# NDN: A Security Perspective

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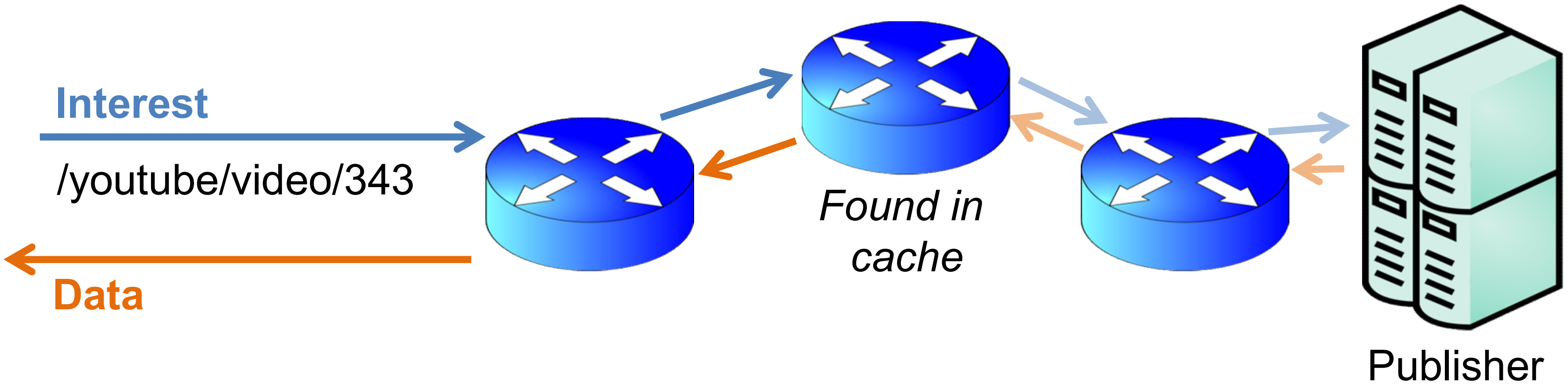
# Named-Data Networking (NDN)



## Interest Packet

**Content Name**

Selectors
(order preference, publisher filter, exclude filter, …)

Nonce

Guiders
(scope, Interest lifetime)

## Data Packet

Name

MetaInfo
(content type, freshness period, …)

**Content**

Signature

# Architectural Security

## Start with Properties

Data integrity

Access control

Privacy protections

User authentication

Server authentication

Denial-of-service prevention

⋮

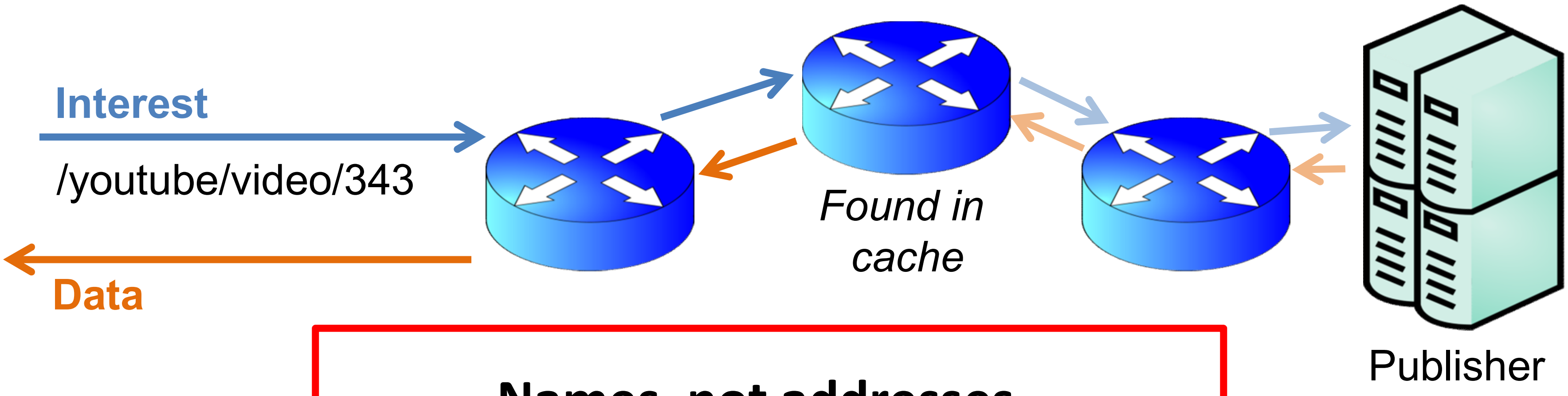
## Start with Mechanisms

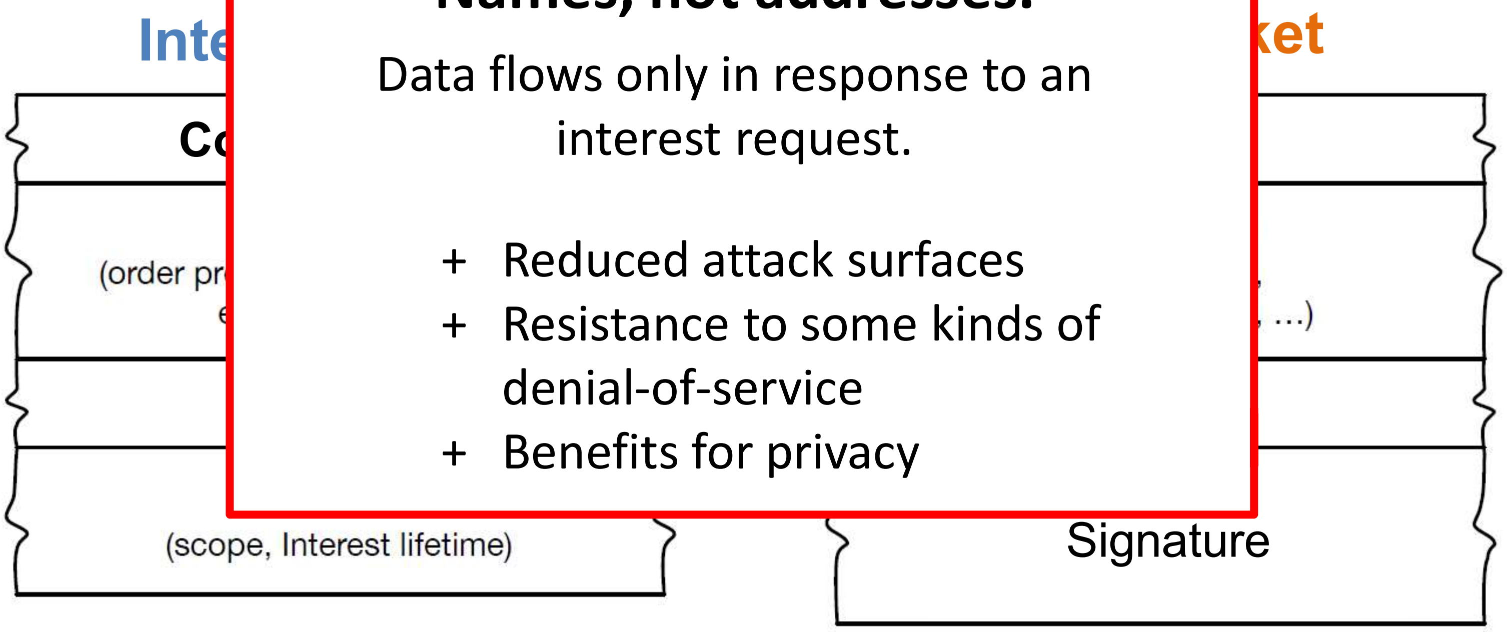
NDN begins with seemingly simple architectural concepts that provide significant security leverage.

Research explores implications and applications of those core ideas.

**We can define actual future mechanisms.**
**We don’t get to define actual future threats!**

# Data-Centric Security



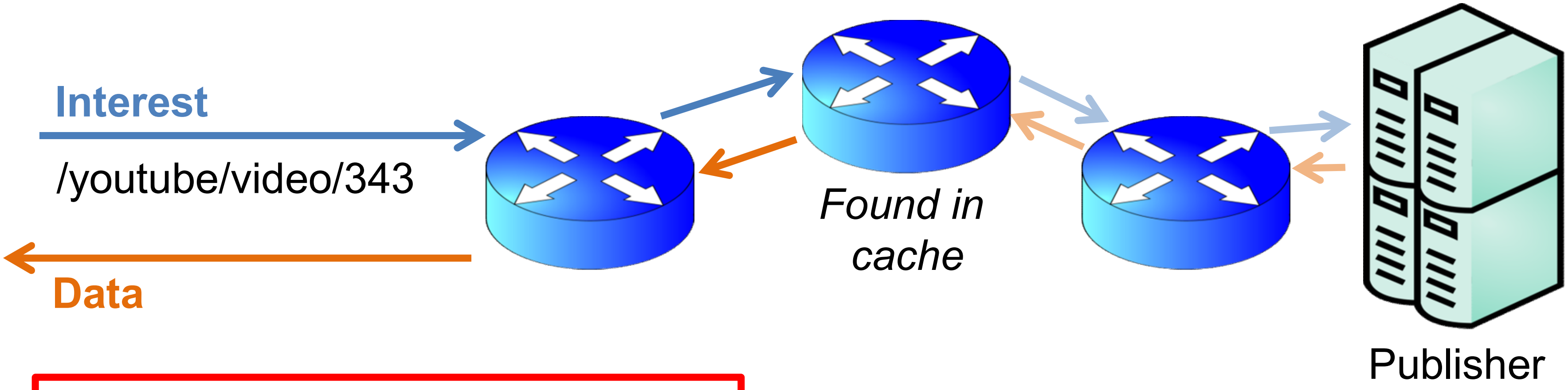


**Names, not addresses.**

Data flows only in response to an interest request.

- + Reduced attack surfaces
- + Resistance to some kinds of denial-of-service
- + Benefits for privacy

# Data-Centric Security



**All content must be signed.**

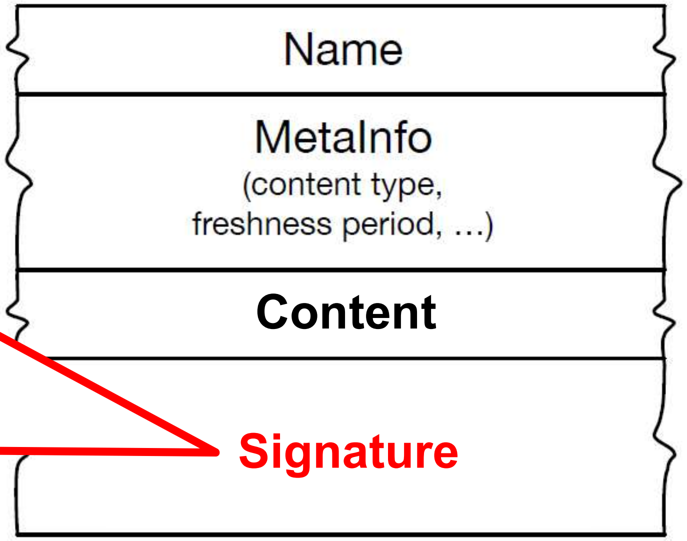
Routers may, clients shall, verify.

Validation policy defined by applications.

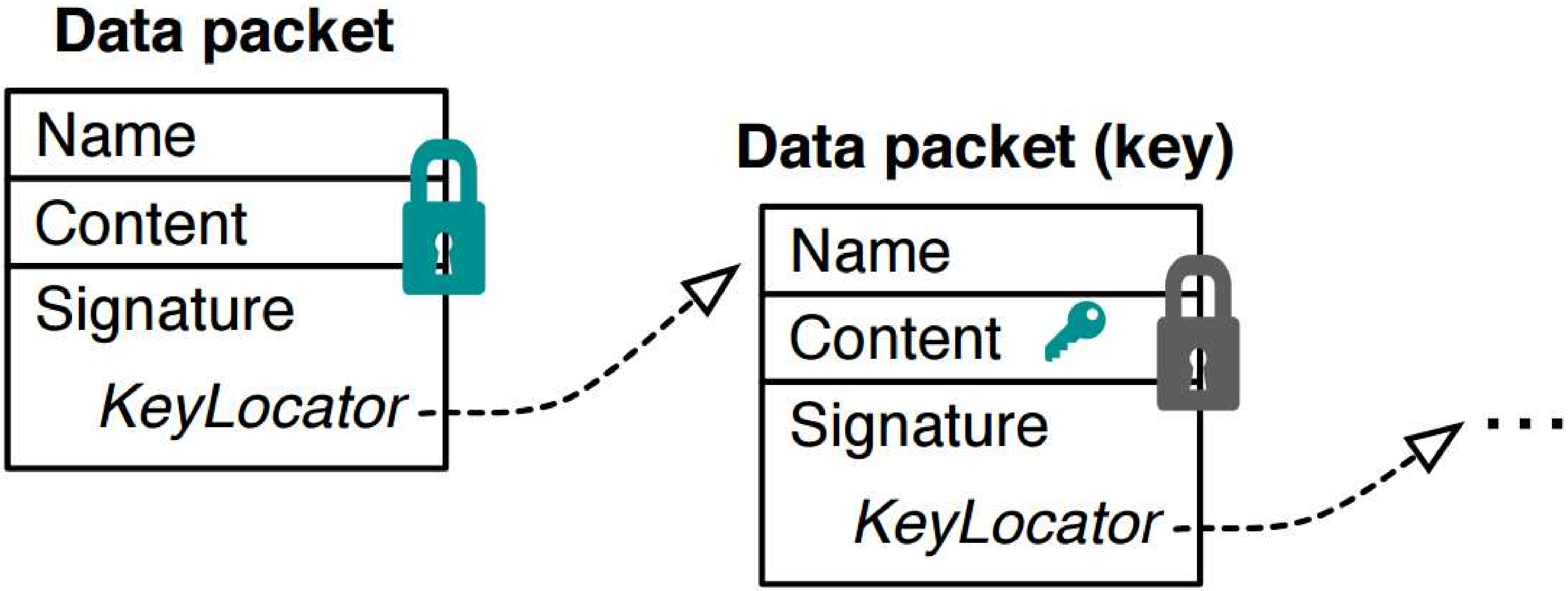
+ Flexible foundation for many security properties:

Integrity, authentication, access control, provenance

## Data Packet



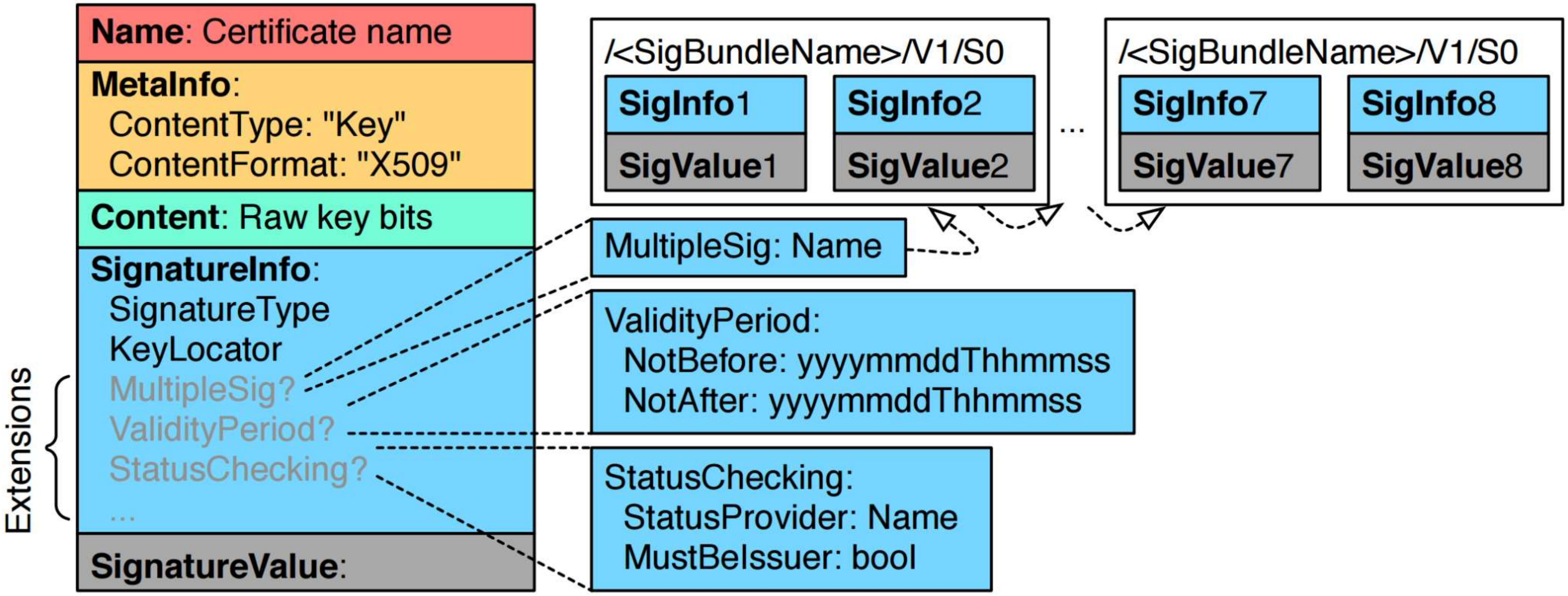
# Signatures in NDN



**Big idea:** Certificates are just named, signed data.
Get them "for free" in the data-centric security approach.

# Signature Format Details

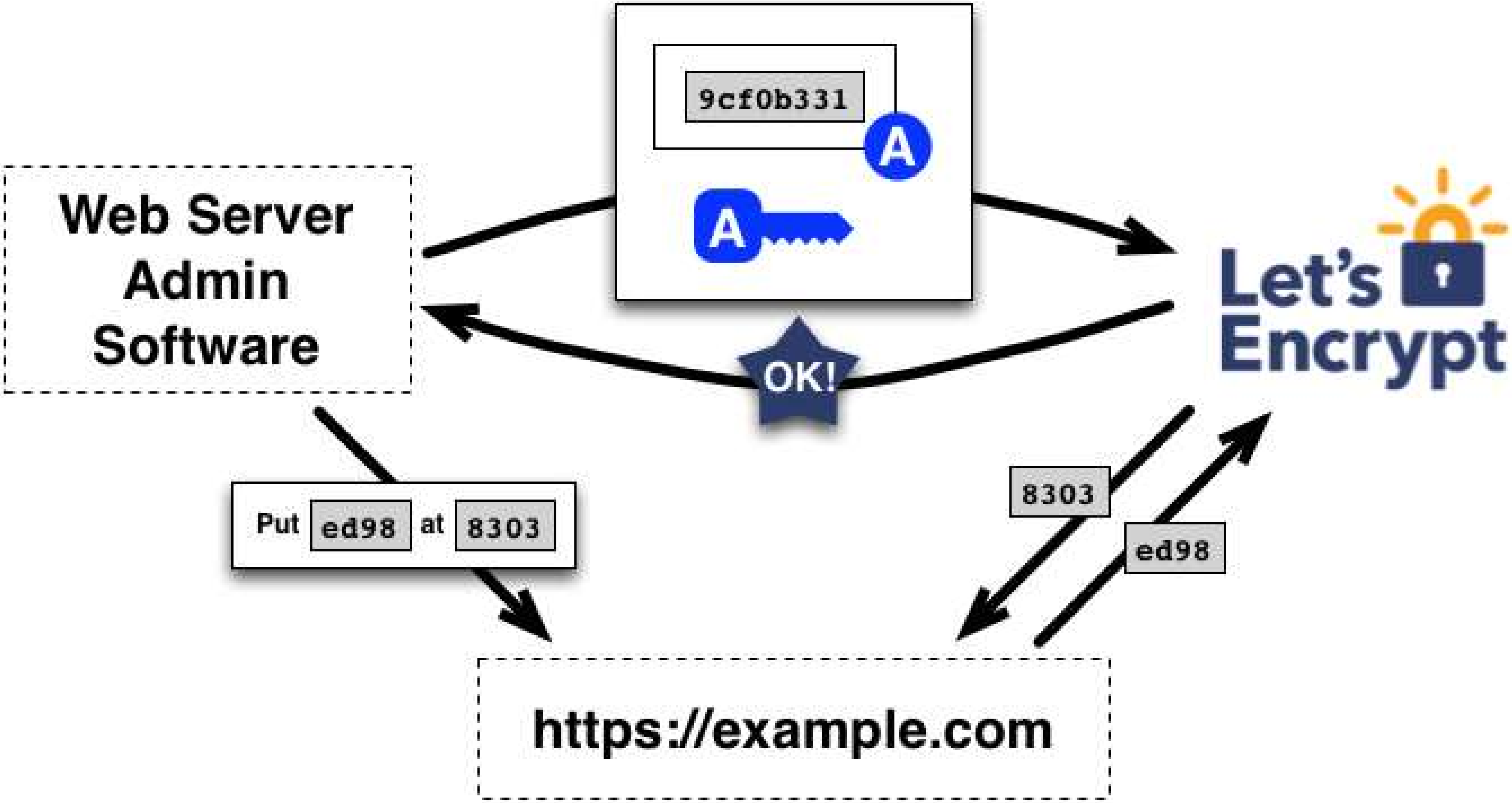
Ensure flexibility, trust agility,
robustness for long-lived signatures.



**Big idea:** With appropriate mechanisms, signatures can outlive the keys that signed them, even if compromised.

# Automatically Provisioning Trust

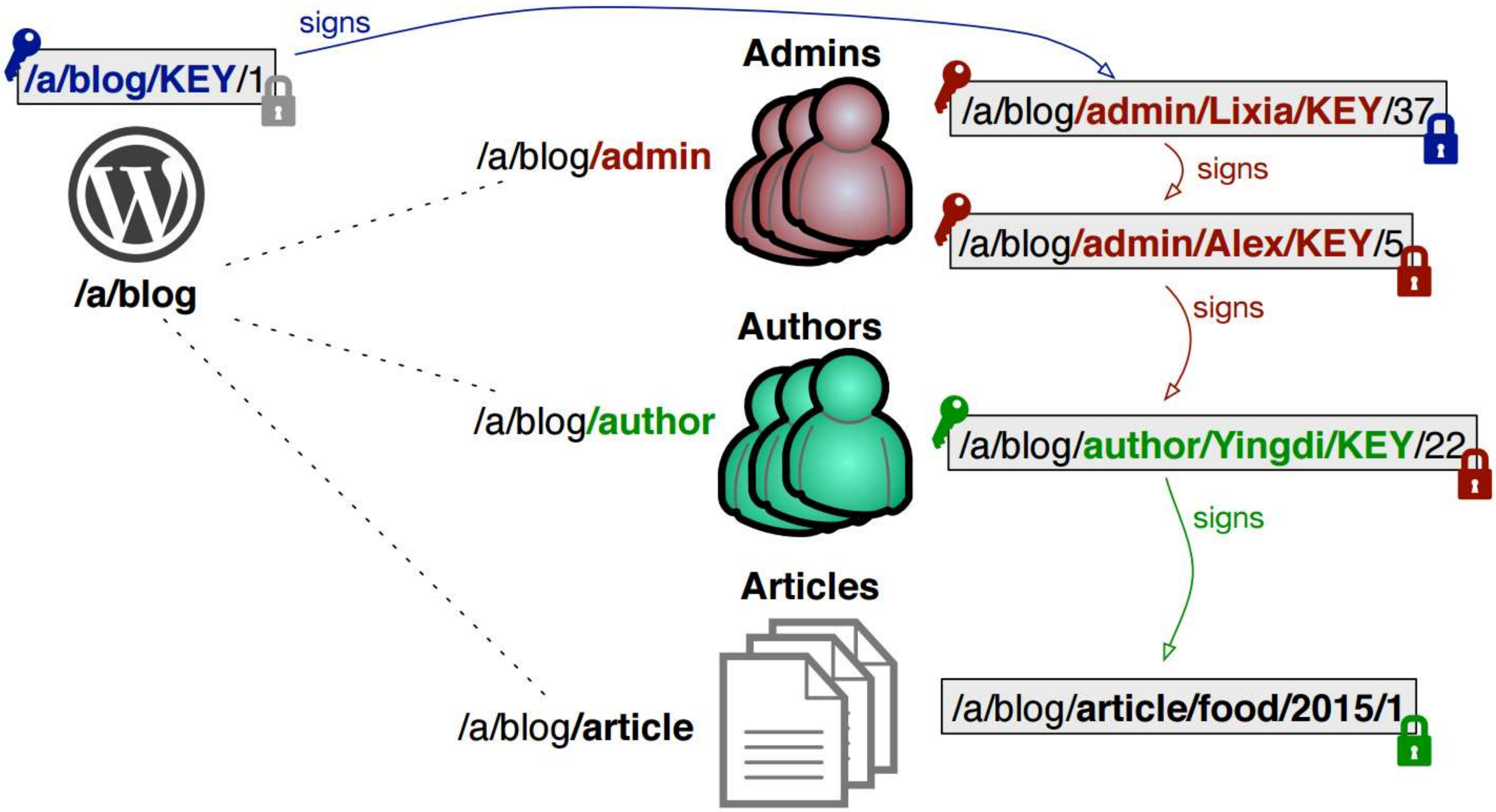
How does a publisher get their keys signed?



**Big idea:** Abstract identity verification and automate issuance.

# Namespaces and Security

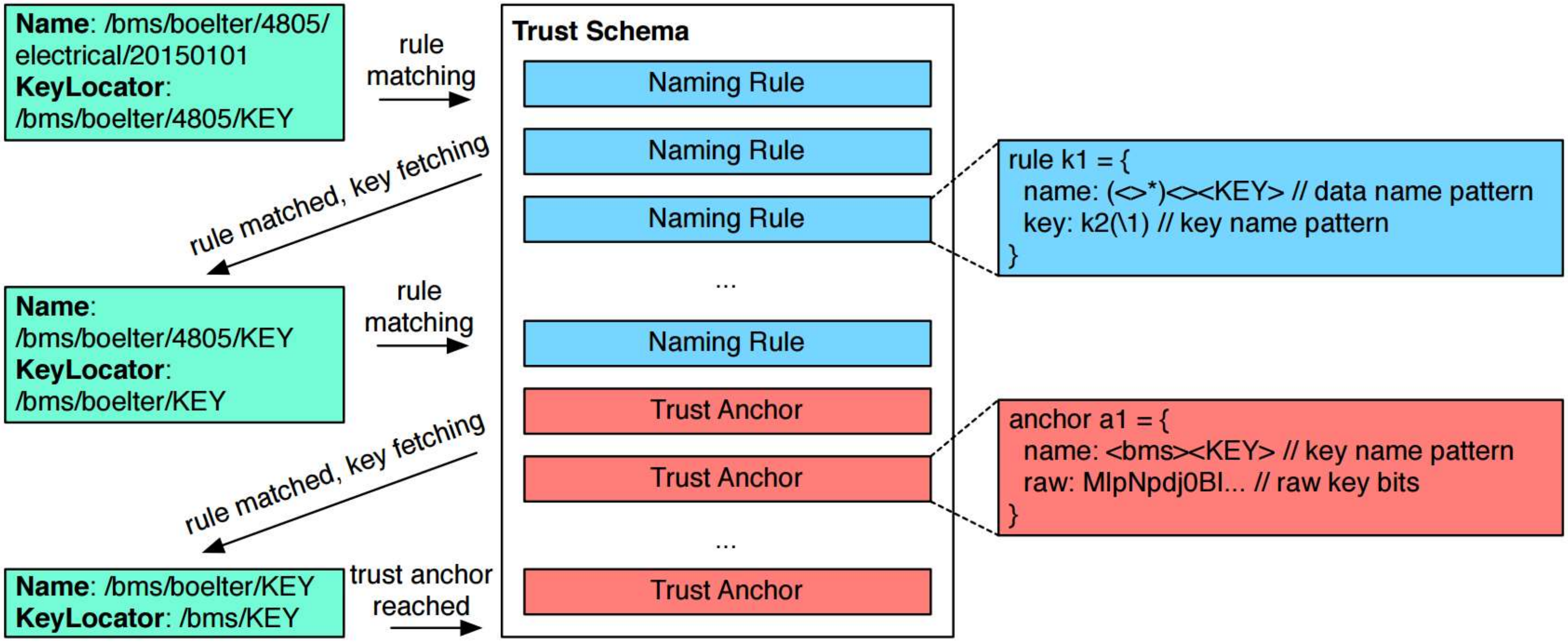
Who is allowed to sign what?



**Big idea:** Namespace design can convey capabilities, structure trust.

# Trust Schemas

**Big idea:** Abstract validation based on structure of namespace, allow applications to define rules for trust or adopt pre-defined templates designed by experts.



**Name**: /bms/boelter/4805/electrical/20150101
**KeyLocator**: /bms/boelter/4805/KEY

**Name**: /bms/boelter/4805/KEY
**KeyLocator**: /bms/boelter/KEY

**Name**: /bms/boelter/KEY
**KeyLocator**: /bms/KEY

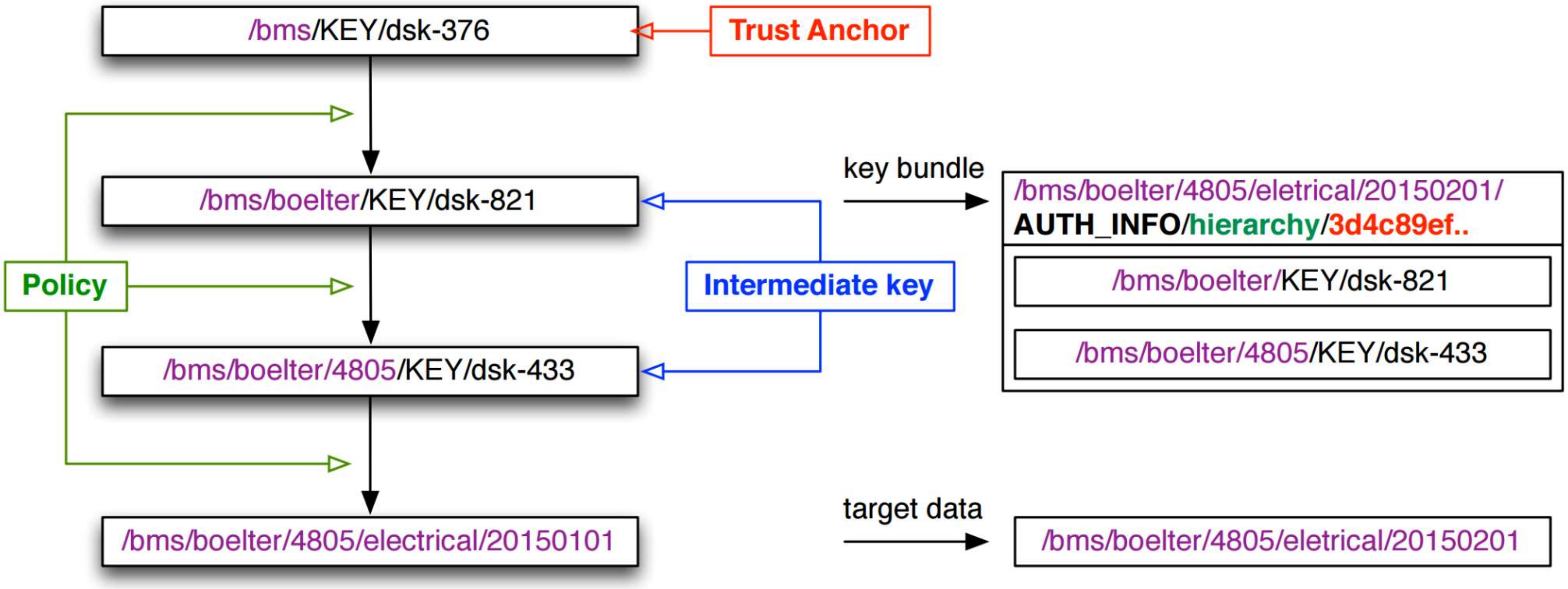
```
rule k1 = {
  name: (<>*)<><KEY> // data name pattern
  key: k2(\1) // key name pattern
}
```

```
anchor a1 = {
  name: <bms><KEY> // key name pattern
  raw: MlpNpdj0BI... // raw key bits
}
```

Achieves vastly greater flexibility and security than existing TLS PKI.

# Optimizing Performance: Key Bundling

Have producers/publishers provide evidence up front, rather than making consumers collect it.



/bms/KEY/dsk-376

Trust Anchor

/bms/boelter/KEY/dsk-821

Policy

Intermediate key

/bms/boelter/4805/KEY/dsk-433

/bms/boelter/4805/electrical/20150101

key bundle

/bms/boelter/4805/eletrical/20150201/
AUTH_INFO/hierarchy/3d4c89ef..

/bms/boelter/KEY/dsk-821

/bms/boelter/4805/KEY/dsk-433

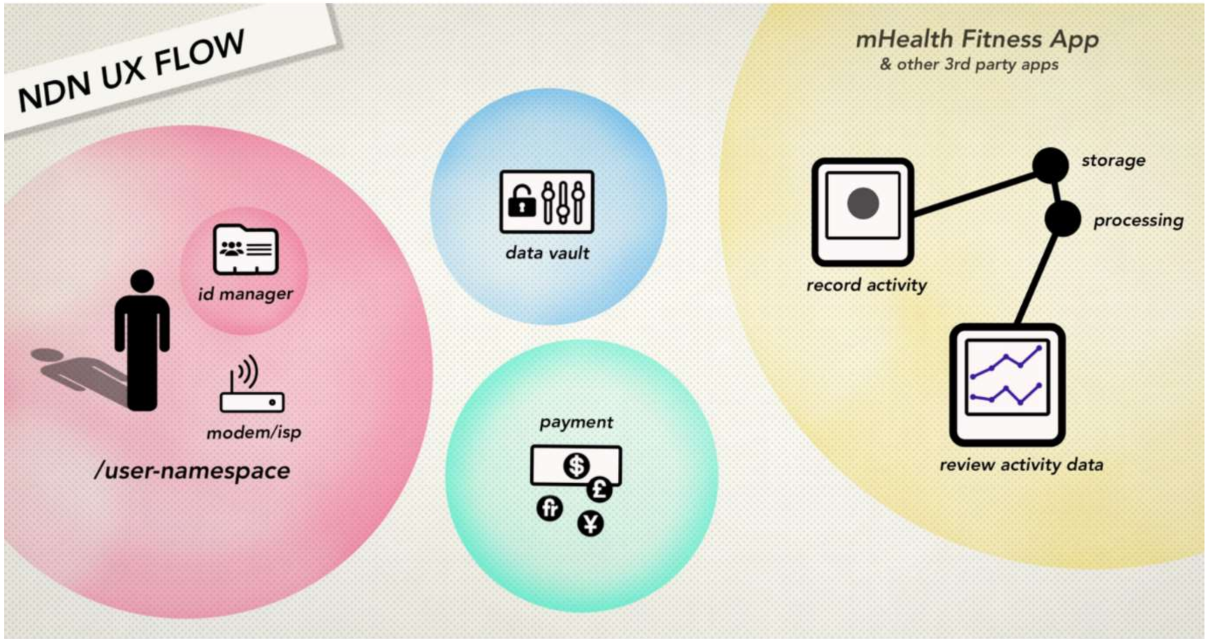
target data

/bms/boelter/4805/eletrical/20150201

Data-centric model enables such optimizations without security loss.

# Learning from Applications: Open mHealth

Granular, user-centric data access control in an ecosystem of composable services

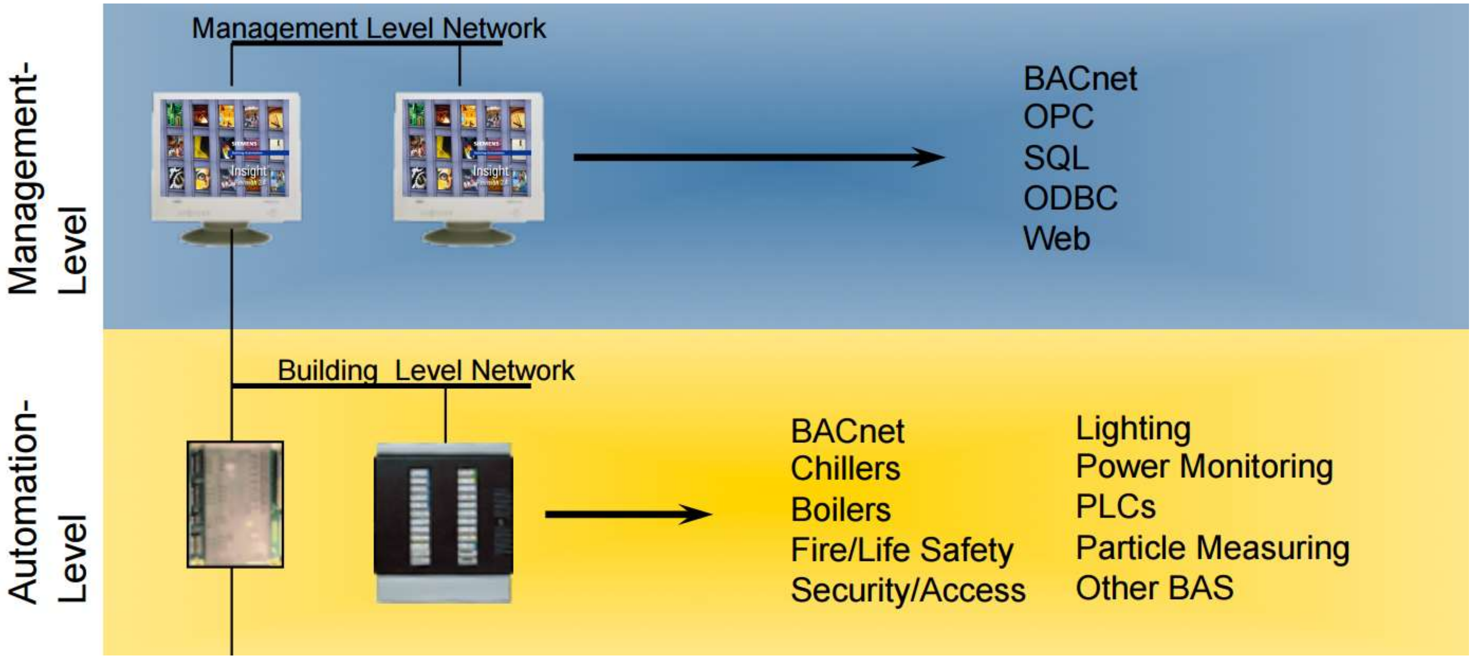


An old idea: Encryption-based access control

New opportunities: Use namespace hierarchy to express fine-grained access policies

# Enterprise Building Automation and Management Systems (EBAMS)

Enterprise-controlled, but authorization hierarchy may not match deployment structure. Resource constrained platforms.

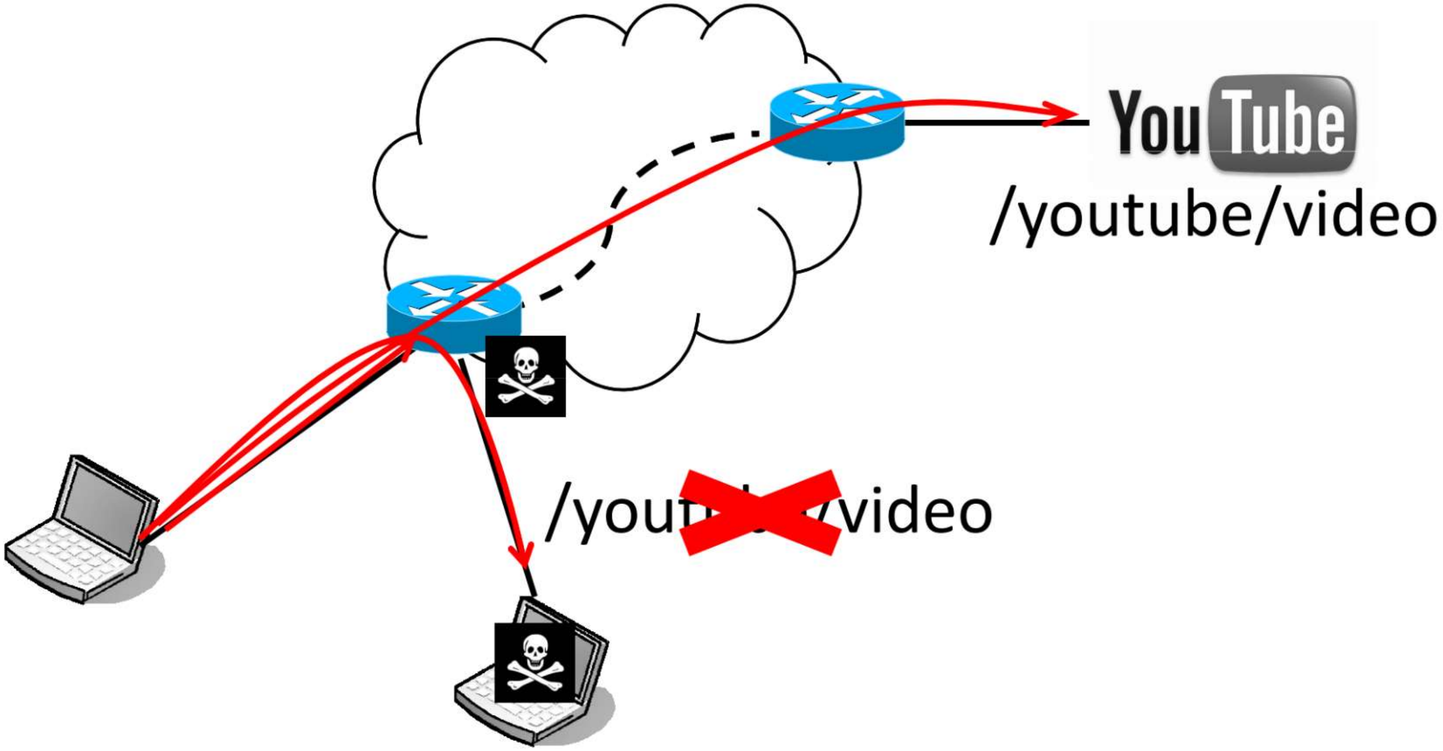


Light-weight crypto for command- and data access control.

Explore use of key publishing and naming instead of interactive security services.

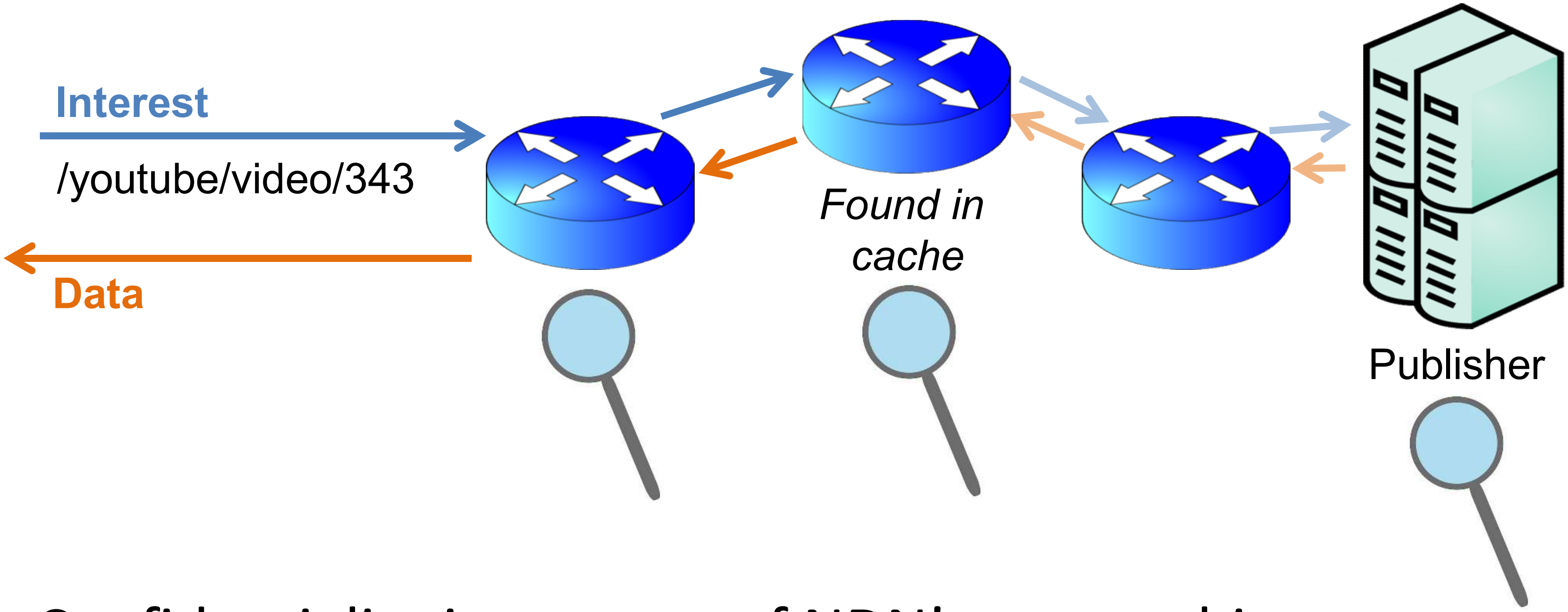
# Content Poisoning

Content-centric approach raises new security challenges



Network can help police, but have to avoid DoS exposure.
Tradeoffs between resistance and flexibility.

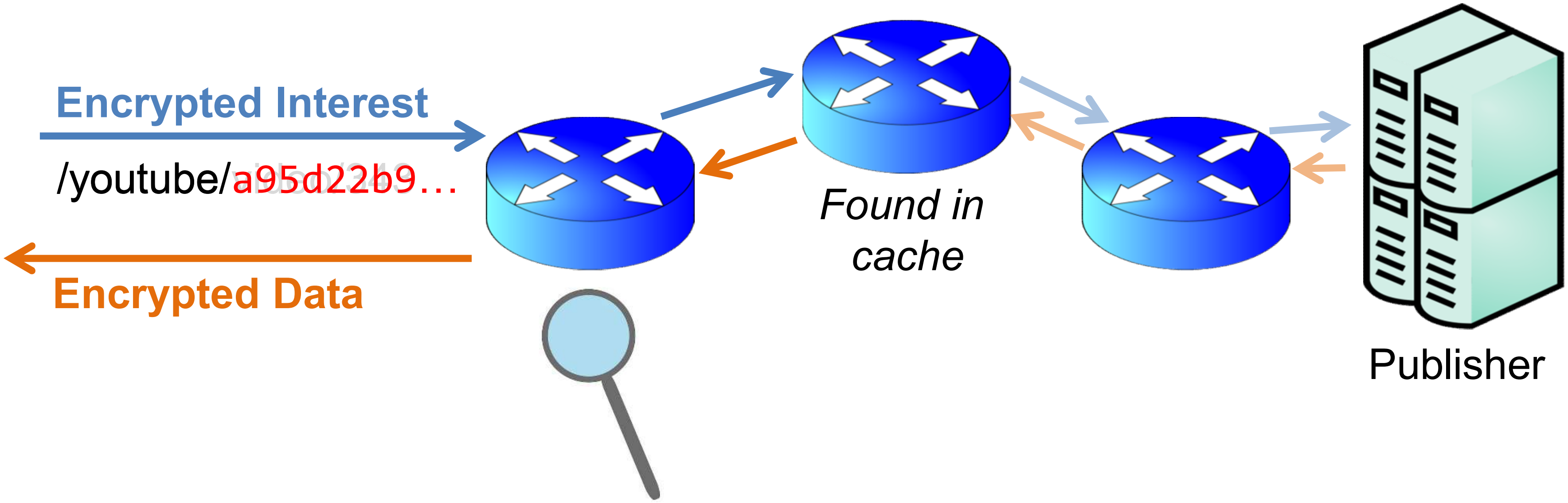
# Confidentiality and Privacy



Confidentiality is not part of NDN's core architecture, left up to applications.

However… design provides certain inherent privacy advantages over IP.

# Confidentiality and Privacy



Encrypted Interest

/youtube/a95d22b9…

Encrypted Data

*Found in cache*

Publisher

Applications can encrypt interests and/or data to provide confidentiality and access control.

Tension between allowing caching and privacy...

# Security Lessons

Data-centric security philosophy allows us to convert hard security problems (e.g., host security) into ones that are relatively easier (crypto, key management).

Security priorities will continue to evolve, and no network architecture will solve them all for all time—but architecture can give us a more solid foundation.

Security-Networking collaboration has been hugely rewarding.  FIA experience has yielded insights on problems and solutions in the IP/TLS architecture.

# NDN: A Security Perspective

Thoughts from the Team