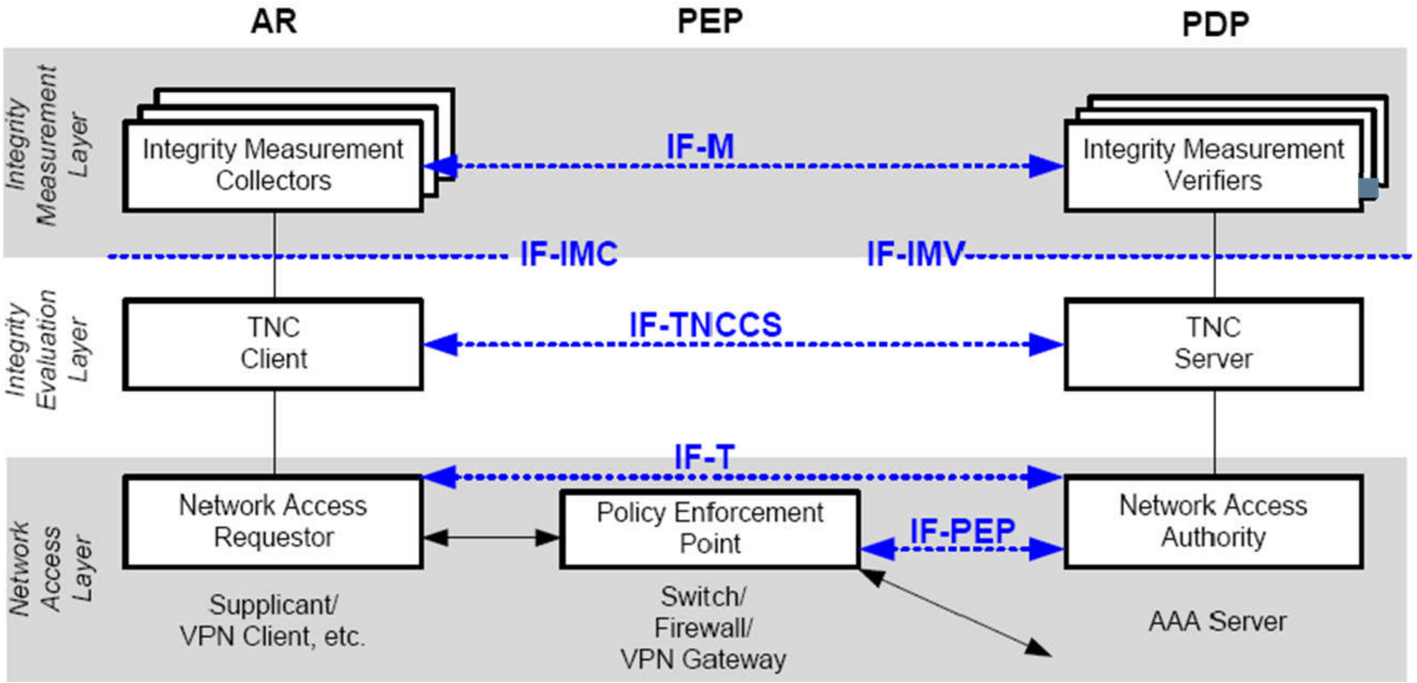


- **TNC Server (TNCS)**
  - Manages the messages between IMVs and IMCs
  - Collects each IMV action recommendations and aggregate these to a **TNCS recommendation** (policy based)
  - Sends the TNCS recommendation to the NAA
  - Quantity: 1

- **Network Access Authority (NAA)**
  - Asks the TNC Server whether the ARs state is policy compliant or not
  - Creates final access decision which is enforced by the PEP
  - Quantity: 1

Trusted Network Connect
→ TNC Interfaces (1/2)

- **Integrity Measurement Collector Interface (IF-IMC)**
  - Used by the TNCC for forwarding:
    - measurements to the IMVs
    - IMV requests to the specific IMCs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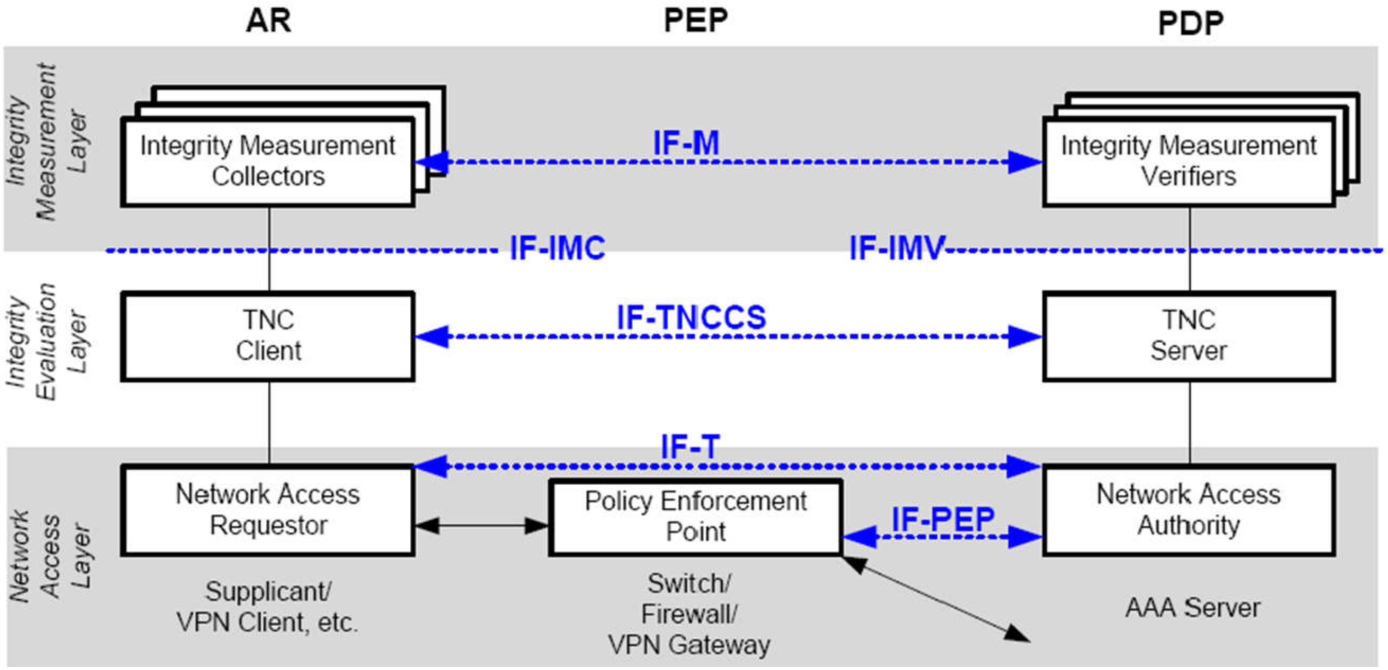
AAA Server

- **Integrity Measurement Verifier Interface (IF-IMV)**
  - Interface between TNCS and the IMVs

- **Policy Enforcement Point Interface (IF-PEP)**
  - enables the communication between PDP an PEP
  - e.g.: PDP instructs the PEP to isolate an AR

Trusted Network Connect
→ TNC Interfaces (2/2)

- **Vendor-Specific IMC-IMV Messages (IF-M)**
  - Interface between IMVs an IMCs
  - Communication of vendor specific messages



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Network Access Authority
Supplicant/ VPN Client, etc.
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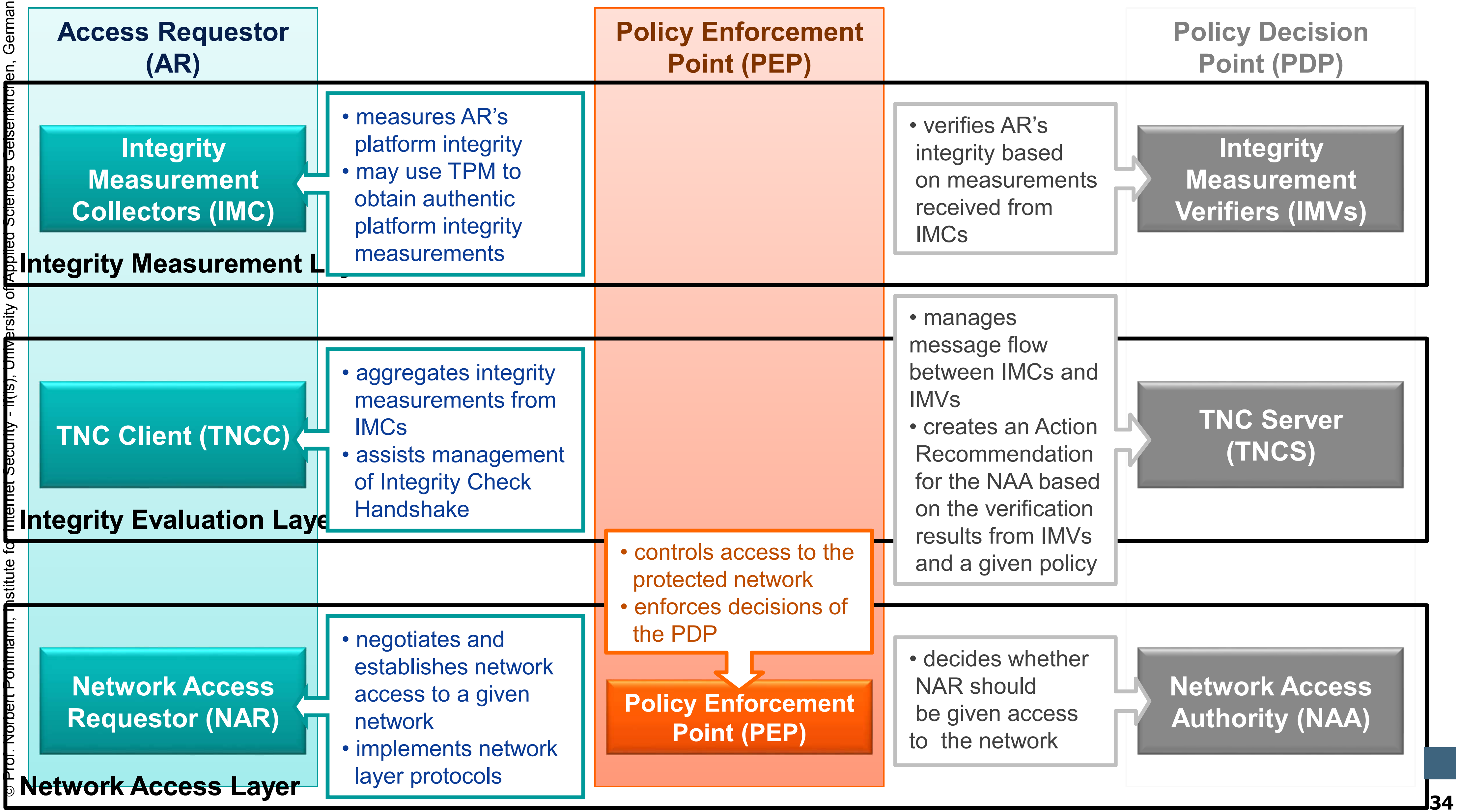
AAA Server

- **TNC Client-Server Interface (IF-TNCSS)**
  - Enables message exchange between IMVs and IMCs

- **Network Authorization Transport Protocol (IF-T)**
  - Communication between AR an PDP
  - Utilize existing technologies (like EAP with IEEE 802.1x)

Trusted Network Connect
→ TNC Architecture – Details



Access Requestor (AR)

Policy Enforcement Point (PEP)

Policy Decision Point (PDP)

Integrity Measurement L

Integrity Measurement Collectors (IMC)

- measures AR's platform integrity
- may use TPM to obtain authentic platform integrity measurements

- verifies AR's integrity based on measurements received from IMCs

Integrity Measurement Verifiers (IMVs)

Integrity Evaluation Laye

TNC Client (TNCC)

- aggregates integrity measurements from IMCs
- assists management of Integrity Check Handshake

- manages message flow between IMCs and IMVs
- creates an Action Recommendation for the NAA based on the verification results from IMVs and a given policy

TNC Server (TNCS)

Network Access Layer

Network Access Requestor (NAR)

- negotiates and establishes network access to a given network
- implements network layer protocols

- controls access to the protected network
- enforces decisions of the PDP

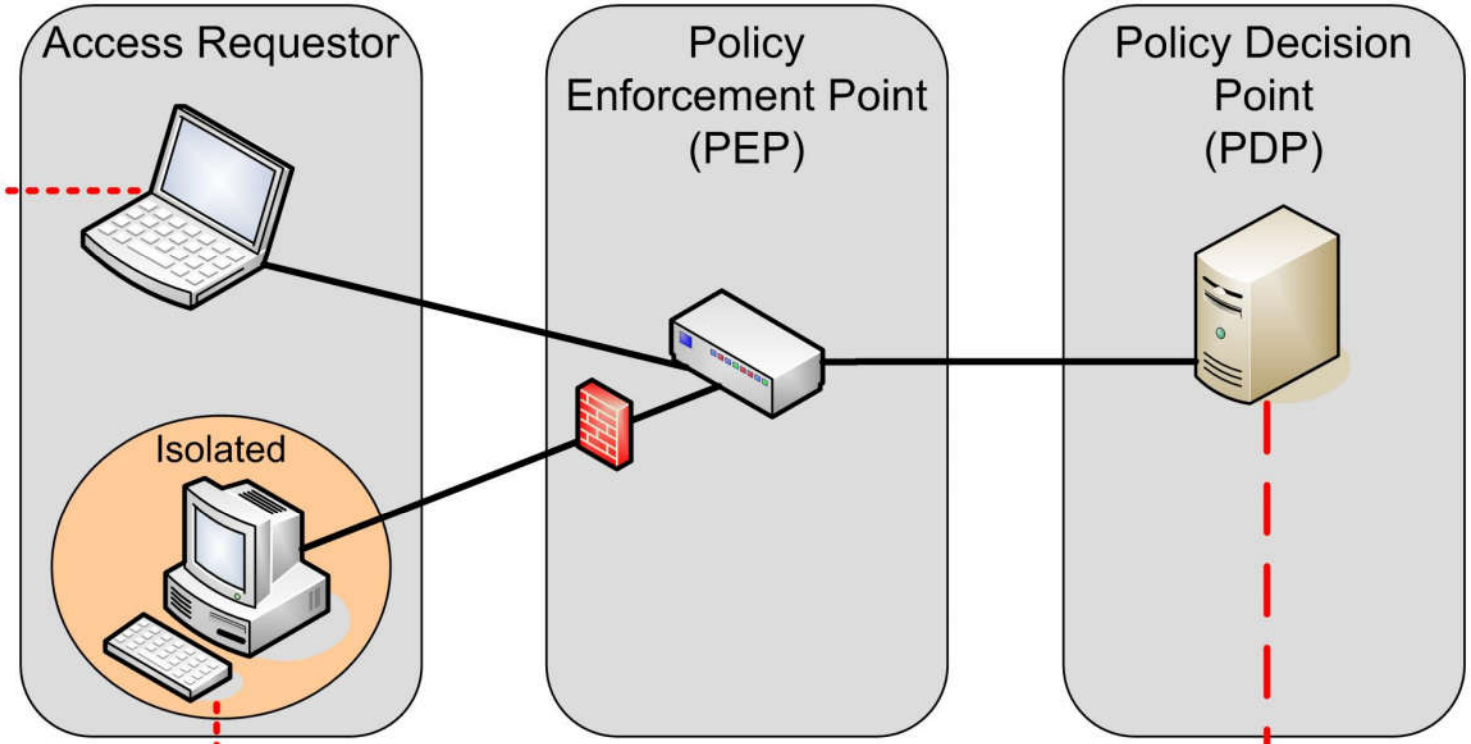
Policy Enforcement Point (PEP)

- decides whether NAR should be given access to the network

Network Access Authority (NAA)

Trusted Network Connect
→ Easy Example: Policy Enforcement

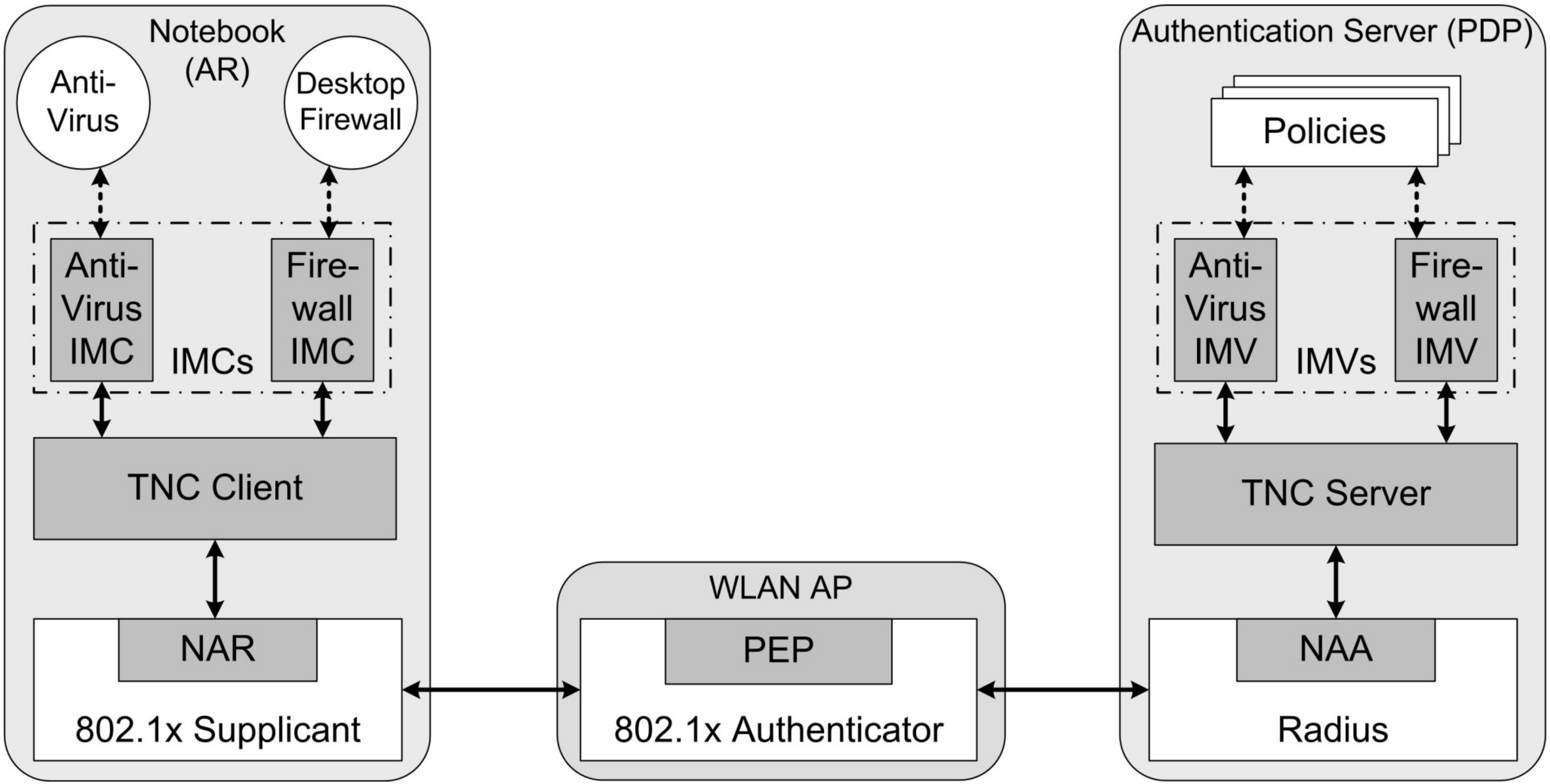
Windows 2000
AntiVirus: true
SignatureAge: 0
Firewall: true
…….



Windows 2000
AntVirus: true
SignatureAge: 1
Firewall: false
…….

If Windows 2000{
AntiVirus: true
maxSignatureAge: 0
Firewall: true
}

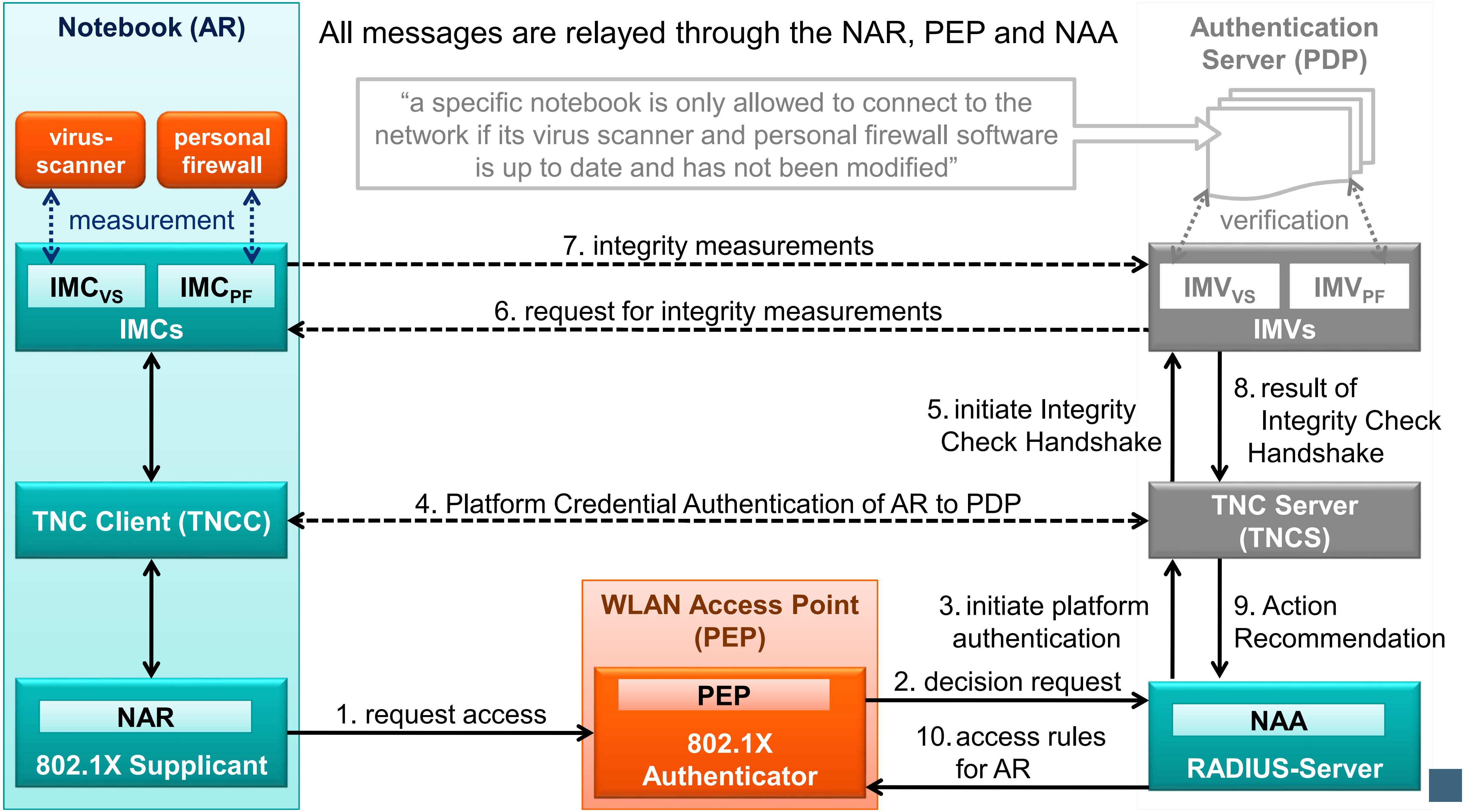
Trusted Network Connect
→ Example: WLAN



Trusted Network Connect → Example: WLAN

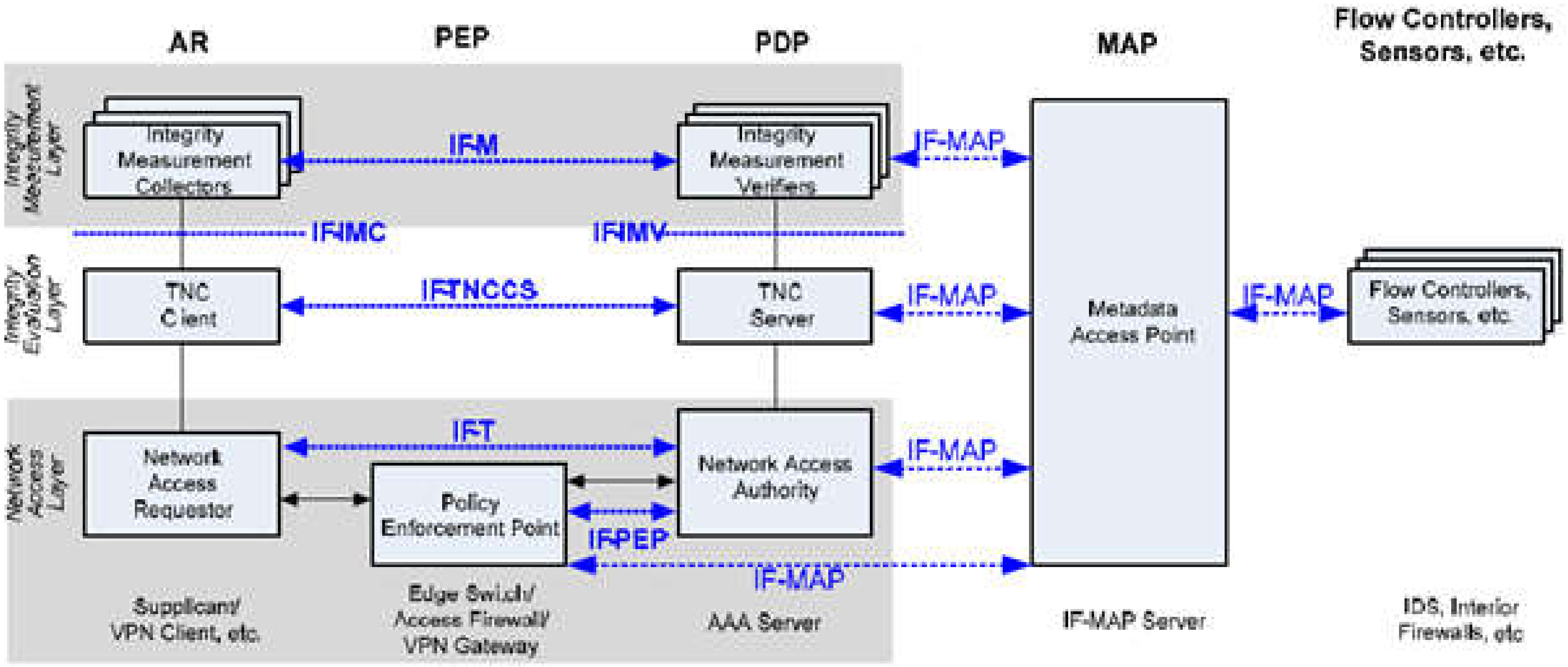
— direct communication

--- logical communication



Notebook (AR)
virus-scanner
personal firewall
measurement
IMC$_{VS}$
IMC$_{PF}$
IMCs
TNC Client (TNCC)
NAR
802.1X Supplicant
All messages are relayed through the NAR, PEP and NAA
"a specific notebook is only allowed to connect to the network if its virus scanner and personal firewall software is up to date and has not been modified"
Authentication Server (PDP)
verification
IMV$_{VS}$
IMV$_{PF}$
IMVs
TNC Server (TNCS)
NAA
RADIUS-Server
WLAN Access Point (PEP)
PEP
802.1X Authenticator
1. request access
2. decision request
3. initiate platform authentication
4. Platform Credential Authentication of AR to PDP
5. initiate Integrity Check Handshake
6. request for integrity measurements
7. integrity measurements
8. result of Integrity Check Handshake
9. Action Recommendation
10. access rules for AR

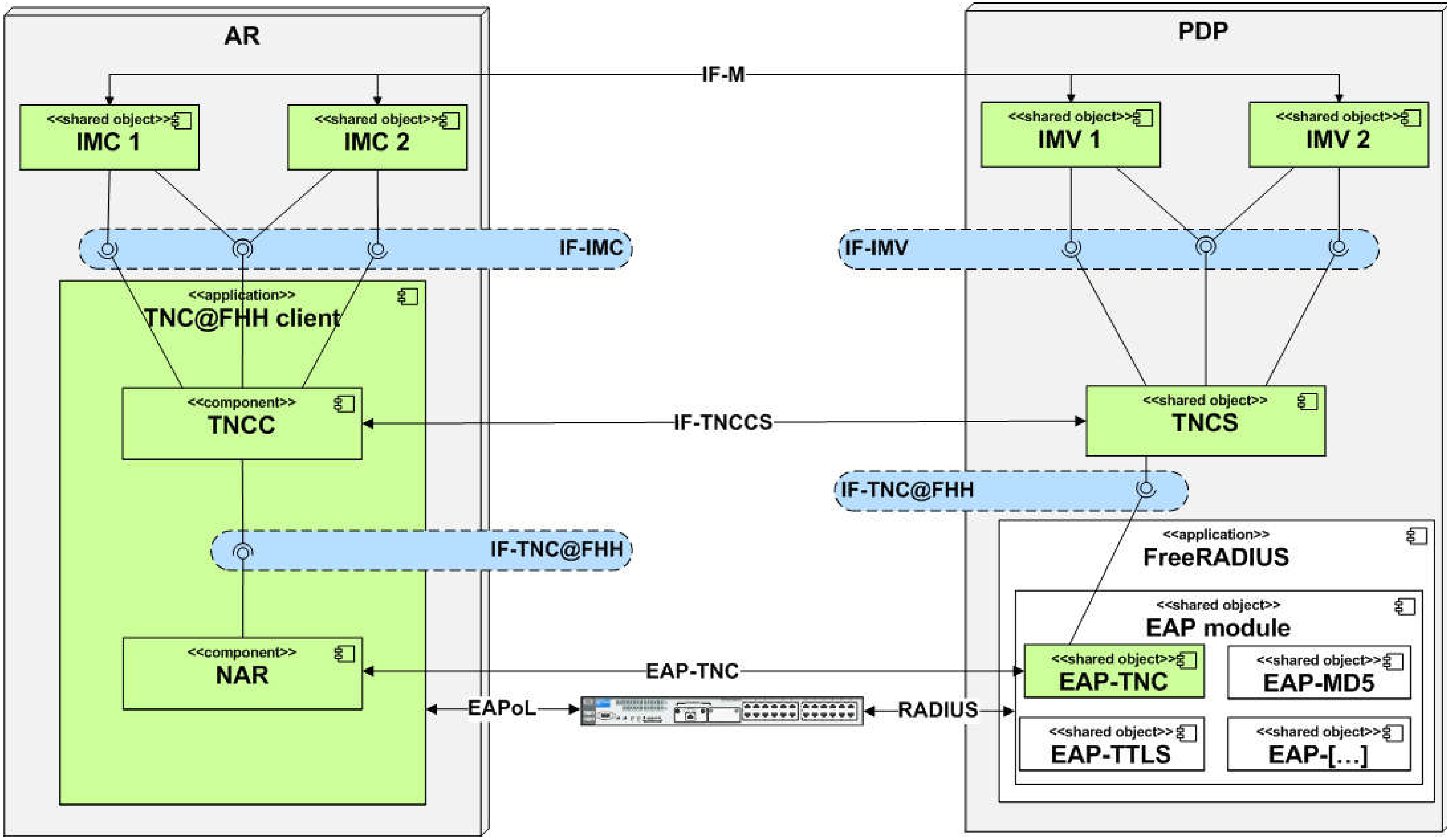
Trusted Network Connect
→ Extension



AR
PEP
PDP
MAP
Flow Controllers, Sensors, etc.
Integrity Measurement Layer
Integrity Evaluation Layer
Network Access Layer
Integrity Measurement Collectors
IF-M
Integrity Measurement Verifiers
IF-MAP
IF-IMC
IF-IMV
TNC Client
IF-TNCCS
TNC Server
IF-MAP
Metadata Access Point
IF-MAP
Flow Controllers, Sensors, etc
IF-T
Network Access Requestor
Policy Enforcement Point
IF-PEP
Network Access Authority
IF-MAP
IF-MAP
Supplicant/ VPN Client, etc.
Edge Switch/ Access Firewall/ VPN Gateway
AAA Server
IF-MAP Server
IDS, Interior Firewalls, etc

- Metadata Access Point (MAP, storing and providing state information)
- Flow controllers, Sensors etc. (like IDS, Interior Firewalls).

Trusted Network Connect
→ Example: TNC@FHH



Trusted Network Connect
→ Example: IMC/IMV Pairs

- **IMCs provided by the TNC@FHH project**
- **Currently “Windows only”**

- **HostScanner**
  - Client-sided port scan

- **Registry**
  - Scans for specific registry entries

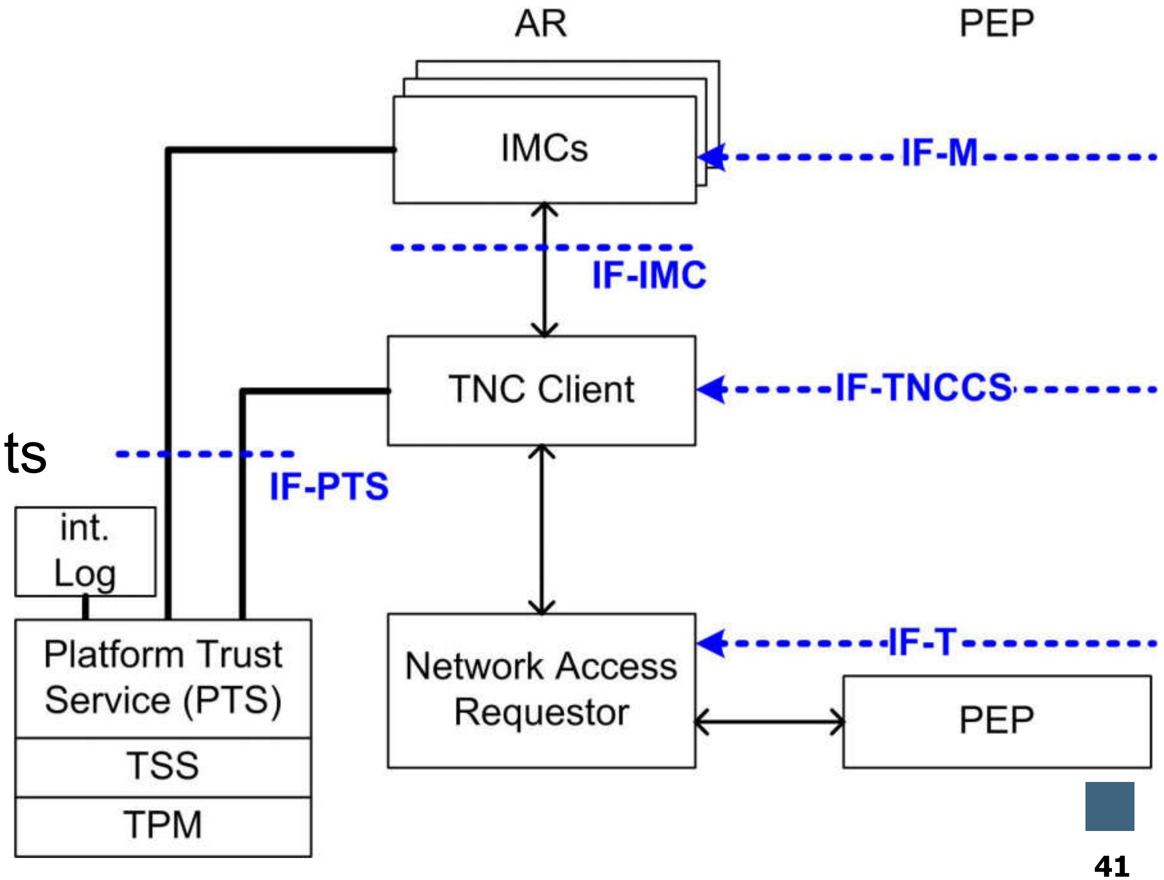
- **SecurityScanner**
  - IMC for the „Microsoft Security Center“
  - Collects data für Windows patch- , antivirus and firewall state

- **ClamWin**
  - IMC for the open source „Clam AntiVirus“ scanner

Trusted Network Connect
→ TPM Support

- **One main advantage of TNC compared to other NAC solutions**
  - Supports use of the TPM during TNC Handshake
  - Promising approach to solve the **„lying endpoint problem“**
  - **Goal:** Ensure integrity of TNC subsystem located on the AR

- **New component:**
  PTS (Platform Trust Services)
  - System service on the AR
  - Exposes Trusted Platform capabilities to TNC components



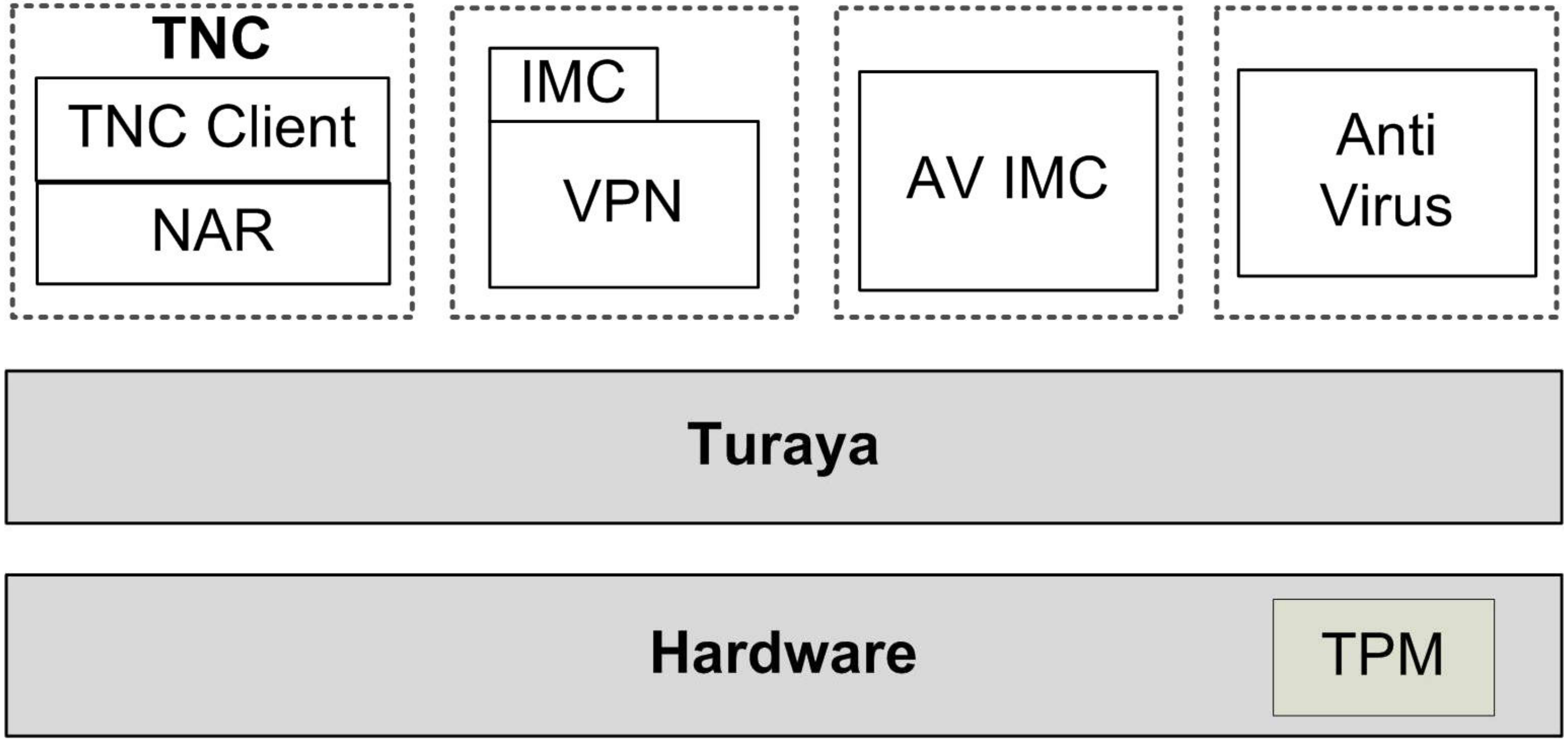
Trusted Network Connect
→ TPM Support

- **Idea: Use TPM capabilities during TNC Handshake**
  - Create integrity reports
    - Including signed PCR values
  - AR sends integrity report to PDP
  - Sign measurements
  - PDP compares received values to known good reference values
    - PDP can verify integrity of TNC subsystem
- **Limitation**
  - TPM components can still get compromised by malware
  - Every data which has to be signed can still get compromised
    → Exclusive use of the TPM cannot solve the lying endpoint problem
    - Due to the use of current OS
    - Only the use of **security platforms** can solve this problem

Trusted Network Connect
→ TNC and Security Platforms (1/3)

Example 1: Integration into Turaya

- Integrate TNC core components into one compartment
- IMCs part of compartments to measure or in isolated ones
- How to remote check Turaya?



Trusted Network Connect
→ TNC and Security Platforms (2/3)

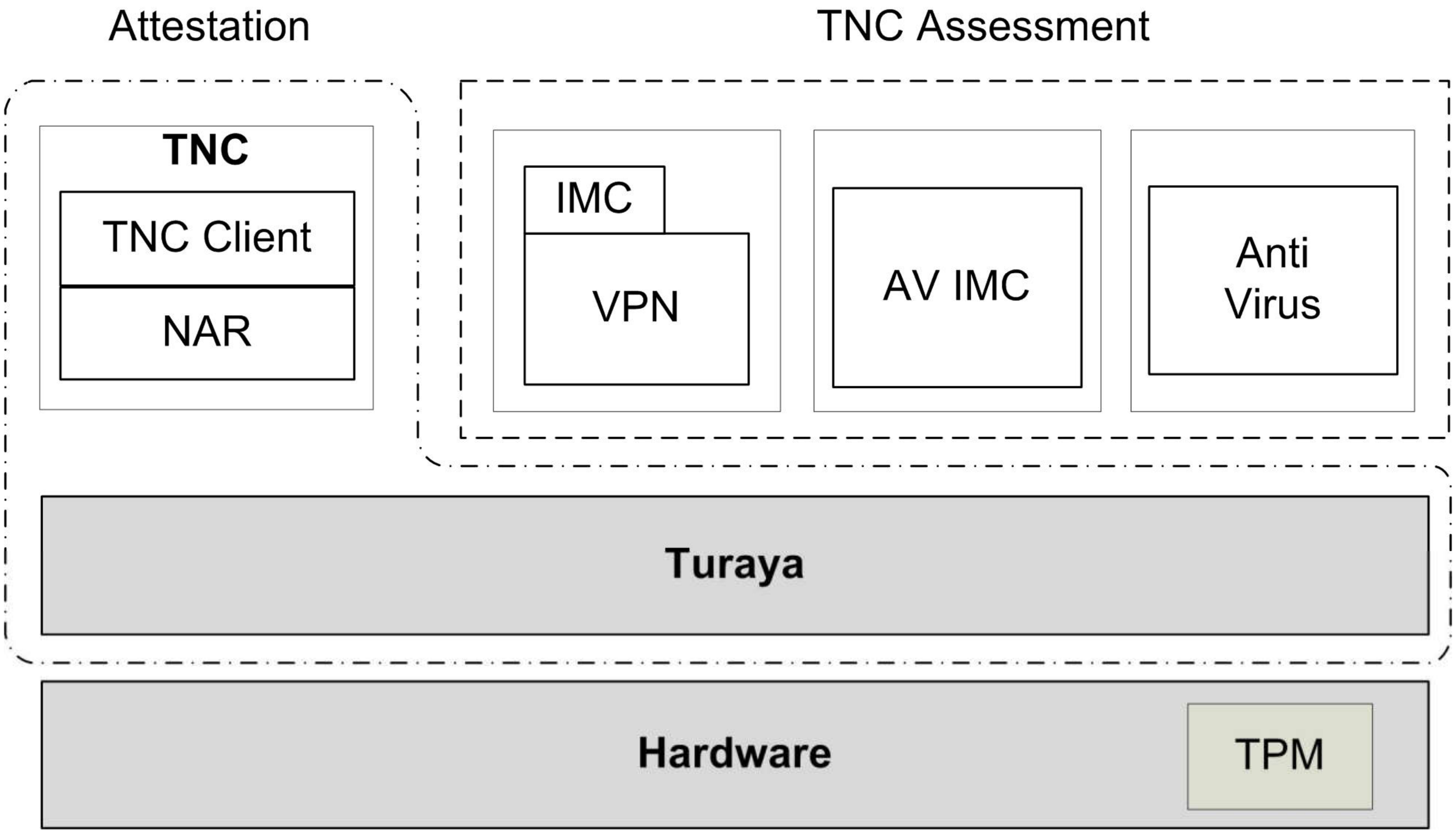
Example 2: Integration into Turaya with Remote Attestation

- Use Remote Attestation for attest Turaya and the TNC core components
- Use TNC to check frequently changing compartments

Benefits

- Check Turaya and the TNC compartment at a high trust level
- Check frequently changing compartment
  - without the need for frequently re-certifications

Trusted Network Connect
→ TNC and Security Platforms (3/3)



Contents

- Aim and outcomes of this lecture
- Introduction
- Network Access Control
- Trusted Network Connect
- **Summary**

TNC Basis
→ Summary

- TNC is a solution to check the trustworthiness of clients!
- TNC makes an access decision as early as possible depending on the trustworthiness level of any accessing device (healthy level).
- TNC proves the trustworthiness of SW and IT security components which change often (OS updates, signature for virus scanner, …)
- The combination of TNC and security platform makes the trustworthiness level higher.

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Trusted Network Connect → Basis

Thank you for your attention!
Questions?

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TNC Basis
→ Literature

- [1] M. Jungbauer, N. Pohlmann: „Integrity Check of Remote Computer Systems - Trusted Network Connect", in "ISSE/SECURE 2007 - Securing Electronic Business Processes - Highlights of the Information Security Solutions Europe/Secure 2007 Conference", Hrsg.: N. Pohlmann, H. Reimer, W. Schneider; Vieweg-Verlag, Wiesbaden 2007
- [2] M. Jungbauer, N. Pohlmann: „Trusted Network Connect Vertrauenswürdige Netzwerkverbindungen", in "Trusted Computing - Ein Weg zu neuen IT-Sicherheitsarchitekturen”, Hrsg.: N. Pohlmann, H. Reimer; Vieweg-Verlag, Wiesbaden 2008

Links:

Institute for Internet Security:
http://www.internet-sicherheit.de/forschung/aktuelle-projekte/trusted-computing/

http://www.internet-sicherheit.de/forschung/aktuelle-projekte/tnac/