Update on the NSF-Intel partnership on ICN-WEN (*Information Centric-Networking in Wireless Edge Networks)*

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NSF-Intel ICN-WEN Partnership:

$6.5M over 3 years, 3 projects awarded

- Focus on Wireless Edge Networks
  - Ultra low-latency and massive IoT applications
- ICN approach to 3 dimensions:
  - wireless device endpoints
  - wireless network infrastructure and architecture
  - wireless data security and privacy
- Clean-slate design
- Research goals: NSF 16-586
  - Create new integrated ICN approach for wireless nets
  - Address fundamental challenges of wireless ICN data delivery
  - Demonstrate & quantify benefits of a potential ICN-WEN
  - Evaluate realistic deployments & implementation complexities

Update

- Discussed ICN-WEN details @ IETF 98, March 2017
- Announced Awardees, May 2017
- Held kick-off workshop @ Intel, June 2017

ICN-WEN Program

***Board Of Advisors**: Udayan Mukherjee, Eve Schooler, Geng Wu, Dave Oran, Christian Tschudin, Morley Mao*

Title: ICN-Enabled Secure Edge Networking with Augmented Reality

PI: Lixia Zhang

Participating Universities: UCLA, New Mexico State University

Title: SPLICE: Secure Predictive Low-latency Information Centric Edge for Next-Generation Wireless Networks

PI: P. R. Kumar

Participating Universities: Texas A&M, Washington University St. Louis, Purdue, Ohio State, University of Illinois Urbana-Champaign

Title: Light-Speed Networking (LSN): Refactoring the Wireless Network Stack to Dramatically reduce Information Response Time

PI: Arun Venkatramani

Participating Universities: U. Massachusetts-Amherst, U. Wisconsin-Madison

Questions?

ICN-WEN

Information Centric-Networking in Wireless Edge Networks

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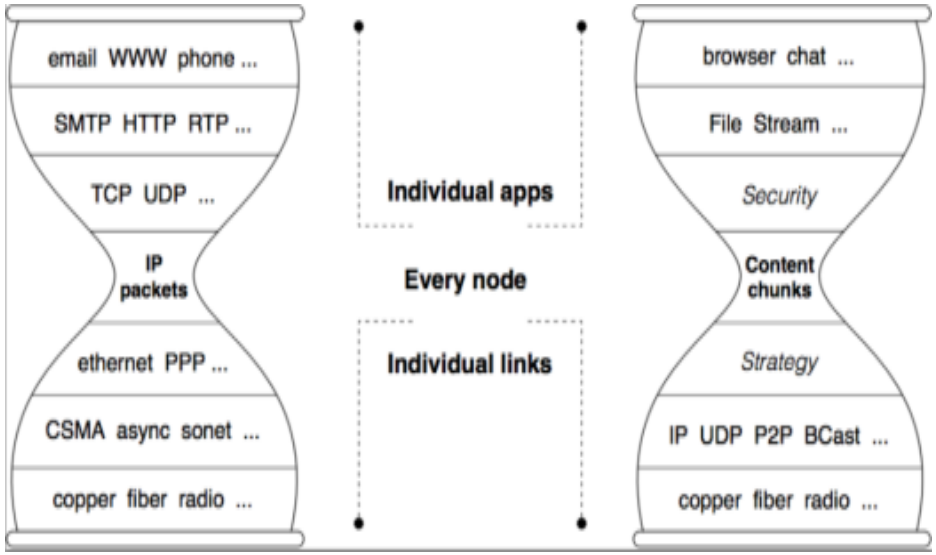
March 30, 2017

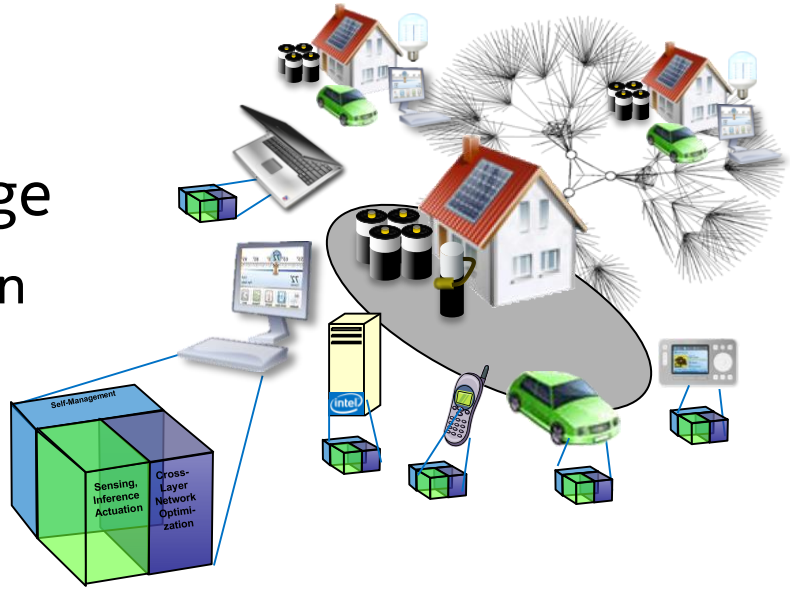
Outline

- Backstory
- ICN-WEN Program
- Next Steps
- Bigger Picture



"Thin waist of the Internet"

Intel Backstory: ICN for IoT



- Deployed ICN at the network edge
  - Within edge administrative domain
  - Sidestepped global deployment
- Built, evolved early IoT PoCs: ICN as a trusted data bus
  - Smart home – *Pub-sub & security APIs*
  - Smart neighborhood – *Data-centric privacy*
  - Massive IoT software updates – *Scalability*
  - Edge computing – *Move the compute to the data*
- Supplied user vs. router insights
- Grew partnership between Labs & IoTG

NSF-Intel ICN-WEN Program:

$6.5M over 3 years, 2-3 projects to be awarded

- Focus on Wireless Edge Networks
  - Ultra low-latency and massive IoT applications
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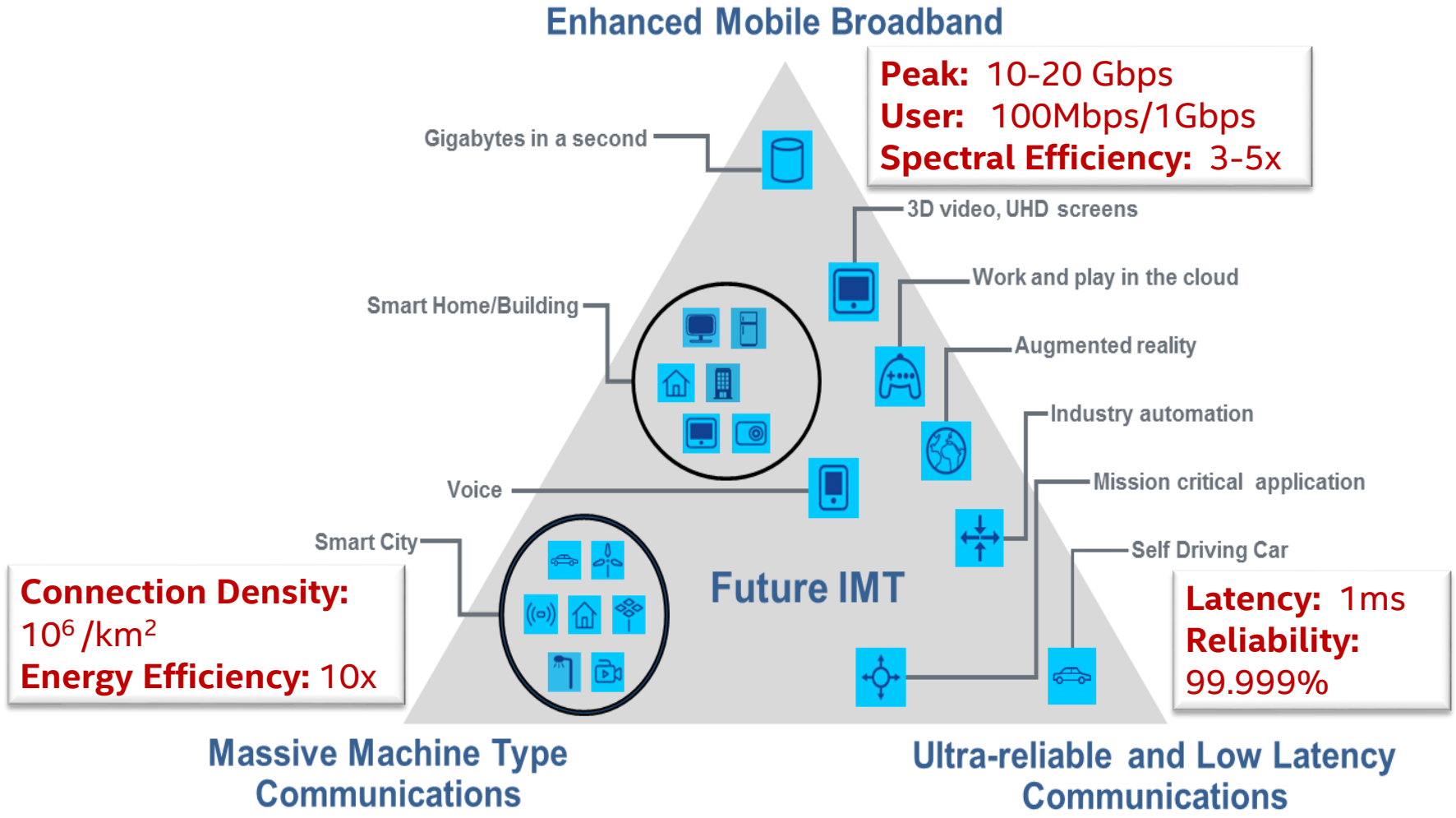
ICN and 5G+ Networks

- ICN over wireless a natural next step
- 5G+ use cases very different from traditional ones
  - High bw and support for large #s of devices
  - AR/VR, autonomous vehicles, dense IoT, robotics, drones, etc.
- New usage models where source-dest model falls short
  - Source is inaccessible: *e.g., in sleep mode, offline, encounters congestion, mobility or interference*
- IoT Data
  - Data often originates and is processed at the Edge
    - May (not) flow back to the core
  - ICN enables access to data within the network
    - With less application dependence

Translating to 5G Requirements:

ITU's IMT Vision



New metrics and wide variety and variability of Services

Likely ICN-over-Wireless Benefits?

- Wireless Edge Networks with dynamic reconfigurations and data requirements
  - Flow of data cannot be programmed during net setup
  - Benefits in routing and data management
- Data access benefits in Non-star topologies
  - Not simple Cellular and WiFi
  - Wireless mesh networks
- Liberation of meta-data
  - Use of contextual info in the lower layers w/out app dependence
- Support for reverse data flows
  - Combines routing with caching/storage … & processing

Challenges and Hard Problems

- Producer mobility
- Security and Privacy
  - End user devices may have limited resources to implement complex encryption
  - How to establish trust?
- Bridging ICN islands with each other and with IP networks
- Modifications to ICN architecture to directly implement over wireless MAC layer
- Wireless co-design with ICN
  - Make ICN wireless-aware
  - Make wireless ICN-aware

Why is Intel interested in ICN?

- ICN has potential, but is it ready for prime time?
  - Develop practical ICN use cases
  - Develop ICN implementations that can be commercialized & standardized for industry adoption
- What is improved if we use ICN instead of IP?
- Evaluate potential for…
  - Being an industry solution
  - Implementing 5G+ networks
  - Meeting ultra low-latency requirements and massive IoT solutions
  - Enabling Edge/Fog computing…

Next Steps

Awardees to be announced Mid-May of 2017!

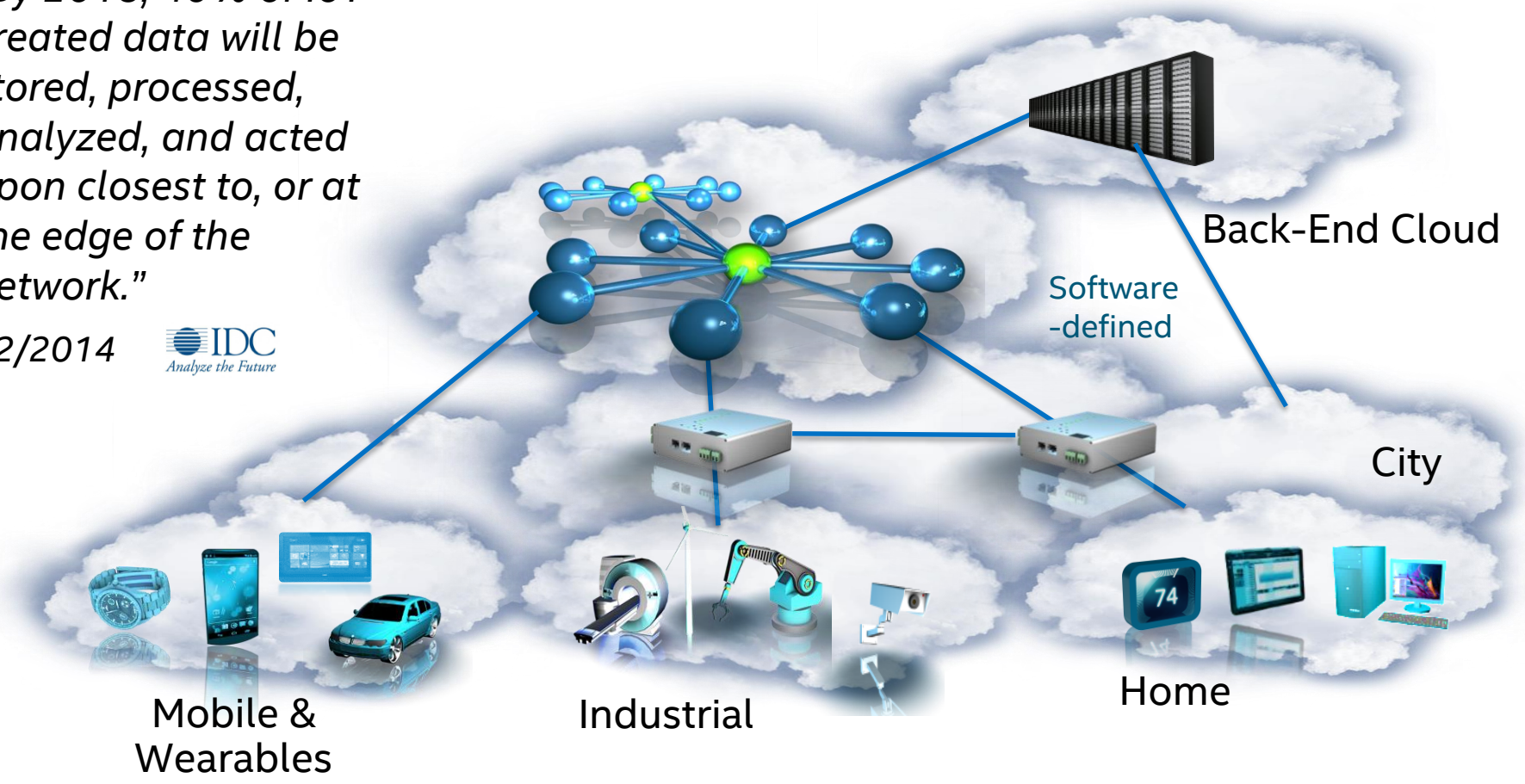
Bigger Picture

Data Inversion Problem: IoT Edge data flows upstream

Cloud functionality migrating to be more proximate to the data

"By 2018, 40% of IoT-created data will be stored, processed, analyzed, and acted upon closest to, or at the edge of the network."

12/2014 IDC Analyze the Future



Problem:
Legacy clouds fall short …or are unusable

When the IoT data generated is

- Delay-sensitive
- High-volume
- Trust-sensitive
- (Intermittently) Disconnected

Countless examples

- Both near term & further out

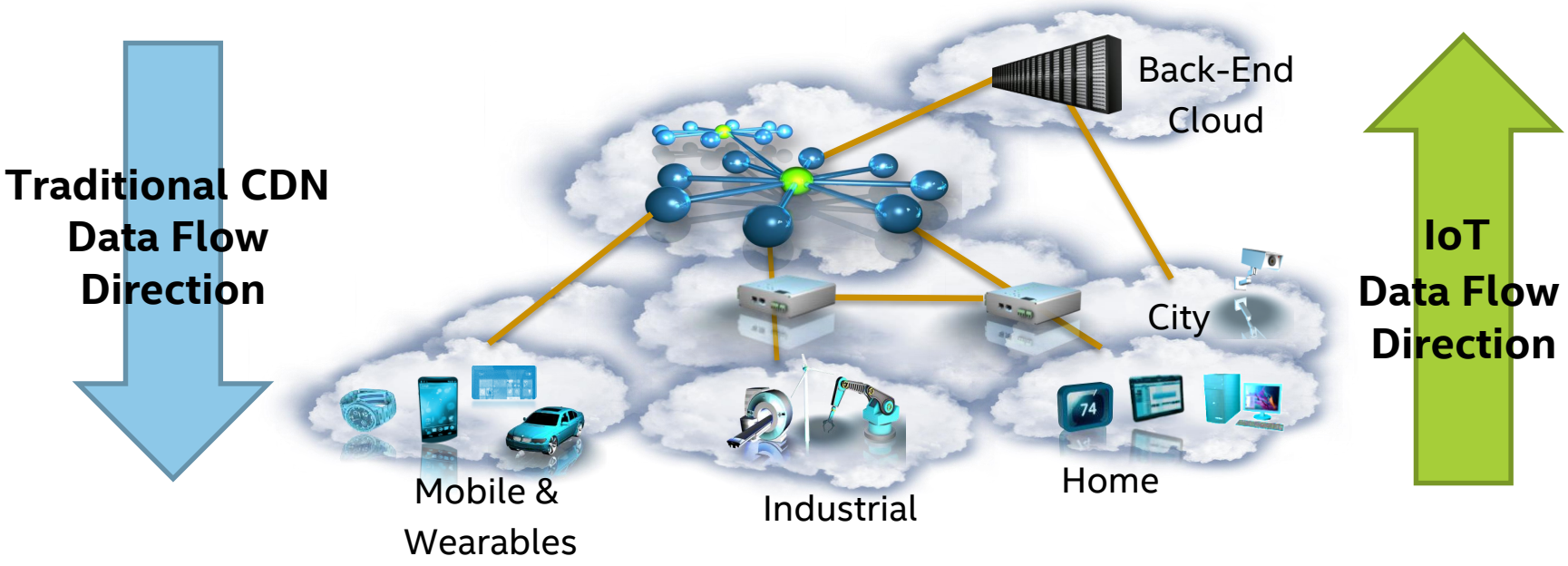
Video Analytics

Augmented Reality

- Data heavy
- Compute intensive
- **Response times <30ms**
- Small form factor
- Low power

Need for Edge and Fog Computing

A Multi-tier Cloud of Clouds



Use ICN for rCDNs (reverse CDNs)?

Reverse data flows combining routing with storage and processing

Bigger Picture:
From Cloud to Edge to Fog Computing

- IoT Data causing disruption …
  - What's the network+compute+storage architecture needed?
  - What's the impact on privacy, security, trust models?
  - How/where to put the control?
- Liberation of data and meta-data
  - Accessible anywhere? Safeguarded everywhere?
- ICN's role in and/or relationship to…?
  - Fog data flows - Intra-cloud, E/W and N/S (rCDNs)
  - Smart data/object frameworks
  - Data naming, lineage and interoperability
  - "Organically-grown" Trust