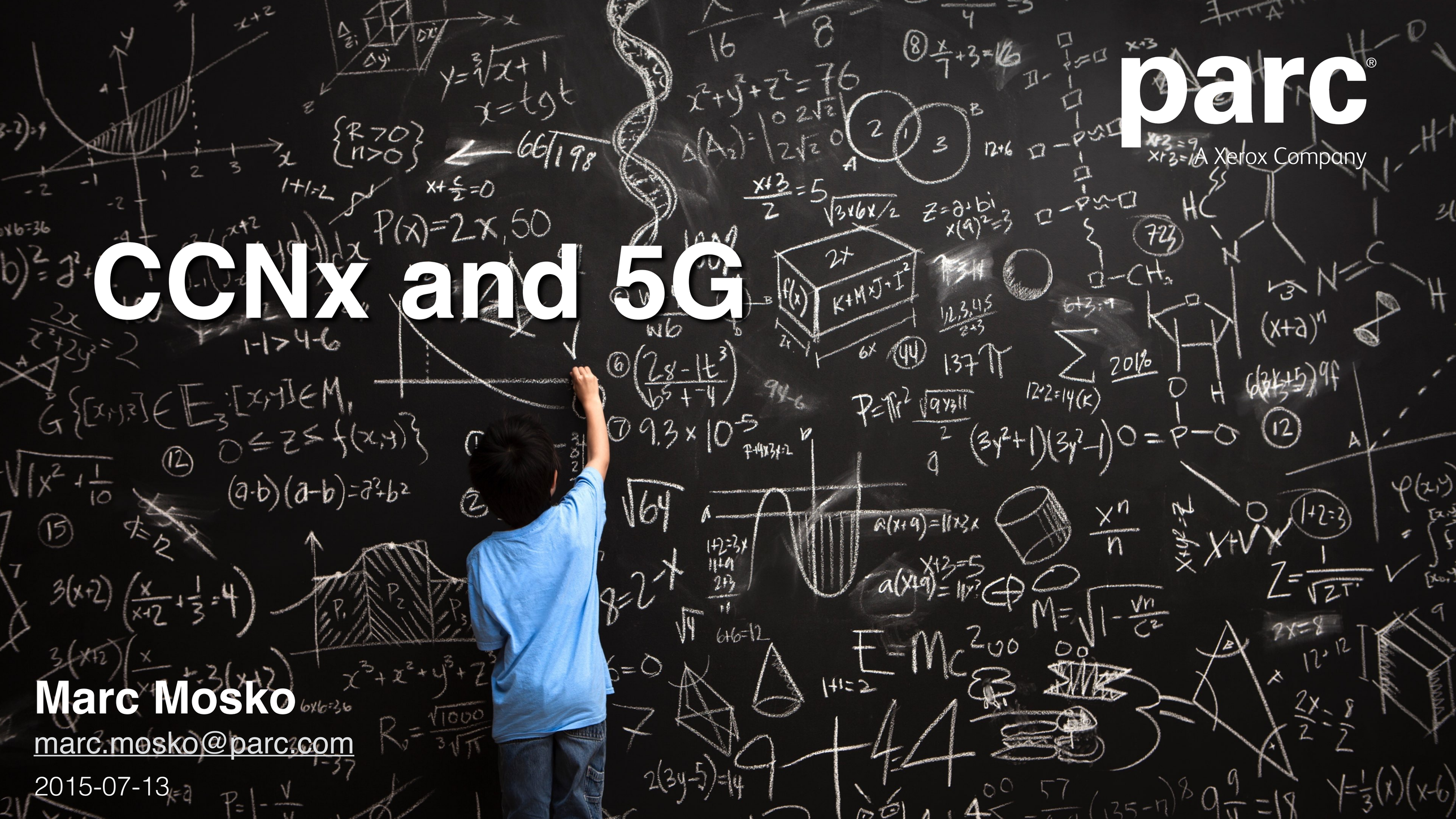

CCNx and 5G

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Scope

- Quick review of CCN
- Mention areas where CCN applies to 5G
- Point out current ICN/CCN research related to 5G
- Address some of specific topics related to CCNx for Scale, Billing, Compression, & Simulation
- Propose specific next steps to evaluation CCN in 5G

The future Internet architecture

We have a proposal that

- Is secure
- Provides high availability
- Transfers data independent of location
- Takes advantage of storage and processing

It does this by

- Naming all data, securing all data and communicating based on name

Scalable Mobile Backhauling with Information Centric Networking, with Giovanna Carofiglio, Massimo Gallo, and Luca Muscariello, in IEEE LANMAN, Beijing, China, April 2015

"We first identify and quantify the opportunities for backhaul evolution by analyzing a large set of traffic measurements collected between the mobile core and backhaul of Orange France"

"A factor three reduction in content delivery time and almost 40% bandwidth savings, when compared to existing alternatives."

Using named content with content-level security maps well to core 5G principles

Simplification — Loose-coupling — Intrinsic Mobility — Security — Orchestration & Virtualization

CCNx in 5G

- Loose-coupling — No address dependencies, security moves with the data, not with the pipe.
- Intrinsic Mobility — Multi-path and multi-source and in-network caching where needed.
- Security — Authentication and selective encryption.
- Orchestration & Virtualization — Object-based solution allows seamless data mobility while preserving security.

Scale

- CCNx decouples content from source without sacrificing authenticity.
- CCNx uses per-object state in Pending Interest Table (PIT), but the PIT does not need to exist everywhere and in some cases can be replaced by per-path state.
- CCNx can operate like a network-facilitated message passing system, which is ideal for IoT applications or other delay tolerant applications.

Billing

Marcel Neuhausler, Steven Gemelos, Ari Saha, Mario Admon , *CCN Video Distribution Platform with Authentication, Authorization and Accounting (AAA)* CCNxCON 2015

Demonstrated a video distribution and billing system
built with CCNx 1.0 pre-alpha code

Signed message exchanges in storable

Audit trails can be made by direct message storage

Compression

- **Manifests**
  - Using Manifests with CCNx means that there are a small set of index nodes and a large set of data objects.
  - All metadata and security is done in the manifest nodes.
  - Data objects have very little overhead — as little as 4 bytes — when addressed using a hash based name from a Manifest.
- **Reconstructable Objects**
  - PARC also has work on something similar to header compression for CCNx where the structure and name are removed from the object and added back on on the other side based on rules.

Simulation Engines

- Simulation Engines
  - ndnSim and SCoNET (both based on NS3)
  - ccnSim (Omnet++)
  - Greg Rutz at CableLabs is spinning up his own simulator
  - Icarus - an ICN caching simulator
  - And more!
  - Many many simulation studies in general and some 4G/5G

Recent published works related to 5G

- Rim Haw, Choong Seon Hong, and Sungwon Lee. 2014. *An efficient content delivery framework for SDN based LTE network*. In Proceedings of the 8th International Conference on Ubiquitous Information Management and Communication (ICUIMC '14)

- *Scalable Mobile Backhauling with Information Centric Networking*, with Giovanna Carofiglio, Massimo Gallo, and Luca Muscariello, in IEEE LANMAN, Beijing, China, April 2015

- Schneider, Klaus M., Kai Mast, and Udo R. Krieger. "CCN forwarding strategies for multihomed mobile terminals." Networked Systems (NetSys), 2015 International Conference and Workshops on. IEEE, 2015.

- Xiaofei Wang; Min Chen; Taleb, T.; Ksentini, A.; Leung, V., "Cache in the air: exploiting content caching and delivery techniques for 5G systems," Communications Magazine, IEEE , vol.52, no.2, pp.131,139, February 2014

Next Steps

- Identify key roles for ICN/CCN in 5G
  - Mobility, backhaul, multi-path / multi-source, named routing
- Define specific evaluations to demonstrate benefits over current approaches
- Identify existing research results in those areas and proposal new studies to fill gaps

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Thank you

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