CCN & Network Coding

Cedric Westphal
Huawei and UCSC

ICN & Network Coding

- RFC7933

```
9.5.  Network Coding for Video Distribution in ICN
   An interesting research area for combining heterogeneous sources is
   to use network coding [Montpetit13b].  Network coding allows for
   asynchronous combining of multiple sources by having each of them
   send information that is not duplicated by the other but that can be
   combined to retrieve the video stream.
   However, this creates issues in ICN in terms of defining the proper
   rate adaptation for the video stream, securing the encoded data,
   caching the encoded data, timeliness of the encoded data, overhead of
   the network coding operations both in network resources and in added
   buffering delay, etc.
   Network coding has shown promise in reducing buffering events in
   unicast, multicast, and P2P settings.  [Medard12] considers
   strategies using network coding to enhance QoE for multimedia
   communications.  Network coding can be applied to multiple streams,
   but also within a single stream as an equivalent of a composable
   erasure code.  Clearly, there is a need for further investigation of
   network coding in ICN, potentially as a topic of activity in the
   research group.
```
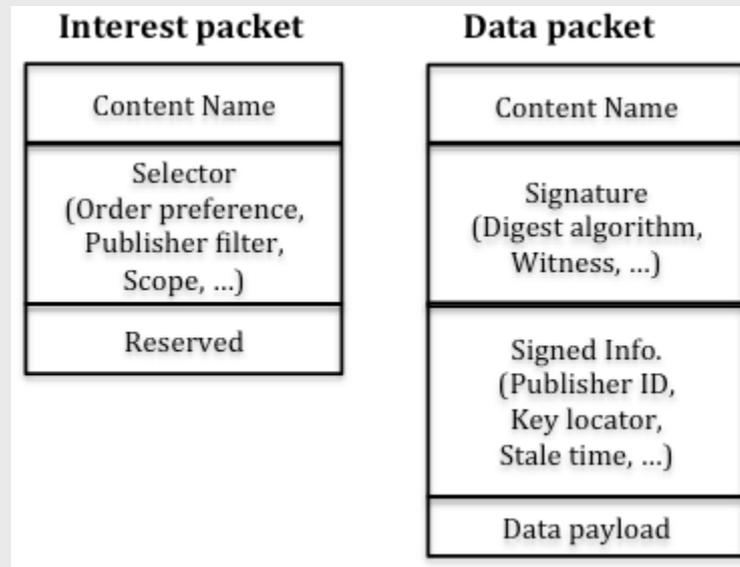
- M-J. Montpetit, C. Westphal, D. Trossen, Network Coding Meets Information-Centric Networking, in Proc. Workshop on Emerging Name-Oriented Mobile Networking (NoM'12), ACM MobiHoc, June 2012
- J. Saltarin, E. Bourtsoulatze, N. Thomos, T. Braun, NetCodCCN: a Network Coding approach for Content Centric Networks, IEEE Infocom 2016
- A. Ramakrishnan, C. Westphal, J. Saltarin, Adaptive video streaming over CCN with network coding for seamless mobility, IEEE ISM 2016
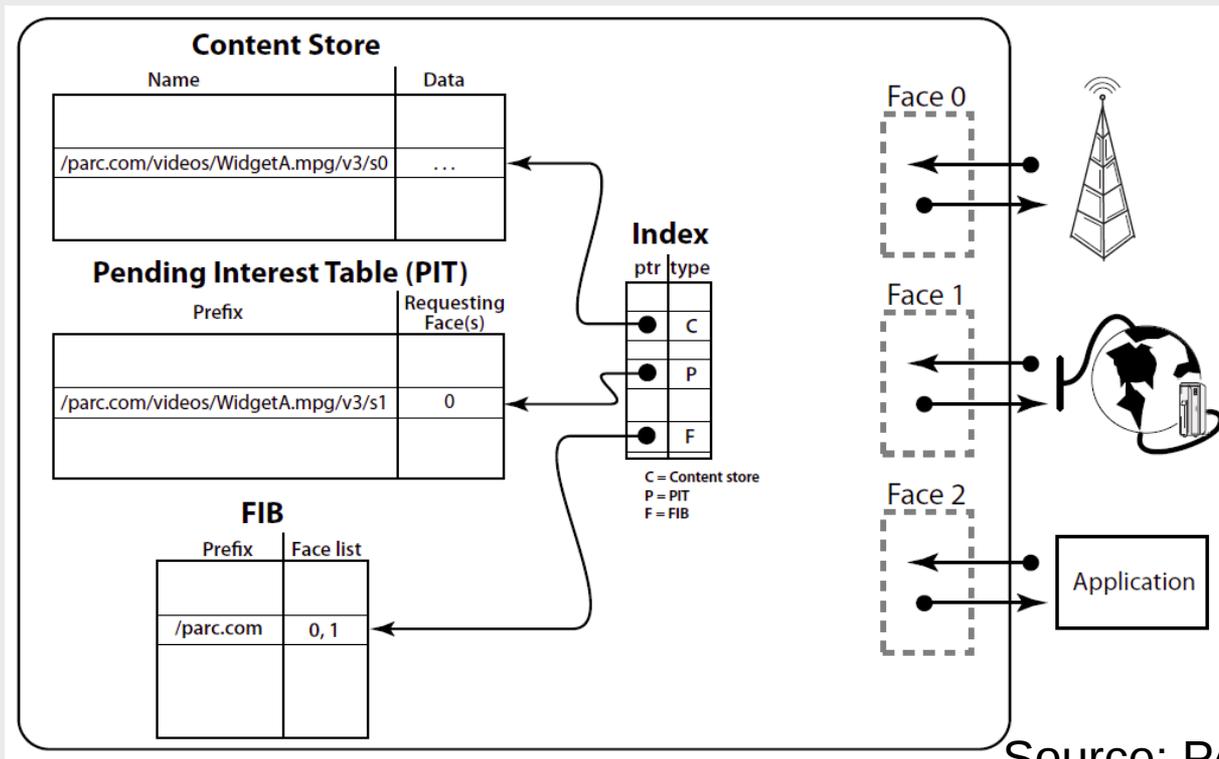
Background on ICN (well, CCN)

- **CCN has been around ten years; will become experimental RFC in the ICNRG working group (last call issued yesterday)**
- **Key principles of ICN:**
  - **Two types of messages, Interest and Data formats**
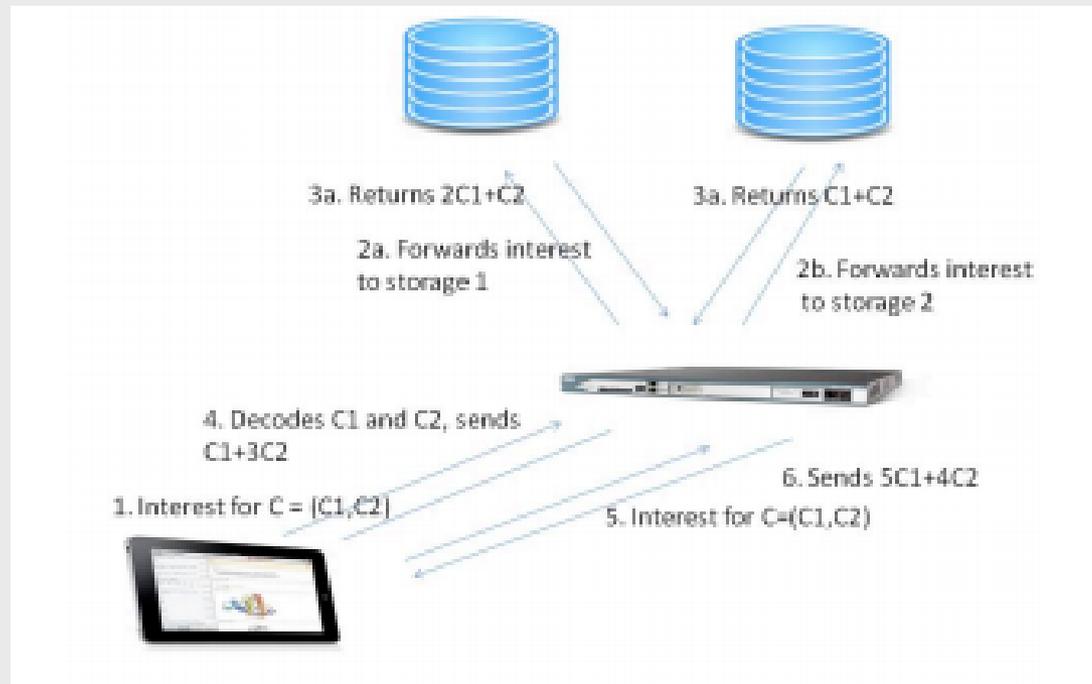 - **Interest(name) request the data; Data(name) returns the data as payload**

Interest packet	Data packet
Content Name	Content Name
Selector (Order preference, Publisher filter, Scope, ...)	Signature (Digest algorithm, Witness, ...)
Reserved	Signed Info. (Publisher ID, Key locator, Stale time, ...)
	Data payload

Processing of Interest at Router

- **Data structures at router:**
  - **Content store (that is, content cache/buffer)**
  - **Pending Interest Table (PIT, that keep tracks of the oustanding interests and allow the return of the data)**
  - **FIB (name-based)**

Source: PARC

Network Coding & CCN

- **Since Interests can be sent over multiple interfaces, it would be beneficial that they return different data if both hit the requested data → send request for coded chunks**
- **Idea first discussed in "Network Coding Meets ICN":**

Benefits

- **ICN benefits: Sessionless transport of ICN; Connect to content directly; Mobility Support; Native multicasting; Leverage of ubiquitous caching**
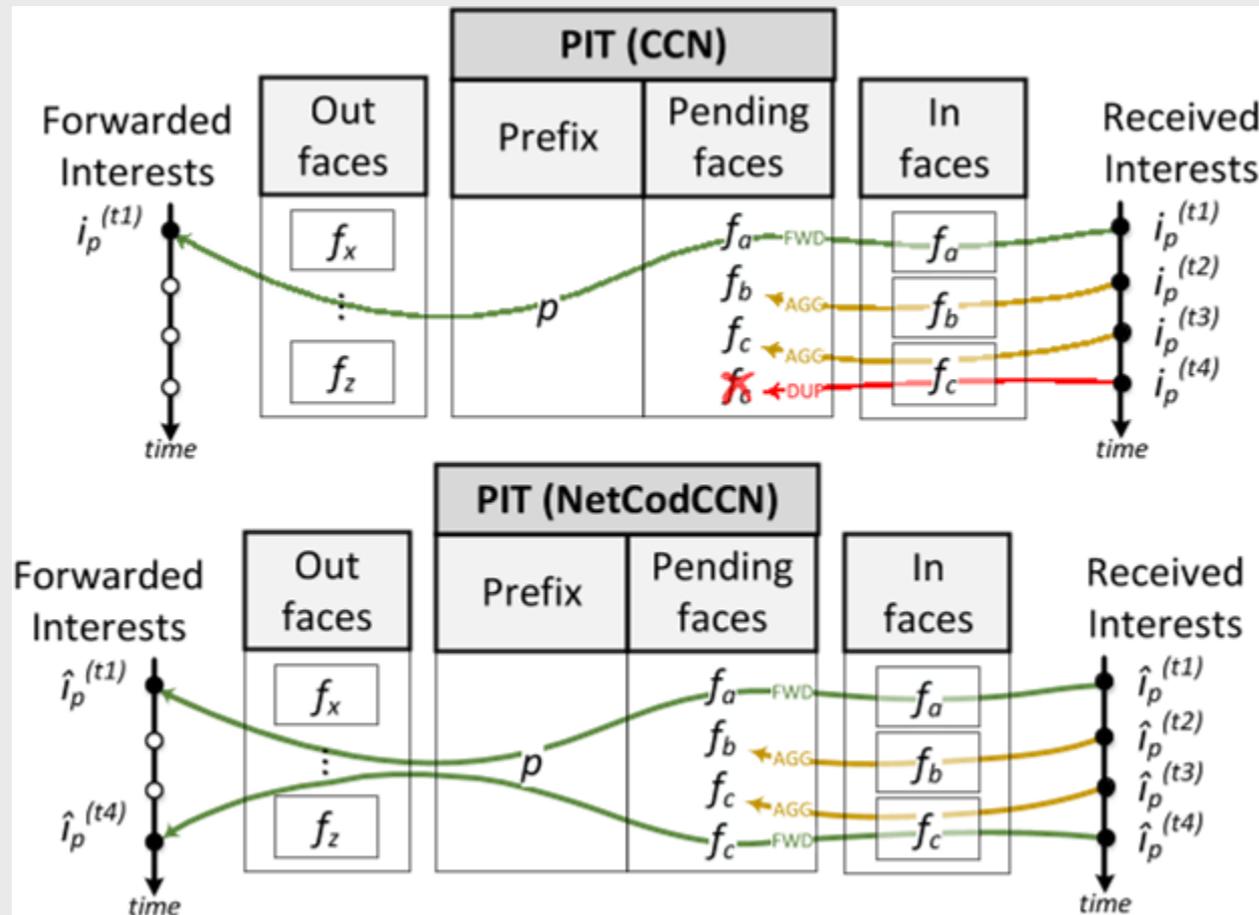
+

- **Network coding benefits:**
- **Asynchronous use of multiple interfaces/paths jointly**
- **If interest is multicast to multiple sources, returned data is not lost but can be cached closer to the requester**
- **Populate the cache faster if multiple clients request the same data**
- **Preserve the 1-interest-1-data flow balance of CCN**

NetCodCCN (Saltarin et al)

- **Instead of requesting a specific segment, request a coded segment, without specifying a specific segment id**
- **Naming: file /provider/videos/largevideo.h264 is partitioned into *K* generations of *H* segments: /provider/videos/largevideo.h264/k/1000 for generation *k* and coding vector [1,0,0,0]**
- **Interest have a NetworkCodingAllowed bit in the interest header**
- **Modified procedure at router of Interests with NetworkCodingAllowed turned on**
- **Modified procedure for data (in particular to match data with Interests for coded segments)**

NetCodCCN (Saltarin et al)

- **Interests are not filtered out in the same manner, depends on a function of the oustanding interests for coded segments**

Video Streaming (Ramakrishnan et al)

- **DASH rate adaptation: measure the bandwidth by the time to download the current segment; adapt the rate of the next segment accordingly**

- **We aligned the generation of the coded segments with the DASH segments**

- **Computed pre-encoding for all DASH rates at the server**

- **We were able to show, using NetCodCCN implementation:**

  - **Little degradation in performance due to network coding overhead**

  - **Rate adaptation on the logical link (composed of multiple paths over multiple interface)**

  - **Seamless session mobility**

Next Steps

- **"Network Coding Meets ICN" has received some attention and there seem to be some interest in this space**
- **What does this RG intend to do?**
- **Collaboration with ICNRG possible?**