# Observe Notifications as CoAP Multicast Responses

*draft-ietf-core-observe-multicast-notifications-09*

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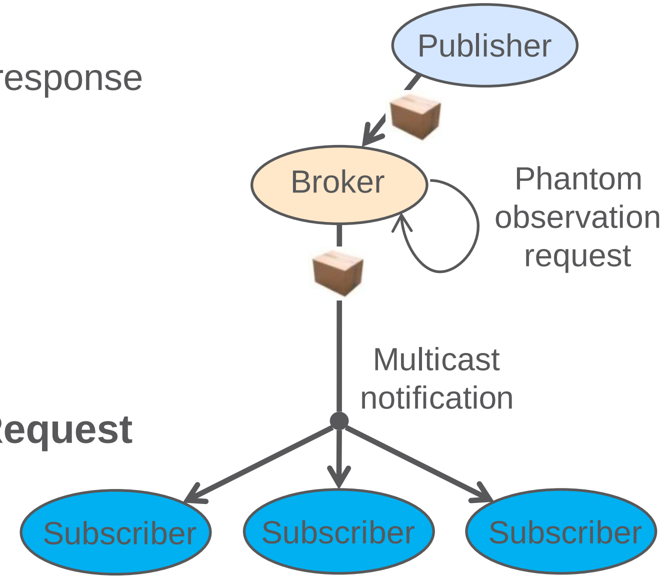
# Recap

- **Observe notifications as multicast responses**
  - Many clients observe the same resource on a server (e.g., pub-sub)
  - Improved performance due to multicast delivery
  - Clients configured by the server, with a 5.03 error informative response
- **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
- **Multicast notifications bound to a Phantom Observation Request**
  - By means of the same Token value for that observation
- **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*



# Latest updates

## Various editorial fixes, improvements, and reference updates

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## Clarifications, considerations, and fixes (1/2)

- **Clients can be pre-configured for listening to multicast notifications**
  - Still useful to send the regular observation request, possibly with No-Response:16
  - This helps the server keep count of the active observer clients
- **Rough counting of active observer clients: discussed accuracy and reliability**
  - More details on the impact due to proxies (with section restructuring)
  - More details on the impact due to the Phantom Request being a Deterministic Request [1]
- **Consistent use of the format *uint* for the Multicast-Response-Feedback-Divider Option**
  - The value 0 is encoded as the zero-length value
- **Early mentioning about the 5.03 error informative response and its content**
  - The source addressing information for the Phantom Request cannot instruct redirection

[1] https://datatracker.ietf.org/doc/draft-amsuess-core-cachable-oscore/

# Latest updates

## Clarifications, considerations, and fixes (2/2)

- **Secured multicast notifications: the replay protection is as per Group OSCORE**
  - No need for restating; removed pointer to RFC 8613
- **Fixed text about the proxy “consuming” proxy-related options (e.g., Proxy-Scheme, …)**
  - Relevant when Group OSCORE is used, and clients send a ticket request to the proxy
- **Appendix C – Server self-managing the OSCORE group**
  - More details on why some Group OSCORE parameters are not needed to be provided
- **Appendix D – Use of Deterministic Requests [1] as Phantom Requests**
  - Revised, brought up text on how the server handles Deterministic Phantom Requests
- **Revised parameter naming, aligned with the naming in Group OSCORE**

[1] https://datatracker.ietf.org/doc/draft-amsuess-core-cachable-oscore/

# Latest updates

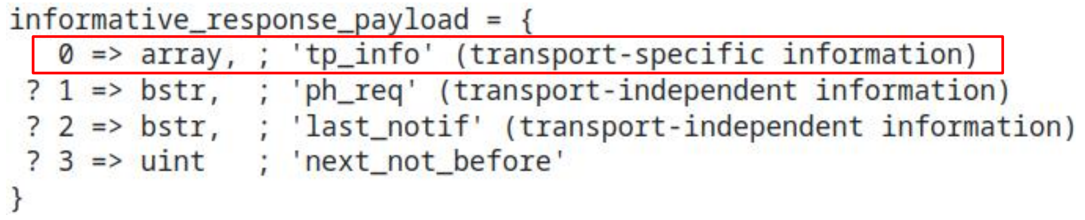
## Protocol behavior (1/2)

- **Appendix A – Early, public distribution of the Phantom Observation Request**
  - The server can rely on means other than the 5.03 error informative response. If so, …
  - The server first starts the group observation, then makes the corresponding data available
- **Appendix C – Server self-managing the OSCORE group**
  - Use of the parameter 'exi' for relative expiration time of the OSCORE group
- **Appendix D – If the Phantom Observation Request is a Deterministic Request [1] …**
  - The server does not assist clients that do not support Deterministic Requests
  - No "twin" group observation based on a non-deterministic Phantom Observation Request
- **Multicast-Response-Feedback-Divider Option, used for the rough counting of clients**
  - More details on how a proxy reacts if receiving the option and not supporting it
- **Mentioned possible use of the new options Proxy-Cri and Proxy-Scheme-Number [2]**

[1] https://datatracker.ietf.org/doc/draft-amsuess-core-cachable-oscore/
[2] https://datatracker.ietf.org/doc/draft-ietf-core-href/

# Latest updates

- **Protocol behavior (2/2) – Major change, discussed at IETF 114**
  - Revised the ‘tp_info’ information bundle in the 5.03 error informative response
  - This meant switching to using CRIs [2] to encode transport-specific information



```
informative_response_payload = {
   0 => array, ; 'tp_info' (transport-specific information)
  ? 1 => bstr,  ; 'ph_req' (transport-independent information)
  ? 2 => bstr,  ; 'last_notif' (transport-independent information)
  ? 3 => uint   ; 'next_not_before'
}
```

- First proposed in the PR #13
  - https://github.com/core-wg/observe-multicast-notifications/pull/13
- Fully specified in the PR #14 [4], now merged
  - https://github.com/core-wg/observe-multicast-notifications/pull/14

[2] https://datatracker.ietf.org/doc/draft-ietf-core-href/

# Latest updates

› **Use of CRIs in ‘tp_info’ – Details in Sections 4.2.1 and 4.2.1.1 of version -09**

**OLD approach**

```
tp_info = [
    srv_addr    ; Addressing information of the server
  ? req_info    ; Request data extension
]

srv_addr = (
    tp_id       ; Identifier of the used transport protocol
  + elements    ; Number, format and encoding based on the valud of ‘tp_id’
)

req_info = (
  + elements    ; Number, format, and encoding based on
                  the valud of ‘tp_id’ in ‘srv_addr’
)
```

**NEW approach in version -09**

```
tp_info = [
    tpi_server,       ; Addressing information of the server
  ? tpi_details       ; Additional information about the request
]

tpi_server = CRI   ; From draft-ietf-core-href, with no local part

tpi_details = (
  + elements          ; Number, format, and encoding based on the
                      ; scheme-id of the CRI in ‘tpi_server’
)
```

# Latest updates

› **Use of CRIs in ‘tp_info’ – Details in Sections 4.2.1 and 4.2.1.1 of version -09**

**Format for CoAP over UDP**

**OLD approach**

```
tp_info = [
    tp_id    : 1,                ; UDP as transport protocol
    srv_host : #6.260(bstr),     ; Src. address of multicast notifications
    srv_port : uint,             ; Src. port of multicast notifications
    token    : bstr,             ; Token value of the Phantom Request and
                                 ; of the associated multicast notifications
    cli_host : #6.260(bstr),     ; Dst. address of multicast notifications
  ? cli_port : uint              ; Dst. port of multicast notifications
]
```

**Format for CoAP over UDP**

**NEW approach in version -09**

```
tp_info_coap_udp = [
    tpi_server          ; Addressing information of the server,
                        ; as a CRI with scheme-id = -1 (coap)
                        ; and with no local part
    tpi_details_udp     ; Additional information about the request,
                        ; when CoAP over UDP is used
]

tpi_details_udp = (
    tpi_client : CRI,   ; Addressing information of the clients,
                        ; as a CRI with scheme-id = -1 (coap)
                        ; and with no local part --- Used as
                        ; destination of multicast notifications
    tpi_token : bstr    ; Token value of the Phantom Request and
                        ; of the associated multicast notifications
)
```

# Latest updates

- **Security considerations**
  - Rough counting of clients when communications are unprotected or protected

- **Examples of message exchanges**
  - Fixes; more details; improved notation; use of AASVG
  - Aligned with the new use of CRIs in the 5.03 error informative response

- **IANA considerations**
  - Fixed details of some registrations (e.g., Media Type)
  - Registration of the target attribute “gp-obs” (like “obs”, but for group observations)
  - Revised definition and pre-population of the new registry "Transport Protocol Indication“
    - || *Scheme ID* || *URI Scheme Name* || *Transport Information Details* || *Reference* ||

## Next steps

› **Describe how this works with a reverse-proxy**
  – Related to the Github issue #4

› **Consider the case where original Observe requests are sent over multicast**

› **Define the server behavior on terminating a group observation …**
  – … whose Phantom Observation Request was publicly advertised. Request revocation?

› **Define how SCHC compression should work for the two new CoAP options**
  – Listen-To-Multicast-Responses
  – Multicast-Response-Feedback-Divider

› **Need for reviews** – Previously promised: Göran, Esko, Jaime, Carsten, Thomas

Thank you!

Comments/questions?

https://github.com/core-wg/observe-multicast-notifications

## Backup

# 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; or
  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 ***error informative response*** with:
  - Transport-specific information, e.g., the IP multicast address where notifications are sent to
  - The serialization of the phantom observation request (optional)
  - The serialization of the latest multicast notification (optional)
  - Minimum amount of time after which the next multicast notification will be sent (optional)

# 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 the 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) the reply as ‘*last_notif*’

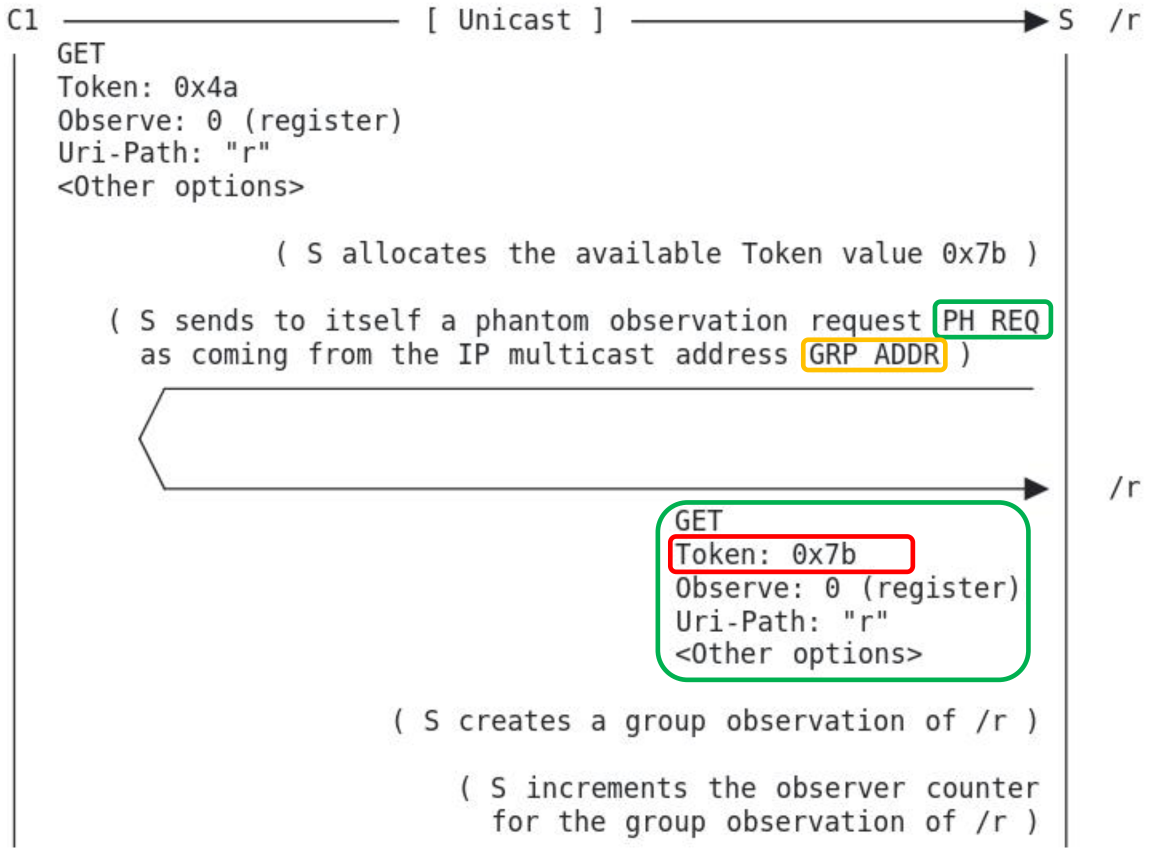
# Interaction with clients

- The server sends to new/shifted clients an ***error informative response*** with
  - '*tp_info*': transport-specific information
    - '*tpi_server*': source addressing information of the multicast notifications (as a CRI)
    - '*tpi_client*': destination addressing information of the multicast notifications (as a CRI)
    - '*tpi_token*': the selected Token value T, used for '*ph_req*' and the multicast notifications
  - '*ph_req*': serialization of the phantom request
  - '*last_notif*': serialization of the latest sent multicast notification for the target resource
  - '*next_not_before*': minimum amount of time after which the next multicast notification will be sent

- When the value of the target resource changes:
  - The server sends an Observe notification to the multicast IP address corresponding to '*tpi_client*'
  - The multicast notification has the Token value T of the phantom request

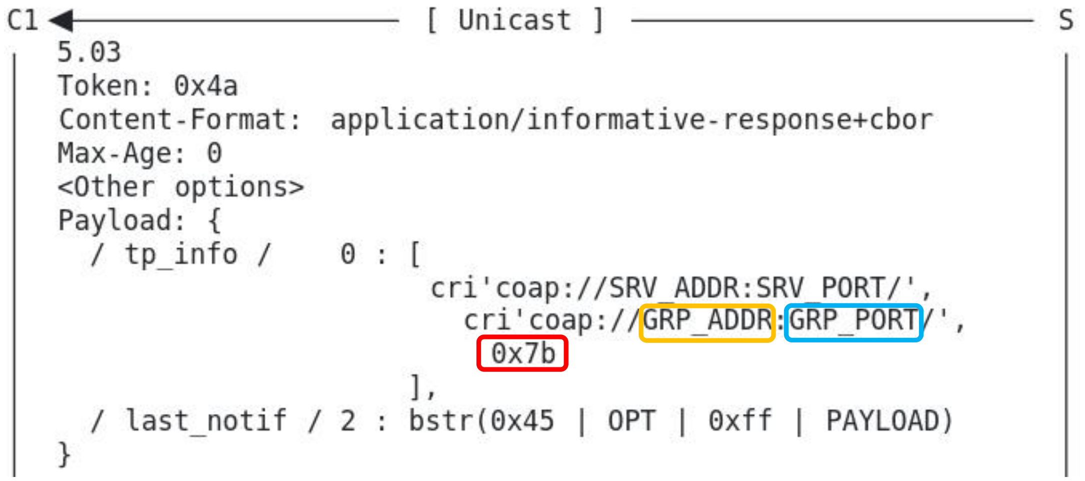
- When getting the error informative response, a client:
  - Configures an observation for an endpoint associated with the multicast IP address
  - Accepts observe notifications with Token value T, sent to that multicast IP address

# C1 registration



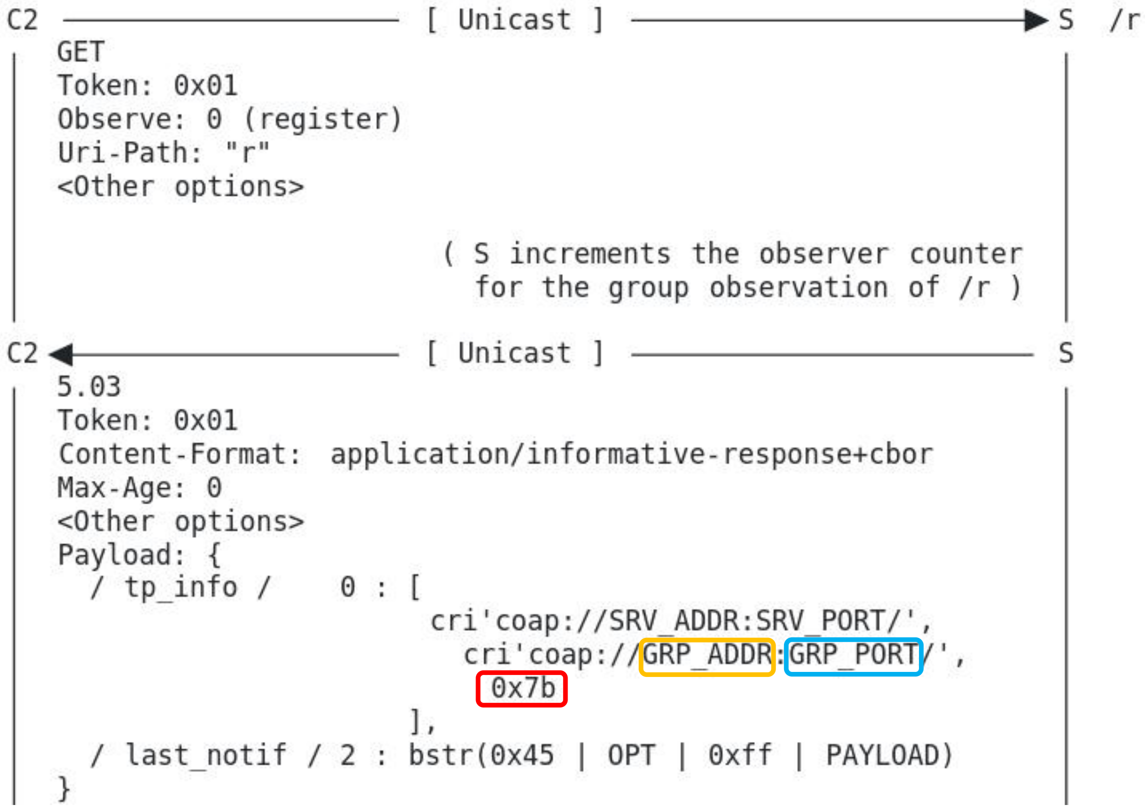
```
C1 ———————————— [ Unicast ] ——————————————▶ S  /r
 |  GET                                       |
 |  Token: 0x4a                               |
 |  Observe: 0 (register)                     |
 |  Uri-Path: "r"                             |
 |  <Other options>                           |
 |                                            |
 |         ( S allocates the available Token value 0x7b )
 |                                            |
 |   ( S sends to itself a phantom observation request PH_REQ
 |     as coming from the IP multicast address GRP_ADDR )
 |                                            |
 |                                            ▶  /r
 |                          GET               |
 |                          Token: 0x7b       |
 |                          Observe: 0 (register)
 |                          Uri-Path: "r"     |
 |                          <Other options>   |
 |                                            |
 |            ( S creates a group observation of /r )
 |                                            |
 |               ( S increments the observer counter
 |                 for the group observation of /r )
```

# C1 registration



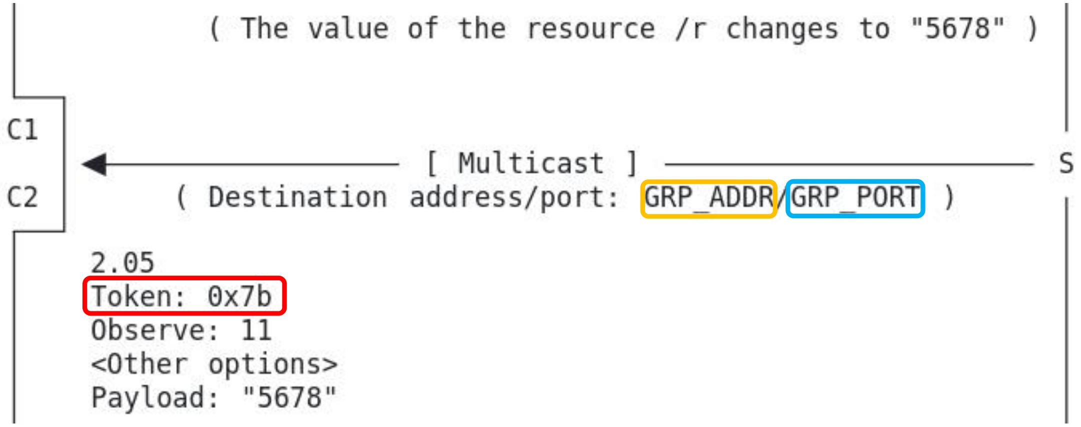
```
5.03
Token: 0x4a
Content-Format: application/informative-response+cbor
Max-Age: 0
<Other options>
Payload: {
  / tp_info /    0 : [
                      cri'coap://SRV_ADDR:SRV_PORT/',
                        cri'coap://GRP_ADDR:GRP_PORT/',
                         0x7b
                     ],
  / last_notif / 2 : bstr(0x45 | OPT | 0xff | PAYLOAD)
}
```

# C2 registration



```
C2 ─────────────── [ Unicast ] ──────────────────▶ S  /r
 |  GET                                            |
 |  Token: 0x01                                    |
 |  Observe: 0 (register)                          |
 |  Uri-Path: "r"                                  |
 |  <Other options>                                |
 |                                                 |
 |                   ( S increments the observer counter
 |                     for the group observation of /r )
 |                                                 |
C2 ◀────────────── [ Unicast ] ─────────────────── S
 |  5.03                                           |
 |  Token: 0x01                                    |
 |  Content-Format: application/informative-response+cbor
 |  Max-Age: 0                                     |
 |  <Other options>                                |
 |  Payload: {                                     |
 |    / tp_info /    0 : [                         |
 |                      cri'coap://SRV_ADDR:SRV_PORT/',
 |                        cri'coap://GRP_ADDR:GRP_PORT/',
 |                          0x7b                   |
 |                     ],                          |
 |    / last_notif / 2 : bstr(0x45 | OPT | 0xff | PAYLOAD)
 |  }                                              |
```

# Multicast notification


( The value of the resource /r changes to "5678" )
C1
C2
[ Multicast ]
S
( Destination address/port: GRP_ADDR/GRP_PORT )

```
2.05
Token: 0x7b
Observe: 11
<Other options>
Payload: "5678"
```

- 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
  - ***z*** : the Group ID (‘kid_context’) used in the OSCORE group
  - Note: the Server <u>consumes</u> the value ***y*** and does <u>not</u> reuse it as SN in the group

- To secure/verify <u>all</u> multicast notifications, the OSCORE *external_aad* is built with:
  - ‘request_kid’ = ***x***
  - ‘request_piv’ = ***y***
  - ‘request_kid_context’ = ***z***

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

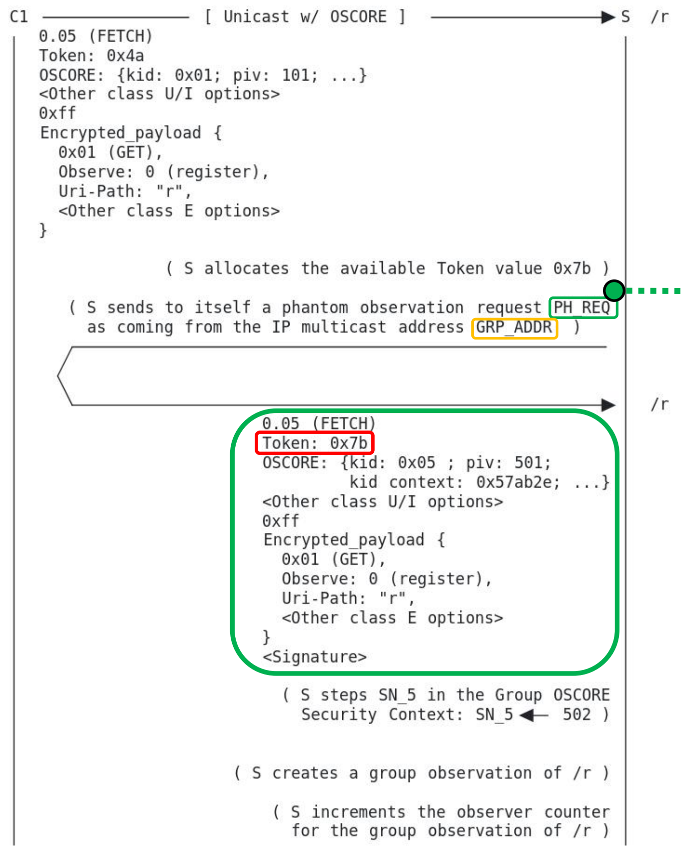
# Security with Group OSCORE

- 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
  - '*hkdf*' : HKDF Algorithm
  - '*cred_fmt*' : Format used in the OSCORE group for the authentication credentials
  - '*gp_enc_alg*' : Group Encryption Algorithm (for encryption with the group mode)
  - '*sign_alg*' : Signature Algorithm
  - '*sign_params*' : Parameters of the Signature Algorithm and signing key
    - '*sign_alg_capab*' : COSE capabilities of the '*sign_alg*' algorithm
    - '*sign_key_type_capab*' : COSE capabilities of the keys used by '*sign_alg*'

MUST

MAY

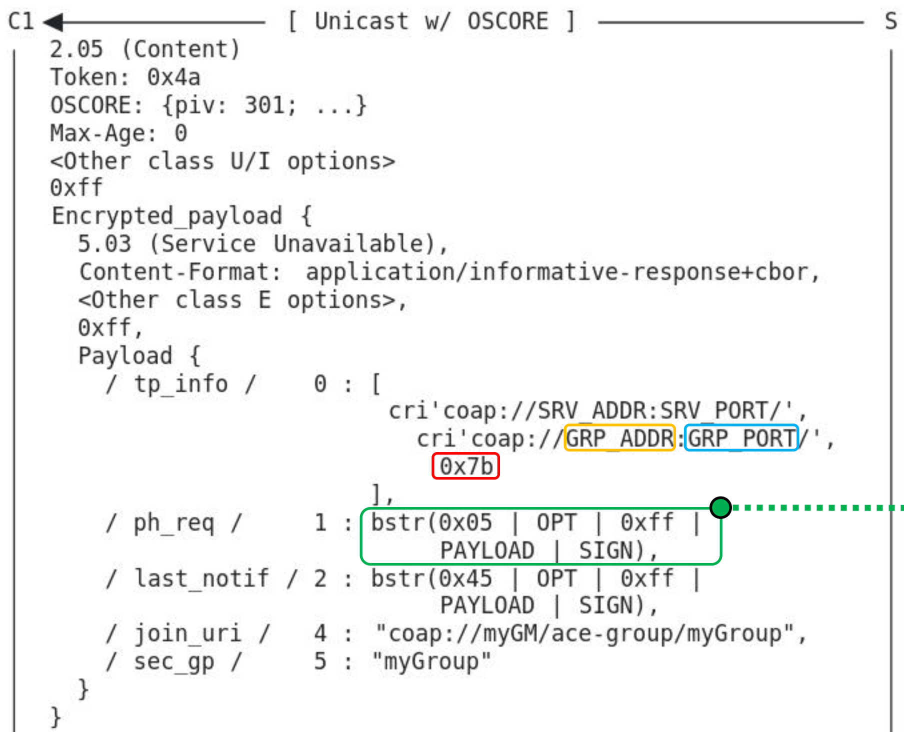
# C1 registration w/ security



```
C1 ─────────── [ Unicast w/ OSCORE ] ──────────────► S  /r
 |  0.05 (FETCH)                                      |
 |  Token: 0x4a                                       |
 |  OSCORE: {kid: 0x01; piv: 101; ...}                |
 |  <Other class U/I options>                         |
 |  0xff                                              |
 |  Encrypted_payload {                               |
 |    0x01 (GET),                                     |
 |    Observe: 0 (register),                          |
 |    Uri-Path: "r",                                  |
 |    <Other class E options>                         |
 |  }                                                 |
 |                                                    |
 |           ( S allocates the available Token value 0x7b )
 |                                                    |
 |    ( S sends to itself a phantom observation request PH_REQ
 |      as coming from the IP multicast address GRP_ADDR  )
 |     ┌──────────────────────────────────────────────|
 |    <                                               |
 |     └─────────────────────────────────────────────►|  /r
 |                        0.05 (FETCH)                |
 |                        Token: 0x7b                 |
 |                        OSCORE: {kid: 0x05 ; piv: 501;
 |                                 kid context: 0x57ab2e; ...}
 |                        <Other class U/I options>   |
 |                        0xff                        |
 |                        Encrypted_payload {         |
 |                          0x01 (GET),               |
 |                          Observe: 0 (register),    |
 |                          Uri-Path: "r",            |
 |                          <Other class E options>   |
 |                        }                           |
 |                        <Signature>                 |
 |                                                    |
 |                  ( S steps SN_5 in the Group OSCORE
 |                    Security Context: SN_5 <-- 502 )
 |                                                    |
 |             ( S creates a group observation of /r )
 |                                                    |
 |                 ( S increments the observer counter
 |                   for the group observation of /r )
 |                                                    |
```

The server protects the Phantom Request with Group OSCORE, using its Sender Context, as if it was the sender.

# C1 registration w/ security

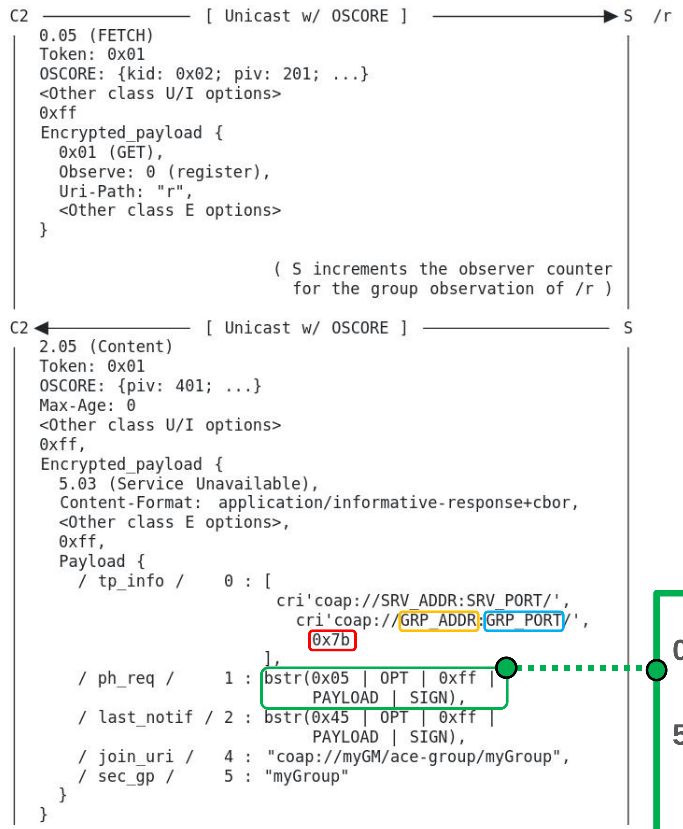


```
C1 <---------- [ Unicast w/ OSCORE ] ------------ S
|  2.05 (Content)                                  |
|  Token: 0x4a                                     |
|  OSCORE: {piv: 301; ...}                         |
|  Max-Age: 0                                      |
|  <Other class U/I options>                       |
|  0xff                                            |
|  Encrypted_payload {                             |
|    5.03 (Service Unavailable),                   |
|    Content-Format: application/informative-response+cbor,
|    <Other class E options>,                      |
|    0xff,                                         |
|    Payload {                                     |
|      / tp_info /    0 : [                        |
|                       cri'coap://SRV_ADDR:SRV_PORT/',
|                         cri'coap://GRP_ADDR:GRP_PORT/',
|                           0x7b                   |
|                      ],                          |
|      / ph_req /     1 : bstr(0x05 | OPT | 0xff | |
|                               PAYLOAD | SIGN),   |
|      / last_notif / 2 : bstr(0x45 | OPT | 0xff | |
|                               PAYLOAD | SIGN),   |
|      / join_uri /   4 : "coap://myGM/ace-group/myGroup",
|      / sec_gp /     5 : "myGroup"                |
|    }                                             |
|  }                                               |
```

**0x05**: 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

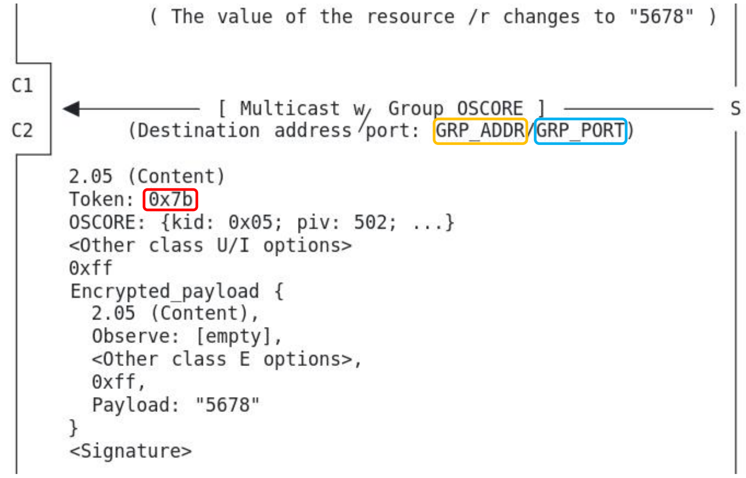


```
C2 ──────────── [ Unicast w/ OSCORE ] ──────────────▶ S  /r
 |  0.05 (FETCH)                                        |
 |  Token: 0x01                                         |
 |  OSCORE: {kid: 0x02; piv: 201; ...}                  |
 |  <Other class U/I options>                           |
 |  0xff                                                |
 |  Encrypted_payload {                                 |
 |    0x01 (GET),                                       |
 |    Observe: 0 (register),                            |
 |    Uri-Path: "r",                                    |
 |    <Other class E options>                           |
 |  }                                                   |
 |                                                      |
 |                         ( S increments the observer counter
 |                           for the group observation of /r )
 |                                                      |
C2 ◀──────────── [ Unicast w/ OSCORE ] ─────────────── S
 |  2.05 (Content)                                      |
 |  Token: 0x01                                         |
 |  OSCORE: {piv: 401; ...}                             |
 |  Max-Age: 0                                          |
 |  <Other class U/I options>                           |
 |  0xff,                                               |
 |  Encrypted_payload {                                 |
 |    5.03 (Service Unavailable),                       |
 |    Content-Format: application/informative-response+cbor,
 |    <Other class E options>,                          |
 |    0xff,                                             |
 |    Payload {                                         |
 |      / tp_info /    0 : [                            |
 |                         cri'coap://SRV_ADDR:SRV_PORT/',
 |                           cri'coap://GRP_ADDR:GRP_PORT/',
 |                           0x7b                       |
 |                         ],                           |
 |      / ph_req /     1 : bstr(0x05 | OPT | 0xff |     |
 |                              PAYLOAD | SIGN),        |
 |      / last_notif / 2 : bstr(0x45 | OPT | 0xff |     |
 |                              PAYLOAD | SIGN),        |
 |      / join_uri /   4 : "coap://myGM/ace-group/myGroup",
 |      / sec_gp /     5 : "myGroup"                    |
 |    }                                                 |
 |  }                                                   |
```

**0x05**: 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



```
         ( The value of the resource /r changes to "5678" )

C1
     <------------ [ Multicast w/ Group OSCORE ] ------------ S
C2     (Destination address/port: GRP_ADDR/GRP_PORT)

       2.05 (Content)
       Token: 0x7b
       OSCORE: {kid: 0x05; piv: 502; ...}
       <Other class U/I options>
       0xff
       Encrypted_payload {
         2.05 (Content),
         Observe: [empty],
         <Other class E options>,
         0xff,
         Payload: "5678"
       }
       <Signature>
```

- When encrypting and signing the multicast notification:
  - The *external_aad* has 'request_kid' = **0x05**, 'request_iv' = **501** and 'request_kid_context' = **0x57ab2e**
  - Same for <u>all</u> 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

# Support for intermediary proxies

- How it works
  - 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 11)
  - The proxy can retrieve the phantom request from the informative response
  - No need to forward the informative response back to the clients

- With end-to-end security (Section 12)
  - 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
  - Exception: the phantom request is a Deterministic Request (see *-core-cachable-oscore*)