RUHR UNIVERSITÄT BOCHUM RUB

CISPA

Scaling Software Security Analysis to Satellites

Automated Fuzz Testing and Its Unique Challenges

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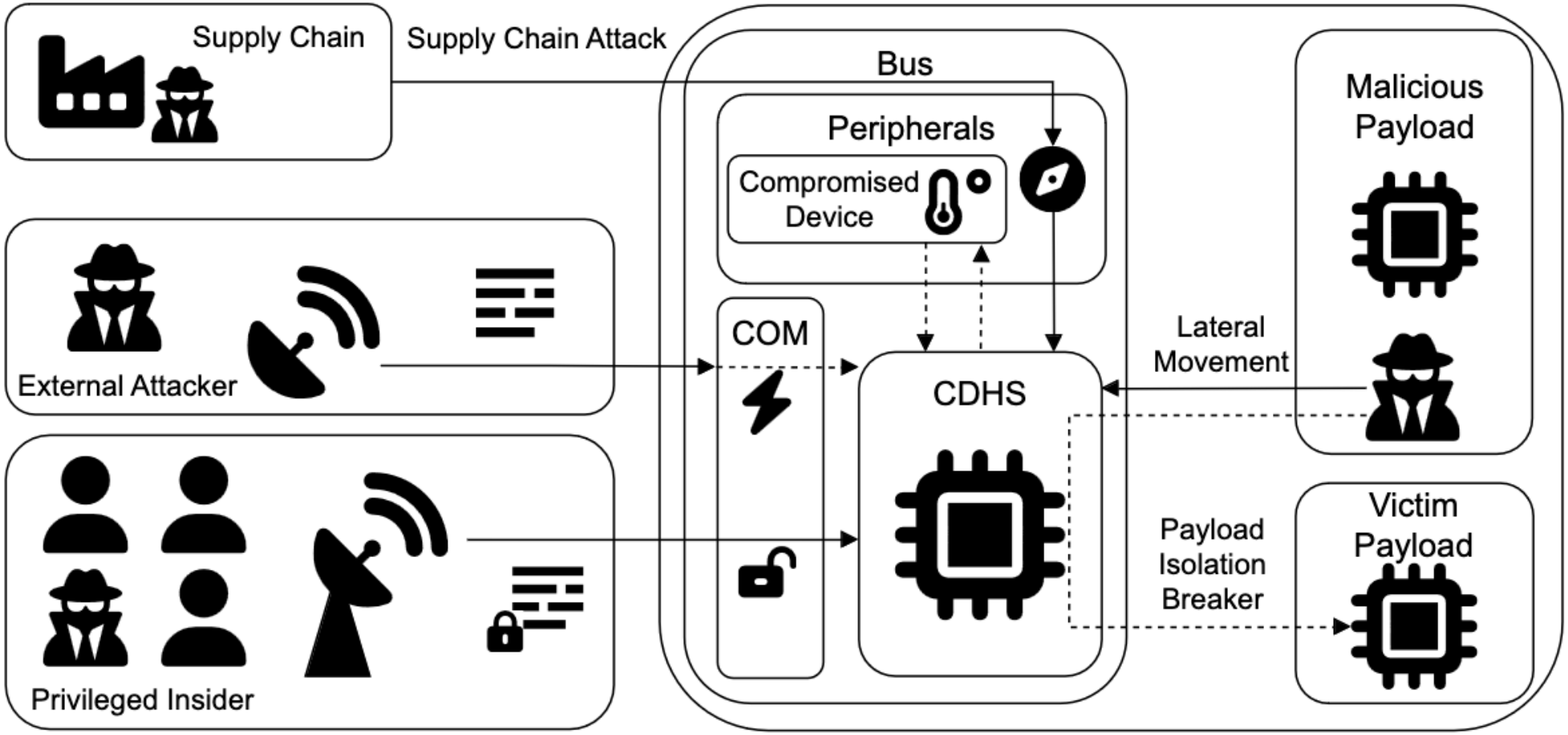
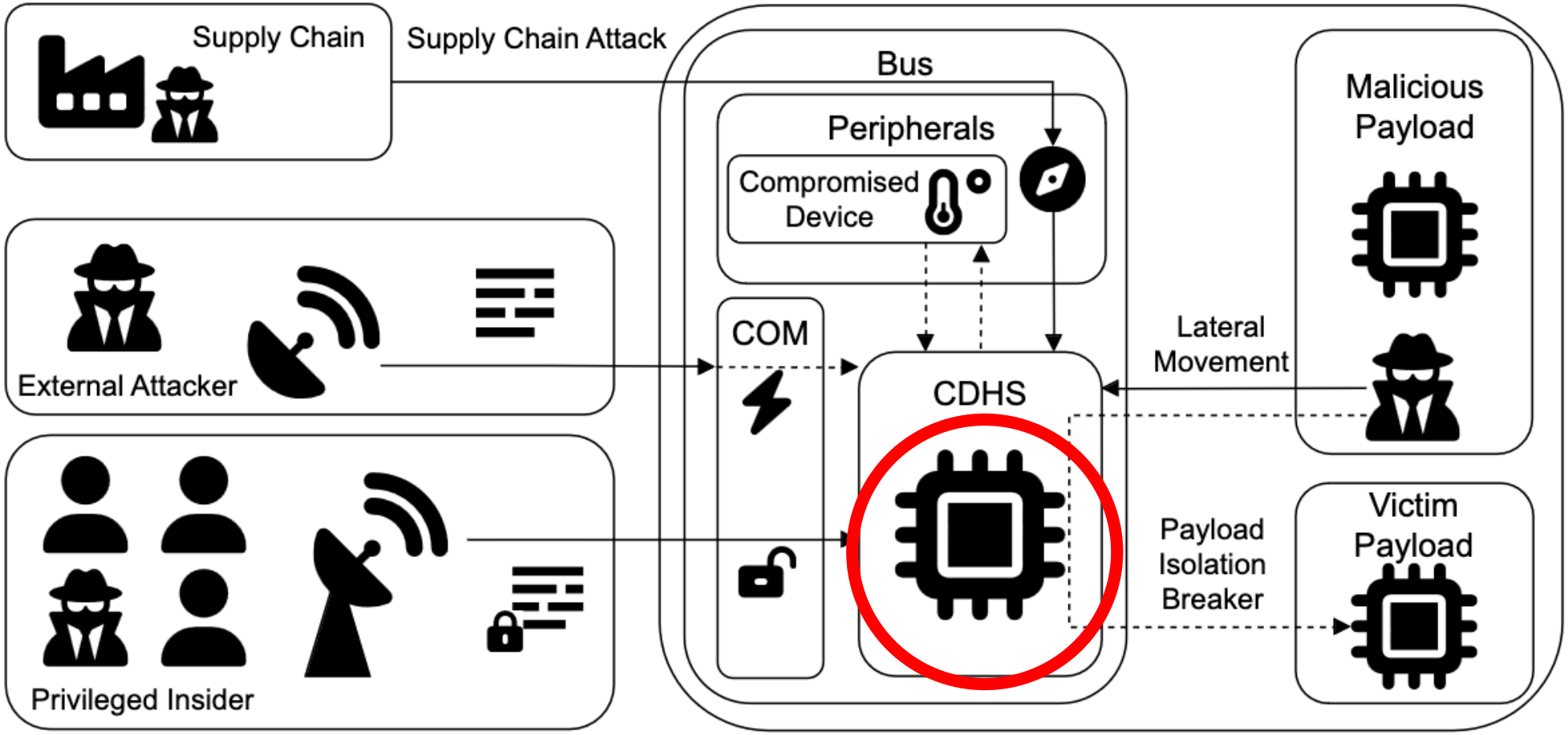
v1.0

Scenario


Supply Chain
Supply Chain Attack
Bus
Peripherals
Compromised Device
Malicious Payload
External Attacker
COM
Lateral Movement
CDHS
Payload Isolation Breaker
Victim Payload
Privileged Insider

Scenario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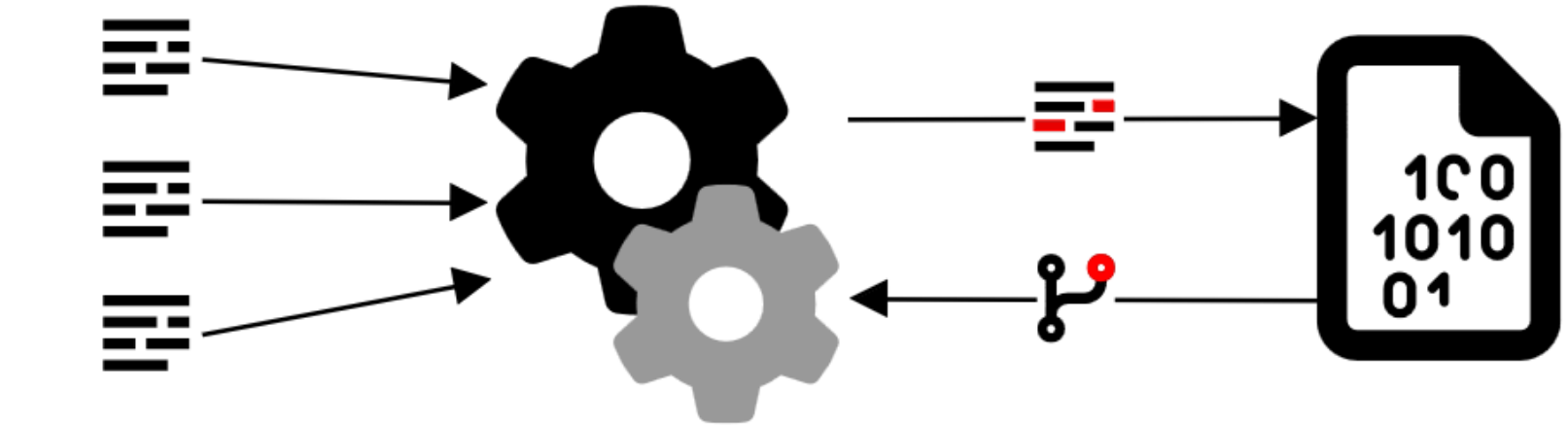
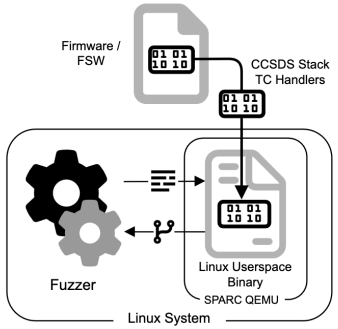
Fuzzing

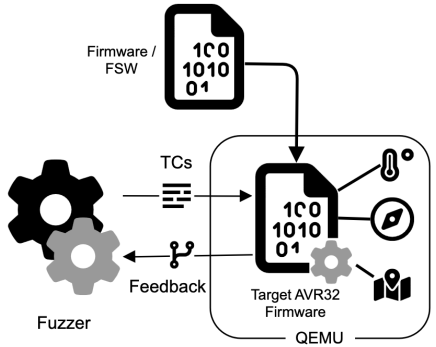


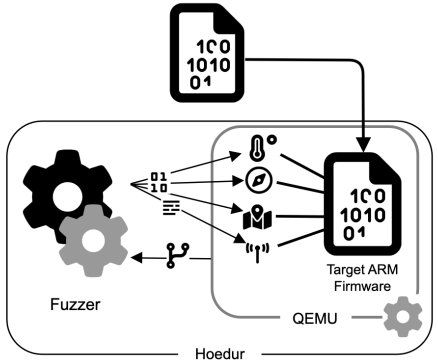
Challenges

1. Complex Satellite Boot Process
2. Only Crashing Inputs
3. Computing Hardware with Limited-Performance
4. Highly Specialized and Individual Setups
5. Performance of Existing Digital Twins

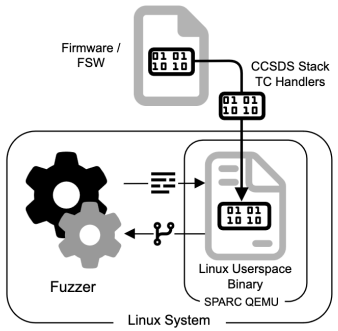
Approaches

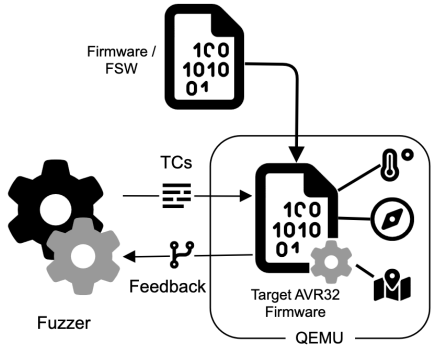

Firmware /
FSW
CCSDS Stack
TC Handlers
Fuzzer
Linux Userspace
Binary
SPARC QEMU
Linux System

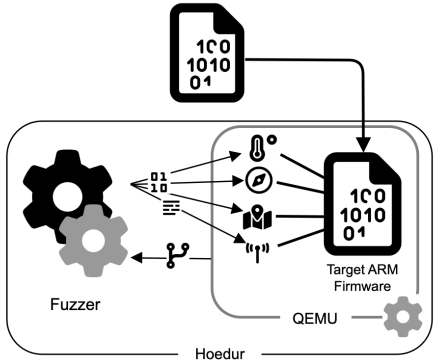

Firmware /
FSW
TCs
Feedback
Fuzzer
Target AVR32
Firmware
QEMU


Fuzzer
Target ARM
Firmware
QEMU
Hoedur

Approaches

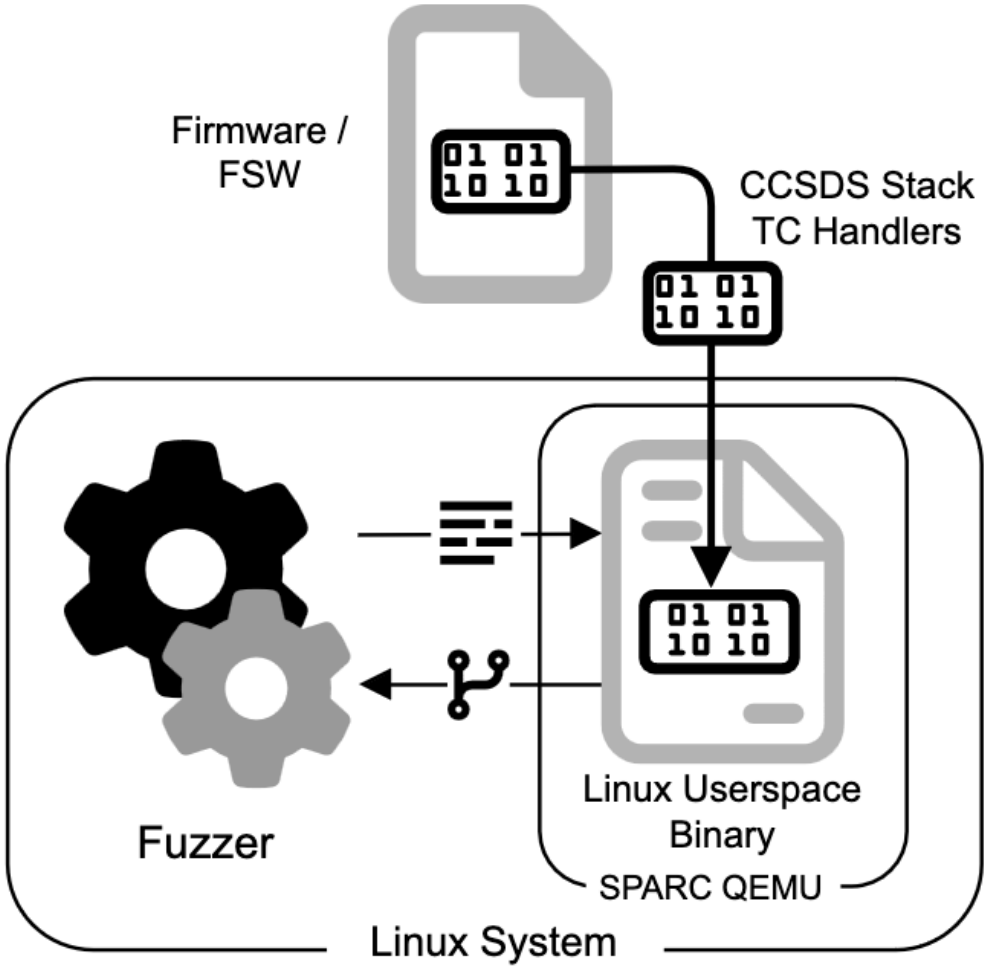






=> No Hardware

Subsystem Extraction

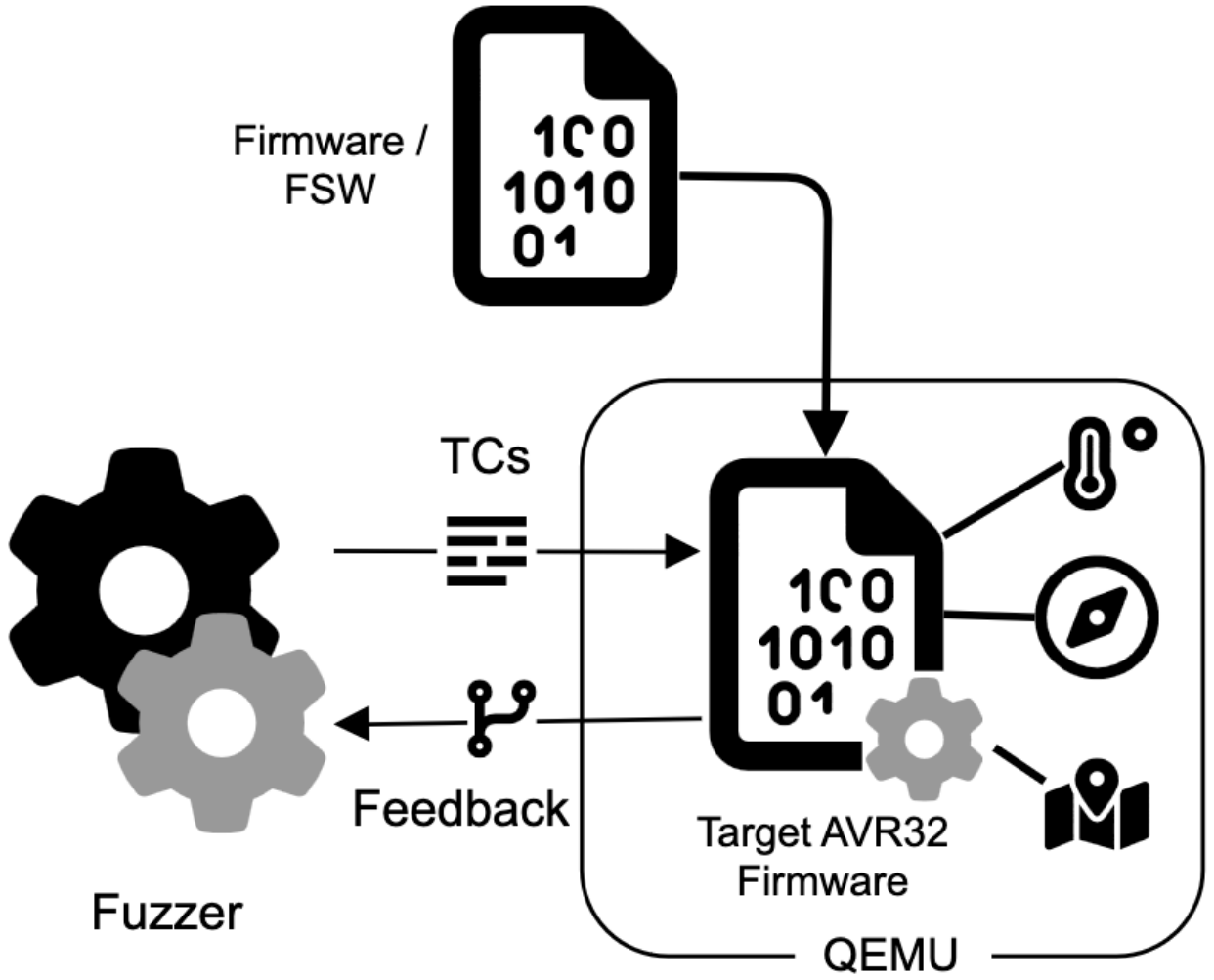


Subsystem Extraction

Issues:

- Many global objects
  - Require manual initialitation and code extraction
- Linux incompatible low-level code
- Extensive manual changes required
- No interactions between components

Persistent Mode Fuzzing

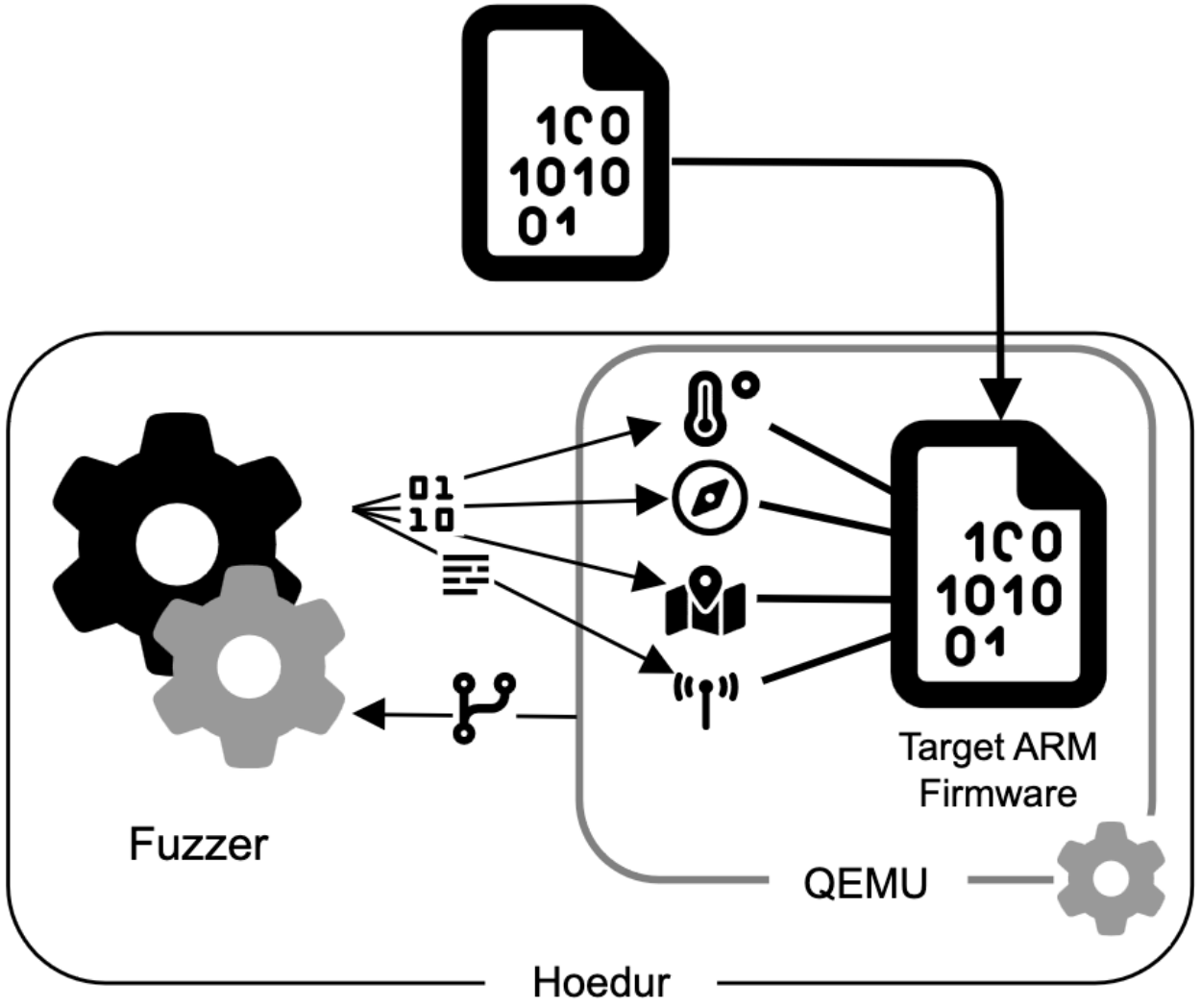


Persistent Mode Fuzzing

Observations

- Skipped bootprocess due to persistent mode
- Potentially non-reproducible bugs due to persistent mode
- Missing peripherals
  - Peripherals with statis responses

Firmware Rehosting



Firmware Rehosting

Observations

- Peripheral modelling replaces specific peripheral simulation
- Snapshoting replaces persistent mode
  - But does not have accumulated state
- Read-only regions allow to detect "Dangerous TCs"

Results

Usual Metric: Code Coverage

Results

~~Usual Metric: Code Coverage~~

Results

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Here: TC Coverage

Results

~~Usual Metric: Code Coverage~~

Here: TC Coverage

Metric	Subsys. Extraction	Persistent Mode Fuzzing	Firmware Rehosting
TC Handlers Reached	-	59/59 (100%)	128/128 (100%)
Code Coverage in TC Handlers	-	1300/1704 (76%)	763/981 (78%)

Results

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Here: TC Coverage

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Roadblocks

- Hashes & CRC-Sums
- Large Value Comparisons
- Grammer Formats
- ...

Q&A

- Fuzzing introudction
- Five satellite fuzzing challenges
- Three fuzzing setups with no hardware
- Evaluation

/jwillbold

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