

# Information-centric Networking through Network Function Virtualization

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# Talk Outline

- Information-centric Networking: Short Intro
- ICN Design Approaches
  - NDN
  - MobilityFirst
  - XIA
  - Publish/Subscribe Internet (PSIRP/PURSUIT)
  - NetInf (4WARD/SAIL)
- ICN Challenges
- ICN and NFV

# Towards 2020

## Device – Smart Pipe – Cloud



# Information-Centric Network

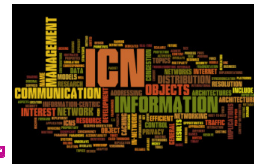
- Van Jacobson: *we are running dissemination networks using methods from a conversational paradigm*
  - Retrofitting dissemination in a conversational paradigm
  - Remote access vs. information dissemination
- Network Paradigm Evolution
  - Telephony: focus on connecting *wires*
  - Internet: focus on connecting *nodes*
  - ICN: focus on connecting *information*



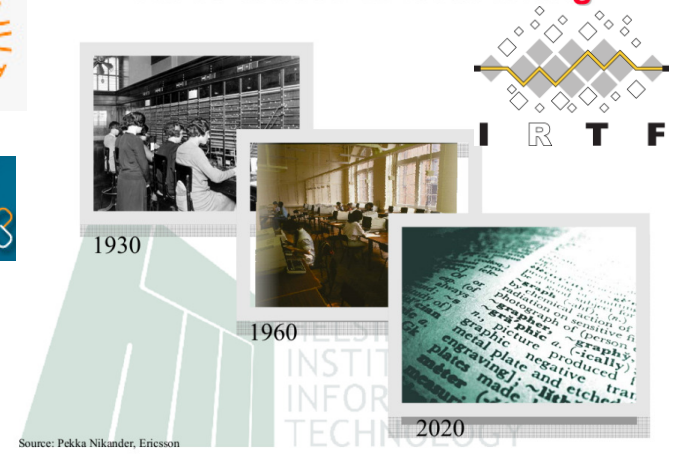
FUTURE INTERNET

Named Data Networking

CCN



## Three Waves of Networking



# Information-Centric Network

- Core network primitives for information, not host-to-host communication and remote access
- Capitalize on all information bits regardless of whether they are bits on the wire, on the ether, or on storage devices
  - Leverages in-network storage natively and in combination with other modern IT concepts such as virtualization
- ICN is still work in progress
  - Long way to go before standardization commences
  - Experimentation, open-source software, simulators and testbeds
  - Not a single or definitive approach
- Review of ICN approaches with respect to naming; resolution and routing; forwarding; transport
  - Backgrounder: [ComMag Feature Topic on ICN](#)

# ICN Design Approaches (1/4)

Project	Naming security vs. scalability	Resolution & routing	Forwarding	Transport
NDN	URL	Name-based routing	Request aggression In-network cache	Hop-by-Hop
MobilityFirst	FLAT	Two phase scheme	In-network storage	Segment-to-Segment
XIA	FLAT	Two phase scheme	In-network cache	-
PSI <i>PSIRP/PURSUIT</i>	<SID, RID>	Two phase scheme	Define a Forwarding ID (FID) for fast forwarding In-network cache	End-to-End
NetInf	<A:L>	Two phase scheme	In-network cache	End-to-End Hop-by-Hop

★ URL-like names are more scalable. FLAT name are self-certifying. PSI and NetInf make a tradeoff by using a two-level hierarchy each of which is FLAT.

# ICN Design Approaches (2/4)

Project	Naming security vs. scalability	Resolution & routing	Forwarding	Transport
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★ NDN routes packet directly according the content name. PSI first resolves content name to an appropriate location, and then routes to this location.

# ICN Design Approaches (3/4)

Project	Naming security vs. scalability	Resolution & routing	Forwarding	Transport
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PSI <i>PSIRP/PURSUIT</i>	<SID, RID>	Two phase scheme	Define a Forwarding ID (FID) for fast forwarding In-network cache	End-to-End
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★ In-network storage is employed to satisfy requests. NDN can aggregate requests to build a multicast tree. PSI uses Bloom filters to encode forwarding trees.



# ICN Design Approaches (4/4)

Project	Naming security vs. scalability	Resolution & routing	Forwarding	Transport
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★ **Transport is receiver-driven** and can be implemented as an IP overlay or on top of L2, with great potential in wireless networking: think broadcast + in-network caching + native multi-\*

# ICN Research Challenges

- Ongoing work in IRTF ICNRG
  - Naming
  - Security
  - Routing
  - Forwarding
  - Transport
  - Mobility management
  - Wireless networking aspects
  - Network management
  - In-network caching

## How to satisfy?

Network Working Group  
Internet-Draft  
Intended status: Standards Track  
Expires: August 14, 2013

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ICN Research Challenges  
draft-kutscher-icnrg-challenges-00

### Abstract

This memo describes research challenges for Information-Centric Networking. Information-centric networking is an approach to evolve the Internet infrastructure to directly support this use by introducing uniquely named data as a core Internet principle. Data becomes independent from location, application, storage, and means of transportation, enabling in-network caching and replication. Challenges include naming, security, routing, system scalability, mobility management, wireless networking, transport services, in-network caching, and network management.

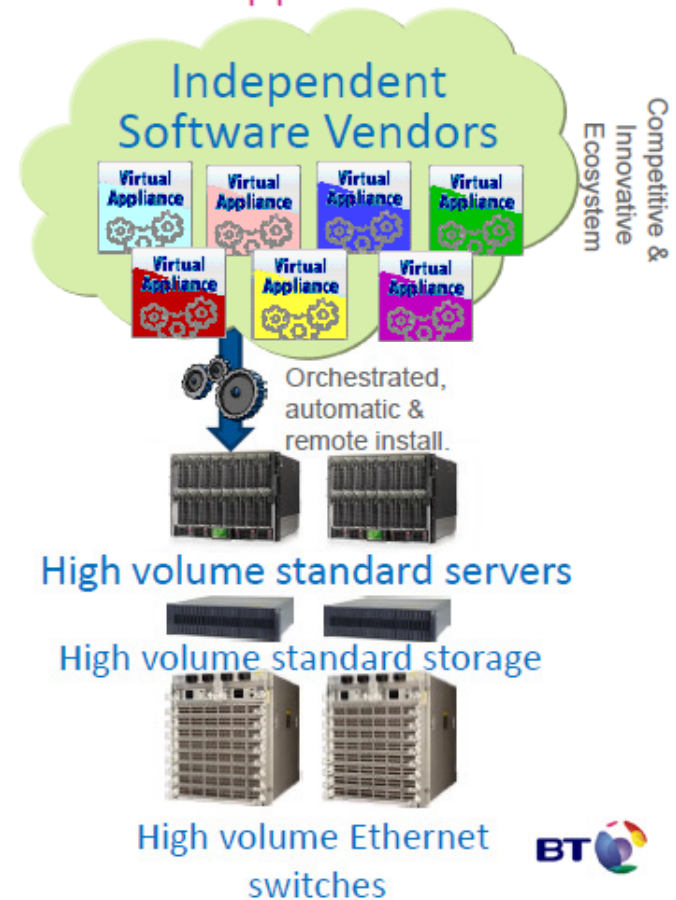
### Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

# Network Functions Virtualisation

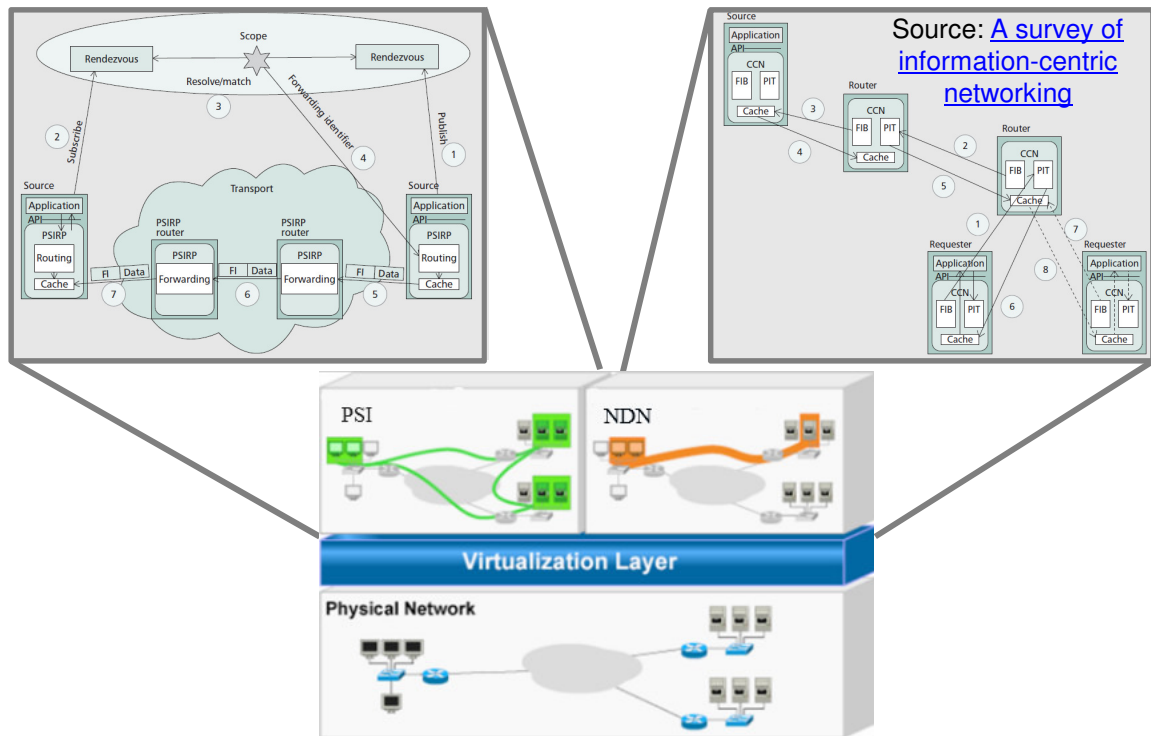
- ICN introduced as NFV software
  - Large scale experimentation with reduced equipment and deployment costs
  - network configuration or topology management in near-real time
  - tailored services
- If NFV is worth its salt, it would be natural to use it for ICN experimentation and deployment

## Network functions Virtualisation Approach



Source: [Network Functions Virtualisation](#)

# Running PSI and NDN side-by-side



## Deployment

- Network slicing for different ICN architectures
- Deploying different routing, forwarding, transport mechanisms
- Traffic isolation for different ICNs

## Management

- Flexible network configuration
- Explore interoperability
- Ease ICN traffic optimization, including in-network cache management, traffic engineering, security and so on

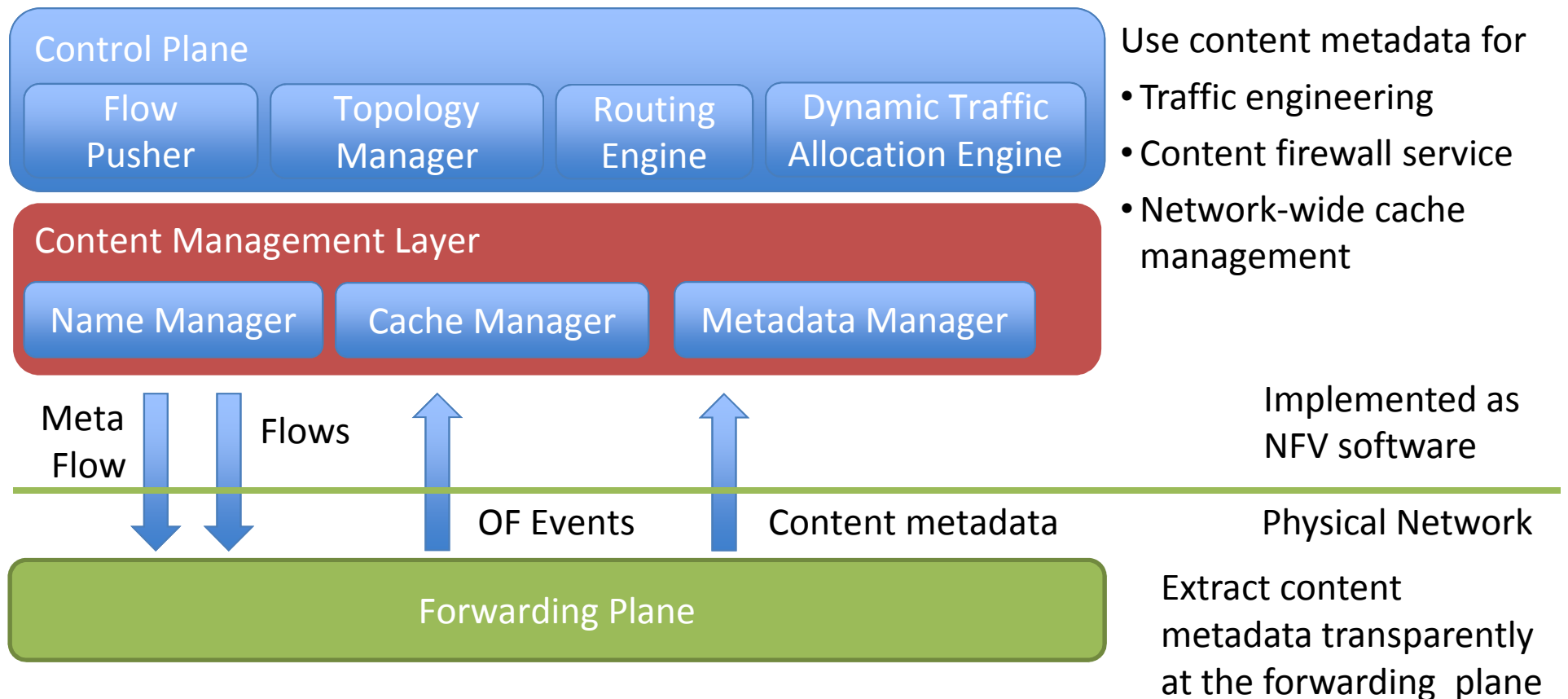
# Addressing the Abstractions Divide

- A flow-based model is not particularly well-suited for ICN
- ICN provides content-level abstractions
  - As opposed to the flow-level abstractions in OpenFlow/SDN
  - OF routes on 12-tuple, not on content
  - Control/Data Plane separation not a big concern in ICN, yet
- Carrier-oriented ICN Control Plane could manage content
  - ICN control plane is explicit in some proposals (say, rendezvous server) and implicit in others
  - Approaches with an explicit control plane may be easier to integrate content management with network functions (and virtualization)
  - Consider content routing, network-wide caching policy, network access management

# Software-Defined ICN

- Extend OpenFlow-based model to support content-centricity
  - Add caching/storage elements to the supported network elements (in addition to switching/forwarding)
  - Identify content and operate at the content level
    - Initially, intercept content requests
      - Forward requests to the control plane for content routing/content caching/late binding decision
      - Map content to specific flow
    - Eventually, recognize content semantics natively
- Extend network controller to operate on content: decide how to route to content, where to cache, where copies are located
- Applications: Traffic Engineering, Content Firewalling

# NFV Application to Network Services



# Thank You!

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