Hierarchical Storage for NDN Building Management System

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Introduction

Building management system (BMS) is a sensor data acquisition system which automatically manages a building's heating, ventilation, air conditioning, and other systems.
An NDN based BMS leverages the architecture's advantages in hierarchical data naming and name-based routing and forwarding, in-network caching, and inherent security support. It may overcome the challenges IP faced, namely the complexity of network addressing and configuration, reliance on middleware, and a lack of security.
This summer's work focuses on the data aggregation and signing/verification in NDN BMS, and updates the previous work by Shang et al. [1].

Objectives

Provide campus, building, and department-level monitoring and query possibility

- Design a hierarchical storage approach and a stream-based approach to calculating aggregates, distributing processing and taking advantage of local storage.
- Data signing and verification

Design Overview

Figure 1 illustrates the namespace of the BMS application;

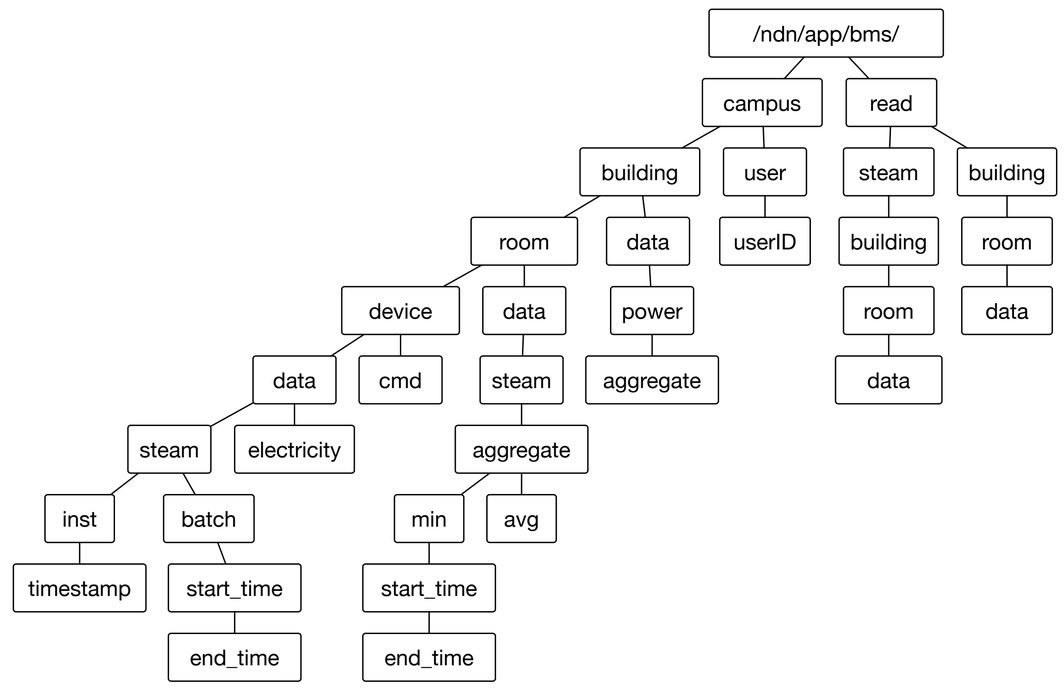

Figure 1: BMS namespace

- Name components in "campus" branch represent the hierarchical structure of BMS data, organized as Campus - Building - Room - Device
- "User" branch records the list of BMS user identities, which can be used for access control

Figure 2 illustrates an example name of a piece of BMS data.

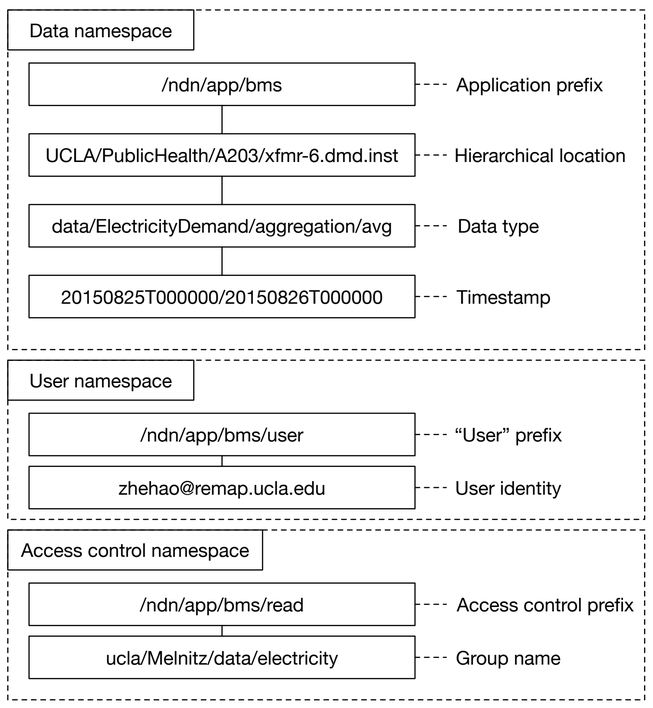

Figure 2: Example BMS data name

Data Aggregation

- Leaf nodes publish aggregated data in a fixed time window
- Non-leaf nodes aggregate the data after all children respond, and publish data within the same time window
- Long lived interests with received start time excluded moves data across layers

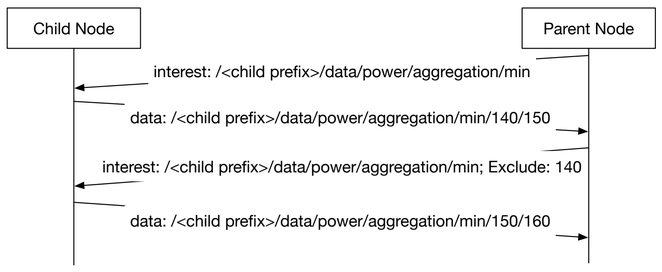

Figure 3: BMS move aggregation sequence

Trust Schema

Signing and Verification

- BMS data is verified hierarchically
- The certificates of the BMS children nodes should be signed by the parent nodes
- Campus certificate is the root of trust for BMS data and user

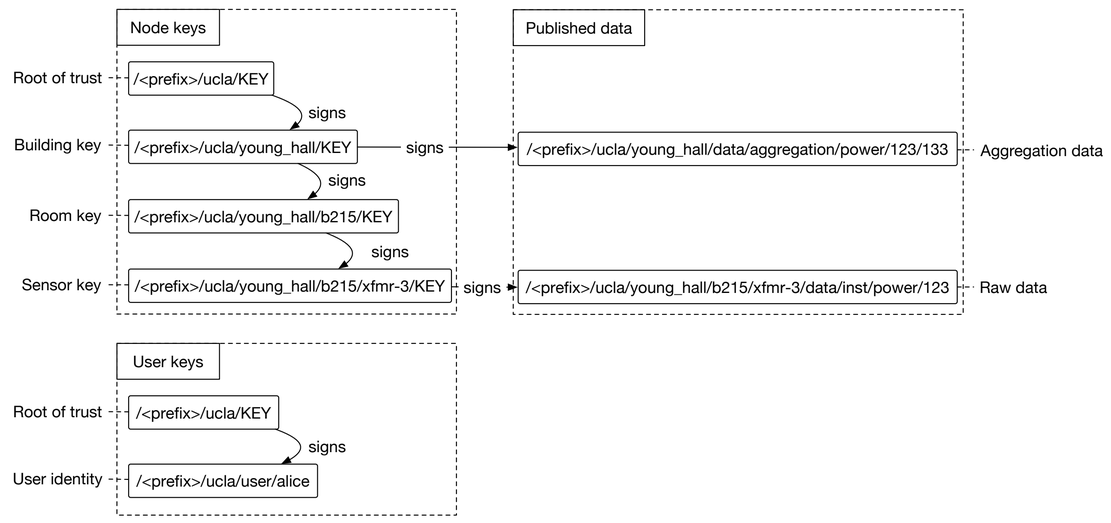

Figure 4: Example of signing in BMS

Bootstrap

- Child node obtains a signed certificate from its parent
- Bootstrapping process from ndn-pi, illustrated in Figure 5, can be used for this process

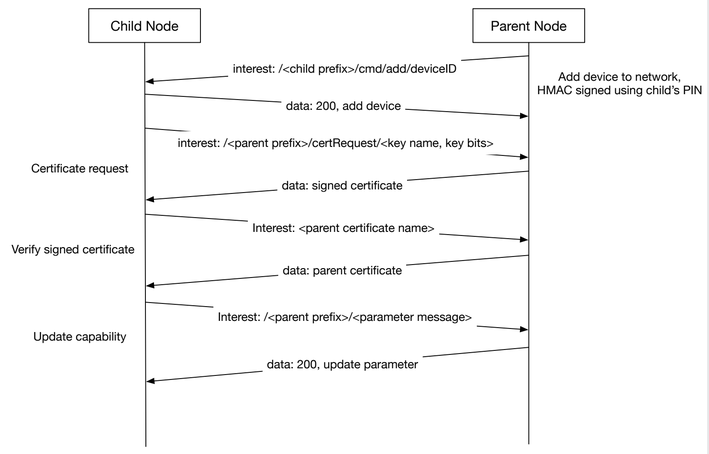

Figure 5: BMS add child sequence

Demo Implementation

We run BMS aggregation nodes in mini-ndn as an experiment.

- Mini-ndn is a mininet based emulation tool that enables easy deployment and configuration of NDN nodes [2]
- Each mini-ndn node has its own forwarder, and runs as a BMS node (for example, Room B217 in Young Hall)
- BMS nodes in mini-ndn connects to UCLA's gateway sensor data publisher, and to the testbed

Figure 6 illustrates the structure of our deployment.

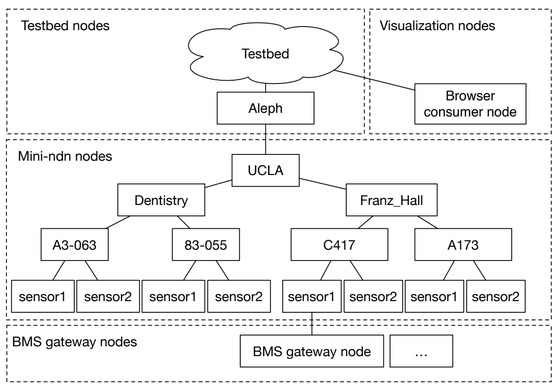

Figure 6: BMS deployment structure

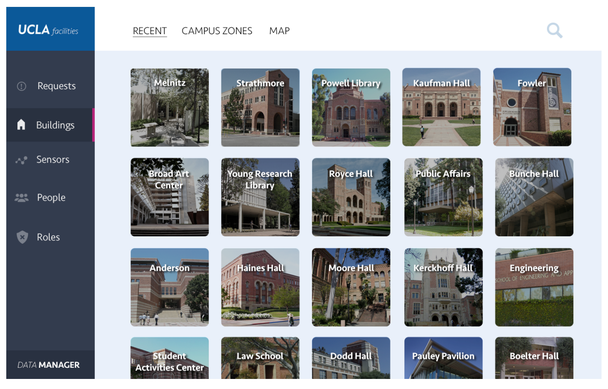

Figure 7: BMS browser UI demo

An in-browser consumer and visualization interface, as demonstrated in Figure 7 is being developed.

Future Work

- Access control in BMS
- In-browser consumer interface
- BMS command namespace

References

[1] Wentao Shang, Qiuhan Ding, A. Marianantoni, J. Burke, and Lixia Zhang. Securing building management systems using named data networking. *Network, IEEE*, 28(3):50–56, May 2014.
[2] Mini ndn on Github. `https://github.com/named-data/mini-ndn`.
[3] Yingdi Yu, Alexander Afanasyev, David Clark, kc claffy, Van Jacobson, and Lixia Zhang. Schematizing and automating trust in named data networking. Technical Report NDN-0030, Revision 3, NDN, June 2015.

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