Controlled Sharing of Sensitive Content

NDN Case Study

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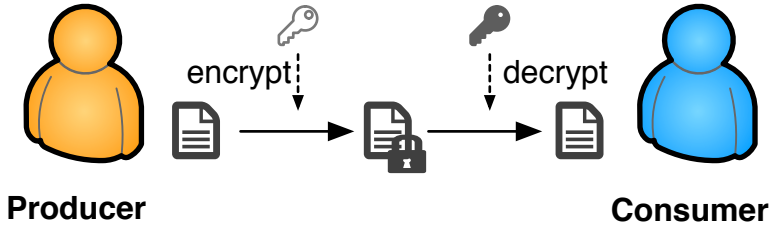
Content-based confidentiality

- Confidentiality stays with content
  - independent from where the content is
  - independent from how it is delivered
  - content are produced in encrypted format
  - only authorized consumers are able to access the content



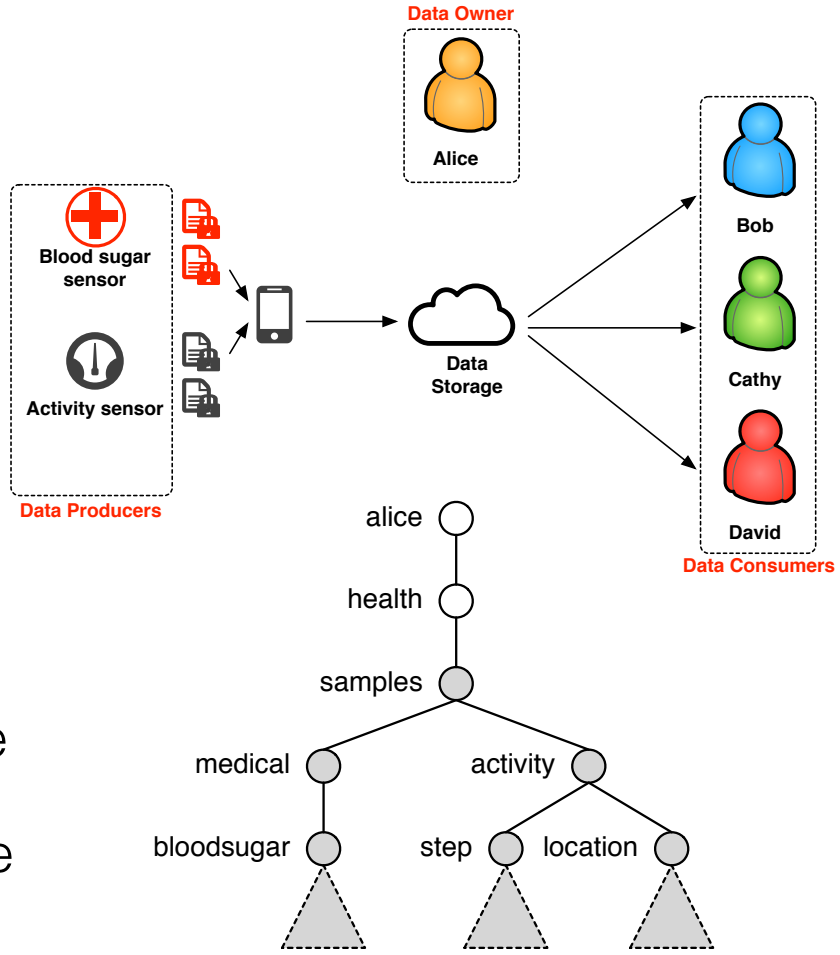
- Application-level end-to-end confidentiality
  - not just the end of a connection
  - multi-party communication

Req. on confidentiality

- Encryption requires careful design
  - differential confidentiality
    - different content may be visible to different groups of consumers
  - flexibility
    - retain the ability of changing access
  - scalability
    - keep reasonable number of encryption keys
    - avoid unnecessary re-encryption/signing
  - forward secrecy
    - make encryption keys less dependent on other keys
- Content encryption should not block data production

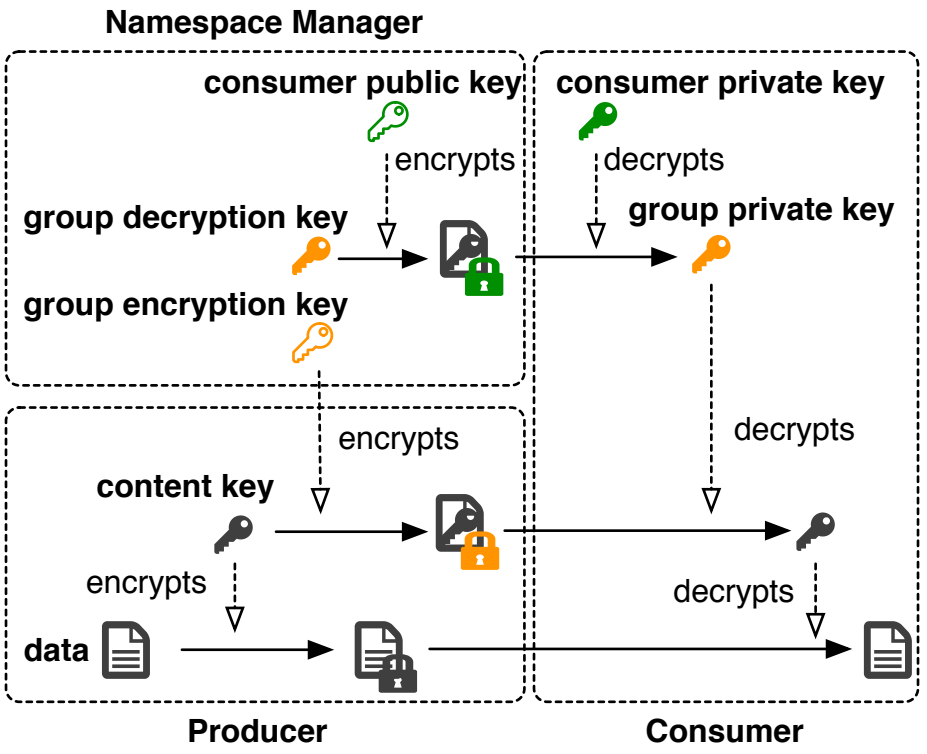
Application driven approach

- NdnFit
  - distributed production
    - a group of producers under the same name space
  - differential confidentiality
    - different consumers may access different content
  - online data sharing
    - producer can freely produce encrypted content without knowing who can access the content



Encryption Scheme

- Separate content production from access control
  - producer-created content key
- Control access through a group key
  - created by namespace manager
  - distributed by namespace manager
  - public key in current implementation
- Producers retrieve group encryption key (public key), encrypt content key properly
- Consumers retrieve group decryption key (encrypted private key)



Name-based Access Control

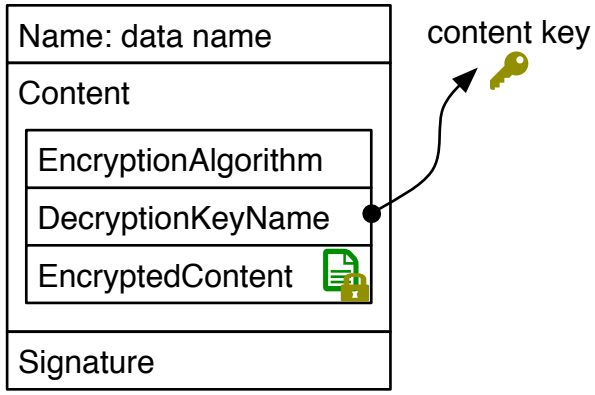
- Name of group encryption key serves as access control instruction
  - /<data_prefix>/E-KEY/<additional_restriction>
  - /alice/health/read/activity/E-KEY/ 20150930160000/20150930180000
  - scope: any Alice's activity data produced during Sep 30, 4pm-6pm
- Producer retrieves group encryption key, encrypts content keys falling into the scope
  - /alice/health/samples/activity/steps/C-KEY/ 20150930170000/20150930180000
  - encrypt Alice's step data produced during Sep 30, 5pm-6pm

Encrypted Content Format

- Data packet must carry enough information for authorized consumers to decrypt content

- Experiment as application semantics
  - content encoding
  - not a part of architecture yet

- Three sub-TLVs:
  - EncryptionAlgorithm
    - may also algorithm-specific fields,
    - e.g., Initial Vector
  - DecryptionKeyName
    - facilitate decryption key retrieval
  - EncryptedContent

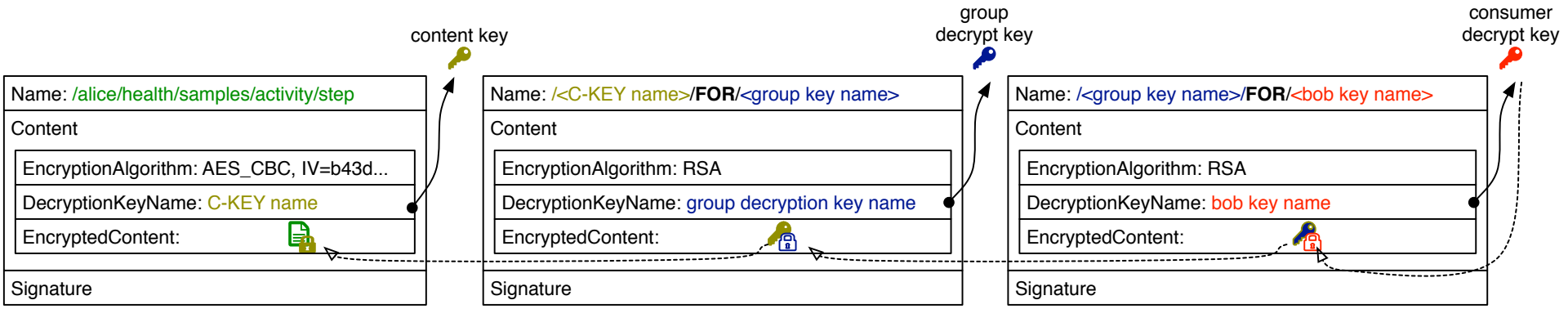


- When a data has more than one encrypted copies
  - each encrypted copy is an independent data packet
  - naming convention: /<content_name>/FOR/<decrypt_key_name>

Content production/consuming

- Producer create a symmetric key (content key) to encrypt content
  - content key has the minimum granularity, e.g. one hour
  - /alice/health/samples/activity/steps/C-KEY/20150928080000/20150928090000
- Producer retrieves group encryption key from namespace manager
  - encrypt content key using a group encryption key if the content key name falls into the scope of the group encryption key
  - /alice/health/samples/activity/steps/C-KEY/20150928080000/20150928090000/FOR/alice/health/read/activity

- Consumer decrypts content by constructing a decryption key chain
  - retrieve encrypted content, encrypted content key, encrypted group decryption key



- Application library will be available in next NDN platform release

Open questions

- Enable forward secrecy: decouple consumer private key with content key
  - key distribution services
- Name privacy
- Convert key exchange between namespace manager and producers to identity-based encryption, attribute-based encryption
- Access revocation
- Secure multi-party computing

Summary

- Content-based confidentiality makes confidentiality of content location-independent
- Content should be carefully encrypted to achieve flexible and scalable access control at fine granularity
- Expressive NDN name can be leveraged for efficient access control
- More encryption schemes need to be explored to address remaining issues