Named Data Networking of Things: **NDN for Microcontrollers (NDN-RIOT)**

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NAMED DATA NETWORKING

The Future is Coming: Internet-of-Things

24 BILLION
There will be 24 billion IoT devices installed by 2020

41% CAGR — total IoT devices installed

Devices Installed (Billions)

30
25
20
15
10
5
-

2015E 2016E 2017E 2018E 2019E 2020E
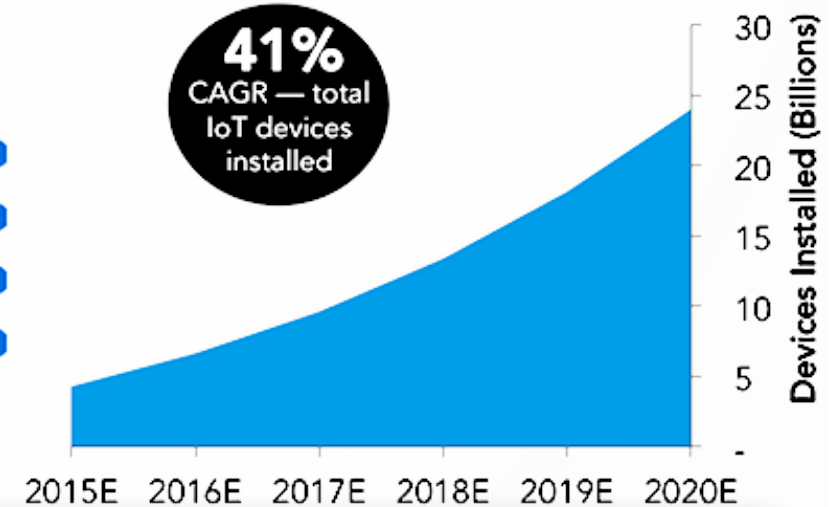
Four Market Drivers

- Expanding Internet Connectivity
- High mobile adoption
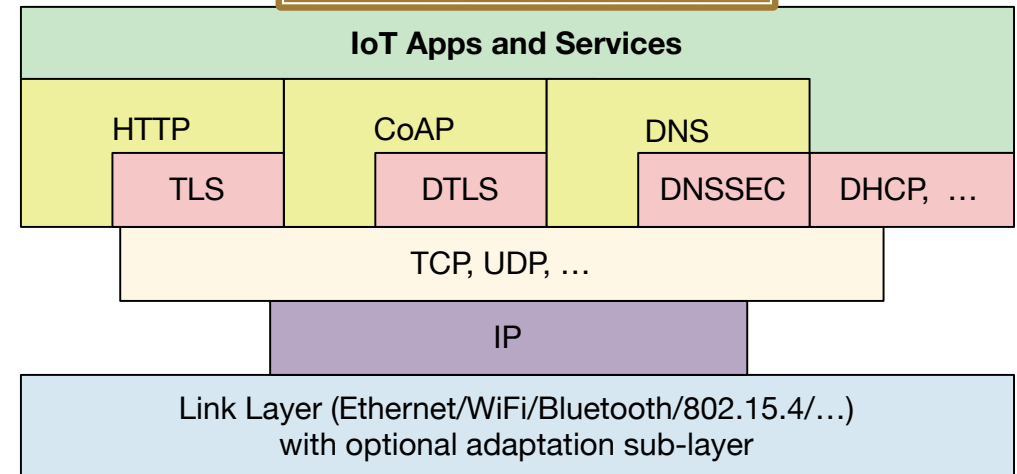- Low-cost sensors
- Large IoT investments
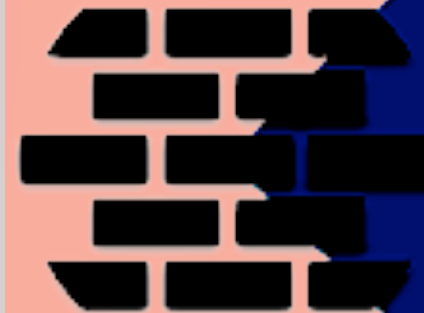
Four Barriers

- Security concerns
- Privacy concerns
- Implementation problems
- Technological fragmentation

Complexity and Semantic Mismatch for IP/IoT

- **App: "Living room frontal view feed"**
- Network:
  - Request stream (HTTP/CoAP)
  - Connect to camera (TCP/IP)
- +
  - Lookup mapping "Living room" -> camera URI
  - Connect to AlexHome.com (cloud?) service
  - DNS lookup IP of AlexHome.com service
  - DHCP to assign IP addresses to all devices

IoT Apps and Services		
HTTP	CoAP	DNS
TLS	DTLS	DNSSEC / DHCP, …
TCP, UDP, …		
IP		
Link Layer (Ethernet/WiFi/Bluetooth/802.15.4/…) with optional adaptation sub-layer		

Named Data Networking of Things

- **App: "Living room frontal view feed"**
  - /AlexHome.com/LivingRoom/VideoFeed/FrontView/mp4/_frame=12/_chunk=20

- Network:
  - Use the name to send request to my camera responsible for Living's room front view
  - OR retrieve data from caches

- +
  - Cameras provision with "identity name" that defines what they are and what data names they produce
  - Can announce name prefixes or respond to local broadcasts

Named secured data chunks

Ethernet, WiFi, …

CSMA, Sonet, …

copper, fiber, radio, …
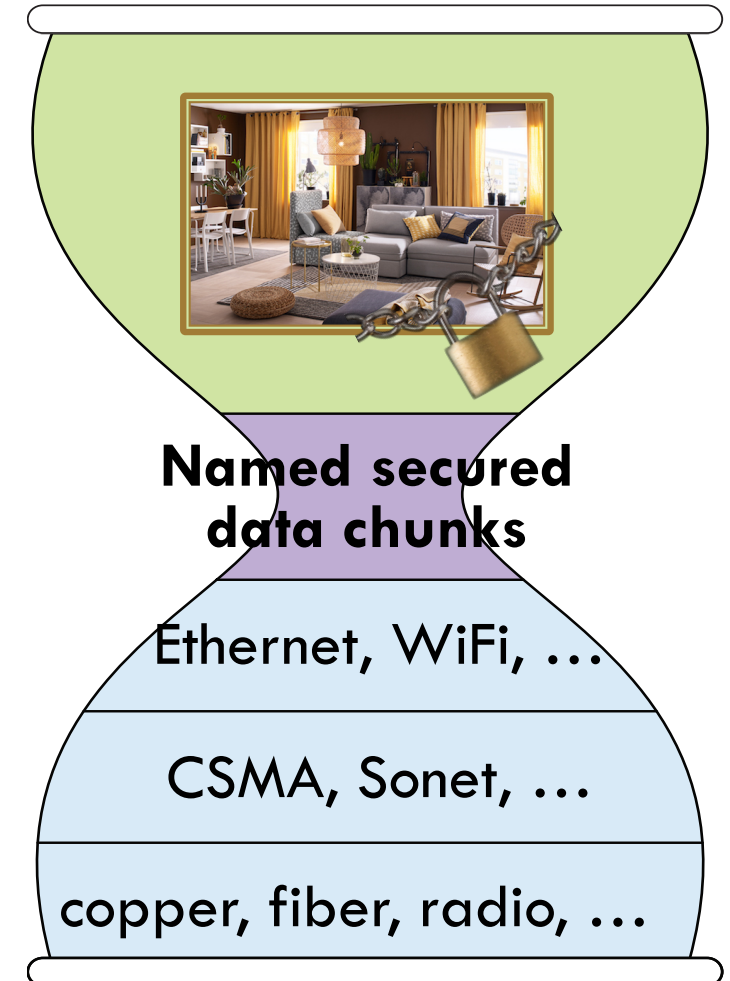
ICN/NDN "Edge" for IoT

- Bring IoT semantics to the network layer
- Name the "things" and operations on "things"
  - "Living room frontal view feed", "CO level in kitchen"
  - "blood pressure", "body temperature"
  - "max/min/avg pH of soil in specific point of US soil grid"
- Focus on data associated with things, not devices
- Secure data directly

W. Shang et. al, "Named Data Networking of Things," in proc. of IoTDI'2016

Smarter IoT with Low-cost Devices

- Hardware: ultra low cost, longevity
  - Constrained battery, low-power networking, limited memory, low CPU
  - ~ 32-bit ARM, 48 MHz, 32KB RAM, 256KB flash
- Application getting smarter and more powerful
  - Need integration with public Internet and cloud service without requiring gateways
  - Need for data-centric security, local trust management
  - Need auto-discovery and auto-configuration
- **Named Data Networking**
  - common protocol for all applications and network environments
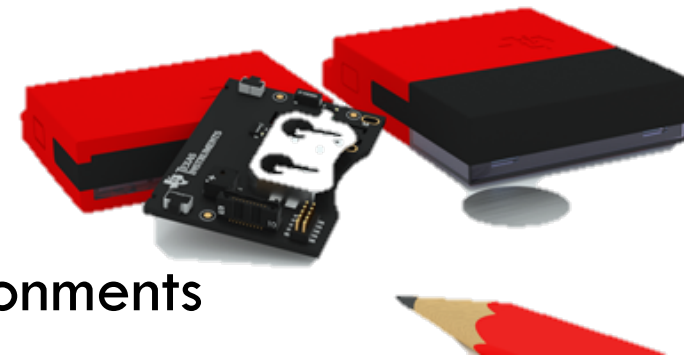
W. Shang, et. al, "Breaking out of the cloud: local trust management and rendezvous in Named Data Networking of Things," to appear in IoTDI'17
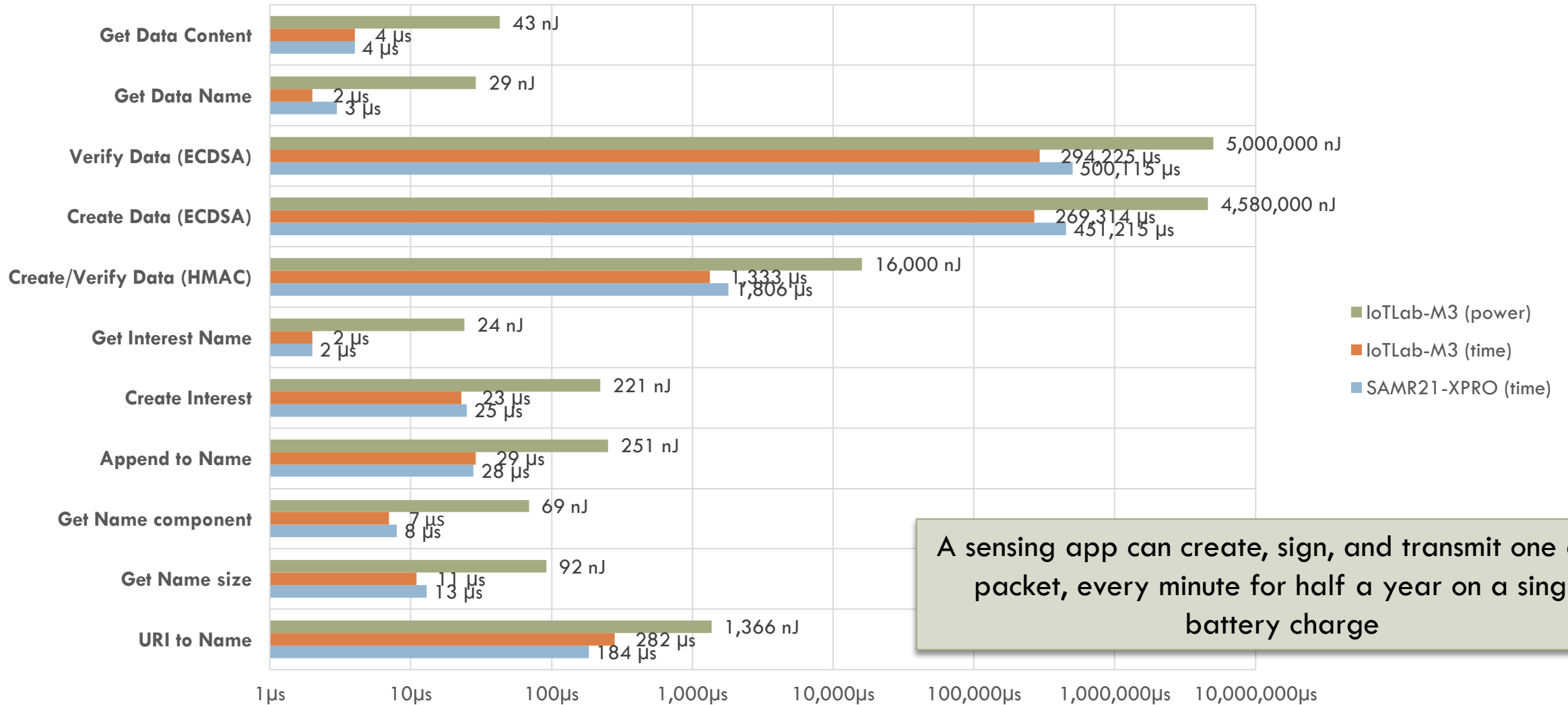
NDN-RIOT: NDN For RIOT-OS

- ☐ Enable IoT apps based on RIOT-OS
- ☐ Support for NDN packet format for limited MTU links
- ☐ Support of data-centric security, including ECDSA and HMAC signatures, AES encryption
- ☐ Replaceable forwarding strategies
- ☐ Support of transmission (+fragmentation) over IEEE 802.15.4 and Ethernet
- ☐ Simple application API

- ☐ A few basic examples
  - ☐ https://github.com/named-data-iot/ndn-riot-examples

Open source, contributions welcome
https://github.com/named-data-iot/ndn-riot

Stack Performance Numbers

A sensing app can create, sign, and transmit one data packet, every minute for half a year on a single battery charge

Other IoT-Related NDN Efforts

- NDN-BMS: encryption-based access control
  - Wentao Shang, Qiuhan Ding, Alessandro Marianantoni, Jeff Burke, Lixia Zhang. "Securing Building Management Systems Using Named Data Networking." In IEEE Network, Vol. 28, no. 3, May 2014.

- NDN-ACE: authorization framework for actuation apps
  - W. Shang, Y. Yu, T. Liang, B. Zhang, and L. Zhang, "NDN-ACE: Access Control for Constrained Environments over Named Data Networking," NDN Project, Tech. Rep. NDN-0036, Revision 1, December 2015.

- NDN-IoT: toolkit for NDN dev on Raspberry Pi
  - https://github.com/remap/ndn-pi
- NDN on Arduino: minimal app for Arduino
  - https://github.com/ndncomm/ndn-btle
- https://redmine.named-data.net/projects/ndn-embedded/wiki