Near Field Communication
Research Lab
Hagenberg

University of Applied Sciences

Secure communication between web browsers and NFC targets by the example of an e-ticketing concept

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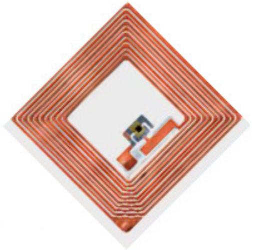
www.nfc-research.at

NFC – What is it all about ...

- NFC can be seen as a further development of RFID
- Radio Frequency (RF) based proximity coupling technology
- Range: 0 – 10 cm (proximity Technology)
- Integrated in mobile devices for consumer market
  - Mobile phones
  - PDAs
- Transmissions on unsecured communication ways
  - Integrity and Authenticity must be guaranteed
  - Authorization mechanism must be implemented

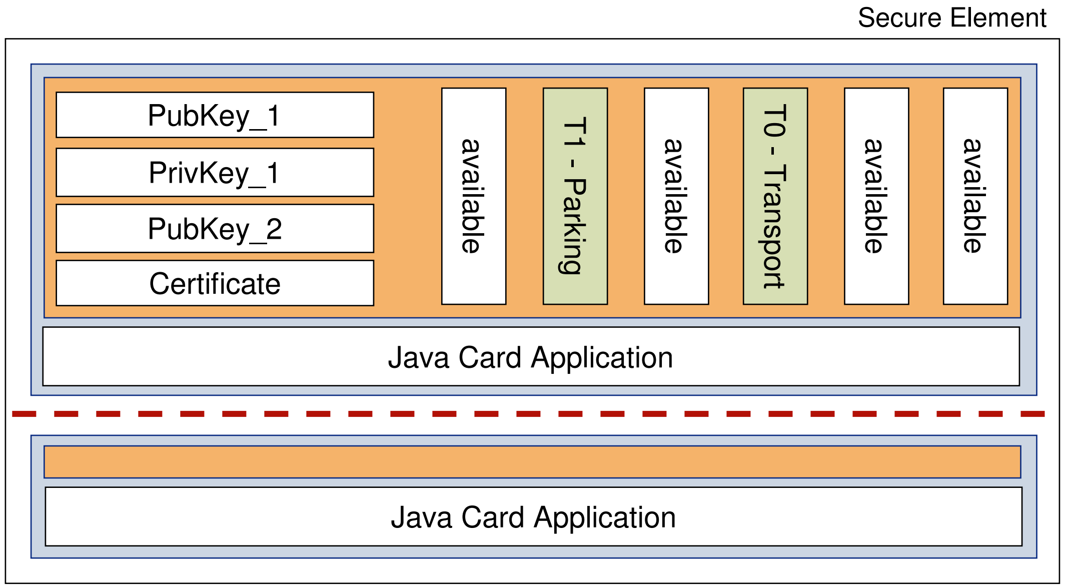


NFC Device Operating Modes

- Data exchange (P2P – NFC peer-to-peer)
  - Bidirectional connection to exchange data between devices
  - P2P Payment, Contacts, vCards, …
- Reader/Writer mode (PCD – Proximity Coupling Device)
  - Mobile Device is able to read external tags/smartcards
  - SmartPoster, WiFi Config, …
- Tag emulation (PICC – Proximity Card)
  - Reader can’t distinguish between smartcard & tag emulation
  - Handset could contain multiple smartcards (smartcard chips)

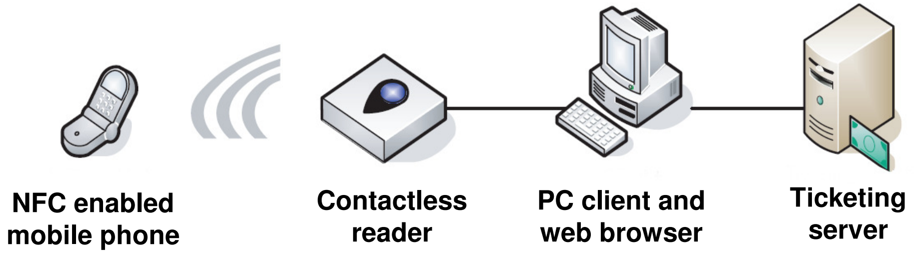
NFC Secure Element

- Dynamic environment where applications can be stored and administrated
  - Delimited memory for each application (sandbox)
  - No communication possible between different applications
  - Cryptographic functions to encrypt, decrypt or sign data



Goal of the Thesis: NFC Secure Communication

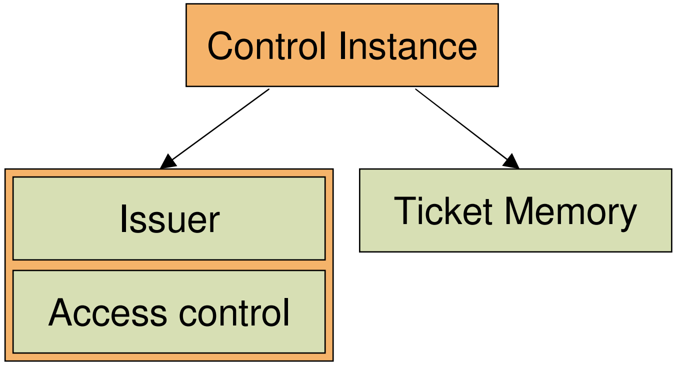
- Simple communication between web browser and NFC devices (e.g. mobile phones)
  - Installation without any user activity (web browser plug-in)
  - Better usability (known tools)
- Secure communication protocol
  - Prevention of any data manipulation (AAA: authenticity, authorization, accounting)
  - Bilateral authentification between all communication parties
  - Timely transmission of tickets (or other data)
- Ubiquitous applications
  - Authentication on web sites
  - Payment



Security concept – Public Key Infrastructure

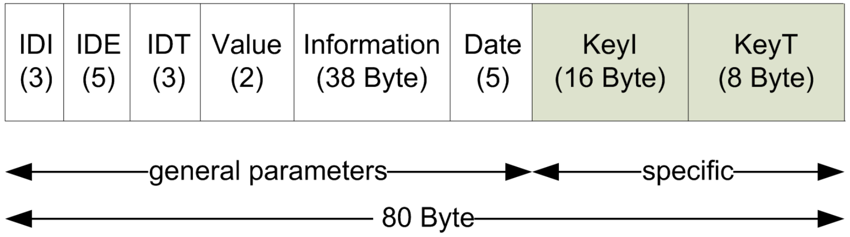
Participants

- Control instance – Trusted Third Party (TTP)
  - Self-signed certificate
  - Confirms the validity of the ticket by its signature
  - Implemented as Web server application
- Issuer
  - Responsible for ticket generation and accounting
  - Implemented as Web Server (View - HTML Content) and Web server application
- Access control
  - Controls the protocol – communication with Secure Element
  - Examines the authenticity of tickets
- Ticket Memory
  - Application for managing tickets in the Secure Element
  - Performing cryptographic functions
  - Implemented as JavaCard application



Ticket

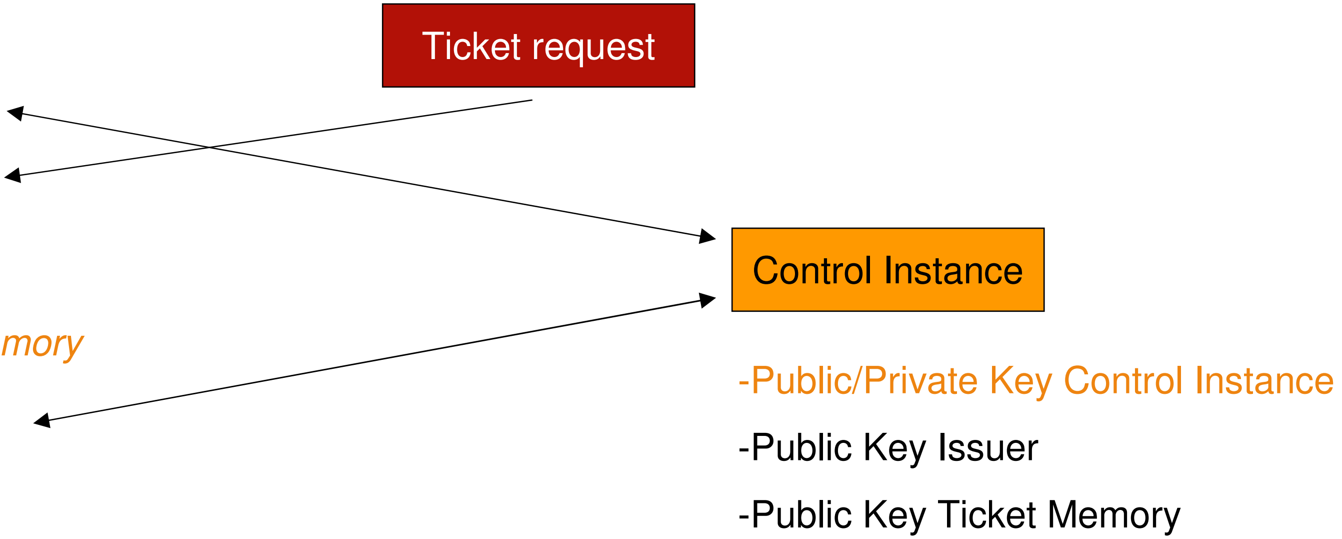
- ID_I +ID_E for event
  - Identification of the Issuer/Event
  - Split between Issuer and Event
- ID_T for ticket
  - Identification of the ticket
- Payload
  - Counter, name, period of validity
- KeyI
  - Public key of the Issuer
  - Key is used to encrypt communication during verification process (issuer content)
- KeyT
  - Public key of the ticket (identification)
  - Key is used to encrypt communication during verification process (ticket content)



IDI (3)	IDE (5)	IDT (3)	Value (2)	Information (38 Byte)	Date (5)	KeyI (16 Byte)	KeyT (8 Byte)

Setup - Key Exchange

- Issuer
  - Public/Private Key *Issuer*
  - Public key *Control Instance*
  - Public/Private Key *Tickets*
- Ticket Memory
  - Public/Private Key *Ticket Memory*
  - Public Key *Control Instance*
- Access Control
  - Public/Private *Key Issuer*
  - Private Keys *Tickets (ticket database)*



Ticket request

Control Instance

-Public/Private Key Control Instance

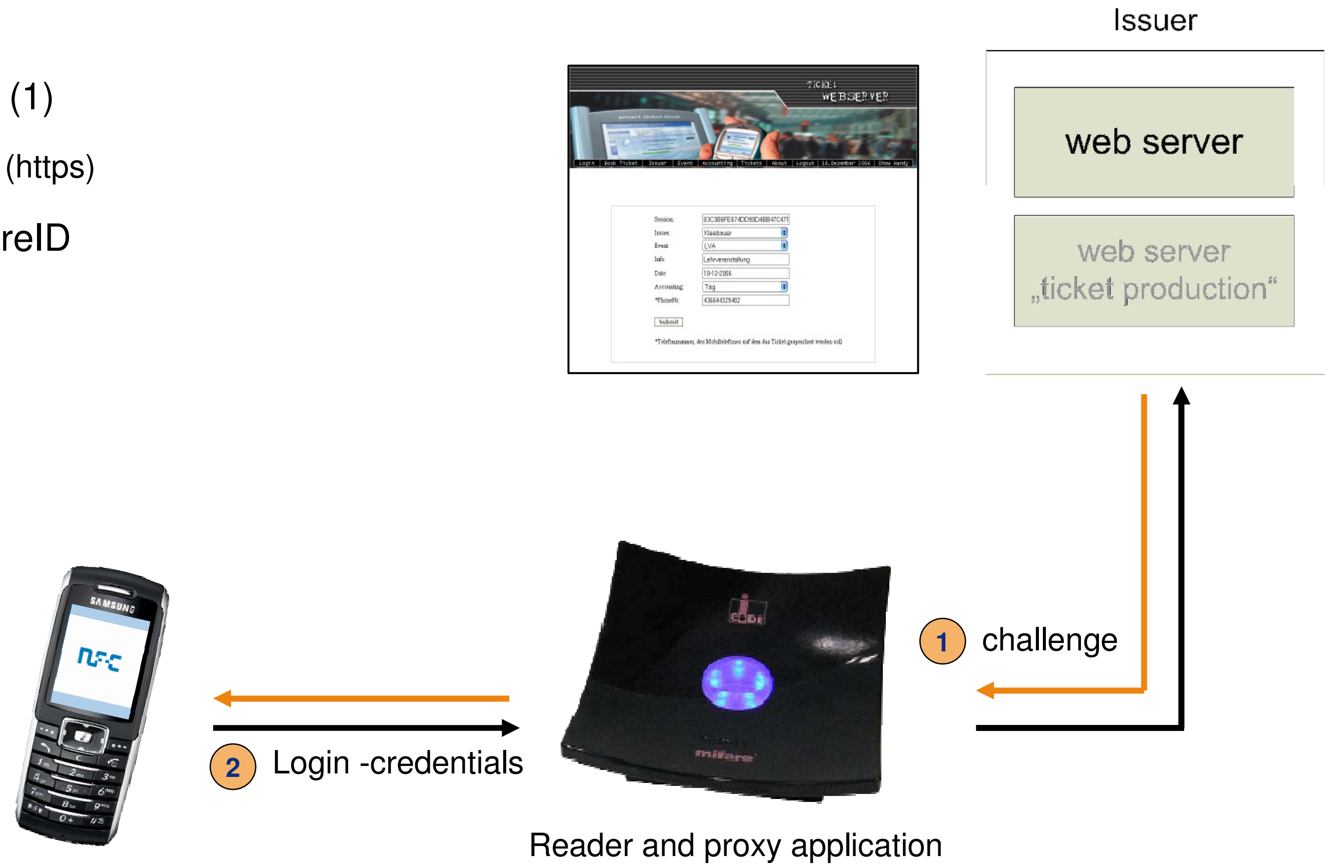
-Public Key Issuer

-Public Key Ticket Memory

Protocol – Ticket Preparation

Login and ticket credentials

- Establish secure connection (1)
  - Web browser and Web server (https)
- Website login using the MifareID



Session: 83C3B6FE674DD90D4BB47C471

Issuer: Kleebauer

Event: LVA

Info: Lehrveranstaltung

Date: 10-12-2006

Accounting: Tag

*PhoneNr: 436644329402

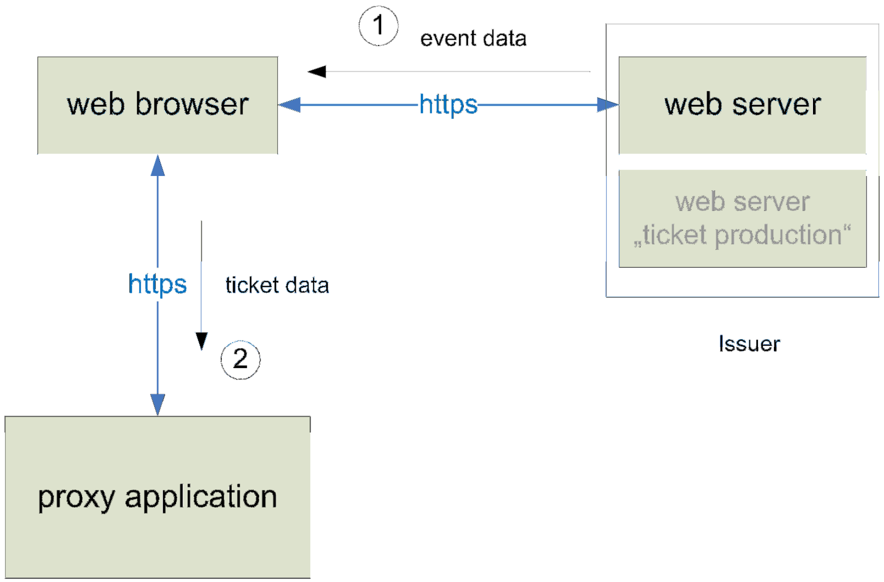
Submit

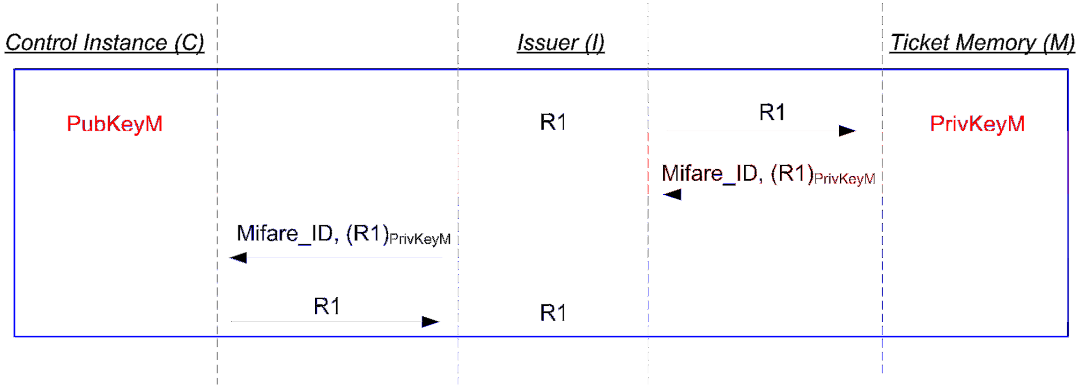
*Telefonnummer, des Mobiltelefones auf dem das Ticket gespeichert werden soll

Protocol – Ticket Preparation

Login and ticket credentials

- Establish secure connection (1)
  - Web browser and Web server (https)
- Website login using the MifareID
  - Challenge – Response procedure
  - Random number prevents Replay attacks
- Ticket data transferred to proxy application (2)
  - XML based structure
  - Further communication controlled by proxy application

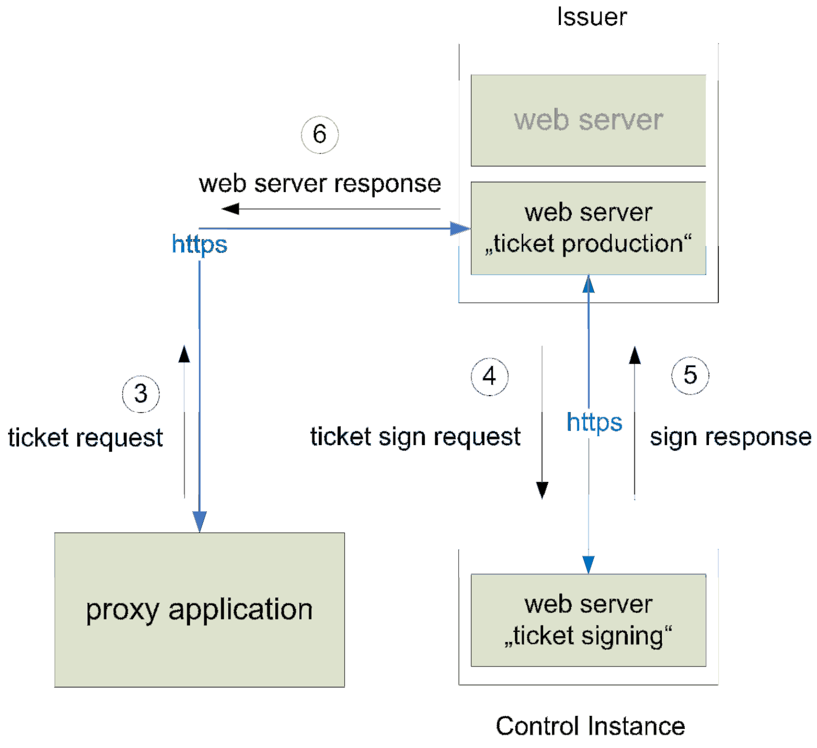




Protocol – Ticket Preparation

Ticket preparation

- Proxy application establish new secured connection (3)
  - Transfer xml based ticket request
- Preparing ticket
  - Web server „ticket production“
- Ticket signing via Control Instance (4,5)
  - Web server „ticket signing“
  - Signed with Private Key *Control Instance*
  - Encrypted with Public Key *Ticket Memory*
- Signed and encrypted ticket (6)
  - Proxy application



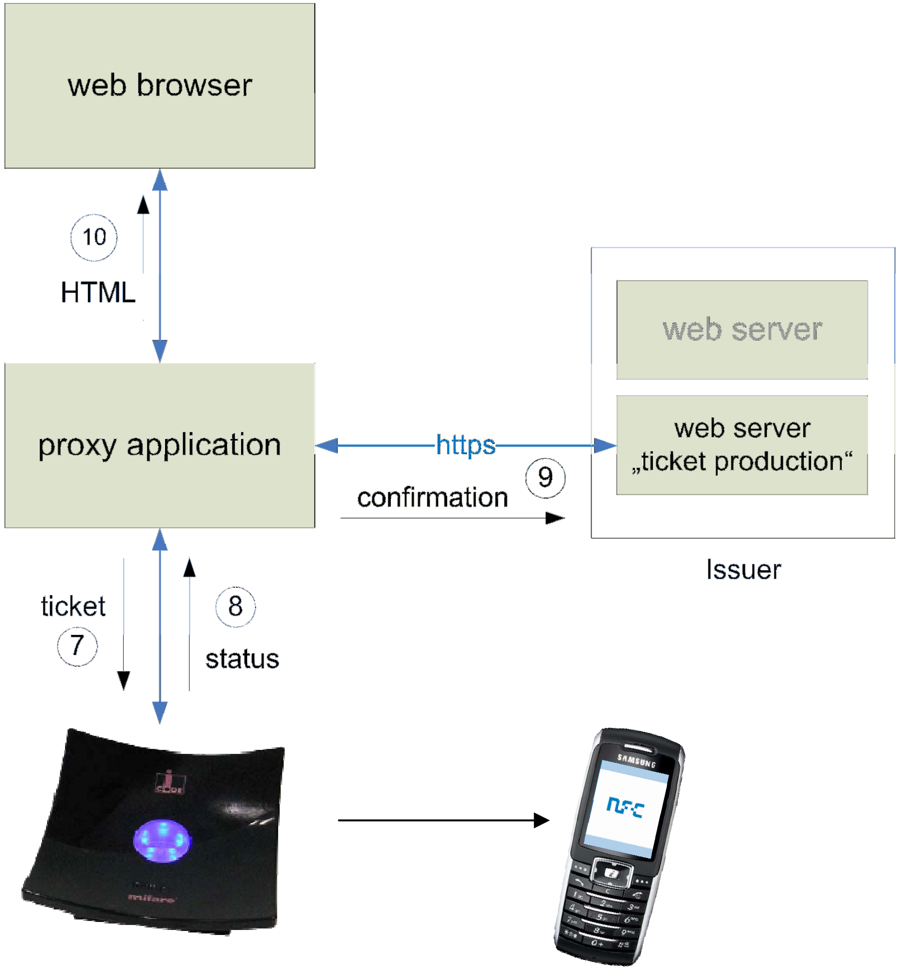
IDI	IDE	IDT	Value	Information	Date	KeyI	KeyT	**Signature**

Encrypted with Public Key *Ticket Memory*

Protocol – Ticket Preparation

Ticket transfer

- Signed and encrypted ticket is processed by *JavaCard application*
  - Ticket decryption
  - Signature check (*Control instance*)
  - Ticket stored in Secure Element (7)
- Status information (8)
  - Issuer activates the ticket (9)
  - User confirmation (web browser) (10)



Protocol – Ticket Verification

- Bilateral authentification (authentication of the *Access Control* and the *Ticket Memory*)
- Encrypted communication
  - Issuer content encrypted with KeyI (part of the ticket)
  - Ticket content encrypted with KeyT (part of the ticket)
- Strictly scheduled protocol sequence
  - Random numbers prevent Replay attacks
- Ticket modification within the ticket itself and the *Access Control* ticket database
- Collection of protocol errors
  - Protocol aborts produces defined status

Protocol – Ticket Verification

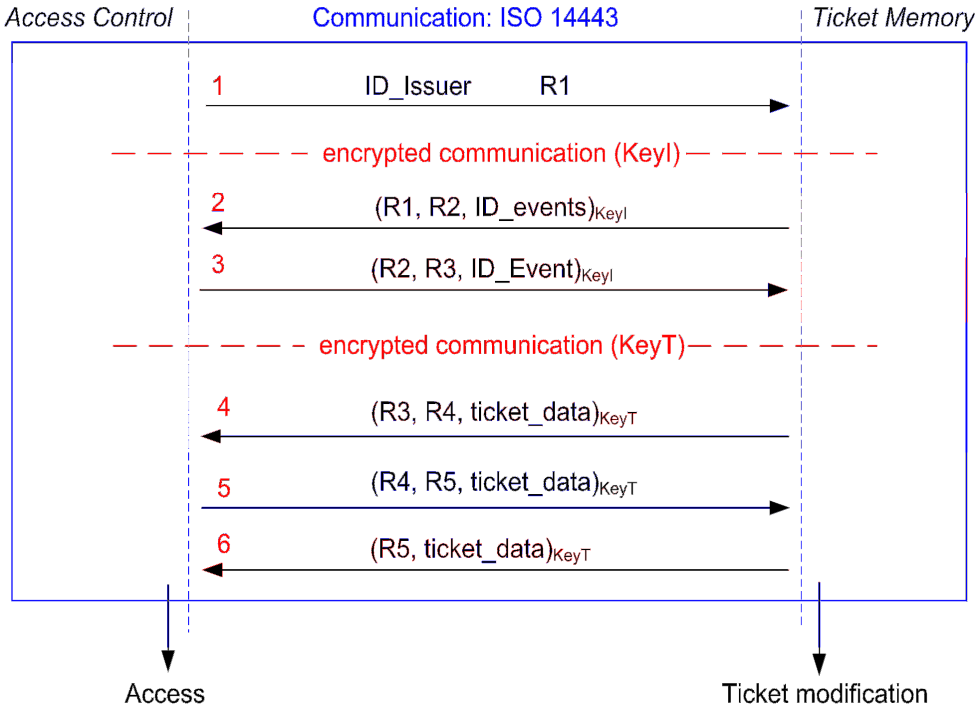
Issuer content

- Valid event IDs are enumerated (1,2)
- *Access Control* choose event ID (3)
  - *Access Control* is authenticated (R2)

Ticket content

- *Ticket Memory* sends ticket data (4)
  - *Ticket Memory* is authenticated
- *Access Control* modificates the ticket (5)
  - Ticket is stored in the Secure Element
- *Ticket Memory* sends the modificated ticket (6)

→ Access



Summarize Security issues

- The *Ticket Memory* is implemented as JavaCard Applet in the Secure Element
  - At no point a 3rd party can access information in the Secure Element without holding the correct key
  - Authorized instances are not able to read other ticket information than their own
- Without a bilateral authentication, neither the smartcard nor the server application will allow a transaction
  - Server credentials in the JRE Certification Store
  - Client credentials in the Secure Element
- No User interaction required at Gate or when ticket is received
  - Good usability to the end users beside ensuring high security
- Issuer immediately knows whether the ticket arrived safely or not

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Happy to answer any questions

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