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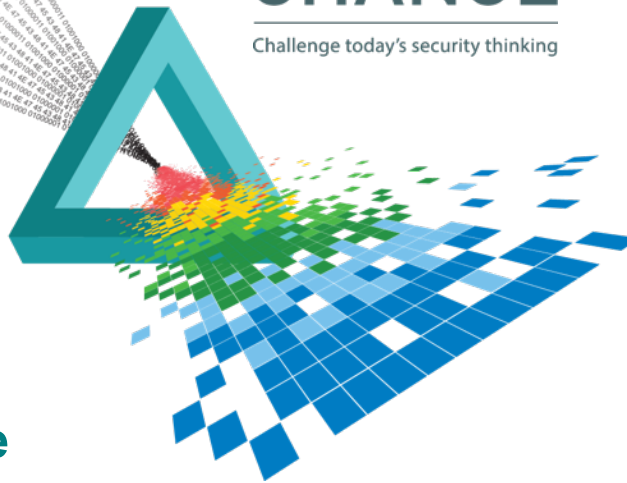
CHANGE
Challenge today's security thinking



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The New Key Management:

Unlocking the Safeguards of Keeping Keys Private

Jono Bergquist

Solutions Engineering Lead -

APJ

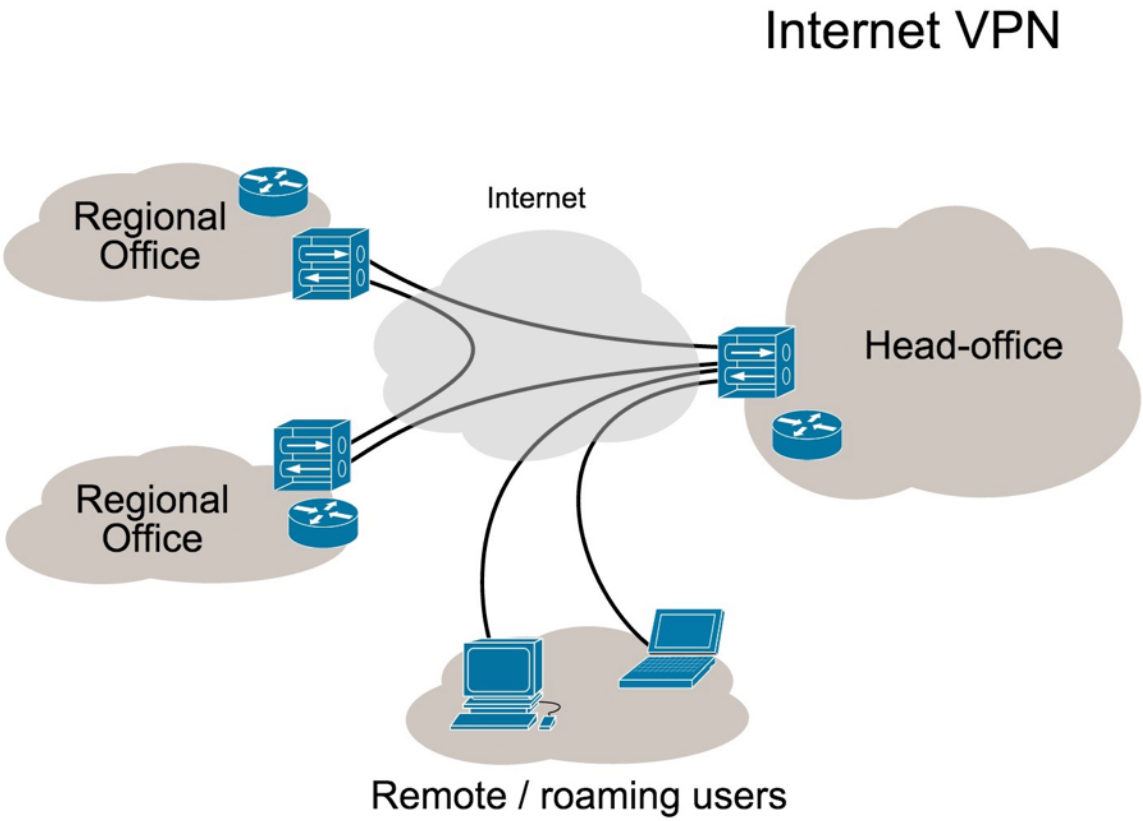
CloudFlare

Outline

- Why application-level TLS is important
- Key management is the hardest part of TLS
- How to use trusted computing for cryptography
- Solving TLS key management with TPMs

The perimeter is porous

Traditional Network Security Topology



Traditional Network Security Topology

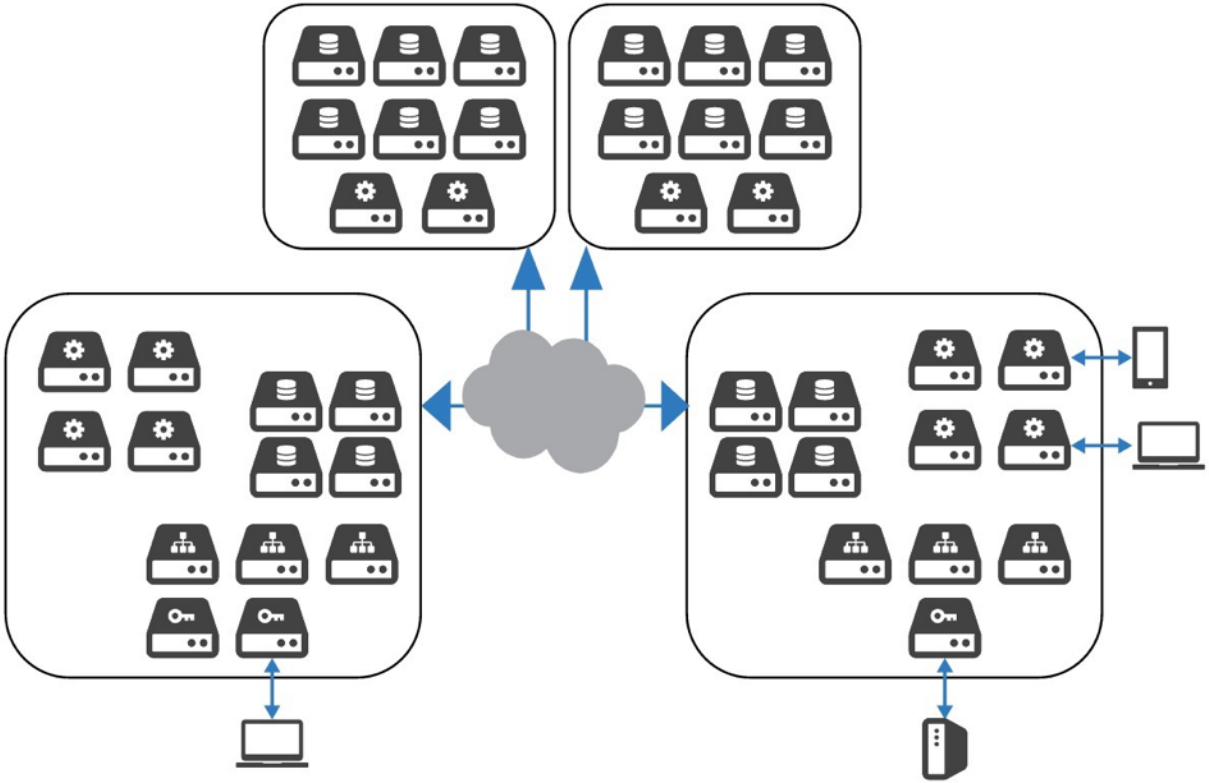
- Multiple internal services
  - Databases with customer data
  - Employee portals
- Cross-datacenter communication across Internet via **VPN**
  - All or nothing access

The perimeter is porous - VULCANDEATHGRIP

Traditional network topology

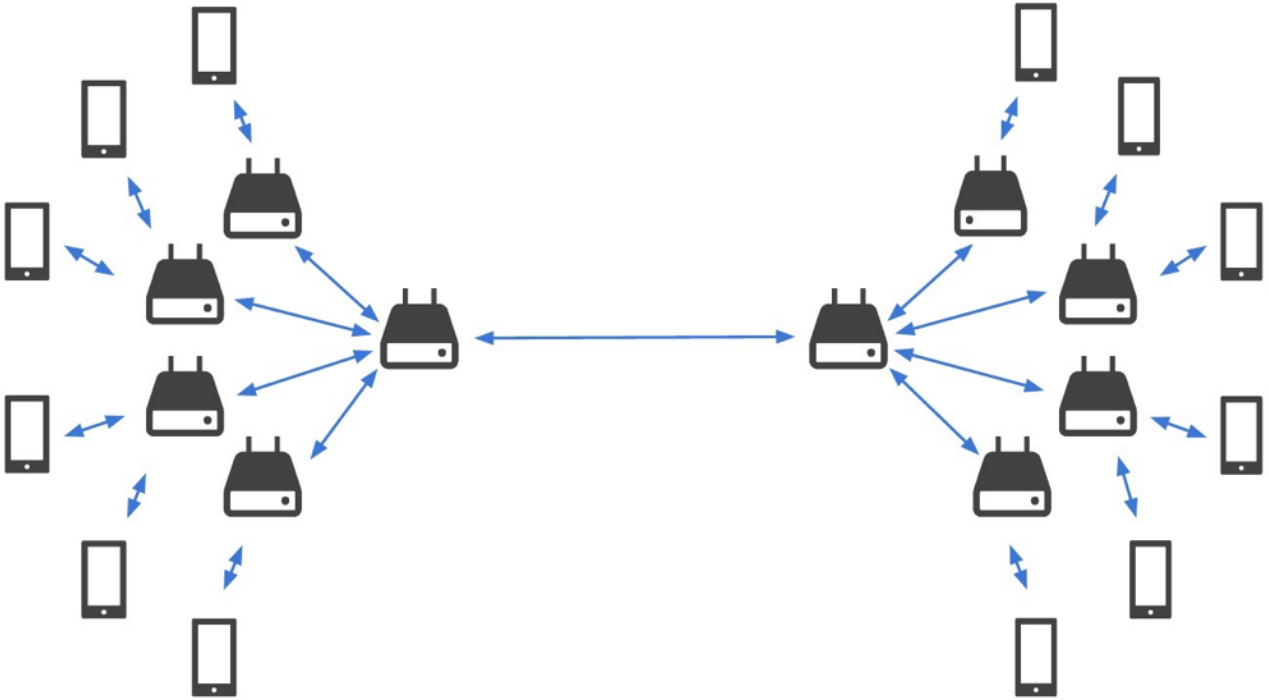
- VPN compromise makes application-to-application data readable

Web Application Security Topology



Edge Network

Mobile network



The modern corporate network

- Components
  - Website hosted on a SaaS/IaaS platform
  - Core business services
  - Loosely affiliated group of services hosted by third parties

The modern corporate network

- Access control
  - Third-party services
    - Federated identity (SAML, OAuth, etc.)
    - Single sign-on
  - Service-to-service authentication
    - Implicit via VPN
    - Token-based

Examples of application-to-application data

- Data breaches
  - User passwords
  - Customer data
  - HR Data
  - Customer lists
  - Proprietary intellectual property

- All from applications inside the network

The modern corporate network

- The perimeter is fuzzily defined
- Move security to a higher level in the stack?

Application-layer Encryption

Encryption

- Corporate data should be encrypted

Encryption

- …at rest
- …in transit
- …with authentication

Layer 3 Encryption

- IPsec tunnel/VPN
  - Expensive hardware
  - Does not scale to edge networks
  - Trust everyone

Layer 5/6 Encryption

- Kerberos
  - Web applications do not use it
- Transport Layer Security
  - Widely supported among a range of applications

Transport Layer Security (TLS)

- The protocol formerly known as SSL
- Provides server-to-server encryption
- Authentication via certificate validation

- Advantages
  - Cheap in software on modern processors (AES-NI)
  - Widely supported in service oriented software

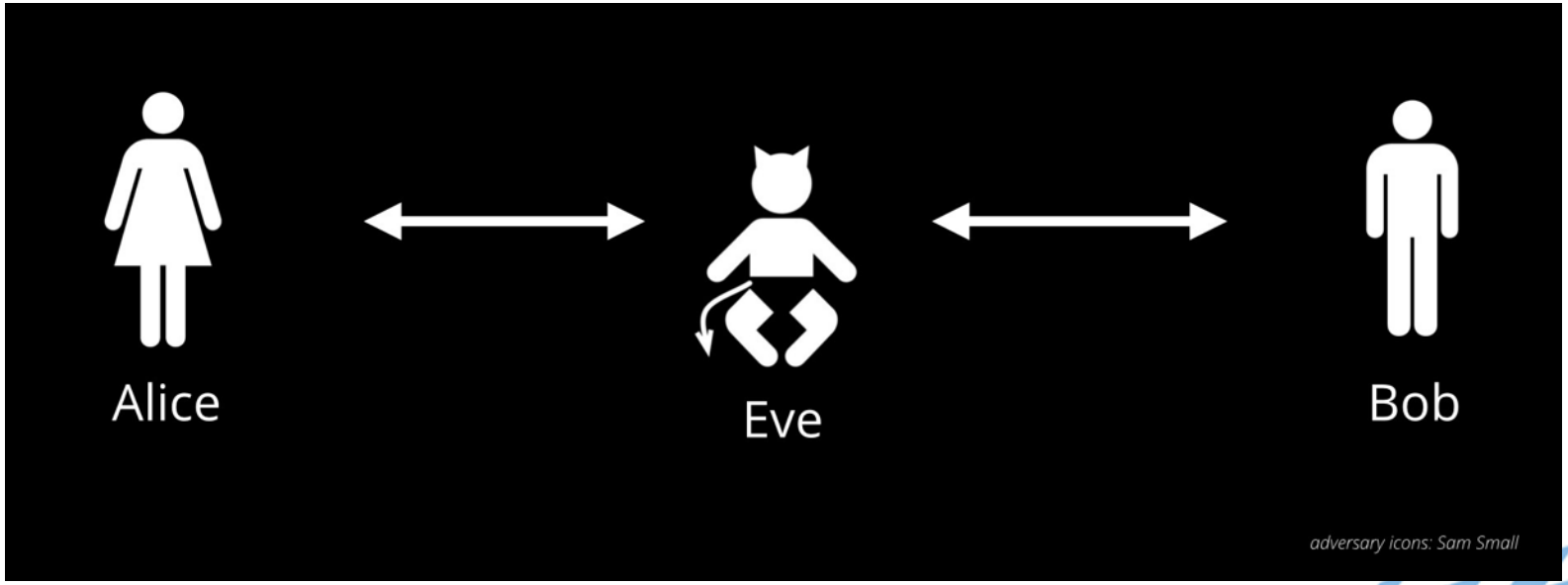
Transport Layer Security (TLS)

- Challenges for application-to-application TLS
  - Building a system of trust
  - Key management

Building trust in applications

TLS without certificate validation

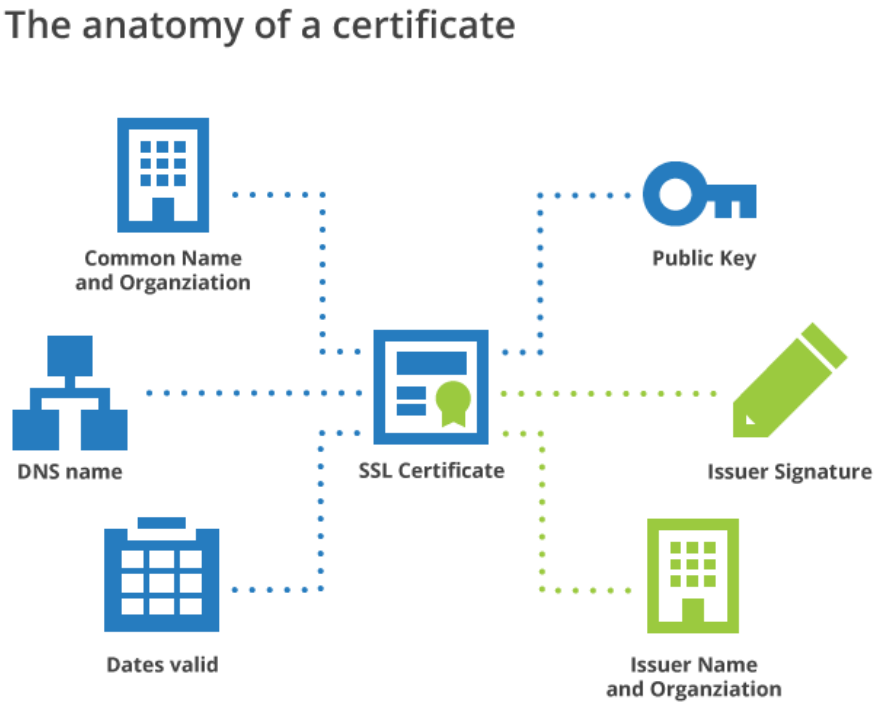
- Traditional man-in-the-middle attack



Trust Models for TLS

- Public Key Infrastructure model
- Each application has:
  - Public X.509 certificate
  - Corresponding private key

X.509 Public Key Infrastructure



Trust Models for TLS

- Session key used to encrypt connection
- Private key used to
  - Prove ownership of certificate
  - Authenticate session establishment
- Validate certificates with a chain of trust

Certificate chain of trust

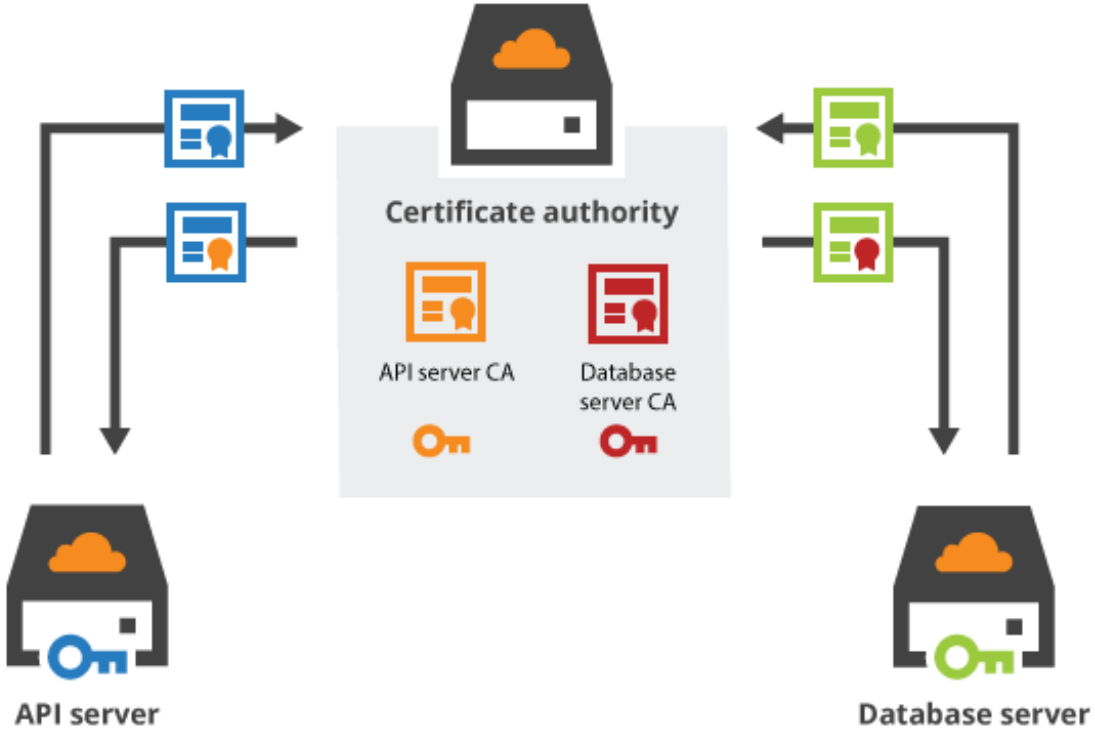
PKI-enabled applications

- Database access
- Business services
- Mobile applications

Private PKI

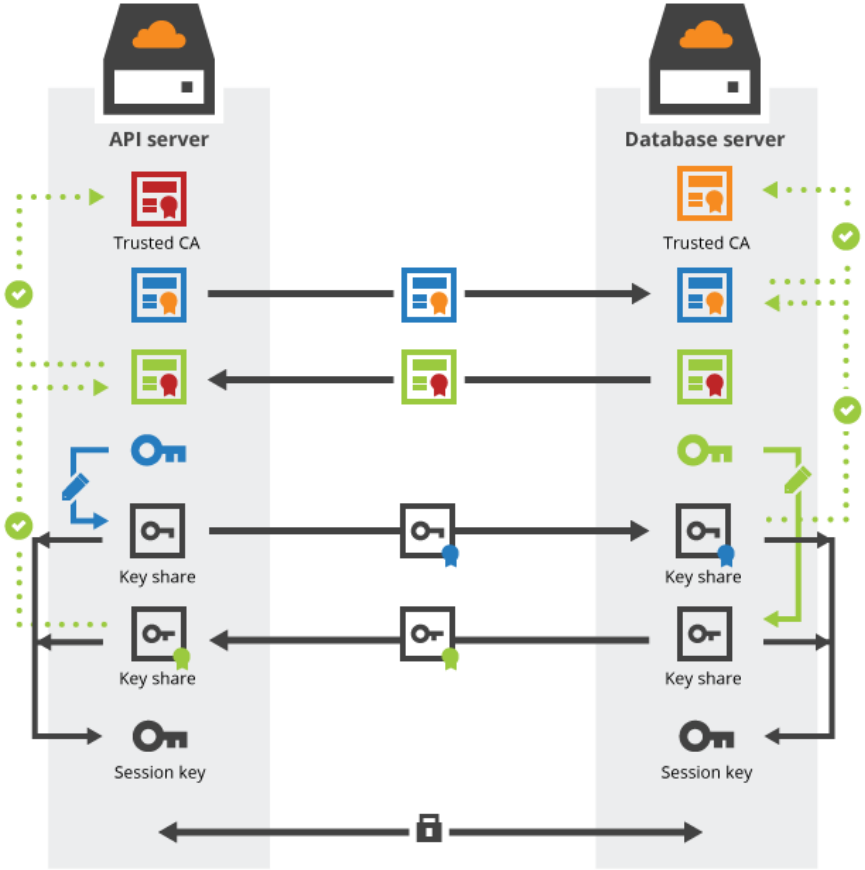
- Run your own internal Certificate Authority
- Generate keys locally on endpoints
- Use internal CA to create certificates

Different CAs for different domains



Service to service communication

With TLS mutual authentication



Tools

- OpenSSL
- CFSSL
  - CloudFlare's open source CA software
- pki.io
- EJBCA
- Commercial options

Advantages

- Application data is encrypted in transit
- Requests are authenticated
- VPN failure is no longer catastrophic

The bootstrap problem

- Enrolling new servers
- Authenticating requests for certificates

Dangers

- Keys live in memory and on disk
- Can be stolen and applications impersonated

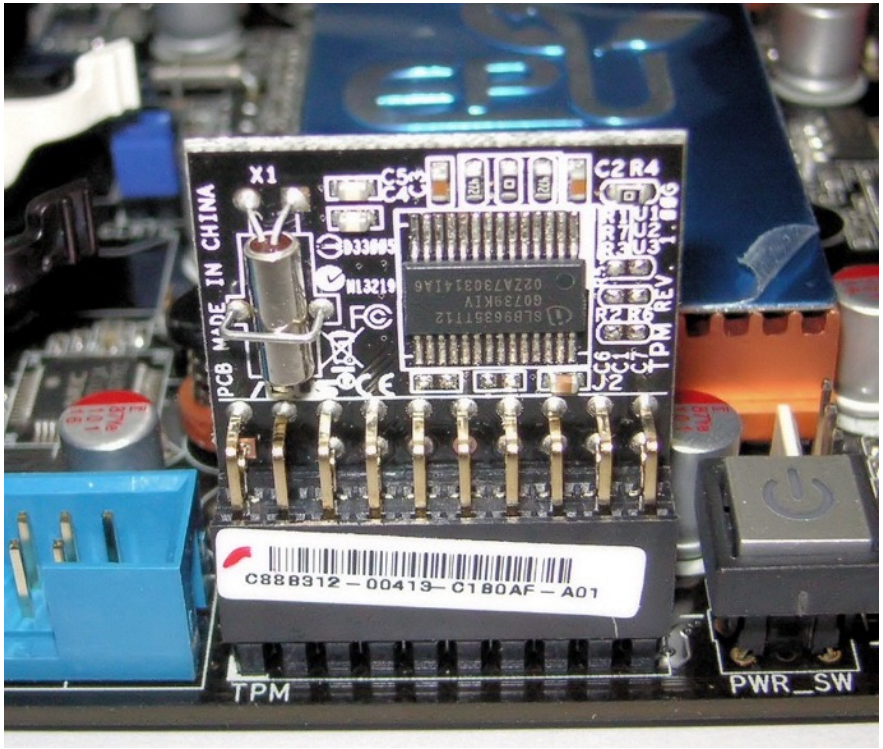
Trusting trusted computing

Protecting keys on servers

- Keep keys in hardware instead of software

- Each machine needs its own hardware
  - HSMs are prohibitively expensive
  - TPMs fit the bill ($15-$30 each)

Trusted Platform Module

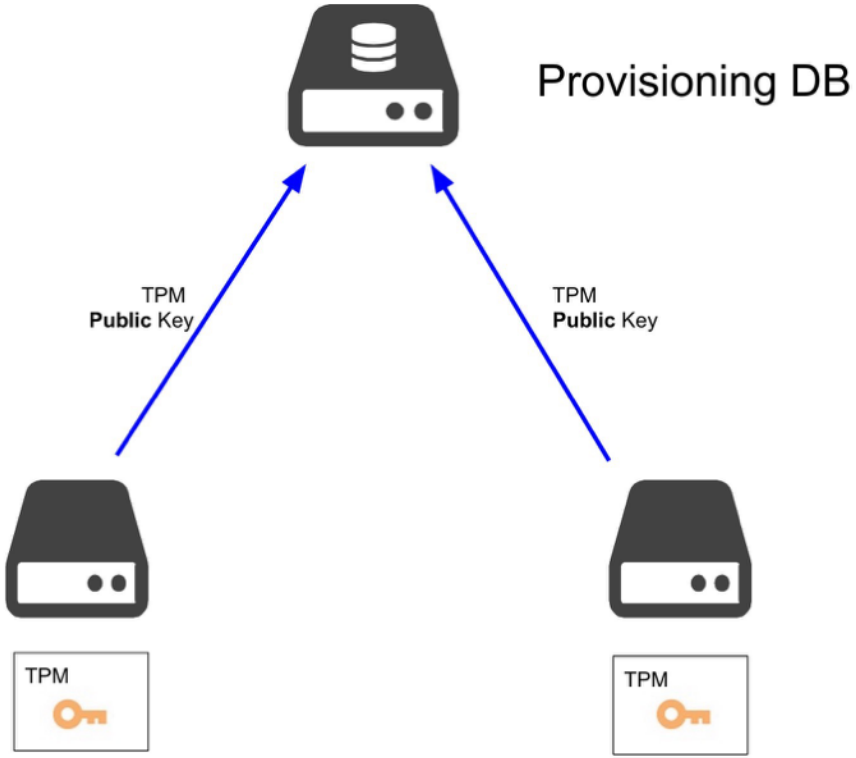


Trusted Platform Module

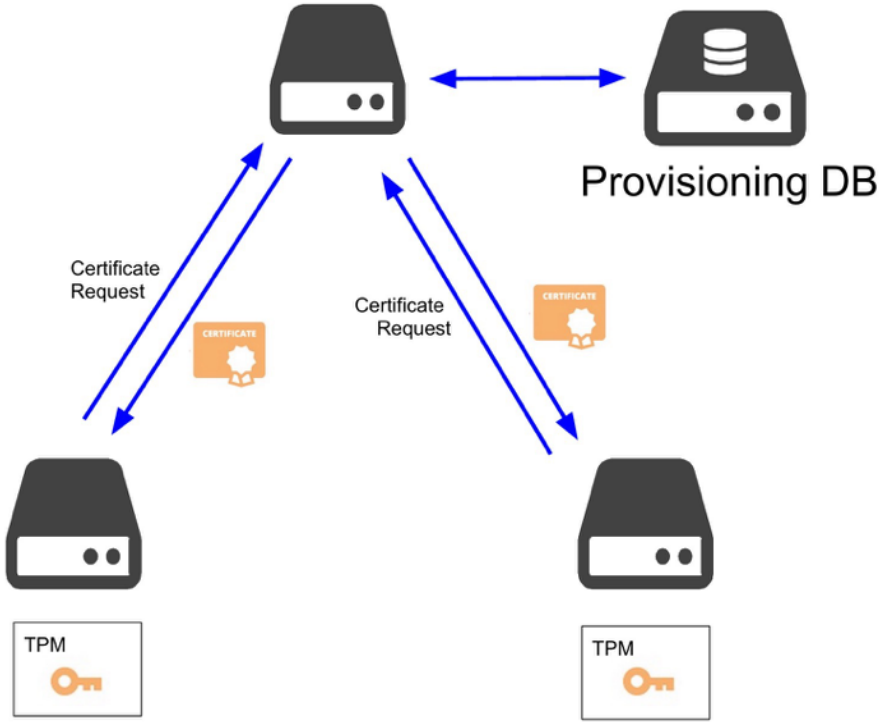
- Most commonly used for Windows trusted boot

- List of features of TPM 1.2
  - Measured Boot
  - Random number generation
  - RSA 2048 private keys

Machine provisioning



Certificate issuance



Benefits

- Keys do not live in software
  - Safe from memory access (Heartbleed, DMA)
  - Safe from theft (TPM locked)
  - Safe from impersonation

Drawbacks

- Not all software supports TPM crypto
- It is slooooow

Simple guide

How to set up secure application transport

- Create your own CA on a trusted machine or HSM
- Create a key on your device TPM
- Use TPM to create a certificate signing request (CSR)
- Create certificate from CSR with CA

- Configure web server to use certificate and TPM for private key operation
- Go for it!

Action

What you can do right now

- Do your applications speak TLS?
- If so, are they doing certificate validation?
- Where are the private keys stored and managed?

What you can do in the next months

- Consider your attacker is an insider
  - Which backend applications accept connections?
- Suppose there is a firewall or VPN misconfiguration
  - Is any data is exposed?
  - What authentication is your database using?

What you can do in the next months

- Once TLS is activated, make sure it is configured properly
  - Certificate validation
  - TLS 1.2

- Start using C or Go services built on open source tools