CSC7970 – NEXT-GENERATION NETWORKING

INFORMATION CENTRIC NETWORKING

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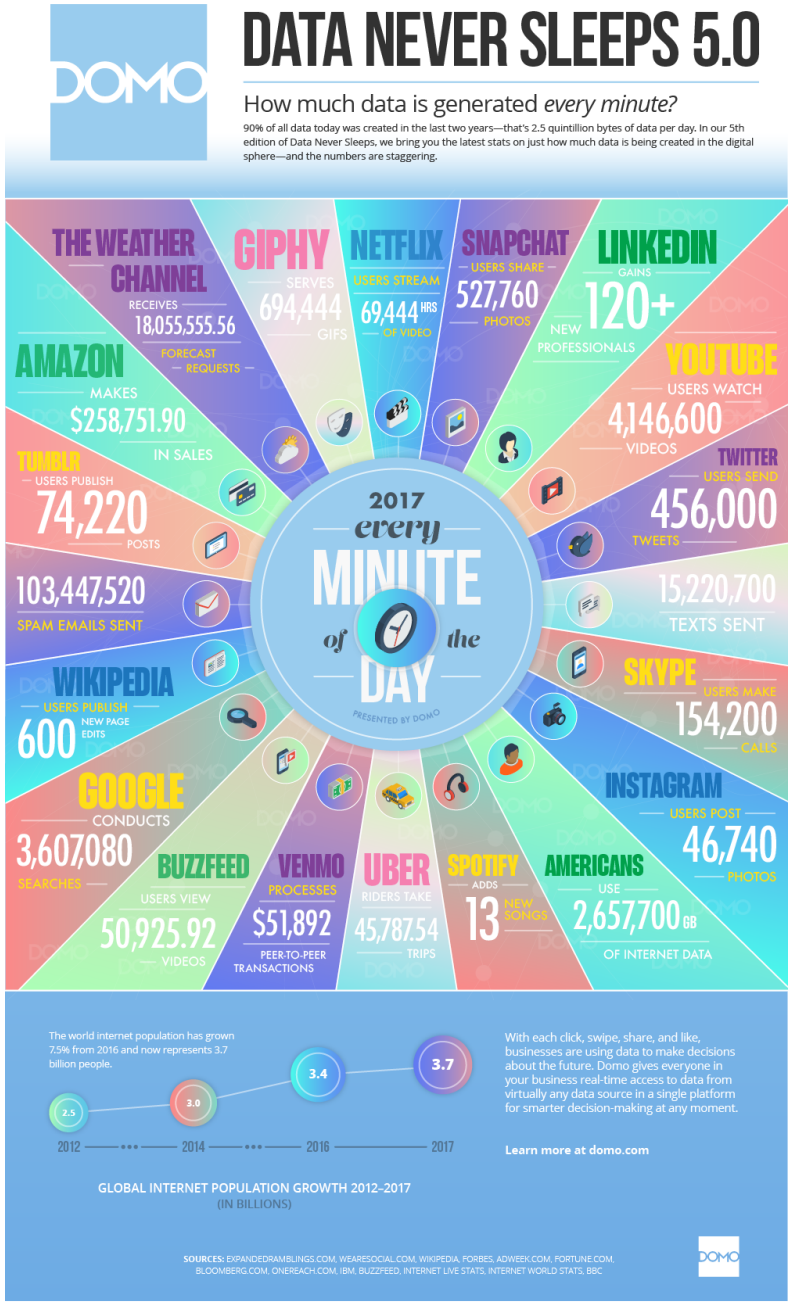
TCP/IP Design Rationale

- The Internet was designed for communication between a source and a destination
  - Networks were slow and computers super expensive
  - Sharing computing resources across long distances was desirable
  - Security was not even considered
  - First use-case: file transfer from/to a server

- Do these assumption hold today?

Today…

- Internet users are streaming data..
  - Many different streaming services (Amazon, Hulu, Netflix..)
- Internet users generate huge amounts of data
  - 2.5 quintillion (10^{18}) bytes per day
  - So many devices (IoT, mobile phones) generating data
- So many heterogeneous network environments
  - Vehicular, core Internet, building sensors, mobile, data center, etc…



Internet is a success because of applications

- Applications today are “data-centric”
  - They request the data they need
  - They do not care where the data comes from
  - All they need is to verify data authenticity

- “Data-centric” applications combined with a “host-centric” Internet and tech companies?
  - Internet consolidation! [1]

[1] https://tools.ietf.org/html/draft-arkko-iab-internet-consolidation-02

What is Internet Consolidation?

- Internet was meant to enable communication among humans
  - Tech companies want any sort of communication to pass through them
  - Why?

- Result: The Internet has become extremely centralized
  - Communication typically passes through a cloud server
  - If users cannot reach the cloud, they cannot communicate
  - Example: messaging app with participants next to each other

- From the IAB draft: ***"If the world changes, the Internet and its technology/architecture may have to match those changes"***

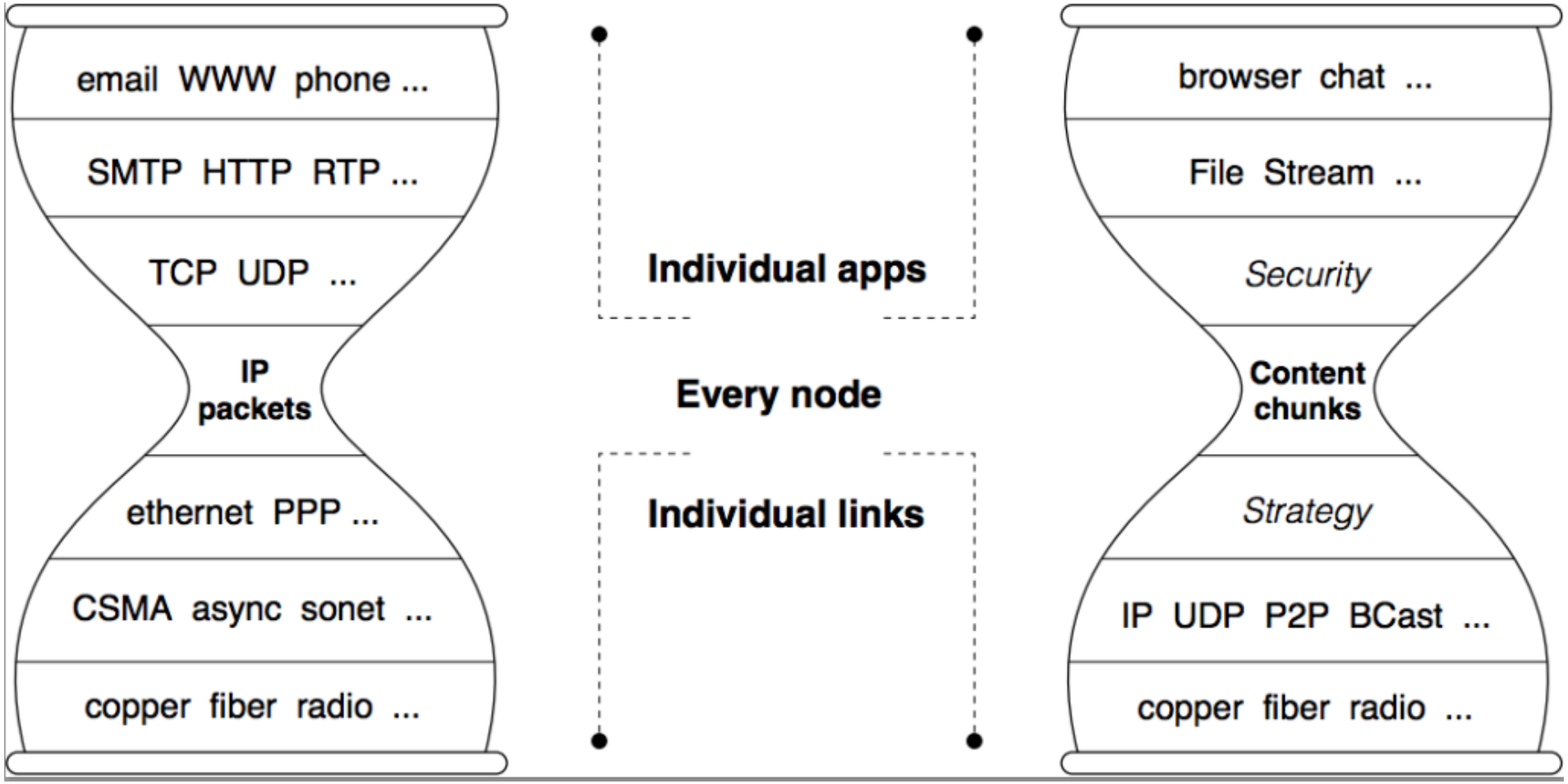
The world is changing..

- “Data-centric” applications
  - That’s the way applications are designed
  - They request data through names (URLs..)
- Heterogeneous network environments
  - Not only file transfers from/to a server!
  - Multicast support necessary
- Security by design
  - We do not know every Internet user anymore…
  - We trust the data we download if we trust the server that we communicate with (i.e., secure connection). What if the server gets hacked?

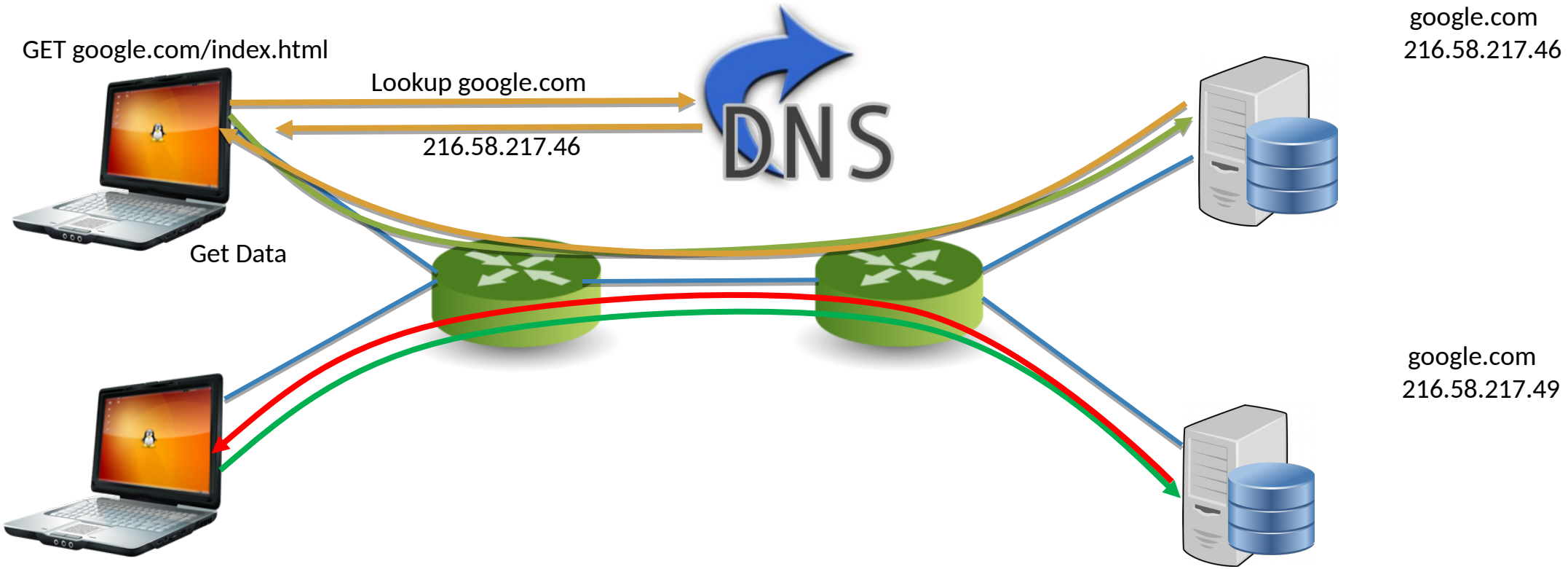
Information-Centric Networking (ICN)

- Shift from a host-centric to a data-centric communication model
  - Instead of using IP addresses, entities communicate based on ”named-information”
- Named Data Networking (NDN): The most prominent realization of ICN
  - Started as an NSF-funded Future Internet Architecture (FIA) project in 2010
  - http://named-data.net

Architectural Comparison with IP



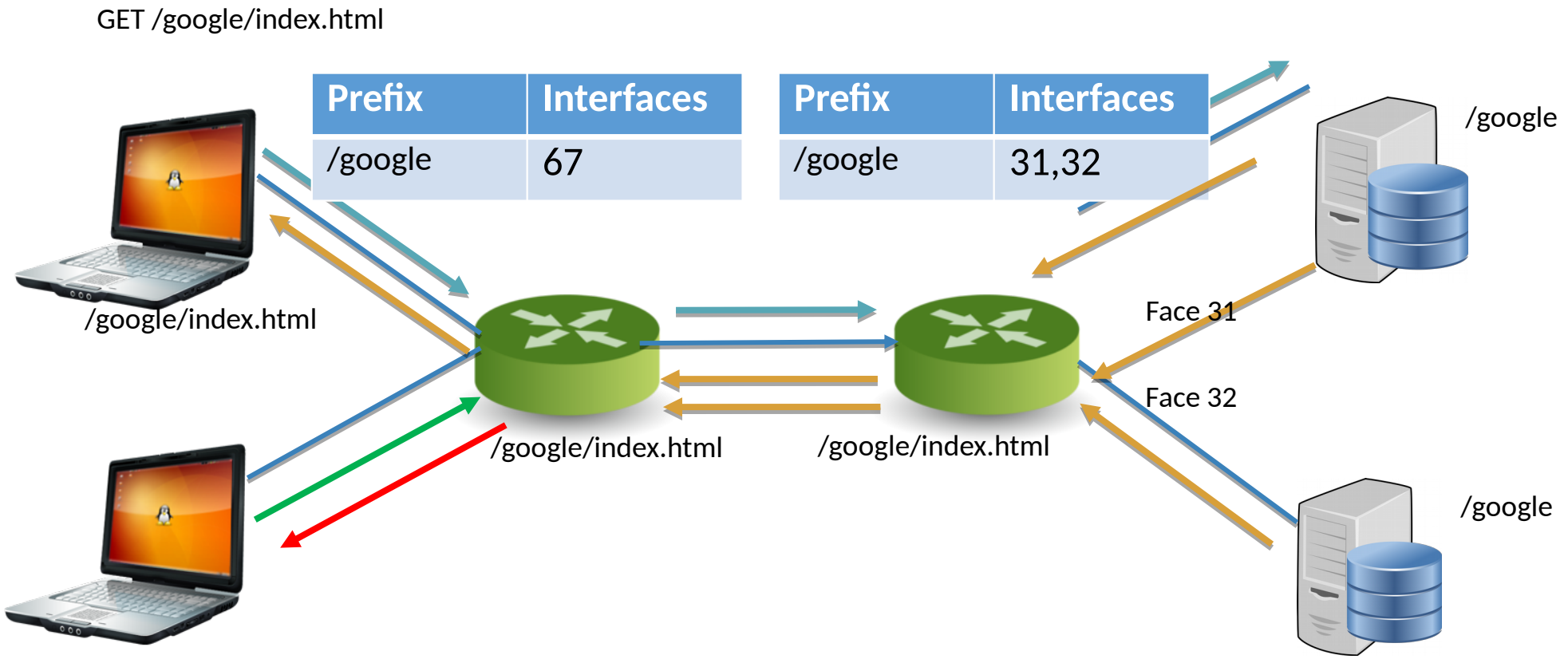
IP Based Communication



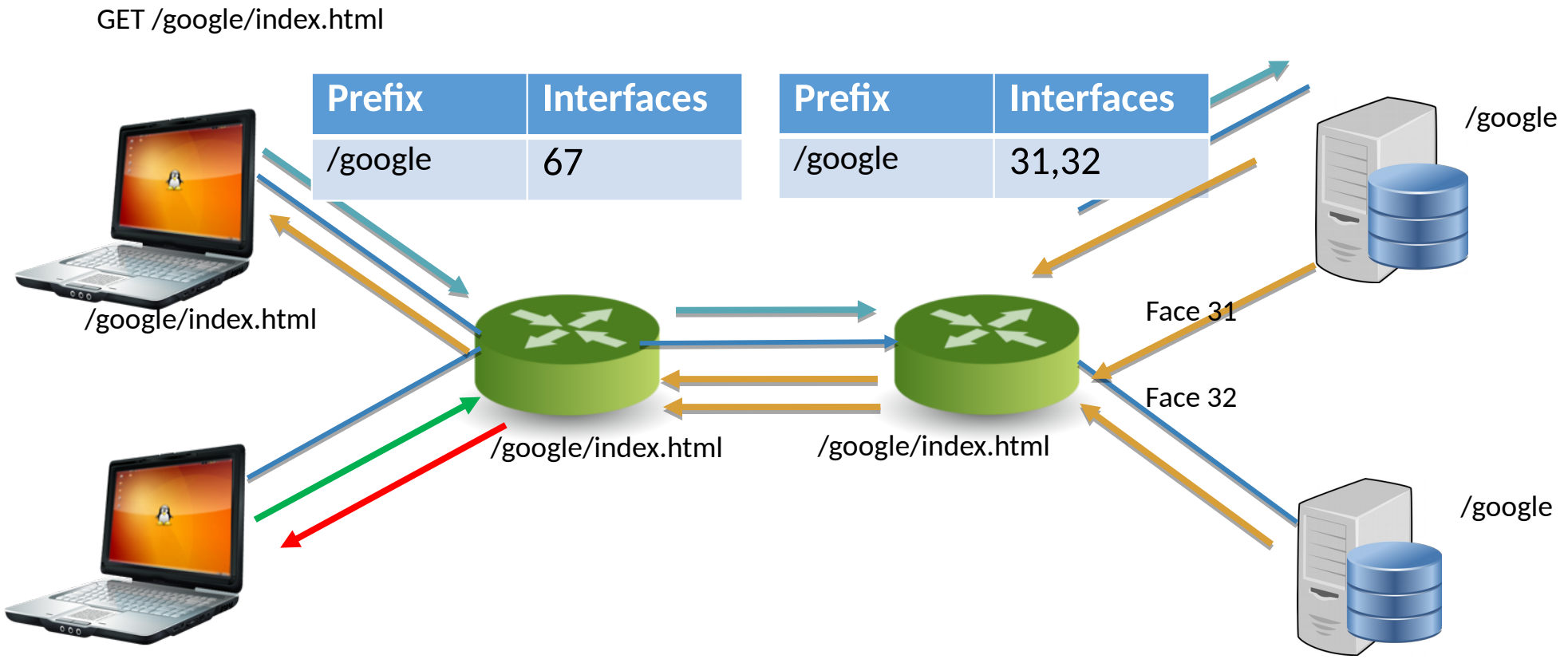
Named Data Networking

- A clean slate future Internet architecture
  - Emphasizes on what (named content), not where (hosts)

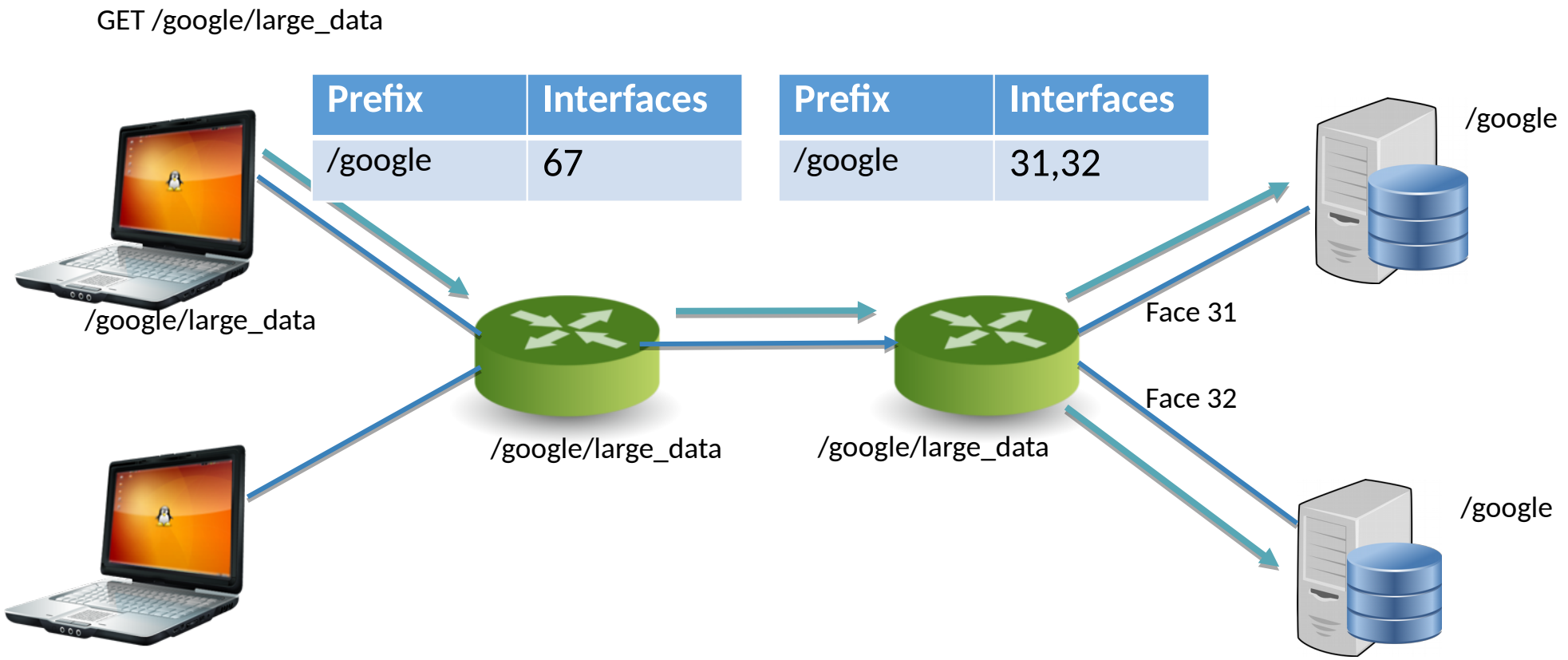
Name Based Communication in NDN



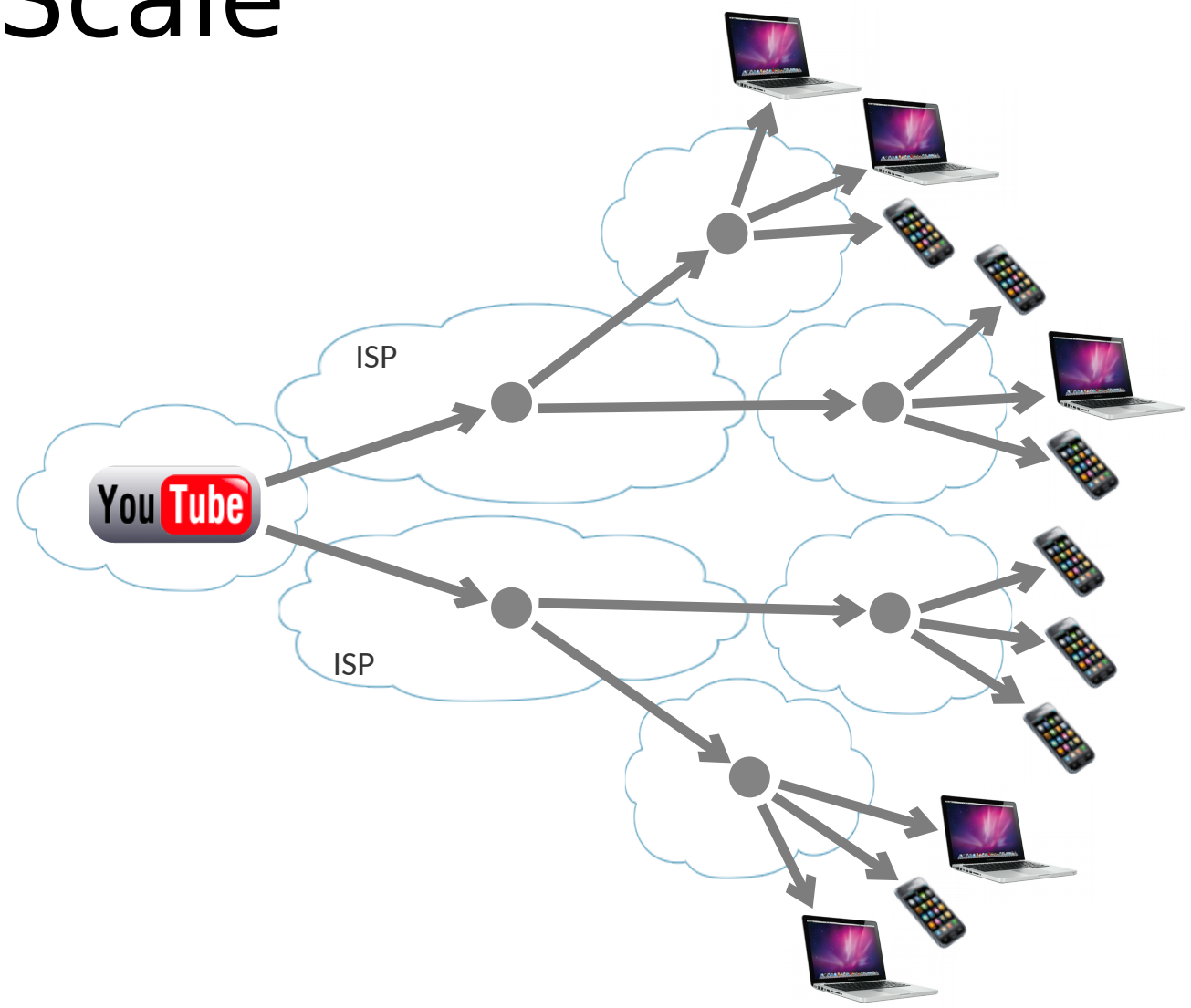
Interest aggregation and caching



Intelligent Forwarding Strategy

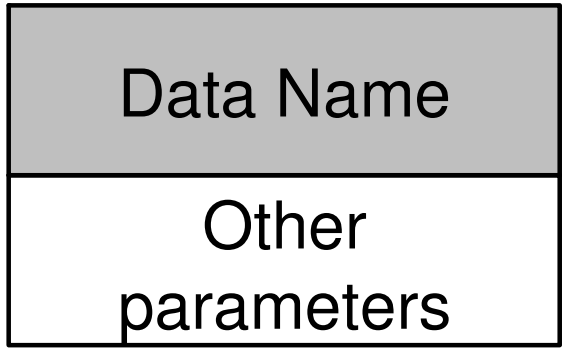


NDN at Scale

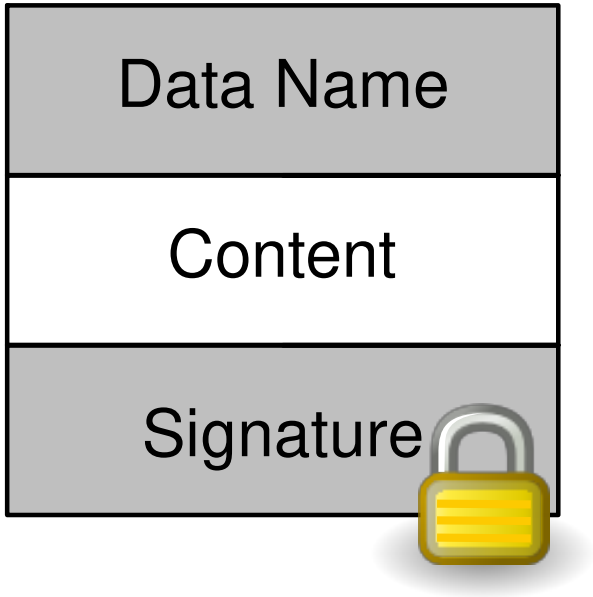


NDN Packet Format

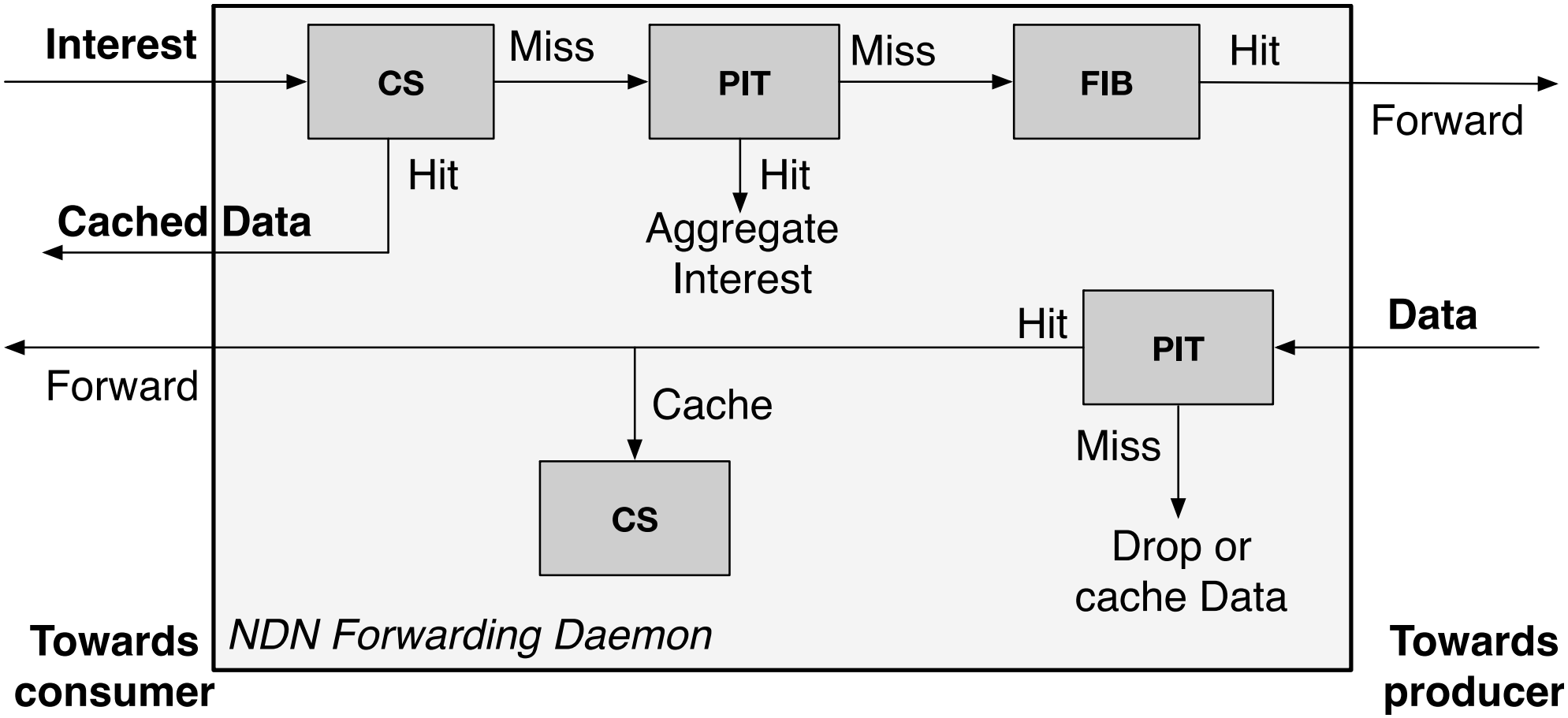
Interest Packet



Data Packet



NDN Forwarding Daemon Workflow



Why Stateful Forwarding?

- "End-to-end principle"
  - Only significantly beneficial functions must be implemented by lower layers of the architecture
  - IP is state-less
  - Why shifting so much? Can state be so beneficial?

- Scale multicast data delivery!
  - Load balancing, congestion control, data retrieval through multiple paths

- Heterogeneous and dynamic network environments
  - Adapt to network failures
  - Multi-homing and intermittent-connectivity

Security in NDN

- Every data packet has a publicly verifiable signature
  - binds content name to actual payload
  - data packets have key locators that points to the signing key
  - enables content from anywhere

- Signature verification is either done by applications or at the network
  - applications choose what to trust

Privacy Point of View

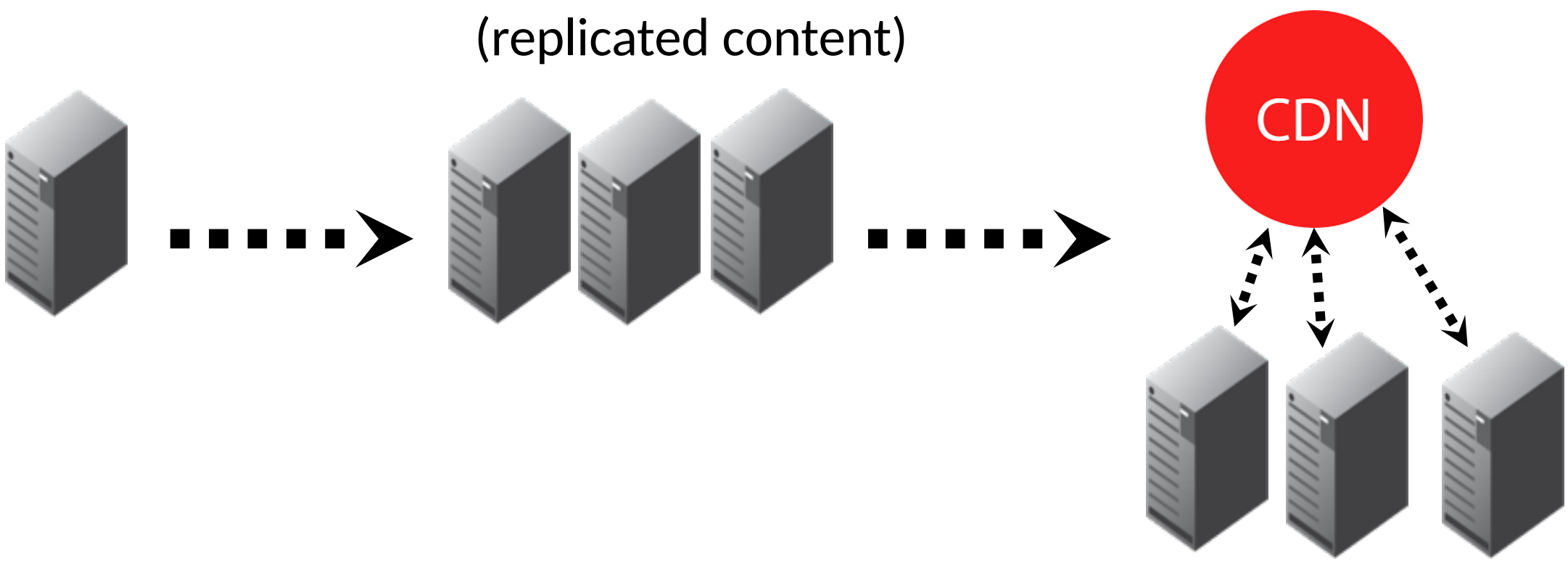
- Interests do not contain the consumer identification
  - What is the consumer identification in IP?
  - Enhances consumer privacy
- Name of requested data may be in plain-text
  - It may give away what we are looking for
- Privacy vs forwarding capability

The CDN model

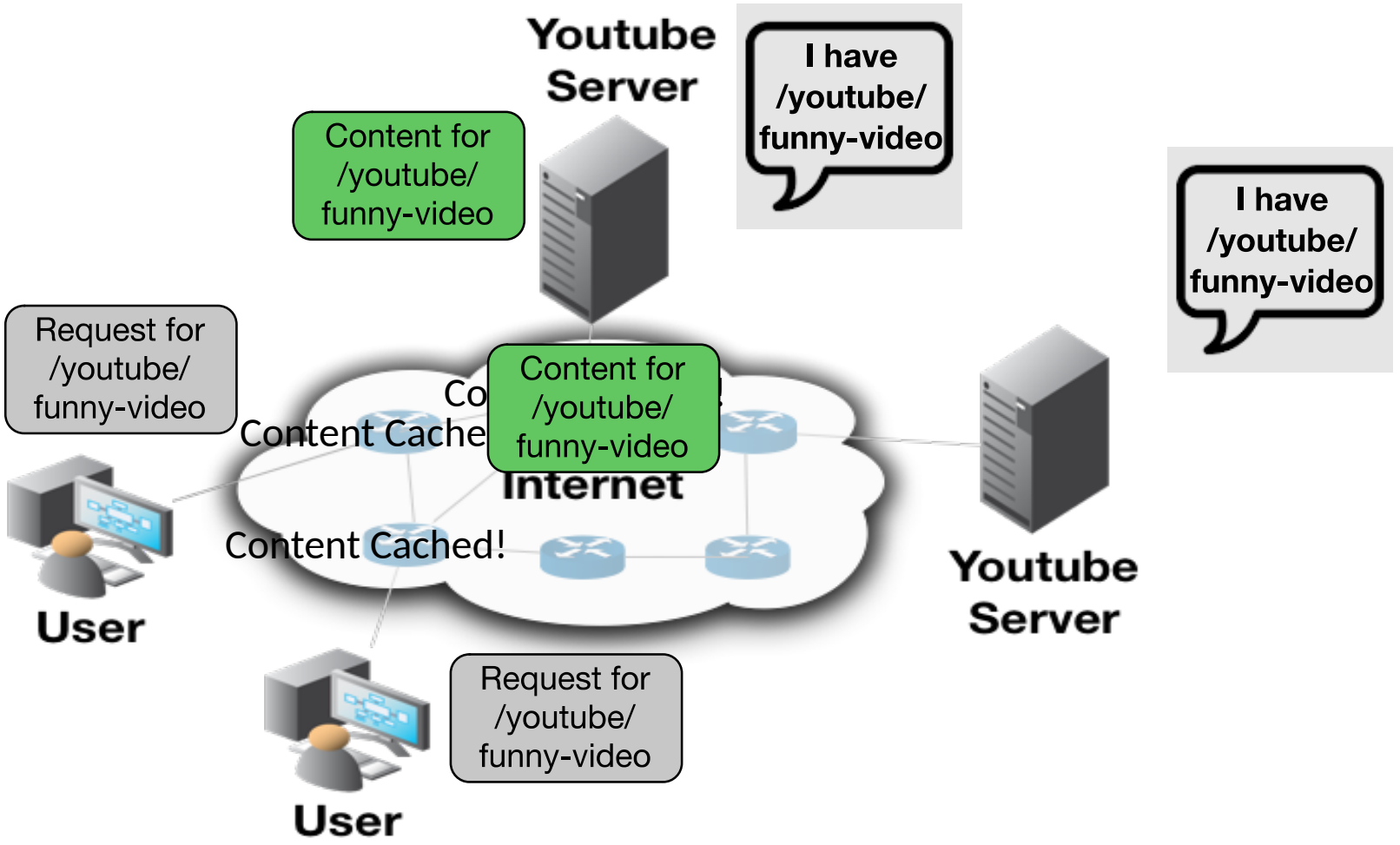
Single server model

Multi-server model
(replicated content)

CDN model



NDN Communication Model Example



IP vs NDN

IP	NDN
Identifies end-hosts (IP addresses)	Identifies data by name
Stateless forwarding	Stateful forwarding
Packet delivery to destination	Request/Response data model
Secure connection	Data-centric security

Conclusion

- NDN is based on content
  - Name it
  - Secure it
  - Forward it
- Better or worse?