Content-Base Confidentiality

lessons learned in the past year

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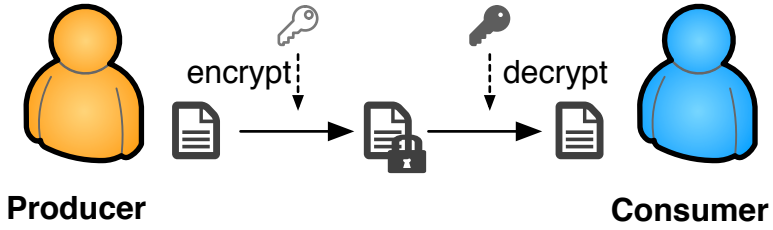
What is content-based confidentiality?

- 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



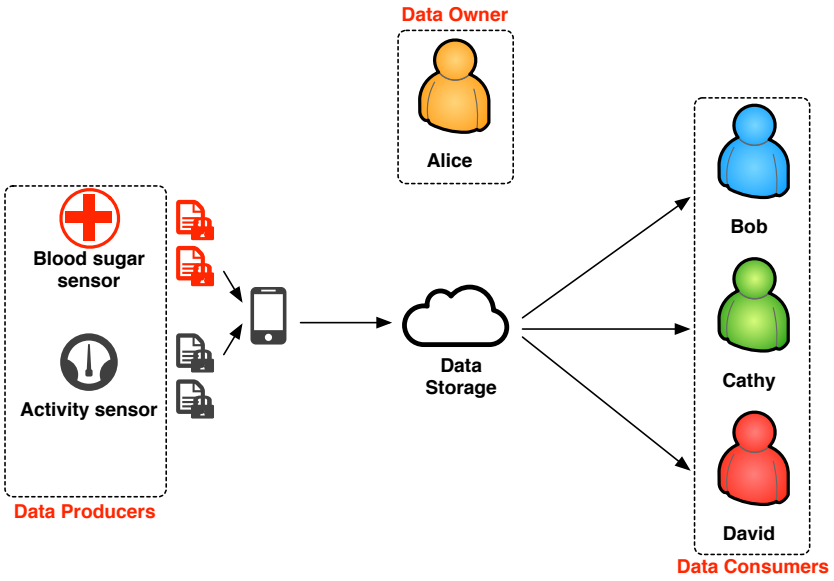
- Application-level end-to-end confidentiality
  - not just the end of a connection
  - multi-party communication

Req. on confidentiality

- Once encrypted, hard to change
  - encrypted content is sealed by digital signature
- Encryption requires careful design
  - fine granularity
    - different content may be visible to different consumers
  - flexibility
    - retain the ability of changing confidentiality without re-encryption
  - 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

- Two pilot applications
  - EBAMS, open mHealth
  - distributed production
    - a group of producers under the same name space
  - differential confidentiality
    - different consumers may access different content
  - Online data sharing



Granularity

- minimum granularity is necessary unless content re-signing is feasible
- content is encrypted directly using key with minimum granularity
- coarse granularity is expressed as a combination of keys with smaller granularity

Flexibility

- grant new consumers the access to content
  - re-encrypt keys rather than re-encrypt content

- revoke consumers' access to content
  - for content yet to be produced
    - give each decryption key a limited scope (e.g., time interval)
    - prevent a consumer from acquiring access to further content
  - for content has been produced
    - make decryption keys unavailable if consumer has not got the key yet
    - still an open question about how to revoke access if consumer has got the decryption key

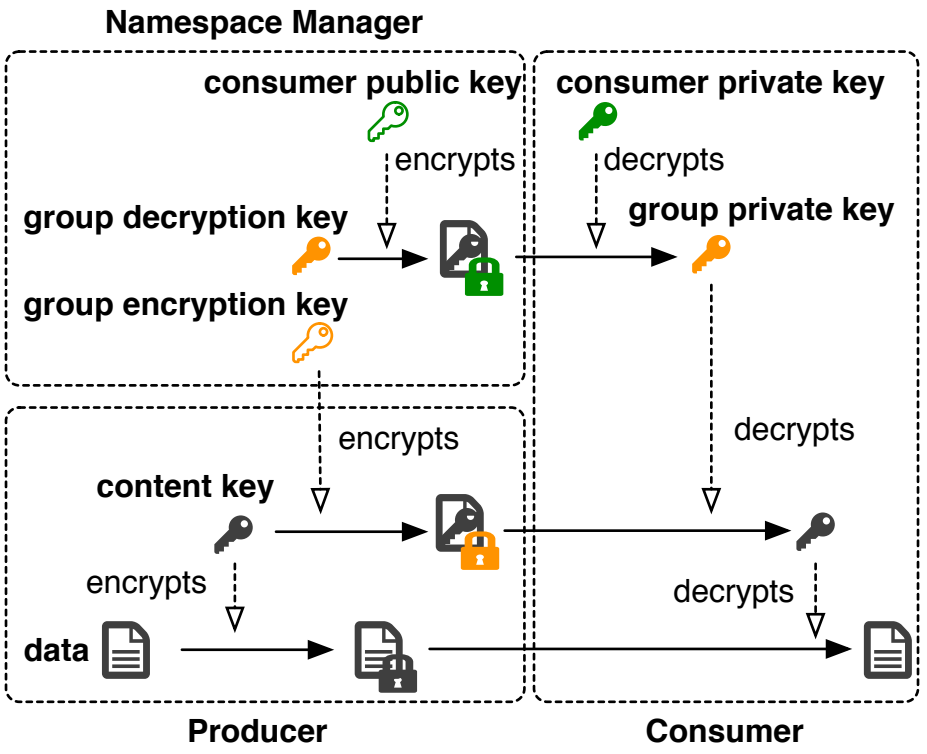
Scalability

- producers <-> consumers
  - it may not scale if each producer has to know every potential consumer
  - need an indirection (namespace manager)
    - present single encryption instruction to producers
    - distribute decryption credentials to consumers

- content production <-> access control
  - content should be encrypted without knowing the access control information
  - need an indirection
    - content is encrypted using a key created by content producer
    - content encryption key is encrypted by another key that represents access scope

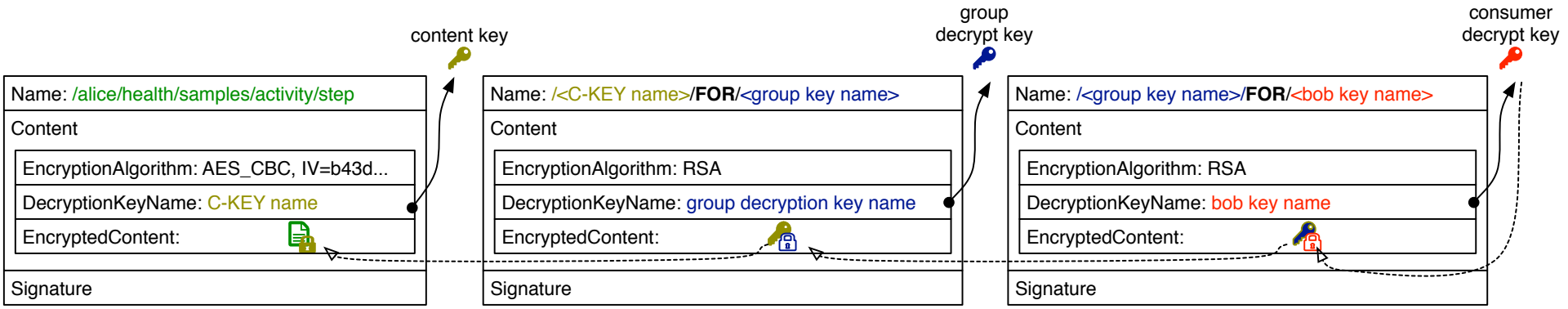
Name-based access control

- Namespace manager publishes encryption instructions in terms of a named public key (group encryption key)
  - /alice/health/read/activity/E-KEY/20150928080000/20150928180000
  - encrypt Alice's activity data produced during 8am to 6pm on Sep. 28th, 2015
- Namespace manager publishes decryption credentials in terms of encrypted private key (group decryption key)
  - encrypted using each authorized consumer's public key
  - /alice/health/read/activity/D-KEY/20150928080000/20150928180000/FOR/bob



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

- Revoke access that has been granted
  - controlled functional encryption
- Avoid key exchange between namespace manager and producers
  - identity-based encryption, attribute-based encryption
- Enable forward secrecy: decouple consumer private key with content key
  - minimize the damage when a private key is compromised later
- Read auditing
- 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