Hardware-Secured Configuration and Two-Layer Attestation Architecture for Smart Sensors

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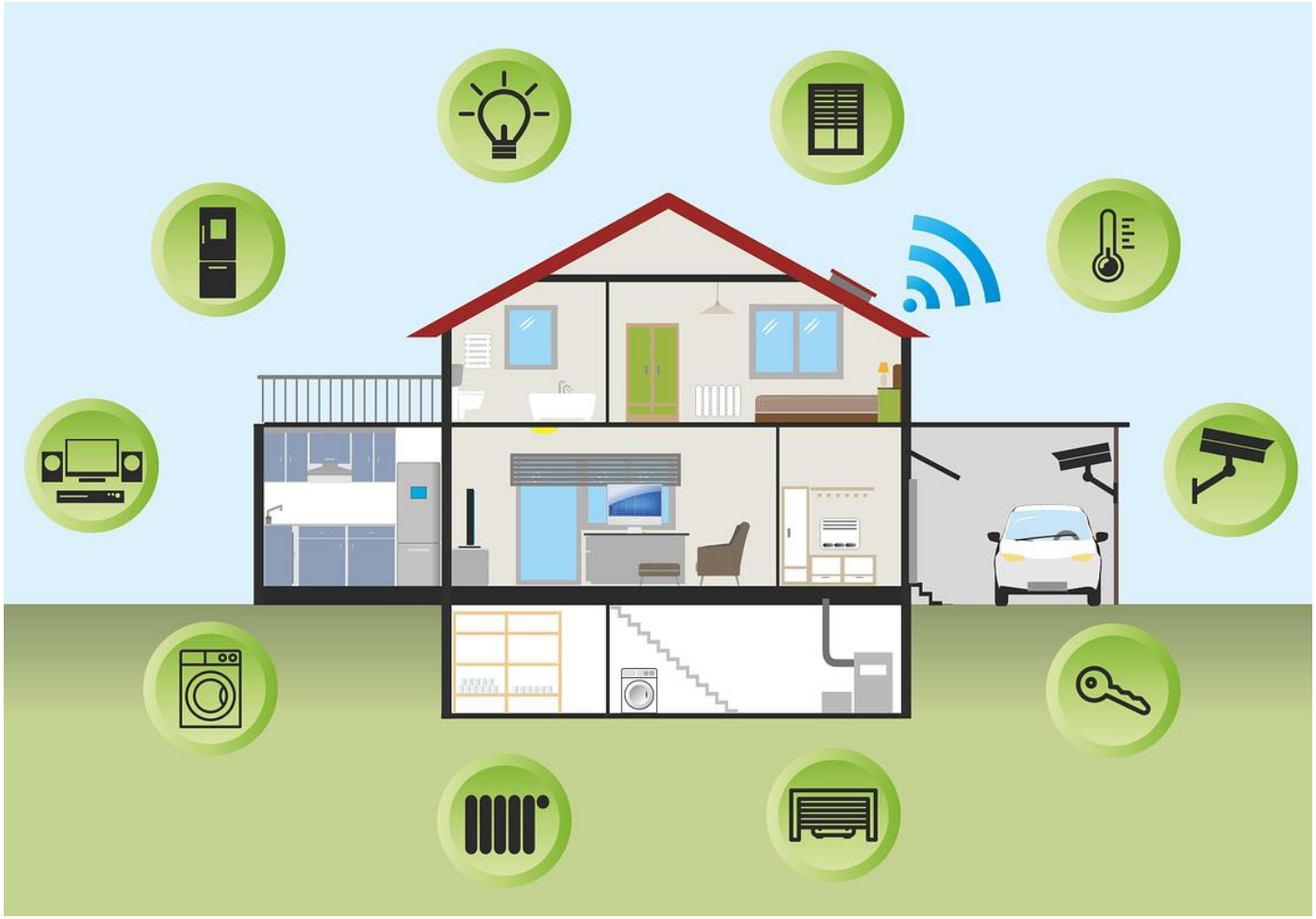
Outline

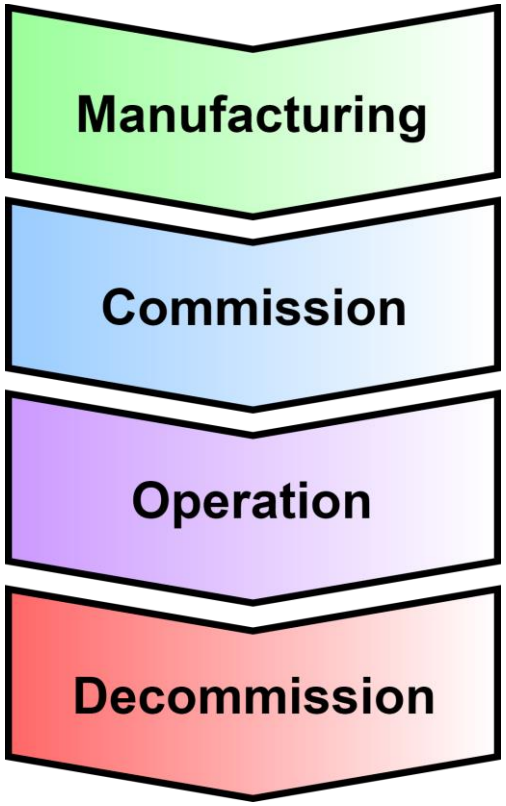
1. Motivation, State-of-the-art
2. Secured Configuration
    1. NFC-Interface
    2. Protocol
    3. System Model
3. Hardware Architecture
    1. Two-Layer Attestation
4. Evaluation
5. Conclusion and Future Work

Motivation – Industry 4.0 / Smart Homes

Motivation – Smart Homes



Motivation – Smart Sensor Configuration



- Initial manufacturer keys
- Initial configuration

- Device owner key update
- Specific configuration updates

- Recurrent configuration updates
- Reconfiguration for changing tasks

- Reconfiguration for resale
- Deletion of confidential data

Motivation – Requirements I/II

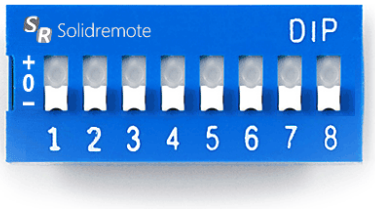
- Secured transfer of configuration data
  - Confidential information
- Tamper resistant
  - Stored data must be protected
- Easy and intuitive to use
  - Applied in industrial and smart home settings
- Attestation mechanism to verify correct config

Motivation – Requirements II/II

- Energy efficient
  - Smart sensors might be operated on battery power
- Configuration update without power source
  - E.g. during manufacturing of sensor

State-of-the-art

- Various configuration interfaces
  - Wired
  - Wireless (WiFi, Bluetooth, …)
  - Buttons, Displays, DIP Switches



- Often limited security considerations
- No arbitrary payloads but firmware, pairing info, …
- No attestation of applied configuration

Contributions

- Define a secured configuration interface
  - Easy and intuitive to use
  - Protocol and hardware
- Suitable for existing devices and new devices
- Show how our proposed architecture can be used for configuration attestation

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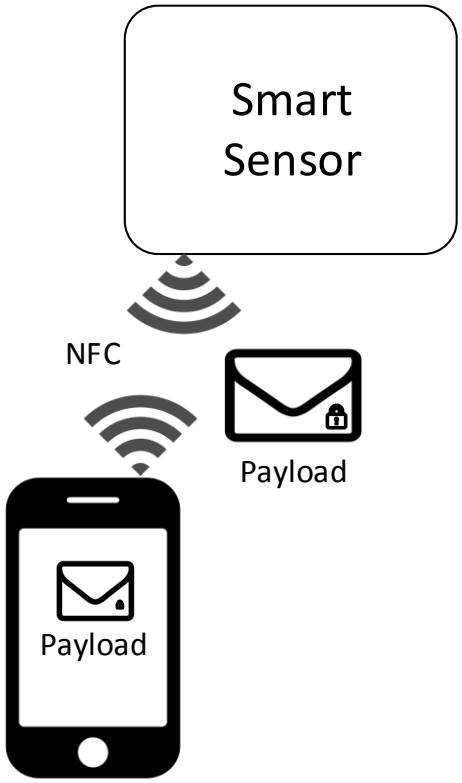
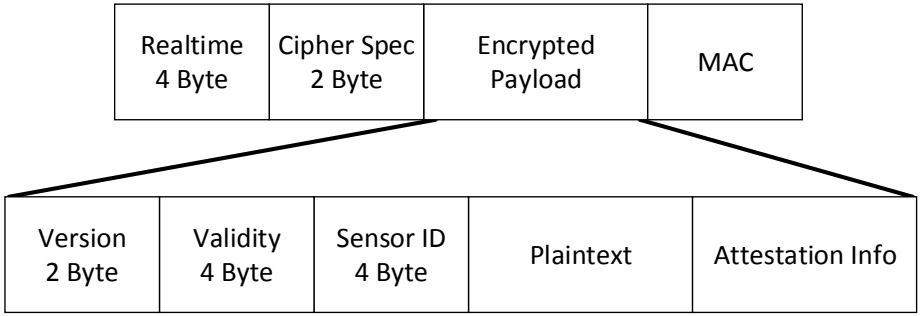
Secured Configuration – NFC Interface

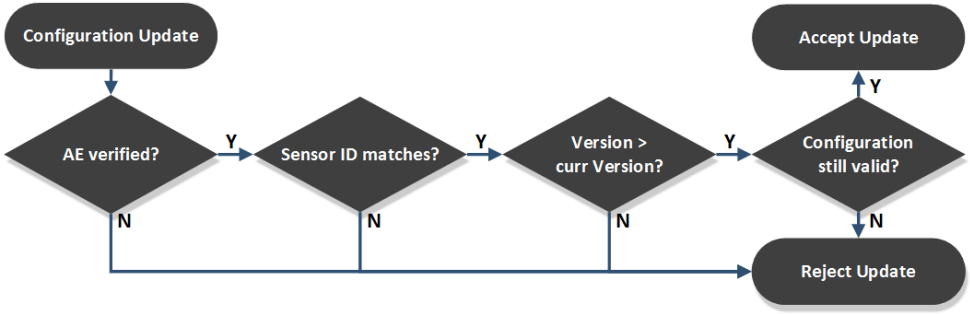
- Use NFC as configuration interface
  - Intuitive to use
  - Little interference compared to other technologies such as WiFi
    - NFC operates at 13.56 MHz
  - „Security by proximity“
    - Roughly 10cm, Eavesdropping 10m!
    - Configuration interface not accessible for remote attackers
    - But no security by protocol!



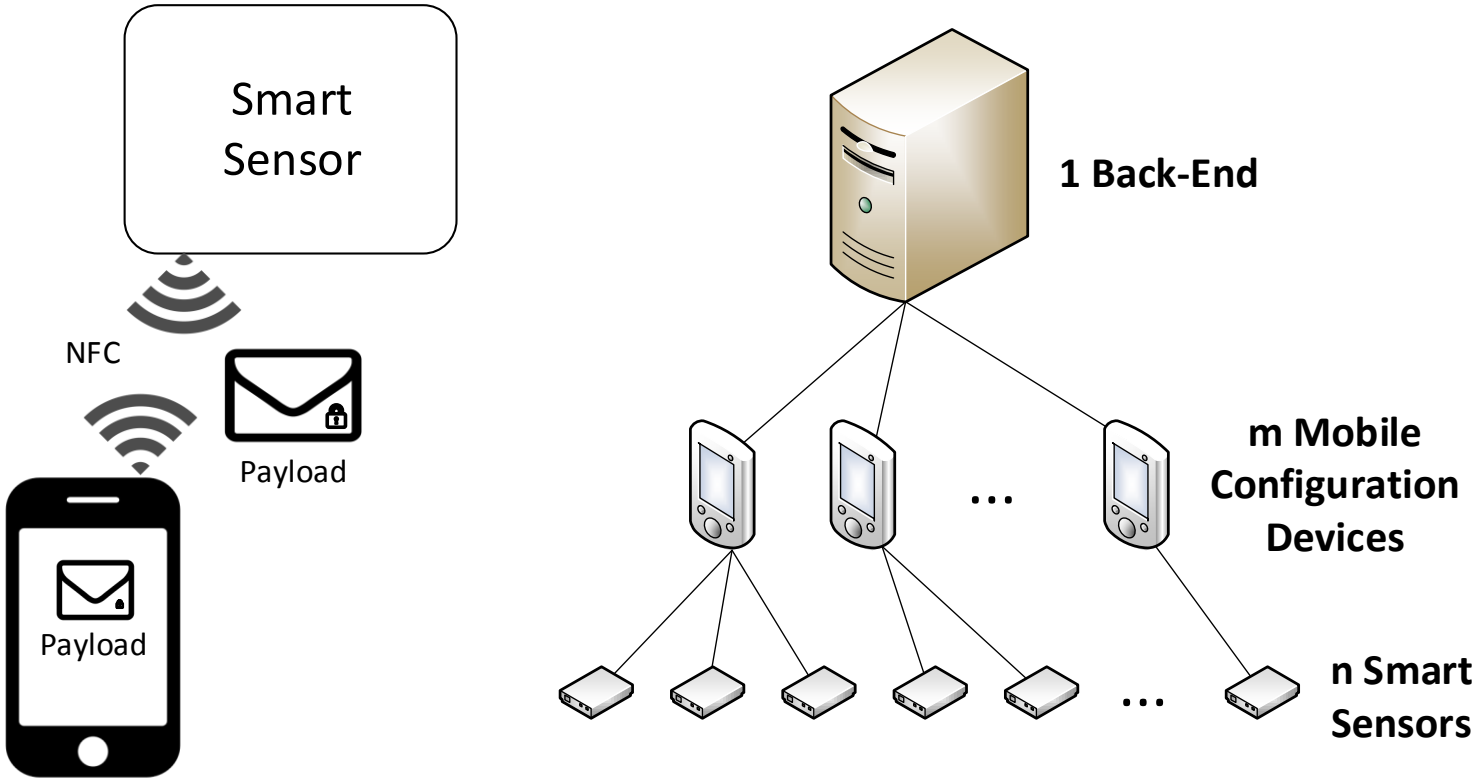
Secured Configuration – Protocol

- NDEF-based protocol for configuration transport
- Data protected by authenticated encryption
- „Ticket“ information to mitigate replay attacks





Secured Configuration – System Model



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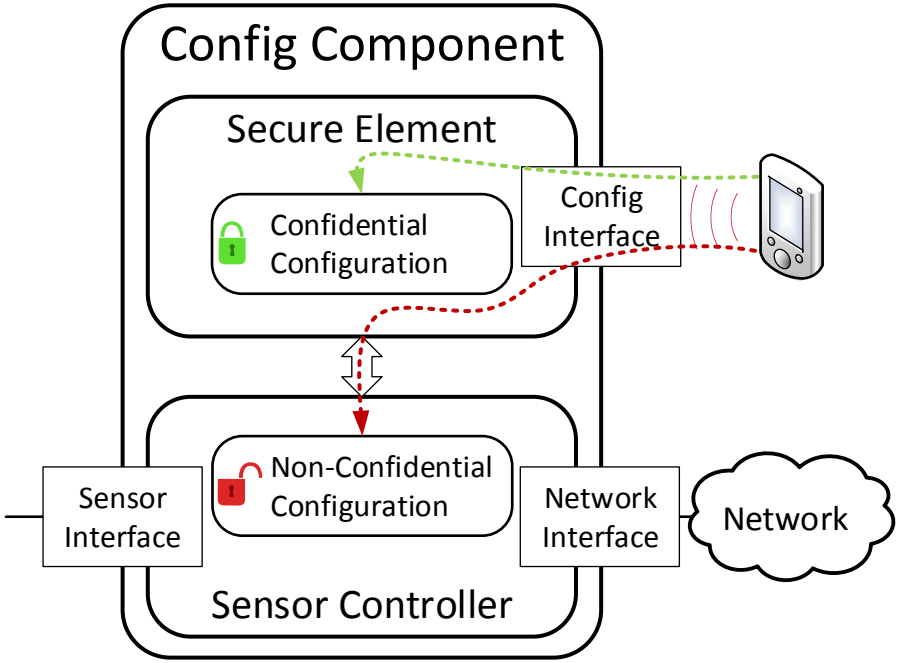
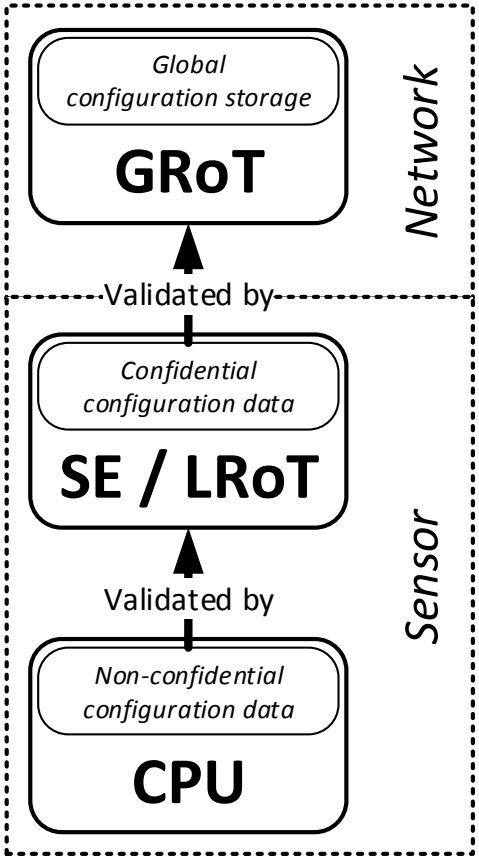
Hardware Architecture

- Component split into two worlds
  - Secured world
  - Normal world
- Security by isolation
- Secure Element
  - Storage
  - Cryptographic Operations



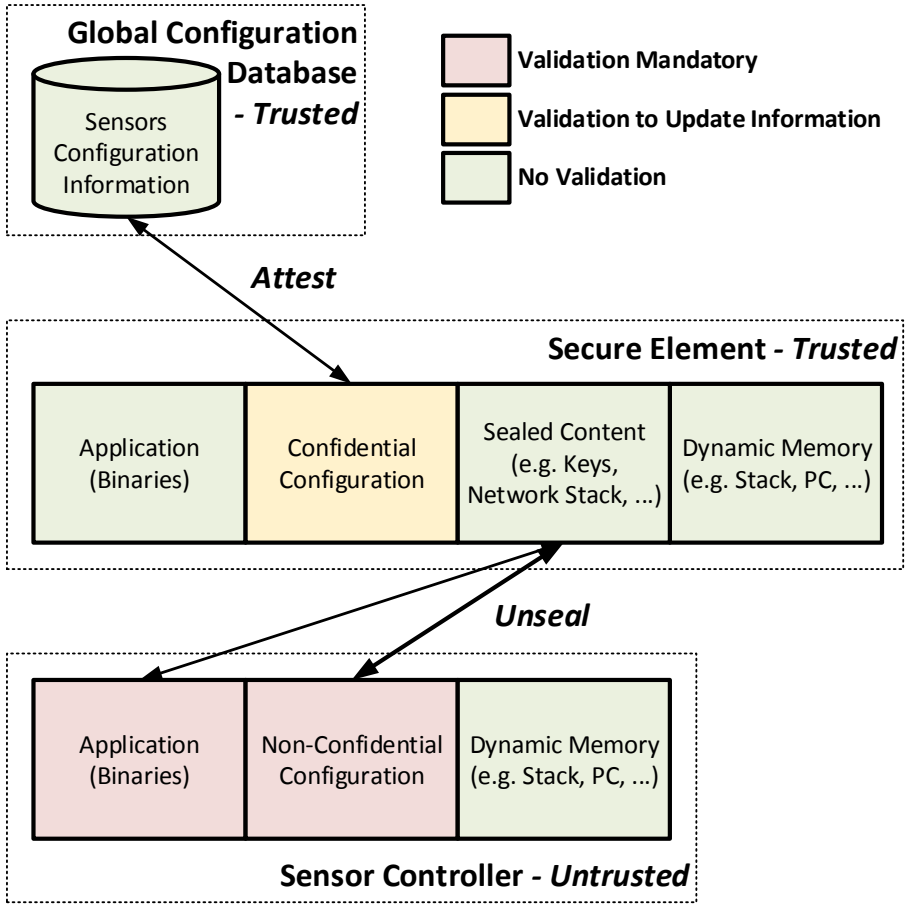
Configuration Attestation / Validation

- Based on hardware architecture
  - Local Root of Trust (LRoT) in any Smart Sensor
- Based on system architecture
  - Global Root of Trust (GRoT) given by global configuration storage present in system model



Configuration Attestation / Validation

- Non-Confidential data
  - Binary attestation
  - Property based attestation
  - „Seal“ network access
- Confidential data
  - Stored in trusted SE
  - Only validation by GRoT to verify update



Design Decisions

- SE over TPM
  - Provides same functionality as TPM
  - Low power consumption (used in smartcards)
  - In addition
    - NFC interface
    - Can be powered through NFC interface
    - Trusted execution environment
- By „sealing“ network access
  - Malicious smart sensor is isolated
  - If data received: sensor and data is trustworthy

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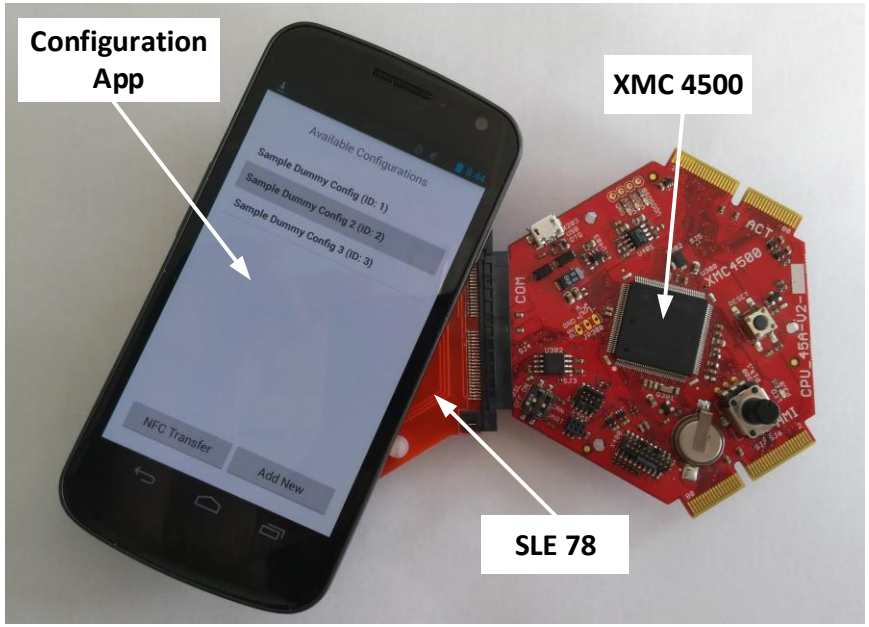
Evaluation

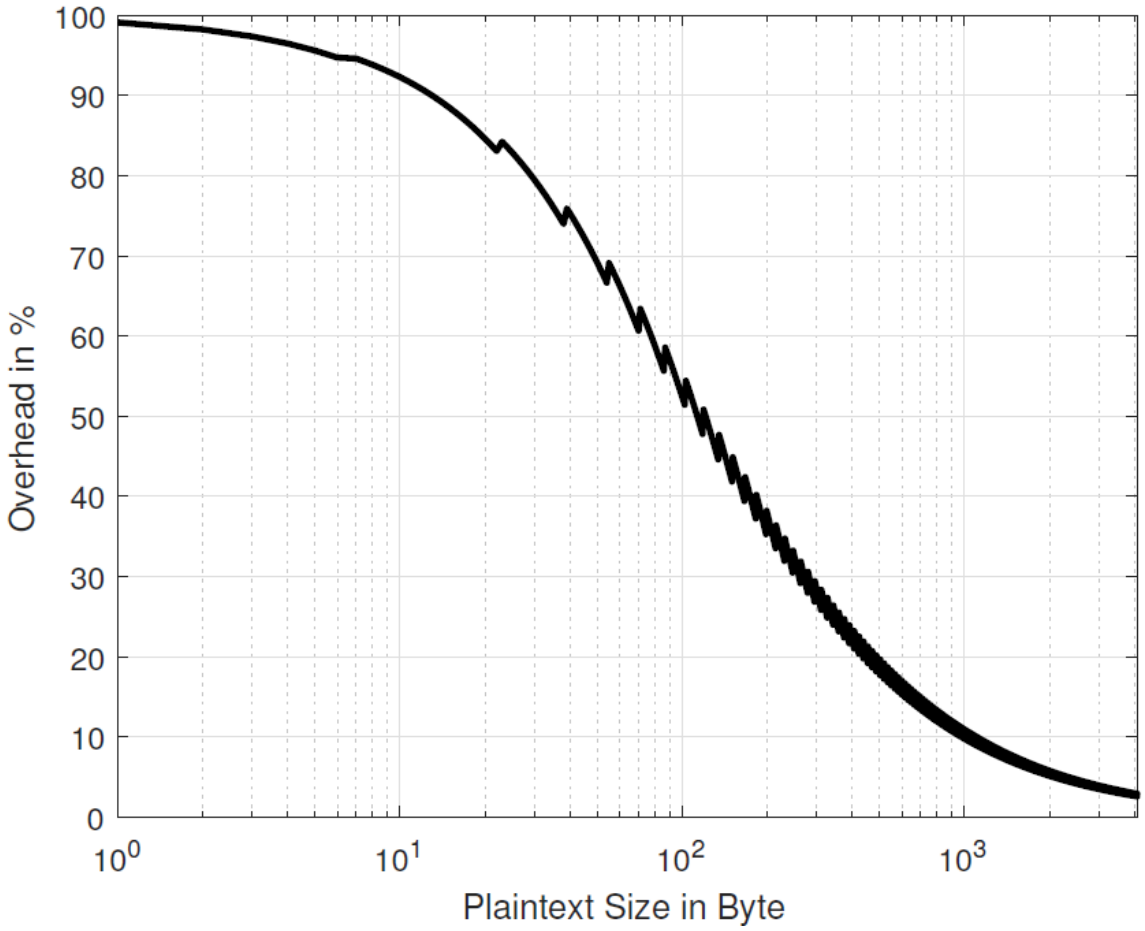
- Feasibility: Prototypical implementation
- Performance: Timing measurements
- Security improvements: Threat analysis

Evaluation – Prototype

- Infineon components
  - XMC4500
  - SLE78
- Android smartphone
- Performance
  - 5-10 parameters
  - 200ms
  - Similar to TLS over WiFi on Raspberry PI3



Evaluation – Protocol Overhead by Security



Evaluation – Threat Analysis

- Not exhaustive, most important threats identified
- Overall 8 threats identified that are mitigated by countermeasures implemented in our approach
- Mitigated: malicious configuration updates, replay attacks, DoS attacks (using configuration interface), and physical attacks

Evaluation – Threat Analysis

- Malicious updates, replay attacks
  - Mitigated by protocol
- Malicious configuration or software
  - Mitigated by attestation
- Remote attacks
  - Mitigated by only allowing updates via NFC
- Adversary with physical access to smart sensor
  - Mitigated by using tamper resistant SE

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Conclusion and Future Work

- Secured and easy-to-use configuration approach
  - Suitable for confidential and non-confidential data
- Can be retrofit into existing sensors and new devices
- Configuration solution is „attestation aware“
  - Attestation is considered in data transfer protocol
- 8 potential threats mitigated by our approach
- Future work: further investigate methods for granting or denying network access to smart sensors

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Questions?

Thank you!