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Secure Routing Extension (SRx) - Proxy Protocol

Abstract

This document describes the communication between the Secure Routing Extension Server (SRx) and its proxy thin client integrated within a BGP router or Policy module. SRx provides the interface to the RPKI/ROA Validation Cache using the RPKI to Router protocol [I-D.ietf-sidr-rpki-rtr] and BGPSEC certificate cache.

Status of This Memo

This document specifies a protocol design for the NIST internal reference implementation for ROA processing [I-D.ietf-sidr-roa-validation] and BGPSEC processing [I-D.bgpsec-spec] on the router side.
This document is NOT an internet standard and currently not intended to become such. Comments and suggestions are welcome and to be send to the author of this document.

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1. Requirements language

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. Introduction

This document describes the communication between SRx and its proxy. This protocol is of interest to those who decide to implement their own proxy module and therefore choose to communicate directly with the server.

The srx-server-protocol is a TCP based, not encrypted protocol that is intended to be used within a trusted and secure environment, hence it is not needed to add an extra layer of security that would only increase the data volume. If security is desired it can be tunneled through using ssh.

The SRx server itself does not provide BGPSEC validation in the sense of a combined origin and path validation. SRx provides both validation types independent from one another and therefore the validation requests within this protocol are NOT requests for ROA validation and BGPSEC vaildation, the requests and result notifications are focussed on each component, origin validation and path validation. The consumer can decide on how to interpred / combine the results according to the implementation choosen.

3. Glossary

SRx: Secure Routing Extension, a framework that allows to out-source the processing of route origin validation and path validation as well as path signing.

Proxy: The thin client of SRx embedded in the router, policy module or other software that will use the SRx. In case the router chooses to implement the proxy itself, it will take on the role of the proxy.

Router: A BGP router that uses the SRx to receive validation information about updates.

Policy Module: A software that generates BGP routing policies that are feed into the BGP router. This policy module might use the SRx to generate/modify policies. In such case the router does not need to use SRx.

Validation Cache: The validation cache is responsible for performing ROA/RPKI validation. Changes in the validation cache are signaled tothe SRx using the Router/RPKI protocol [I-D.ietf-sidr-rpki-rtr].

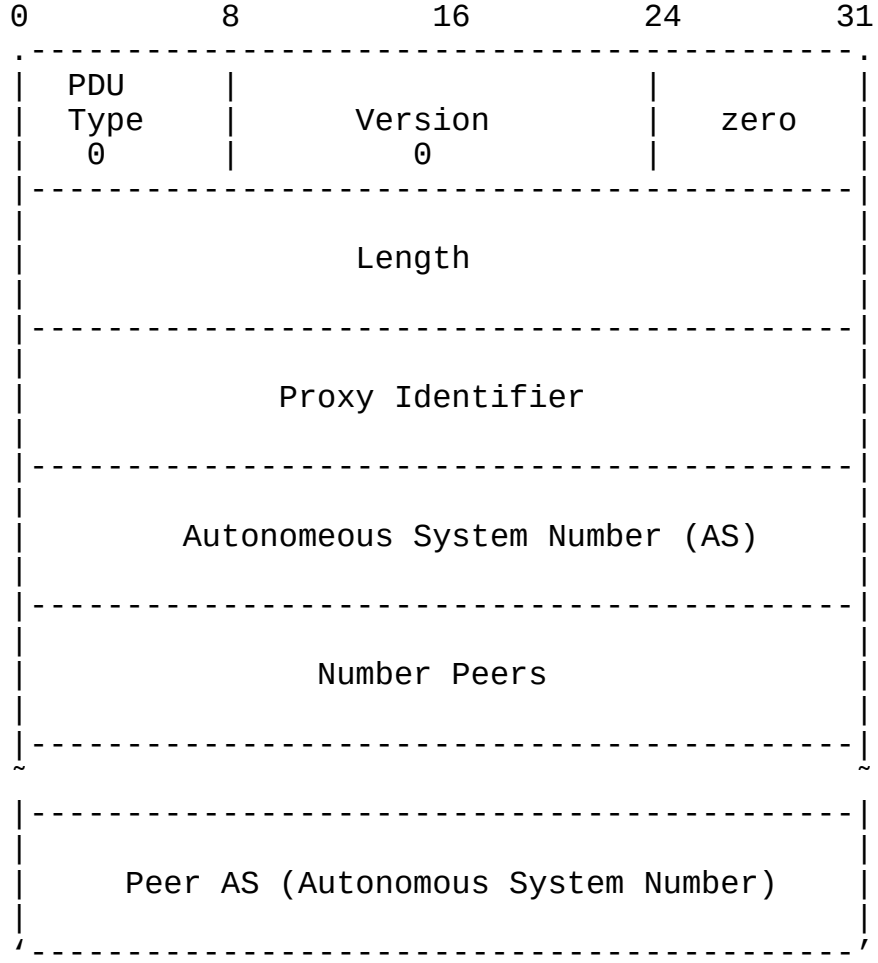
4. Protocol Data Units (PDU)

4.1. Session Packets

This chapter deals with the session handshake and session tear down.

4.1.1. Hello

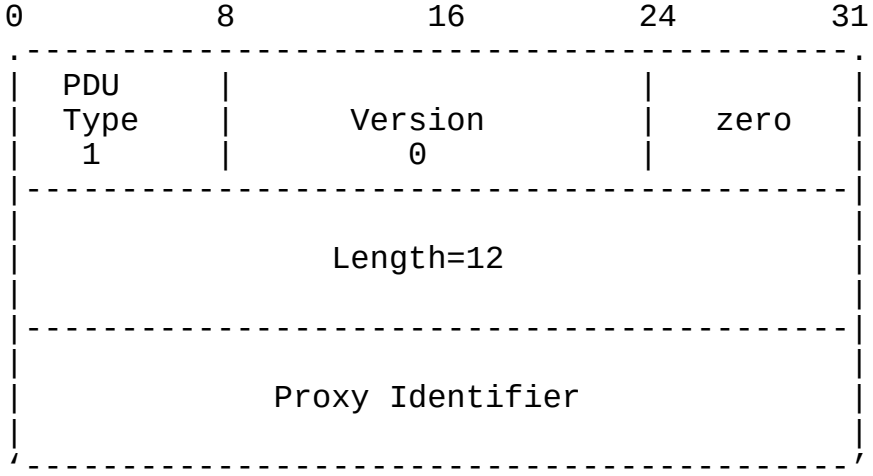
The proxy connects to the client and negotiates a session. The negotiation is done by sending a hello packet to the SRx server. The server will answer with a Hello Response packet that contains the connection status and proxy identifier. The packet MUST contain at least one "Peer AS". This information allows the SRx to precalculate signatures while in IDLE mode. The precalculation will only be performed for updates received, not for updates that are originated by the proxy AS. The default prepend count of the own AS number is "1". The "Sign Request" packet (Section 4.2.3) allows to specify a different prepend count.



Each connection between a proxy and SRx MUST have a unique identifier. Each proxy can have only one AS number. The router implementation MUST NOT share one proxy instance with multiple internal router instances. Each router instance MUST have its own proxy.
The SRx answers to the hello packet either with a "Hello Response" message or with an error packet (Section 4.4.4). In case the provided proxy identifier (Section 5.1) has the value "0" zero, SRx will generate one and return it back using the Hello Response message. Otherwise the SRx returns the provided proxy identifier.

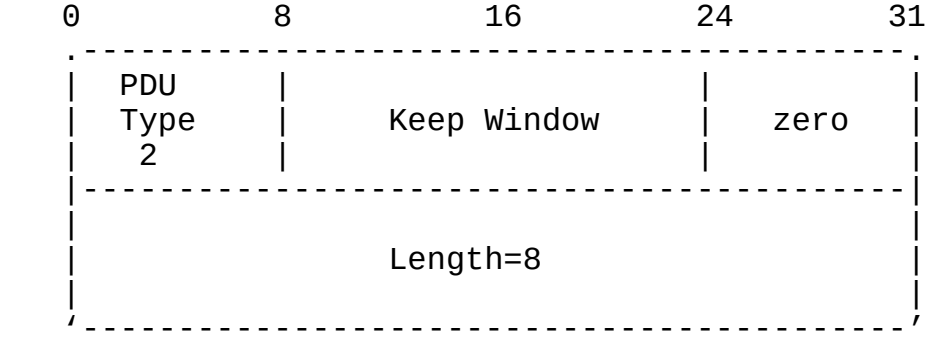
4.1.2. Hello Response

The Hello Response packet finalizes the handshake. The proxy MUST use the proxy identifier provided within this packet. This value MUST be the same as the provided one using the Hello packet except the initial value was set to "0" zero. IN this case the SRx generated the identifier.



4.1.3. Goodbye

The Goodbye message is send to orderly disconnect the session between SRx and proxy. This packet is used by both, SRx as well as its proxy.



The field Keep Window is a request for both sides to not remove data associated to this session. This value is in seconds and is a request only.

4.2. Origin and Path Validation Request Communication

SRx provides two different services. The first one is the validation of updates received, the second one is the signing of BGP updates selected bu the router and send out to its peers.

(1) Origin and Path Validation:
The Verify Request will be performed using two packet types, one for IPv4 prefixes and the other for IPv6 packages. The Verify Request messages are used to request the verification of an update.
Within each request the proxy provides SRx with a predefined validation result (Section 5) to allow SRx to return a preliminary result as soon as SRx generated a unique ID for this update. This ID is the communication interface between SRx, the proxy and the router / Policy module.
The validation packets are used for both request types, Origin validation request as well as Path validation request. Both requests can be either combined into one single packet or send as two separate requests. Eventually all requests for the same update will result in the same update identifier.
Updates that are originated by the router do not need to be verified. Nevertheless these updates need an update ID to be able to use the SRx signing mechanism. In this case the update MUST be processed using a validation request with the exception that none of the "Validation Type" (Section 5.5) bits is set. This will prevent the update from being further processed in

regards to validation. This is considdered the "Safe Only" mode.

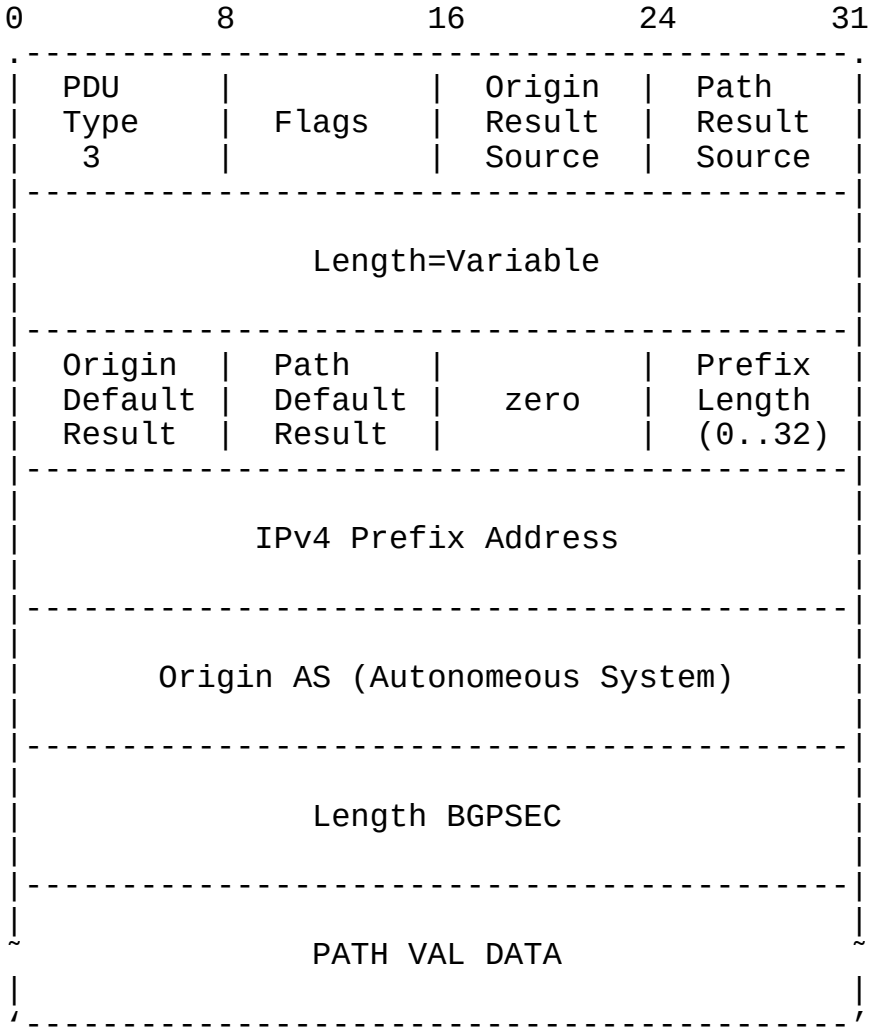
(2) Path Signing:
The path signing request starts the signing operation within SRx. SRx is able to precompute signatures for updates that underwent BGPSEC validation. Updates that are originated by the router can not be precomputed due to the fact that one element the signature covers is the origination time stamp. This will be taken in the moment of sending. All other updates can be precomputed by SRx during idle times.
If the precomputation of update signatures is performed it is up to the SRx implementation to decide if by default the own AS is used once of multiple times. It is recommended though to precompute without any traffic engineering. The signing request can make these requests on an individual base using the "Prepared Counter" (Section 5.16) field of the request package.

SRx only monitors verification results only for updates for which it received at least once a validation request. This means in case a validation request was made for origin validation but not path validation, the monitoring is performed for origin validation only. In case an additional request for the same updates is received but this time for path validation, SRx will start adding path validation to the monitor. In this case it will monitor both validations. This allows to just store updates by submitting a validation request but leaving the field "Flags" (Section 5.5) empty. This allows the proxy to receive an update id that can be used for later signature requests. (Important for self originated updates!)

Validation requests normally result in validation receipts (Section 4.3.1). This is necessary to allow the SRx to return the generated update ID. Therefore the proxy needs to wait for the receipt after each update request. This might create an uneccesary processing delay on the routers side, especially in situations where the update id is already known Section 4.4.3. In such situations receipts can be omitted (Section 5.5). The SRx then will only send a notification in case a change in validation result occured. In case the proxy omits all receipts the proxy has to generate the update ID (Section 5.10) on its own. In this case the proxy MUST assure to use the identical algorithm for generating the ID as the SRx otherwise they will not properly communicate to each other.

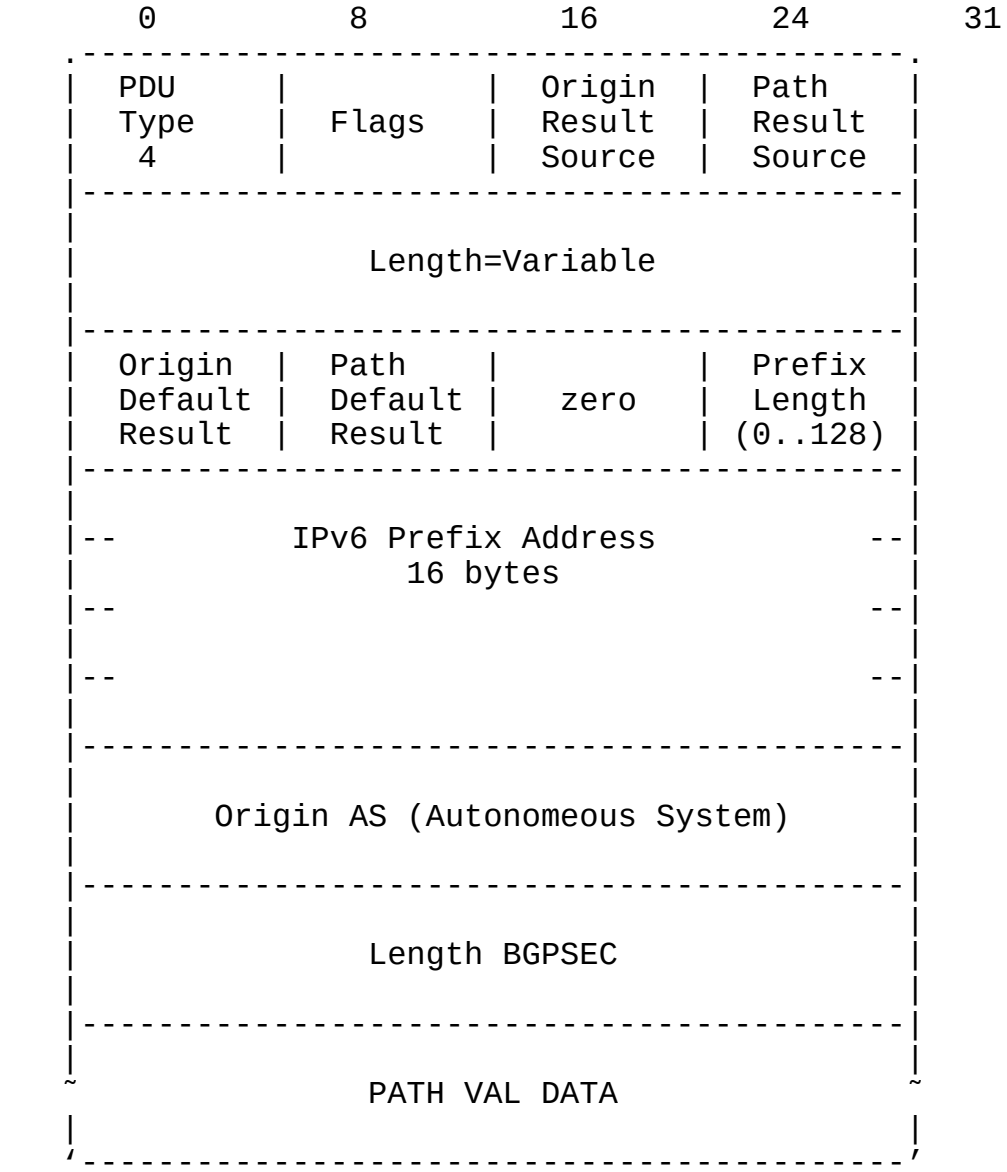
4.2.1. Verify Request IPv4

The following PDU describes the verification request packet for IPv4 Prefix / Update validation.



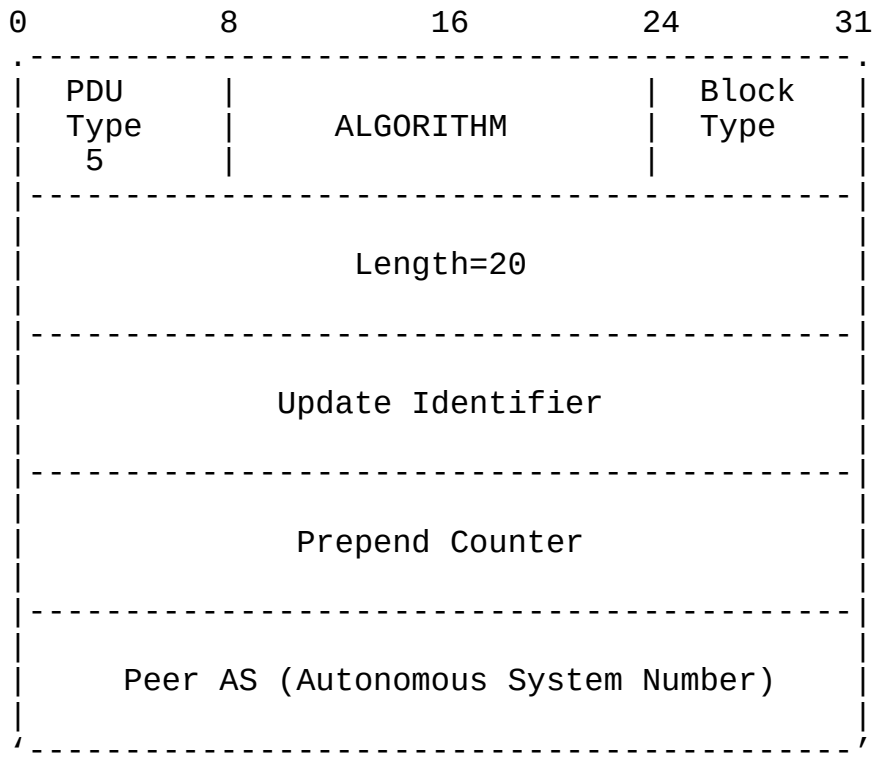
4.2.2. Verify Request IPv6

the following PDU describes the verification request packet for IPv4 Prefix / Update validation.



4.2.3. Sign Request

This PDU is used to sign the as path and its attributes. This request needs only to reference the peer AS the update will be send to. SRx is capable of precomputing default signatures; signatures with no additional content other than already provided during initial validation request. The field "Prepend Counter" (Section 5.16) allows traffic engineering in form of path-length within the signature generation.



4.3. SRx to Proxy Result Notification

The PDU's described here are used by SRx to communicate the requested result as well as changes within the results to the proxy and therefore to the router or policy module. Notifications can occur due to multiple events:

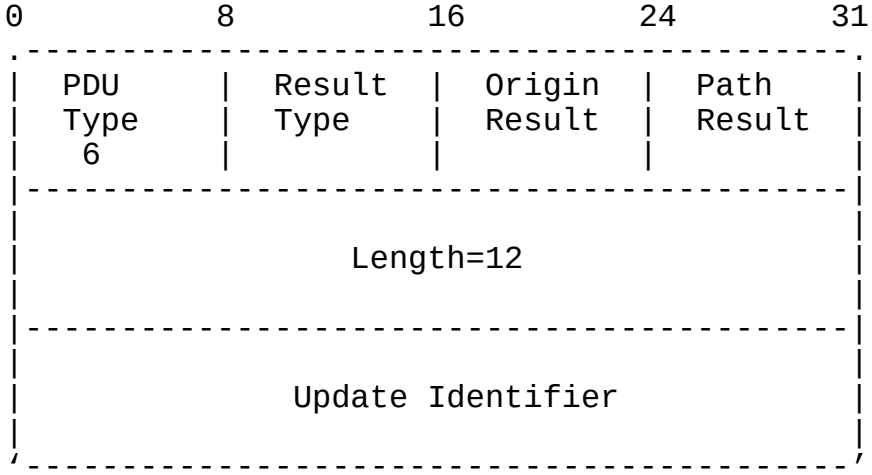
(1) Origin / Path Validation:
Each request for validation will result instantaneously in a result notification. For this kind of notification the "Receipt" (Section 5.9) flag is set. This result does not only return a "preliminary/final" result, it also returns the unique update ID that is used for all future communication regarding this particular update.
Repeated validation requests of the exact same update MUST result in the same update ID.

(2) Signature Request:
Different to the validation request, the signature request will result in a signature validation. The router must decide if it only sends updates fully signed or if it allows sending unsigned packages followed by resending the update again once the signature is fully computed.

(3) Validation Changes of ROA's or Signature keys:
SRx monitors the state of updates in such as it received information about ROA expiration, revocations, key expiration etc. These events can change the validation result of a prior processed update. In case a validation state of an update changes, SRx MUST send a notification message to the proxy. This notification messages MUST NOT have the "Receipt" flag set.

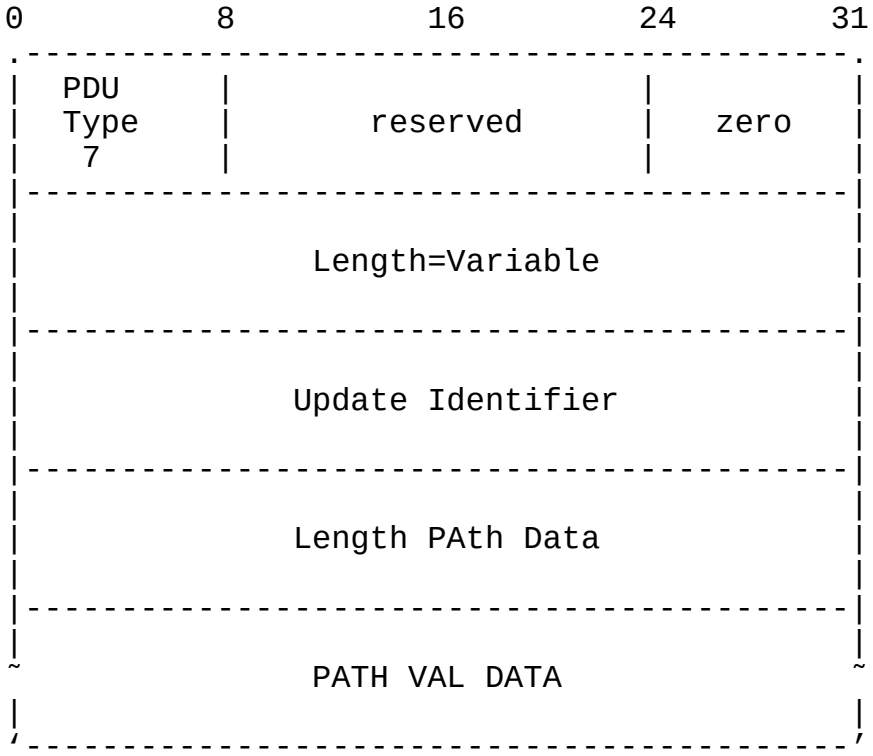
4.3.1. Verify Notification

This packet is used by SRx to communicate the validation result to the proxy. The results communicated using this packed must reflect the validation result of SRx as soon as possible. This means that as soon as SRx results are available these results MUST be used, the results provided during the last request are ignored. The "Receipt" (Section 5.5) flag specifies if this notification MUST be handles as validation receipt or validation result notification.



4.3.2. Signature Notification

This packet is used by SRx to communicate the BGPSEC portion of the update back to the proxy. Depending on the sign request type (Section 5.15) the data returned contains either only the latest signature block or all signature blocks. This allows the user of the proxy (e.g. router) to either strip all BGPSEC information from the update and keep the memory consumption low or keep the data traffic to a minimum by only transmitting the new signature block. In both cases SRx keeps all BGPSEC related data cached.

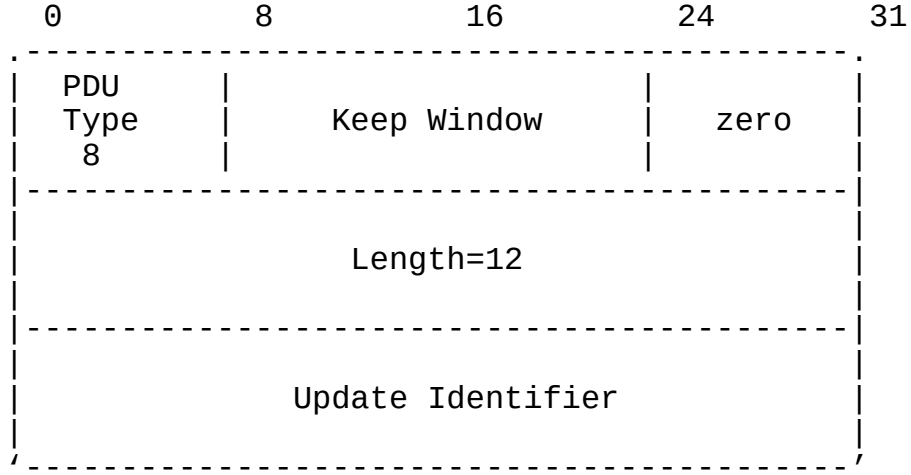


4.4. SRx Maintenance and Error Handling

PDU's specified in this section define maintenance packets. They are used to allow synchronization, failure notification, "house keeping", and peer configuration. SRx can implement the functions anticipated behind these messages but does not need to do so. Both, SRx as well as the proxy MUST accept packages of this type according to the communication schematics.

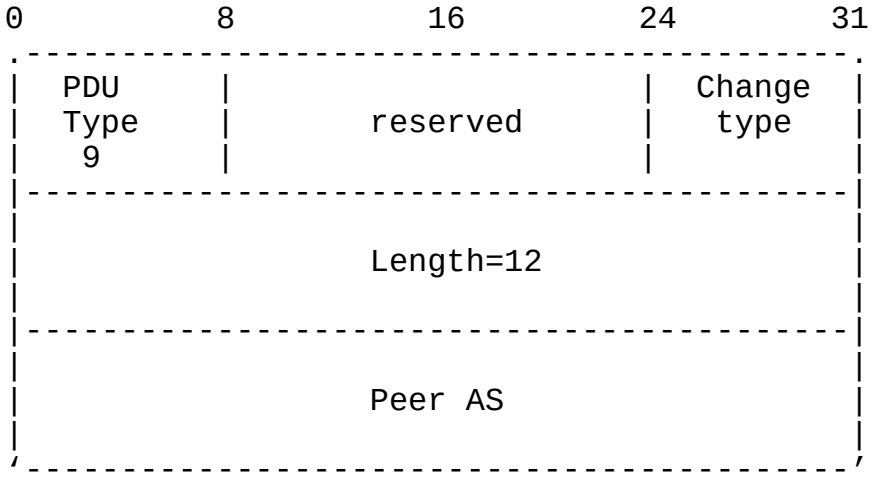
4.4.1. Delete Update

This packet is used to inform the SRx that the specified update is not available anymore in the router. SRx itself does not need to react on this but it will allow SRx to free up resources. Furthermore the proxy makes sure it will NOT receive any further notifications related to this update. The "Keep Window" field allows to inform SRx that the update might be requested again within the "Keep Window" time. SRx is not obligated to follow this request. This field is purely a performance setting.



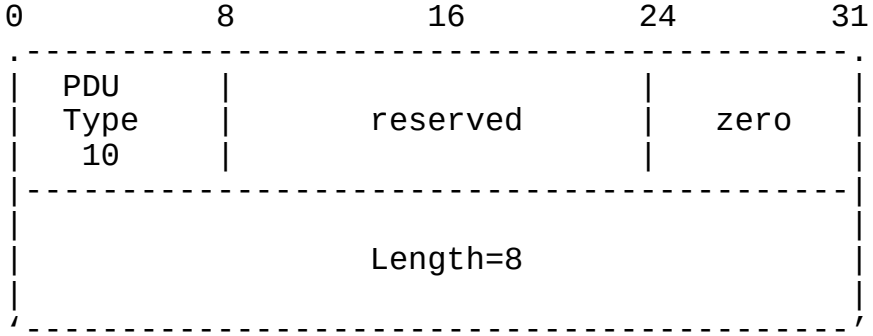
4.4.2. Peer Change

This packet is used by proxy to indicate a change in the peer configuration.



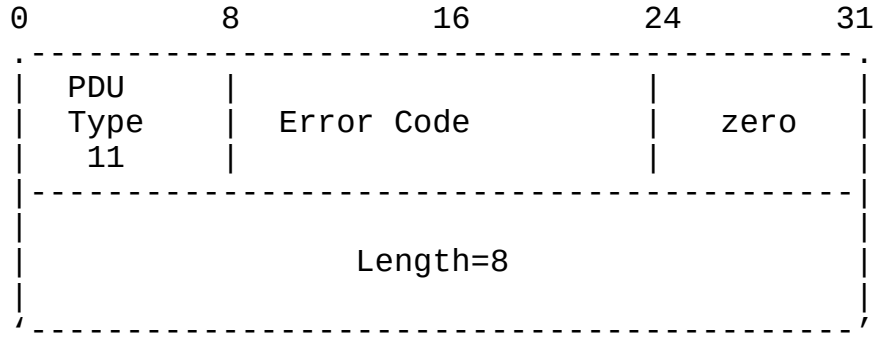
4.4.3. Synchronization Request

This packet is used if SRx assumes that the connection with the proxy is out of sync. This could be due to a session restart or other problems. It is IMPORTANT that the proxy performs a synchronization once the server requested one to assure that SRx has a complete view on the data of proxy. The synchronization is performed by sending a validation request for each update located within the RIB in of the BGP router. Due to the fact that this could be a very expensive operation the SRx implementation should be conservative in the usage of this request.



4.4.4. Error Packet

This packet is used by SRx in case an error occurred. All errors are considered fatal and are followed by a goodbye if possible.



5. PDU Data Fields

This section describes the data fields used within each PDU.

5.1. Proxy Identifier

The Proxy Identifier is a unique 4 byte value that allows the SRx to map internal values to the proxy itself. A preferred value is the IPv4 address of the proxy.
During the handshake the identifier is allowed to have the initial value of "0" zero provided by the proxy. In this case the SRx will generate a SRx wide unique identifier for this proxy. Each identifier can only be mapped to one proxy at a time. In case the proxy provides an identifier during handshake and this identifier is currently mapped to an existing session an error will be produced and the handshake fails.

5.2. Number Peer AS

The number of BGP peers the proxies user (most likely the BGP router) has. In case the value of this number is odd, the last two bytes of the packet MUST be filled with "0" zero. The number of peers MUST be greater or equals to "1" one.

5.3. Peer AS (Autonomous System)

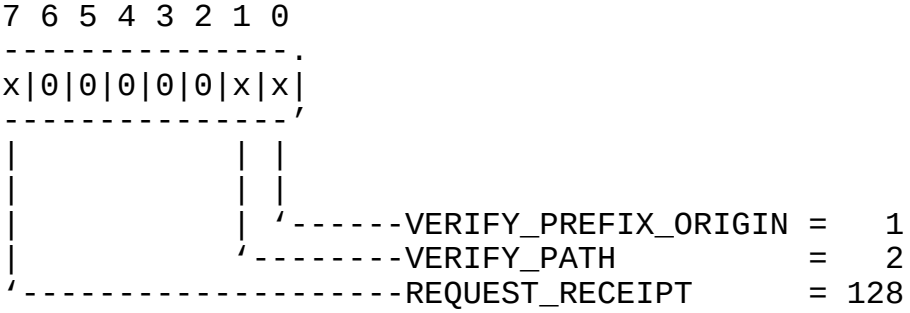
Contains the AS number of a peer. This is used to allows SRx to precompute signatures for the moment when the proxy requests a path signature for a particular selected path. This operation can be performed by SRx during idle times.

5.4. Change Type

The change type is used to indicate if the specified peer as is removed or added to router configuration. Adding a peer is done by setting the value to "1" one, removing is done by setting the value to "0" zero.

5.5. Flags

The flags field is bit coded and informs the SRx server what to do.



In case none of the bits is set the update will only be stored. This is needed for updates originated by the router that uses the proxy but do not need any validation applied to.

Request Prefix Origin validation. With this flag set the SRx will perform an origin validation. In case the SRx already performed this validation it is expected to return its result. No new validation needs to be performed. Changes in validation status due to expired or revoked ROA's will be triggered by the validation cache.

Requests for patch validation. With this flag set the SRx will perform a path validation on the passed update. This setting also indicates that SRx must monitor changes within the key valitity. In case a key is revoked or expired its signatures will become invalid and this change will be signaled to the router / proxy via a Validation Notification massage.

This flag indicates the proxy requests a notification receipt. A receipt is similar to a notification except that the SRx MUST send it regardless if the provided given validation state matches the validation result generated by SRx during a prior validation request. The request receipt is most importantly used to receive the unique update id. In case the proxy generates the update IS it MUST use the same algorithm as SRx to prevent comunnication problems.

5.6. Origin / Path Result Source

These two fields specify what to do with the provided default result values. It is possible that the BGP router might call the validation and provides a prior calculated validation result. this can be as a result of a SYNC request from the SRx server itself. It also could be used after a session reboot between SRx and router.

This field can take the following values:

0: SRX
1: ROUTER
2: IGP
3: UNKNOWN

IGNORE: Do not provide default result in case no result is available yet.

All the others: In case the SRx does not already have a validation result it will return the predefined value. In case the validation comes back with a different validation result than the provided one, SRx will notify the router of the change.

5.7. Default Origin Result

A predefined validation result that if used is returned to the proxy in case no current result is available.

The following values can be used:

0: VALID
SRx knows about a ROA that covers this pair of Prefix/Origin.

1: UNKNOWN
The prefix is not covered by any ROA nor is a ROA known that describes a less specific prefix.

2: INVALID
A ROA exists that covers either this prefix or a less specific prefix but none includes the given prefix.

3: UNDEFINED
SRx does not have any result available and no default value was provided.

5.8. Default Path Result

A predefined validation result that if used is returned to the proxy in case no current result is available.

The following values can be used:

0: VALID
SRx could validate the path according to the specifications.

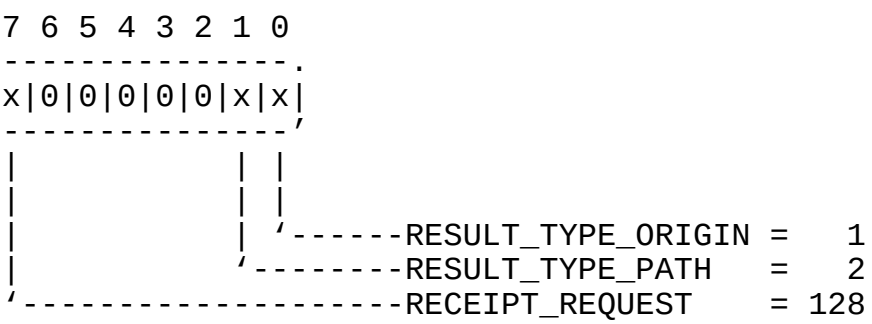
2: INVALID
SRx could not validate the path according to the specifications.

3: UNDEFINED
SRx does not have any result available and no default value was provided.

5.9. Result Type

Identifies which result to use. This field MUST NOT be "0" zero filled.

The result type is bit coded.



5.10. Update Identifier

Specifies a unique id within the router that is used to identify the update when talking between proxy and SRx. It is expected that the identical update results in the the exact same Update Identifier at all times.

5.11. Origin AS

The originator of the update. Will be ignored if origin validation is turned off (VERIFY_PREFIX_ORIGIN not set). [3]

5.12. IPv4 Prefix / IPv6 Prefix

The IPv4 or IPv6 prefix (In Network order).

5.13. Prefix Length

The length of the IP prefix. This value can be 0..32 for IPv4 and 0..128 for IPv4. All other values are resulting in an error response.

5.14. ALGORITHM

BGPSEC path validation only allows two algorithms at the same time for the reason of algorithm change. In case the requested algorithm is not supported, an "Algorithm Not Supported" exception MUST be thrown.

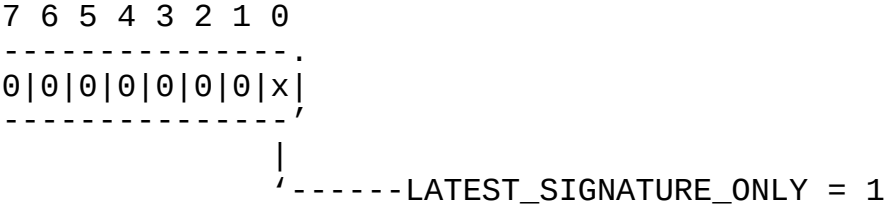
1: ALGORITHM_1: The first older algorithm that is either the only currently active algorithm or about to be replaced by the newer algorithm specified as ALGORITHM_2.

2: ALGORITHM_2: The newer algorithm that is intended to replace the older algorithm ALGORITHM_1.

0xFFFF: This algorithm is just for test purpose until the BGPSEC specification is finished. A request for this algorithm MUST not produce an "Algorithm Not Supported" error.

5.15. Block Type

The Block Type specifies if the return value of the signature request MUST result in the complete set of BGPSEC data or only the latest signature. If the bit LATEST_SIGNATURE_ONLY is set to "1" one, only the latest signature is transmitted.



5.16. Prepend Counter

By default SRx uses the current AS only once for (pre)calculating signatures. For traffic engineering reasons a particular update can contain the same prefix multiple times. The "Prepend Counter" allows the calculation of signatures over multiple entities of the own prepended AS.

5.17. Length Path Data

specifies the length of the data needed for path validation. This data is located in the data blob. If no data is provided this value MUST be "0" zero.

5.18. PATH VAL DATA

This field contains the data that has to be validated as a byte stream. A more detailed structure is not defined yet!
@TODO: Define detailed structure of such data block. Currently contains the AS path only! (To Be extended!)

5.19. Keep Window

Keep Window allows to request the SRx to not delete the data assigned to the current connection anfter the connection is terminated. If used, the keep widow specifies the time in seconds the proxy user needs to reconnect back to the SRx server. This SHOULD be the reboot time of the BGP router, approx. 15 minutes = 900 seconds. The SRx itself does not need to follow the request but is is recommended to reduce the recalculation time.

5.20. Error Code

All fatal errors MUST result in a Goodbye message followed by closing the connection. Errors are only send out from SRx, SRx itself does not except any errors. In case SRx receives an Error it MUST return an error packet with error code 2 followed by a Goodbye message.

0: Wrong Protocol Version (fatal): The handshake fails due to a conflickt of version number between the speakers.

1: Duplicate Proxy Identifier (fatal): The handshake fails due to a conflickt of the proxy identifier. An other currently active proxy is using the proxy identifier provided.

2: Invalid Packet (fatal): This error is send when SRx receives a packet that is either unknown or unexpected. An example could be twice a Hello Packet, a Hello Packet with insufficient number of peers provided, an Error packet send from proxy to SRx, or other.

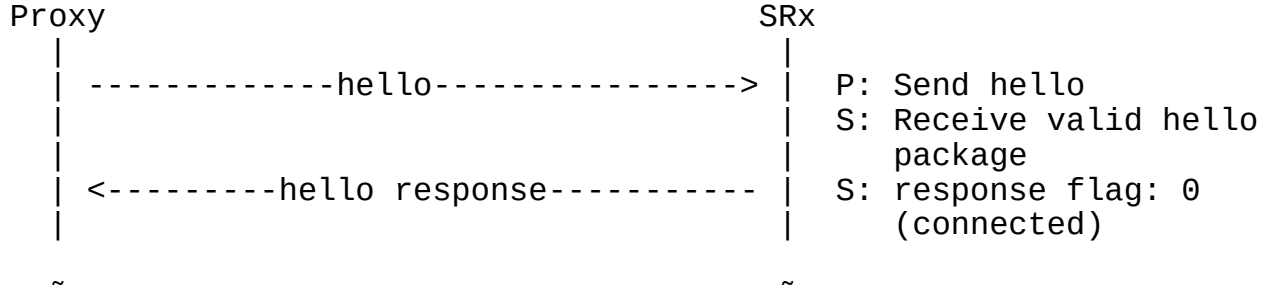
3: Internal error (fatal): The SRx has an internal error (memory, etc.) and is forced to abort the communication. This error might be followed by a goodbye message if possible. Otherwise the client can shutdown the connection and try to reconnect after some time. For instance 30 seconds.

4: Algorithm Not Supported: This error is thrown when the given algorithm for path signing / validation is not supported. This error is not considered to be fatal. It signals the proxy to resend the signing request using an alternative algorithm.

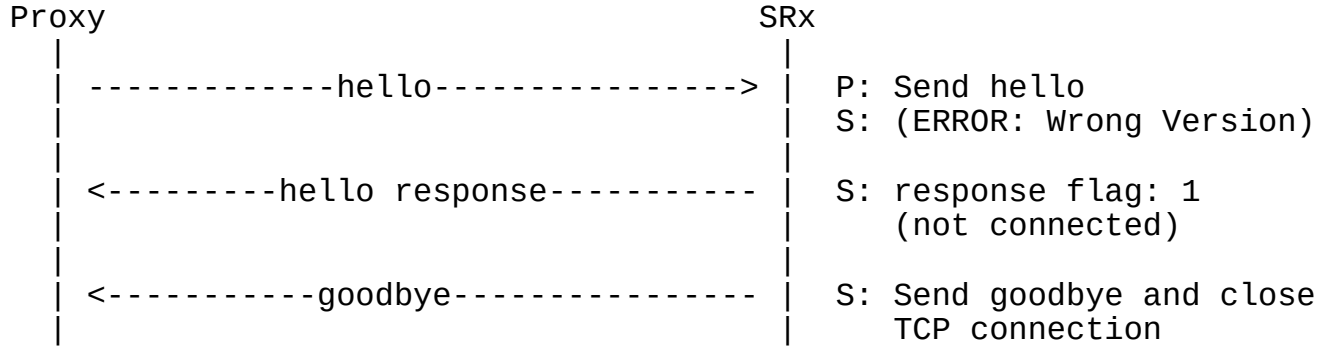
4: Update Not Found: This error is thrown when a signing request for an update can not be processed because the update can not be found within the database of SRx.
Even though this error is not considered to be fatal, it should result in a synchronization request (Section 4.4.3) to allow a synchronization between both parties.

6. Communication

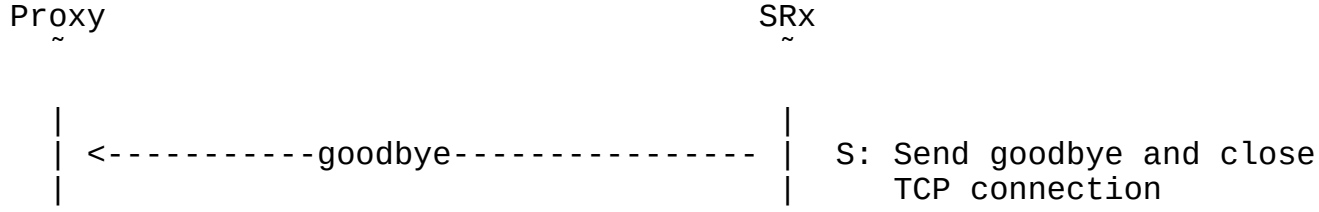
6.1. Establish a Connection



The time between sending a "hello" packet and and receiving a "hello response" SHOULD not exceed 30 seconds.
In case of an error - for instance wrong version number - SRx will send an error message as response followed by a Goodbye message

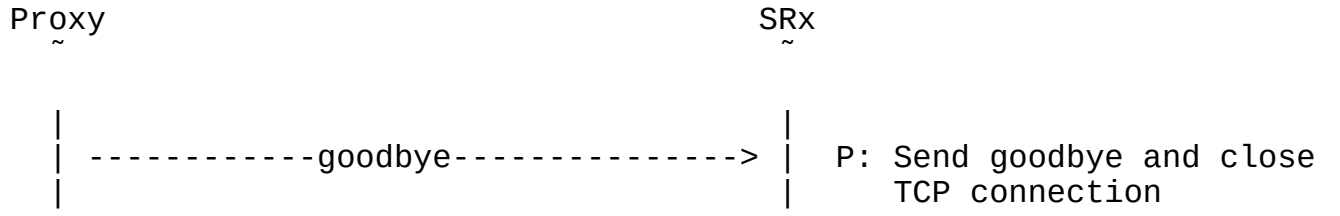


6.2. SRx server closes the connection



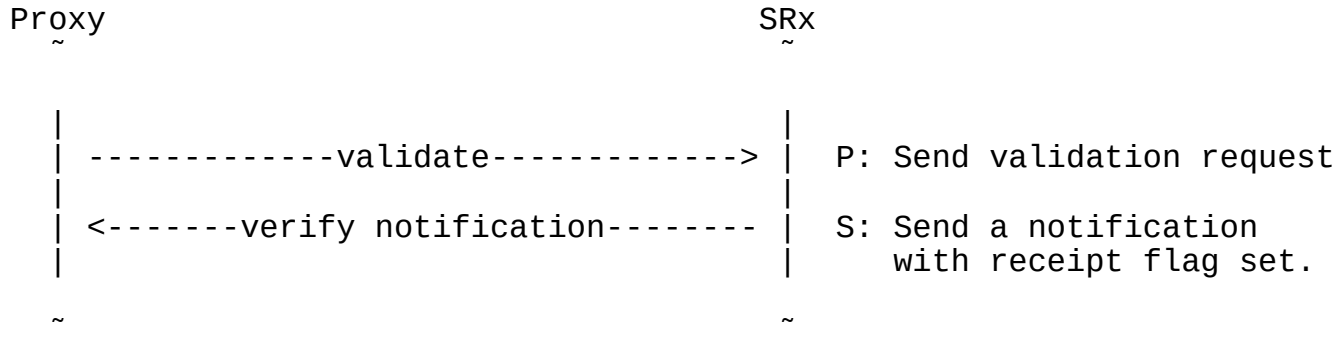
Once the goodbye message is send out, the server can immediately tear down the connection.

6.3. Proxy closes the connection



Once the goodbye message is send out, the proxy can immediately tear down the connection. SRx can free up all resources or keep them up for some grace period in case the connection will be reopened. The Keep Window field of the goodbye message specifies a time in seconds the data should be held.

6.4. Create a validation request

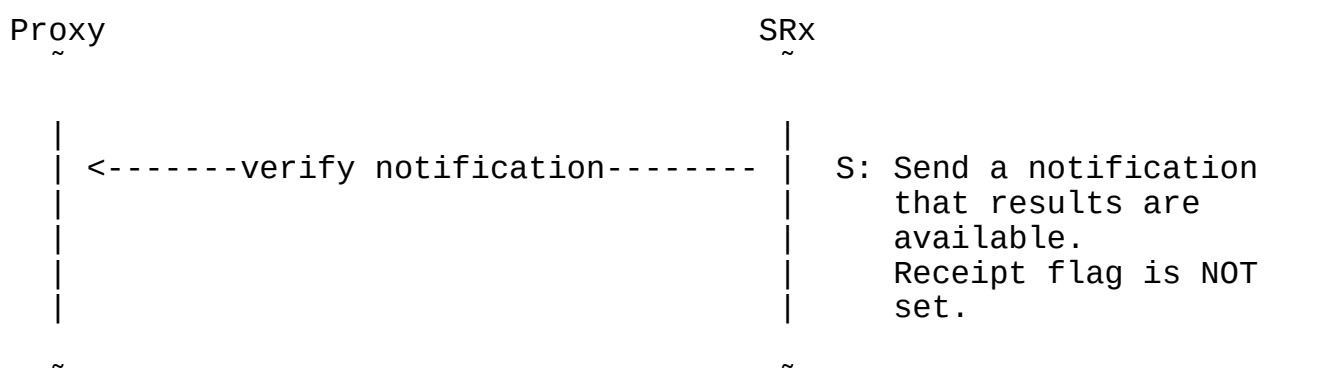


The validation request performs two major actions:
A: Initiate a request for Origin / Path validation
B: Generate a unique update id.

With each request the proxy provides validation results for both the requested origin validation result (Section 5.7) as well as the requested path validation result (Section 5.8) to SRx. SRx uses this results in case no other validation result is available.
Once SRx completed the validation and the result differs from the previous results a result notification message is send to the proxy.

In case the validation request did not specify a validation method, no further validation is started and in such case no validation notification will be send to the proxy. This is useful in regards to updates that originate from the router that implements/uses the proxy instance. In case an update is originated the update Id is also necessary for path signing.

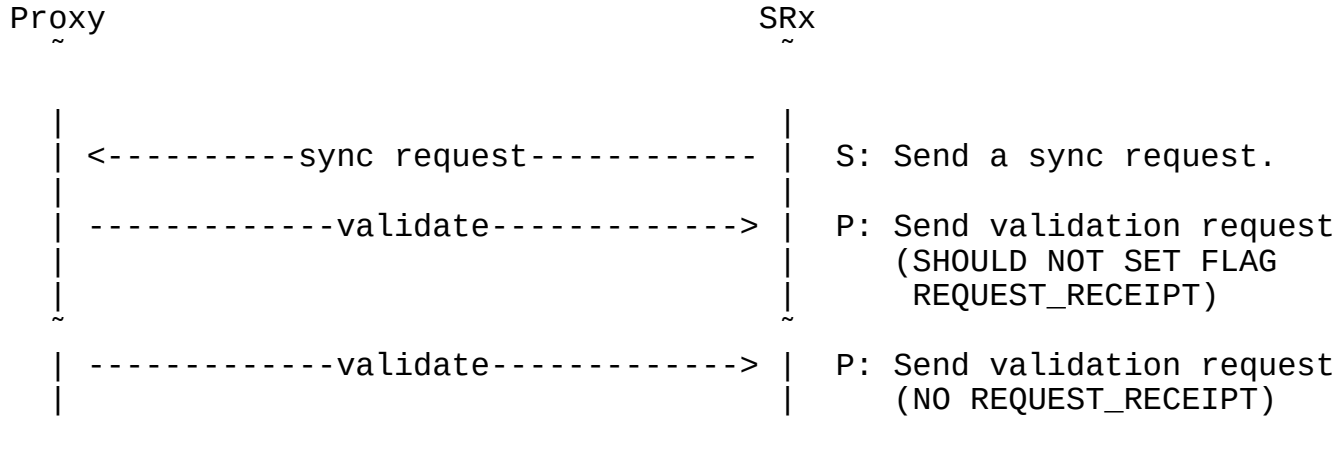
6.5. Create a validation result notification.



A verify notification is send for validation prior requests only. In case a verification was requested for origin validation only, only changes within origin validation are performed. Same with path validation.

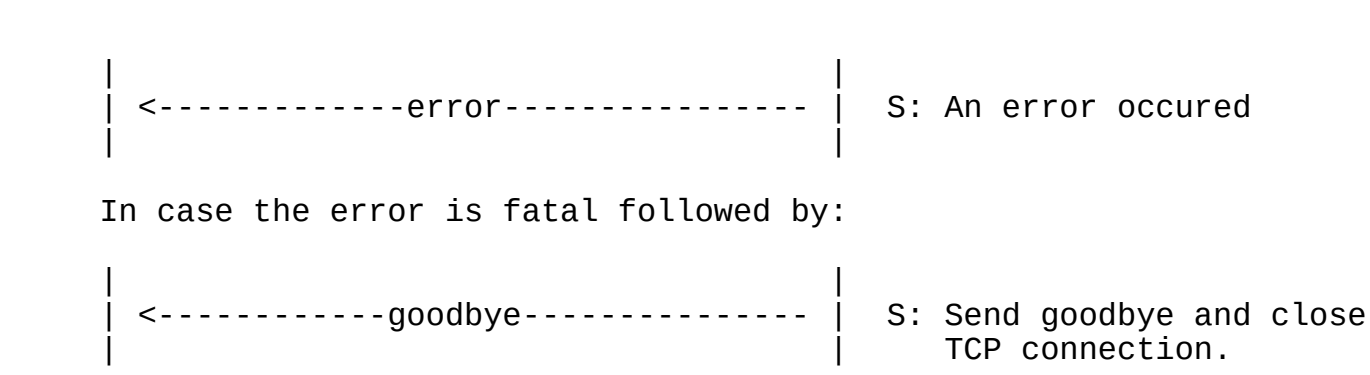
6.6. Synchronization Request

The synchronization request is initiated by the SRx due to the believe that SRx and proxy might be out of sync. The proxy need not to answer this request but it is strongly recommended. Furthermore it is recommended that the proxy provides the results once received from SRx to reduce the back traffic due to new notifications. In addition it is recommended that the proxy SHOULD NOT set the "receipt flag" to prevent receiving receipts for already known update results. In case a result differs from the provided default result, SRx will send notifications. In case nothing changed in the validation no further traffic has to be processed and therefore no change should be triggered within the decision process of the router.



6.7. Error Communication

At any point in time if an error occurs, SRx initiates an error message indicating the error. In case the error is considered fatal the connection MUST be closed.



In case the error is fatal followed by:

Errors that are considered fatal require a reboot of the session.

7. Implementation Suggestions

This section deals with implementation modes this protocol tries to address. In general it is thought that a router might access the SRx trough a proxy API. The proxy API then needs to implement this protocol to talk to SRx and communicate validation requests and request results between the router and SRx. This communication can be performed in two modes, synchronous and asynchronous. Regardless of the mode the proxy is operated in some parts are and will always be asynchron. The synchronization defined here is in regards to validation requests and their initial result value. The router itself receives four values from SRx that need to be added to each update entry within the router.

Update Identifier
: The Update Identifier (Section 5.10)

Validation Result
: Origin (Section 5.7) Path (Section 5.8)

7.1. Asynchronous Processing

TODO: Short explanation of how asynchronous processing could be envisioned.

7.2. Synchronous Processing

TODO: Short explanation of how synchronous processing could be envisioned.

8. Acknowledgments

The Author wants to thank Doug Montgomery and Sebastian Spiess for their input.
This protocol is vaguely based upon the SRx API communication protocol used for prototype 0.1, co-designed and implemented by Patrick Gleichmann.

9. References

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