CSC 525:
Computer Networks

Named Data Networking (NDN)

History

- 2006 Van Jacobson proposed CCN
- 2010 Lixia Zhang and Van Jacobson started the NDN project
  - A continuation of CCN architecture
  - Part of the NSF Future Internet Architecture (FIA) program.
  - Collaboration of 12 institutions
- 2014 NDN Next Phase (NDN-NP)

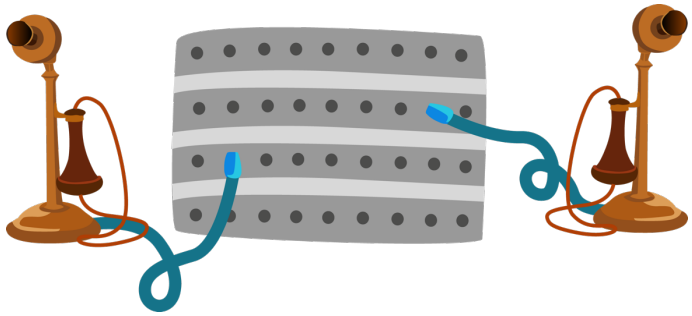
Growing Research Community

- The general Information-Centric Networking (ICN) paradigm
- US, Europe, Asia, etc.
- Both academia and industry, e.g., Cisco, Huawei, Samsung, Intel, Panasonic, etc.

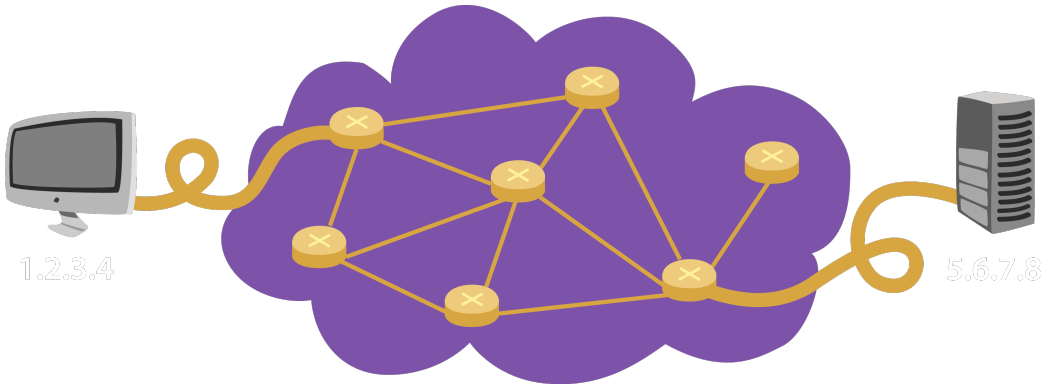
NDN as a network architecture

Evolution: Telephony → IP → NDN

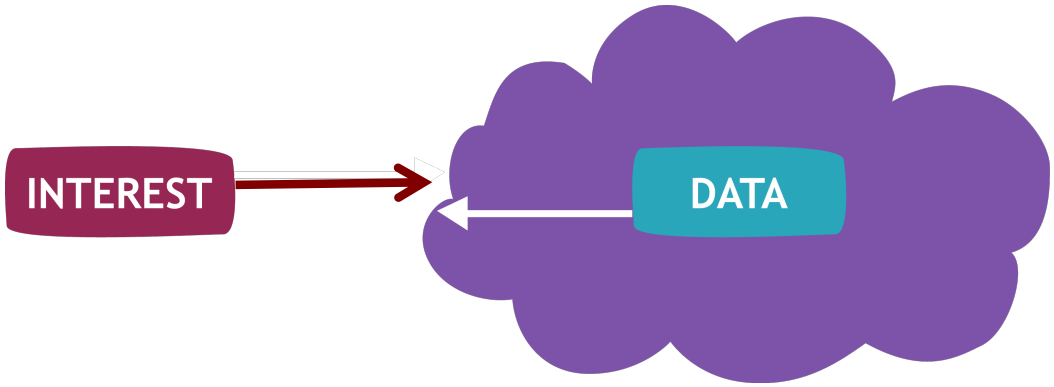
Evolution of Communication Abstraction



Telephony: name the path

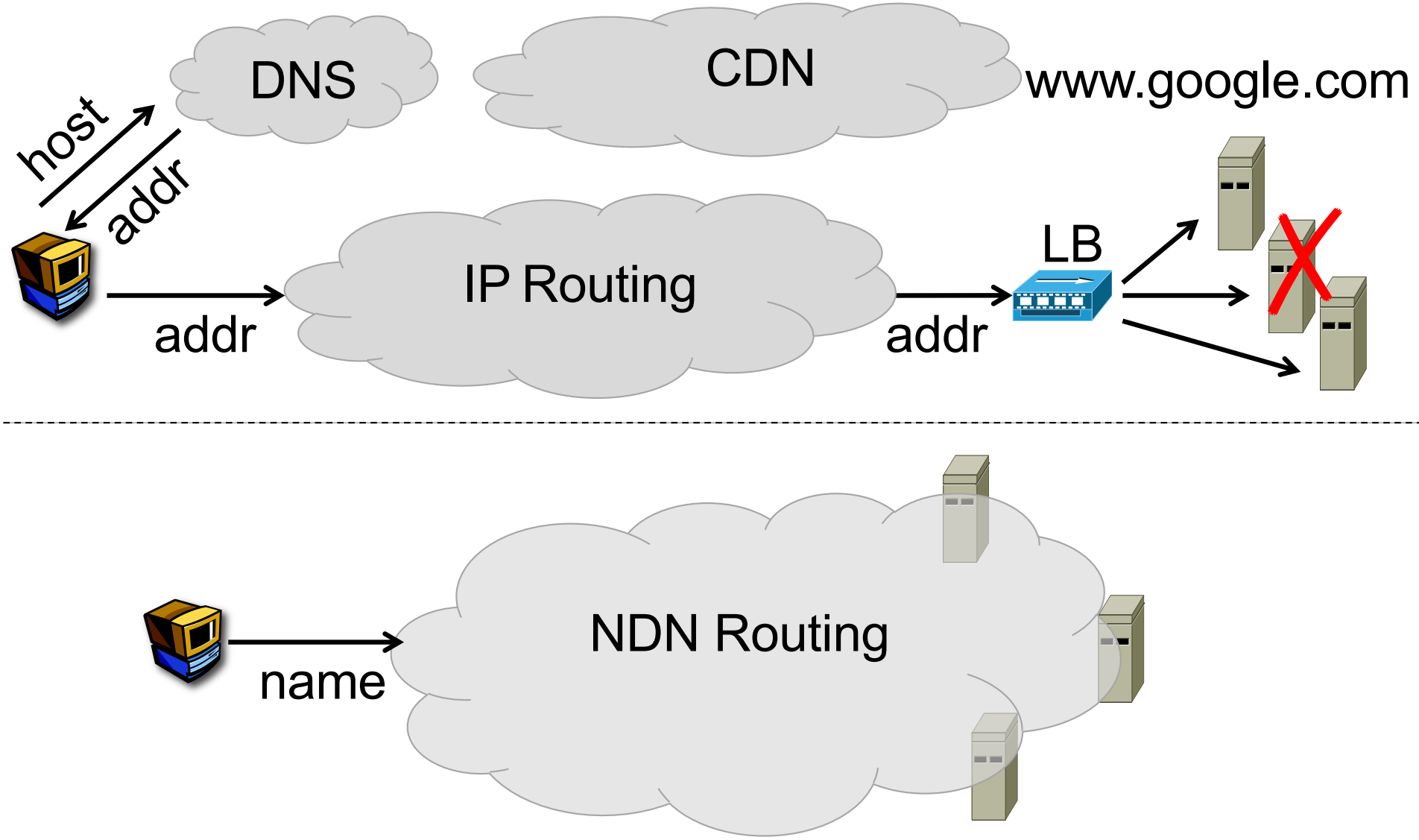


IP: name the endpoint

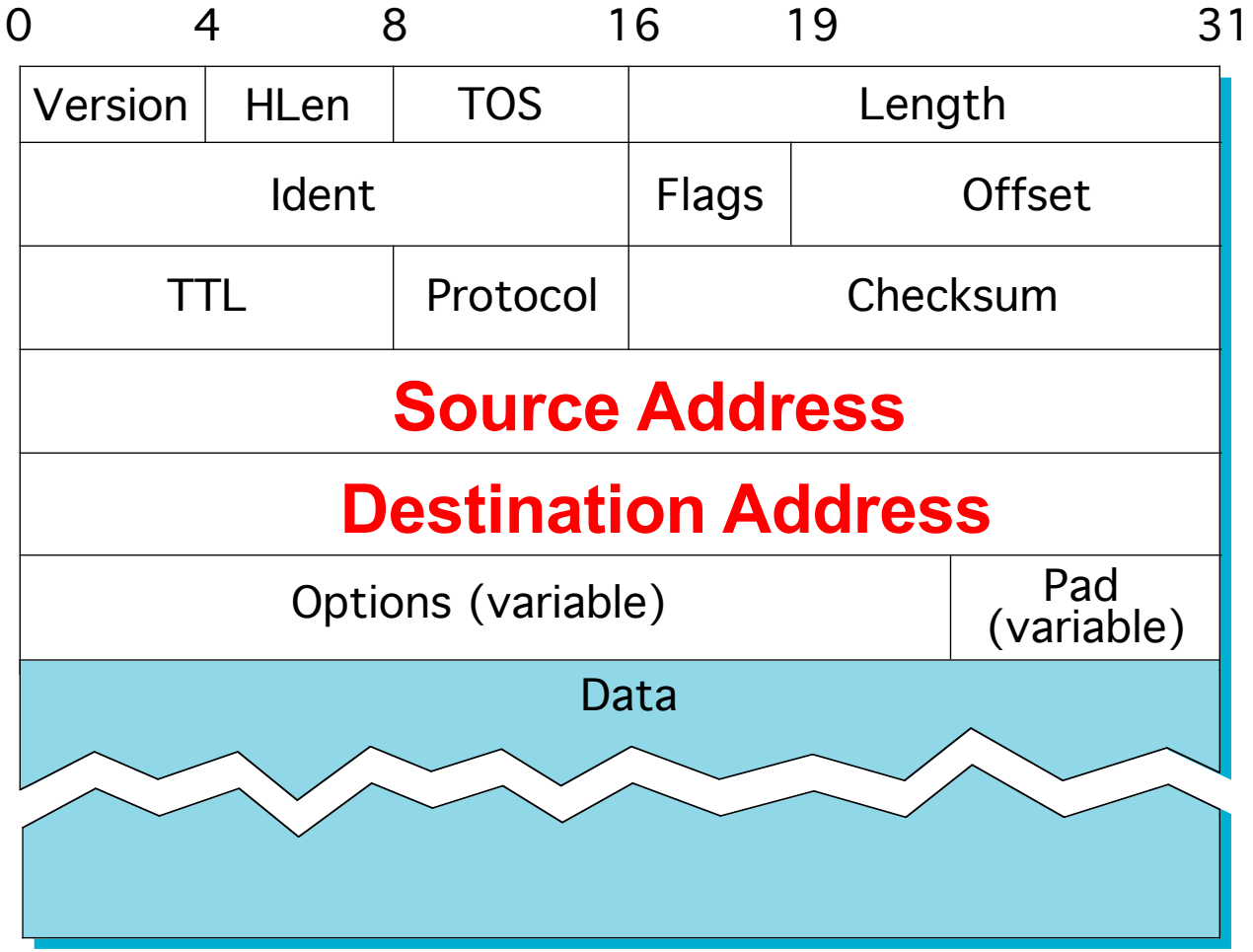


NDN: name the data

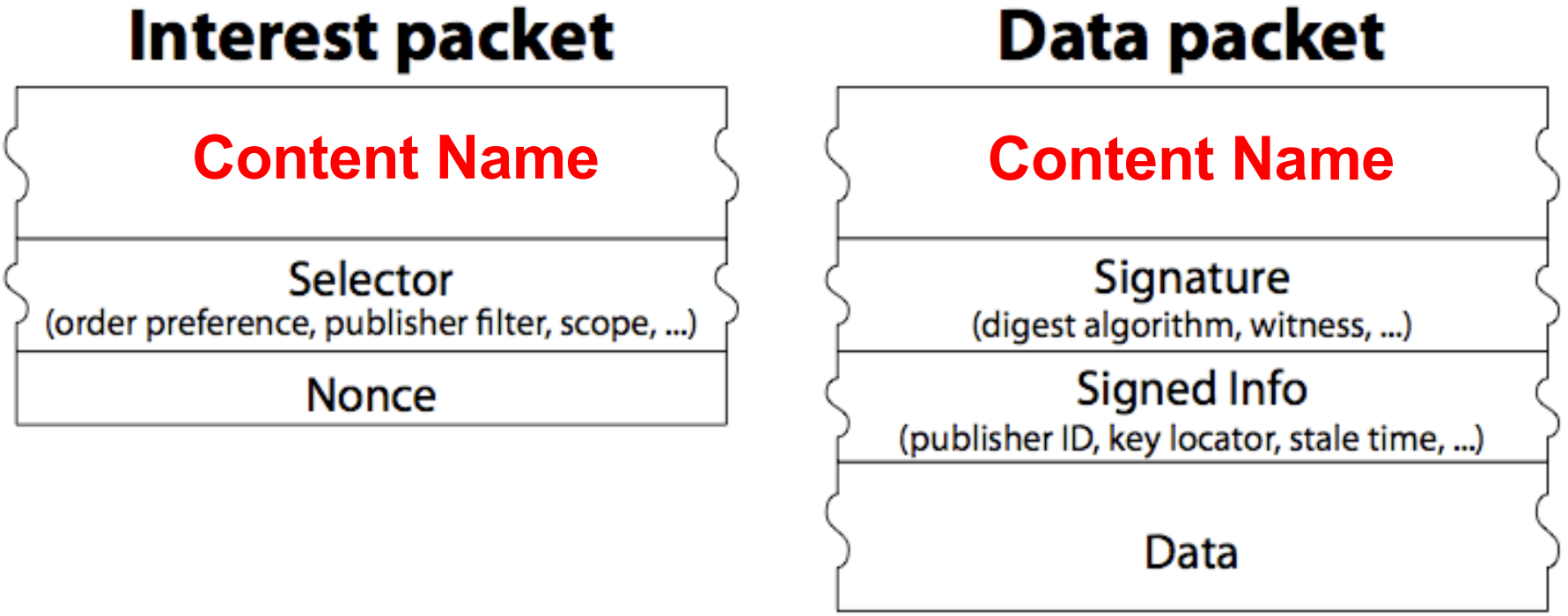
Example


DNS
CDN
www.google.com
host
addr
addr
IP Routing
addr
LB
name
NDN Routing

IP: Delivering packets to endpoints



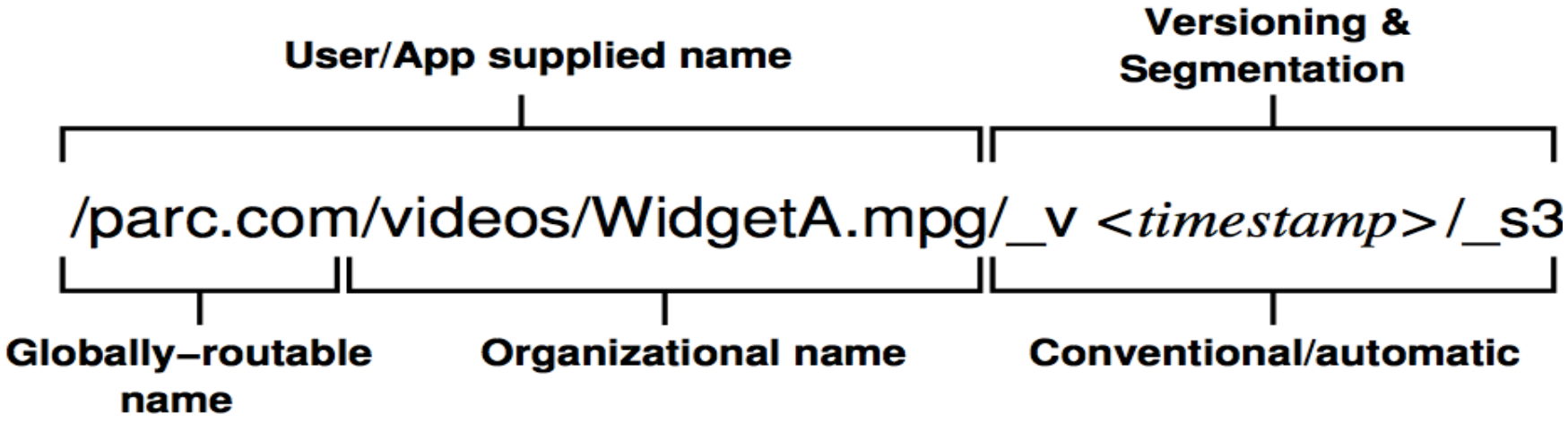
NDN: Retrieving Named Data



Content Model and Naming

Names are generated by apps, opaque to networks.

- Every packet has its unique name
- Hierarchical names to identify relationship between data and facilitate name aggregation.
- The signature binds the name, content, and key.



Basic Operations

PUBLISHER

- Announce name prefix(es)
- Name and sign data packets
- Answer interests

CONSUMER

- Express interest packets for data by name,
- Receive data, verify signature, decrypt if necessary.

ROUTER

- Route and forward Interest/Data based on names instead of addresses.

Address Independence

IP addresses were assumed to be abundant, unique, and fixed, but not any more.

- Address exhaustion
- NAT (public vs. private, v6 vs. v4)
- Mobility support
- Address management

Using application-generated names as network layer identifiers eliminates the above problems.

Location Independence

Content can be supplied by anyone from anywhere, as long as the names match, and the signature verifies.

- Fault tolerance
- Load balancing
- Mobility

Content Distribution Example

36.7M
Views

IP needs large infrastructure and complicated technical solutions.

Content Distribution Example

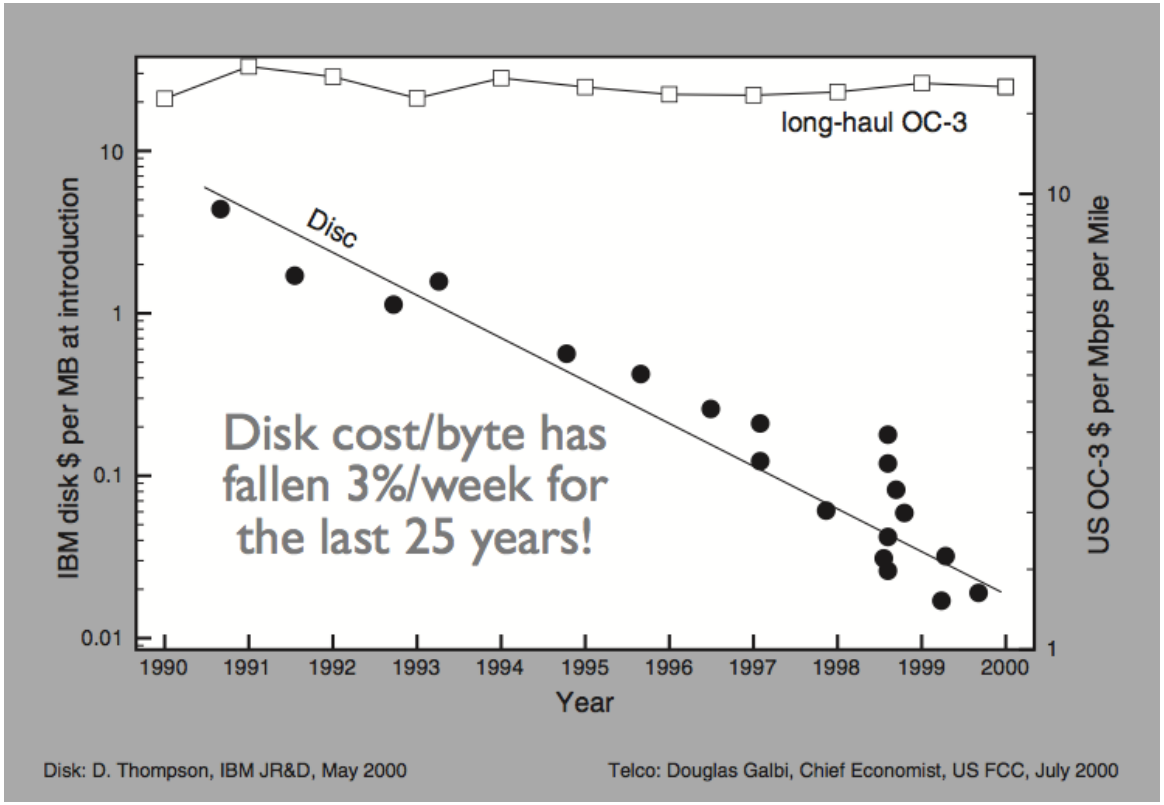
36.7M
Views

NDN's multicast and caching are native and built-in.

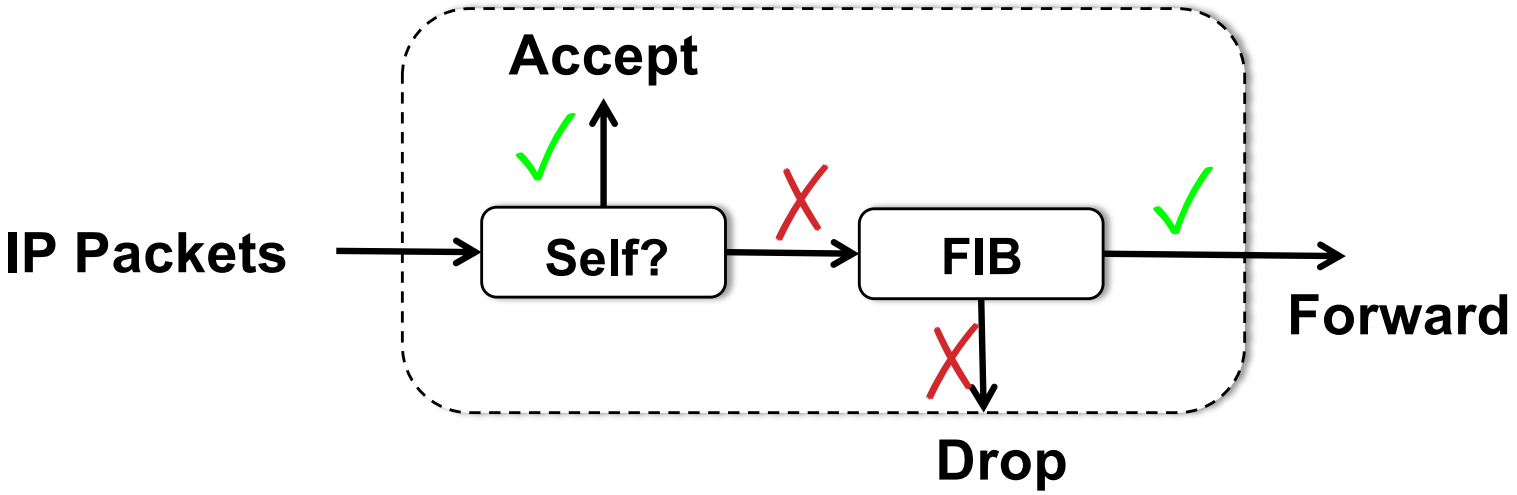
In-network Storage

Multicast, caching, loss recovery, mobility, …

The trend of cost favors storage over bandwidth



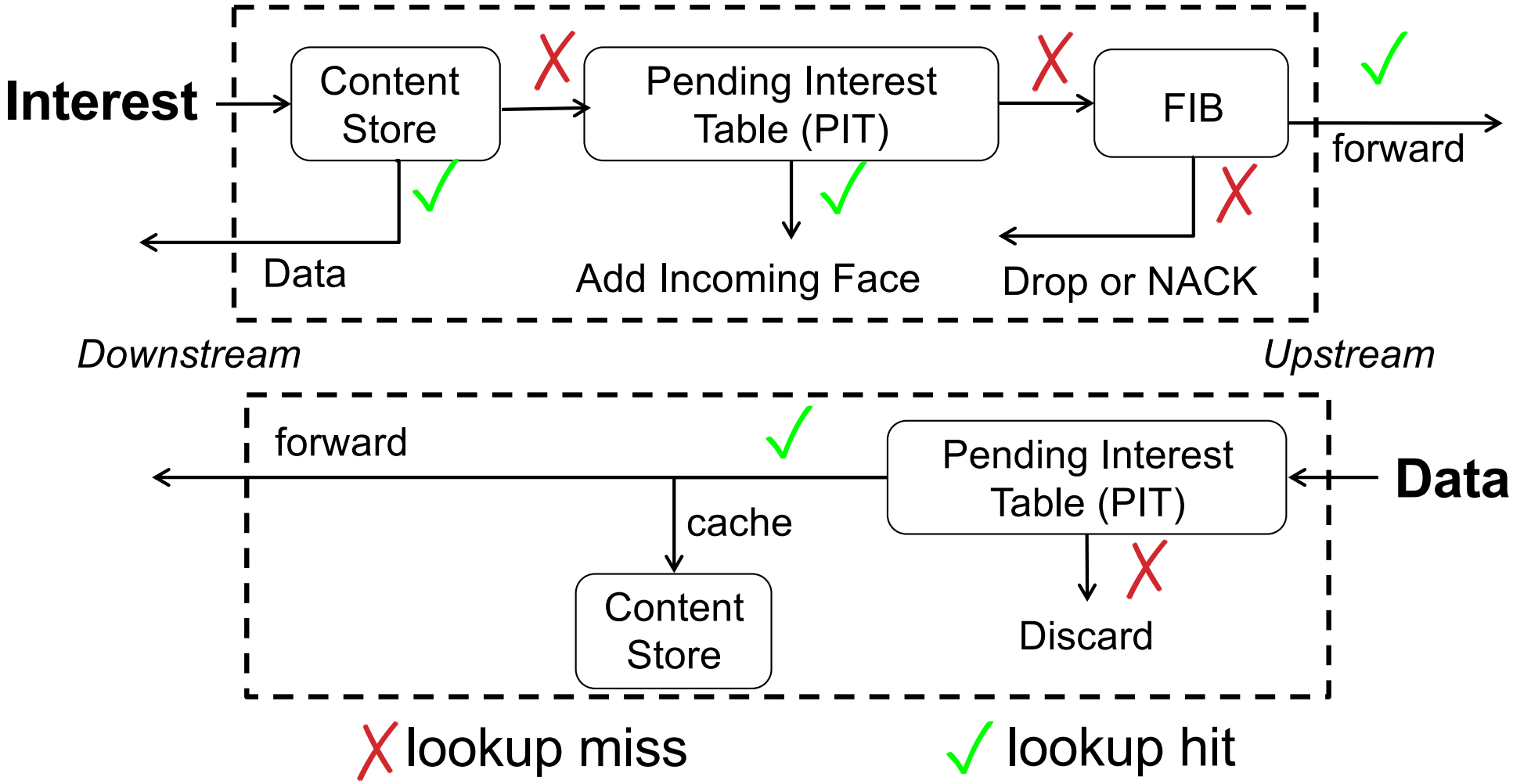
IP's Node Model



✗ lookup miss ✓ lookup hit

One-way traffic, stateless, no storage.

NDN's node model



Two-way traffic, stateful, explicit storage.

Data-centric Security

In NDN, Data always come with signature

- Integrity
- Provenance

Secure the content, not the container nor the channel.

Force app developers to think about security from the beginning.

Research Challenges

Application Development

- Naming, trust, …

Security and Privacy

- Data-centric, trust management, …

Routing

- Scalability, multipath, security, …

Forwarding strategy

- Resiliency, congestion control, …

Scalable forwarding engine

- wire-speed processing and forwarding

How to realize a new architecture

Application-driven development

- Running code, useful apps, testbed with real traffic
- Start with emerging environments or apps where no good IP solutions yet.

Incremental Deployment

- NDN runs on everything, and everything runs on NDN.
- Start as an overlay, same as how IP did it.

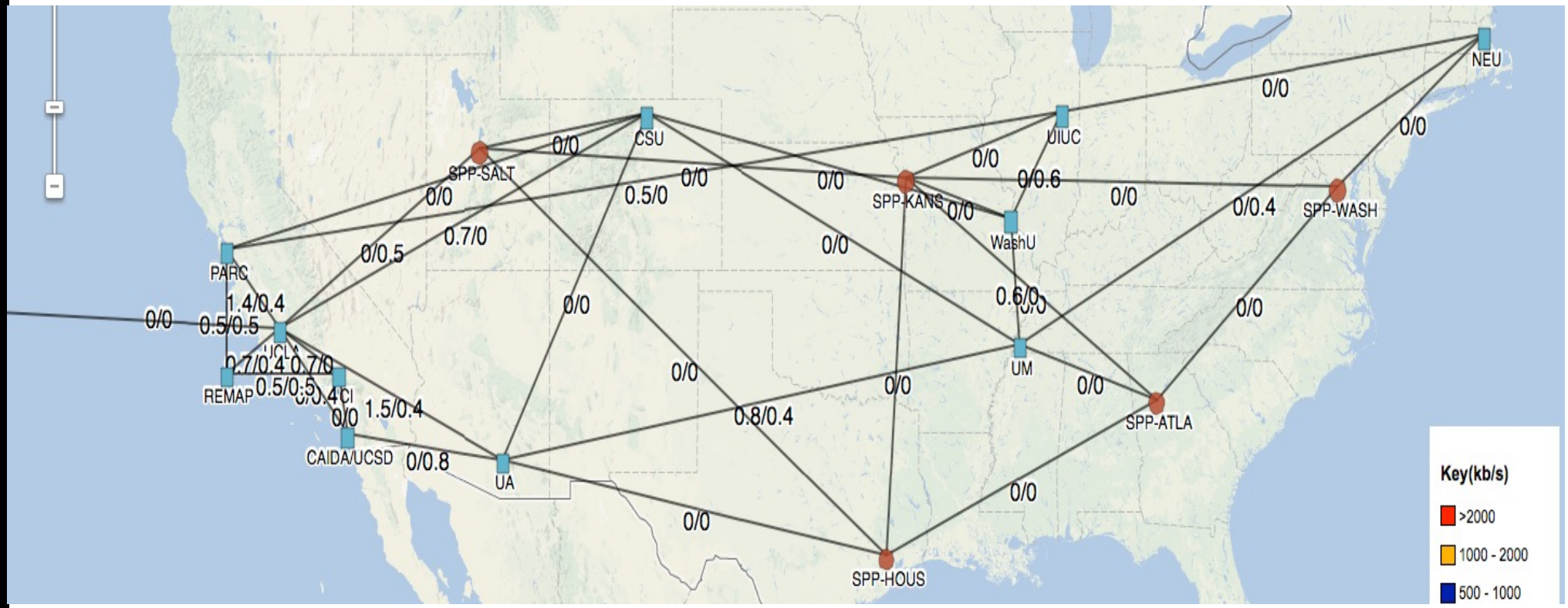
Running Code on NDN Testbed

Source code available at http://github.com/named-data

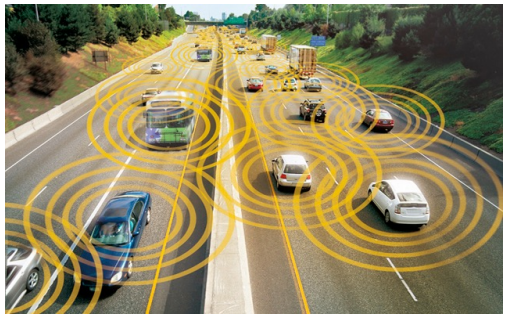
Deployable now as an overlay (TCP, UDP) or on Layer 2.

C, C++, Java, Python, Javascript libraries.

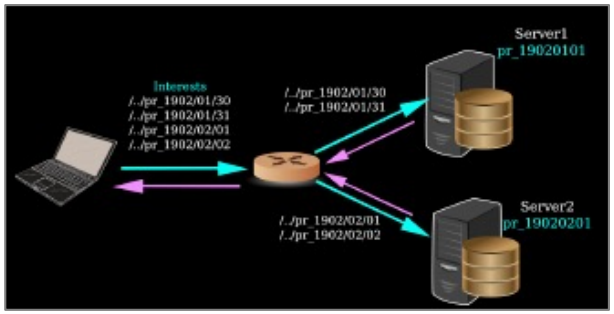
Testbed of 30+ nodes worldwide.



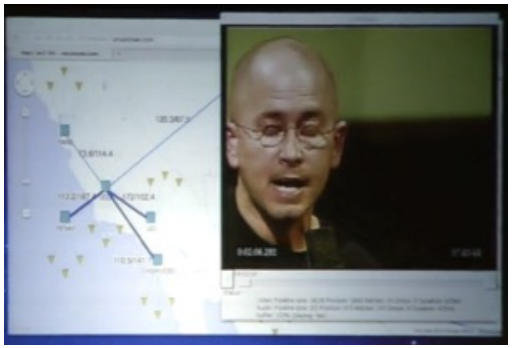
Some applications in progress



Vehicular Network



Conferencing

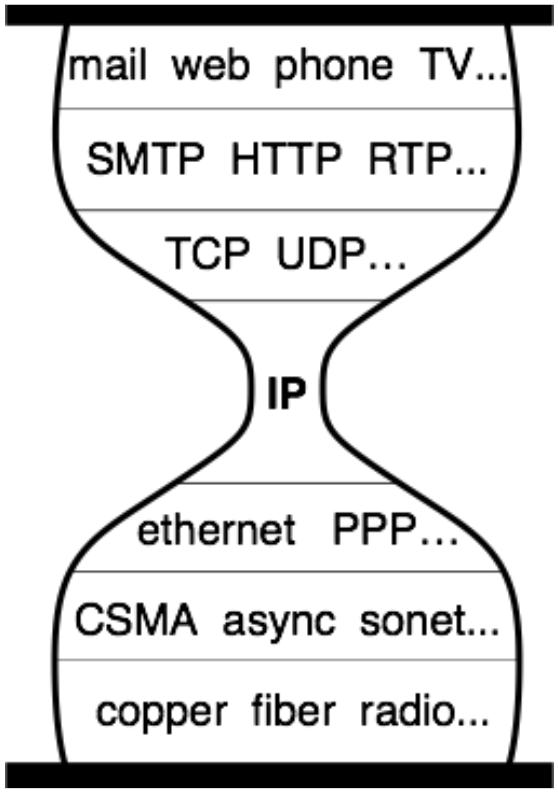


Video Streaming

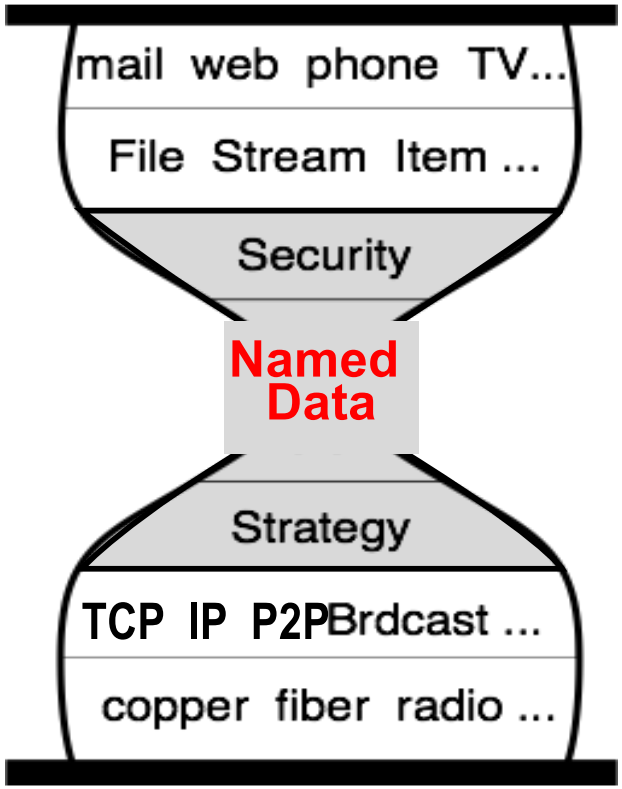
Building Control

Evolving into the Future

To destination addr



Get named data



http://www.named-data.net/