Named Data Networking (Part 2)

Intel/NSF ICN-WEN Kickoff Workshop Tutorial

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NAMED DATA NETWORKING

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Named Data Networking Communication Model

Interest packets

Name

Optional fields

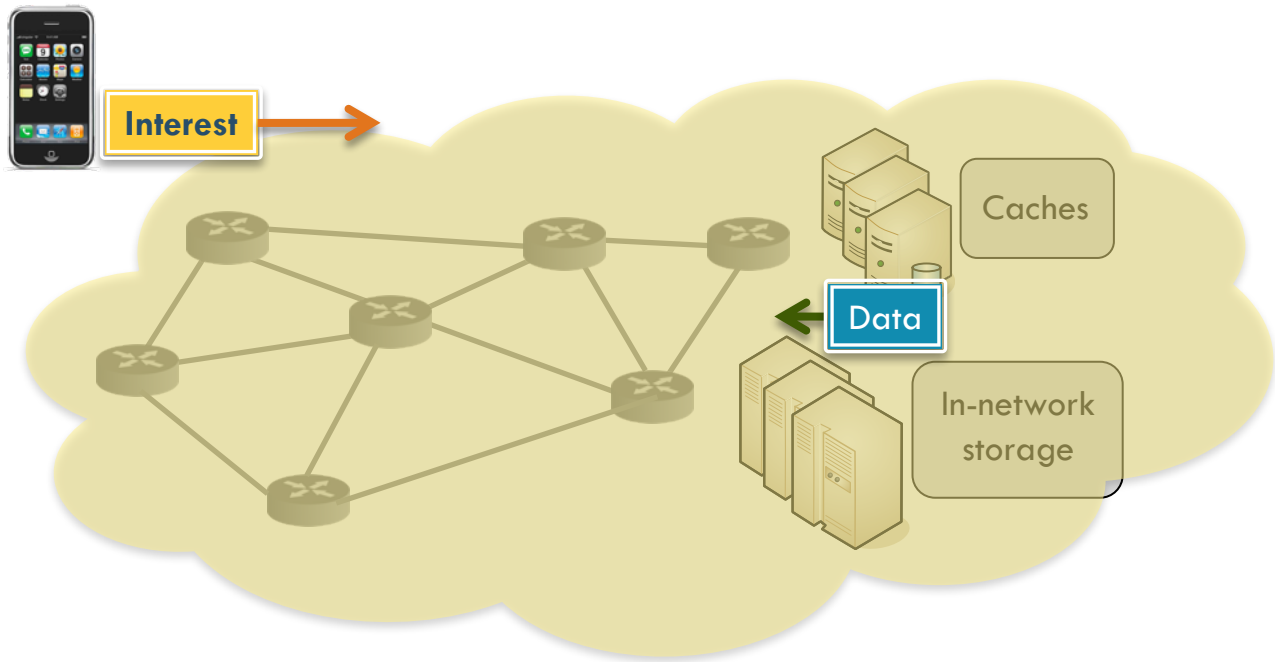
Data packets

Name

Content

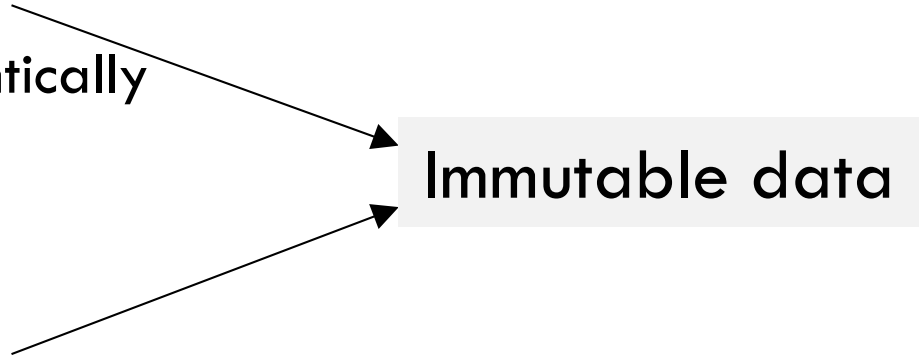
Signature

Building security principles into the networking architecture

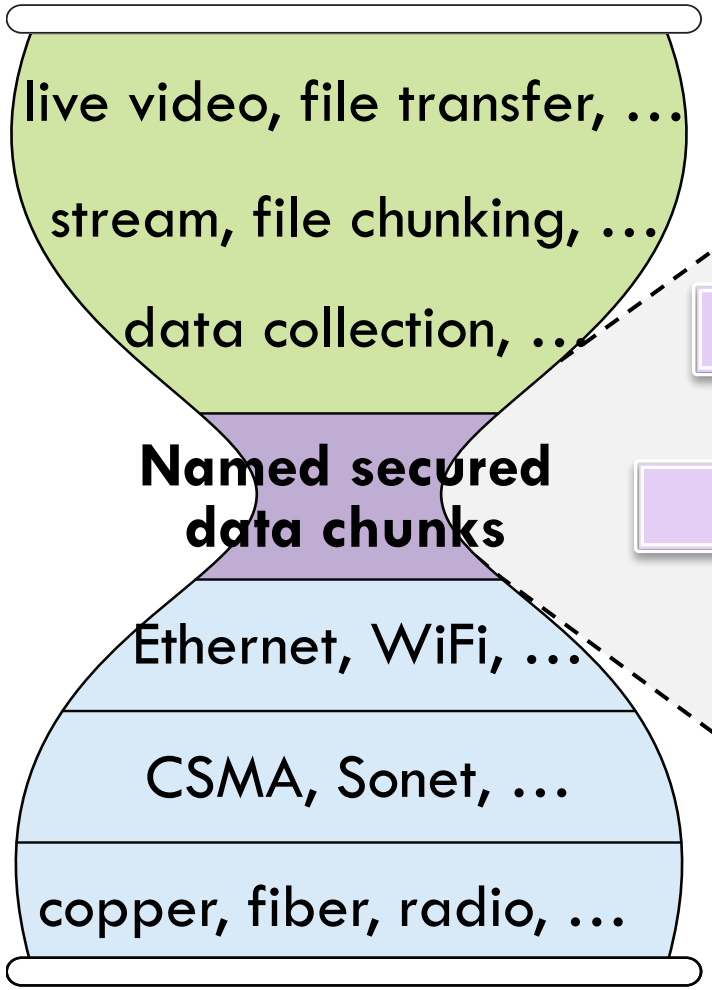


NDN: Just Three Simple Ideas

1. Per Interest, per hop forwarding state
   - → Creating closed feedback loop
     - Measure performance, detect failures
   - → Enabling multi-path forwarding
     - Add a strategy module to assist the forwarding decisions
2. Hierarchical naming of data
   - → Fetching data by application-defined, semantically meaningful names
3. Securing every data packet
   - → Removing dependency on transport security



Application-Defined, Semantically Meaningful Names for All Data Packets



Raw frames of video feed — **/UCLA/Campus/RoyceHall** /ARFeed/**FrontView**/mp4/_frame=12/ _chunk=20

Commands to a projector — /**_thisRoom**/Projector/SHOW/…

Video frame analysis — /**FUN:**/SLAM/(/…/ARFeed/…) /…

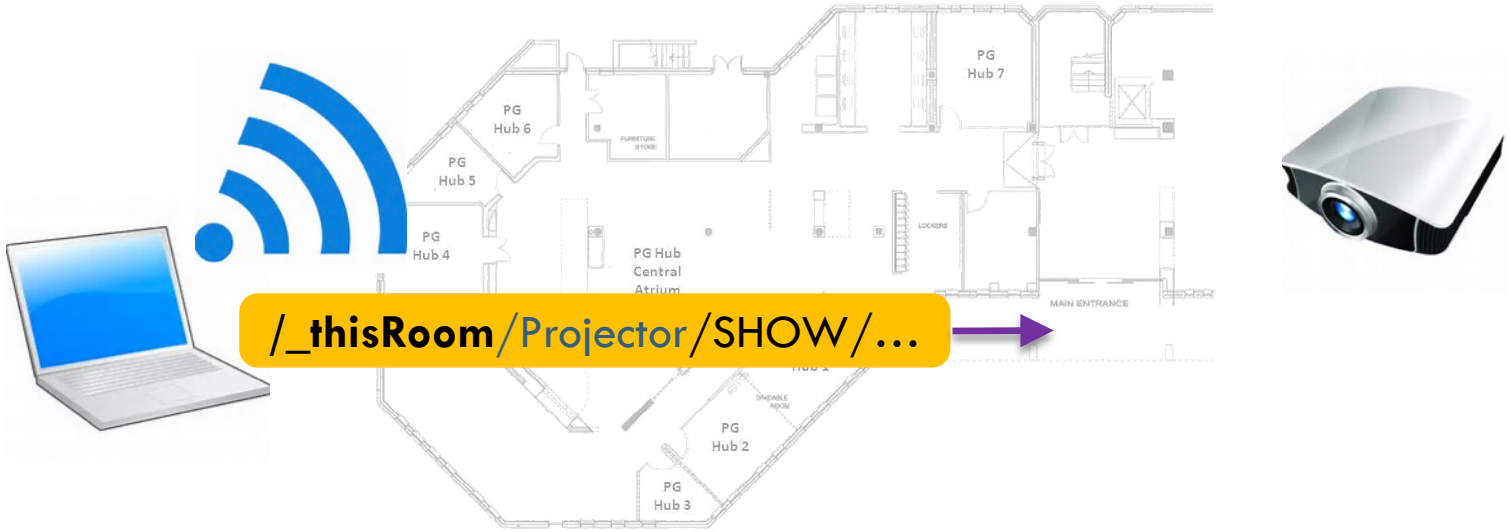
Parking lot information — /**UCLA**/Parking/**LOT8**/Info/…

Cryptographic keys — /**UCLA**/Faculty/HSEAS/CS /Alex/**BoelterHall**/KEY/_id=42

Fetching Data by Application Names enables

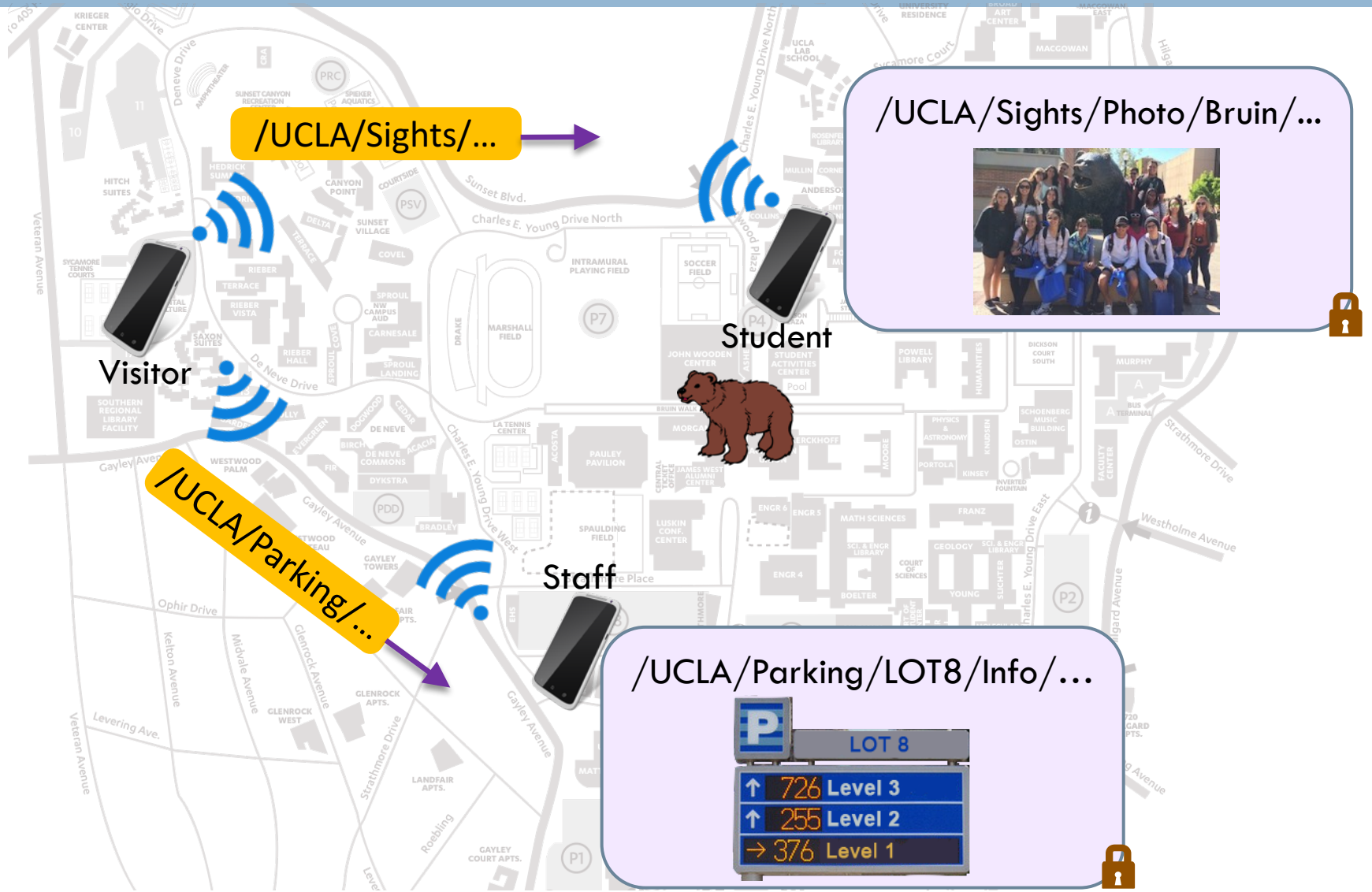
- Zero configuration and auto-discovery
- Seamless ad hoc communication
- Integration of computation, storage, networking
- Ability to use multiple interfaces at once
- And more

Zero Configuration and Auto Discovery



- Utilizing well defined naming conventions
  - "/**_thisRoom**": Interest carrying this prefix travels within local one room environment (e.g., one hop)
    - local: WiFi, Ethernet, etc; no long distance like LTE
  - "/Projector": identifies type of the device for which the interest is intended
    - Once projector located, may have further exchange on model/parameter details

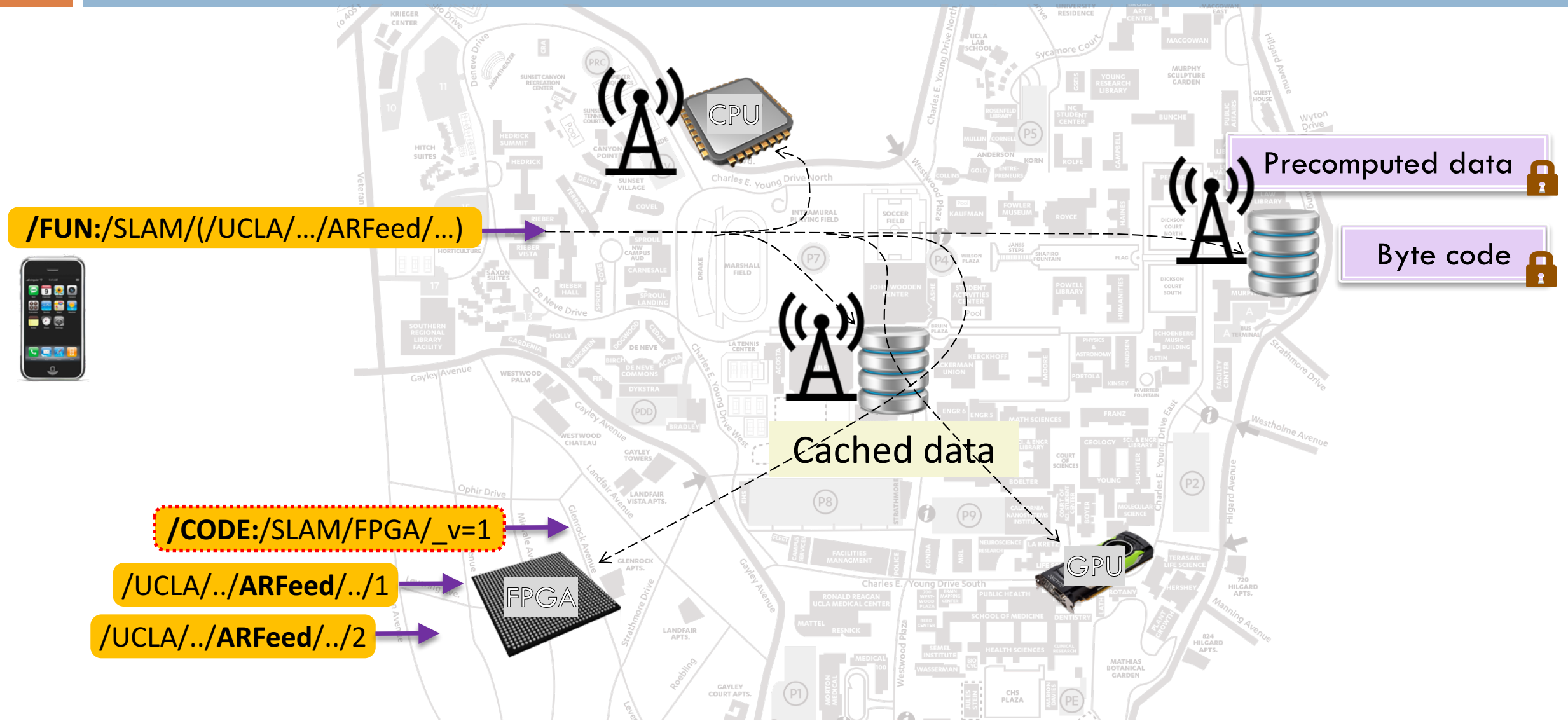
Seamless Ad Hoc Communication



Wi Fi DIRECT

Bluetooth

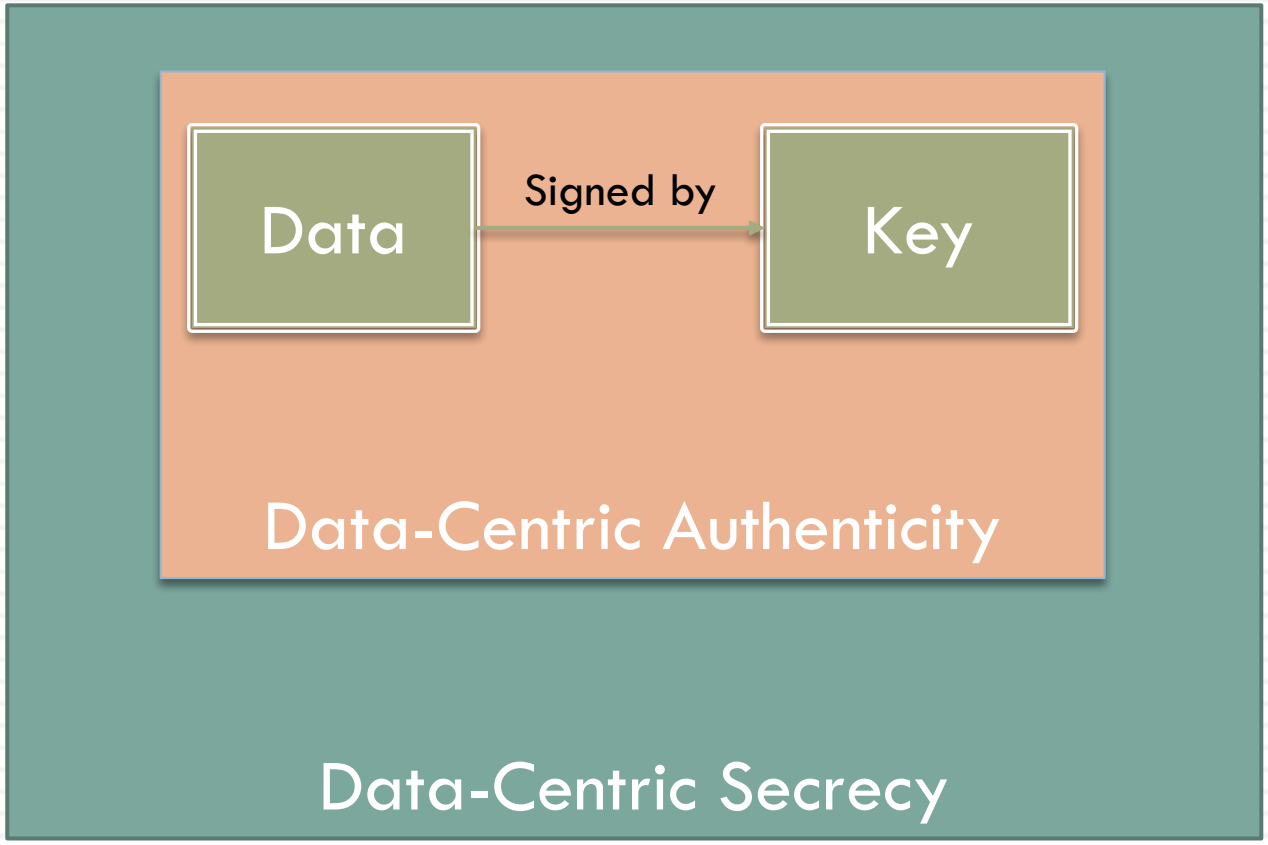
Integration of Networking, Storage & Computation



Use of Multiple Interfaces at Once

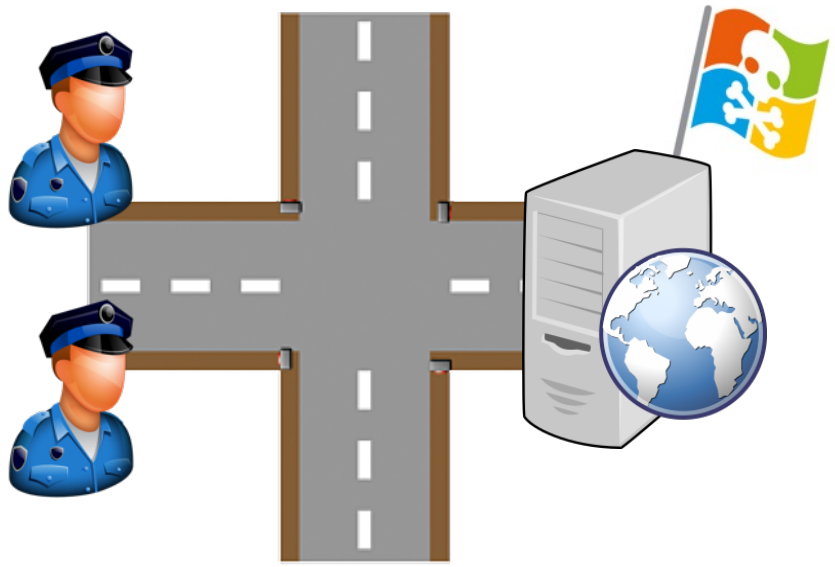
Data request by its name is independent of the link or location

Data-Centric Security of NDN

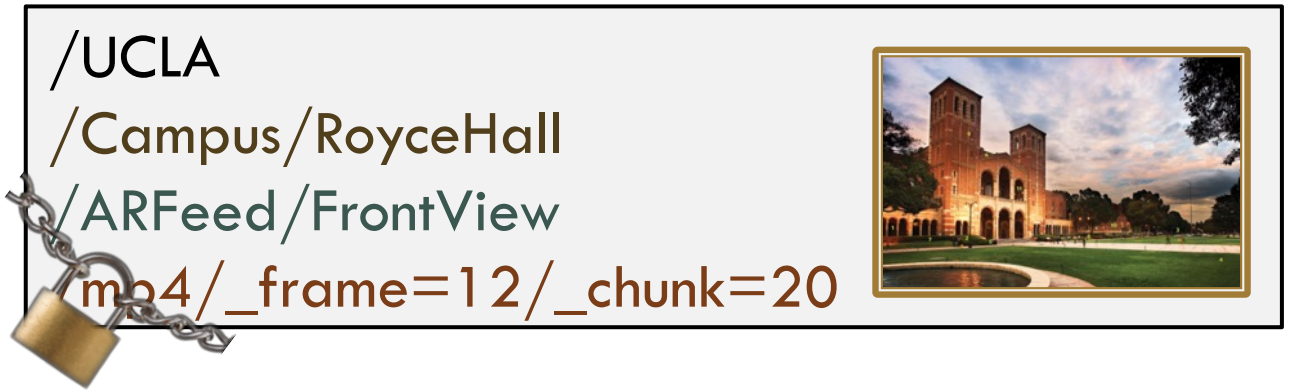


Built-In For Every Data Packet

- In the Internet you secure your path..
- ..but the server may still be hacked!



- In NDN you **sign** the data with a **digital signature..**
- ..so the users know when they get bad data!
- **Data secured in motion and at rest**



Authentication of NDN Data

/UCLA
/Campus/RoyceHall
/ARFeed/FrontView
/mp4/_frame=12/_chunk=20

Signed by

/UCLA
…/KEY

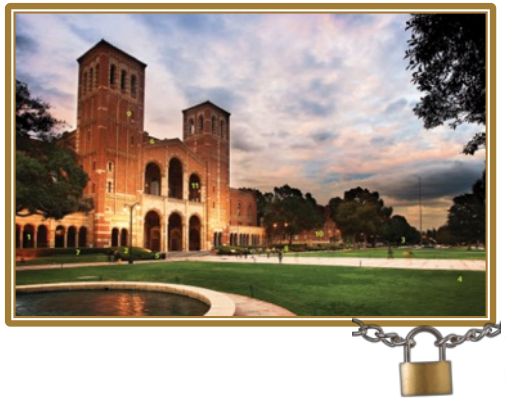
Signed by

KeyLocator: /UCLA/…/KEY

KeyLocator: /UCLA/…/KEY

Key Privilege Separation

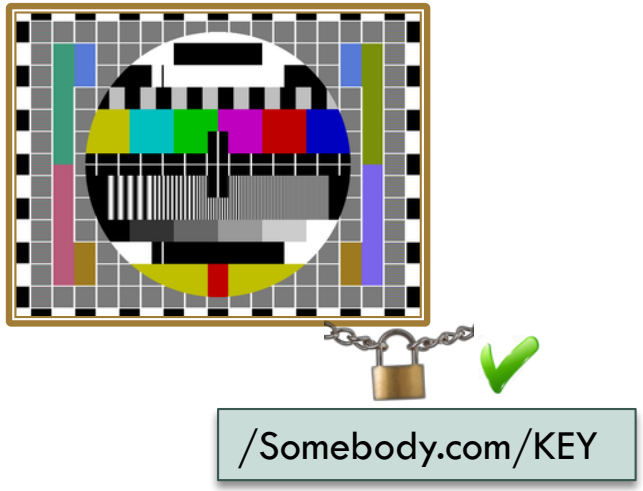
/UCLA/Campus/RoyceHall/ARFeed/FrontView
/mp4/_frame=12/_chunk=20



/UCLA/Camera/…/Campus
/RoyceHall/Camera/KEY

A frame from a camera installed in the Royce Hall

/UCLA/Campus/RoyceHall/ARFeed/FrontView
/mp4/_frame=12/_chunk=20

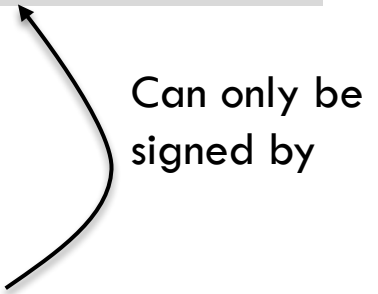


/Somebody.com/KEY

A forged frame

Name-Based Limit of Key Power

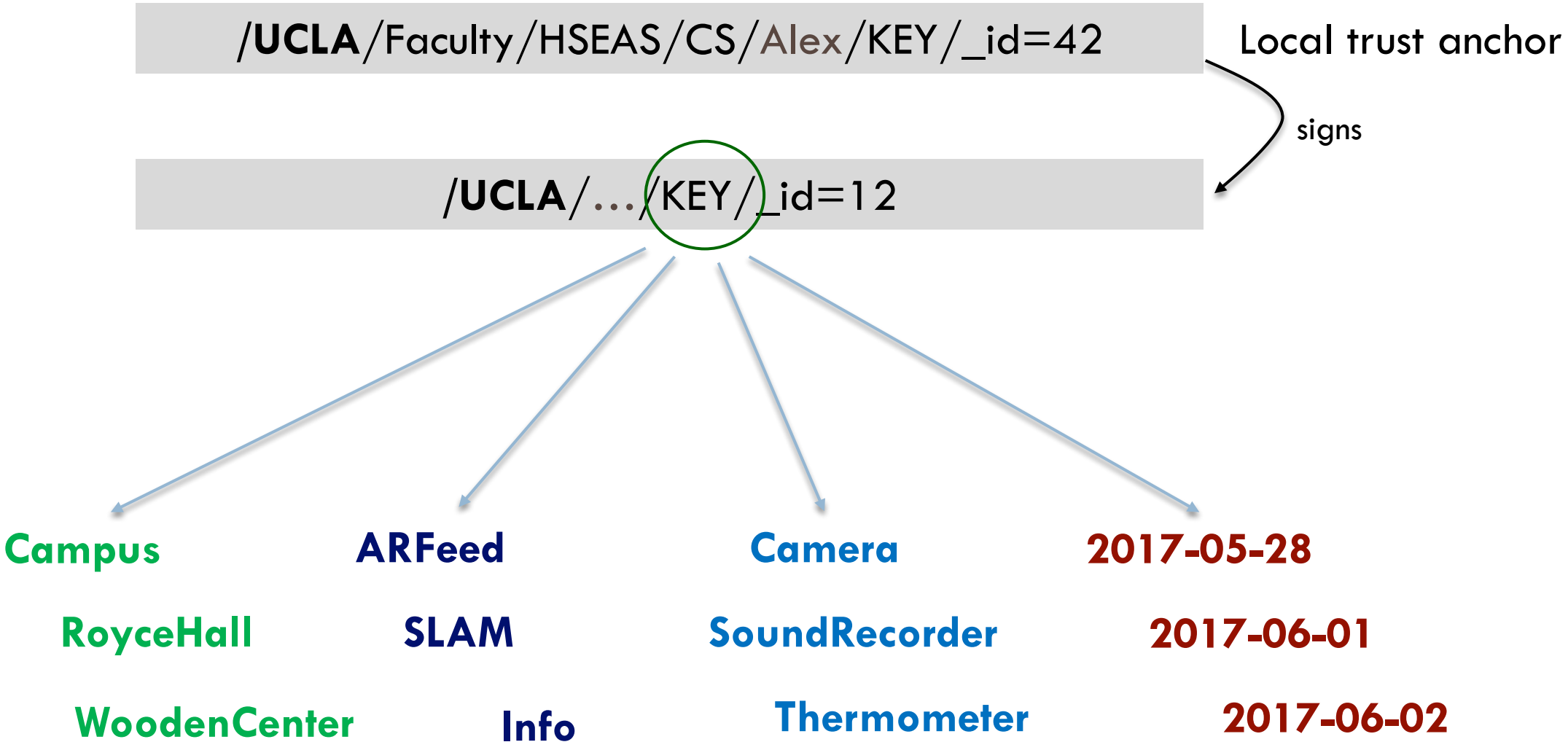
/**UCLA**/Campus/RoyceHall/**ARFeed**/…/mp4/_f=…/_s=…



/**UCLA**/**Cameras**/_id=…/RoyceHall/…/KEY/_id=…

ARFeed data to be valid, must be signed with a "Camera" key under the same name hierarchy

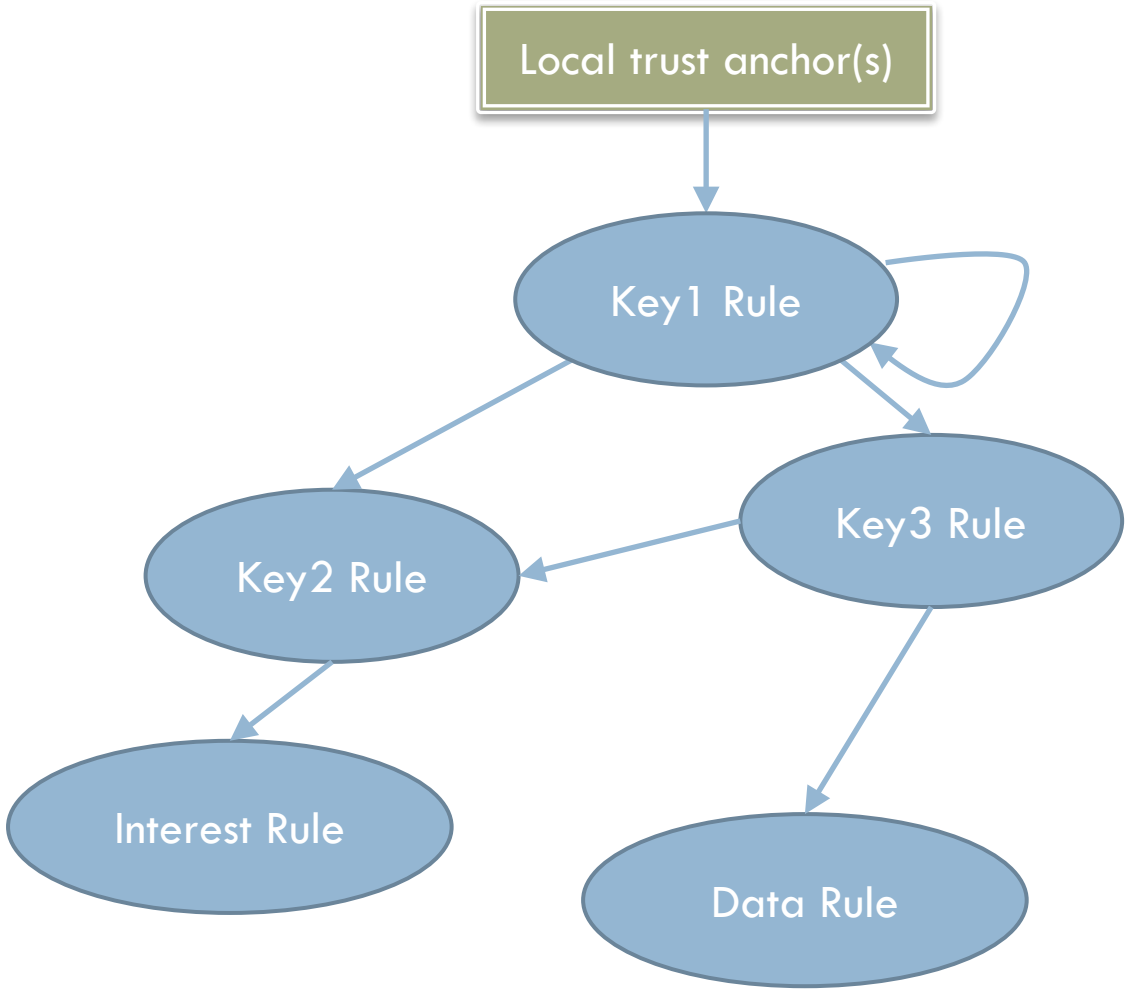
Flexible Restrictions through Namespace Design



Trust Schema: Name-Based Definition of Trust Model

- A formal language to formally describe trust model
  - Schematize data and key name relationships

```
<>      <CONST>
token*  token?
[func]
(:group:token)
```



An Example of Trust Schema for Smart Campus

(:Prefix:<>*)(:Location:<>?)<ARFeed>[View]<mp4><frame><chunk>

Camera(Prefix, Location, View)

(:Prefix:<>*)<Cameras>[cam-id](:Location:<>?)<View>[View]<KEY>[key-id]

Faculty(Prefix, Location)

(:Prefix:<>*)<Faculty>[user](:Location:<>?)<KEY>[key-id]

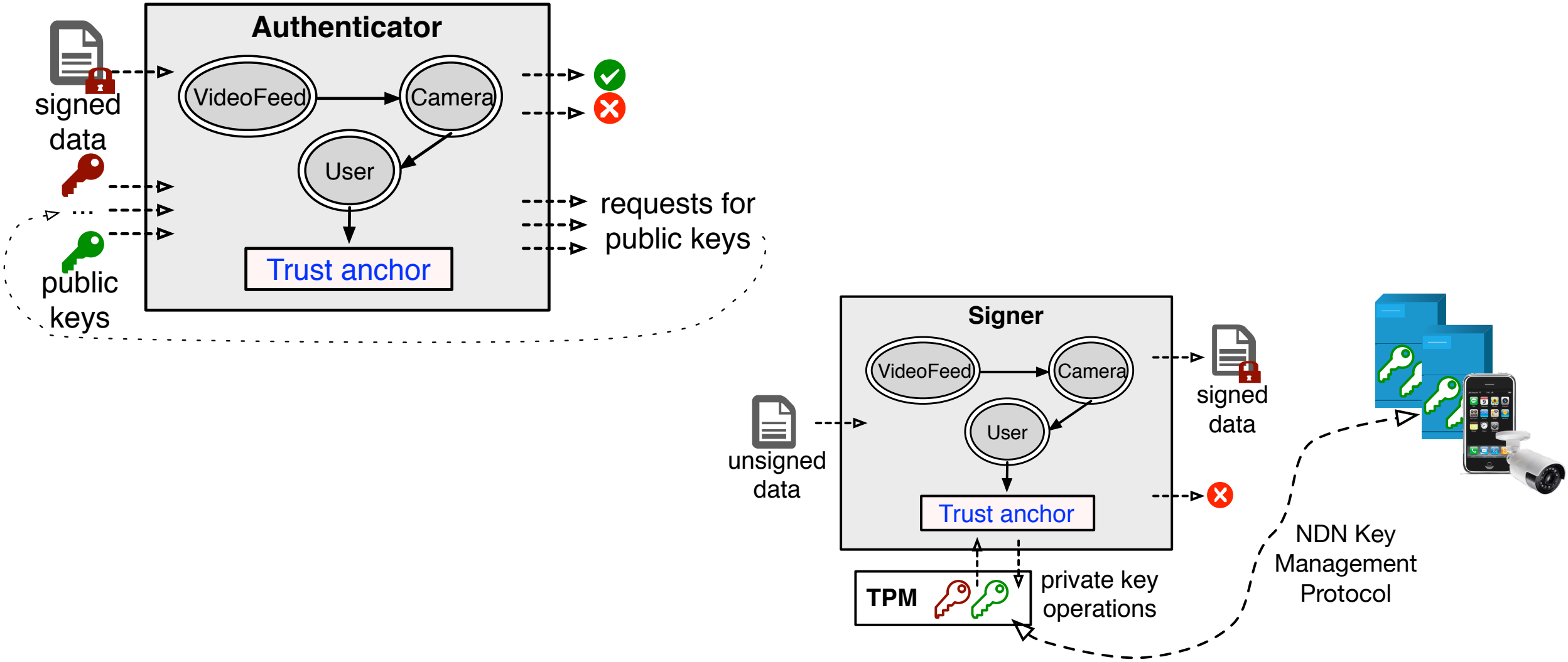
LocalAnchor(Prefix)

General Trust Model

/UCLA/KEY/_id=1

Trust Model Specialization for UCLA campus

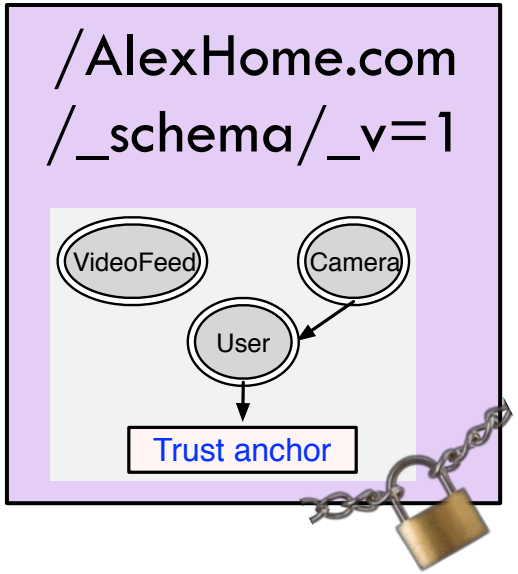
Trust Schema as an Automation Tool



Trust Schema as a Bag of Bits

- Can be distributed and updated using NDN mechanisms
- Secured as any other data packet

- Power of trust schema data
  - My phone can reliably validate the received video feed data
  - Camera can properly sign video feed data
  - Camera can validate commands from my phone
  - Routers can validate data and authorize requests



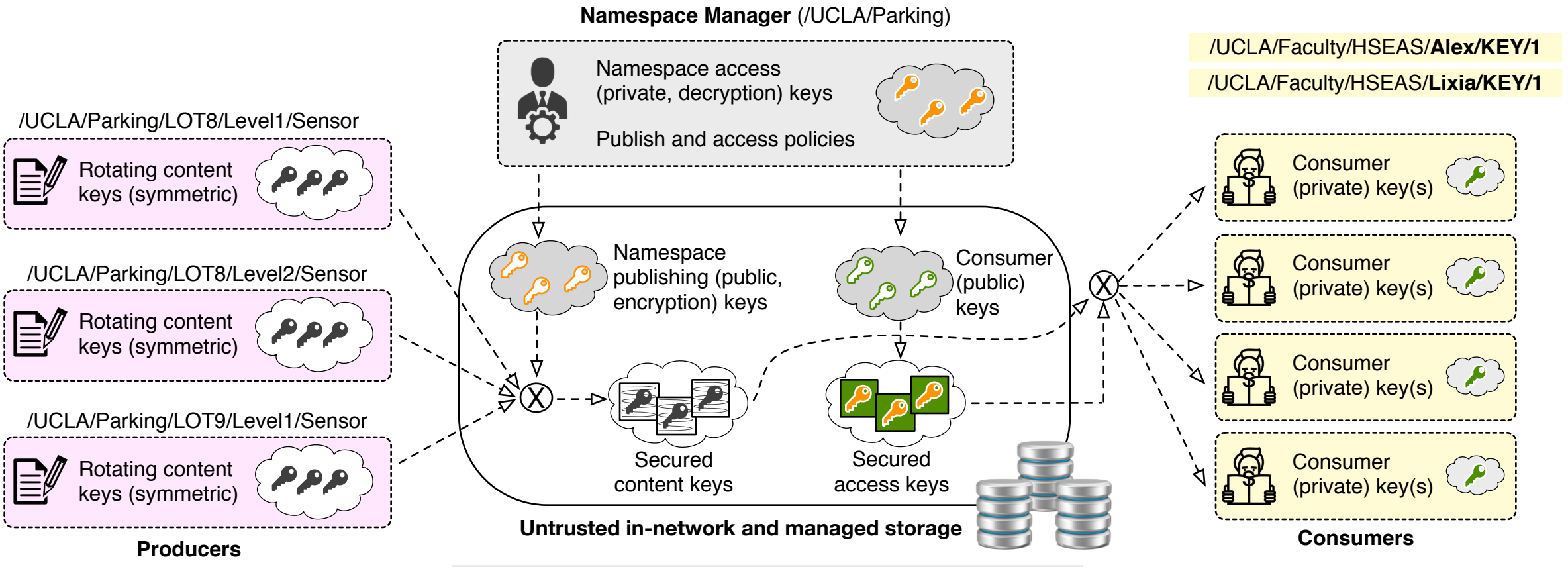
Data-Centric Secrecy

Name-Based Confidentiality and Access Control

Confidentiality and Access Control Requirements

- Data-centricity
  - Confidential “end-to-end” (app-to-app), in motion or at rest
- Flexible controls
  - Granting access to publish/read at fine granularities
  - Changeable policies at any time
- Asynchrony
  - No tight coupling between distributed data production and access granting
- Scalability
  - Manageable number of encryption/decryption keys
- Multi-party
  - Seamless coordination of control among distributed data producers and consumers

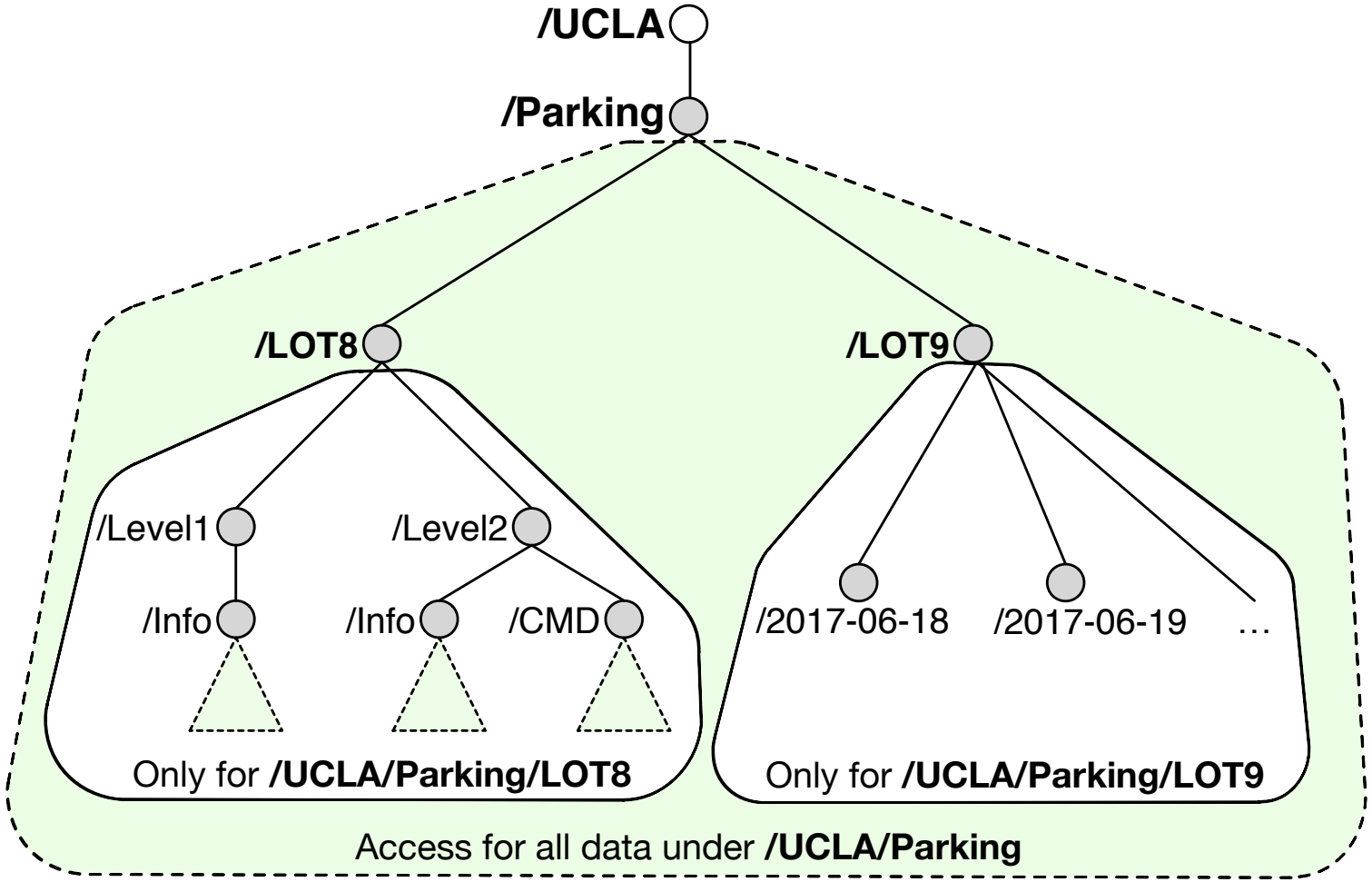
Name-Based Access Control



Control Granularity

- Naming conventions to leverage hierarchical scopes for read and write access

- Based on data type
  - LOT8 vs LOT9
  - Level1 vs Level2
- Based on data attributes
  - Time
  - Location



Takeaway Points

- NDN: a great enabler for boosting secure, reliable, yet simple edge networking
- Key idea: letting network and applications share the same namespace
  - Enabling ad hoc, DTN communication via established namespace
  - Integrating networking, storage, processing via named data
  - Directly securing data
  - Leveraging names of data and keys
    - To define trust schema for distributed authentication and authorization
    - To define groups and access permissions in distributed (decentralized) way