X-Road: The Security Perspective
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Cybernetica AS

- Cybernetica is a R&D intensive ICT company
  - Established: 1997 based on Institute of Cybernetics
  - Personnel: 130 employees, 10% with PhD
  - Offices located in Tallinn and Tartu
  - Integrated Management System: ISO 9001 and ISO 27001
  - Research cooperation with DARPA and EU
- Has received various international and national acknowledgements
What is X-Road?

- Technology for governmental e-services backbone
  - Scalable and secure
  - Supports collaboration and cooperation
- Dual usage
  - Delivery platform for citizens e-services
  - Platform for governmental data exchange and business processes automation
Why is X-Road Interesting?

- A complete, working system
  - PKI
  - Digital signatures
  - Long-term validity
  - Covers all the bases
- An example of trade-offs between security goals
  - e.g., performance vs. long term validity
- Mix of technical and organizational security measures
Brief History

- 2001 – first version of X-Road goes live
- 2002 – v2, SOAP support, asynchronous messages
- 2003 – v3, SOAP attachments, access control groups
- 2005 – v4, message log encryption, secure e-mail (removed in v5), move from appliance to debian packages
- 2010 – v5, web UI, Document/Literal encoding, Ubuntu support
- 2015 – v6, based on UXP technology. Rewrite of the system
X-Road Overview

- X-Road provides secure, unified transport protocol for web services
- Distributed architecture
  - Organizations have control over their data
  - No central database (no “big brother”)
- Supports heterogeneous systems
  - Works well with legacy systems
  - Does not need changes to legislation and organizational structure
X-Road Overview (2)

- Secure
  - Uses strong authentication
  - All traffic over encrypted channel
  - Digital signing, time stamping and audit logging create accountability

- Scalable, resilient
  - No central bottlenecks
  - No single points of failure
  - All the components can be made redundant
A Digital Ecosystem
System Architecture
System Architecture
System Architecture
Technical Architecture

UXP Registry
- distributes list of trusted UXP members to security servers

UXP Monitoring
- monitors the UXP infrastructure to discover operational issues

UXP Connector
- encrypted channel between servers

TAX BOARD
- Information System

Security Server

Security Server

BANK
- Information System

POLICE
- Information System

Security Server

Security Server

TELECOM
- Information System
Important Features

- Communication is peer to peer
  - End to end encryption between organizations
  - Nobody but the communicating organizations can see the data
- Data owner sets the rules
  - Sets requirements for data users
  - Manages access control rights
Important Features (2)

- Communication is implemented as web services
  - SOAP protocol is used between security servers and organization information system
  - Adapters can be used to interface with existing information systems
The Importance of Services

- All the data access is via services
- Service encapsulate the storage and implementation details
- Services provide limited view on data
  - Limit on search fields
  - Limit on output fields
  - Business rules can be applied on input or output
- Different services can be developed for different clients
- The data owner is responsible for developing services
Authentication and Access Control

- All data access must be authenticated and access control rules must be applied

- Create central database of persons' access rights?
  - Who are the data sources?
  - Who updates the data?

- Do we offer end-to-end security?
  - What about legacy systems?
More on Authentication

- The user invokes the service through her employer's IS
  - Technically, the IS can always impersonate the user
- The service provider does not know anything about the end user
  - Users and their roles are defined in the client organization
Two-Level Access Control

- The X-Road core deals only with inter-organizational access control, where access is granted to an organization as a whole.
- The client organization must ensure that only right people can use the service, by using whatever technical means it sees appropriate.
- This obligation is enforced by service provisioning contract between the organizations.
Two-Level Access Control (2)

- Before joining X-Road, a client organization must prove that it has implemented suitable authentication and access control mechanism.
- Ideally, the information system should be audited by external auditor.
Two-Level Access Control (3)

- Two-level access control isolates the details of organizational authentication and access control mechanisms
- The impact to the existing systems is minimized
- Balanced use of technical and organizational security measures
Additional Controls

- Monitoring – query statistics are sent to monitoring system
  - Can be viewed by security server administrator and central administrator
  - Can be used to discover usage that does not correspond to normal usage patterns
- Public query log – registries keep log of queries
  - Can be viewed by citizens via citizen portal
### Public Query Log

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In Case of Incident

- X-Road signatures can be used to prove actions between organizations
  - For example service provider can prove that the query originated from the client organization
  - When necessary, organizations must implement measures to prove actions of users
    - Audit logs
    - End-user digital signatures
Federation

Country A

Country A PKI

Country A units
Federation

Country A

Country A PKI

Country B

Country B PKI
Federation

Country A

Country A PKI

Country A units

Federation Agreement

Country B

Country B PKI

Country B units

Cross-border services