Multipurpose IP/NDN Gateway and Bridge for Heterogeneous Network Interoperability

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Today's Internet: Communication Networks as Distribution Networks

The communication-centric design enables point-to-point communcation between any two parties:

- Names and interfaces
- Supports end-to-end conversations
- Provides unreliable packet delivery via IP datagrams
- Compensates for simplicity of IP via complexity of TCP

Important observation: Helped facilitate today's concent-centric world, *but was never designed for it!*

NDN is a new architecture designed for content-centric networking

NDN Overview

Content-centric networking flips around the host-based model of the Internet architecture

- *Content names*, rather than content locations, become addressable.
- Content is retrieved via *interests*, which are similar to URLs:

  `ccnx://rit/gccis/cs/spr/ramsey_survey`

- The network is permitted to store (cache) content that is in high demand
- End result: less traffic to/from the content's original source, better usage of network resources, less latency, etc etc.

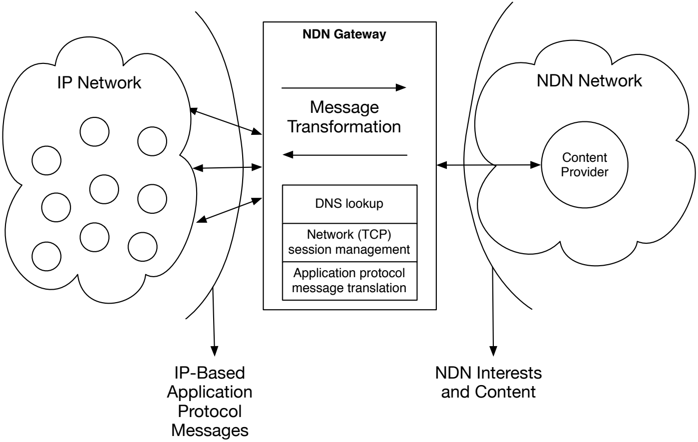
Motivation for NDN Gateway/Bridge

Question: If adopted, how will NDN be deployed?

1. "Turn off" the Internet, swap in new hardware, and then flip the switch again
   - Bad idea...
2. Incrementally "roll out" NDN hardware and slowly make it interoperable with existing IP network
   - How to enable NDN-based applications to communicate with IP-based applications (and vice versa)?
   - ...and how to do this without re-writing the transport/network layer of IP-based applications to use CCNx (i.e., implement NDN functionality on top of IP)?

Answer: Use a NDN-network edge gateways to hide the details of NDN/IP communication mechanics and translate IP messages to compliant NDN interests (and vice versa), and use NDN-network edge bridges to connect isolated NDN "islands".

Gateway Semantic Translations



IP-to-NDN Traffic

- HTTP GET requests issued to get content with a similar name
  - e.g., `GET X.X.X.X:80/ndn/ccnx/name/of/content`
  - The request path is mapped to the outgoing interest name
- TCP connections established to stream data to NDN producers
  - Socket connection between IP-based client and gateway established, NDN producer name first sent, and then all remaining data is streamed
  - The gateway partitions data from the socket and packs it into an interest for the desired NDN producer

NDN-to-IP Traffic

Interests are encoded according to a special grammar to enable the gateway to parse interests and issue them using the appropriate IP-based protocol

<ip-interest>: ’/. . . /ip/’<protocol>.

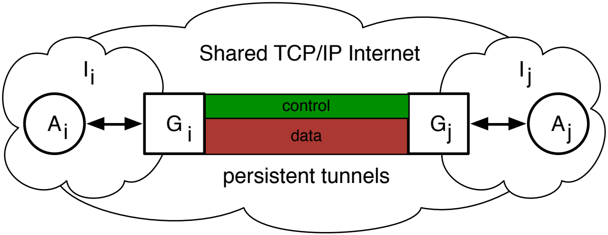
<protocol>: ’http/’<http-cmd>[’/’<http-path>] | ’tcp/’<tcp-ident>’/’<uri-encoded-string>.

<http-cmd>: ’GET’ | ’PUT’ | ’POST’ | ’DELETE’.

<http-path>: <uri> | <ip-address>[port][’/’<uri-encoded-string>]

<tcp-ident>: <SHA256-hash>’/’<nonce>.

Bridging NDN Islands



Performance Measurement: Experiments and Metrics

We will assess the design and implementation performance with the following experiments:

- Bidirectional “application-layer” and “transport-layer” communication across the gateway
- Unidirectional messages sent from IP and NDN hosts

We will collect the following metrics and model them as a function of the number of gateways *n* and estimated clients *m*:

- Unidirectional message translation overhead
- Unidirectional message trip time
- Bridge mode message latency (RTT)
- Bridge mode symmetric key establishment overhead time