Direct Anonymous Attestation in the Wild

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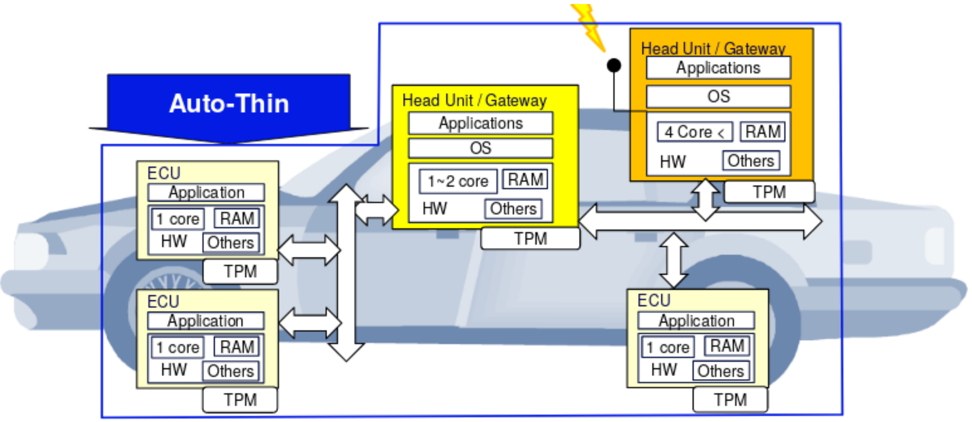
Outline

DAA in Theory

- History
- Formal Analysis

DAA in the Real World

- Vehicular use case
- Implementation challenges



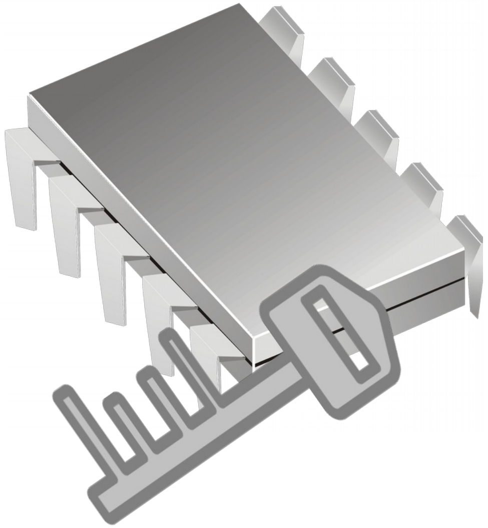
Direct Anonymous Attestation (DAA)

- Anonymous Digital Group Signature scheme
  - Strong but privacy-preserving authentication
  - ISO/IEC 20008 2013

- Hardware-backed attestation using Trusted Platform Modules (TPM)

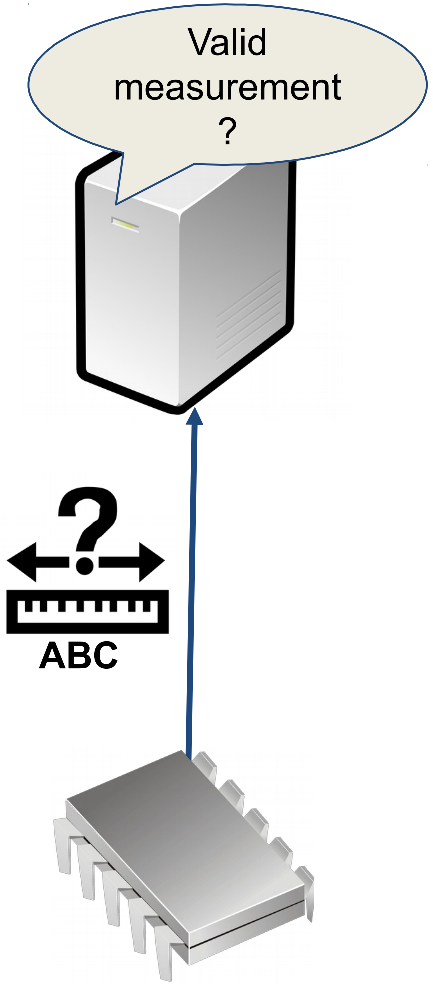
- Properties of DAA:
  - **User-controlled Anonymity**

  - **User-controlled Traceability**
    - Host controls whether signatures can be linked



DAA Schemes

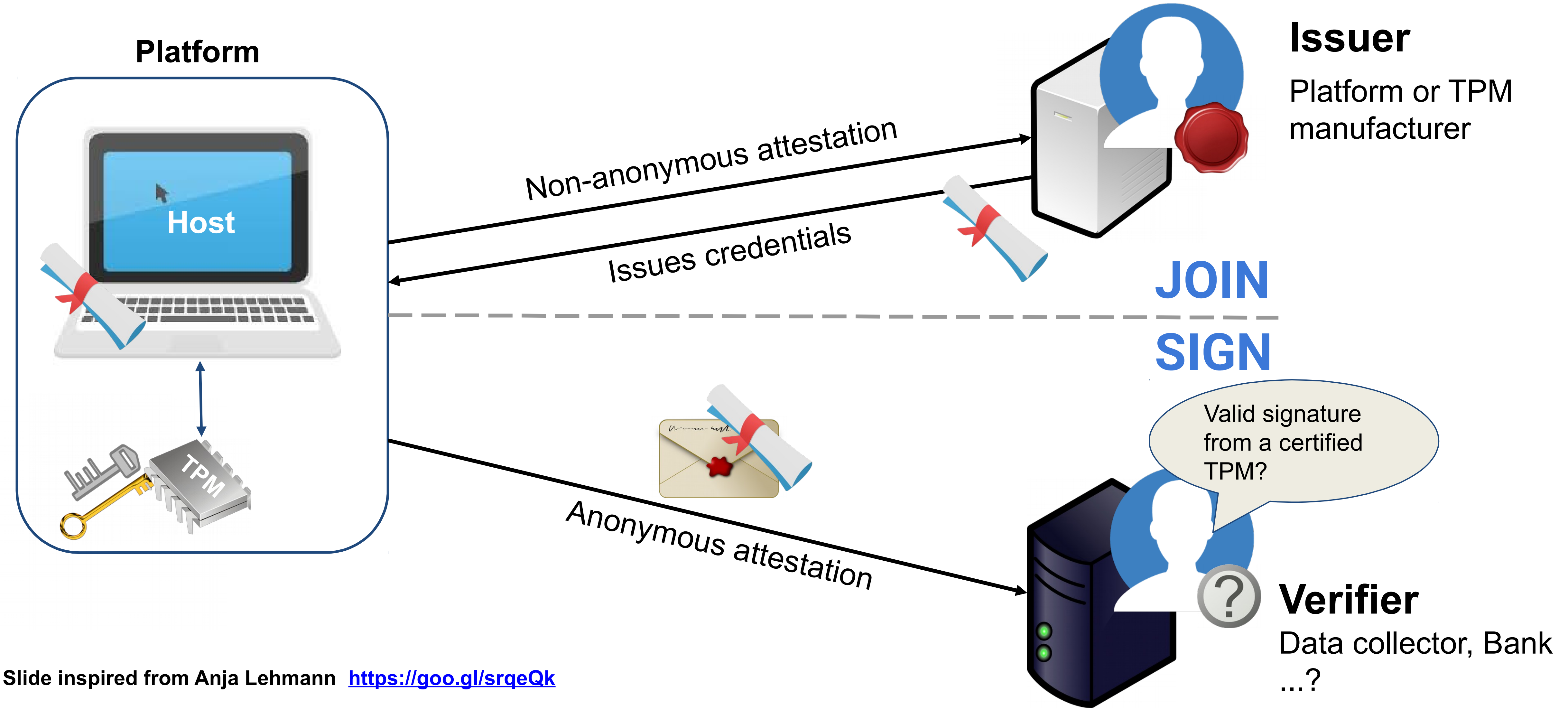
- **TPM 1.2** (RSA-based) [BCC04]
  - ISO/IEC 20008-2 mechanism 2
- **TPM 2.0** (pairing-based) [BCL08, BCL09]
  - ISO/IEC 20008-2 mechanism 4 & ISO/IEC 11889
  - Smaller keys & signatures!
  - Proposed for FIDO 2
- **Enhanced Privacy ID** (EPID) [BL07, BL11, BL12]
  - Used by Intel SGX
  - Improved revocation



TPM 2.0 DAA Vulnerabilities

- **TPM 2.0 API was insecure** [ANZ13]
  - Static Diffie-Hellman oracle present
  - Fix: updated protocol
- **Use of BN P256 curve**
  - 128-bit security reduced to 85-bit
  - Fix: Move to a larger curve
    - BN P638 already in standards

Overview of DAA

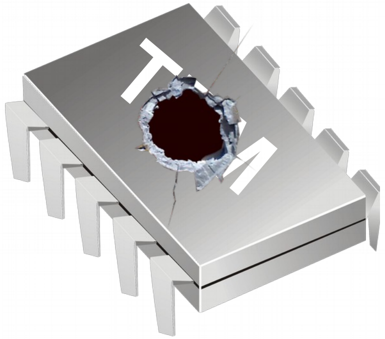


Platform
Host
TPM
Non-anonymous attestation
Issues credentials
Issuer
Platform or TPM manufacturer
JOIN
SIGN
Valid signature from a certified TPM?
Anonymous attestation
Verifier
Data collector, Bank ...?

* Slide inspired from Anja Lehmann https://goo.gl/srqeQk

Formal Analysis of ECC-DAA

Found an attack when the endorsement key of one TPM is compromised, the security of all TPMs cannot be guaranteed in a JOIN

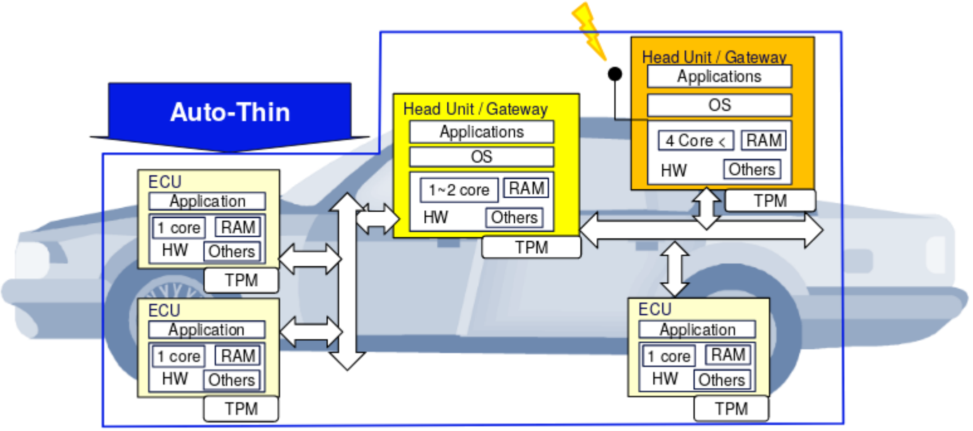


We have identified a fix by including a TPM endorsement public key during a JOIN

Proofs and Disproofs obtained using the Tamarin Prover
https://tamarin-prover.github.io/

DAA implementation in vehicular architecture

- Use-case targeting V2X communication using DAA
  - V2X requires authentication and privacy
  - State-of-the-art: Public Key Infrastructure



- TCG Automotive-thin profile for TPMs in vehicles [TCG15]

- Vehicle credentials (pseudonyms) can be **created**, **signed** and **verified** using DAA

"Privacy-Enhanced Capabilities for VANETS Using Direct Anonymous Attestation."
In *2017 IEEE Vehicular Networking Conference,*
VNC 2017

Implementation of vehicular architecture

Hardware

- Raspberry Pi 3B
- Infineon TPM 2.0 developer module
- NexCom VTC in-vehicle computer

Software

- C++ / Java
- OpenSSL
- AMCL Crypto Library
- IBM Trusted Software Stack

Implementation Timings

Operation	Approx. Time* (ms)
JOIN	820 + Issuer
CREATE and **CERTIFY** a pseudonym key	420
SIGN a message to send (ECDSA)	80
VERIFY a received message	
VERIFY the pseudonym key	200
VERIFY the message signature (ECDSA)	10
REVOKE	330

*Timings based upon measurements of the TPM commands and of the operations on the NexCom box. Values are given to the nearest 10ms.

TPM Implementation Challenges

- **Multiple TPMs had different versions**:
  - ECDAA signature for TPM 2.0 version 1.16 up to Errata 1.4, different to TPM 2.0 version 1.16 Errata up to 1.5 and TPM 2.0 version 1.38
  - Accommodating these differences made the system more complicated

- **Complexity:** >1600 pages of documentation!

- **Insecure curves**
  - BN P256 insecure
  - BN P638 secure but unimplemented in TPM
    - TCG should update standards to require more secure curves

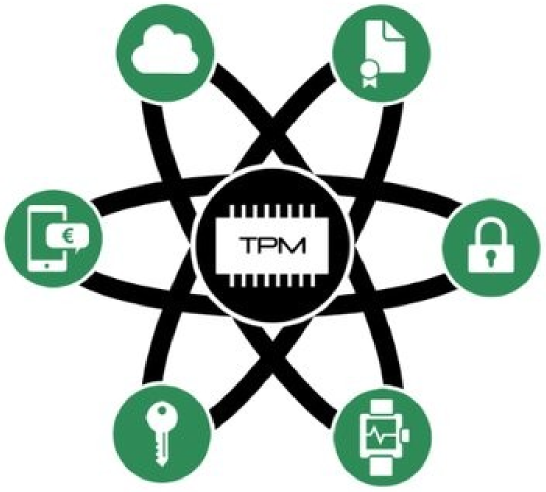
- **Compatible crypto libraries**
  - “*Exotic*” cryptography not widely implemented

Future TPM: A Quantum-Resistant TPM

Goal: To develop a **Quantum-Resistant** TPM

www.futuretpm.eu

@FutureTPM_H2020



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Conclusion

TPM development is hard

Consider other use cases for DAA

Analysis of FIDO 2 ECDAA scheme

https://jwhitefield.co.uk

@sudo_jorden

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