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Conditional observe in CoAP
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Abstract

CoAP is a RESTful application protocol for constrained nodes and networks. Through the Observe option, clients can observe changes in the state of resources and obtain a current representation of the last resource state. This document defines a new mechanism in CoAP Observe so that a CoAP client can conditionally observe a resource on a CoAP server, only being informed about state changes meeting a specific condition or set of conditions. This offers possibilities to extend network intelligence, enhance scalability, and optimize the lifetime and performance in order to address the requirements from the Constrained Nodes and Networks.

Note

Discussion and suggestions for improvement are requested, and should be sent to core@ietf.org.

Status of This Memo

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1. Introduction

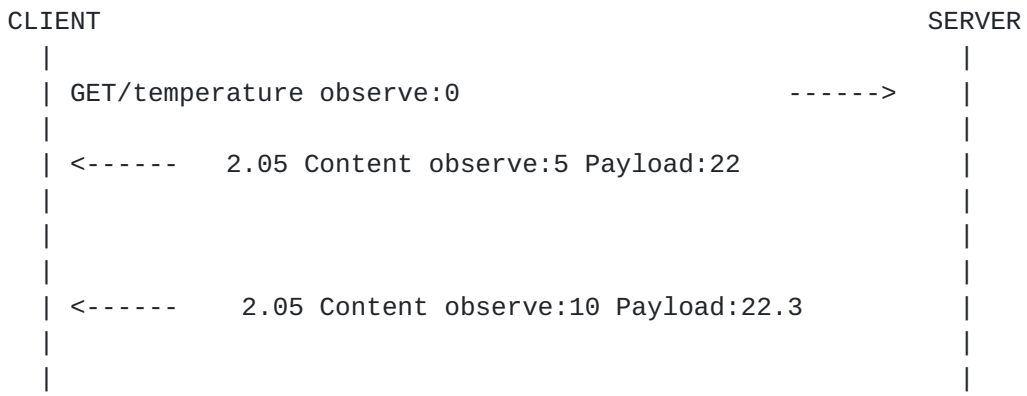
CoAP [I-D.ietf-core-coap] is an Application Protocol for Constrained Nodes/Networks. The observe [I-D.ietf-core-observe] specification describes a protocol design so that a CoAP client and server can use the subject/observer design pattern to establish an observation relationship. When observe is used, the CoAP client will get a notification response whenever the state of the observed resource changed. However, in some scenarios, the CoAP client may only be interested in a subset of state changes of the resource, other state changes might be meaningless. This inability to suppress additional notifications results in superfluous traffic. This memo defines a new CoAP option "Condition" that can be used to allow the CoAP client to condition the observe relationship, and only when such condition is met, the CoAP server shall send the notification response with the latest state change. When such a condition fails, the CoAP server does not need to send the notification response.

1.1. Justification

A GET request that includes an Observe Option creates an observation relationship. When a server receives such a request, it first services the request like a GET request without this option and, if the resulting response indicates success, establishes an observation relationship between the client and the target resource. The client is notified of resource state changes by additional responses sent in reply to the GET request to the client.

CoAP is used for Constrained Networks, especially used for transporting sensor data. Different sensor equipments have different properties, e.g. different change rates, data unit, different response time, etc. resulting in varying clients' interests that differ from mere state changes. As such, when a client wants to collect information from a sensor, it does not want to receive useless information. In addition, this would cause the transmission of irrelevant information in an already constrained network.

Consider the following example.



```
   |                                                       |
   | <------    2.05 Content observe:15 Payload:22.6       |
   |                                                       |
```

Figure 1: GET request with observe

In this example, the sensor acts as a server, and it collects the resource data every 5 seconds. When the client observes a resource on the server, it will receive a response whenever the server updates the resource, that is to say, mostly every 5 seconds the client will receive a notification response. However, the client might be a quite simple equipment not too sensitive to the resource state change, so it may not want to receive notifications that often. One possible solution could be to alter the sensor's configuration, e.g. to shorten the collecting frequency. However, the sensor should be able to provide services to many other clients, making it hard to find the best configuration that fits all clients' requirements.

1.2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2. Motivation

The CoAP Observe Option gives clients the ability to observe changes in the state of resources. A notification relationship is established and whenever the state of the resource changes, the new representation is pushed to the observer. In many cases, an observer will typically be interested in state changes that satisfy a specific condition. In addition, similar conditional observations will prove useful for many different resources. For example, being informed when the state of a resource exceeds a specific value.

Defining an agreed set of commonly used conditional observations has a number of advantages. In a well-defined way, clients can observe different resources conditionally. At the same time, these resources can clearly announce how they can be observed, facilitating machine processing of this information. Also, intermediaries can process multiple conditional observations, having as goal to alleviate the load on the constrained network and devices. In the absence of such a set of commonly used conditional observations, where every application developer can specify its own mechanisms, these advantages are lost.

2.1. Comparison to RESTful method

In [I-D.shelby-core-interfaces] a simple RESTful mechanism is described to provide additional conditions to the Observe Option through the use of URI query parameters. It proves that conditional observations are useful but begs the question how the two approaches stack up to each other. The authors think that both approaches come with their advantages and disadvantages. Here we try to give an overview for both approaches. This short list of arguments for and against both approaches isn't meant to be exhaustive. We as authors of this draft are aware that we are - by definition - biased and we welcome any feedback via our contact details and/or via the CoRE mailing list.

When using the RESTful approach care should be given to avoid overlap with URI query parameters that a resource might want to use itself. Therefore a clear RESTful interface should define how all the possible condition type are mapped to said interface. Specifying conditions via URI query parameters also requires a separate request for the conditions because - by default - all URI query parameters in a request are part of the Cache-Key. Furthermore, it makes identifying conditions harder when compared to a dedicated CoAP condition option. The current approach also doesn't allow multiple clients observing the same resource with different conditions. Including this into the RESTful approach, while keeping caching in mind, has yet to be considered. Another unspecified matter is signalling which condition types are supported by a resource.

The main advantage of the approach proposed in the interfaces draft is that due to its RESTful design it doesn't rely on Application protocol specific mechanisms (like CoAP options). This means that the interface can easily be supported by any other (application) protocol that supports the RESTful paradigm. It also means that servers and clients can limit their implementation of CoAP to the basic building blocks of the protocol and use those to add additional logic (in the form of RESTful interfaces) as opposed to supporting yet another option. Another - albeit a purist - argument is that CoAP options should limit themselves to controlling the CoAP protocol and should not influence the representations offered by a resource, as these should be defined within the REST interactions themselves.

3. The Condition Option

Type	C/E	Name	Data type	Length	Default
18	E	Condition	uint	1-5 B	(none)

Table 1: Condition Option number

The Condition Option has the option number 18. The last bit indicates it is an elective option and the second to last bit indicates that this is a Proxy Unsafe option (similar to the Observe Option). The delta between the Condition Option and the Observe Option is 12.

The Condition Option can be present in both request and response messages. In both cases, it must be used together with the Observe Option, since it extends the meaning of the Observe Option.

In a GET request message, the Condition Option represents the condition the client wants to apply to the observation relationship. It is used to describe the resource states the client is interested in.

In the response to the initial GET request message, the Condition Option, together with the Observe Option, indicates that the client has been added to the list of observers and that notifications will be sent only when the resource state meets the condition specified in the Condition Option. In all further notifications, the Condition Option identifies the condition to which the notification applies.

Basically, a similar procedure as described in the observe draft [I-D.ietf-core-observe] is followed, but extended with additional behaviour by taking the Condition Option into account. The exact semantics are defined in the sections below.

The size of the Condition Option value is not fixed and can range from 1 to 5 bytes. The value carried is in a specific format that consist of two parts: a mandatory condition header and an optional condition value. The condition header has a fixed length of 1 byte and the condition value, when present, can range from 1 to 4 bytes. The condition header consists of 3 fields: the condition type (TYPE), reliability flag (R) and value type (V).

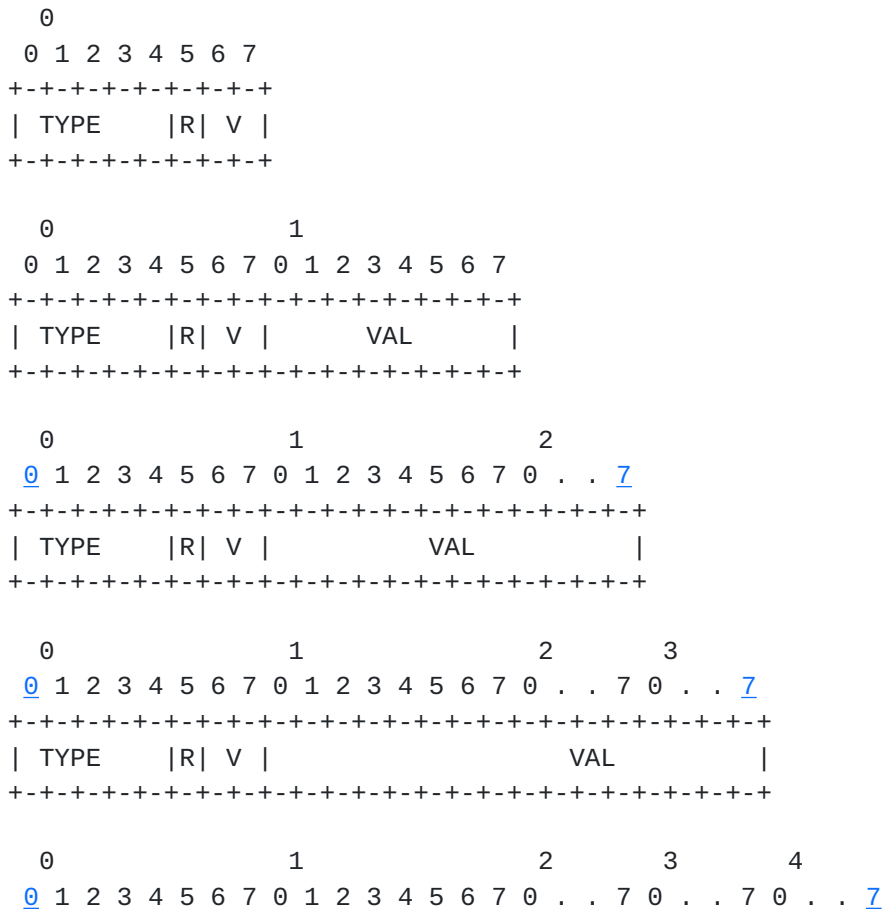
The Condition Option may occur more than once. If multiple Condition Options are present in a request, their relationship is "AND", meaning that the server will only send a notification when both conditions are fulfilled. In the notifications to such a request, the same Condition Options are present. The Figure 10 presents an example of a multiple condition with "AND" conjunction.

Note that in order to establish an "OR" relationship between conditions, a client simply needs to send separate requests using

different source endpoints. The Figure 11 presents an example of OR condition with multiple requests, which are sent in two messages via different source transport ports.

Since this solution could be considered as non-optimal, an alternative solution is proposed for discussion in the Annex "Logic flag", where multiple OR relationships with multiple conditional options can be defined, similar as has been presented for the "AND" conjunction.

In case of multiple Condition options, the main reason for choosing "AND" semantics over "OR" semantics is motivated by the fact that in case of the "OR" semantics the notification must be send anyway (as opposed to the "AND" case). This choice minimizes the amount of useless notifications that are sent over the network. The authors foresee that for some constrained devices supporting more than 1 condition per relationship might not be possible, in that case the client should try to establish the required behaviour using a minimal number of 1-condition relationships and filtering out unwanted notifications at the client-side.



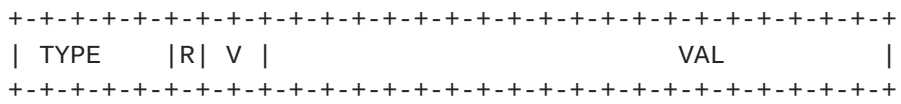


Figure 2: Condition Option value

TYPE: The condition type is a 5 bit integer indicating the type of the condition in the observe request or in a notification. Every value of TYPE represents the type ID of a specific condition type. Every condition type can be complemented by a condition value in the VAL field, further specifying the condition in more detail. Below is the definition of identified condition types.

R: In an observe request, the reliability flag indicates whether notifications for that condition need to be send non-confirmable (0) or confirmable (1). In the initial response, this flag indicates the server's willingness or ability to send the notifications confirmable or non-confirmable, as requested by the client. In all further notifications, this flag can be changed depending on the server's decision. In case of a request containing multiple Condition Options, the client must use the same value of the R flag in all Condition Options. If the server receives a request with multiple Condition Options, which do not all share the same value of the R flag, the server MUST respond with a 4.00 "Bad Request" response code. Note that the observe draft states that the message type of a notification is independent from the type used for the request or any previous notification. The R flag doesn't violate this behaviour and a client should expect that a CON notification might arrive without this being explicitly signalled by the server (as a NON-notification signalling this, might not arrive).

V: The value type is a 2 bit field in a request or response that gives the data type of the condition value, when present in the Condition Option. If no condition value is present, this field has no meaning and must be 0. Table 2 gives an overview of all available value types. The Duration data type is defined in Appendix C.2 of [I-D.bormann-coap-misc]. The representation of floating point numbers in a common format that is understandable by constrained devices is outside the scope of this document.

Value type (2 bit)	Id.
Integer	0
Duration (s)	1

Float	2

Table 2: Value types

VAL: The condition value is 1 to 4 byte value of the type indicated by the V flag. The condition value is used to indicate the value that further specifies the condition type (e.g. a threshold). Condition types can require the presence of a condition value. When a condition value is present in an observe request, the same value must be used in the initial response. In all further notifications, the condition value can be left out to reduce the size of the option.

4. Condition Types

Table 3 gives an overview of all currently identified condition types. If supported by the server, different condition types can be combined in a request to express a logical AND relationship. By default, logical OR of condition types is always supported through sending separate requests using different source endpoints.

Condition type (5 bit)	Id.	Condition Value
Cancellation	0	no
Time series	1	no
Minimum response time	2	yes
Maximum response time	3	yes
Step	4	yes
AllValues<	5	yes
AllValues>	6	yes
Value=	7	yes
Value<>	8	yes
Periodic	9	yes

Table 3: Condition types

Time series: This condition indicates that a client wants to receive all state changes of a resource, but that it does not want to receive a notification in case the time since the last notification was sent became greater than the max-age of the resource and the resource did not change during this period. --> This is a variant of the observe draft [I-D.ietf-core-observe] that deals with eventual consistency, which may result in notifications even if the resource did not change in order to ensure the observer has a fresh representation of the resource. Note that the observe draft states that if the age of the latest notification becomes greater than its indicated Max-Age, then the client MUST NOT use the enclosed representation until it is validated or a new notification is received. In case of the Time series condition a client might opt to divert from this behaviour and use these older notifications anyway. The client signals this to the server by choosing a Time series condition value larger than the Max-Age of the resource and including this option in its observe request. In case the server thinks this behaviour isn't feasible, it signals this to the client by removing the time series Condition option from its response. In case the server's response does echo the Time series condition, then the client is allowed to divert from the behaviour specified in the observe draft and use these 'older' notifications. Similar considerations hold true for the other timing condition types that are defined in this draft.

Minimum response time: For this condition, the value specified in the condition value field gives the minimum time in seconds the server should leave between subsequent notifications.

Maximum response time: For this condition, the value specified in the condition value field gives the maximum time in seconds the server is allowed to leave between subsequent notifications.

Step: For this condition, the value specified in the condition value field gives the minimum state change of a resource (since the last notification) before the server should send a new notification.

AllValues<: This condition indicates that a client is only interested in receiving notifications whenever the state of the resource changes and the value is less than the value specified in the condition value field.

AllValues>: This condition indicates that a client is only interested in receiving notifications whenever the state of the resource changes and the value is greater than the value specified in the condition value field.

Value=: This condition indicates that a client is only interested in receiving notifications whenever the state of the resource changes

and the value is equal to the value specified in the condition value field.

Value<>: This condition indicates that a client is only interested in receiving a single notification whenever the state becomes higher or lower than the value specified in the condition value field. Once the notification has been sent, no new notifications are sent for subsequent state changes where the value remains higher or lower. As such, a single notifications is sent whenever a threshold is passed in either direction.

Periodic: This condition indicates the periodic interval in seconds with which new notifications should be sent.

5. Using the Condition Option

Whenever a client wants to initiate a Conditional Observation relationship, it sends a GET request with both an Observe and at least one Condition Option. The Condition Option extends the meaning of the Observe Option by including a condition that describes the resource states the client is interested in. It represents the condition the client wants to apply to the observation relationship.

When a server receives such a request, it first services the request the same way as described in [I-D.ietf-core-observe]. Next, if the server supports the Condition Option, it analyses the Condition Option to find the condition requested by the client. If the condition is supported, the relationship is stored and the client is informed about the successful establishment of the conditional relationship. This is done by sending a response containing both the Observe and Condition Option, which implies that the client has now been added to the list of observers and will only be informed about state changes or resource states satisfying the condition described in the Condition Option.

Since the Condition Option is elective, an observe request that includes the Condition Option will automatically fall back to a basic observe request if the server does not support the Condition Option. There is no default value for the Condition Option. Also, if the Condition Option is supported, but the requested condition is not supported by the resource, the request will also fall back to a basic observe request, resulting in a response only containing the Observe Option. This implies that the client will now receive notifications as described in [I-D.ietf-core-observe] and that the client itself is responsible for processing the resource state in the notifications in order to identify whether the condition of interest is fulfilled.

Whenever the state of a resource that supports conditional observations changes on the server, the server needs to check the established conditional relationships. Whenever the relationship condition(s) is(are) met, the server sends the notification response to the client that has established the relationship. In case the server is still waiting for a confirmable notification to be acknowledged or the 3 seconds on average for a non-confirmable notification to elapse, it MUST adhere to the behaviour specified in section 4.5 of [I-D.ietf-core-observe]. The response contains both the Observe Option and the Condition Option, where the latter option describes the condition that has been fulfilled. If not met, the server does not send any response to the client. Furthermore, the server also doesn't send a response when the last notification is older than Max-Age.

A client is allowed to use multiple Condition Options in an observe request in order to express a logical AND relationship between different condition types. When a server receives such a request and it does not support composed conditions, the request will also fall back to a basic observe request, resulting in a response only containing the Observe Option. If the server supports this, it will store the relationship and send back a response echoing the same multiple Condition Options.

In case a client wants to establish multiple different conditional relationships with the same server, it needs to use a different source endpoint for every conditional relationship.

6. Cancellation, updating and existence of conditional relationships

6.1. Cancellation and updating

In case a client wants to cancel an existing conditional relationship, it has to perform a GET request to the target resource without Observe and Condition Option using the same source endpoint used to establish the conditional relationship (i.e. source endpoint of the original request). Upon reception of such a GET request, the server will remove the client from the list of conditional observers for that resource.

Alternatively, the client can also send a confirmable request containing a Condition Option with condition type _Cancellation_. The source endpoint used by the client together with the request URI uniquely identifies the conditional relationship the client has with the server. Upon reception of such a message, the server knows that the client wants to terminate the relationship it has established.

This cancellation mechanism implies that whenever a client wants to establish multiple different conditional relationships with the same resource on the same server, it needs to use a different source endpoint for every conditional relationship.

When a client has established a conditional relationship and it sends a new conditional observe request using the same source endpoint to the same resource, the existing relationship is removed and the new relationship established. This way, a client is able to update existing relationships.

Apart from the cancellation through sending a GET request without Observe and Condition Option, a conditional relationship can also be cancelled by sending a RST message in response of a confirmable notification. When a client rejects a non-confirmable notification with a RST, the server can remove the client from the list of observers interested in the specific condition of the resource in case the server maintains state information about non-confirmable notifications.

Additionally, if the server is for whatever reason not able to further fulfill the conditional relationship of a client, the server can also send a confirmable notification containing a Condition Option with condition type 'Cancellation' (echoing the Token in the notification). The client's endpoint and the request URI uniquely identify a conditional relationship with a server. As such, upon reception of such a message, the client can infer the request URI from the request associated with the Token contained in the response and knows the relationship that has been terminated by the server.

Finally, when a server sends a confirmable notification that is not acknowledged by the observer, the server may terminate the relationship after the last unsuccessful delivery attempt of said notification.

Note: The possibilities to establish a Cancellation flag have also been evaluated, see Annex "Cancellation flag". This has been discarded since, as it is too complex for processing, when multiple conditions are defined.

6.2. Existence

The observe draft [I-D.ietf-core-observe] specifies that at a minimum a server must send a notification in a confirmable message at least every 24 hours. In case of monitoring critical events this 24-hour interval is most likely too short. Therefore additional, more flexible mechanisms for checking the existence of a (conditional) relationship are needed. This paragraph presents two ideas in the

form of CoAP options that augment the default periodic confirmable message.

A client has the possibility to establish and remove conditional relationships and a server can also inform a client about the removal of a conditional relationship. Next to this, there is the issue of how long the relationship is guaranteed to exist in the absence of any explicit removal from either the client or server side (e.g. a client that wants to maintain the relationship for a very long time) or in the absence of frequent notifications. To this end, a mechanism is needed for a client to know whether it is still on the list of observers and for a server to know whether a client is still an observer.

In order for a client to know whether it is still on the list of observers after a long period without notifications or without confirmable notifications, the server can use the Pledge Option, as defined in [I-D.bormann-coap-misc]. By adding this option to its notifications, the server indicates how long it minimally promises to maintain that specific conditional relationship. In case no new notifications or non-confirmable notifications are sent and the duration indicated in the Pledge Option is to expire, the client must renew the relationship by resending the same request, preferable as a confirmable message.

In case the duration indicated in the Pledge Option expires at the server side and the client did not renew the relationship, the server must remove the relationship by sending an explicit cancellation message (a confirmable notification to the client's source endpoint containing a Condition Option with condition type 'Cancellation'.). As such, the use of the Pledge Option extends the establishment and removal mechanism with a server-initiated mechanism to realize intermediate refreshments of the relationship.

The second mechanism, for a server to determine whether a client is still an observer, is realized by adding a Keep-Alive Option to the observe request. The size of the Keep-Alive Option value is 1 byte and represents a duration in seconds, using the Duration data type as defined in Appendix C.2 of [I-D.bormann-coap-misc].

Type	C/E	Name	Format	Length	Default
30	E	Keep-alive	Duration in s	1 B	(none)

Table 4: Keep-alive Option number

The Keep-Alive Option has the option number 30, meaning that it is an elective, Proxy Safe option, but not a cache key.

When the client adds the Keep-Alive option to its conditional observe request, it requests the server to confirm that the relationship is still alive every time the duration expires and no notifications or only non-confirmable notifications have been sent during that period. If the option is supported by the server, the option is echoed in its first response. Every time the duration expires and no notifications or only non-confirmable notifications have been sent, the server sends a confirmable notification to the client with an empty payload (since the condition is not fulfilled). As such, the use of the Keep-alive Option extends the establishment and removal mechanism with a client-initiated mechanism to realize intermediate refreshments of the relationship. Furthermore it allows a client to explicitly specify the 24-hour interval mentioned in the observe draft.

The Pledge Option allows a server to request a client to confirm its interest and the Keep-Alive option allows a client to request a server to confirm whether it is still an observer. In case neither of the two options are supported, the only way for the client to ensure the relationship is still existing in the absence of incoming notifications is to periodically re-establish the relationship and the only way for the server to ensure the client is still interested is to send a confirmable notification from time to time.

7. Discovery

The Condition Option enables the establishment of well-defined set of conditional observations. It is equally important for a resource to be able to announce in a well-defined way which conditional observations it supports. Clients can then discover these capabilities and process them automatically.

In [I-D.ietf-core-observe], the "obs" attribute is introduced as a target attribute. It is used as a flag without any value, indicating that the resource is observable. In order to describe the conditional observe capabilities of a resource, a value is added to the obs attribute. To describe which of the 2^5 possible condition types a resource supports, a 32-bit value is used where a bit-value of 1 at position X (starting from 0 and from right to left) indicates that the condition type X is supported. As such, by a client can discover the supported observe capabilities by parsing the value of the "obs" attribute. In case no value is present, the "obs" attribute preserves its original meaning.

8. Examples

This section gives a number of short examples with message flows to illustrate the use of Condition Option in a observe GET request. Note that, in order to keep the figures readable, the Condition Option that is included in every notification is not shown.

The first example (Figure 3) shows that the client sets the Condition Option to Type: 1 - No Value (1/-). The condition is Time Series, meaning that the client wants to receive all state changes. In case the state of the resource does not change, no notifications are sent, also not in case max-age expires. We assume a max-age value of 60 seconds.

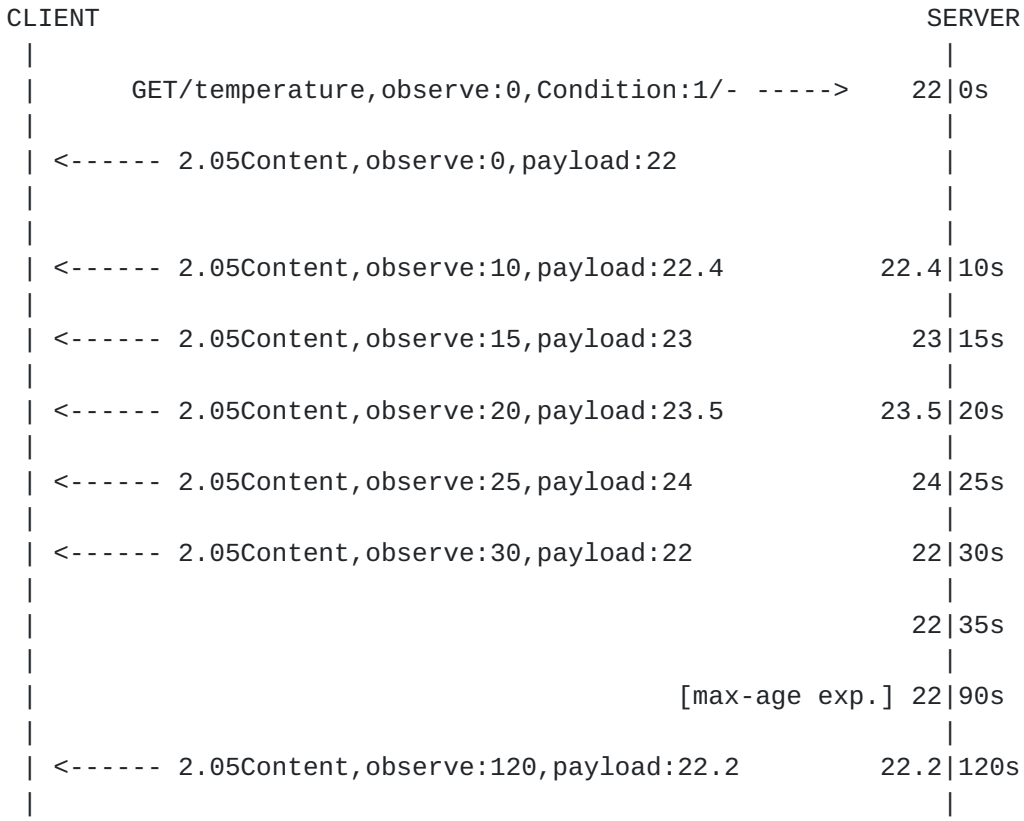


Figure 3: Condition Option with value 1/- (Time Series)

The following example (Figure 4) shows that the client sets the Condition Option to Type: 2 - Value: 10 (2/10), This means that the server shall wait at least 10s between sending notification responses, indicating changes in the state of the resource, to the client.

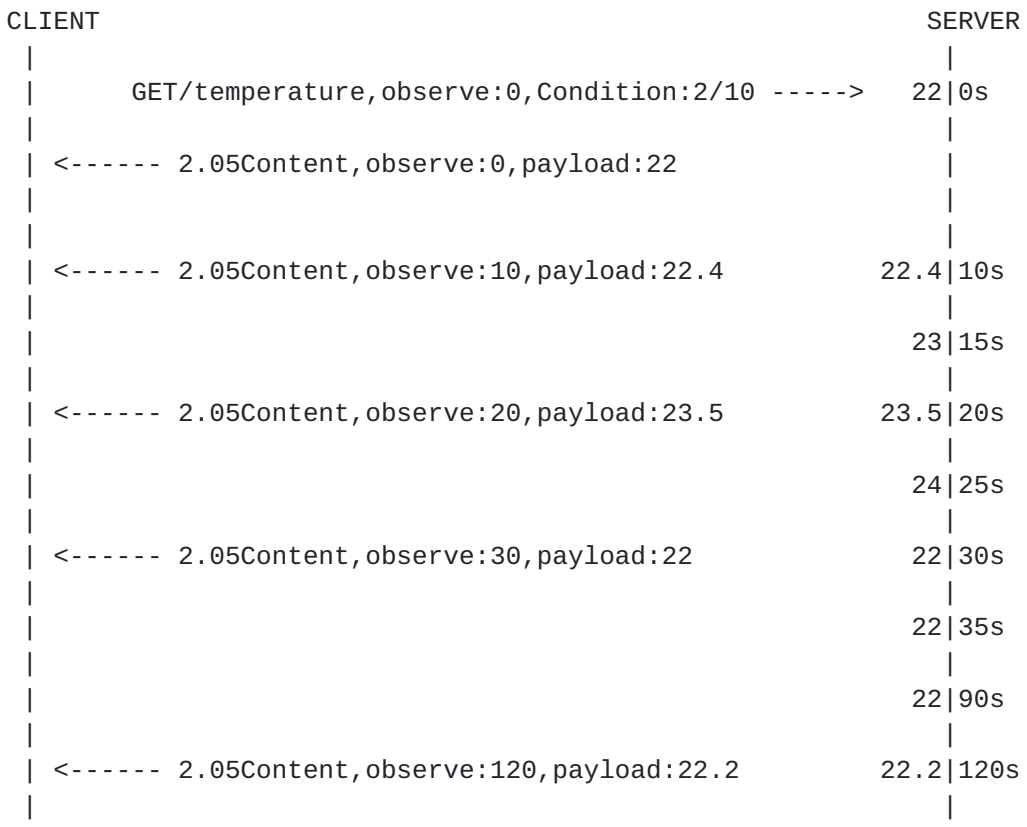
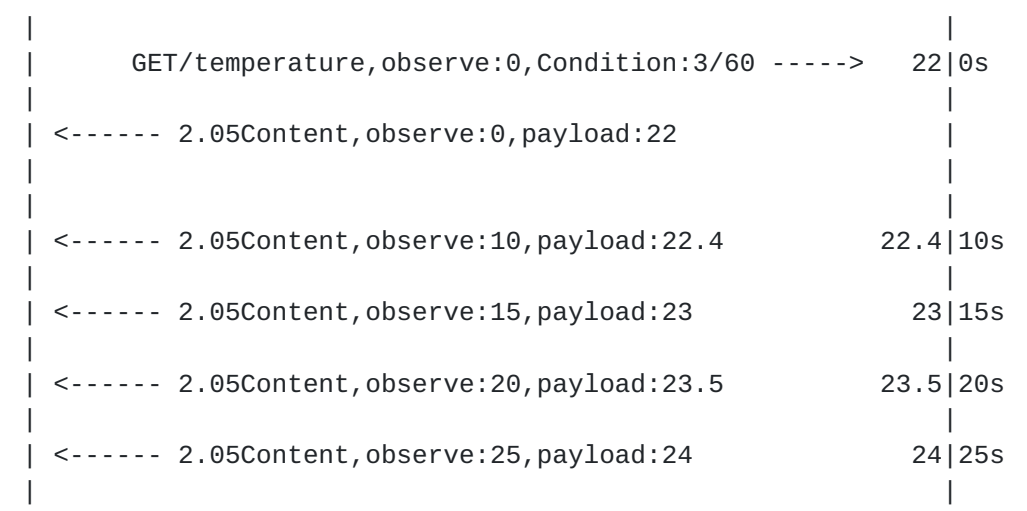


Figure 4: Condition Option with value 2/10 (Minimum Response Time)

The next example (Figure 5) shows that the client sets the Condition Option to Type: 3 - Value: 60 (3/60). The server will send notifications upon every state change, but will leave maximally 60s between subsequent notifications, even if they do not incur a state change.



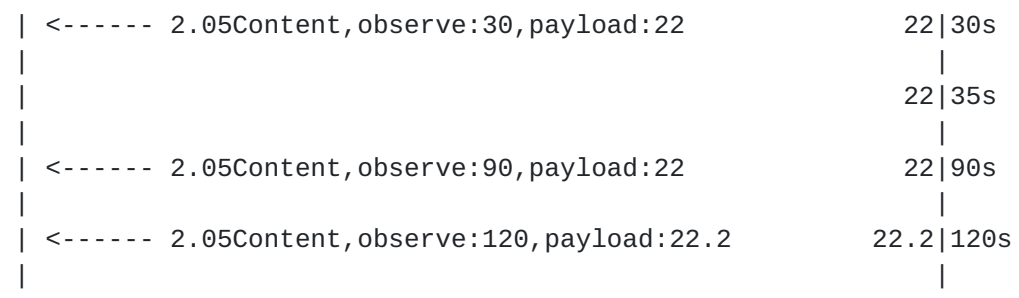


Figure 5: Condition Option with value 3/60 (Maximum Response Time)

Figure 6 shows a client setting the Condition Option to Type: 4 - Value: 1 (4/1). The server will now send notifications every time the change in state of the resource is at least 1.

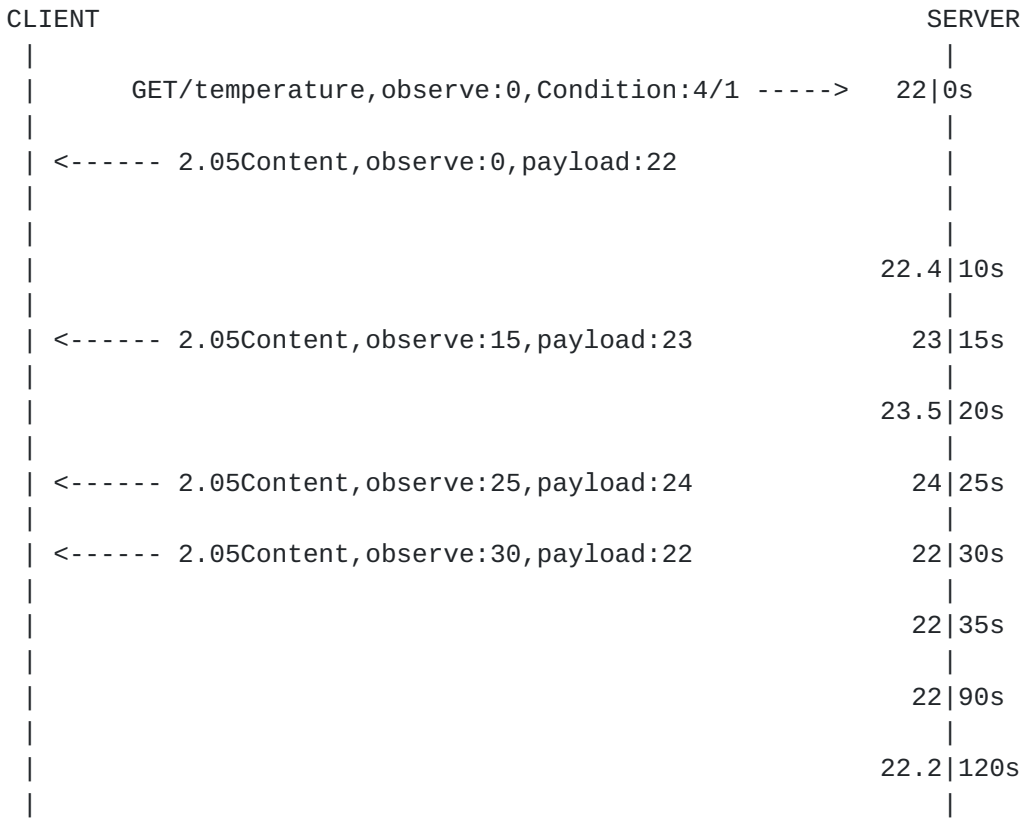


Figure 6: Condition Option with value 4/1 (Step)

The example in Figure 7 shows that the client sets the Condition Option to Type: 6 - Value: 23 (6/23). The server will send notifications to the client only if the resource value is bigger than 23.

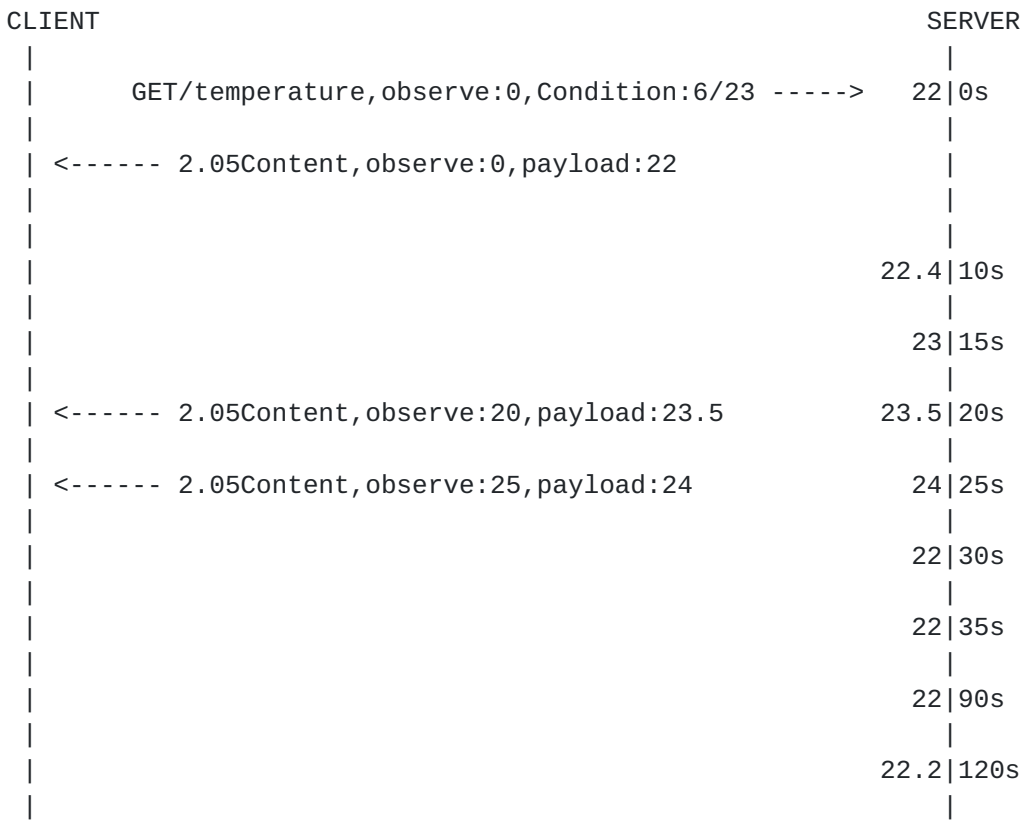


Figure 7: Condition Option with value 6/23 (AllValues>)

Figure 8 is an example of a client setting the Condition Option to Type: 8 - Value: 23 (8/23). The server will send a single notification whenever the state becomes higher or lower than 23.

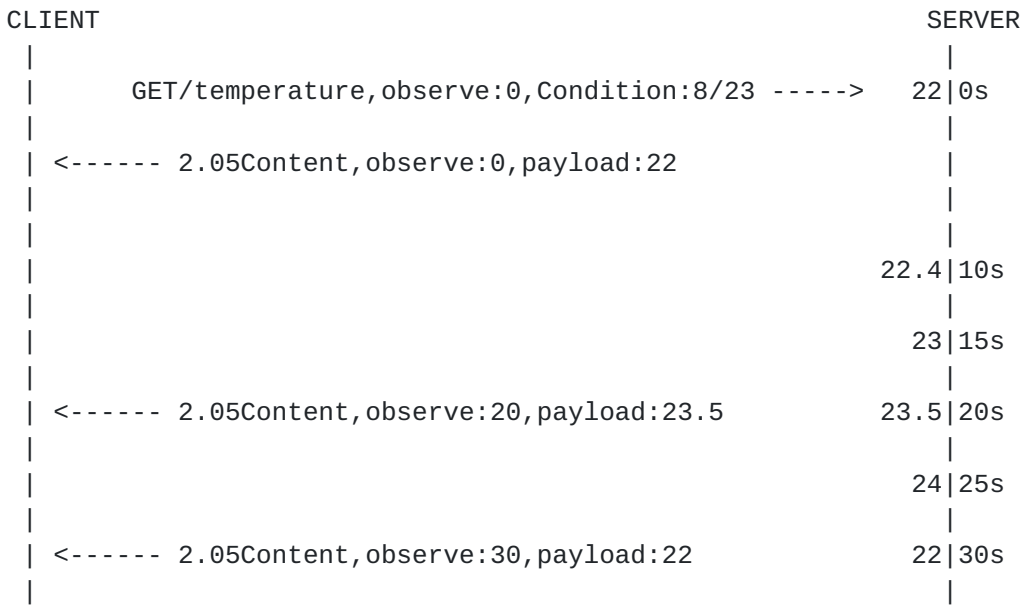


Figure 8: Condition Option with value 8/23 (Values<>)

Figure 9 is an example of a client setting the Condition Option to Type: 9 - Value: 30 (9/30). The server will send notifications every 30 seconds, independent whether the resource has changed or not.

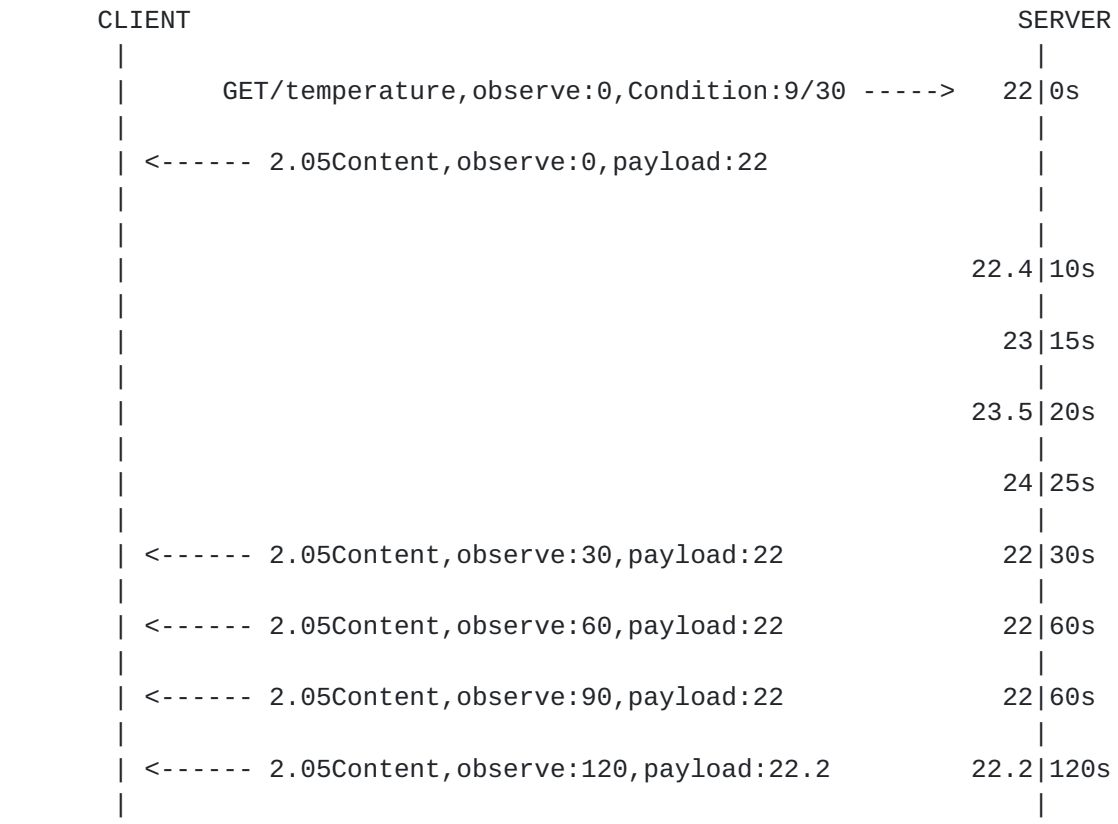


Figure 9: Condition Option with value 9/30 (Periodic)

In the following examples, we illustrate the combination of different conditions. The example in Figure 10 shows the client adds two range Condition Options in the request, one set to 6/5, another one set to 5/15. It means that the range is within 5 and 15, i.e. value > 5 AND value < 15. Since it is an AND condition, the two conditions can be specified in the same observe with multiple options.

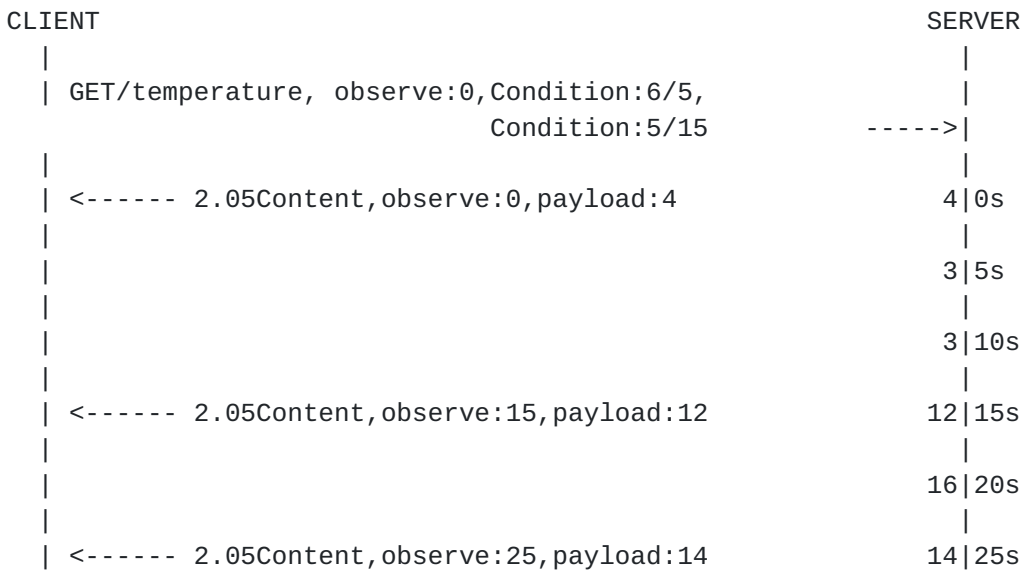


Figure 10: Two Condition Options to define in-side a range option 6/5 AND 5/15 (AllValues> AND AllValues<)

The last example (Figure 11) shows the client adds two Observe request messages to build a range, one sets to 6/22, another one sets to 5/16. It means that the range is out of range between 16 and 22, i.e. value > 22 OR value < 16. This requires two messages, since it is the OR option, which is defined with multiple observe messages. An example of the application for this option can be found in the implementation of the conditional observer [SENSORS].

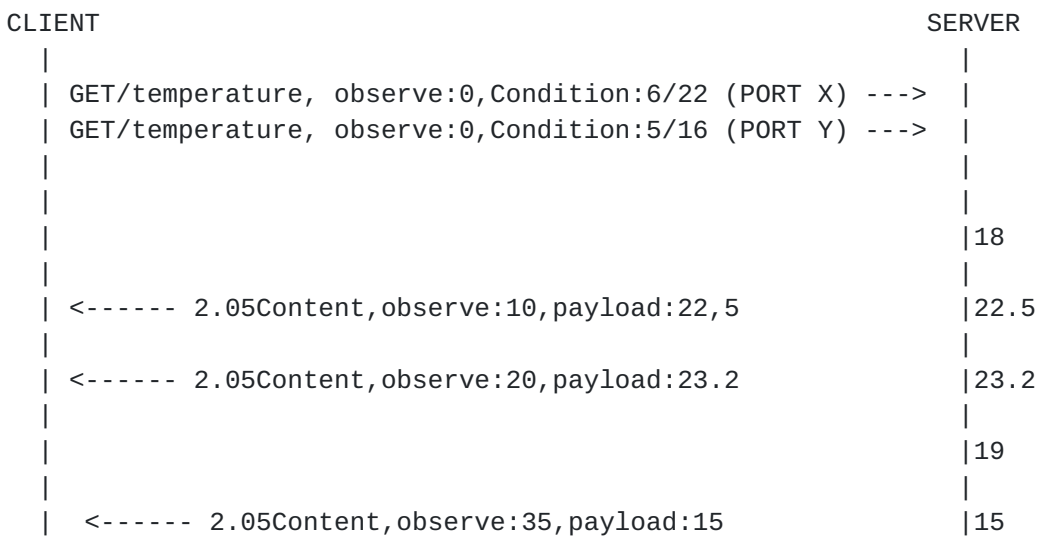


Figure 11: Two Observe requests to define out-side a range 6/22 OR 5/15 (Allvalues> OR Allvalues<)

Further, in [CPSCOM], an evaluation can be found regarding the feasibility of implementing conditional observations on real constrained devices, together with a basic performance comparison between conditional observe (server-filtering) and normal observe in combination with client-side filtering.

9. Security Considerations

As the Condition Option is used together with the Observe option, when it is used it must follow the security considerations as described in Observe draft [I-D.ietf-core-observe].

10. IANA Considerations

10.1. Condition option registry

This draft adds the following option numbers to the CoAP Option Numbers registry of [I-D.ietf-core-coap]

Number	Name	Reference
26	Condition	[RFCXXXX]
28	Keep-alive	[RFCXXXX]

Table 3: Condition and Keep-alive Option number

10.2. Condition type registry

The Condition types defined in this draft are identified by a string, such as "Step". In order to minimize the overhead of using these condition types, this document defines a registry for the condition types to be used in CoAP and assigns each a numeric identifier.

Each entry in the registry must include the condition type registered with IANA, the numeric identifier in the range 0-31 to be used for that condition type in CoAP, and a reference to a document defining the usage of that condition type.

Initial entries in this registry are as follows:

Condition type	Id.	Reference
Cancellation	0	[RFCXXXX]
Time series	1	[RFCXXXX]
Minimum response time	2	[RFCXXXX]
Maximum response time	3	[RFCXXXX]
Step	4	[RFCXXXX]
AllValues<	5	[RFCXXXX]
AllValues>	6	[RFCXXXX]
Value=	7	[RFCXXXX]
Threshold	8	[RFCXXXX]
Periodic	9	[RFCXXXX]

Table 5: Condition Option type

11. Further considerations

Intermediaries, caching, retransmissions

12. Acknowledgements

Thanks to the IoT6 European Project (STREP) of the 7th Framework Program (Grant 288445).

13. Normative References

[CPSCOM] Ketema, G., Hoebeke, J., Moerman, I., Demeester, P., Li, Shi., and A. Jara, "Efficiently observing Internet of Things Resources", The 2012 IEEE International Conference on Cyber, Physical and Social Computing November 20-23, 2012, Besancon, France, Novemer 2012.

[I-D.bormann-coap-misc] Bormann, C. and K. Hartke, "Miscellaneous additions to CoAP", draft-bormann-coap-misc-13 (work in progress), March 2012.

[I-D.ietf-core-coap] Shelby, Z., Hartke, K., and C. Bormann, "Constrained Application Protocol (CoAP)", draft-ietf-core-coap-17 (work in progress), May 2013.

[I-D.ietf-core-link-format] Shelby, Z., "CoRE Link Format", draft-ietf-core-link-format-14 (work in progress), June 2012.

[I-D.ietf-core-observe] Hartke, K., "Observing Resources in CoAP", draft-ietf-core-observe-08 (work in progress), February 2013.

[I-D.shelby-core-interfaces] Shelby, Z. and M. Vial, "CoRE Interfaces", draft-shelby-core-interfaces-05 (work in progress), March 2013.

[OMADM] Alliance, OMA., "Lightweight Machine to Machine Technical Specification", OMA-TS-LightweightM2M-V1_0-20130301-D Open Mobile Alliance (OMA), March 2013.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[SENSORS] Castro, M., Jara, A., and A. Skarmeta, "Architecture for Improving Terrestrial Logistics Based on the Web of Things", Sensors 12, no. 5, 6538-6575, 2012, May 2012.

Appendix A. OMA Information Reporting with CoAP Conditional Observe

The Open Mobile Alliance (OMA) has defined the Lightweight Machine to Machine (LWM2M) Technical Specification [OMADM]. This specification uses CoAP as the transport for the device management in terms of registration, service discovery, bootstrapping, service enablement, and information reporting.

Information reporting presents a similar philosophy that CoAP conditional observe. In details, it is defined for the periodic reporting of data, or an event-triggered reporting based on changes in some of the resource values.

Information reporting allows to send an Observe GET request for an Object Instance (Objects is the organization of resources in OMA LWM2M), which results in asynchronous notifications whenever that Object Instance changes (periodically or as a result of an event). The minimum and maximum period of notifications can be controlled by including the minimum (pmin) and/or maximum (pmax) period for notifications to be sent in seconds.

An example of the logical operation defined by OMA LWM2M is a GET with Observe option:

```
/{Object ID}/{Object Instance ID}/{Resource ID}
?pmin={minimum period}&pmax={maximum period}
```

The answer is a 2.05 Content with Observe option, 4.00 Bad Request, 4.04 Not Found, 4.05 Method Not Allowed, or in case of Asynchronous Response 2.04 Changed.

Note, that the resources are logically organized into Objects. Thereby, multiple resources are defined per Object, and each resource is given a unique identifier within that Object. Each Resource is defined to have one or more Operations that it supports. A Resource MAY contain multiple instances as defined in Object specification. An Object defines a grouping of Resources. Object MUST be instantiated, which is called Object Instance before using the functionality of an Object. After Object Instance is created, that Object Instance and Resources which belong to that Object Instance. As a result, it is required to reference the Object ID, Object Instance ID, and finally Resource ID.

The operations defined for the information reporting interface are: observe, notify, and cancel observation.

First, the observe interface, following the OMA LWM2M requirements, needs to define the Minimum and Maximum period parameters.

Minimum period indicates the minimum time in seconds the device SHOULD wait between sending a new notification.

Maximum period indicated the maximum time in seconds the device SHOULD wait between sending the next notification (regardless if the value has changed).

These options correspond with the Minimum response time (option 2), and Maximum response time (option 3) of the presented Conditional Observe.

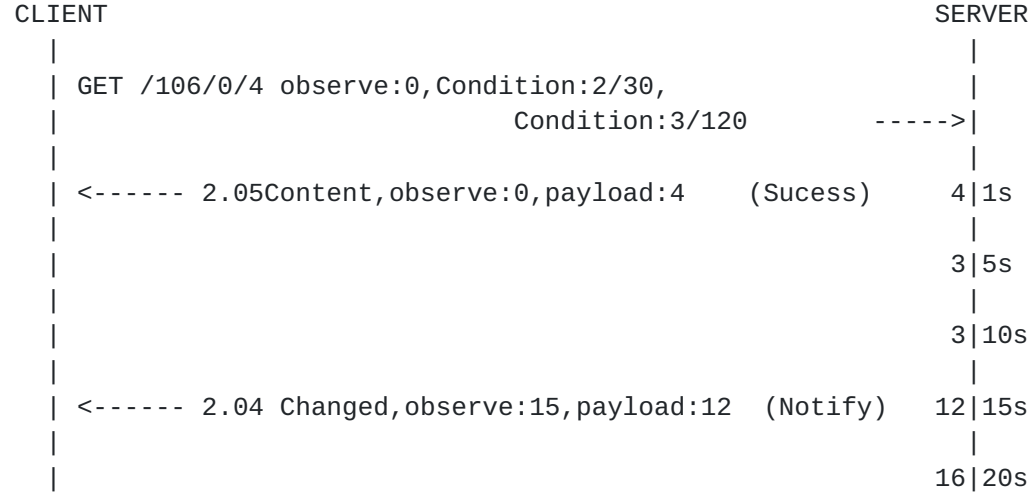
Second, the cancel observation interface of the OMA LWM2M for the information reporting corresponds with the Cancellation (option 0).

Finally, the notification interface is similar.

Therefore, OMA LWM2M Information Reporting can be implemented with the Conditional Observe. In addition, Conditional Observe offers a set of extra features in order to set up more complex logic for the observation (subscription).

The main difference and advantage of using Conditional Observe is that the minimum and maximum period options will be defined as part of the condition, since they are two options offered by conditional observe. Thereby, it is not required the definition of minimum and maximum period by parameters (i.e., using the ?pmin={minimum period} and pmax={maximum period}).

The Figure 12 presents an example to conditional observe the OMA Object 106 (which is an IPSO Sensor), Object instance 0, and the resource ID 4 (which is, for this example, a temperature value). This carries out a registration with a minium period of 30 seconds and a maximum period of 120 seconds.



```
|                                                          |
| <------ 2.04 Changed,,observe:25,payload:14 (Notify)   14|25s
```

Figure 12: Example of conditional observe following the OMA LWM2M Information Reporting requirement. This example is observing the OMA Object 106, Object Instance ID 0, and Resource ID 4. This is defining a minimum period of 30 seconds and maximum period of 120 seconds.

Appendix B. Alternative approaches

In this appendix, we include some alternative solutions the authors have discussed regarding cancellation of relationships and the logical combination of different relationships. The mechanisms described here allow more flexibility, but introduce additional (undesired?) complexity. We put their description in this appendix to trigger further discussion and provide more background.

B.1. Annex: Cancellation flag

An alternative way to allow the explicit establishment and removal of conditional relationships and to allow the establishment of multiple conditional relationships to the same server using the same source transport address, is through the introduction of a 1 bit cancellation flag (C) as part of the 1 byte condition header. The following paragraphs describe how this flag would change this behaviour.

C: The cancellation flag, when used in an observe request, indicates whether the client wants to establish a conditional observation relationship (0) or cancel an existing conditional relationship (1). In the initial response, the server uses the same value as in the request. In all further notifications, this flag has no meaning and must be 0. In case of a request containing multiple Condition Options, the client must use the same value of the C flag in all Condition Options. The cancellation flag allows a client to establish multiple conditional observation relationships and remove individual relationships from the same address and port.

When using this cancellation flag, a client is able to establish multiple conditional relationships using the same source transport address. Different from [I-D.ietf-core-observe] a GET without observe issued by a client, will not result in the removal of established conditional relationships. Instead the client has the possibility to explicitly terminate any established conditional relationship by sending the same observe request, but with the

Condition Option having the C flag set in order to trigger the cancellation of the request. This way, the same end point can manage multiple conditional observation relationships without the risk of accidentally removing them.

When a server receives a cancellation request, it removes the relationship indicated by the Condition Option and sends back a response containing both the Observe and the Condition Option with the cancellation flag set to 1.

In case a client wants to terminate all existing conditional observation relationships with a server, it should send a request with Condition Option, where the Condition Type is set to the reserved value 0 and the cancellation flag to 1. Upon reception of this message, the server removes all existing relationships and sends back a response containing the same Condition Type.

In case a client has established a conditional relationship that is the result of a request with multiple Condition Options, the client can cancel this relationship by sending the same request, but now with all cancellation flags set to 1.

If the server is for whatever reason not able to further fulfil the conditional relationship of a client, the server can also send a confirmable notification containing the Condition Option with the C flag set to 1 in order to terminate the observation relationship.

B.2. Annex: Logic flag

Different condition types can be combined in a request to express a logical AND relationship. By default, logical OR of condition types is always supported through sending separate requests. In order to express an out-of-range condition (notification when value is lower than X OR higher than Y), two separate conditional observe requests have to be sent. Through the introduction of a 1 bit logic flag (L) as part of the 1 byte condition header, this can be avoided.

L: The logic flag in a Condition Option indicates how the condition should be combined logically with the condition in the next Condition Option. A value of 0 means AND and a value of 1 means OR. The flag has no meaning if the Condition Option is the only or last Condition Option in the request. Through the use of the L flag it is possible to logically combine different conditions in a single request (e.g. C1 AND C2 OR C3 AND C4). As a drawback, when used, it complicates processing at the server side.

This example (Figure 12) shows the same example from the (Figure 11) but with this alternative. This example presents as the client adds

two Observe options to build a range, one set to 6/22, another one set to 5/16. It means that the range is out of range between 16 and 22, i.e. value > 22 OR value < 16. The first option is defined by default with the Logic flag equal to 0. The second option is defined with the Logic flag equal to 1, since it is the OR option. Note as it has been simplified from two messages to only one message with two options, and the most important, it has avoided the management of multiple ports.

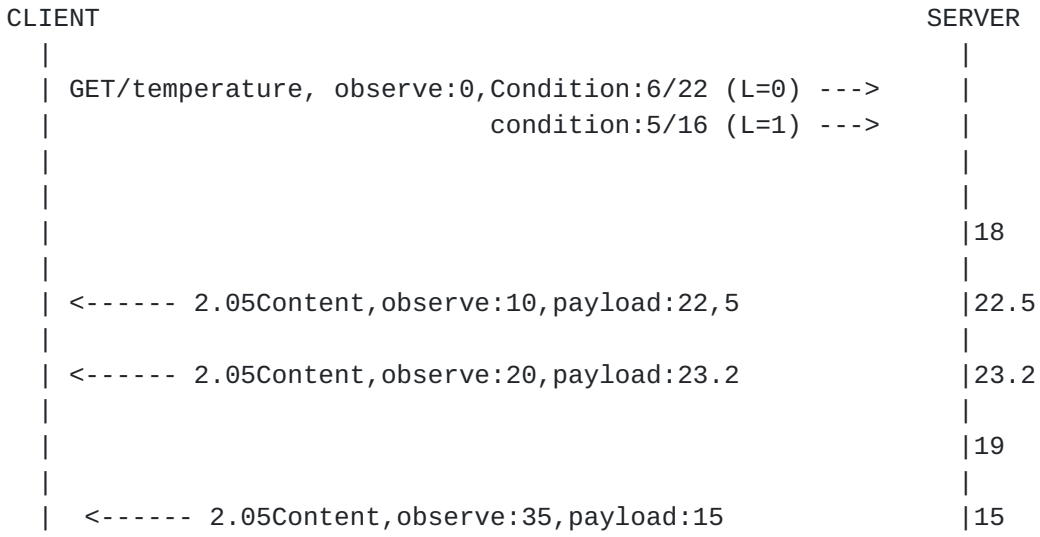


Figure 13: Two Observe options with Logic flag to define out-side a range 6/22 OR 5/15.

Appendix C. Change log

Changes in v04

- Updated draft to be consistent with updated observe draft:
  - Took request URI into consideration for Cancellation.
  - Explicitly stated that the timing conditions allow a client to use a representation that is older than Max-Age without verifying the representation first. This collides with a MUST NOT from the observe draft.
  - Stated that a server should follow the text from the observe draft for an unacknowledged notification in regards to the transmission of new notifications and the cancellation of existing relationships.

- Added section 2.1 comparing the RESTful approach from draft-shelby-core-interfaces to our approach for conditional observations.

- Clarified why "AND" semantics are preferred over "OR" semantics in case of multiple Condition options.

- Clarified that the R flag doesn't violate the behaviour defined in the Observe draft.

- Clarified that a client might opt to use representations older than Max-Age without validating these first in case of most of the timing conditions. A server has the ability to deny the client this sort of behaviour however.

- Updated source endpoint terminology.

Changes in v03

- Examples for most condition types

- Update the option number according to the new numbering scheme

- Added reference to paper validating implementation on constrained device

Changes in v02

- Restructured entire document

- Detailed description of the Condition Option and updated format of the Condition Option value

- Added more Condition Types

- New section on cancellation, updating and existence of conditional relationships

- New section on discovery

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