



CNS

CENTER FOR NETWORKED SYSTEMS

OCTOBER 2020 RESEARCH REVIEW

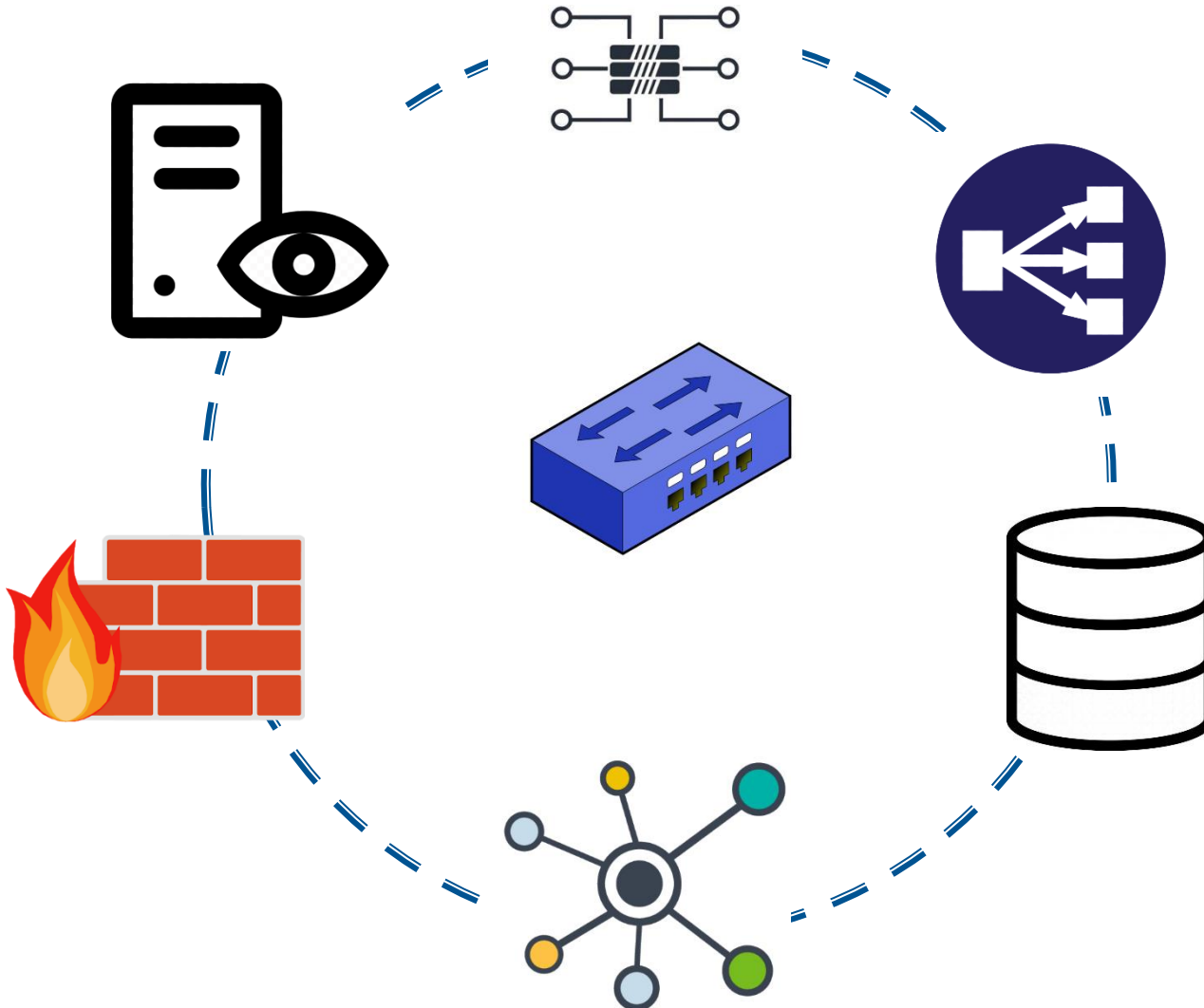
ActiveP4: Enabling Active Networking on Programmable Switch Hardware

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UC San Diego

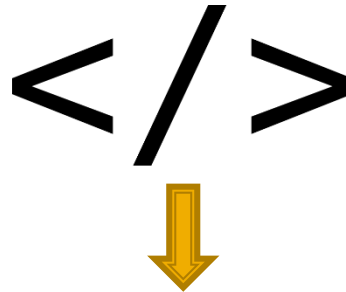
JACOBS SCHOOL OF ENGINEERING
Computer Science and Engineering

In-Network Functionality



Emerging Hardware

Programmer writes
P4 program

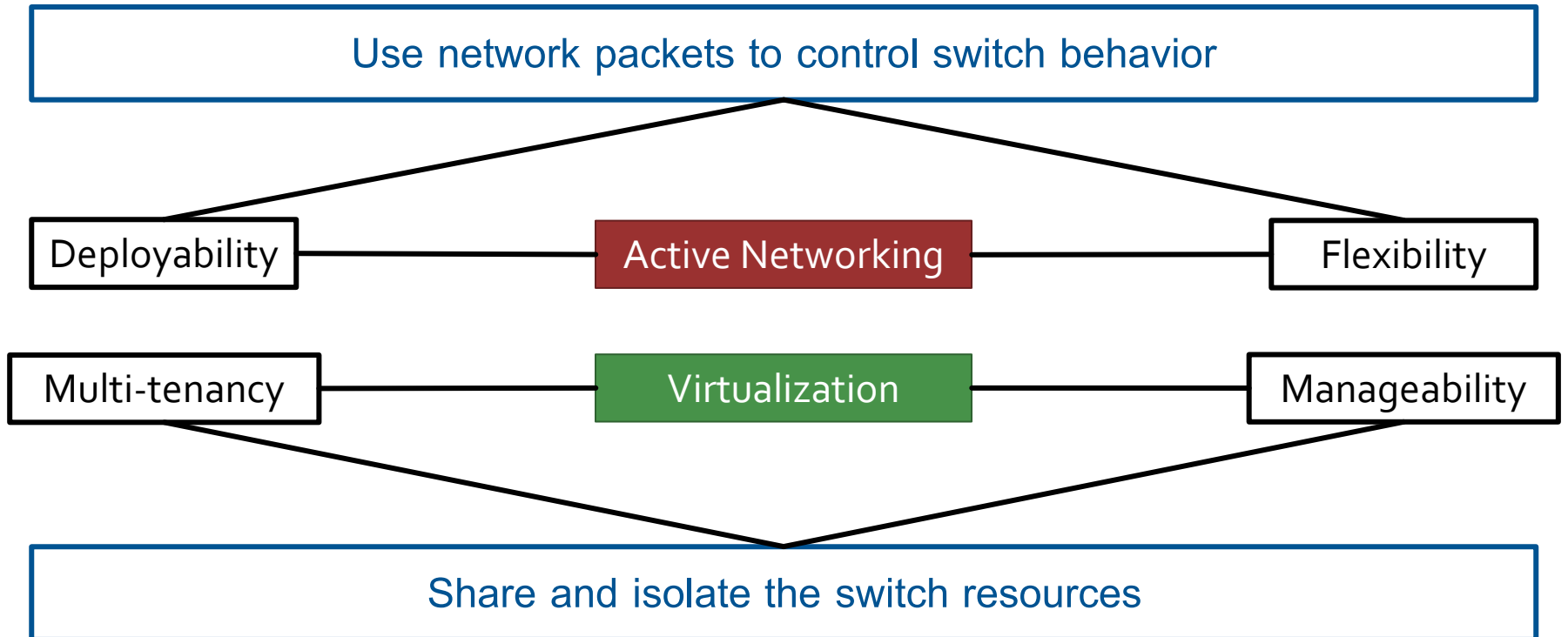


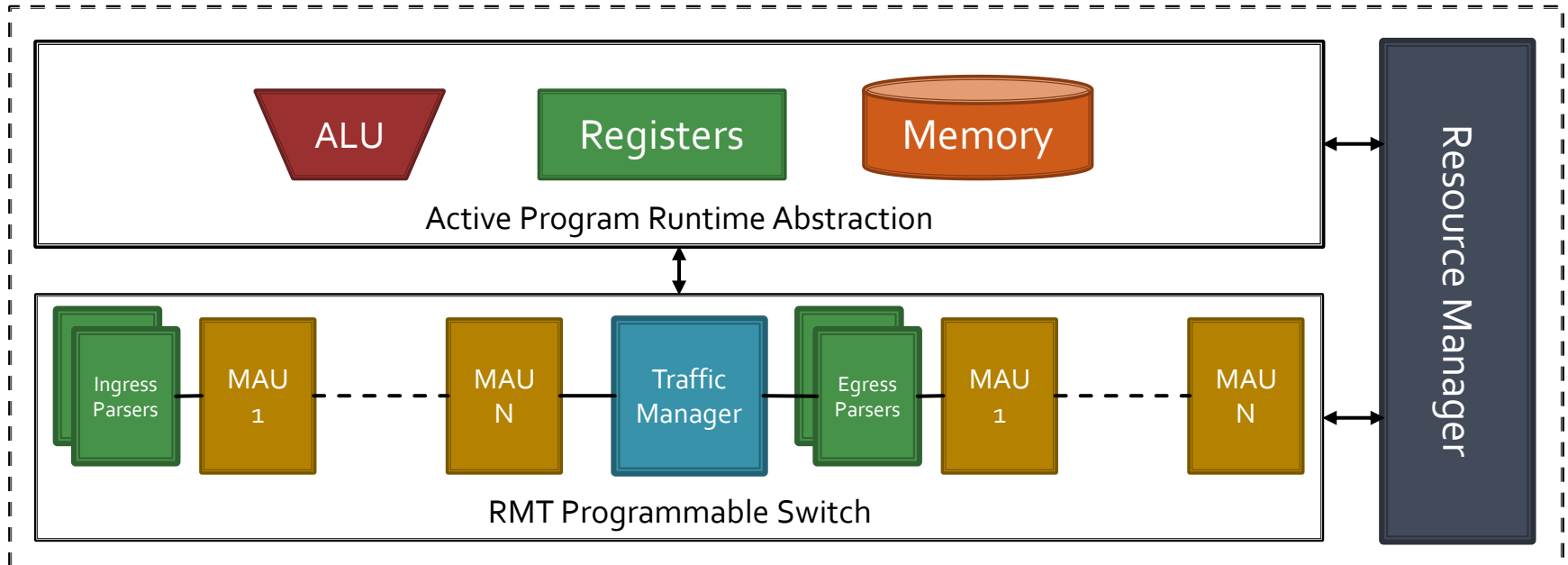
Performs Computation / Storage



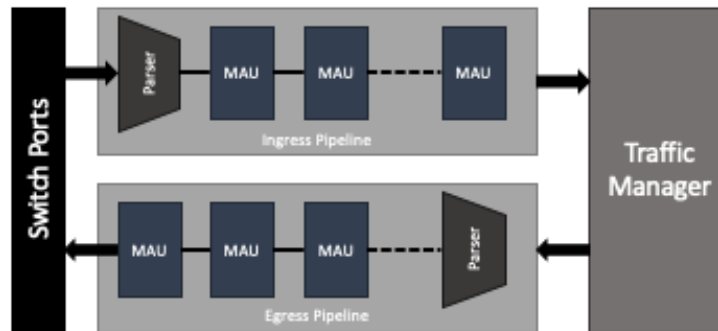
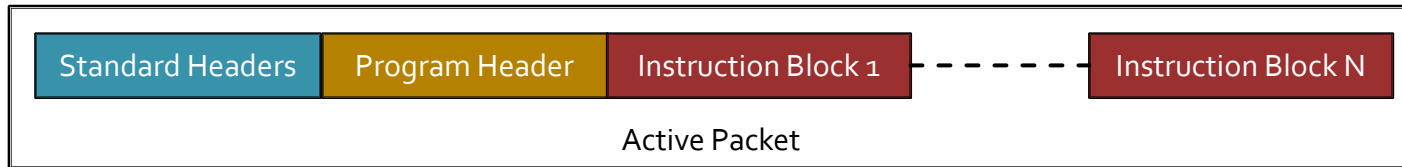
Limitations

- **Deployability & Flexibility:**
 - Requires intervention from network operators.
- **Multi-tenancy:**
 - Applications can't dynamically share switch.
- **Manageability:**
 - Resources statically assigned to applications.



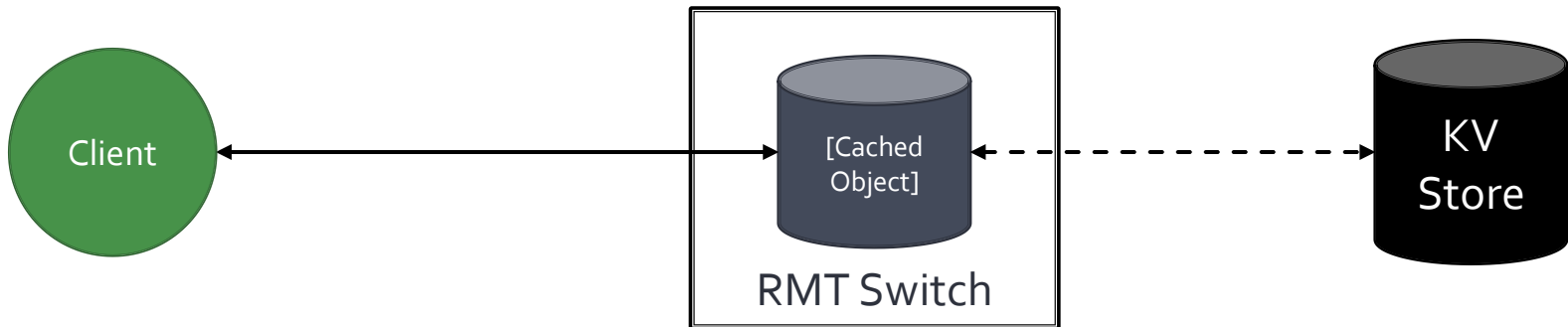
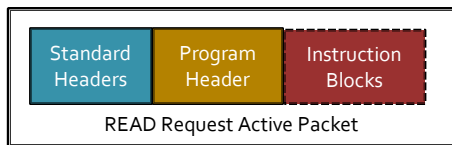


Program Execution

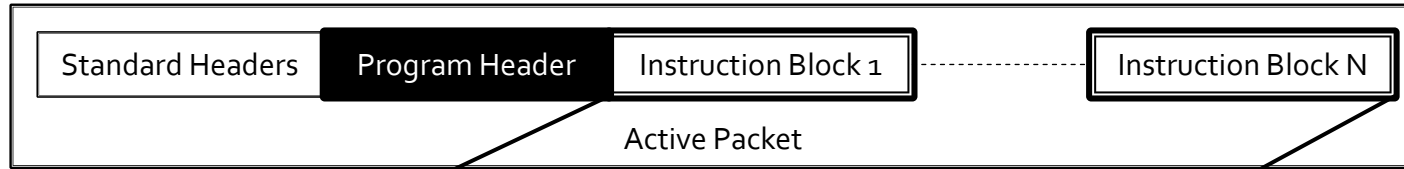


RMT Programmable Switch

Example: Object Cache



Active Program

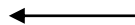


1. MAR_LOAD, *<object_key>*
2. HASH_MAR
3. BIT_AND_MAR, *arg=<pagemask>*
4. MAR_ADD, *arg=<base_address>*
5. MEM_READ
6. CJUMPI, *goto=<regular_fwd>*
7. ACC_LOAD
8. RTS, *label=<regular_fwd>*
9. RETURN

Address Translation

Send cached object to sender if hit

Read Object



Active Program Example: A Toy Object Cache Read

**Assumes cache is pre-populated with objects.*

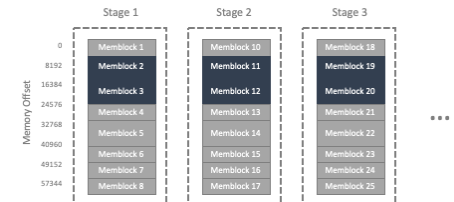
Memory Management

```

1. MAR_LOAD, <object_key>
2. HASH_MAR
3. BIT_AND_MAR, arg=<pagemask>
4. MAR_ADD, arg=<base_address>
5. MEM_READ
6. CJUMPI, goto=<regular_fwd>
7. ACC_LOAD
8. RTS, label=<regular_fwd>
9. RETURN
  
```

Active Program Example: A Toy Object Cache Read

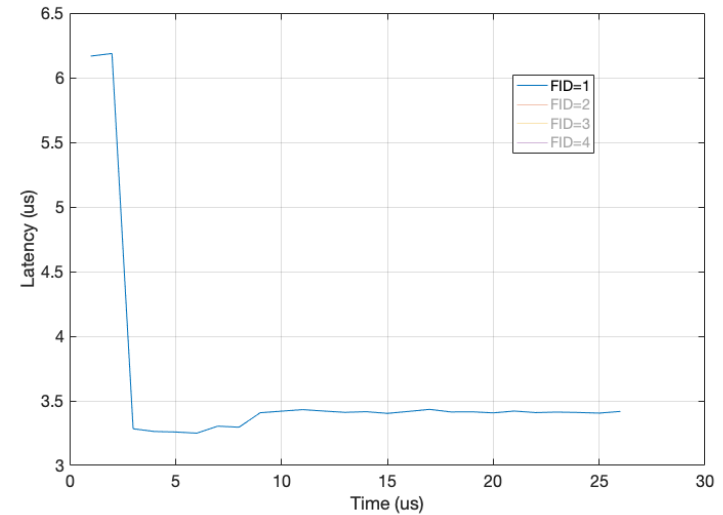
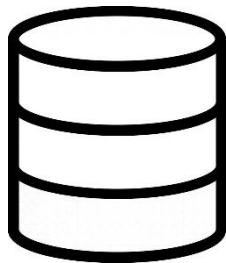
Memory Access



**Assumes cache is pre-populated with objects.*

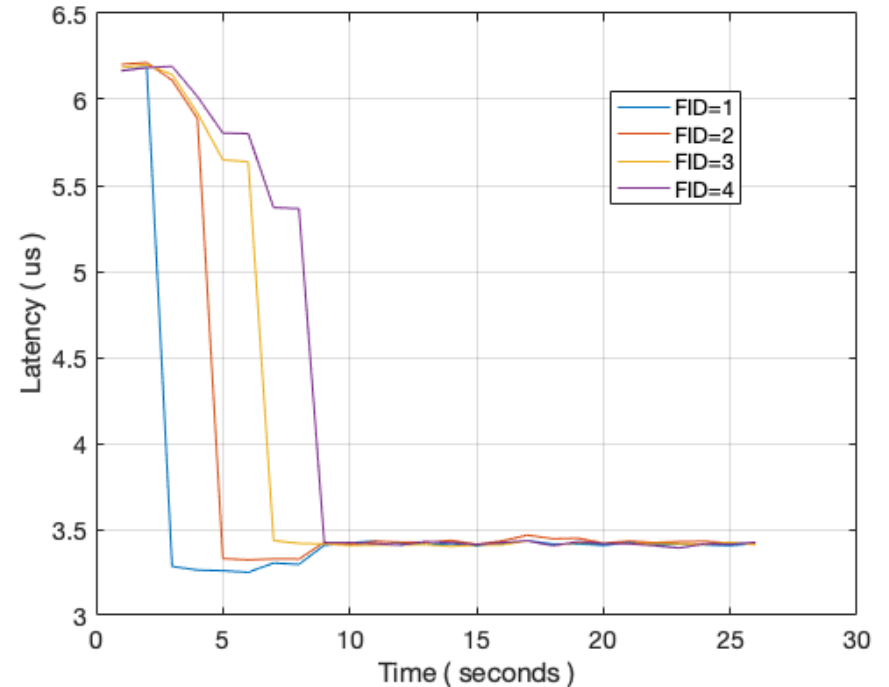
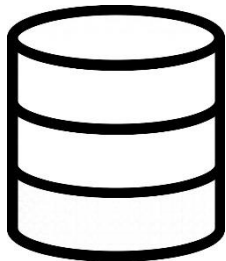
Benefits of ActiveP₄

- KV-Store Application
- In-Switch Cache
- Flow of Object Requests
- T=3 seconds: introduce cache
- T=6+ seconds: introduce 3 apps

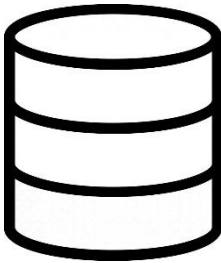


Dynamic Reallocation

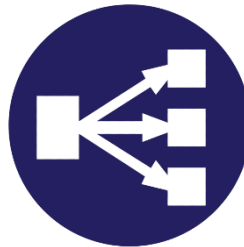
- Huge latency benefits
- Memory allocated equally
- Latencies converge



- **Operations:** arithmetic ops, logical ops, hashing, ...
- **Control flow:** branching, loops.
- **Memory:** direct access and associative.
- **Examples:**



Cache



Load Balancer



Database Joins

Work In Progress

- Efficient resource management
 - Memory allocation policies
- Efficient network goodput
 - Cache programs on the switch
 - Invoke programs stored on the switch



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**THANK
YOU!**