S C I E N C E ▪ P A S S I O N ▪ T E C H N O L O G Y

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Memory-Efficient On-Card Byte Code Verification for Java Cards

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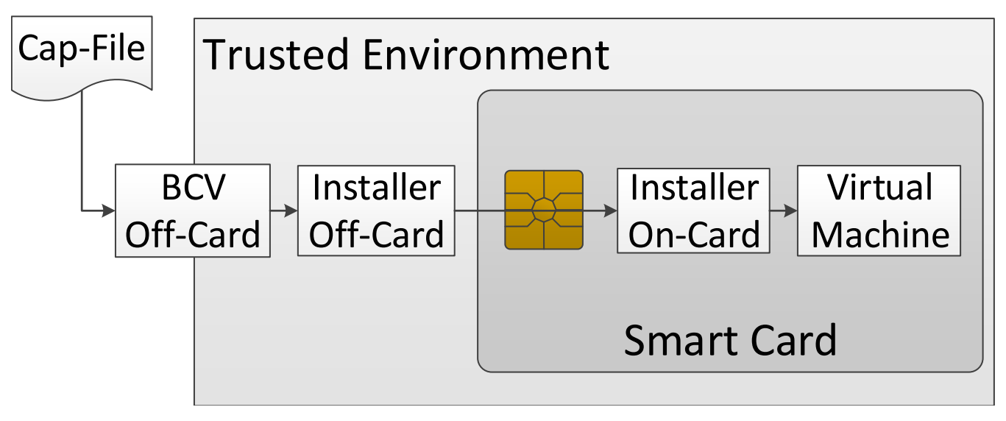
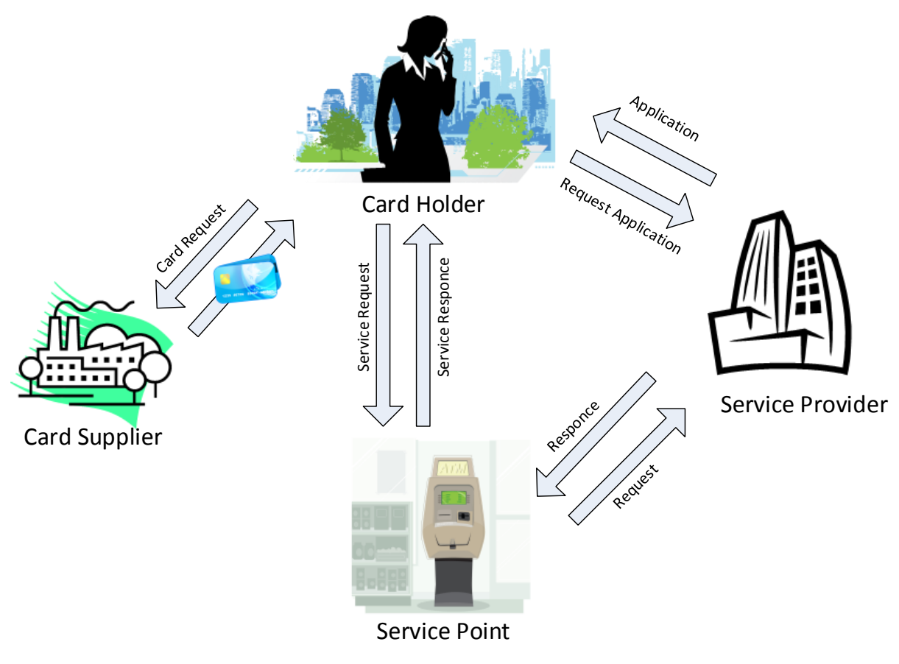
Motivation

Java Card Security [7, 10]

- Bytecode
  - Verification (BCV) [4, 8]
  - Off-Card
  - Resource intense algorithm
- Secure Loading
  - Off and On-Card Component
  - Done by Cryptographic Signature
    - Key-exchange between Card Supplier and Issuer

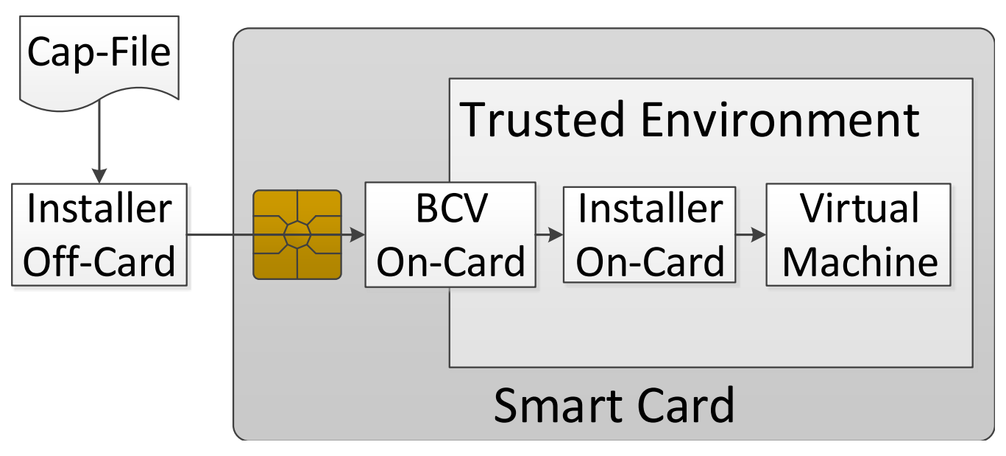


User Centric Ownership Model [1]



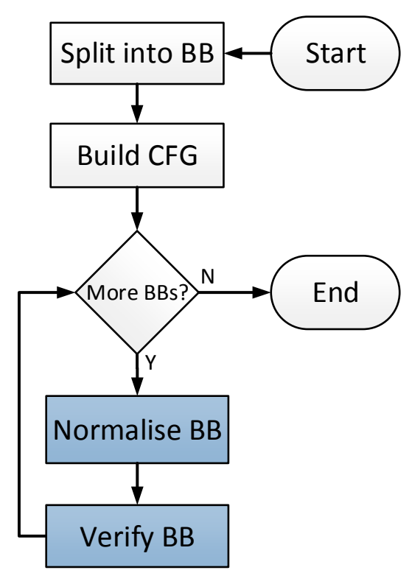
Overview of the User Centric Ownership Model [1]

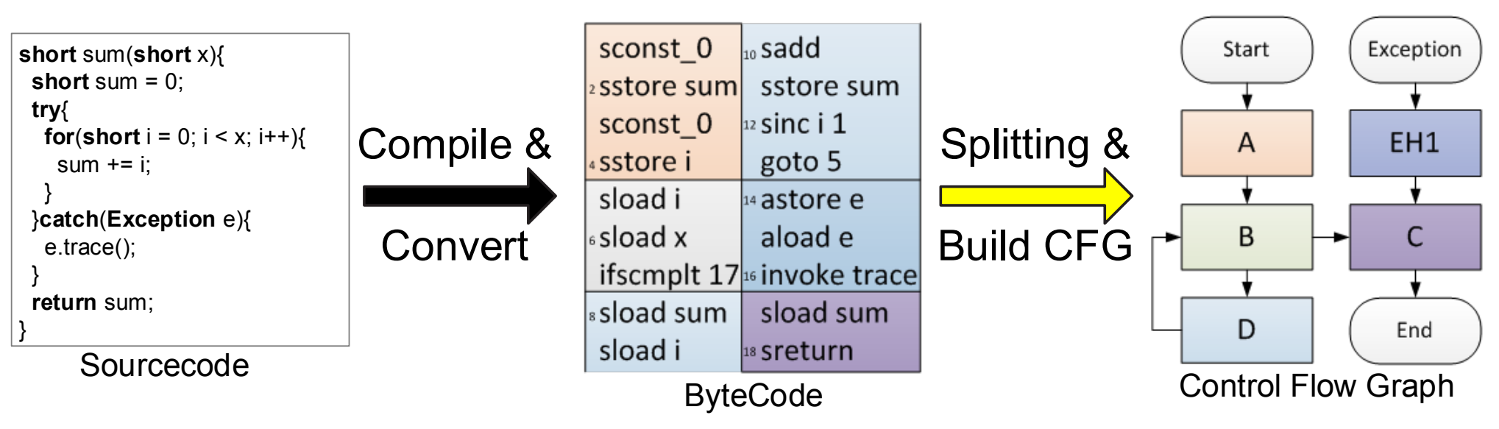
- No Secure Loading
  - No Business relationship between Card Supplier and Issuer
- Needs On-card BCV



Memory-Efficient BCV

- Working on Basic Blocks
  - Combining Normalising and CFG
  - BB is smallest verifiable unit
- Building CFG
  - On-Card
  - In linear time
  - Reuse of Objects to minimize memory usage





```
short sum(short x){
  short sum = 0;
  try{
    for(short i = 0; i < x; i++){
      sum += i;
    }
  }catch(Exception e){
    e.trace();
  }
  return sum;
}
```

Sourcecode

Compile & Convert

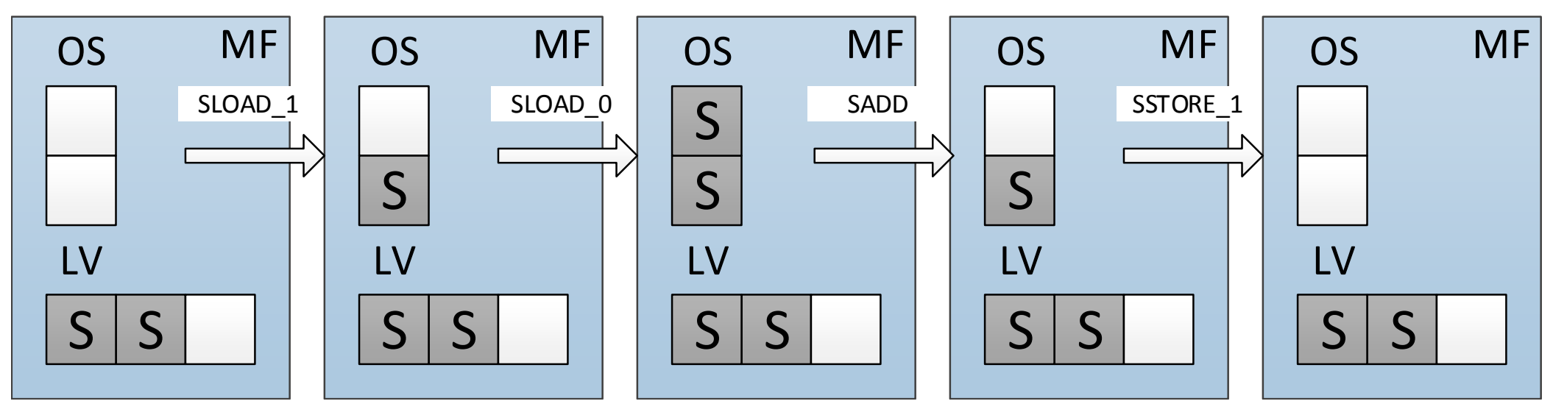
```
  sconst_0       10 sadd
2 sstore sum        sstore sum
  sconst_0       12 sinc i 1
4 sstore i          goto 5
  sload i        14 astore e
6 sload x           aload e
  ifscmplt 17    16 invoke trace
8 sload sum         sload sum
  sload i        18 sreturn
```

ByteCode

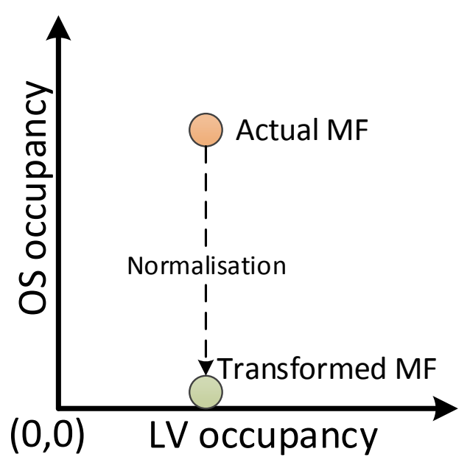
Splitting & Build CFG

Control Flow Graph

- Abstract Interpretation
  - On-Card
  - Working on BB

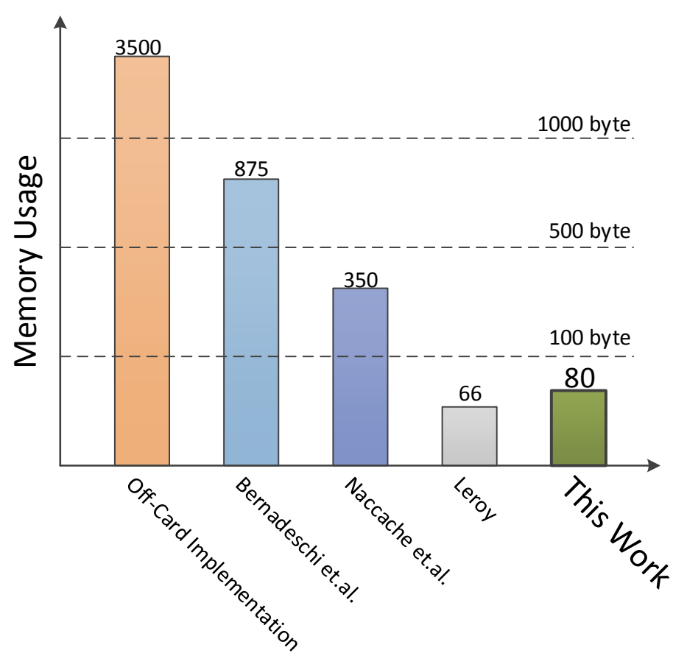


- Temporary Normalisation
  - On-Card
  - Not changing execution of Application



Conclusion

- On-Card
  - Algorithm running on-card
  - Standard Compliance
- Temporary Normalisation
  - Reducing Memory conumption
  - Usable also on low-cost Smart Cards



References

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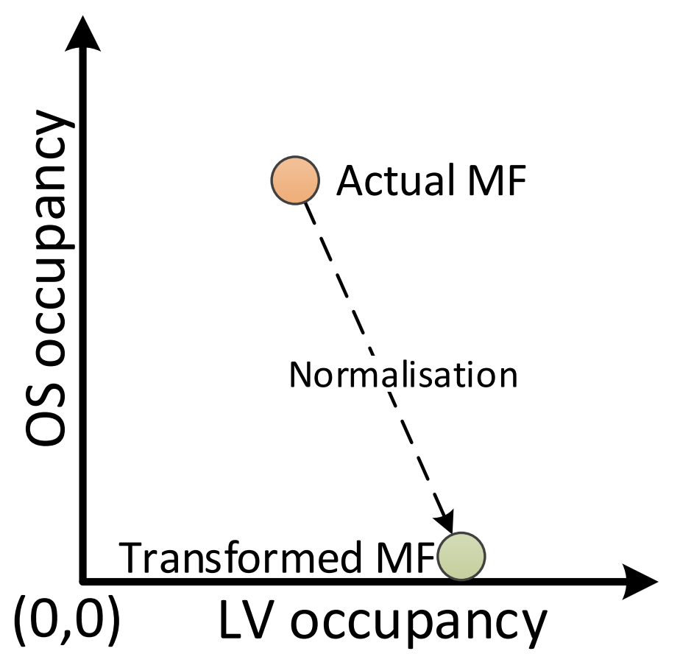
Related Work

Byte Code Verification

- Original BCV [4, 8]
  - Off-Card
  - Resource intense algorithm
  - Abstract interpretation
  - Part of the Sandbox Concept of Java



Normalising in the MF-Plane [5]

On Card BCV

- Proof Carrying Code (PCC) [9]
  - Needs Off-Card Components
  - Verification in Single pass
  - +50% size for PCC
- Normalising [5]
  - Needs Off-Card Components
  - Same memory consumption as execution
- Reducing the Dictionary [2, 6]
  - Using Control Flow Graphs
  - Minimizing saved elements of Dictionary

This project is sponsored by . . .

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