Software Card Emulation in NFC-enabled Mobile Phones: Great Advantage or Security Nightmare?

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Outline

- Introduction
  - Near Field Communication
  - Secure Element-based Card Emulation
  - Software Card Emulation
- Software Card Emulation
  - Advantages
  - Disadvantages
- Conclusion

Near Field Communication

- Advancement of proximity RFID and smartcard technology
- Idea: Touch an object to trigger an action
- 3 operating modes
  - Peer-to-peer mode
  - Reader/writer mode
  - Card emulation mode

NFC in a Mobile Phone

(1)

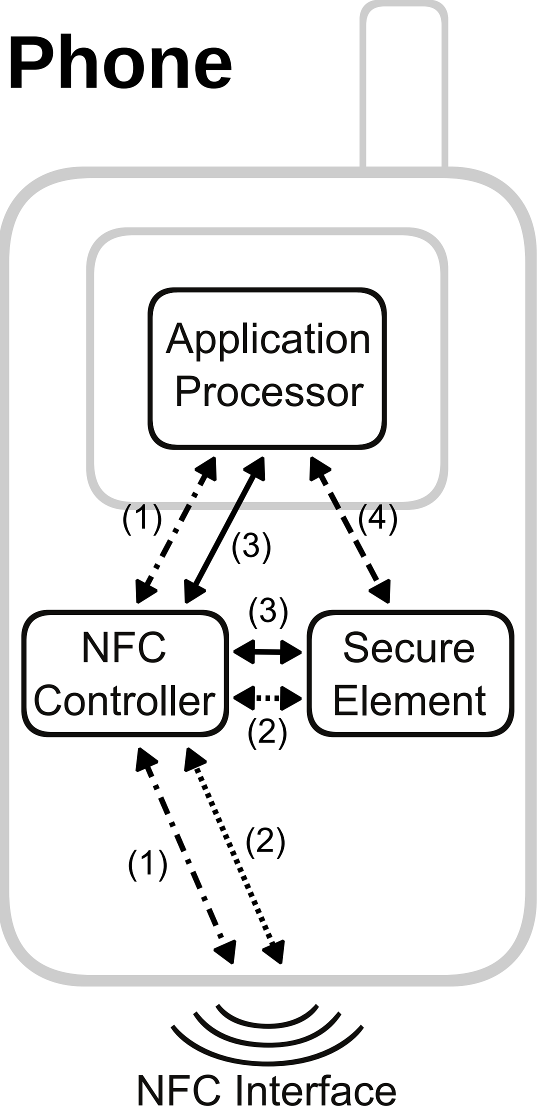
Application processor – NFC interface

Peer-to-peer mode,
Reader/writer mode,
Software card emulation

(2)

Secure element – NFC interface

Secure card emulation



(3)

Application processor – Secure element (via NFC controller)

Secure card emulation (internal access to secure element)

(4)

Application processor – Secure element (direct)

Secure card emulation (internal access to secure element)

Card Emulation

- NFC device emulates a contactless smartcard
  - Access control token
  - Credit card
  - …
- Compatibility to existing proximity smartcard infrastructure
- Emulation by
  - Smartcard chip (secure element)
  - Software on application processor

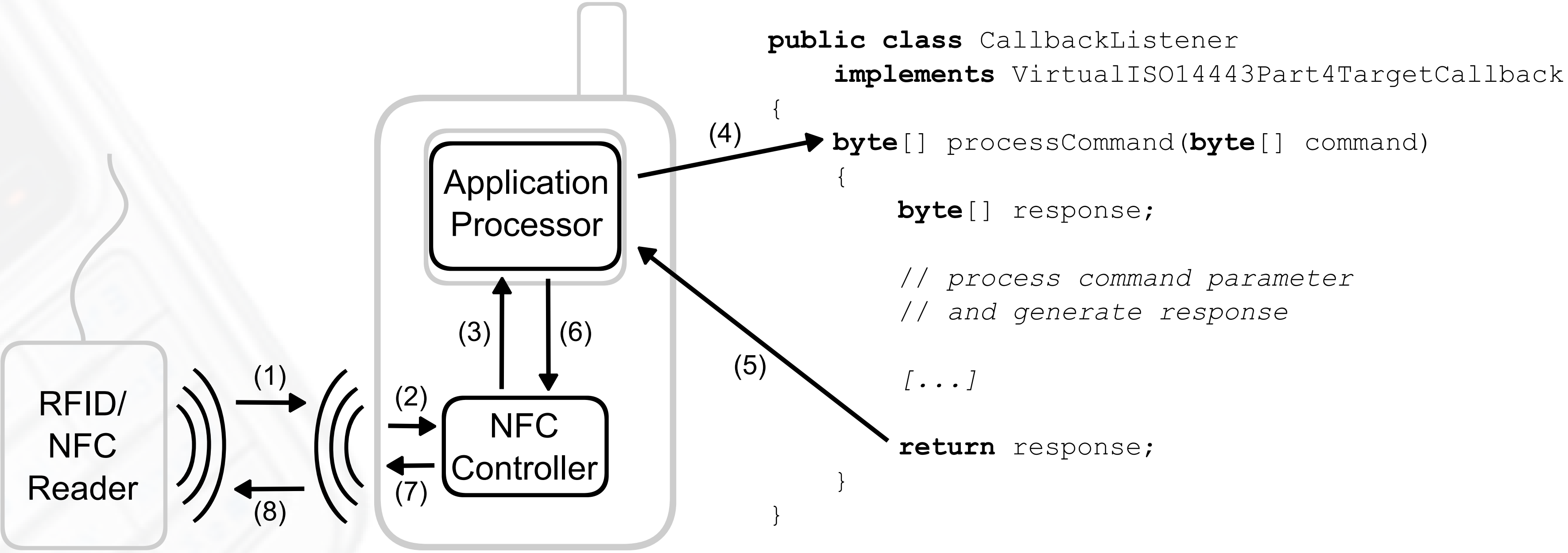
Secure Element-based Card Emulation

- Secure Element
  - Dedicated secure element chip
  - UICC (“SIM card”)
  - SD memory card
- Same high security level as other smartcards
  - Secure storage
  - Secure execution environment
  - Hardware-based cryptographic operations

Attacks on Card Emulation and Smartcards

- Example: Relay Attack
  - Communication between smartcard and reader can be relayed over longer distances
  - Proxy reader in proximity of the smartcard
  - Proxy card emulator in proximity of the actual reader
  - Proxy card emulator and proxy reader communicate over an alternative channel (e.g. Bluetooth)

Software card emulation



```
public class CallbackListener
  implements VirtualISO14443Part4TargetCallback
{
  byte[] processCommand(byte[] command)
  {
    byte[] response;

    // process command parameter
    // and generate response

    [...]

    return response;
  }
}
```

- No secure element
- Smartcard commands handled by software on the application processor

Availability of Software Card Emulation

- All BlackBerry NFC mobile phones
- CyanogenMod 9 after-market firmware for Android devices
- Dedicated NFC reader devices (e.g. ACR 122U)
- Dedicated card emulators (Proxmark, …)

Advantages of Software Card Emulation

- Card emulation is often associated with high revenue applications (payment, ticketing, access control)
  - Everyone wants to develop these applications
- BUT:
  - Secure element is under tight control of handset manufacturer/trusted service manager/mobile network operator
  - Competing applications not likely to be allowed to coexist on one secure element
  - High cost to get applications onto a secure element (due to limited space and expensive certification)

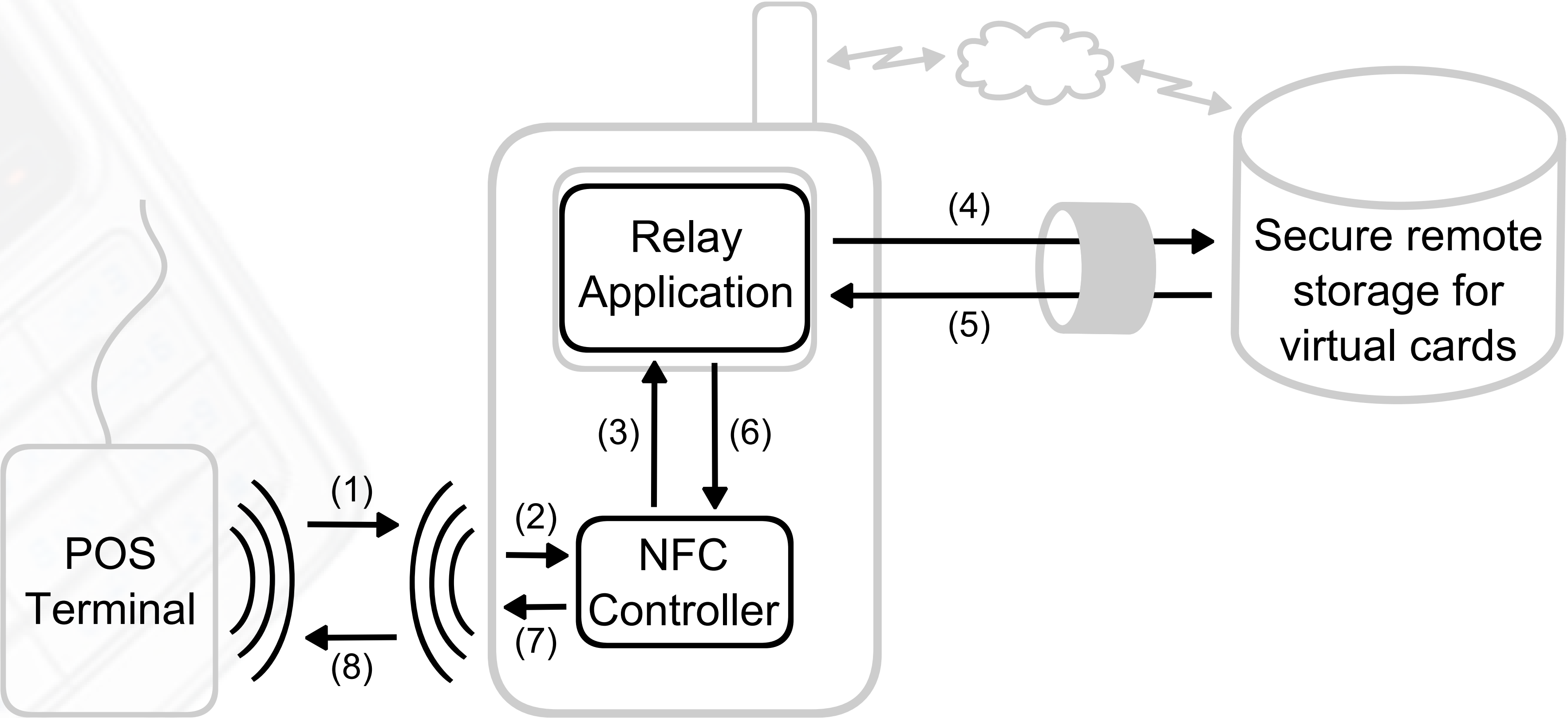
Advantages of Software Card Emulation

- Software card emulation opens card emulation applications to average developers
  - Complex secure element is not needed
- Anybody can develop applications based on existing reader infrastructure
- Software card emulation can be used as an alternative to peer-to-peer mode
  - Peer-to-peer mode is still not (fully) supported by many NFC devices
  - Many smartcard readers for PCs do not support peer-to-peer mode
  - Reader/writer mode is well supported on the PC platform through PC/SC (peer-to-peer mode is not!)
  - Software stack for reader/writer mode is less complex than that of peer-to-peer mode
- Great chance for others than the “big players” to create innovative NFC applications

Disadvantages of Software Card Emulation

- Application processor is less secure than secure element (no secure storage, no trusted execution environment)
  - Difficult to store sensitive data
  - Possible interference by other applications
  - Maybe okay for some applications (e.g. ticketing)
  - Problematic with other applications (e.g. payment, access control)
- Software card emulation devices as attack platform
  - Card emulator for relay attacks
  - Mobile phones have form factor expected for NFC/contactless transactions
  - Mobile phones have network connectivity for the relay channel

Cloud-based Secure Element



Conclusion

- Software card emulation is a great opportunity for developers
  - Breaks the barrier of secure element-based solutions
  - Easy integration into existing contactless smartcard systems
  - Easier to use than peer-to-peer mode
- Significant risk
  - Developers may be lazy with securing their applications and data
  - Devices may be used as platform for relay attacks

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http://congress.nfc-research.at/

Thank You!

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