Named Data Networking of Things: NDN for Microcontrollers (NDN-RIOT)
The Future is Coming: Internet-of-Things

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

There will be 24 billion IoT devices installed by 2020

CAGR — total IoT devices installed
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

![Diagram of IoT Apps and Services](image-url)
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
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

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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

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

- **NDN-ACE**: authorization framework for actuation apps

- **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