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CONTENT NETWORKING OVERVIEW

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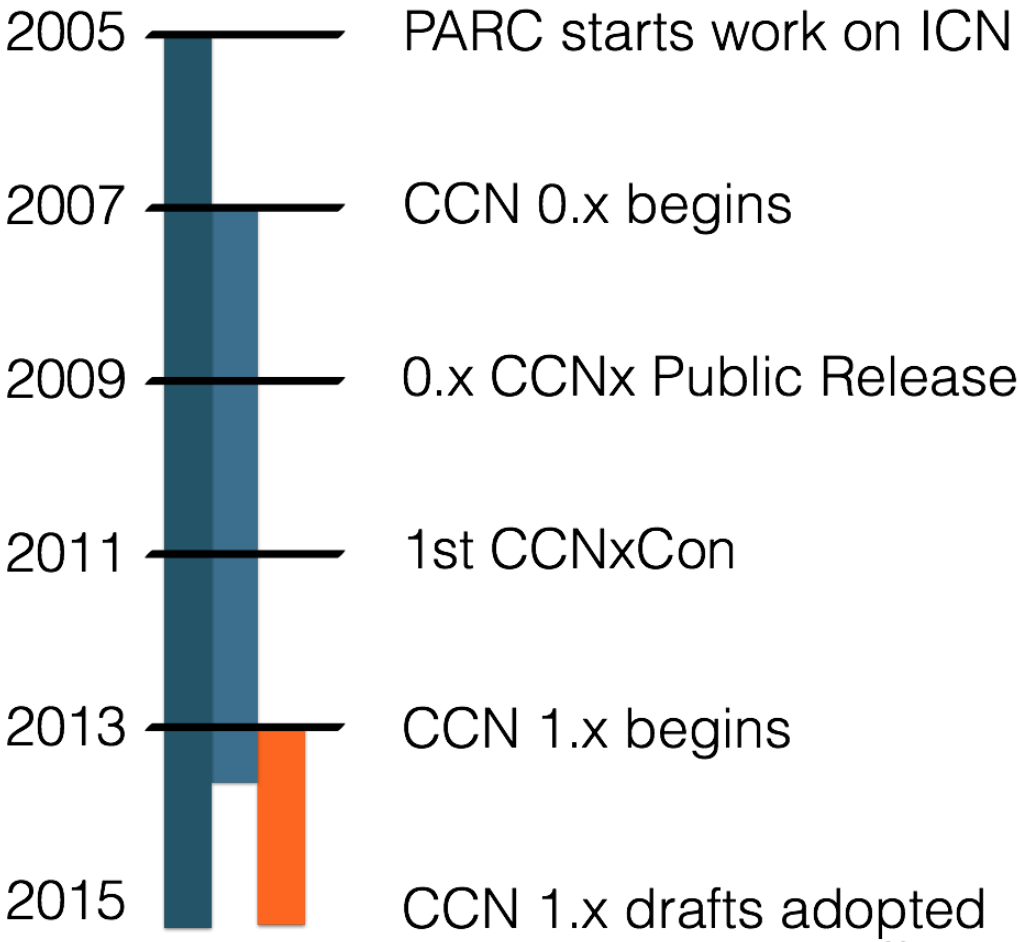
FEATURES AND GOALS

- Features
  - Directly name data and services, not hosts
  - Securely bind the names to principals
  - Standardize mechanisms of provenance
- Goals
  - Up-level the application API to the network
  - Untether data and services from location
  - Separate pipe confidentiality from provenance
  - L3 and L4 and L7 use cases

CCNX AT PARC



ICN Research
CCN 0.x
CCN 1.x

NDN Formed (2010)
1st Dagstuhl Seminar (2010)
1st SIGCOMM workshop (2011)
1st INFOCOM workshop (2012)
1st ICNRG meeting (2012)

1st NDNCom meeting (2014)
1st ICN Conference (2014)

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THE NDN PROJECT

- Offshoot from CCNx 0.7 (2010)
- Part of NSF Future Internet Architectures
- PARC part of project for first 2 years
- Run and lead by universities
- Many similarities with CCNx 1.0 and a few key differences

CCNX AND NDN COMPARISON

Feature	CCNx 1.0	NDN
Protocol Evolution	IRTF / IETF	NDN project governance
Open Source License	Modified BSD 2-clause	(L)GPLv3
Names	Hierarchical, explicit types	Hierarchical, application types
Name Matching	Exact	Suffix completion
Content Matching	Name, KeyId, Hash	Name, KeyId, Hash, suffix restrictions, exclusions
Loop Termination	Hop Limit	Per-packet nonces (state at each forwarder)
Discovery	Protocols on top	Required at each forwarder
Cache Directives	Absolute times	Relative times
Packet Format	Allows end-to-end mutable fields	All inside signature
Wire format	Fixed header + TLV (2+2)	Pure TLV (1/3/5/9)

CCNX IN INDUSTRY

- Implementations by
  - Cisco, Alcatel, Huawei, PARC, CCN-Lite (OSS project)
- Hardware implementations
  - Cisco: 4.8 Mpps for 500 byte data (2013) [1]
  - Alcatel: 10 Gbps line rate (2015) [2]
  - Huawei: VSER (OpenStack, ONS) for video conferencing [3]

[1] So, Won, et al. "Named data networking on a router: forwarding at 20gbps and beyond." ACM SIGCOMM Computer Communication Review. Vol. 43. No. 4. ACM, 2013.
[2] https://www.caida.org/workshops/ndn/1509/slides/ndncomm2015_dperino.pdf
[3] http://www.itu.int/en/ITU-T/focusgroups/imt-2020/Documents/Workshop-Turin/ravi-slides.pdf

CCNX IN 5G (A FEW HIGHLIGHTS)

- KDDI/Sony/Tokyo Tech
  - Use CCNx in 40 – 60 GHz PoC to carry state between hot spots [4]
- ICN to meet mmW “security is a fundamental design criteria” [6]
- PARC encryption-friendly proxies
  - Allows optimized congestion control on wire side even for encrypted sessions
- Anchorless mobility [5]
- IoT without all the addresses

[4] http://www.titech.ac.jp/english/news/2016/033635.html
[5] Augé, Jordan, et al. "Anchor-less Producer Mobility in ICN." Proceedings of the 2nd International Conference on Information-Centric Networking. ACM, 2015.
[6] http://apps.fcc.gov/ecfs/document/view?id=60001413989 (4G Americas FCC filing)

CCNX - ADOPTION & VALUE PROPOSITIONS IN EXISTING NETWORKS

- CableLabs: IETF April 2016 – CDN to CCN transition
- US carrier: Mid 2016 – Video streaming
- Universities: Late 2016 – Genome data file transfers
- PARC: 2016
  - Optimized over-the-air interface (save bandwidth)
  - Performance enhancing proxy for encrypted data

CCNX IN STANDARDS

- IRTF Research Group (ICNRG)
  - CCNx 1.0 protocol specification is a RG document (5 documents)
  - Moving towards publication as Experimental RFCs
- IETF Working Group Plan
  - Forming Birds of a Feather (BoF) for July 2016
  - Work Group charter by November 2016
- ITU-T SG13 Focus Group IMT-2020
  - Participation around standardization gaps for non-IP protocols
  - 2015 produced gaps analysis
  - 2016 producing prototypes and PoCs
- NIST Advanced Network Technology Division
  - Workshop on Named Data Networking
  - Interest especially for IoT

CCNX FUTURE

- Standards-based approach
- Driven by research and industry inputs
- Integrated CCNx / 5G prototypes and PoCs
- Incremental and transparent deployments plus green field
- Operator Recommendations
- New research on more scalability than IP/DNS, less state on routers