Secure Replicas and Nomad Sessions

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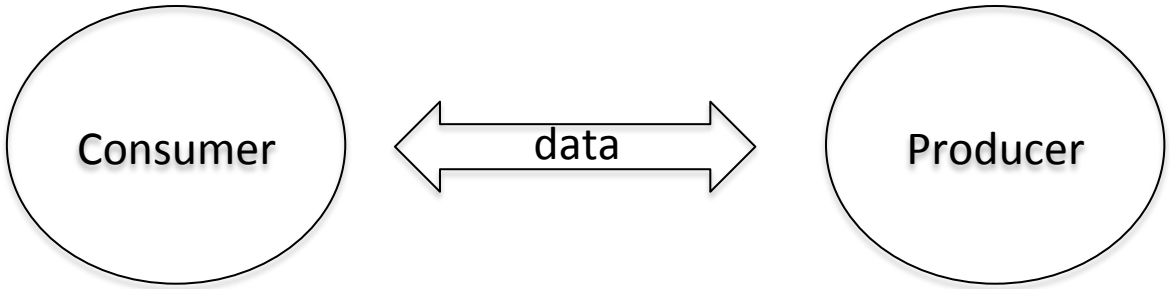
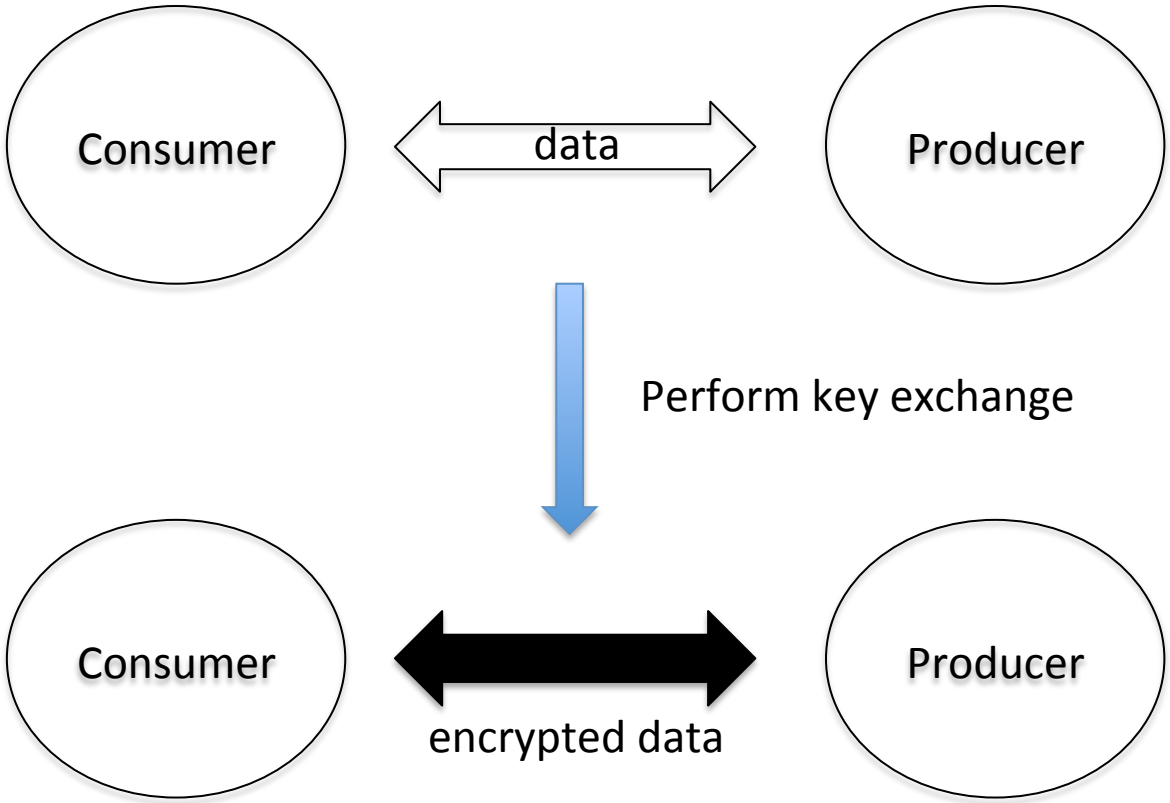
Session-Based Communication in CCN

- Problem:
  - A client and server (replica) want to establish a secure session in which all messages will be encrypted
- One approach:
  - Use CCNx-KE – a TLS-like key exchange protocol tailored for CCN
  - Clients authenticate the server (and vice versa) and the parties establish a shared forward-secure session key
  - The session key is used to encrypt all subsequent traffic carrying application data

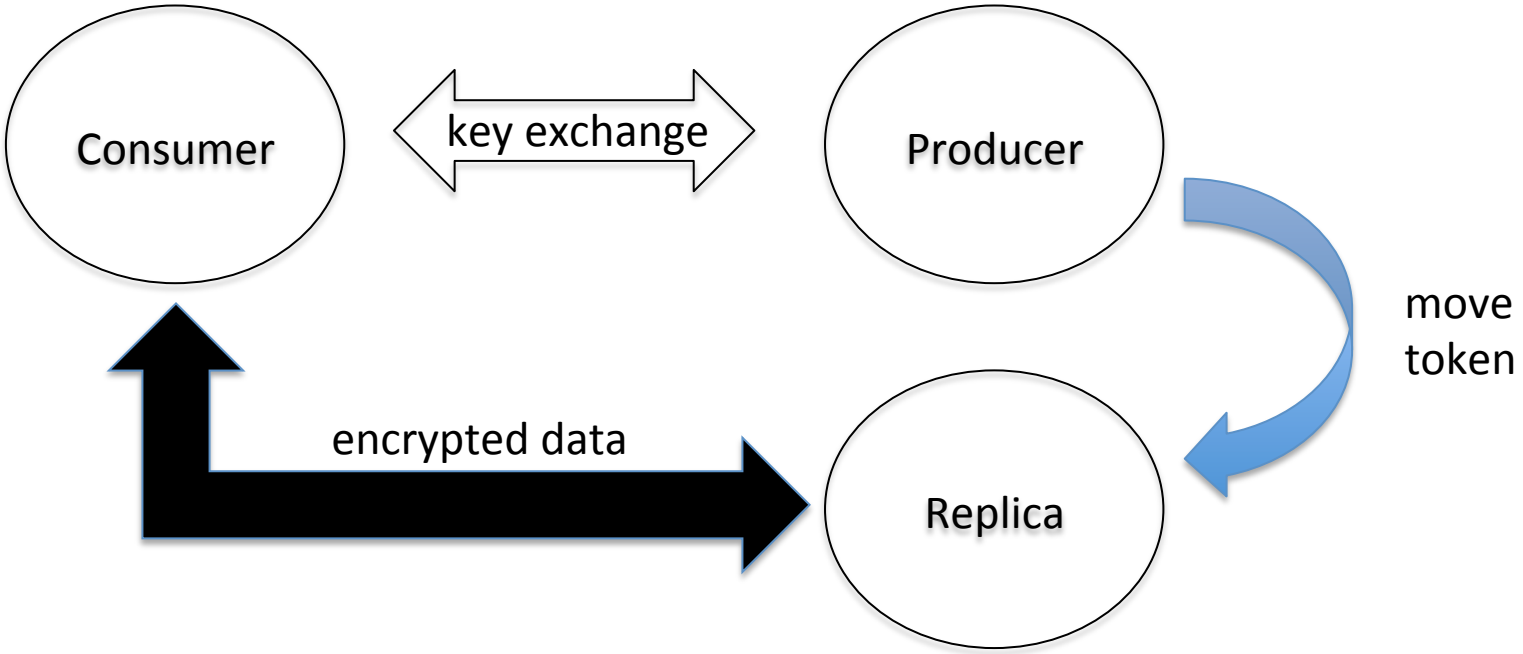
Standard CCN Session Communication



Standard CCN Session Communication



Session Relocation



CCNx-KE Features

- A consumer authenticates itself with a content producer and creates a forward-secure key and session.
- The content producer can serve content under that session or issue a **move token** to let another party serve content.
- Authentication and authorization are decoupled from data production
  - Benefits:
    - no private keys need to be shared between the server and replica
    - minimal information disclosure

Problems to Address

1. What is the trust relationship between the producer and the replica?
   - Same or different owner
2. How is the move token transferred from the producer or the replica, or how is it created so that the replica can use it?
   - Stateful or stateless?

Trust Model #1

- The producer and replica have some relationship.
  - The producer pays for replica services.
  - A MNO distributes users to the best replica.
  - The authentication server passes the user to a load balancer (via a move token).
- The producer is capable of creating a secure channel between the replica.
- The producer and replica can create and share keys (and re-key) on a regular basis.

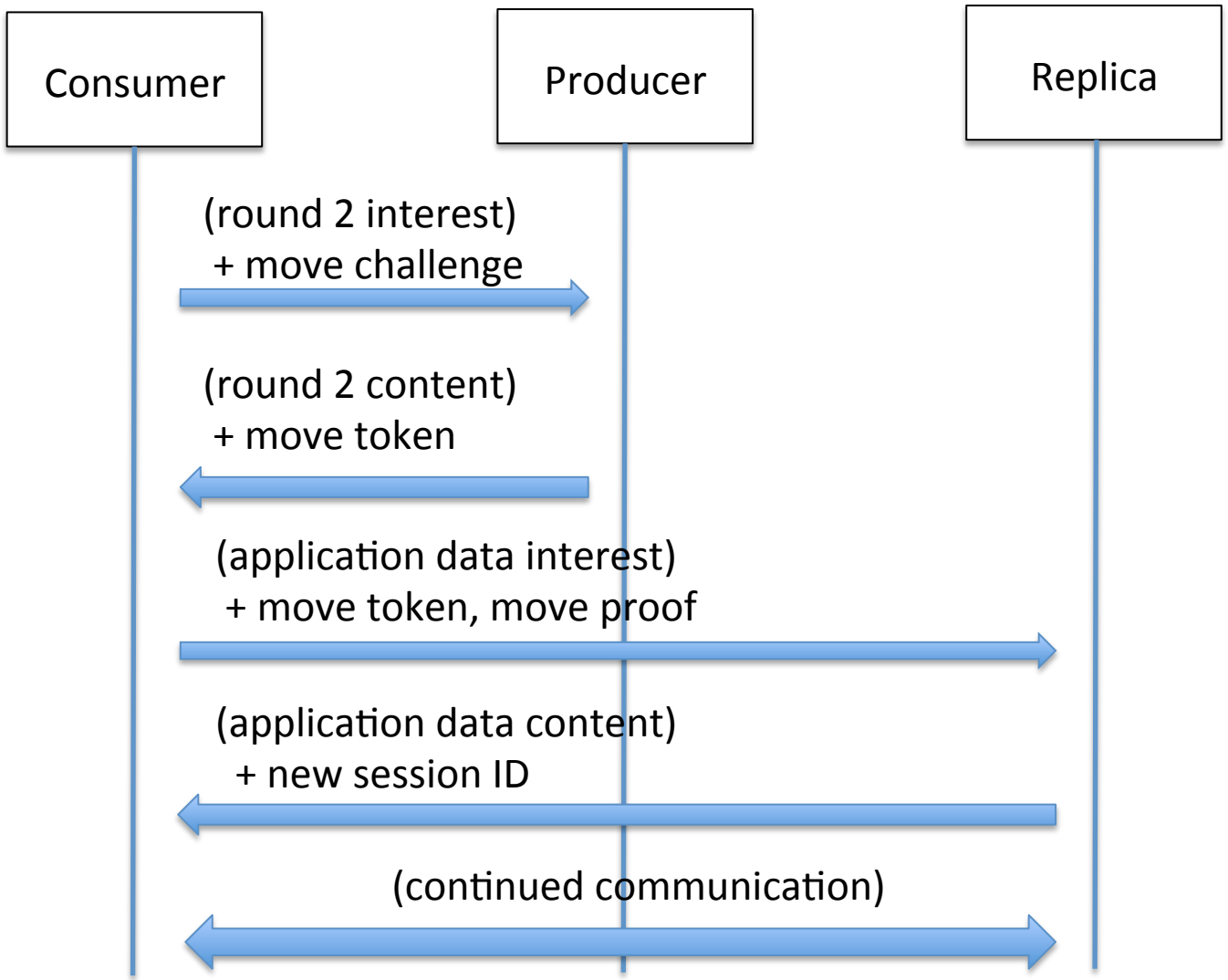
Trust Model #2

- The producer and replica are owned by the same entity
  - They can share a key
- Shared keys are regenerated regularly

Move Token Goals

- A move token must enable the replica to decrypt interests and encrypt content responses
  - This requires the **traffic secret** established by CCNx-KE
- In trust model #1: a consumer must **prove** that they fetched their move token from the producer
- In trust model #2: the consumer proves nothing

Move Token Usage



Move Token Construction

- Move challenge

  $Y = H(X)$, for some $X \leftarrow \{0,1\}^{128}$

- Move token

  $T = k_{ID} \,||\, Enc_k(Y \,||\, \text{traffic\_secret})$

- Move proof

  X

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Replica check:

1. If k_{ID} not valid, drop
2. $Y \,||\, traffic\_secret = Dec_k(T)$
3. If H(X) != Y, drop

Properties

- k_{ID} is a key that's routinely refreshed between the producer and replica (e.g., on a daily basis).
- Replica work is minimized:
  - no public-key crypto
  - single symmetric decryption and hash computation
- Two round trips before data can be retrieved
  - 1) Authenticate with the producer
  - 2) Start a new session with the replica and get the first chunk of data

Summing Up

- CCNx-KE is used to separate authentication and authorization from the retrieval of actual application data.
- Producers can upload encrypted data to a replica that only authorized consumers can decrypt.
- The replica session is used as a form of “transport encryption.”

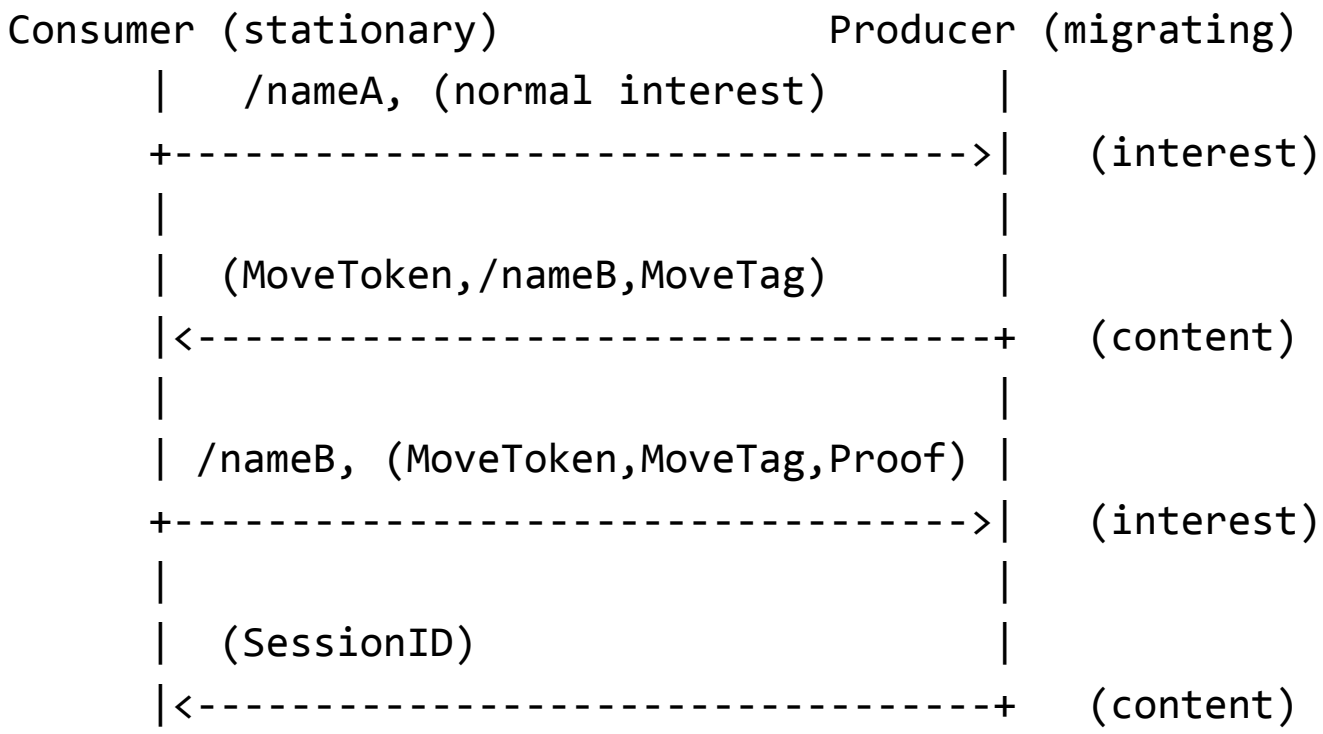
Session Identifiers

- CCNxKE session identifiers are bound to a **name prefix**
- CCNxKE handshakes can establish bidirectional session identifiers
  - Consumer to producer
  - Producer to consumer

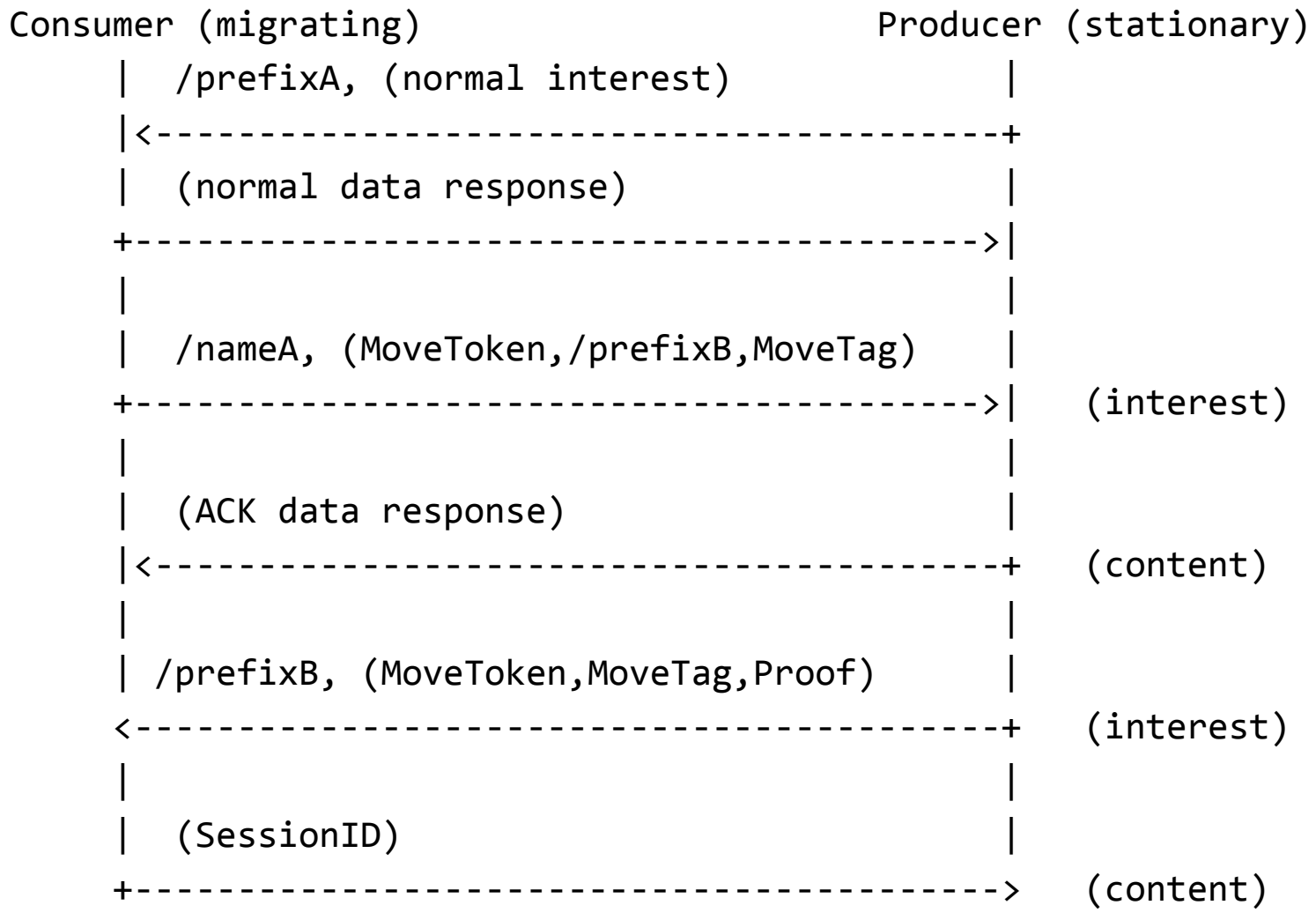
Nomad Sessions

- If names are location-agnostic, consumers and producers can move freely without re-establishing sessions
- If either end-host moves, we want to minimize or prevent re-keying
  - How? Generalize move tokens

Nomad Example #1
(soft handoff)



Nomad Example #2
(soft handoff)



Don’t Reinvent the Wheel

- RFC 5169: Handover Key Management and Re-Authentication Problem Statement
- RFC 6696: EAP Extensions for the EAP Re-authentication Protocol (ERP)
- RFC 6697: Handover Keying (HOKEY) Architecture Design
- Mobile DTLS (draft-barrett-mobile-dtls-00)