Packet Fragmentation in NDN:

Why NDN Uses Hop-By-Hop Fragmentation

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Introduction

- Heterogeneous networks, different MTU sizes
- Network-layer protocols either
  - use smallest MTU among all networks, or
  - perform fragmentation and reassembly
    - end-to-end fragmentation
    - **hop-by-hop fragmentation (NDN choice)**

"Fragmentation Considered Harmful"

Kent, Christopher A., and Jeffrey C. Mogul. Fragmentation considered harmful. In ACM SIGCOMM. 1987.

- Context of the paper
  - buggy implementations of IP fragmentation that amplified performance problems

- Inefficient use of resources
  - computational cost for fragmentation by the router and defragmentation by the receiver
  - more packets to forward
  - additional headers consumer bandwidth
  - poor choice for fragment size greatly increases cost of the datagram
- Loss of one fragment requires whole high-level packet to be retransmitted
  - (constraint interface buffering on routers at the time, Proteon ring one example)

"Fragmentation Considered Harmful"?

- Paper argues for consideration of transparent (link-layer, hop-by-hop) fragmentation
  - link layer can implement efficient method for loss recovery (if necessary)
  - can increase efficiency in networks with large MTUs

The Basic NDN Architecture Concept

Named-data networking: give a name, network returns data
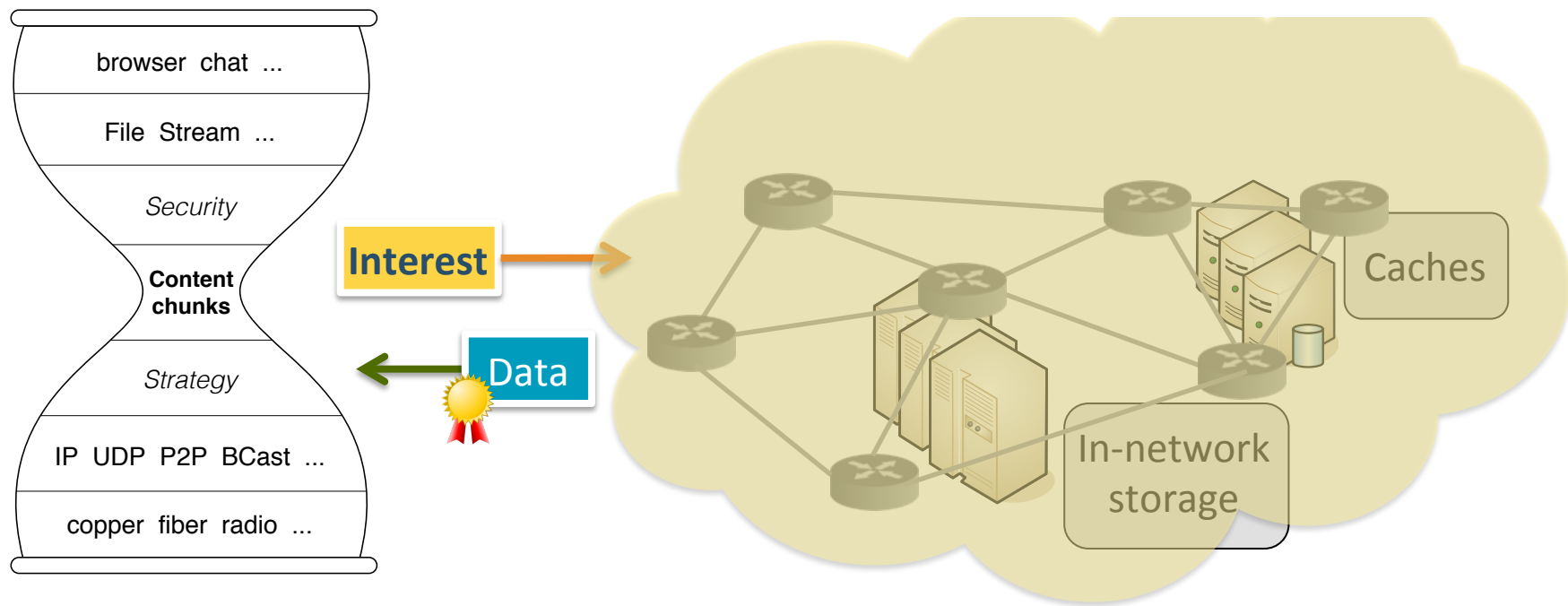
- no longer point-point communication;
- IP's E2E path concept is gone
- Network figures out how/where to get the data back to consumers
- Potentially multiple producers, multiple consumers, muti-path forwarding

NDN and Fragmentation

- Interests cannot be fragmented
  - Routers need the whole question to answer it
- Data should not be fragmented
  - To cache, the whole packet is needed
  - the same data requested by multiple clients with different path MTUs
- PIT entry can be satisfied only when Data packet arrives or time out occurs
  - routers are required to reassemble Data packet

When packet size > link MUT, NDN perfroms hop-by-hop fragmentation & reassumbly

Hop-By-Hop Fragmentation

Advantages

- Hop-by-hop protocol can efficiently handle fragment losses
- Transparent for both receiver and consumer
- If only one link has low MTU, rest of the network benefit from large MTU

Issues

- Additional overhead on routers
- Potential for repeated fragmentation/reassembly

Hop-By-Hop Fragmentation Issues

- NDN is at research stage
  - performance (CPU/memory overhead on routers) consideration goes after architecture considerations
- Repeated fragmentation can be minimized by careful selection of segment sizes
  - we still may need some MTU measuring/guessing mechanism, so higher level protocols segment data in reasonable chunks

Conclusions

- Host-by-host fragmentation is the only option for NDN

- Implementation problems can exist, but they are solvable
  - bugs are not the fault of the design