NFCGate - NFC relaying for Android

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SEEMOO SECURE MOBILE NETWORKING

Motivation and Research Goal

Motivating Scenario

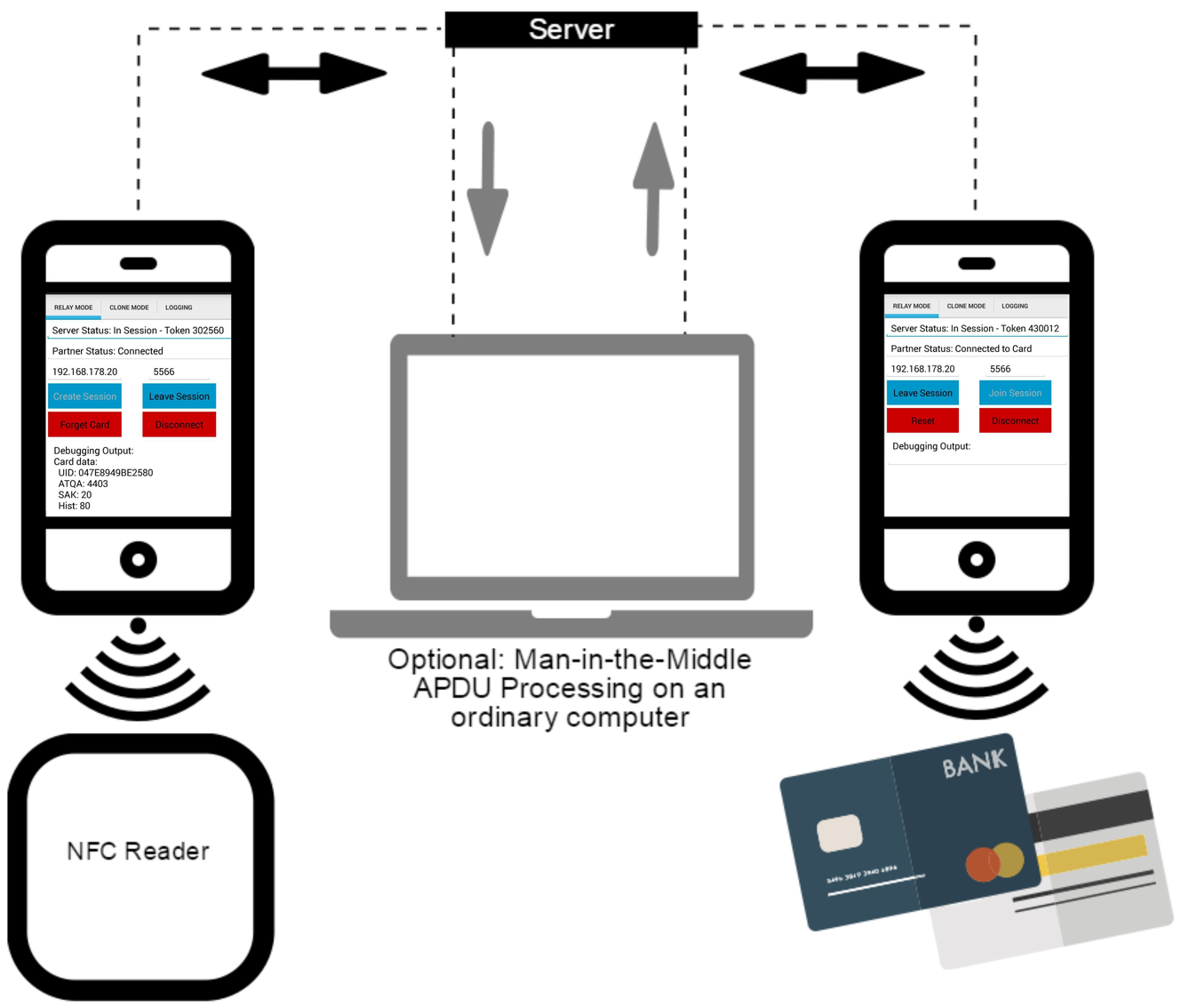
- Near-Field Communication (**NFC**) is widely used for security-critical applications like payment or access control systems
- Assumption: Low range of wireless communication ensures physical proximity of card and reader
- Some systems not protected against **wormhole attacks**
- Existing wormholing solutions expensive, impractical, or complicated to set up

Research Goal and Approach

- Leverage NFC capabilities of Android phones to build an **inexpensive wormholing setup** for future research
- **Avoid flashing** the device with custom ROM
- Gain **access** to transmitted data for other attacks

Challenges

- HCE only supports APDU commands based on **ISO 7816-4** and only forwards sessions starting with a SELECT command. This excludes popular protocols like (native) Mifare DESFire
- HCE uses a random Unique Identifier (**UID**), which may be detected and blocked by readers performing UID verification and cannot be changed by the application
- Android HCE implementation has **no support** for setting fixed UID



Design and Implementation

Circumventing AID Verification

- **AID detection** and verification is performed by **two parts** of the system: libnfc (native C) and android.nfc.cardemulation (Android OS, Java)
- Modify Java part at runtime using **XPosed** [3] to always return a special AID, regardless of the received command
- Register the special **wildcard AID** for our application
- From XPosed, load a library into the NFC daemon and live-patch the binary ARM code to re-route function calls to our own code
- Android will now route **any received NFC command** to our application, regardless of the used protocol or AID
- This also ensures compatibility with other protocols like **DESFire**

UID Emulation

- **Analysis** of libnfc-nci source code (libnfc for Broadcom chips) shows function for passing arbitrary config strings to NFC chip firmware
- Further analysis reveals **command bytes** for setting UID of chip
- At runtime, **read** UID from card, **transmit** to the other device, and **set** the UID of that device using an IPC command to the NFC daemon
- Code inside the NFC daemon **uploads** the newly built config to the chip
- Chip will now use the **emulated UID** instead of a random value
- Emulation of **ATQA, SAK** and **Historical Byte** works the same way

Limitations

- UID Emulation only possible for certain **Broadcom** Chips (used in Nexus 4 and 5, among other devices)
- Assorted bugs in Chip Firmware and Android

Results and Discussion

Results

- Successful test of wormholing capabilities against a real-world **contactless payment** and **access control system**
- NFC commands **logged** on the device for later inspection
- **Modification** of **NFC commands** in transit possible using a Python client
- Dedicated **UID clone mode** to bypass UID-based systems

Discussion

- Relay introduces noticeable **delay** of 65 ± 38 ms when using a local WiFi, higher delays when routing over the public internet
- Relay can be detected if the system checks the **timing** of commands or uses other methods for **distance bounding**
- Delay could be reduced by using other technologies like Bluetooth
- **Modification of NFC traffic** directly on the Android device would be more efficient. Infrastructure in place, but GUI currently missing.

For more Information, visit

seemoo.de/nfcgate

/nfcgate

Related Work

[1] L. Francis, G. P. Hancke, K. Mayes, and K. Markantonakis. Practical Relay Attack on Contactless Transactions by Using NFC Mobile Phones. IACR Cryptology ePrint Archive, 2011:618, 2011

[2] E. Lee. NFC Hacking Made Easy. Def Con 20, 2011

[3] rovo89, XPosed Framework. http://repo.xposed.info/

Future Work

Further improvements

- Rule-based, **on-the-fly modification** of NFC traffic on the Android devices
- **Compatibility** with other NFC Chips
- More **communication** channels (Bluetooth, WiFi Direct, …)

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