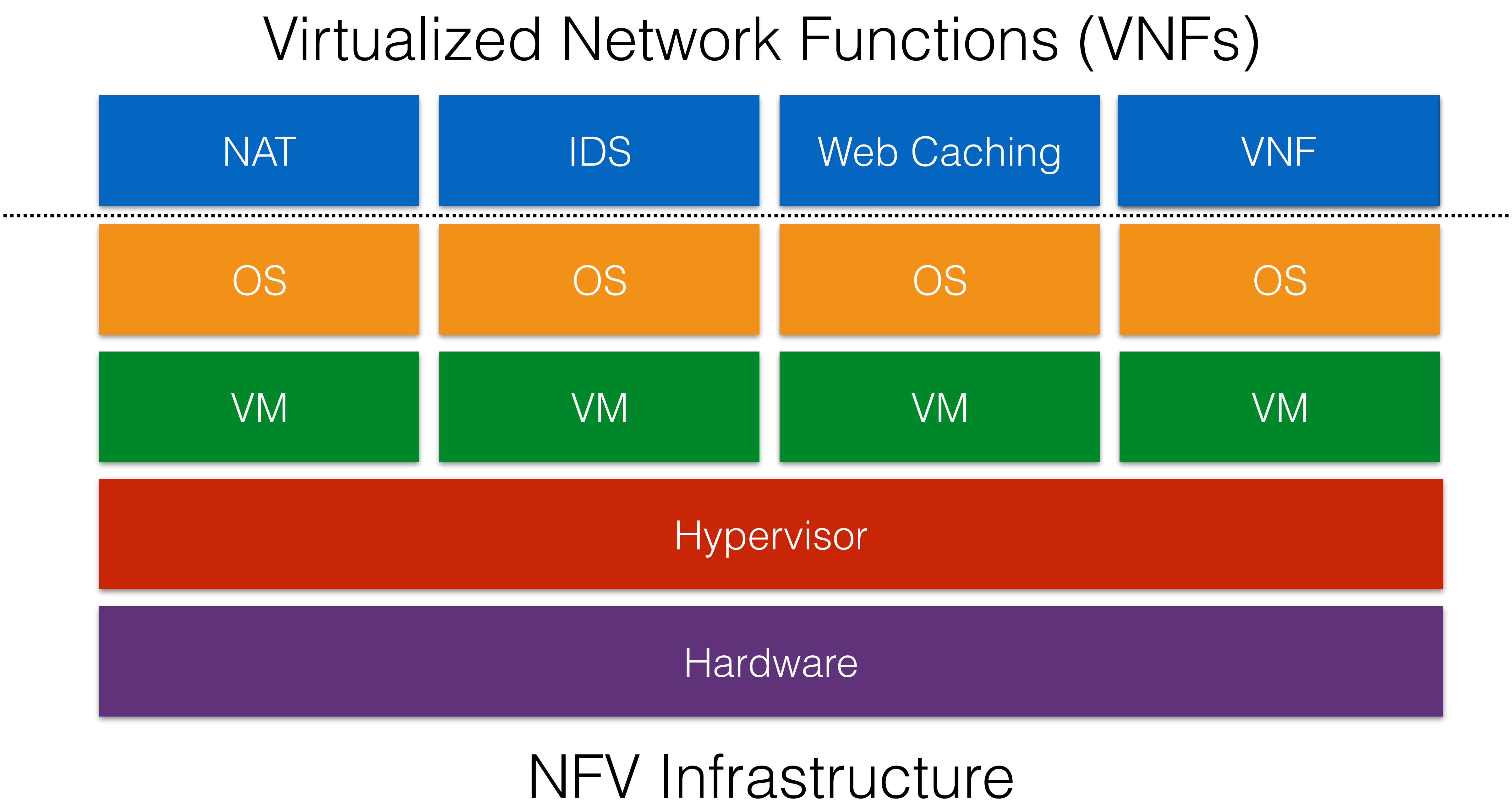
S-NFV: Securing NFV states by using SGX

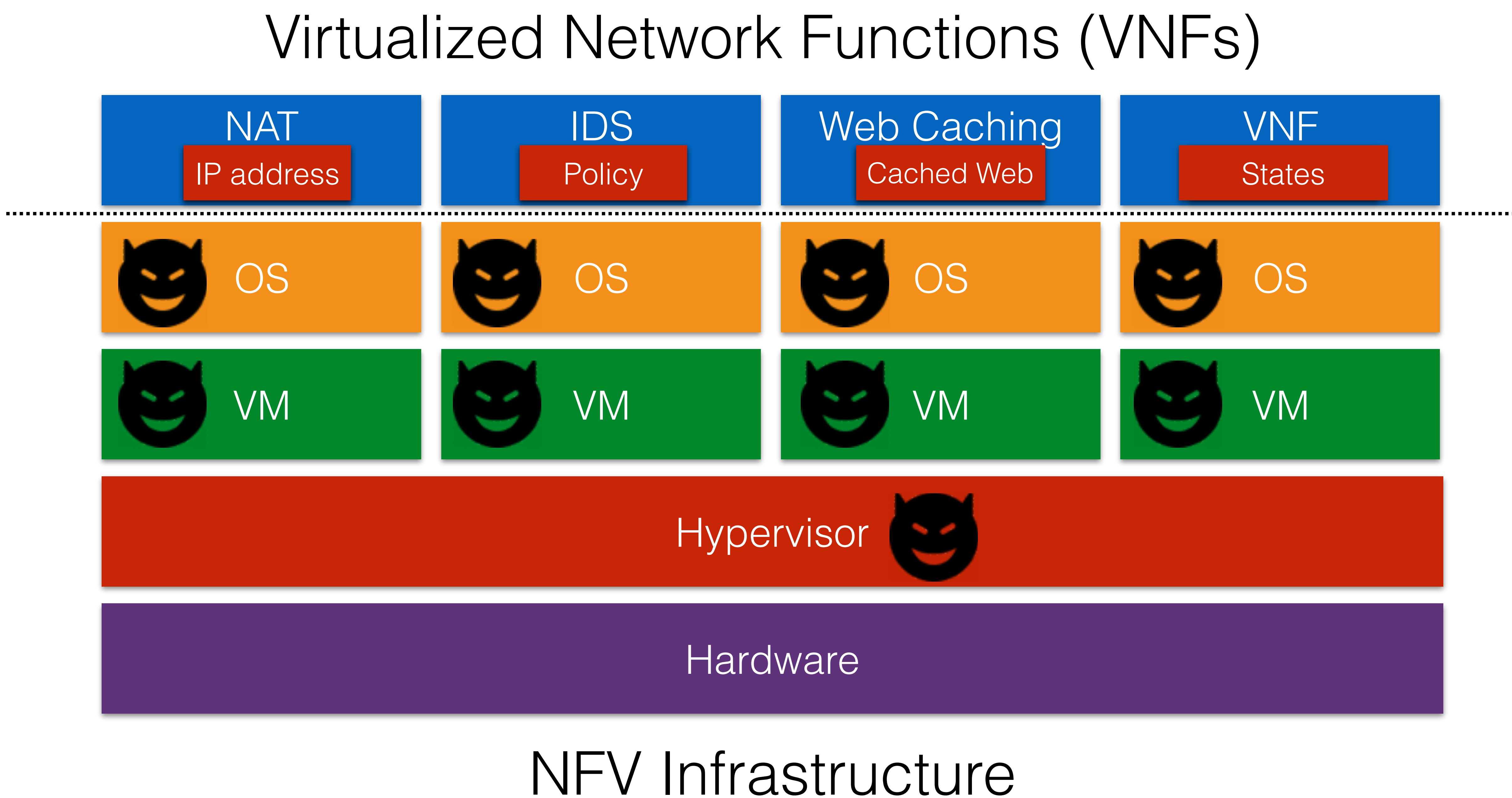
Ming-Wei Shih Mohan Kumar Taesoo Kim Ada Gavrilovska
Georgia Institute of Technology

Network Function Virtualization (NFV)



Georgia Tech Institute for Information Security & Privacy

Stateful network functions

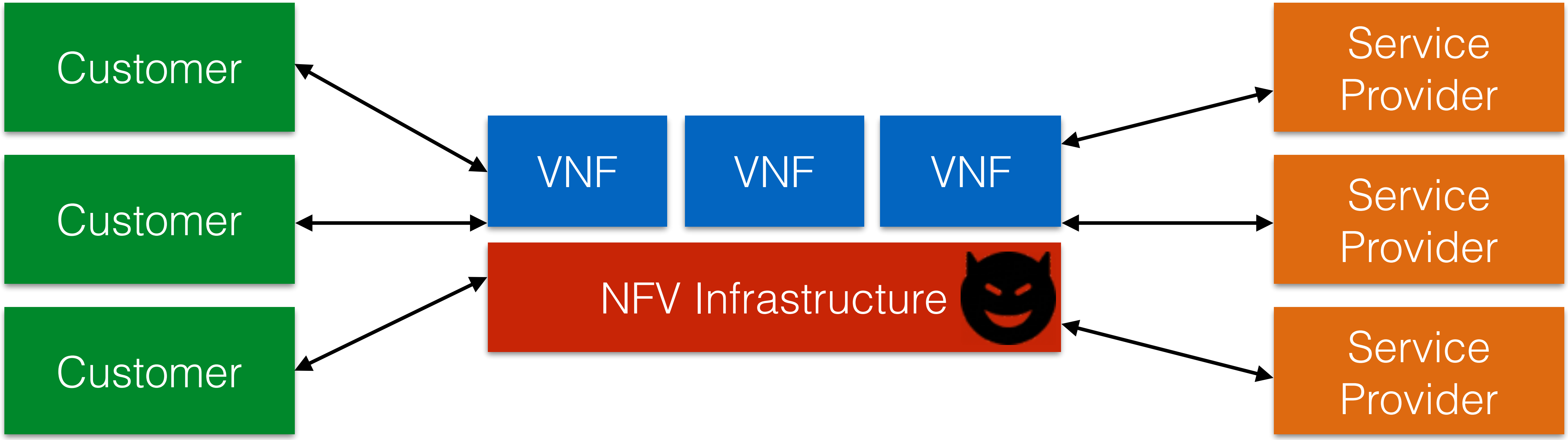


Georgia Tech Institute for Information Security & Privacy

“Introspection Risk for NFV
Hypervisor introspection, including administrative and process introspection, presents a risk to ***confidentiality***, ***integrity***, and ***availability*** of the NFV. Introspection can enable the ability to **view**, **inject**, and/or **modify operational state** information associate with NFV…” — ETSI GS NFV-SEC 003

S-NFV: Design Goal

- Threat Model
  - Underlying software is untrusted
- How can remote parties gain trust on VNFs?
- How to ensure the security of NFV stats?



S-NFV: Design Goal

- New NFV framework
  - Integrate with Intel SGX
    - Ensure the security of NFV applications' states
    - Allow remote party to verify
  - Requires only application-level changes

Intel Software Guard Extensions (Intel SGX)

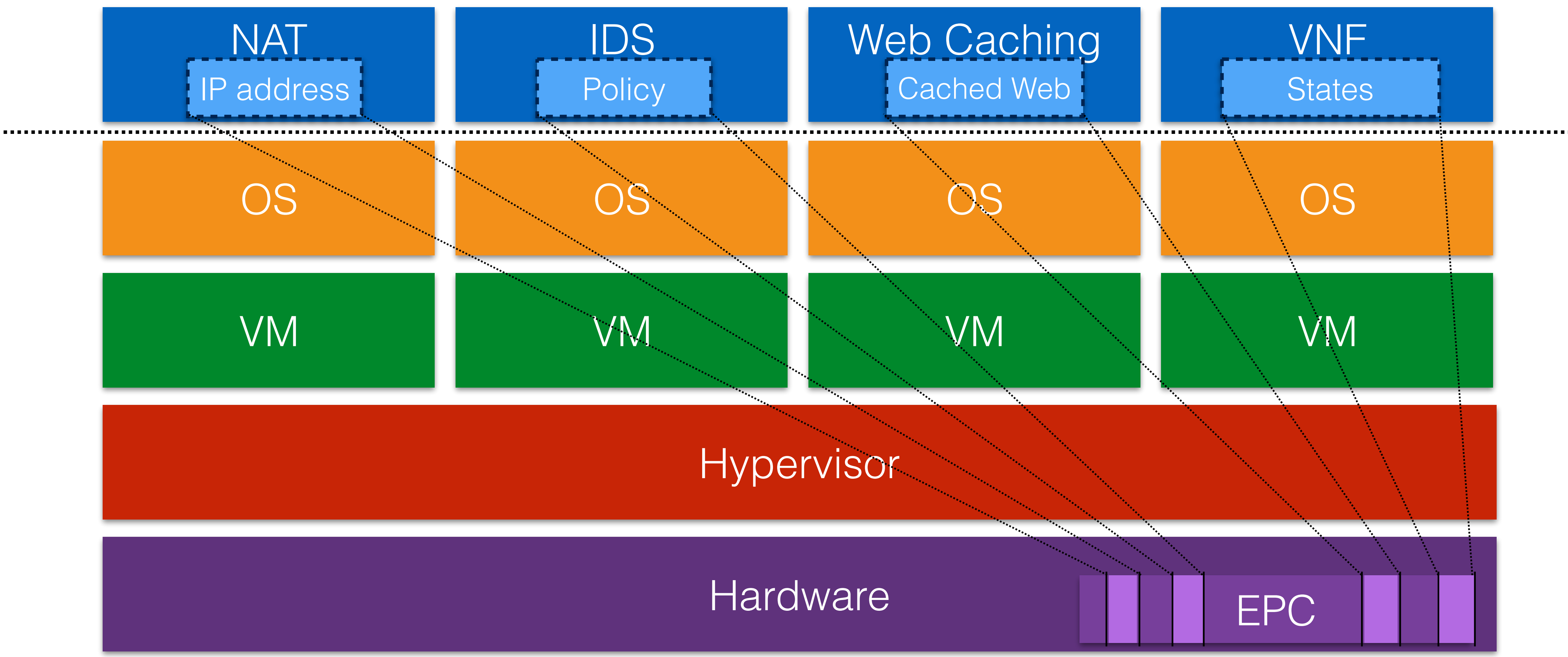
- Intel CPU extensions
  - Code/Data can be kept in a secure container (*enclave*)
    - Dedicated physical memory (Enclave Page Cache, EPC)
    - Different memory access semantics are enforced
  - Support remote attestation over enclave
- Supported by Intel Skylake CPUs
  - SGX-enabled version is released on October 2015

intel

Georgia Tech Institute for Information Security & Privacy

S-NFV Overview

Virtualized Network Functions (VNFs)

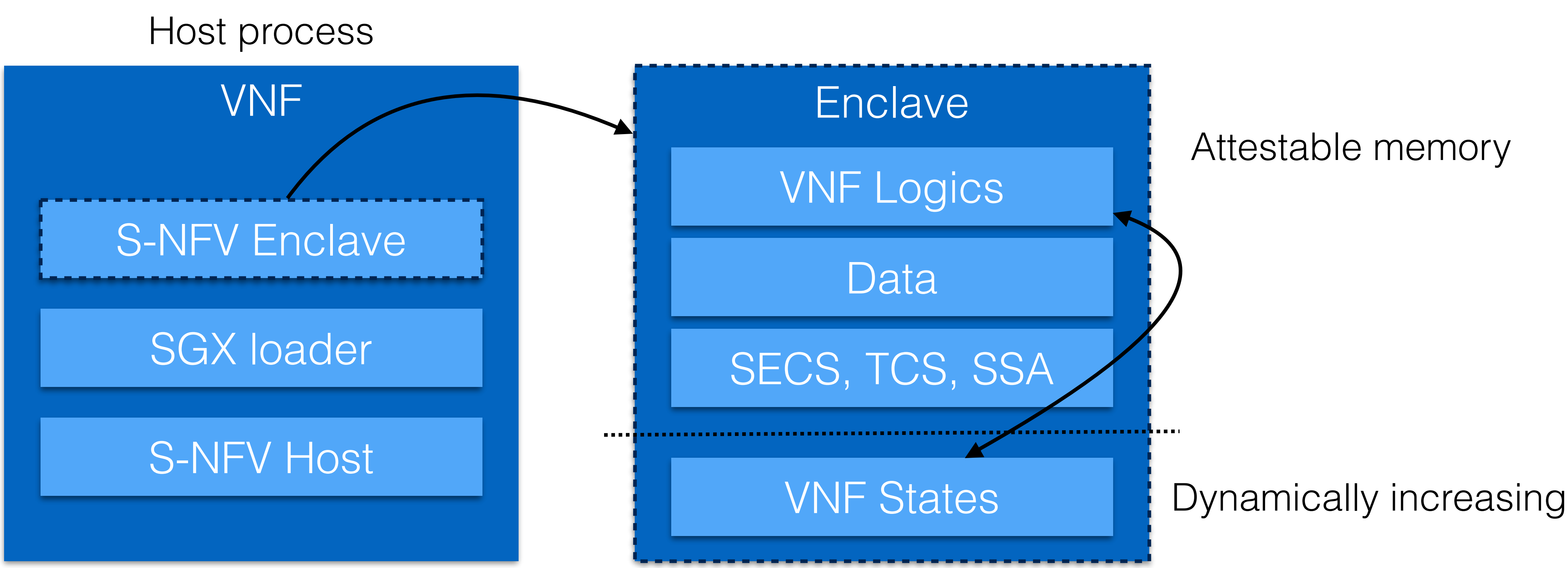


S-NFV Framework

Georgia Tech Institute for Information Security & Privacy

S-NFV Overview

- Decouple original VNF
  - S-NFV Enclave: contains states and related logics
  - S-NFV Host: the rest code of VNF

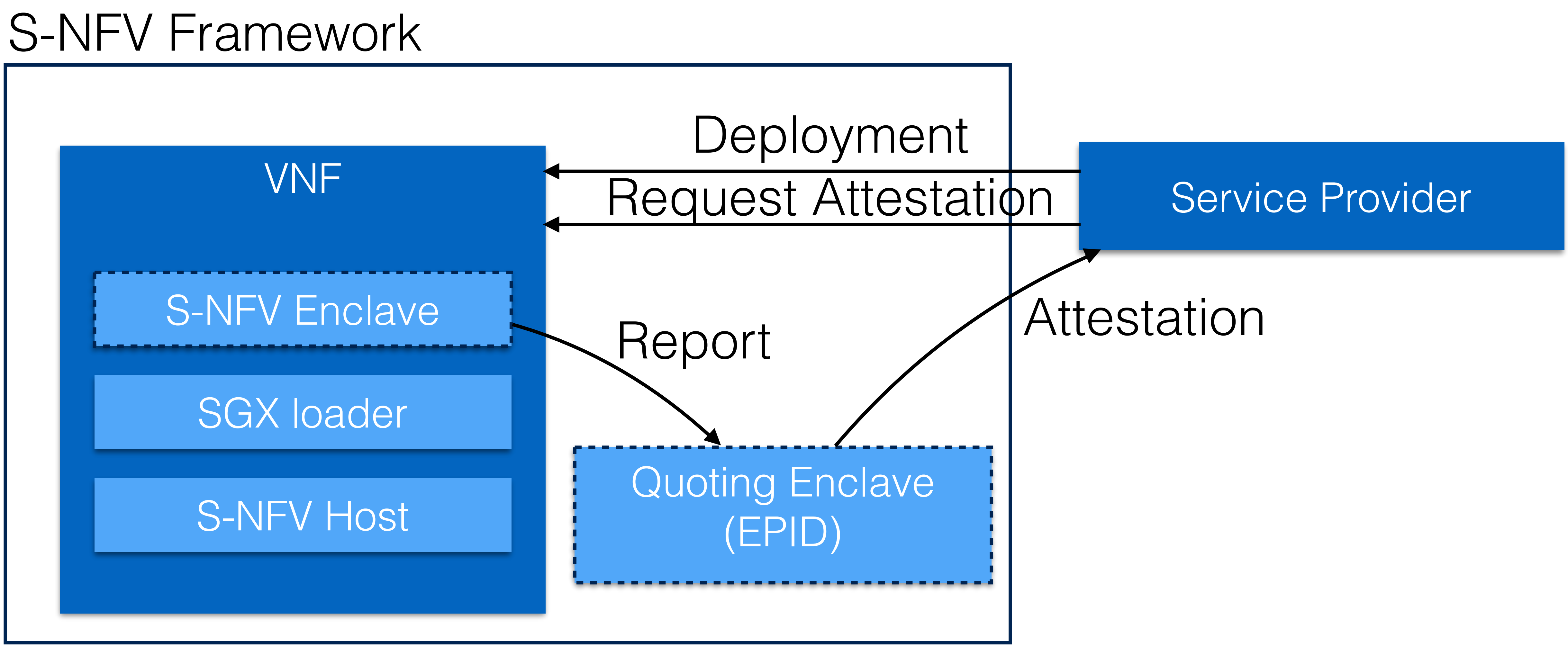


S-NFV Overview

- S-NFV Enclave Design
  - Clear Isolation
    - Separating out states and related operations from original VNF
  - Safe APIs
    - Provide interfaces to support host and enclave interactions without revealing states

Remote Attestation

- Leverage SGX's remote attestation feature to attest S-NFV enclave
  - Secure bootstrap
  - Establish secure channel



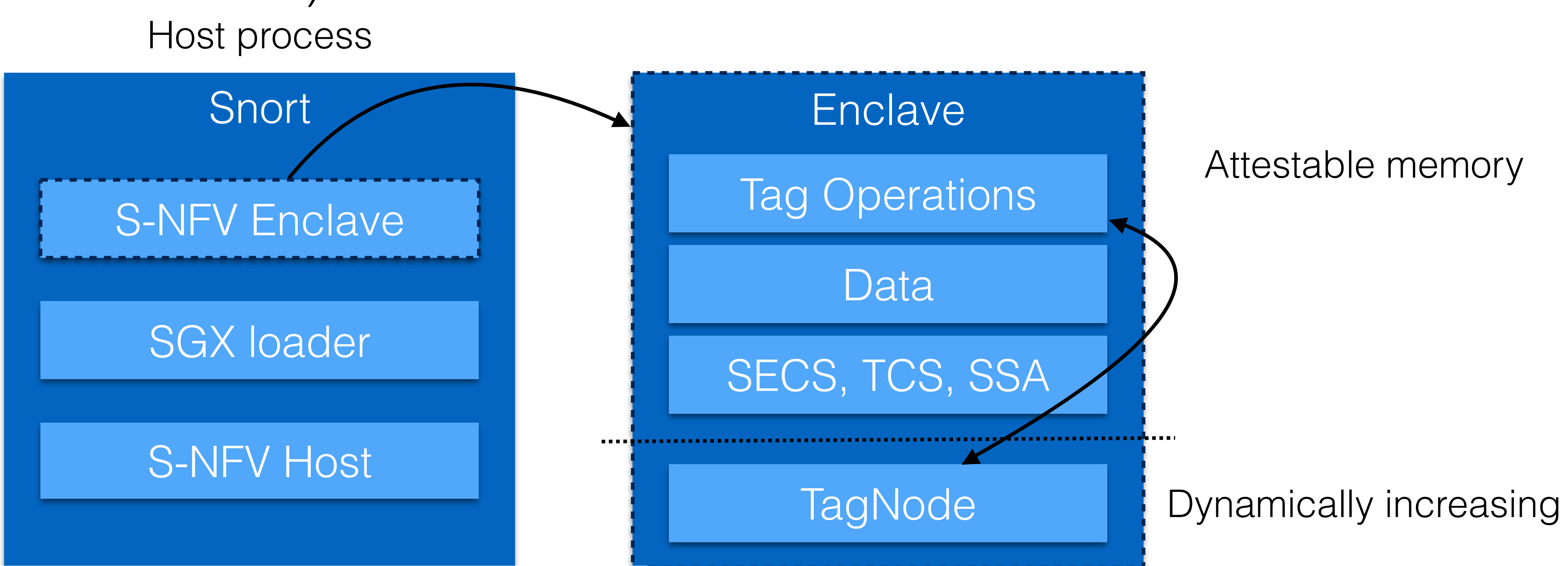
Georgia Tech Institute for Information Security & Privacy

Case Study: Snort

- Snort
  - Lightweight network intrusion detection system
  - States: IDS policy (TagNode data structure)
    - Configured during the bootstrap
    - Dynamically create/update and used to check packet during the runtime

Implementation

- Implement prototype on OpenSGX
  - Extract TagNode and Tag Operations from Snort
- Port on SGX-supported machine (no available SDK as the time of submission)



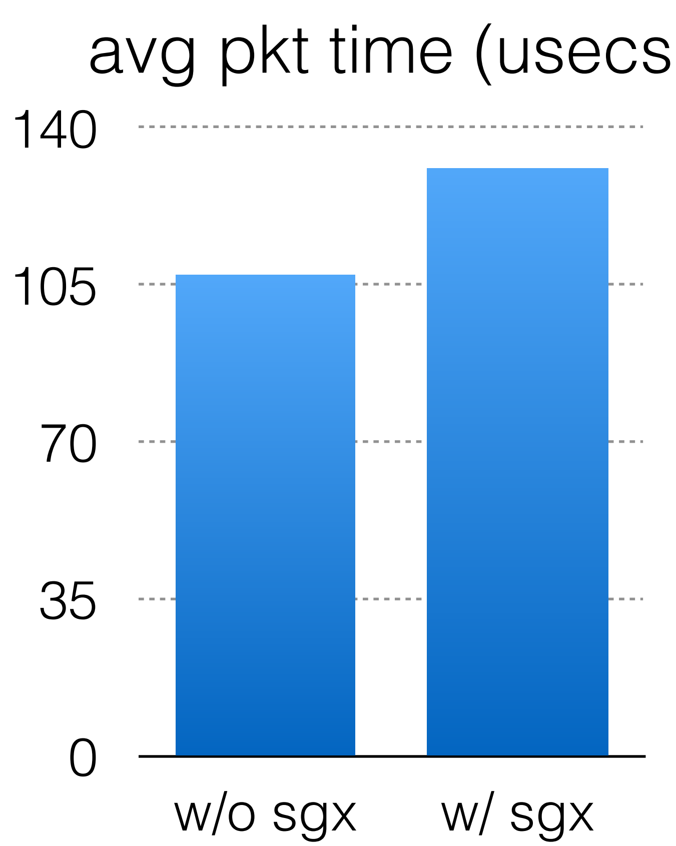
Case Study: Snort

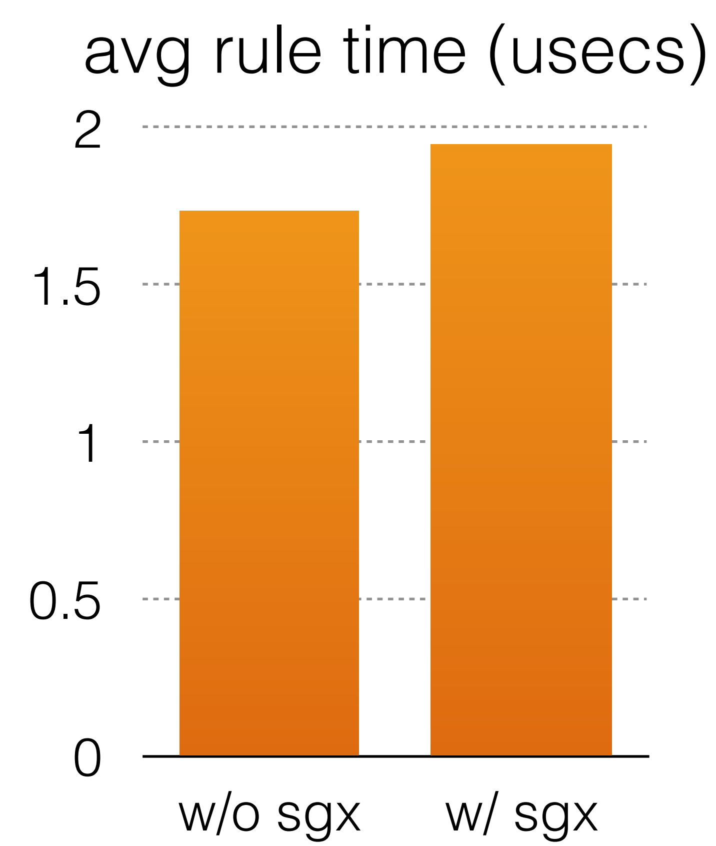
- Result
  - Modify 5 Tag operation APIs
  - 489 LoC changes to orignal Snort

API	**Modification**
void InitTag(void)	-
void CleanupTag(void)	-
int CheckTagList(char*, Event*, void*)	 Packet* → char* void** → void*
void SetTags(char*, TagData*, -, uint16_t)	 Packet* → char* OptTreeNode* → TagData* RuleTreeNode* → -
void TagCacheReset(void)	-

Evaluation

- Based on Packet Performance Monitor plugin in Snort
  - ~20% overhead on packet processing
  - ~10% overhead on rule checking





Georgia Tech Institute for Information Security & Privacy

Conclusion

- We take a first step toward protecting network function's states by proposing new NFV framework
- Use Snort as a case study
  - decoupling an original NFV application to fit S-NFV model
  - preliminary evaluation on real hardware