Observe Notifications as CoAP Multicast Responses

draft-tiloca-core-observe-multicast-notifications-04

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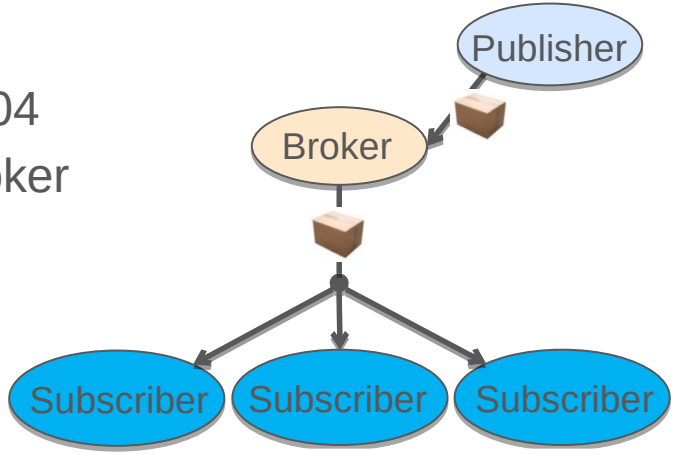
What, Why

- Observe notifications as multicast responses
  - Many clients observe the same resource on a server
  - Improved performance due to multicast delivery
  - Multicast responses are not defined yet – Token binding, security, …

- Example of relevant use case
  - Pub-Sub scenario, also discussed at IETF 104
  - Many subscribers to a same topic on the Broker
  - Better performance
  - Subscribers can remain clients only



Single notification response over multicast

How

- Define multicast responses, in particular Observe notifications

- Token space managed by the server
  - The Token space belongs to the group (clients)
  - The group entrusts the management to the server
  - All clients in a group observation use the same Token value

- Group OSCORE to protect multicast notifications
  - The server aligns all clients of an observation on a same *external_aad*
  - All notifications for a resource are protected with that *external_aad*

Phantom request and error response

- The server requests the observation on its own, e.g. when:
  1. a first traditional registration request comes from a first client
  2. some threshold is crossed – clients can be shifted to a group observation

- Consensus on Token & external_aad , by using a phantom observation request
  - Generated inside the server, it does not hit the wire
  - Like if sent by the group, from the multicast IP address of the group
  - Multicast notifications are responses to this phantom request

- The server sends to clients a 5.03 “informative response” with:
  - The serialization of the phantom request
  - The IP multicast address where notifications are sent to
  - The serialization of the latest multicast notification (i.e., the current resource status)

Updates from -04

- Improved and extensible encoding of the informative error response
  - Transport-independent information, for the phantom request and the latest notification
  - Common transport-specific information; detailed specification for CoAP over UDP

```
informative_response_payload = {
  1 => bstr,   ; phantom request (transport-independent information)
  2 => bstr,   ; latest notification (transport-independent information)
  3 => array   ; transport-specific information
}
```

```
tp_info = [
  tp_id : 1,      ; UDP as transport protocol
  token : bstr,   ; Token of phantom request and multicast notifications
  srv_addr : #6.260(bstr),   ; Src. address of multicast notifications
  srv_port : uint,           ; Src. port of multicast notifications
  cli_addr : #6.260(bstr),   ; Dst. address of multicast notifications
  ? cli_port : uint          ; Dst. port of multicast notifications
]
```

OLD

```
Payload: { ph_req     : bstr(PH_REQ.CoAP),
           last_notif : bstr(LAST_NOTIF.CoAP)
           cl_addr    : bstr(GROUP_ADDR),
           cl_port    : GROUP_PORT,
           srv_addr   : bstr(SERVER_ADDR),
           srv_port   : SERVER_PORT,
         }
```

```
Payload: {
  ph_req     : bstr(0x01 | OPT),
  last_notif : bstr(0x25 | OPT | 0xff | PAYLOAD),
  tp_info    : [1, 0x7b, bstr(SRV_ADDR), SRV_PORT,
                bstr(GRP_ADDR), GRP_PORT]
}
```

NEW

Updates from -04

- Improved rough counting of active clients, by poll for interest
  - New CoAP option in successful multicast notifications ✉ **Now the length is max 1 byte!**

- Server current rough estimate: *COUNT*
  - *N* = max(*COUNT*, 1)
  - *M* desired confirmations
  - *L = ceil(log2(N / M))*
  - Option value: *Q* = max(*L*, *0*)
  - Each client picks a random value *I* : [0, *2^Q*)
  - If *I* == 0, the client sends a re-registration request
    - Non Confirmable; w/ No-Response; w/ the new Option having empty value
  - The server receives *R* of such requests; meanwhile, the estimate has become *COUNT '*
  - *F = R * (2^Q)* ; then *COUNT* ← *COUNT '* + *((F – N) / D)* , with *D* > 0 as dampener

No.	C	U	N	R	Name	Format	Len.	Default
TBD		x			Multicast-Response-Feedback-Divider	uint	0-1	(none)

C = Critical, U = Unsafe, N = NoCacheKey, R = Repeatable

- Pseudo-code in Appendix B, also optimized for constrained clients

Updates from -04

- Added support for intermediary proxies
  - The proxy (next to the server) directly listens to the IP multicast address
  - The original Token of the phantom request has to match at the proxy
  - The proxy forwards multicast notifications back to each client
    - The proxy uses the Token values offered by the clients
- Without end-to-end security (Section 8)
  - The proxy can retrieve the phantom request from the informative response
  - The informative response is still forwarded back to each new client
- With end-to-end security (Section 9)
  - The informative response is also protected with OSCORE or Group OSCORE
  - The proxy **cannot** retrieve the Phantom request from the informative response
  - Each client has to explicitly provide the Phantom request to the proxy

Updates from -04

- The client sends the rebuilt Phantom request as addressed to the proxy
  - The request itself already provides the transport-specific information
- The sent request includes a new CoAP option Listen-To-Multicast-Responses
  - This provides the transport-independent information
  - Value: serialized CBOR array, i.e. ‘tp_info’ from the informative response

No.	C	U	N	R	Name	Format	Len.	Default
TBD	x	x			Listen-To-Multicast-Responses	(*)	3-1024	(none)

C = Critical, U = Unsafe, N = NoCacheKey, R = Repeatable

```
tp_info = [
  tp_id : 1,      ; UDP as transport protocol
  token : bstr,   ; Token of phantom request and multicast notifications
  srv_addr : #6.260(bstr),  ; Src. address of multicast notifications
  srv_port : uint,          ; Src. port of multicast notifications
  cli_addr : #6.260(bstr),  ; Dst. address of multicast notifications
  ? cli_port : uint         ; Dst. port of multicast notifications
]
```

- Now the proxy has all it needs to receive multicast notifications
- Appendix C and Appendix D include interaction examples

Open points

- Proxy example fixes
- Negotiation: What to do when there is no common way?
- '*last_notif*' in the informative response
  - Serialization of latest sent multicast notification
  - To be made optional (like an empty ACK)

```
Payload: {
  ph_req     : bstr(0x01 | OPT),
  last_notif : bstr(0x25 | OPT | 0xff | PAYLOAD),
  tp_info    : [1, 0x7b, bstr(SRV_ADDR), SRV_PORT,
                bstr(GRP_ADDR), GRP_PORT]
}
```

- OSCORE group possibly self-managed by the server
  - The observation request might even double as joining request of a Monitor member
  - The informative response would include also key material, as in a Joining Response
  - Thoughts? Objections?

Summary

- Latest additions
  - Improved and extensible encoding of the informative error response
  - Improved rough counting of clients; added pseudo-code for constrained clients
  - Added support for intermediary proxies, with or without end-to-end security
  - Re-organization of sections and editorial improvements
- Next steps
  - Address open points
  - Investigate possible optimization with a deterministic phantom request
- Need for document reviews
  - Potential reviewers: Göran, Jaime, Carsten

Thank you!

Comments/questions?

https://gitlab.com/crimson84/draft-tiloca-core-observe-responses-multicast

Backup

Server side

1. Build a GET phantom request; Observe option set to 0

2. Choose a value T, from the Token space for messages …
   - … coming from the multicast IP address and addressed to target resource

3. Process the phantom request
   - As coming from the group and its IP multicast address
   - As addressed to the target resource

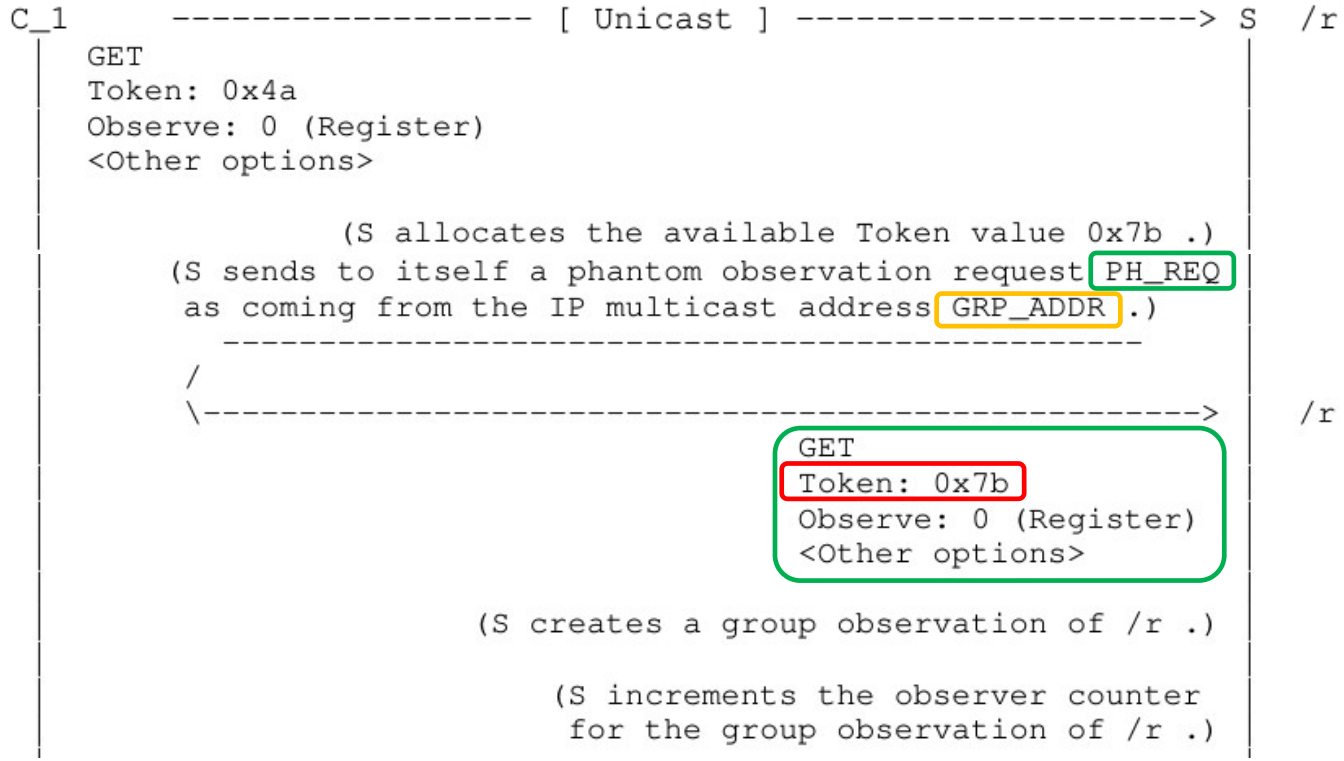
4. Hereafter, use T as token value for the group observation

5. Store the phantom request, store (not send) reply for last_notif

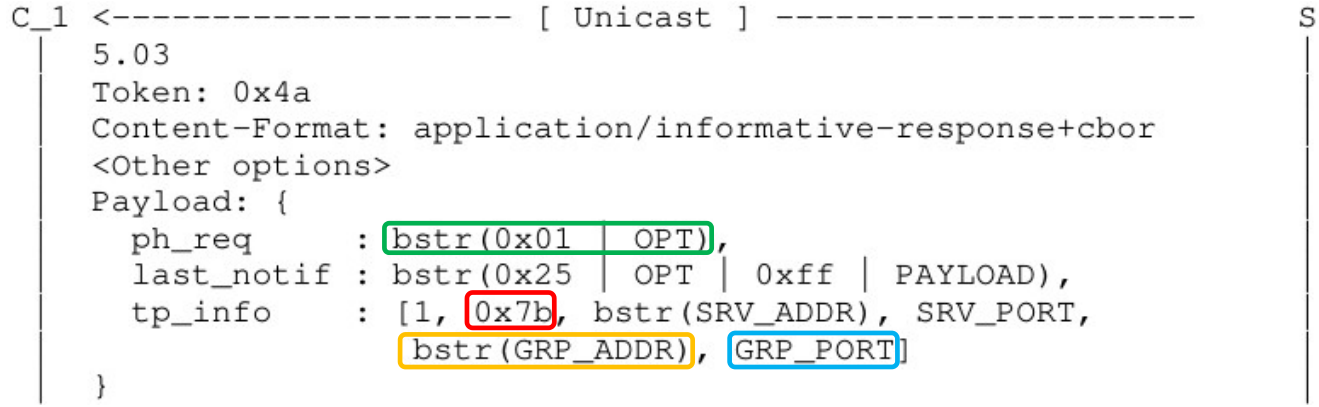
Interaction with clients

- The server sends to new/shifted clients an ***error response*** with
  - '*ph_req*': serialization of the phantom request
  - '*last_notif*': serialization of the latest sent notification for the target resource
    - '*token*': the selected Token value T, used for '*ph_req*' and '*last_notif*'
    - '*cli_addr*' and '*cli_port*': source address/port of the phantom request
    - '*srv_addr*' and '*srv_port*': destination address/port of the phantom request
- When the value of the target resource changes:
  - The server sends an Observe notification to the IP multicast address '*cli_addr*'
  - The notification has the Token value T of the phantom request
- When getting the error response, a client:
  - Configures an observation for an endpoint associated to the multicast IP address
  - Accepts observe notifications with Token value T, sent to that multicast IP address

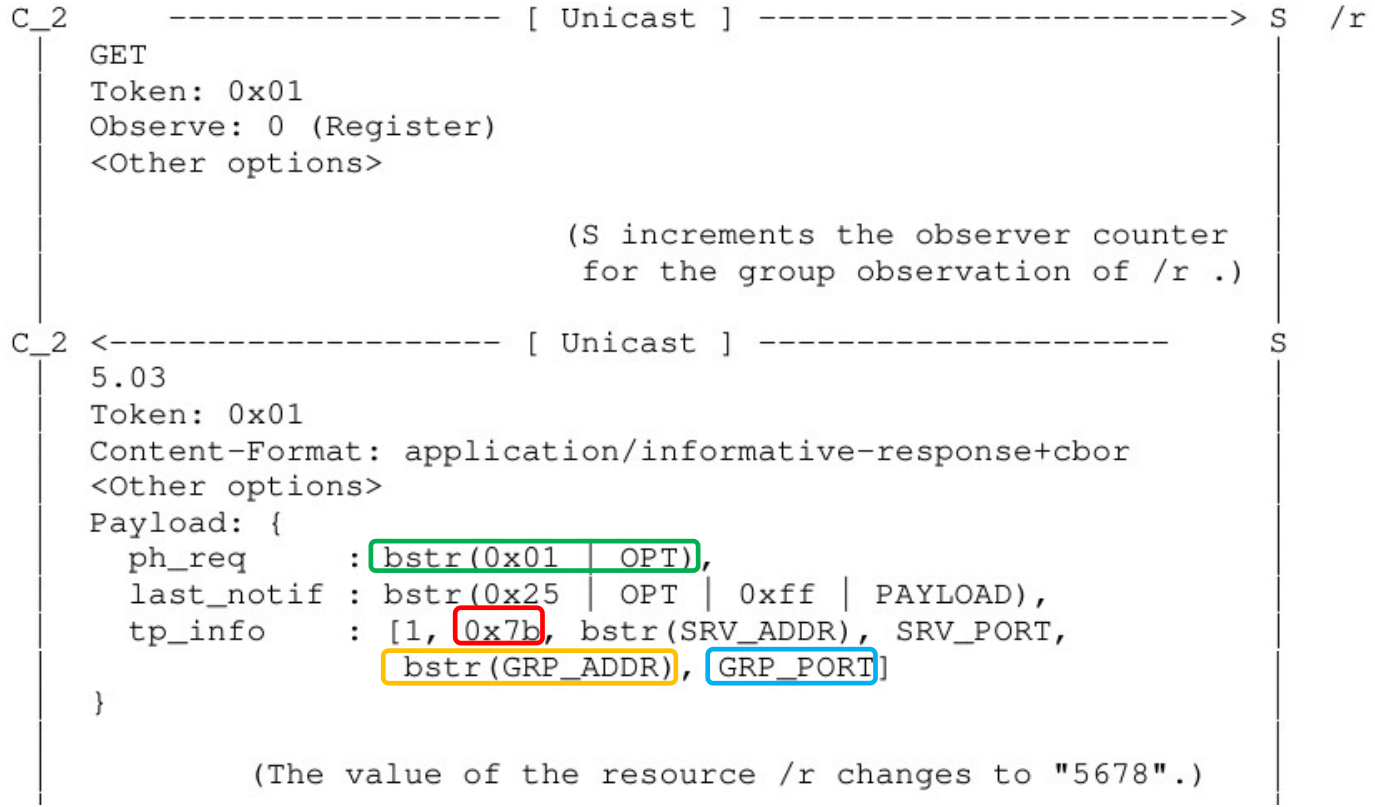
C1 registration



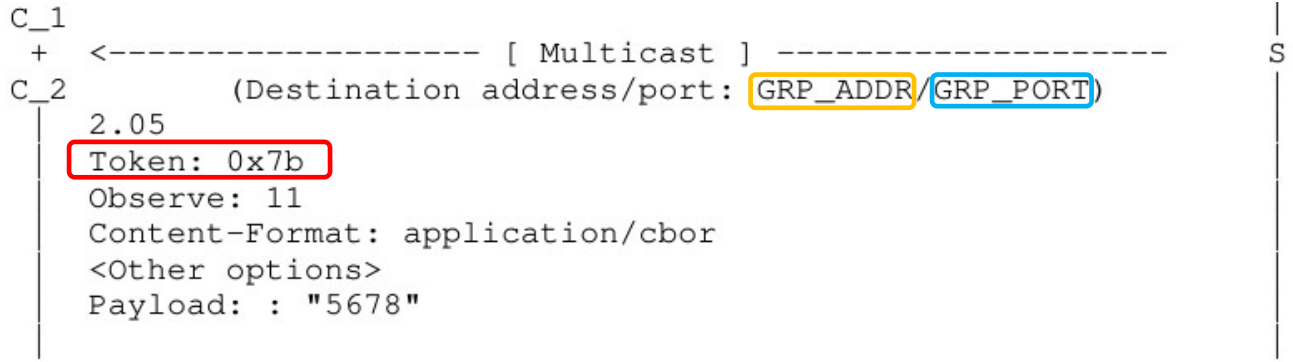
C1 registration



C2 registration



Multicast notification



- Same Token value of the Phantom Request
- Enforce binding between
  - Every multicast notification for the target resource
  - The (group) observation that each client takes part in

Security with Group OSCORE

- The phantom request is protected with Group OSCORE
  - ***x*** : the Sender ID ('kid') of the Server in the OSCORE group
  - ***y*** : the current SN value ('piv') used by the Server in the OSCORE group
  - Note: the Server consumes the value ***y*** and does not reuse it as SN in the group

- To secure/verify all multicast notifications, the OSCORE *external_aad* is built with:
  - 'req_kid' = ***x***
  - 'req_piv' = ***y***

- The phantom request is still included in the informative response
  - Each client retrieves ***x*** and ***y*** from the OSCORE option

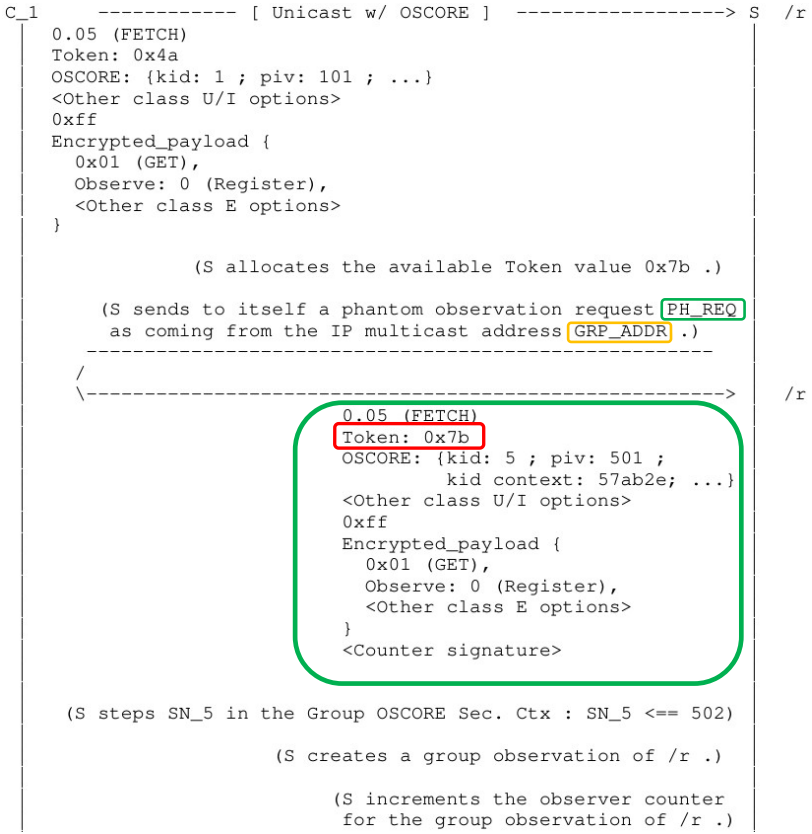
Security with Group OSCORE

- In the error response, the server can ***optionally*** specify also:
  - '*join-uri*' : link to the Group Manager to join the OSCORE group
  - '*sec-gp*' : name of the OSCORE group
  - '*as-uri*' : link to the ACE Authorization Server associated to the Group Manager
  - '*cs-alg*' : countersignature algorithm
  - '*cs-alg-crv*' : countersignature curve of the algorithm
  - '*cs-key-kty*' : countersignature key type
  - '*cs-key-crv*' : countersignature curve of the key
  - '*cs-kenc*' : countersignature key encoding
  - '*alg*' : AEAD algorithm
  - '*hkdf*' : HKDF algorithm

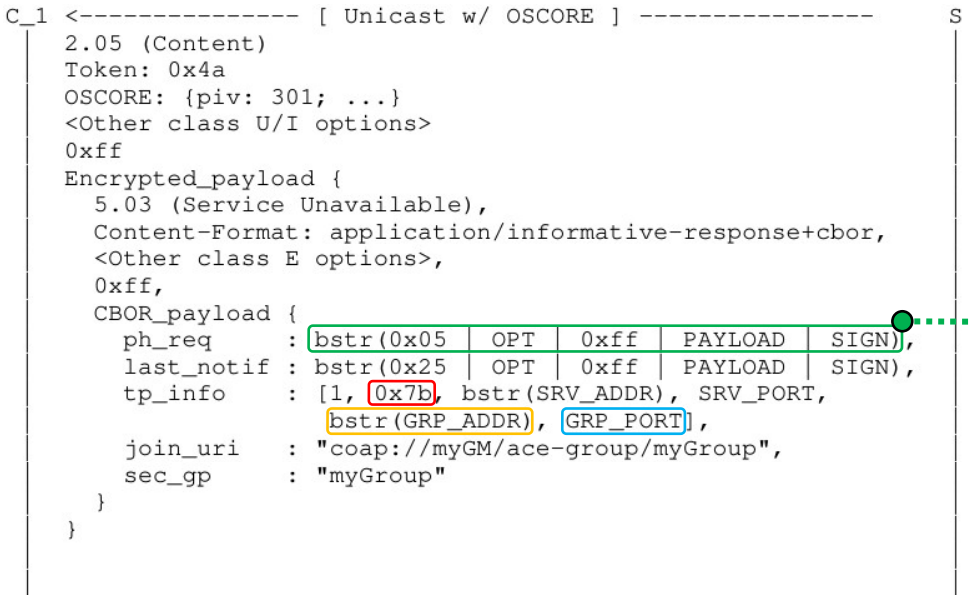
MUST

MAY

C1 registration w/ security



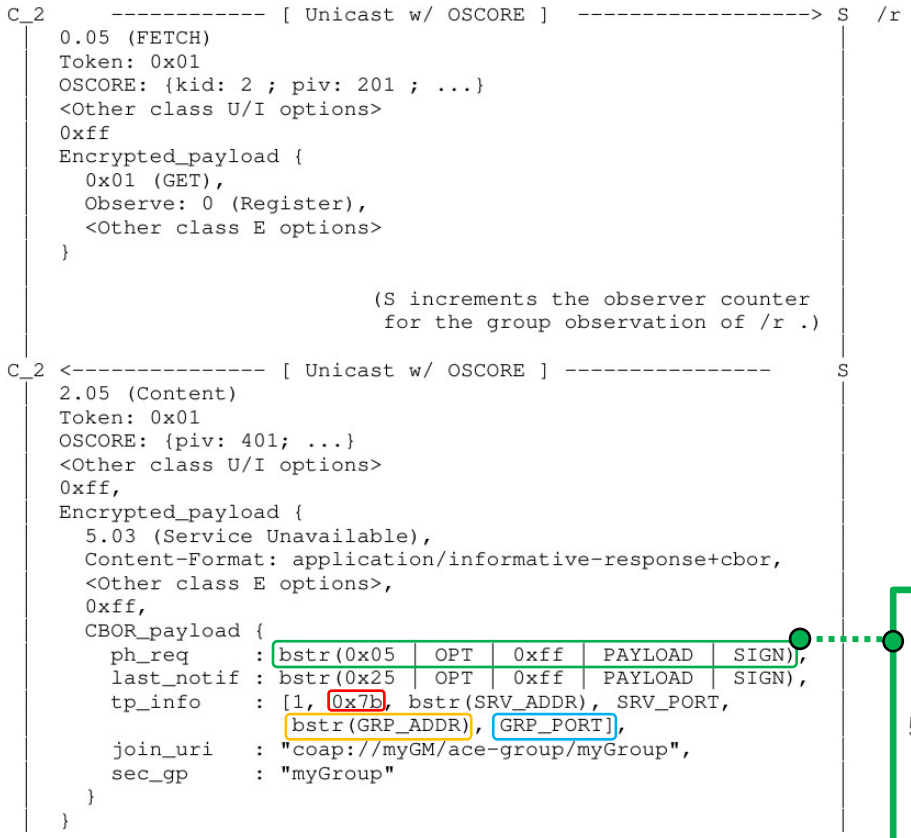
C1 registration w/ security



5: Sender ID ('kid') of S in the OSCORE group

501: Sequence Number of S in the OSCORE group when S created the group observation

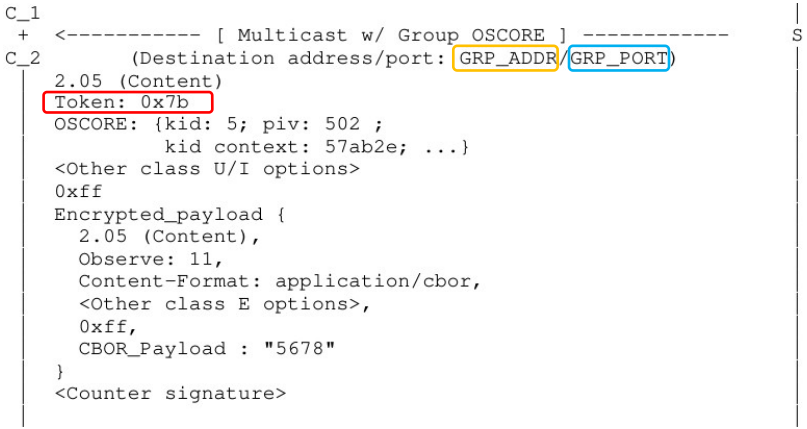
C2 registration w/ security



5: Sender ID ('kid') of S in the OSCORE group

501: Sequence Number of S in the OSCORE group <u>when S created the group observation</u>

Multicast notification w/ security



- When encrypting and signing the multicast notification:
  - The OSCORE *external_aad* has 'req_kid = **5** and 'req_iv = **501**
  - Same for all following notifications for the same resource
- Enforce secure binding between
  - Every multicast notification for the target resource
  - The (group) observation that each client takes part in