Hybrid Information-Centric Networking

ICN inside the Internet Protocol

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ICNRG Interim Meeting, London, 18th of March 2018

Outline

- Motivation
- Naming data with IPv6
- The network architecture
- Application support

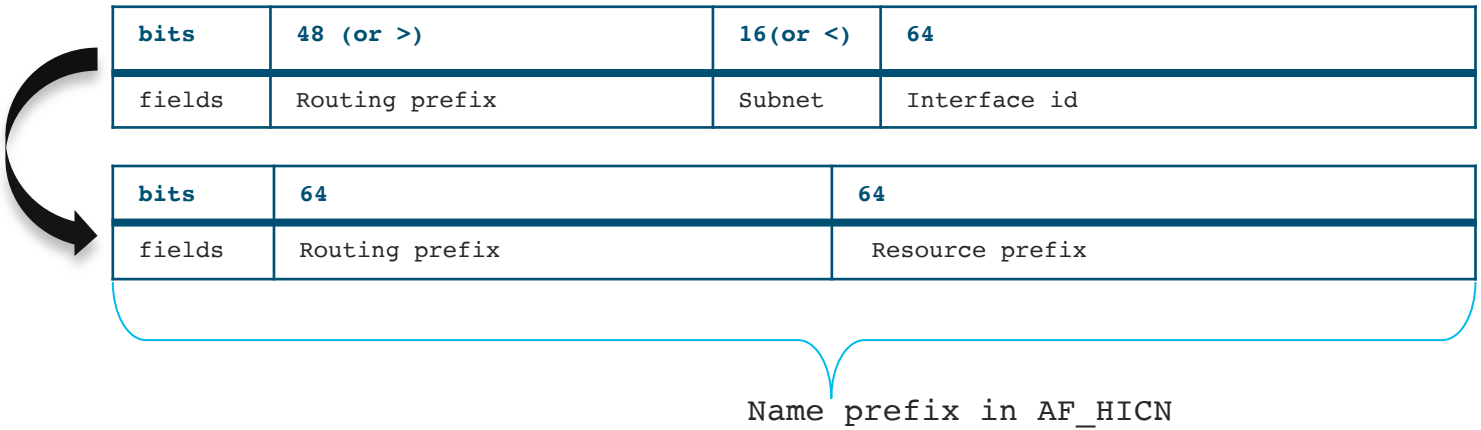
Motivation

- Insert ICN into the Internet Protocol
- Evolutionary implementation
- Shorter time to deployment
- Minimize standardization effort
- Minimize clean-slate work in routers and end-hosts
- Possibility to fall back to IP at run time
- Enable hybrid deployment and interconnection of IP and hICN
- hICN as an overset of IP

Name prefixes in IPv6 numbers

Naming data with the Internet Protocol

- Definitions:
  - **Name prefix**: encoded as an IPv6 128 bits word and carried in IPv6 header fields
  - **Name suffix**: encoded in transport headers fields such as TCP
  - **Name**: hierarchical concatenation of name prefix and suffix



IPv6 prefixes for data names

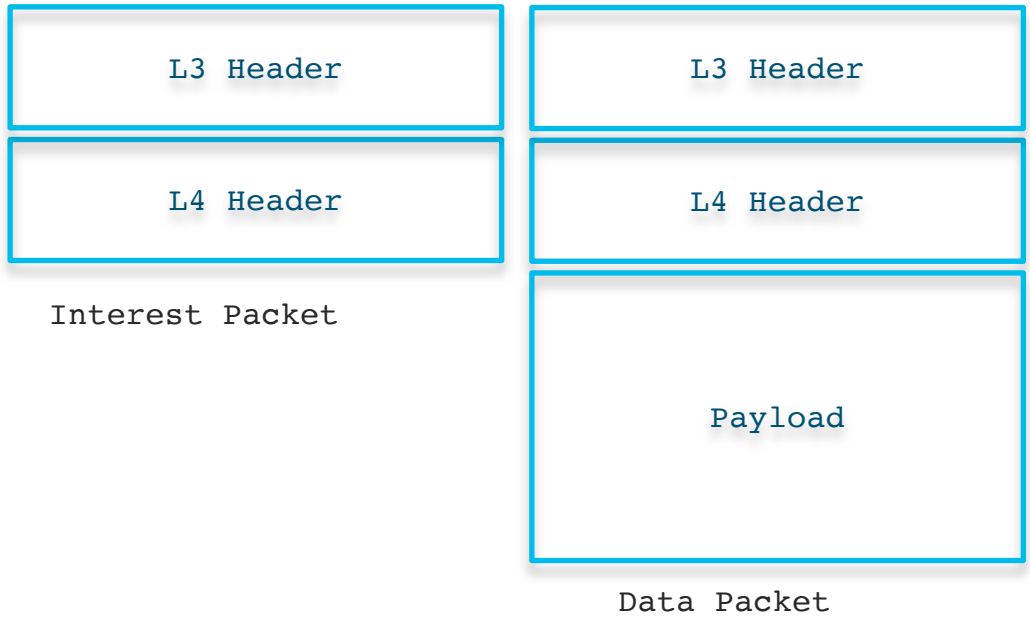
- It is an open problem to determine which IPv6 prefixes should be used as name prefixes: several options are possible.
- It is desirable to be able to recognize that an IPv6 prefix is a name prefix, e.g. with an address family
- However this can be determined and distributed by a control plane to configure routers

1. a new IPv6 address family AF_HICN, b0001::/16
2. Let the management and control plane to locally configure HICN prefixes and announce them to neighbors for interconnection. A prefix owner can reuse existing prefixes
3. Other solutions...

Packet format

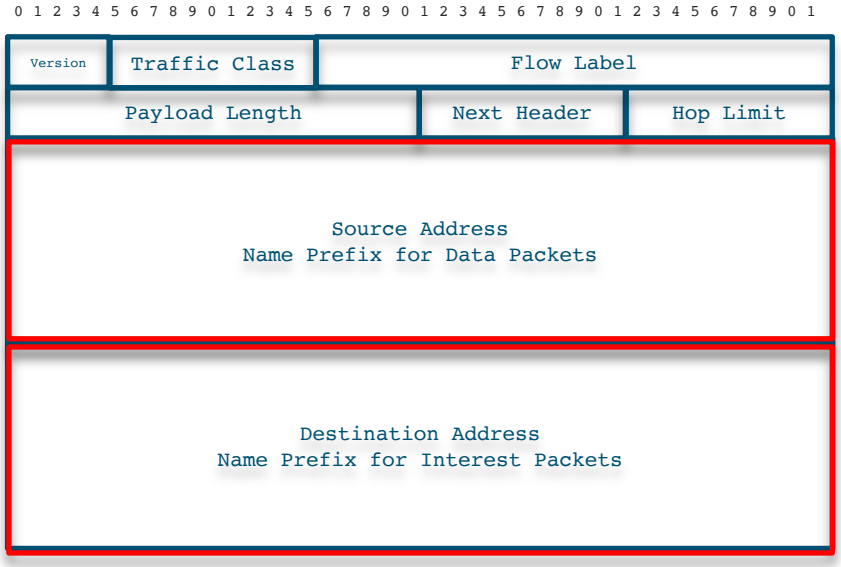
Packet format: two protocol data units

- The protocol semantic is request/reply
- Two protocol data units: Interest/Data
- Interest is used to query Data with a 1:1 match
- The semantics are unchanged w.r.t. NDN/CCN



Packet format L3

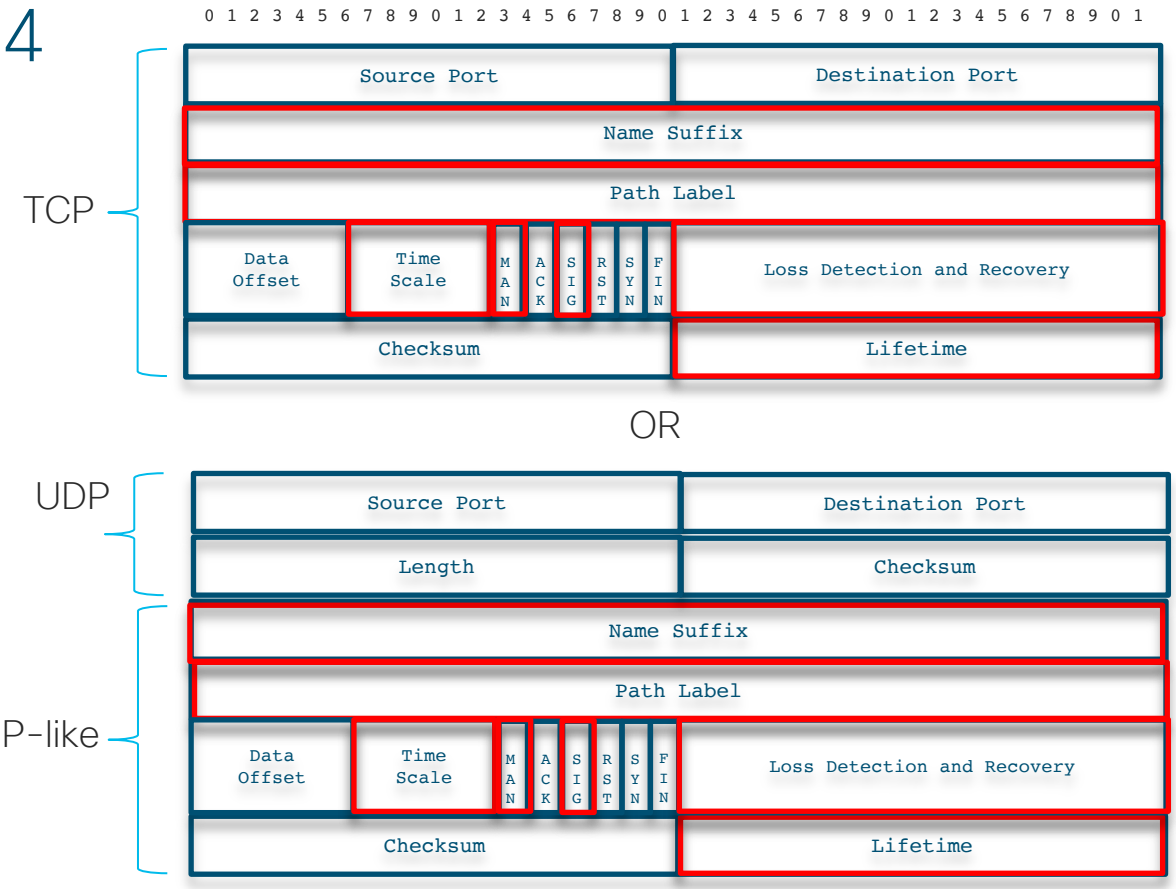
- The name prefix is stored in the **DST** address field to exploit IP routing/forwarding of the **requests**
- The name prefix is stored in the **SRC** address field as **replies** are not routed by name
- SRC and DST in Interest/Data are valid IPv6 addresses (locators), i.e. identifiers of network interfaces



Packet format L4

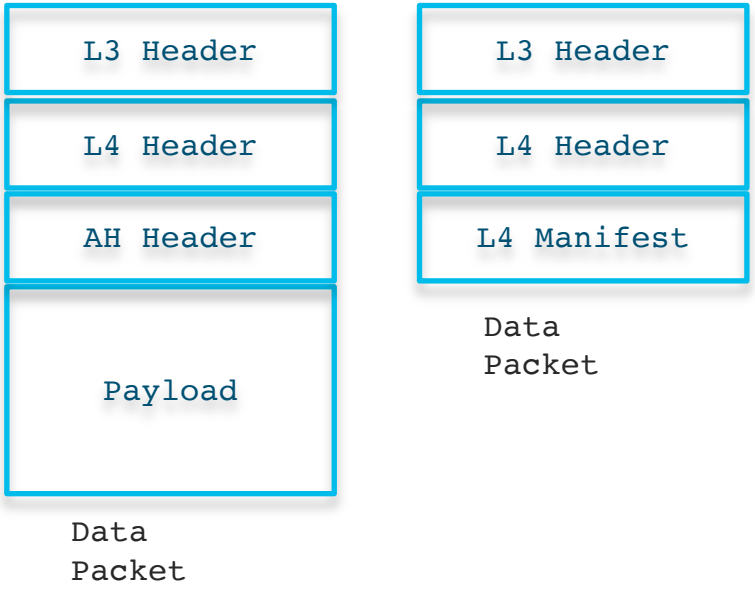
- Use the TCP header
- Could also use other L4 headers
- Keep src/dst ports
- E.g. for HTTP

- But also UDP header to carry a hICN L4 header
- E.g. for RTP



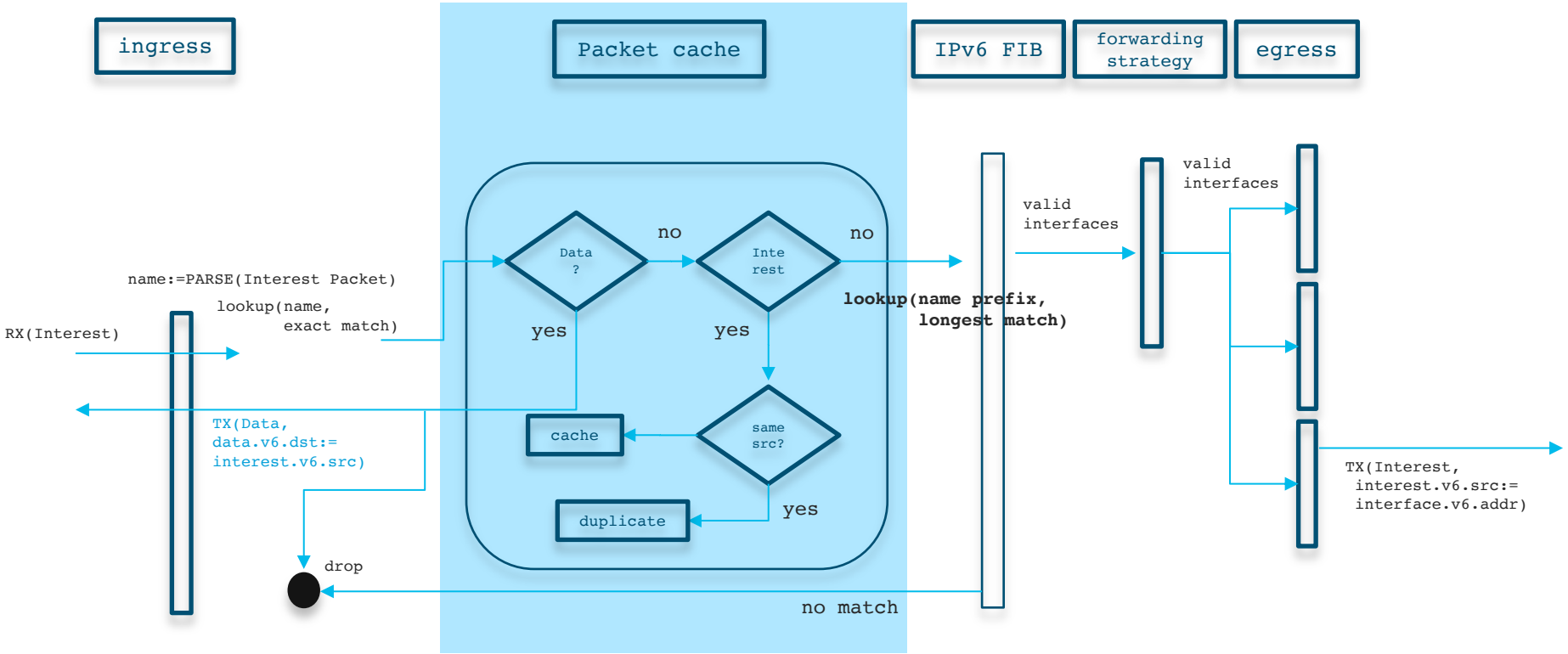
Security: authentication and integrity

- Authenticity and Integrity provided by using crypto signatures
- Two signature envelops: a single data packet or the transport manifest
- In the first case the signature is carried by the IP authentication header
- In the second case the transport manifest is the only signed unit
- Definition of L4 Manifest
  - A low level index of names of a collection of data packets
  - Carries hashes of data for integrity
  - Carries the signature of the manifest for authentication

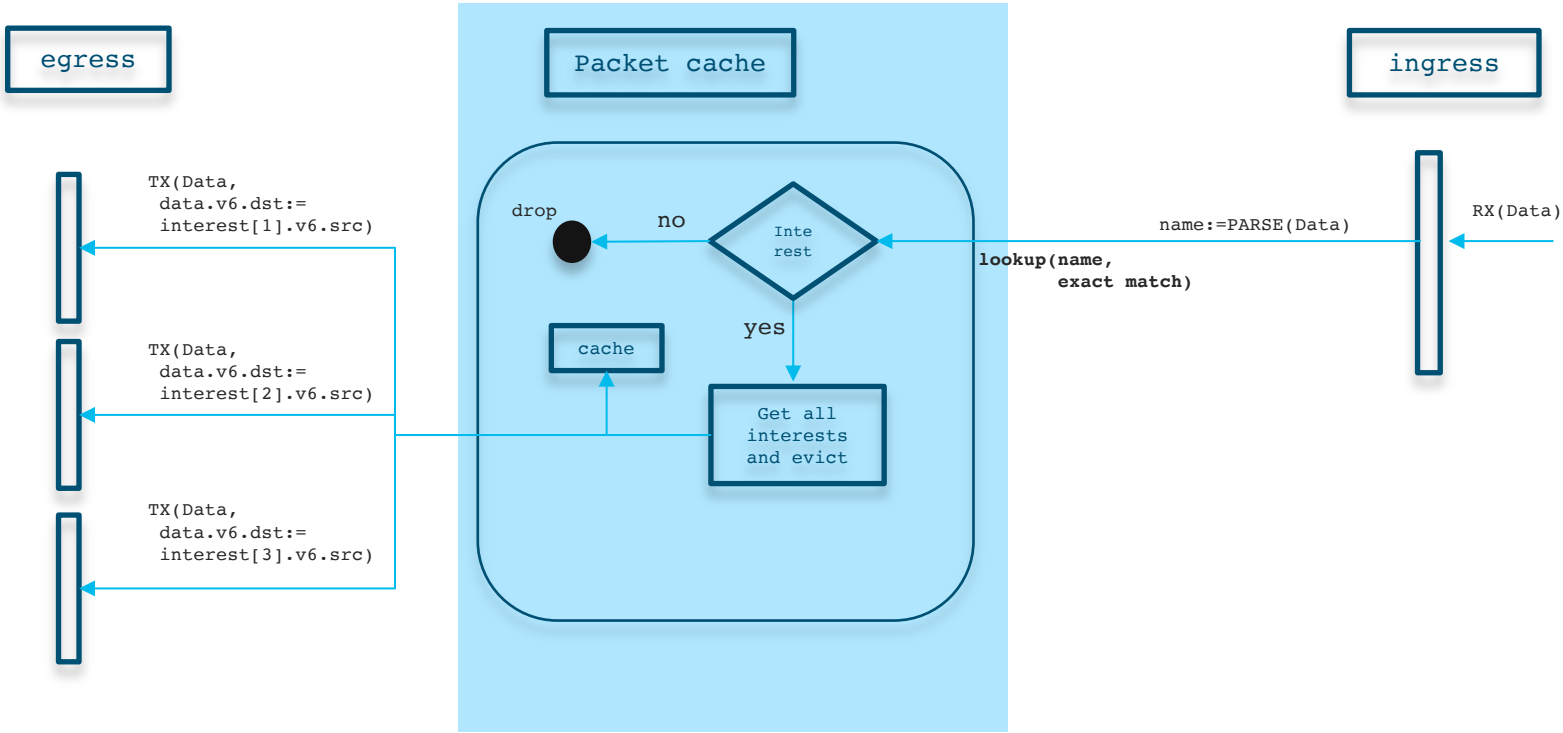


Forwarding path

hICN protocol semantics: the interest path



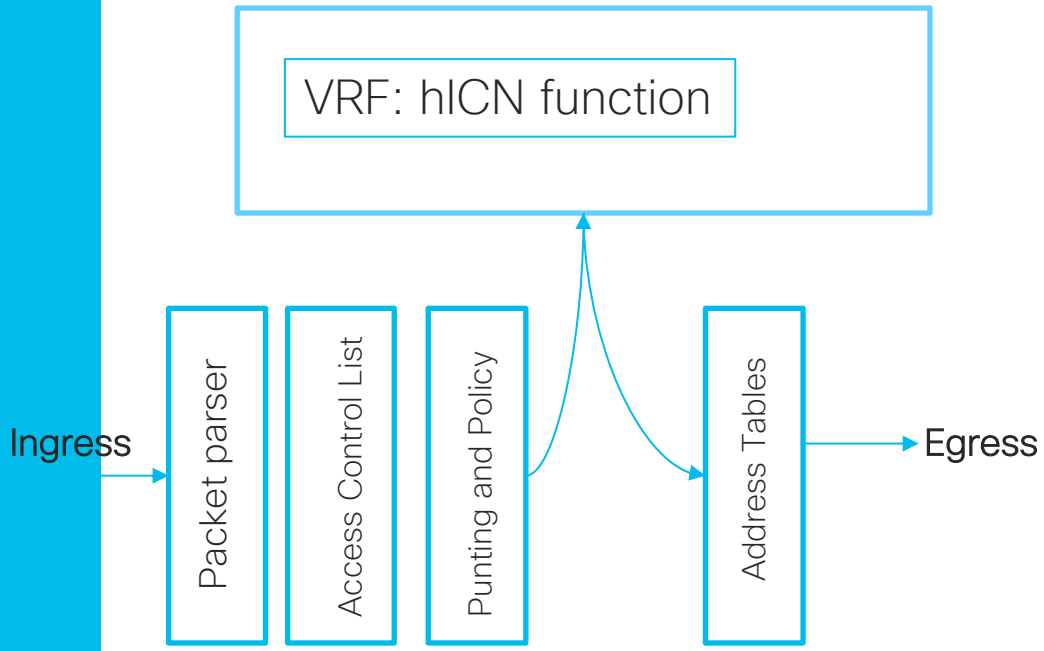
hICN protocol semantics: the data path



Punting

- hICN traffic requires a punting rule
- Has to be efficient and easy to manage
- AF_HICN putting using ACL
- Explicitly flag hICN traffic, how?

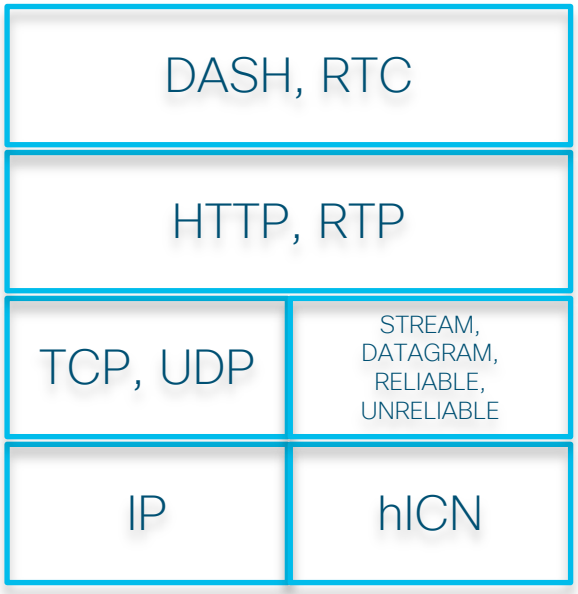
  Port numbers?



Application Support

Transport Layer and Socket API

- An INET like Socket API
- Unidirectional sockets: producer and consumers
- Socket identifiers based on name prefixes
- Segmentation and signature computation at the producer
- Reassembly and signature verification at the consumer
- DATAGRAM or STREAM transport
- Reliable or unreliable
- Support of current applications: HTTP, RTP



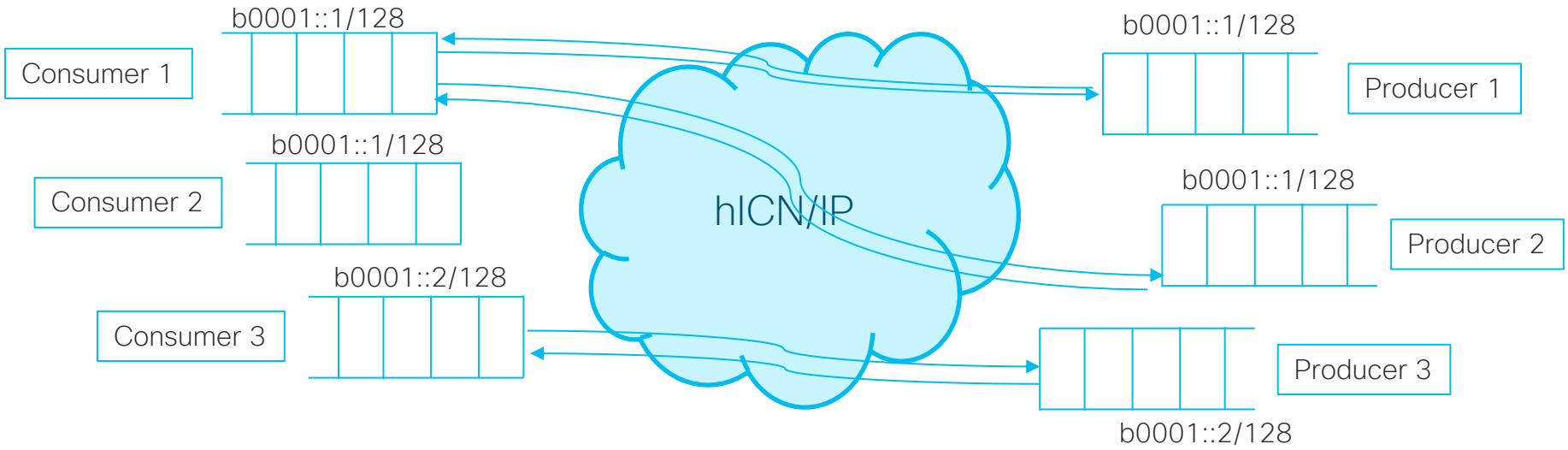
Consumer/Producer Socket

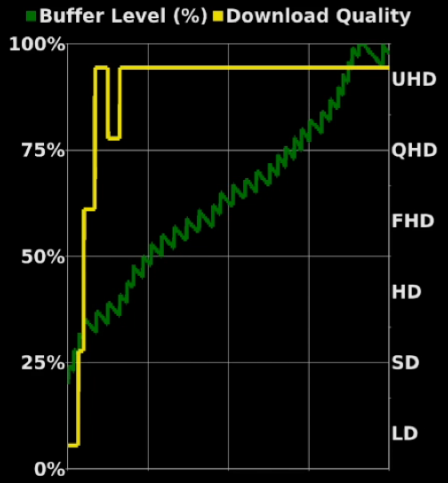
Consumer

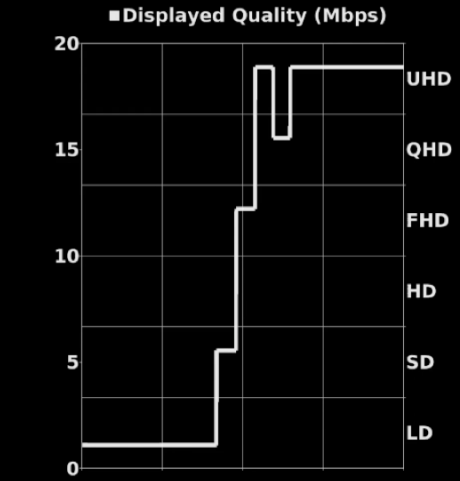
- Unidirectional socket to fetch data into a receive buffer
- The socket buffer binds to a name prefix

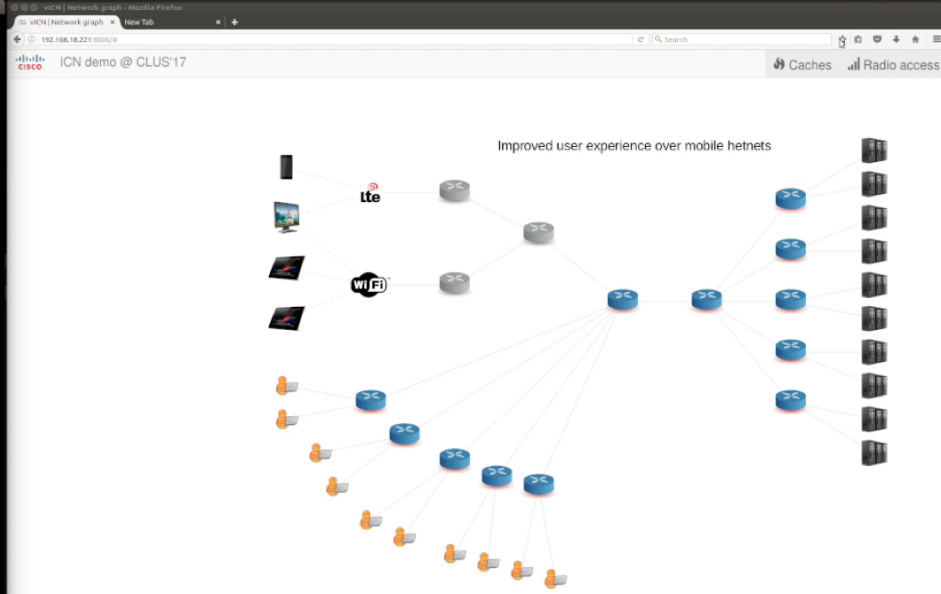
Producer

- Unidirectional socket to publish data into a send buffer
- The socket buffer binds to a name prefix




Buffer Level (%)
Download Quality
100%
75%
50%
25%
0%
UHD
QHD
FHD
HD
SD
LD


Displayed Quality (Mbps)
20
15
10
5
0
UHD
QHD
FHD
HD
SD
LD


ICN demo @ CLUS'17
Caches
Radio access
Improved user experience over mobile hetnets
lte
wifi


LTE cache upstream bandwidth
WiFi cache upstream bandwidth
Backhaul cache upstream bandwidth
Mbps

Conclusion

- It is possible to deploy ICN now using hICN
- Reduced time to market
- No tradeoffs in terms of ICN features
- Prototype available at Cisco with focus on HTTP and RTP


CISCO