

Multipurpose IP/NDN Gateway and Bridge for Heterogeneous Network Interoperability

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Agenda

Overview

Modes of Operation

Gateway Functionality

Bridge Functionality

Internal Design

Experimental Setups

Today's Internet: Communication Networks as Distribution Networks

The communication-centric design enables point-to-point communication 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 content-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.
- ▶ 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.

NDN Overview (continued)

How is data actually retrieved?

- ▶ A consumer C sends out an *interest* for content they desire.
- ▶ A router R_i use the information in their forwarding information base (FIB) table and data in cached in their content store (CS) to handle incoming interests:
 1. If content with the same name matches what's stored in the CS, return that content
 2. Else, store the interest in their pending interest table (PIT) (including the downstream router R_{i-1} or consumer C that made the request), and forward the request upstream to the next router R_{i+1} based on their FIB.
 3. FIBs are configured using protocol similar to OSPF
- ▶ Once the interest is satisfied in R_i , the PIT entry is cleared, the content is cached, and the data is sent downstream to C or R_{i-1} .

Interest Format

- ▶ Interests are similar to URLs:

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

- ▶ The / character is a delimiter that separates name *components*
- ▶ A component can be *anything*, including binary data (e.g. ciphertext)
- ▶ Interests are matched to providers in FIBs using a standard longest-prefix rule (to my knowledge, interests in CSs must match completely)

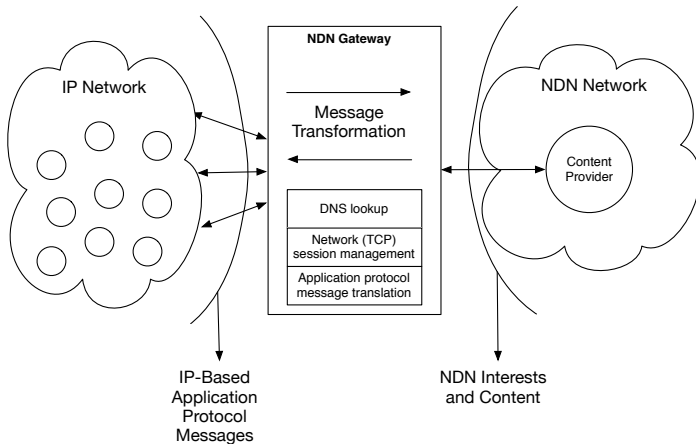
Motivation for NDN Gateway/Bridge

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

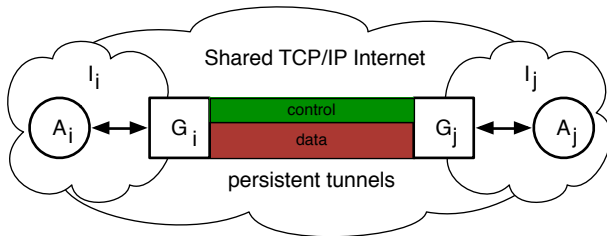
- ▶ HTTP GET requests issued to get content with a similar name
 - ▶ e.g., GET X.X.X.X:80/ndn/ccnx/name/of/content
 - ▶ The request path is mapped to the outgoing interest name
- ▶ TCP connections established to stream data to NDN producers
 - ▶ Socket connection between IP-based client and gateway established, 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

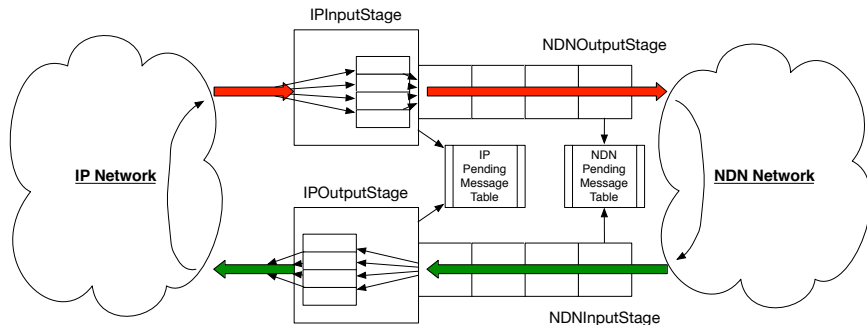
- ▶ Interests are encoded according to a special grammar to enable the gateway to parse interests and issue them using the appropriate IP-based protocol

```
<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



Pipeline-Based Load Balancing Design



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