

# Packet Classification with Explicit Coordination



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## MOTIVATION

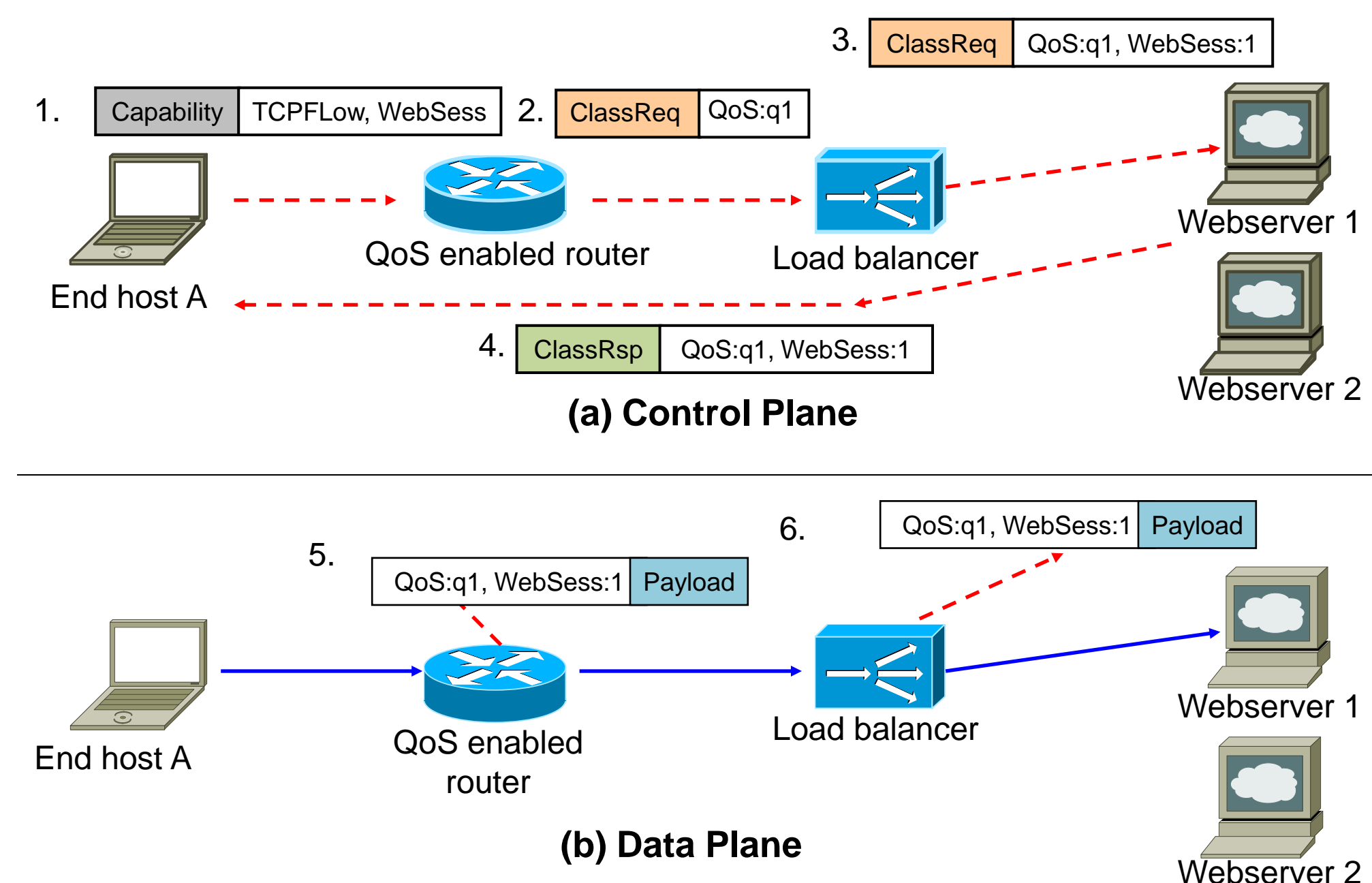
- Packet classification is a fundamental building block of many network services and applications

| Layer     | Service/Application          | Speeds | Number of Fields | Classification Type          |
|-----------|------------------------------|--------|------------------|------------------------------|
| Two / 2.5 | Switching, MPLS              | OC48c  | Single           | Exact Match                  |
| Three     | Forwarding                   | OC48c  | Single           | Longest Prefix Match         |
| Four      | Flow identification, IntServ | OC48c  | Multiple         | Exact Match                  |
| Four      | Filtering, DiffServ          | OC48c  | Multiple         | Prefix or Range Match        |
| Seven     | Load Balancing               | 1GE    | Multiple         | Scan with Exact/Prefix Match |
| Seven     | Intrusion Detection          | 1GE    | Multiple         | Scan and Match RegEx         |

- It is resource- and computation-intensive
- Classifiers often do not have semantic context of what they are classifying

## APPROACH

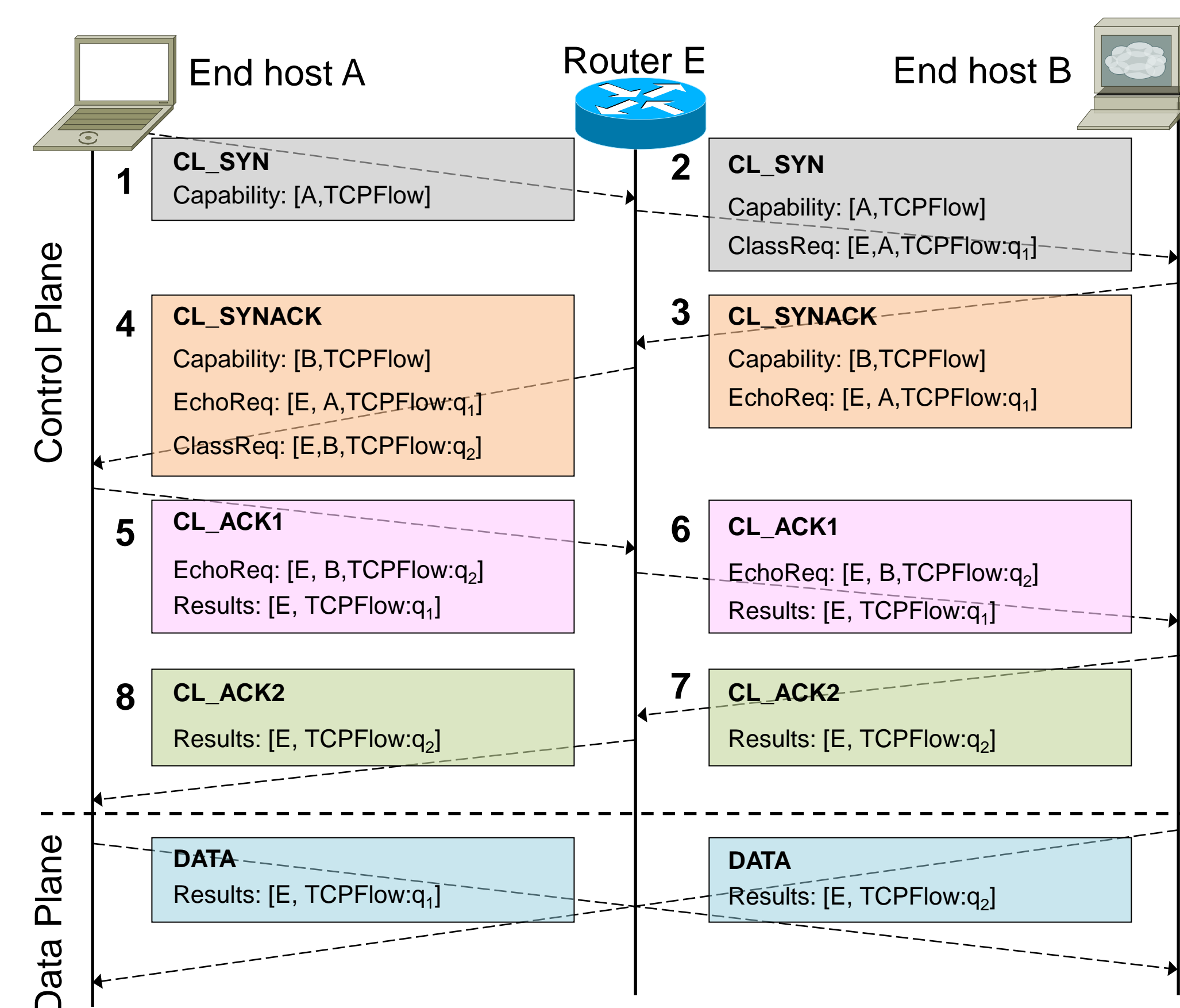
- Introduce packet classification as a fundamental primitive of the network protocol stack
  - New classification layer – **CLayer**
- Offload part of classification tasks to the *helpers* (e.g., end hosts, edge routers) that have better semantic context than the *classifiers* (e.g., middleboxes)



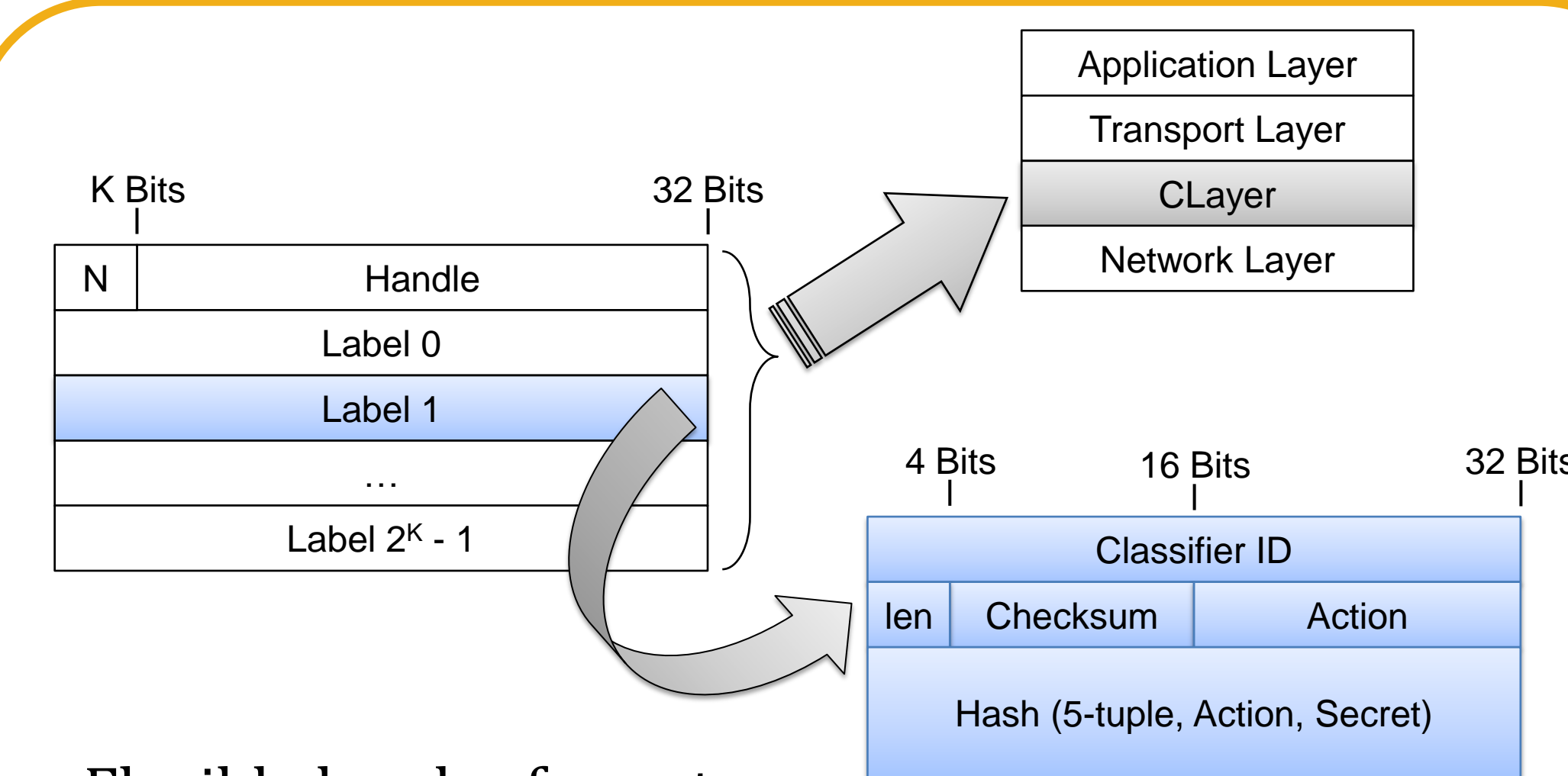
- Create a robust signaling protocol to coordinate between helpers and classifiers that can handle
  - Non symmetric paths and path changes
  - State discrepancies and losses (use soft-states)
  - Trust, security, and privacy concerns
- Design and develop a generic API to make CLayer functionalities accessible from different network services and applications

## CLayer PROTOCOL

- CLayer uses a 4-way handshaking protocol
  - Analogous to the 3-way TCP handshaking



## CLayer HEADER & API



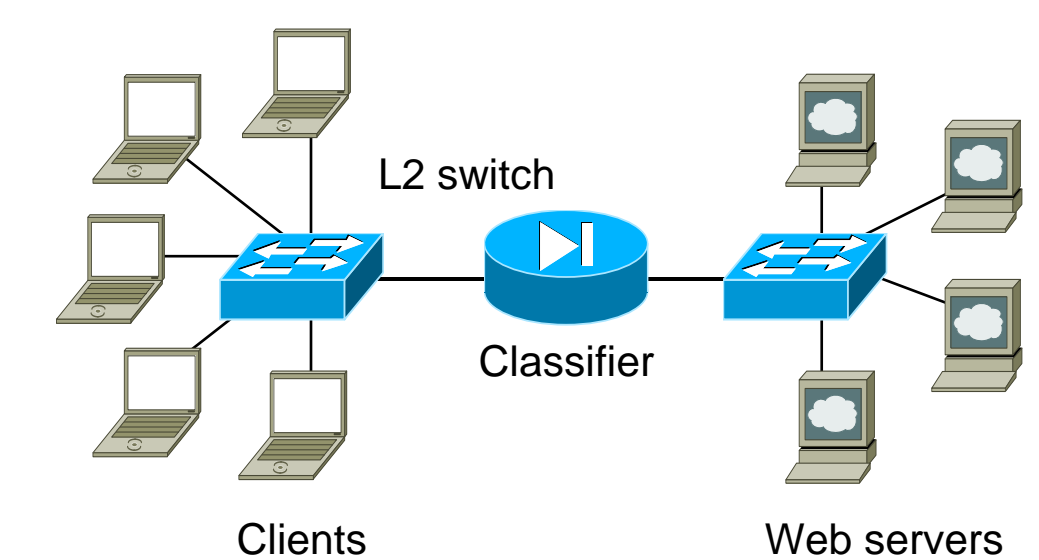
- Flexible header format
  - Except for the *len* field, a classifier has full control over everything
- Bottleneck of the design

| CLayer API   |                     |
|--------------|---------------------|
| c1_socket()  | c1_session_create() |
| c1_bind()    | c1_add_capability() |
| c1_connect() | c1_add_request()    |
| c1_accept()  | c1_set_property()   |
| c1_close()   | c1_read_result()    |

## EVALUATION

- Prototype implemented using Click modular software router
- Minimal changes required to port existing software
- Experimental results are collected from a 10-node 2-LAN topology on the DETERlab testbed

| Component                        | SLOC |
|----------------------------------|------|
| lighttpd                         | 19   |
| httperf                          | 7    |
| wget                             | 10   |
| Layer-4 firewall                 | 308  |
| Layer-4 load balancer            | 190  |
| CLayer socket library and daemon | 4025 |



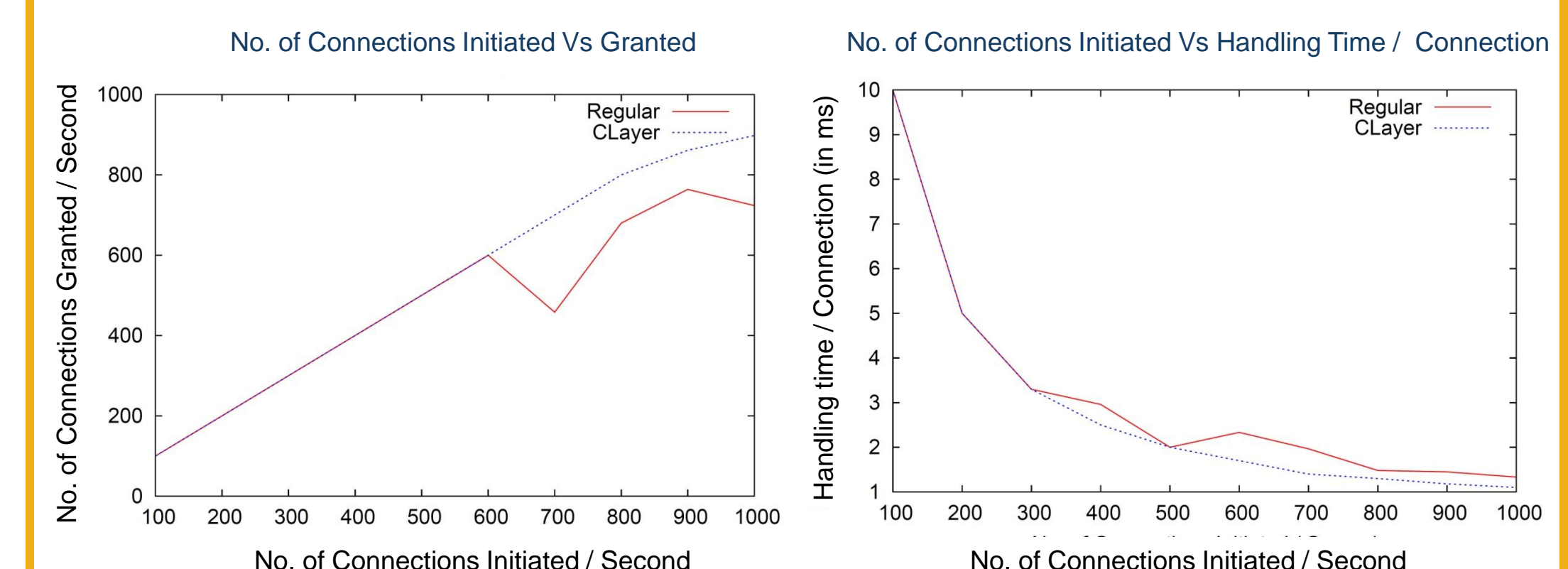
## RESULTS

### Firewall Prototype



- Regular firewall throughput drops 60-80% as the number of rules increases
- CLayer-enabled firewall shows almost no change

### Load Balancer Prototype



- Regular load balancer can handle 20% less connection while taking 20% more time per connection