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CCNinfo: Discovering Content and Network Information in Content-Centric Networks

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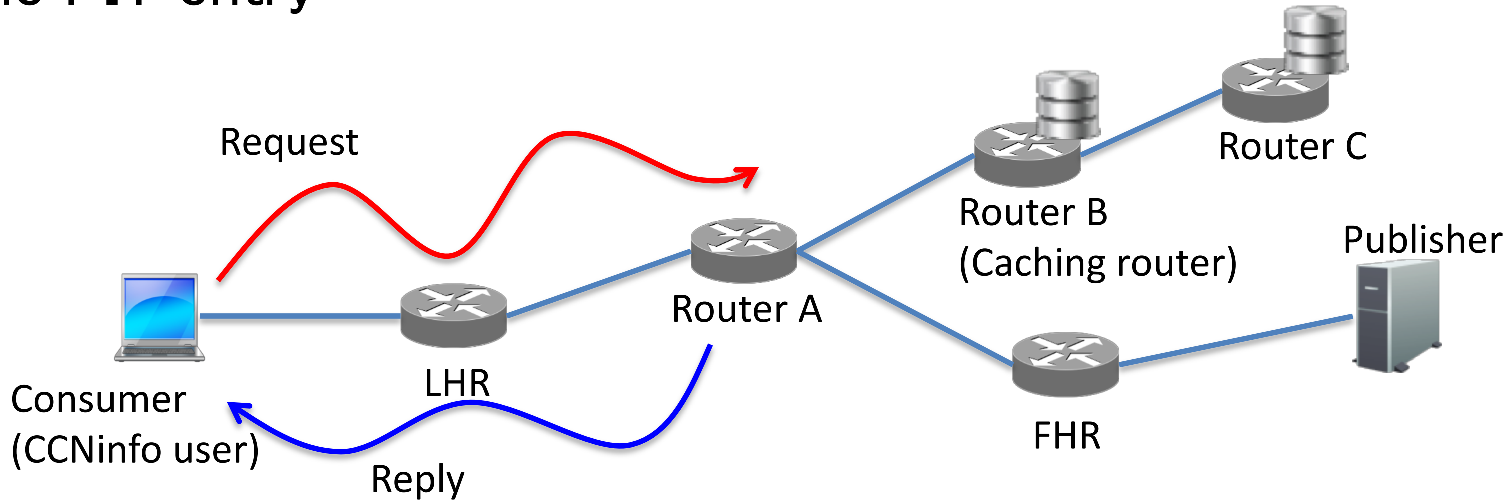
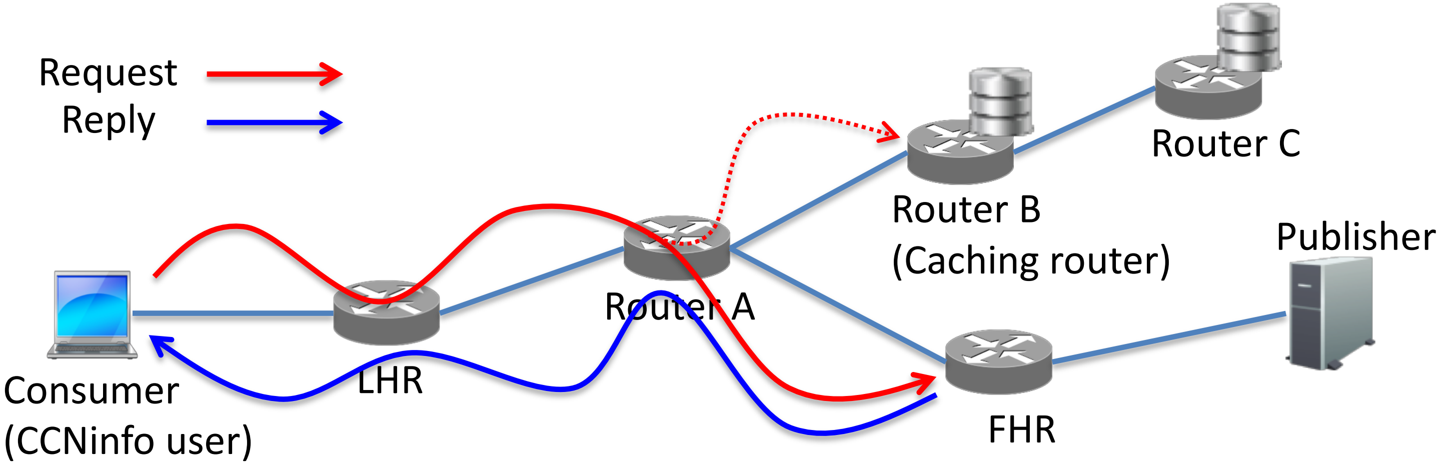
CCNinfo Request and Reply

- **CCNinfo user** initiates **Request message** (with **Request block**) and sends the message to **LHR**
- **LHR** and **other routers** along the path insert their **Report blocks** in the hop-by-hop header and forward the message based on their FIBs in a hop-by-hop manner
- **Caching routers** (having the specified content) or **FHR** append **Reply block** and **Reply sub-block(s)** to the message and send the message as **Reply message** toward CCNinfo user along the PIT entry



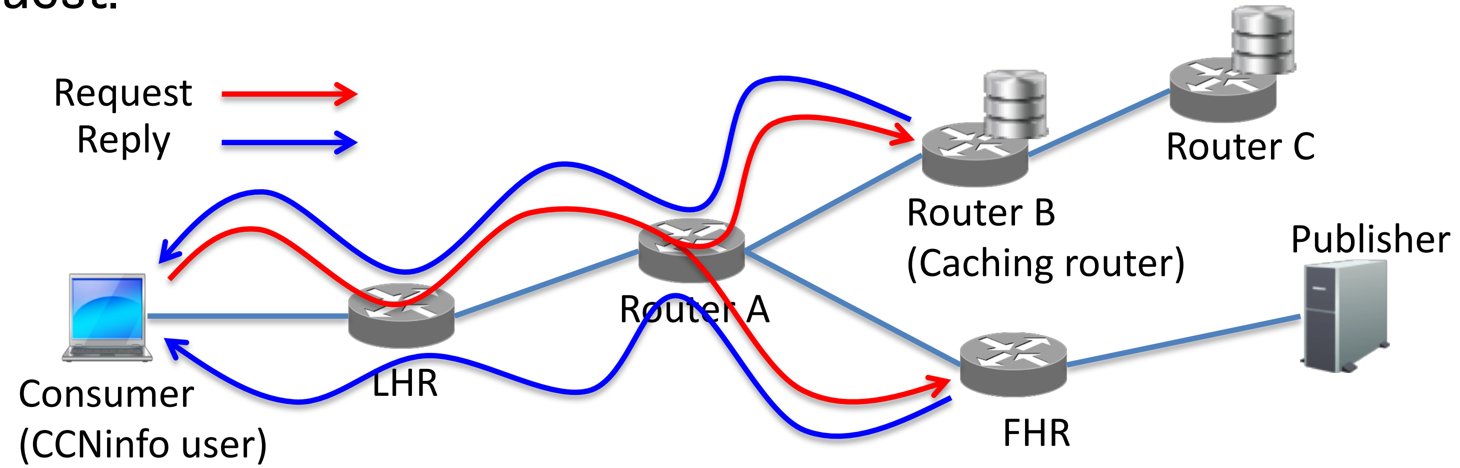
Default Behavior

- Some router may have strategy for multipath forwarding; when it sends Interest messages to multiple neighbor routers, it may delay or prioritize to send the message to the upstream routers.
- The CCNinfo Request, as the default, complies with such strategy; a CCNinfo user could trace the actual forwarding path based on the forwarding strategy.



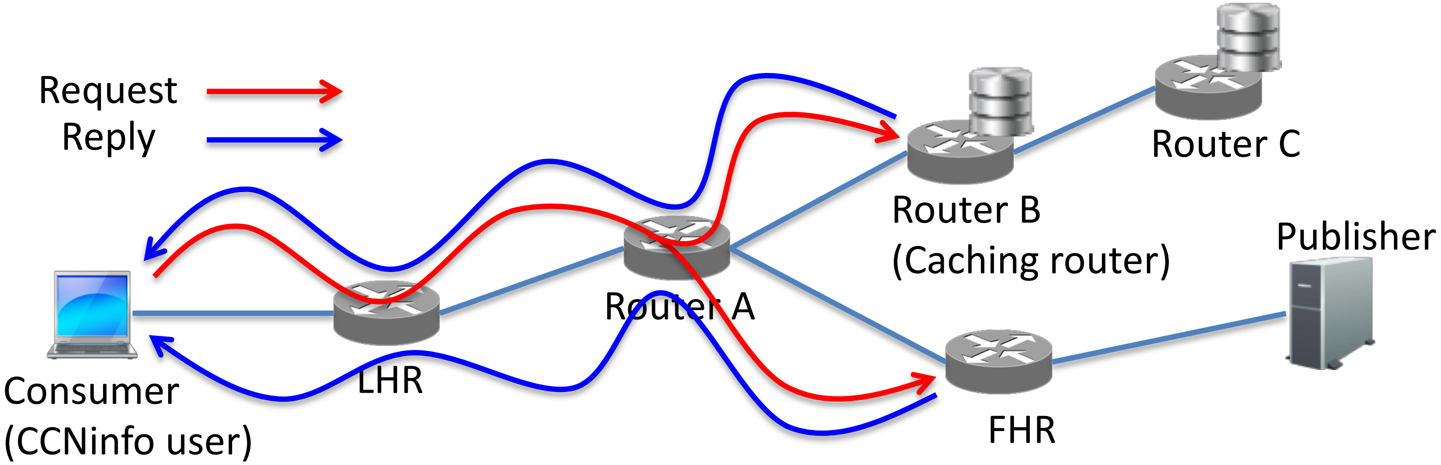
Full Discovery Request

- There may be the case that a CCNinfo user wants to discover all potential forwarding paths based on routers' FIBs. The full discovery request enables this function.
- If a CCNinfo user sets the F flag in the Request block of the Request message to request the full discovery, the upstream routers forward the Requests to the all multiple upstream routers based on the FIBs simultaneously. Then the CCNinfo user could trace the all potential forwarding paths.
- Note that some routers MAY ignore the full discovery request according to their policy. In that case, the router terminates the Request.



Full Discovery Request – cont’d

- When a CCNinfo user requests the full discovery, to receive the different Reply messages forwarded from different routers, PIT entries initiated by CCNinfo remain until the configured CCNinfo Reply Timeout passes.
- In other words, unlike the ordinary Interest–Data communications in CCN, if the router accepts the fill discovery request, the router SHOULD NOT remove the PIT entry created by the CCNinfo Request until the timeout value expires.



CCNinfo Request/Reply Messages

- Compatible with CCNx-1.0 TLV format
- CCNinfo Request Message
  - Request message consists of a fixed header, Request block TLV, Report block TLV(s), and Name TLV
- CCNinfo Reply Message
  - Reply message consists of a fixed header, Request block TLV, Report block TLV(s), Name TLV, and Reply block/sub-block TLV(s)

- Type values used by CCNinfo
  - Packet type: PT_REQUEST and PT_REPLY
  - Top level type: T_DISCOVERY
  - Hop-by-hop type: T_DISC_REQ and T_DISC_REPORT
  - CCNx message type: T_DISC_REPLY

Request Message

```
                    1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|    Version    | PT_REQUEST(=4)|          PacketLength         |
+---------------+---------------+---------------+---------------+
|    HopLimit   |   ReturnCode  |Reserved (MBZ) | HeaderLength  |
+===============+===============+===============+===============+
|                                                               |
+                       Request block TLV                       +
|                                                               |
+---------------+---------------+---------------+---------------+
/                      Report block TLV 1                       /
+---------------+---------------+---------------+---------------+
/                      Report block TLV 2                       /
+---------------+---------------+---------------+---------------+
/                               .                               /
/                               .                               /
+---------------+---------------+---------------+---------------+
/                      Report block TLV n                       /
+===============+===============+===============+===============+
|         T_DISCOVERY(=5)       |         MessageLength         |
+---------------+---------------+---------------+---------------+
|            T_NAME             |             Length            |
+---------------+---------------+---------------+---------------+
/ Name segment TLVs (name prefix specified by ccninfo command)  /
+---------------+---------------+---------------+---------------+
```

Hop-by-hop header

Request Block and Report Block

- Request block TLV

```
                     1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|          T_DISC_REQ           |            Length             |
+---------------+---------------+-------------------------+-+-+-+
|          Request ID           | SkipHopCount  |  Flags  |F|O|C|
+---------------+---------------+-------------------------+-+-+-+
|                     Request Arrival Time                      |
+---------------+---------------+---------------+---------------+
/                        Node Identifier                        /
+---------------+---------------+---------------+---------------+
```

- Report block TLV

```
                     1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|         T_DISC_REPORT         |            Length             |
+---------------+---------------+---------------+---------------+
|                     Request Arrival Time                      |
+---------------+---------------+---------------+---------------+
/                        Node Identifier                        /
+---------------+---------------+---------------+---------------+
```

Reply Message

```
                    1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|    Version    | PT_REPLY(=5)  |         PacketLength          |
+---------------+---------------+---------------+---------------+
|   HopLimit    |  ReturnCode   |Reserved (MBZ) | HeaderLength  |
+===============+===============+===============+===============+
|                                                               |
+                       Request block TLV                       +
|                                                               |
+---------------+---------------+---------------+---------------+
/                               .                               /
/                      n Report block TLVs                      /
/                               .                               /
+===============+===============+===============+===============+
|        T_DISCOVERY(=5)        |         MessageLength         |
+---------------+---------------+---------------+---------------+
|            T_NAME             |            Length             |
+---------------+---------------+---------------+---------------+
/ Name segment TLVs (name prefix specified by ccninfo command)  /
+---------------+---------------+---------------+---------------+
/                        Reply block TLV                        /
+---------------+---------------+---------------+---------------+
/                               .                               /
/                               .                               /
+---------------+---------------+---------------+---------------+
/                      Reply sub-block TLV k                    /
+---------------+---------------+---------------+---------------+
```

Hop-by-hop header

Reply Block

```
                     1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|         T_DISC_REPLY          |             Length            |
+---------------+---------------+---------------+---------------+
/         Reply sub-block TLV
+---------------+---------------+---------- ...
```

Reply Sub-Block

```
                     1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|             Type              |            Length             |
+---------------+---------------+---------------+---------------+
|                          Object Size                          |
+---------------+---------------+---------------+---------------+
|                         Object Count                          |
+---------------+---------------+---------------+---------------+
|                      # Received Interest                      |
+---------------+---------------+---------------+---------------+
|                         First Seqnum                          |
+---------------+---------------+---------------+---------------+
|                          Last Seqnum                          |
+---------------+---------------+---------------+---------------+
|                      Elapsed Cache Time                       |
+---------------+---------------+---------------+---------------+
|                    Remain Cache Lifetime                      |
+---------------+---------------+---------------+---------------+
|            T_NAME             |            Length             |
+---------------+---------------+---------------+---------------+
/                       Name segment TLVs                       /
+---------------+---------------+---------------+---------------+
```

Security Considerations

- Policy-based information provisioning for request
  - The access policy regarding “who is allowed to retrieve” and/or “what kind of information” can be defined for each router using signature.
- Filtering of CCNinfo users located in invalid networks
  - A router MAY support an access control mechanism to filter out Requests from invalid CCNinfo users. If invalid, the Request MUST NOT be processed.
- Topology discovery and administratively prohibited
  - If a network topology is a secret, CCNinfo Requests SHOULD be restricted at the border of the domain
- Characteristics of content
  - If some information is a secret, CCNinfo Requests SHOULD be restricted at the border of the domain
- Longer or shorter CCNinfo reply timeout
  - Routers MAY configure the timeout value, which is shorter than the user-configured CCNinfo timeout value
- Limiting Request rates
- Limiting Reply rates
- Adjacency verification

Adjacency Verification

- To support policy-based information provisioning and full discovery request, CCNinfo Request and Reply messages should be forwarded by adjacent neighbor nodes or routers. Defining the secure way to verify the adjacency cannot rely on the way specified in CCNx message format or semantics.
- An adjacency verification mechanism and the corresponding TLV for adjacency verification using hop-by-hop TLV header is the potential way and will be defined in a separate document.
  - Ruidong will present the potential solution, HopAuth.

Conclusion

- CCNinfo, which is compatible with CCNx-1.0 TLV format, is a powerful network tool providing various information in CCN
- Several unique points
  - CCNinfo Requests SHOULD NOT result in PIT aggregation in routers during the Request message transmission.
  - CCNinfo Replies MUST NOT be cached in routers upon the Reply message transmission.
  - (Upon full discovery request) Routers SHOULD NOT remove the PIT entry created by the CCNinfo Request until the Reply timeout value expires.
- Security considerations described
- Implementation is on-going in Cefore
  - https://cefore.net/
  - We are in the Hackathon!