



Information Centric Networking for Media Distribution: ***Will it Blend?***

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Information Centric Networking (ICN)

Many formulations with some common themes

- Focus on access to and exchange of information objects rather than communication among hosts
- Make storage a “first class” component of networking, along with communication and computation
- Secure the data, not the channel

Media Distribution – What's involved

- **Media Preparation Pipeline** (aka Production)
- **Media Management** (metadata, search, asset management)
- **Publishing**
 - Primary Distribution (e.g. broadcast, movie theater)
 - Secondary Distribution (re-broadcast, VoD, Internet)
 - *N.B. – these categories are becoming blurred, to the dismay of the intermediaries in the distribution chain*
- **Content Distribution** (e.g. CDNs, Video Stores)
- **Playout**
 - Download
 - Streaming

Another Dimension to view the space

- Business/eCommerce
 - How do I buy or rent or subscribe?
- Security/Authorization
 - How to navigate the DRM swamp?
- Control Plane for Playout
 - Where to I fetch from, and how?
- Data Plane for Playout
 - How is the large amount of data moved?

ICN might apply to any or all of these...but where's the win?

General Principles: What does ICN have to have to displace current technology?

(these should be obvious, but bear repeating)

- Do something you can't do today at all, or at a minimum cost-effectively, or
- Be dramatically simpler than existing stuff (i.e. strip away expensive and failure-prone complexity), or
- Ride the coat-tails of some new application that has no current technology wide deployment, and
- Get over the energy barrier of initial deployment

Why would one adopt ICN in these areas?

Warning: unsubstantiated opinion alert

Area	ICN opportunities
Production	Possibly in media capture, otherwise today's stuff doesn't have problems that are obviously solved by ICN
Media Management	Metadata is a swamp – switching to ICN doesn't change the dynamic
Primary Distribution	The hard parts have nothing to do with networking or storage
Secondary Distribution	Possible play as an alternative to IP multicast for real-time distribution, but...HAS-style distribution is rapidly invading this space
CDN and Streaming	Obvious insertion point – but it has to be a big win
Players	Hard to see how ICN by itself makes client players better compared to HTTP Adaptive Streaming.

Let's concentrate on CDN / Streaming

What are the issues with today's solutions

- **Complex and fragile Naming**
 - Abuses of DNS for load balancing & redirection
- **Security/Privacy**
 - Trust/custody issues across CDNs
 - Privacy, DRM swamp
- **Messy Control System**
 - No real “publishing” interface
 - No universal/global/standard routing method
- **HTTP Caching/Proxying possibly poor match for media**
 - Large objects, but fragmented in case of HAS
 - “Transparent” caching (see trust/custody issues under security too)
- **Adaptive Streaming interacts in strange ways with HTTP/TCP**
- *This gives rise to a whole industry/market just in delivering media at scale*

Can we do better with ICN? - Routing

Speculation: *yes, unify naming and routing/forwarding*

- Data producers announce their names (prefixes)
- Routers propagate name(prefix) announcements
- Each router builds FIB
 - Can have multiple forwarding entries per prefix, allowing multi-path forwarding.
- Hierarchically structured names naïvely should enable similar scaling as HTTP/TCP/IP, but:
 - ICN supports inherent multi-homing as same named object can be published in many places, so no obvious topological aggregation
 - Number of named objects probably $O(10^{12}-10^{15})$ compared to $O(10^9)$ for IP.

Routing Paradigms for ICN

- Multi-level DHT routing
 - Arguably scales, but very large stretch
- Insert a Translation layer
 - Map location-independent to location dependent names
 - Many options, from DHT, DNS-like, “closed form” making mappings just NDN data object that get fetched
- Label-based Routing
 - Similar to XIA in some ways – construct a DAG or partial order and route to those “waypoints” that have topological significance (idea from us, being pursued us together with SICS)
- Bloom Filters...of course the universal hammer-du-jour
 - Nice compression of FIBs with inexact forwarding
 - Symmetric routing with nonce-based loop detect saves it from falling over
 - Hard problem: when to recompute the filter
- Hyperbolic Routing (ala Krioukov)
 - Very elegant, names map (via a level of indirection) to multi-dimensional geographic coordinates
 - Update-free!!! (except for the name mapping...)
 - Problem: identifiers get very large as number of dimensions of the coordinate space increases

Can we do better with ICN? - Security

Speculation: *arguably better, but who cares?*

- Secure the content rather than the container (e.g., router, cache, host) or communication channel
 - Integrity and Provenance apply to the data rather than the connection.
 - No free lunch: ICN doesn't answer long-standing PKI and key management challenges – these seem fundamental.
- Integrity versus mutability tradeoff
 - Integrity via immutability (i.e. signed objects) is nice, but current content purveyors want intermediaries that *transcode, re-package, splice, etc.*
- Privacy – arguably better, especially with NDN
 - But content owners care more about piracy than privacy
 - Audience measurement and targeted advertising trumps privacy here, just as on the web

Can we do better with ICN? - Caching

Speculation: *No, at least not for performance*

- Heavily studied area – 15+ years of work
 - *On-path, pervasive, cooperative schemes*
- Most of the issues are independent of the underlying architecture
 - *Popularity measurement*
 - *Replacement policies*
 - *Pre-placement vs. prediction*
- Initial research results don't seem to show significant improvement
 - At least for NDN...

Can we do better with ICN? - Streaming

Speculation: *too soon to tell*

- Lots of pathologies in HTTP/TCP/IP Streaming
 - *Double-loop adaptation (TCP + application)*
 - *Demonstrated oscillations, naïve adaptation algorithms*
 - *Stalls still a prevalent phenomenon*
- Interactions between caching and streaming are complicated
 - *Caches hide end-to-end content dynamics of fetches, particularly with large populations competing for cache space*
- Multi-homing and multi-path routing of ICN may help
 - *Spread the load*
 - *Rapid response to flash crowds*

Can we do better with ICN? - Mobility

Speculation: *promising*

- Goal of ICN architectures: moment you get connectivity, you can communicate
 - Insensitivity to attachment point addresses
- Client/Subscriber mobility
 - User issues a request - can get a response based on the forwarding of data along the path taken by the request
 - Client issues request: name in the packet makes requests idempotent; exactly identifies content of interest
- Publisher/Server mobility
 - When a publisher moves, publish from the new location (send an announcement)
 - Current node where publisher is or a cache in the network can respond to subsequent requests

Can we do better with ICN?

Scorecard!

Technical Area	Score
Naming / Routing	Looks promising but too soon to tell (hard to do worse than today's mess though)
Security	Mixed bag – specifics of media industry get in the way
Caching	Not likely to help much
Streaming	Way too soon to tell
Mobility	Could be the winner but also way too soon to tell

- What is one to conclude from this?
 - If you're a content owner, yawn
 - If you're a CDN operator, watch and wait
 - If you're a vendor, hedge your bets, and
- If you're a researcher, ***MORE RESEARCH!!!***

How good a match is ICN for Media Distribution?

In other words...*Will it Blend?*

