Hash Chain: a Scalable Content Provenance and Integrity Verifying Protocol for NDN

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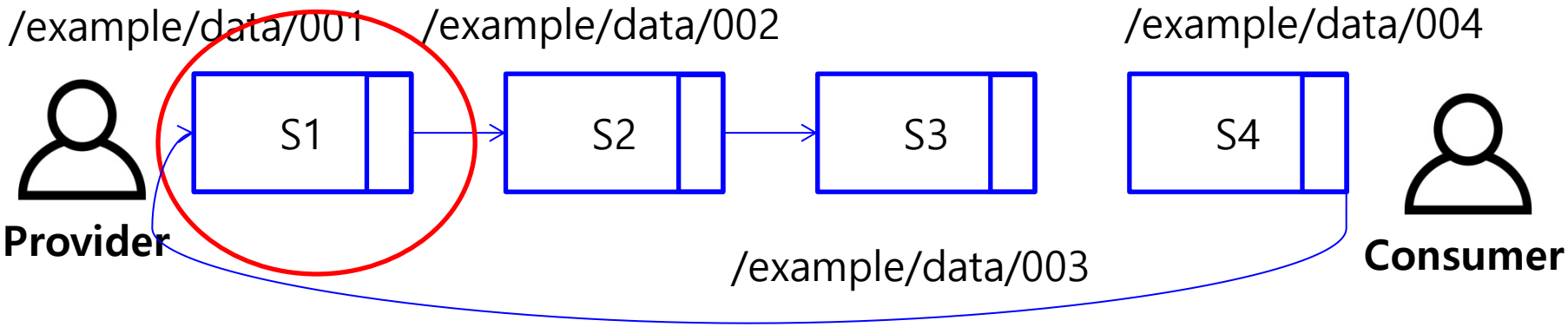
Hash Chain light-weight per-packet authentication

- Hash Chain (HC) has two mechanisms.
  - Backward Chain: This is the default mode that guarantee the provenance upon receiving the packet. However, the provider needs to have the entire sequences before generating hash chain signatures.
  - Forward Chain: This is apt for real-time usage. However, this cannot guarantee the provenance until it receives the last packet.

Backward Chain Signature Generation Example

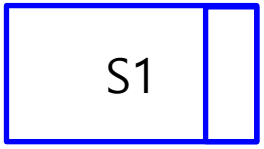


/example/data/004

K4 = H(name4 || data4 || 0x0000)

Null_hash = H(0x00000000000000000000)

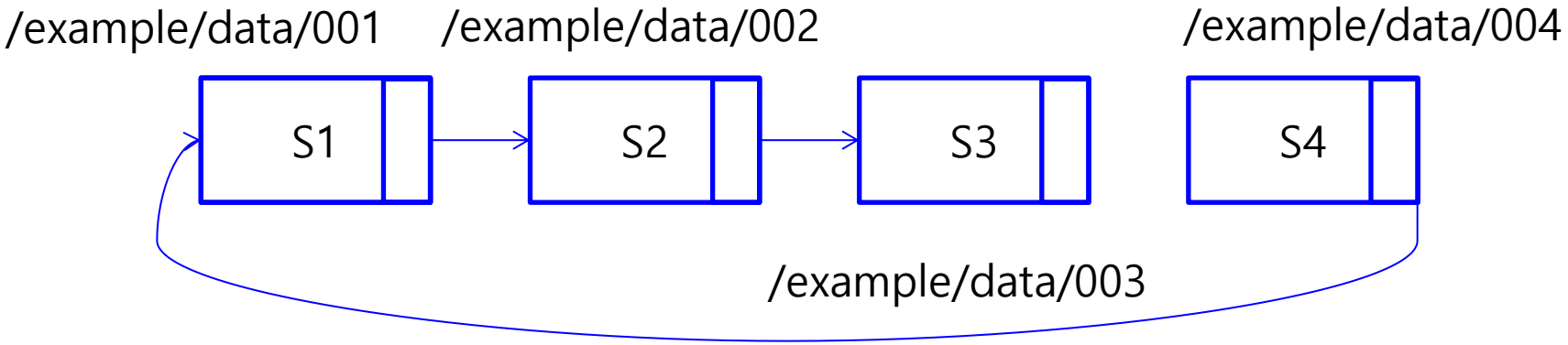
/example/data/001



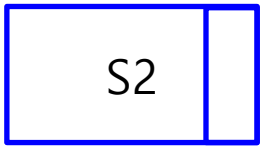
K1 = H(name1 || data1 || k4)

k4 = 0x66970e0d57360fdd4835c80

Backward Chain Signature Generation Example

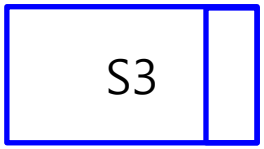


/example/data/002



K2 = H(name2 || data2 || k1)

/example/data/003



K3 = H(name3 || data3 || k2)

Backward Chain Signature Generation Example

- 0-step $m_1 = name_1 + data_1$
- (BC-1) $k_n = H(m_n \| null\_hash)$
- (BC-2) $k_1 = H(m_1 \| k_4)$
- (BC-3) $RSA\_SIGN(PR_{CP,} K_1)$ -> maybe required to hash one more time
- (BC-4) $k_i = H(m_i \| k_{i-1})$, all $n > i > 1$
- (BC-5) $S = E(PR_{CP}, H(K_1) \| K_4)$

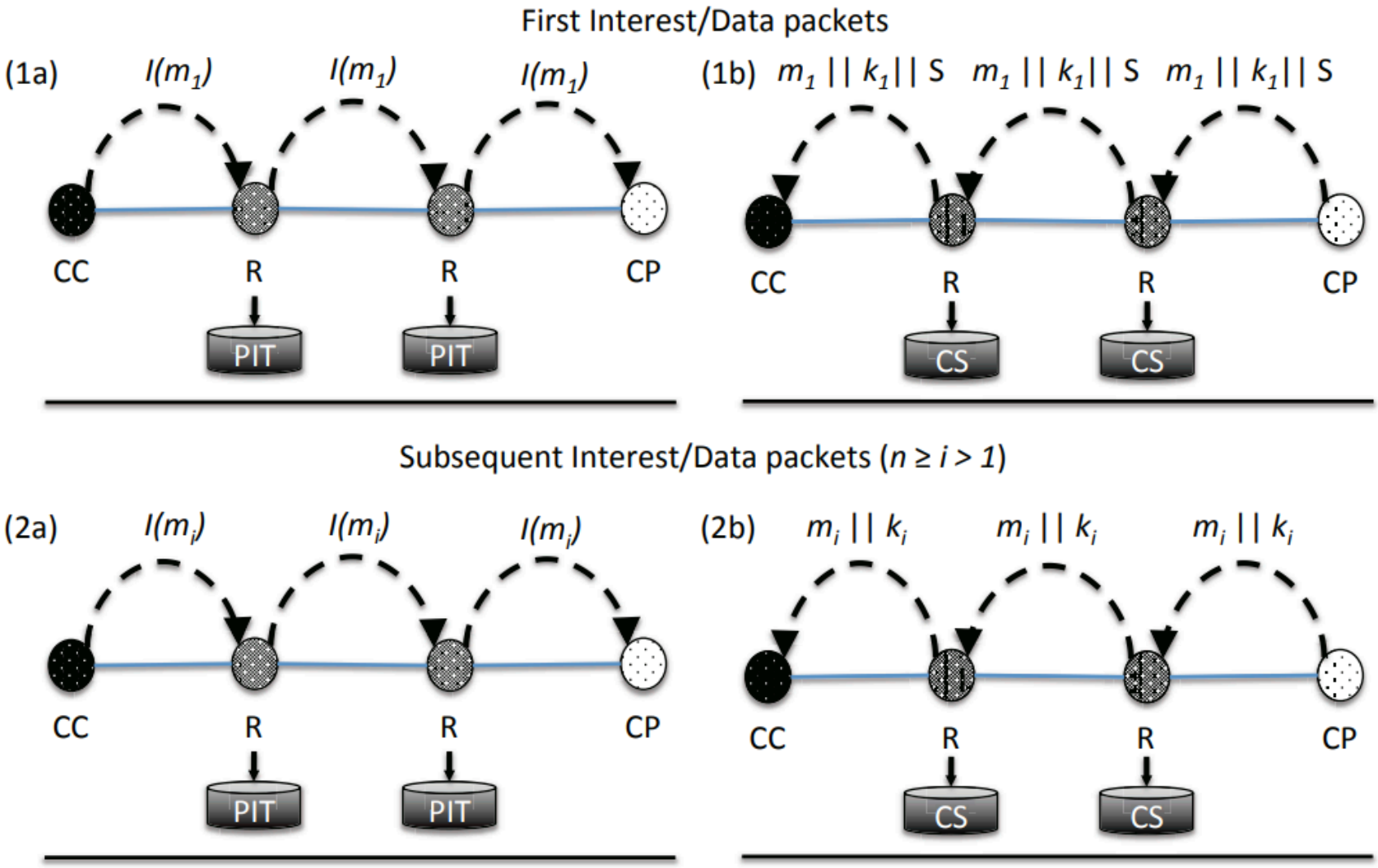
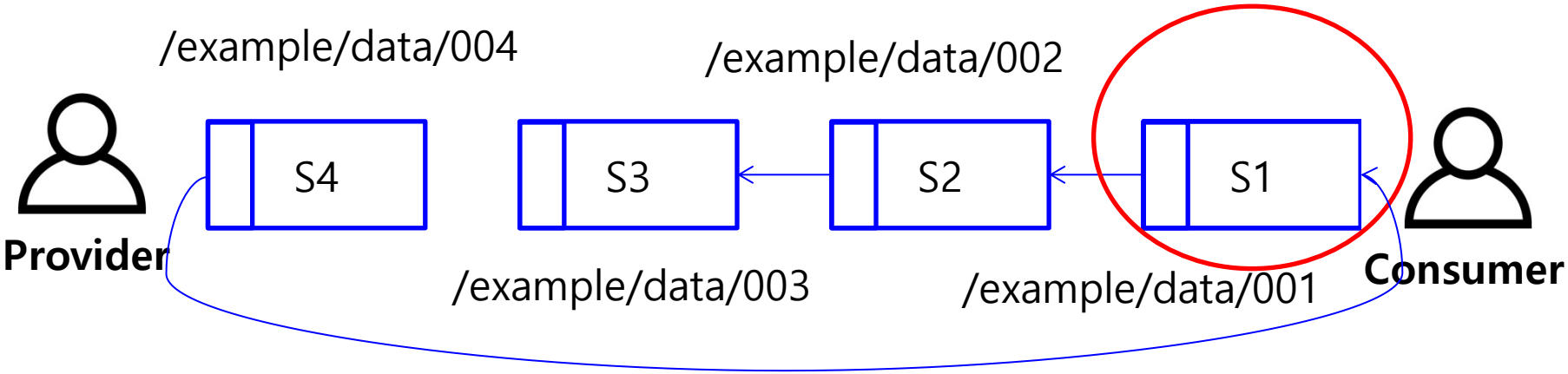
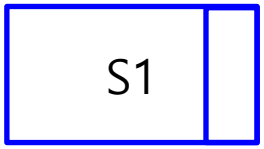


Fig. 1. Propagation of Interest and Data packets for the *Backward Chain*.

Backward Chain Signature Verification Example



/example/data/001

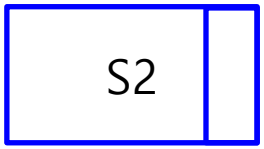


$K4 = Decrypt(PUB_{CP,} S)$

$K1 = H(name1 \| data1 \| k4)$

If $K1 == K1'$: pass

/example/data/002

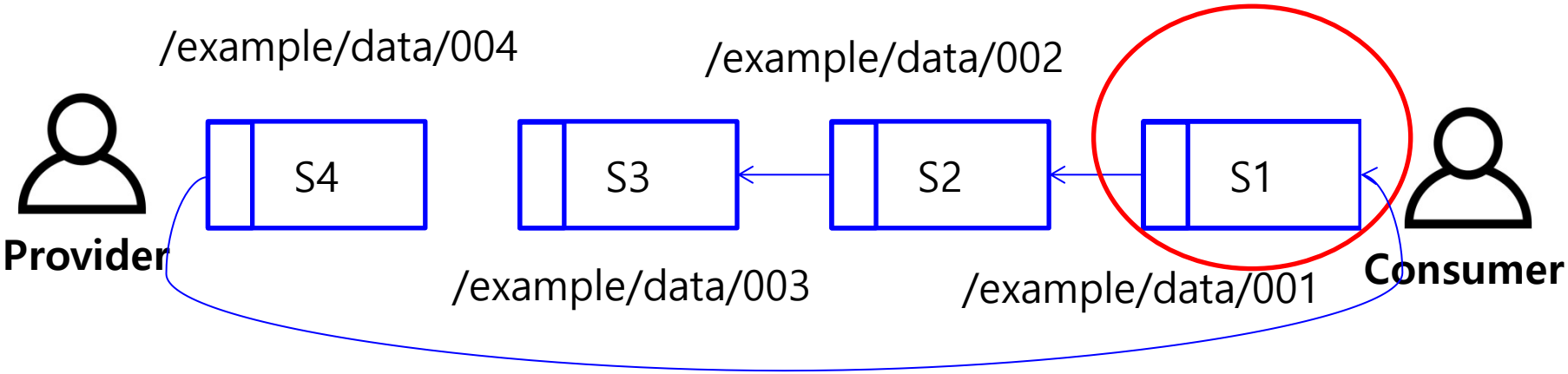


$K2 = H(name2 \| data2 \| k1)$

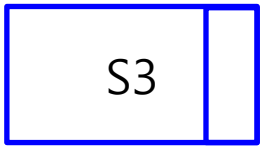
If $K2 == K2'$: pass

※ K1′ prime means calculated

Backward Chain Signature Verification Example



/example/data/003



K1 = H(name3 || data3 || k2)

If K3 == K3′ : pass

/example/data/004

K4 = H(name4 || data4 || null_hash)

If K4 == K4′: pass

Value	Reference	Description
0	DigestSha256	Integrity protection using SHA-256 digest
1	SignatureSha256WithRsa	Integrity and provenance protection using RSA signature over a SHA-256 digest
3	SignatureSha256WithEcdsa	Integrity and provenance protection using an ECDSA signature over a SHA-256 digest
4	SignatureHmacWithSha256	Integrity and provenance protection using SHA256 hash-based message authentication codes
5	SignatureSha256WithHashChain	Integrity and provenance protection using HashChain signature over a BLAKE3 digest
6	DigestBlake3	Integrity protection using Blake-3 digest
7	SignatureBlake3WithHashChain	Integrity and provenance protection using HashChain signature over a BLAKE3 digest
2,5-200		reserved for future assignments
>200		unassigned

BLAKE-3

- BLAKE-3 is compatible with SHA-256
  - https://github.com/BLAKE3-team/BLAKE3
  - https://github.com/BLAKE3-team/BLAKE3/tree/master/c
  - BLAKE3 is based on an optimized instance of the established hash function BLAKE2 and on the original Bao tree mode. The specifications and design rationale are available in the BLAKE3 paper. The default output size is 256 bits. The current version of Bao implements verified streaming with BLAKE3.

Implementation

- https://named-data.net/doc/NDN-packet-spec/current/signature.html
- Ndn-cxx HashChain
- ndn-cxx/ndn-cxx/security/
  - Along with signature-sha256-with-ecds
  - Digest-sha256
  - Digest-blake3
  - Signature-hash-chain-with-blake3
- Validation-policy and key-chain:
  - Make changes to validate hash chain
  - Make changes to validate Blake3

Conclusion

- Let's discuss!
- How to embed a Signature and keys
  - Signature in the data
  - (Data – size of signature)
  - Keys are placed as same as DigestSha256
  - https://named-data.net/doc/ndn-cxx/current/doxygen/d4/d08/sha256_8cpp_source.html