(h)ICN Socket Library for HTTP

Leveraging (h)ICN socket library for carrying HTTP messages

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Motivations for a Socket Library

- Consistency
  - Same APIs for everyone
- Separation
  - ADU for applications PDU for Network
- Complexity
  - No layer 4 challenges for applications
- Security
  - Authentication and Integrity as built-in

Transport Services

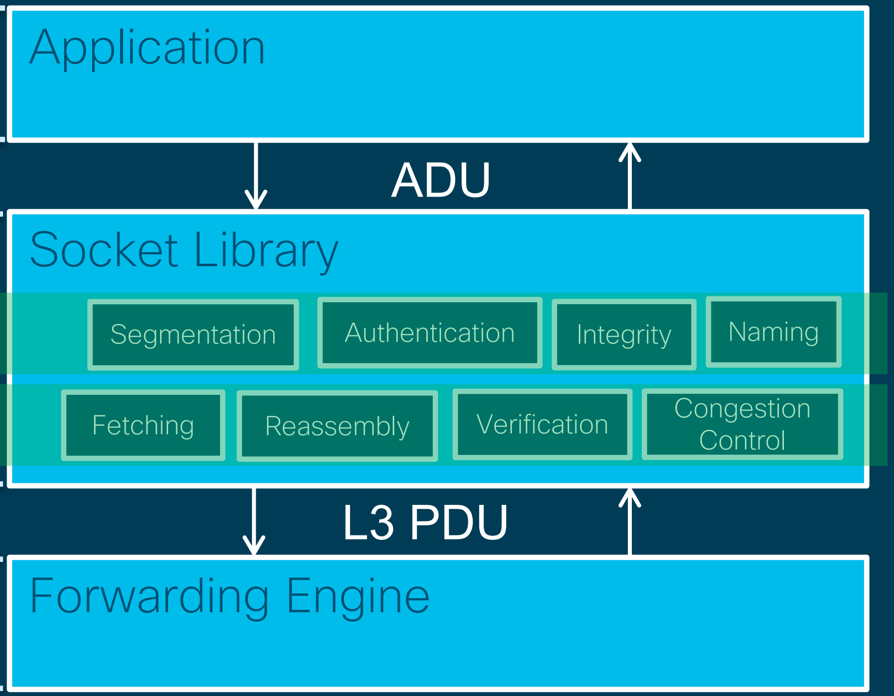
Application Logic

Transport

Producer Services

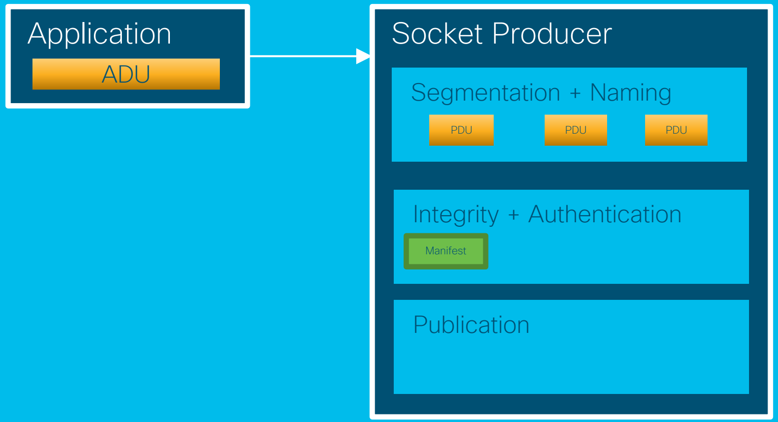
Consumer Services

Routing and Forwarding



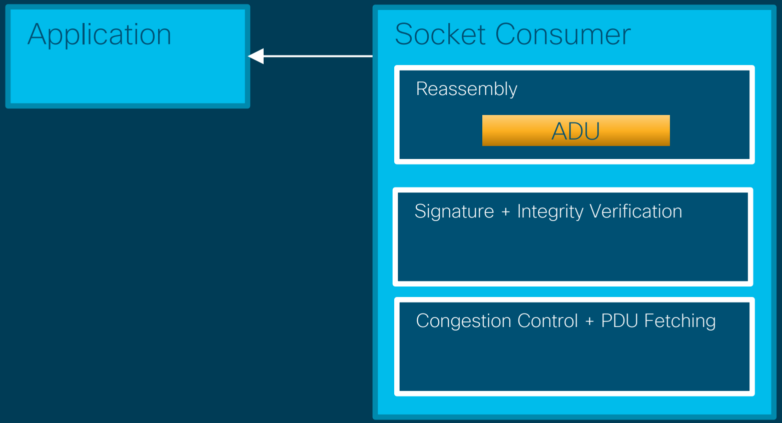
Producer Socket

- ADU Segmentation
- Naming
- Integrity
- Authentication



Consumer Socket

- Congestion Control
- PDU Fetching
- Signature and Integrity verification
- ADU Reassembly



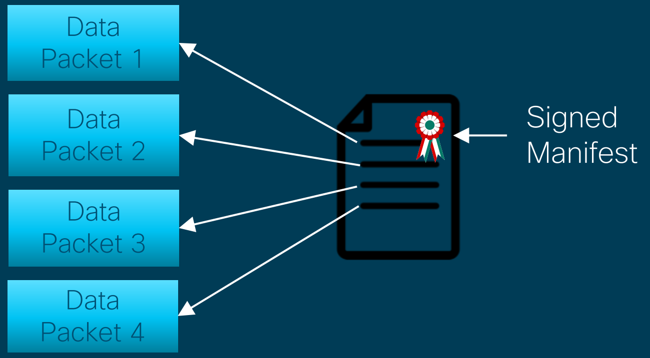
Transport Manifest

- Metadata and prefetching
  - Network names of next data to pull
- Signature Verification
  - Manifest always signed
- Integrity Verification
  - It contains hashes of contents that are going to be pulled
- Performance
  - Amortizes verification cost of each content object

Authentication and Integrity

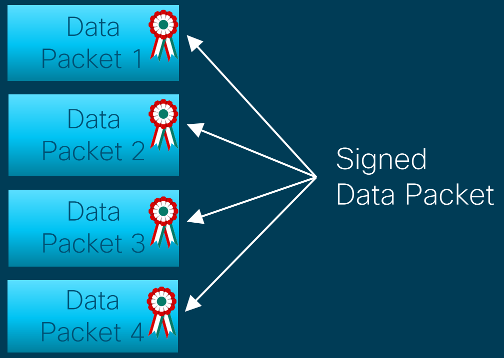
- Native security features, transparently offered to each application
- 2 Approaches: **Manifest authentication** vs **per packet authentication**

- Manifest Authentication



Integrity verified with HASH inside Signed Manifest.

- Per Packet Authentication



Integrity verified with the signature itself

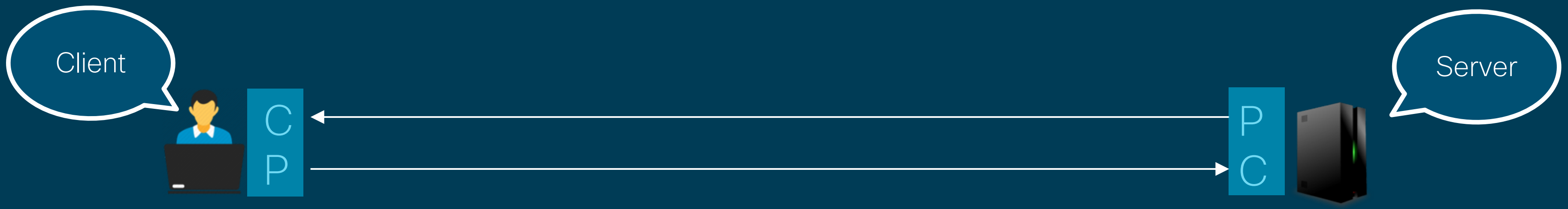
fd.io open source project

```
git clone -b libicnet/master https://gerrit.fd.io/r/cicn libicnet;
```

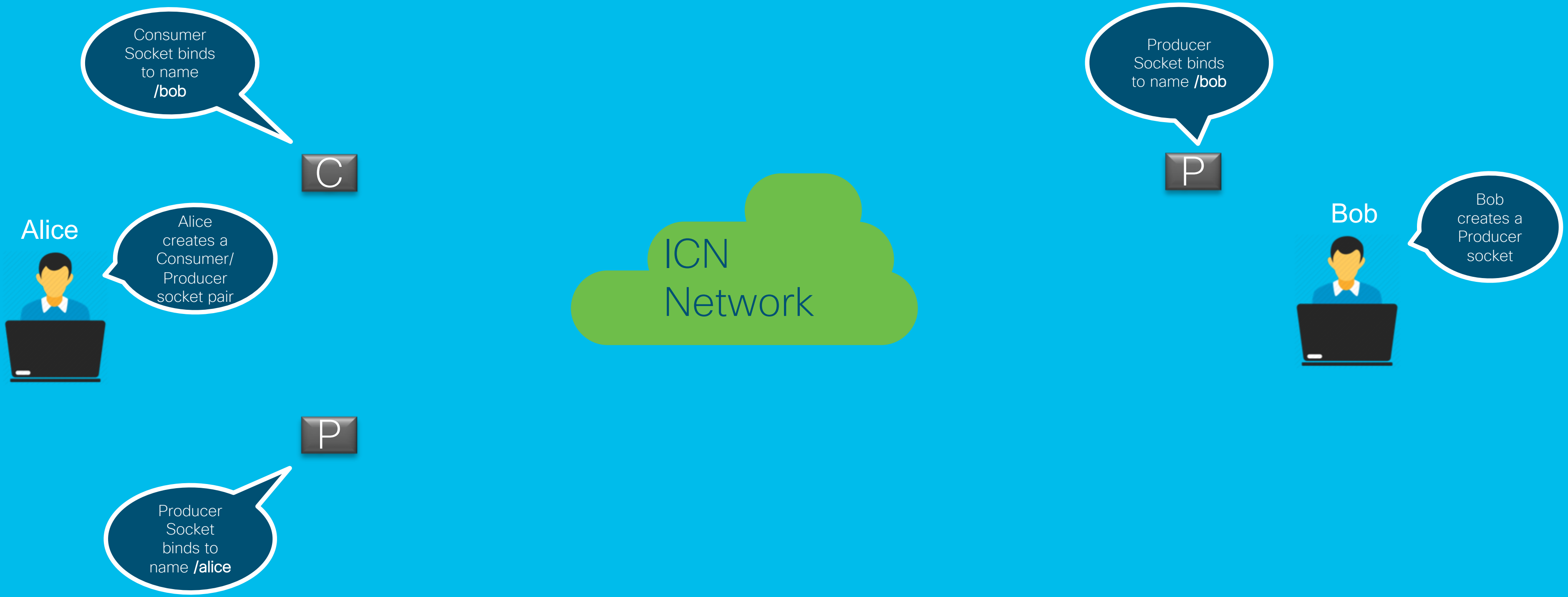
- The ICN transport library, called Libicnet, has been open sourced under APACHE 2.0 license on FD.io (https://wiki.fd.io/view/Cicn)
- Language: C++
- Supported Platforms: Ubuntu, CentOS, macOS, iOS, Android
- It allows applications to transparently connect to 2 ICN Forwarders:
  - sb-forwarder (a.k.a. Metis)
  - cicn-forwarder (vpp based plugin)
- Applications written using this library are able to work also with the hICN library (libhicnet)

Bidirectional data exchange between two applications

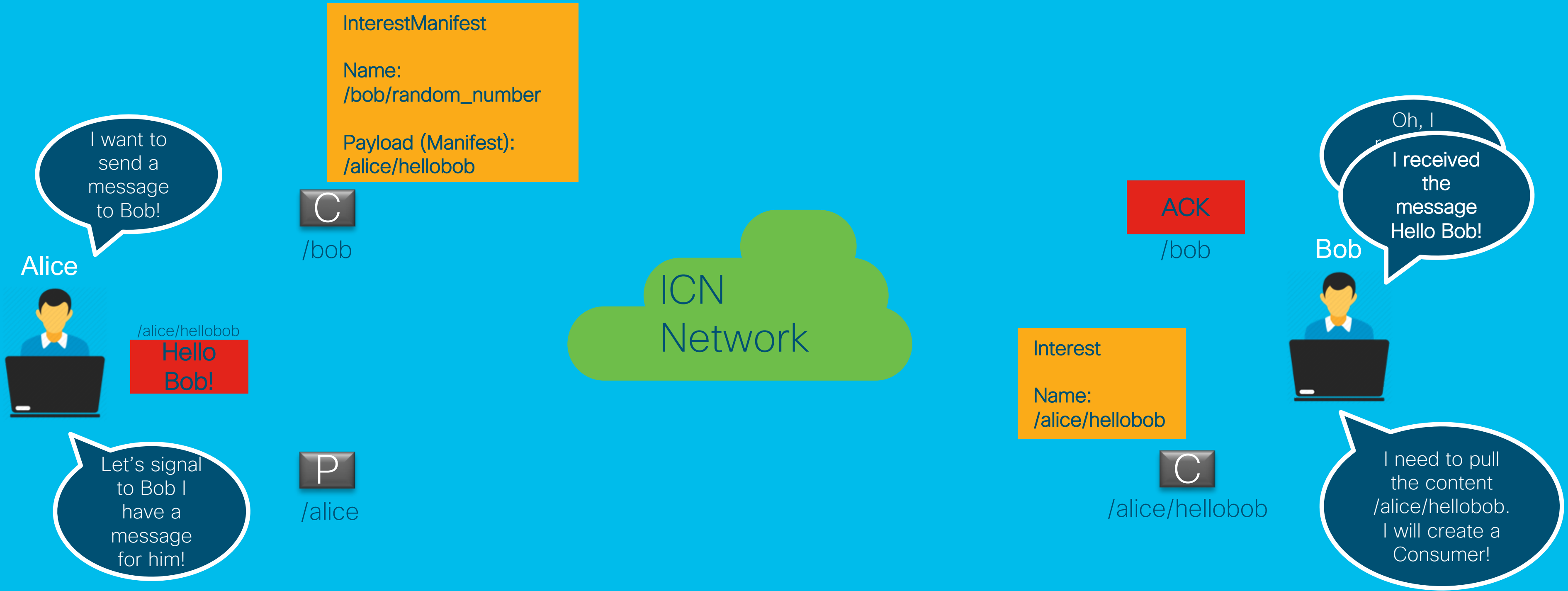
- Each socket identifies an unidirectional channel (multi-point)
- By using Producer/Consumer sockets an application is able to Send/Receive data
  - ➢ The Consumer Socket pulls contents from a Producer socket
  - ➢ The Producer Socket publishes data to be pulled by a Consumer Socket



Example: Implementing push semantics using the reverse pull(1)



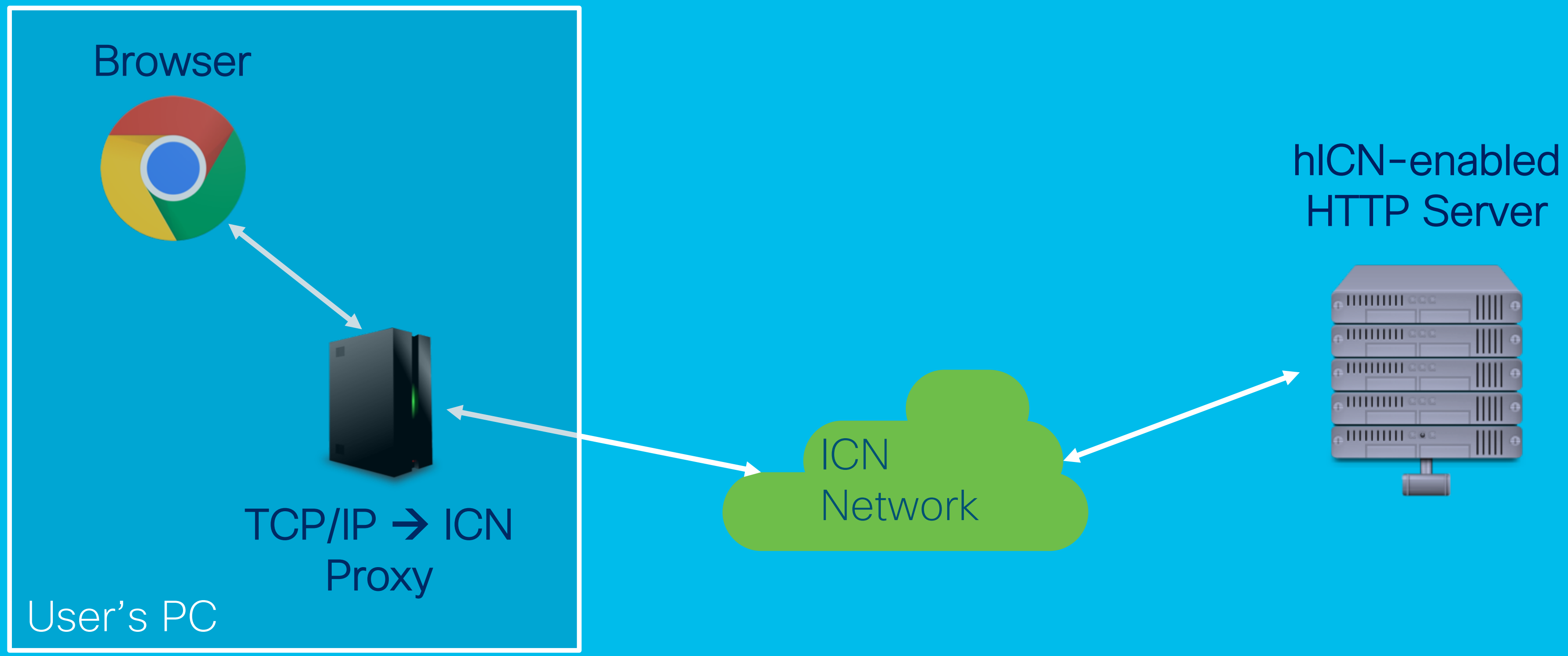
Example: Implementing push semantics using the reverse pull(2)



HTTP Client and Server

- The concept explained in the previous slides can be easily applied for achieving full HTTP Client/Server communications.
- Clients send HTTP Requests in the same way as explained before
- Servers process Requests and publish Responses
- Clients pull back Responses

HTTP over ICN PoC



Optimizations

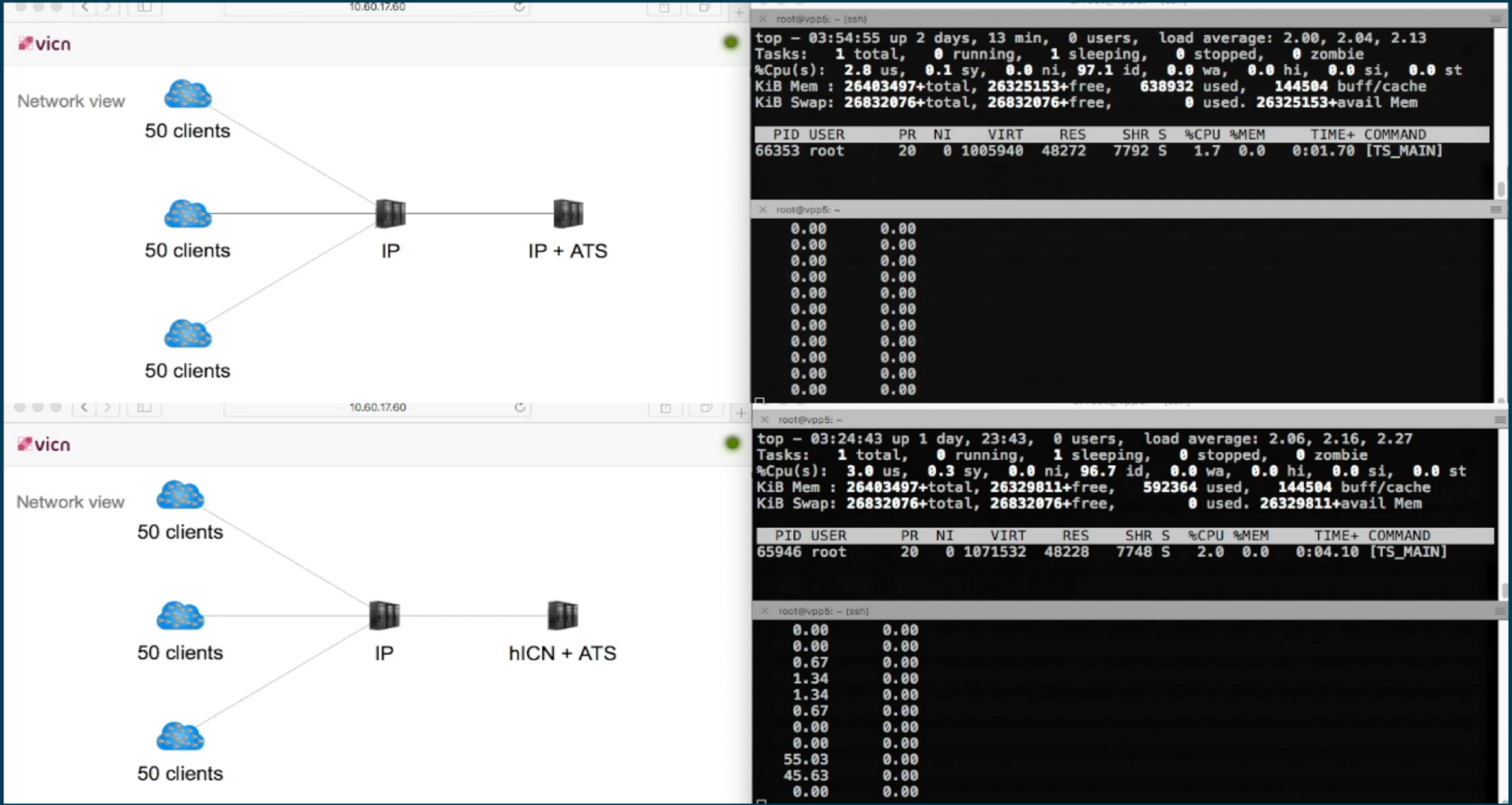
- If the size of the HTTP requests fits one MTU, it can be directly piggybacked within the first interest manifest, by sending the request in half RTT.
  - The SPDY whitepaper states that typically Request header size of 700-800 bytes is common (https://www.chromium.org/spdy/spdy-whitepaper)
- When the client sends the interest manifest to the server, the latter can append to the ACK a signed manifest containing the information for retrieving the response, allowing clients to directly retrieve it.

HTTP Request and Response multiplexing

- It refers to the problem of sending multiple requests/responses in parallel
- The client must be able to associate each response to the corresponding request
  - HTTP 1.0 uses multiple TCP connections for multiplexing Requests and Responses
  - HTTP 1.1 can reuse the same TCP connection, but for being able to associate Responses and Requests the server needs to process them in order, likely causing a HOL blocking
  - HTTP 2.0 uses one persistent TCP connections and streams, with the overhead of demultiplexing at application layer
- ICN solves this problem by associating to each request/response a different name prefix: the client always knows what request originated a certain response, so it can easily send multiple requests in parallel.

Scalability PoC: Multicast and Server Load

- This experiment shows relevant benefits in using HTTP with an ICN transport, in particular for scalability at Server Side
- We consider the case of DASH **linear video distribution**:
  - Cluster of 150 clients connected to an ICN enabled Apache Traffic Server (ATS)
    - Reverse Proxy, 2 GB cache, nginx origin server serving 48 channels
  - Each client requests one of the 48 available channels (*zipf* distribution, $\alpha=1.4$)
  - An HTTP Request can be directly served by the transport (rather than by ATS), if the corresponding Response has been already published in the Producer socket output buffer
- The video distribution <u>scales with the number of active channels</u> instead of the number of active users as using a TCP/IP network.
  - Server load (Memory/CPU) considerably reduced with ICN transport


10.60.17.60
vicn
Network view
50 clients
50 clients
50 clients
IP
IP + ATS
root@vpp5: ~ (ssh)
top - 03:54:55 up 2 days, 13 min, 0 users, load average: 2.00, 2.04, 2.13
Tasks: 1 total, 0 running, 1 sleeping, 0 stopped, 0 zombie
%Cpu(s): 2.8 us, 0.1 sy, 0.0 ni, 97.1 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
KiB Mem : 26403497+total, 26325153+free, 638932 used, 144504 buff/cache
KiB Swap: 26832076+total, 26832076+free, 0 used. 26325153+avail Mem
PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
66353 root 20 0 1005940 48272 7792 S 1.7 0.0 0:01.70 [TS_MAIN]
root@vpp5: ~
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
0.00 0.00
10.60.17.60
vicn
Network view
50 clients
50 clients
50 clients
IP
hICN + ATS
root@vpp5: ~
top - 03:24:43 up 1 day, 23:43, 0 users, load average: 2.06, 2.16, 2.27
Tasks: 1 total, 0 running, 1 sleeping, 0 stopped, 0 zombie
%Cpu(s): 3.0 us, 0.3 sy, 0.0 ni, 96.7 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
KiB Mem : 26403497+total, 26329811+free, 592364 used, 144504 buff/cache
KiB Swap: 26832076+total, 26832076+free, 0 used. 26329811+avail Mem
PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
65946 root 20 0 1071532 48228 7748 S 2.0 0.0 0:04.10 [TS_MAIN]
root@vpp5: ~ (ssh)
0.00 0.00
0.00 0.00
0.67 0.00
1.34 0.00
1.34 0.00
0.67 0.00
0.00 0.00
0.00 0.00
55.03 0.00
45.63 0.00
0.00 0.00

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