

Workgroup: NETCONF Working Group
Internet-Draft:
draft-ietf-netconf-list-pagination-nc-01
Published: 11 March 2023
Intended Status: Standards Track
Expires: 12 September 2023
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NETCONF Extensions to Support List Pagination

Abstract

This document defines a mapping of the list pagination mechanism defined in [[I-D.ietf-netconf-list-pagination](#)] to NETCONF [[RFC6241](#)].

This document updates [[RFC6241](#)], to augment the <get> and <get-config> "rpc" statements, and [[RFC8526](#)], to augment the <get-data> "rpc" statement, to define input parameters necessary for list pagination.

Status of This Memo

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1. Introduction

This document defines a mapping of the list pagination mechanism defined in [[I-D.ietf-netconf-list-pagination](#)] to NETCONF [[RFC6241](#)].

This document updates [[RFC6241](#)] and [[RFC8526](#)], as described in [Section 2](#).

While the pagination mechanism defined in this document is designed for the NETCONF protocol [[RFC6241](#)], the augmented RPCs MAY be used by the RESTCONF protocol [[RFC8040](#)] if the RESTCONF server implements the "ietf-list-pagination-nc" module.

The YANG data model in this document conforms to the Network Management Datastore Architecture defined in [[RFC8342](#)]

1.1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

1.2. Conventions

Various examples used in this document use a placeholder value for binary data that has been base64 encoded (e.g., "BASE64VALUE="). This placeholder value is used as real base64 encoded structures are often many lines long and hence distracting to the example being presented.

2. Updates to NETCONF operations

2.1. Updates to RFC 6241

The <get> and <get-config> rpc statements are augmented to accept additional input parameters, as described in [Section 3](#).

2.2. Updates to RFC 8526

The <get-data> rpc statement is augmented to accept additional input parameters, as described in [Section 3](#).

3. List Pagination for NETCONF

In order for NETCONF to support [[I-D.ietf-netconf-list-pagination](#)], this document extends the operations <get>, <get-config> and <get-data> to include additional input parameters and output annotations.

The updated operations accept a content filter parameter, similar to the "filter" parameter of <get-config>, but includes nodes for "list" and "leaf-list" filtering.

The content filter parameter is used to specify the YANG list or leaf-list that is to be retrieved. This must be a path expression used to represent a list or leaf-list data node.

The following tree diagram [[RFC8340](#)] illustrates the "ietf-netconf-list-pagination" module:

```
module: ietf-list-pagination-nc
```

```
augment /nc:get/nc:input:
  +---w list-pagination
    +---w where?          union
    +---w sort-by?        union
    +---w direction?      enumeration
    +---w cursor?         string
    +---w offset?         uint32
    +---w limit?          union
    +---w sublist-limit?  union
augment /nc:get-config/nc:input:
  +---w list-pagination
    +---w where?          union
    +---w sort-by?        union
    +---w direction?      enumeration
    +---w cursor?         string
    +---w offset?         uint32
    +---w limit?          union
    +---w sublist-limit?  union
augment /ncds:get-data/ncds:input:
  +---w list-pagination
    +---w where?          union
    +---w sort-by?        union
    +---w direction?      enumeration
    +---w cursor?         string
    +---w offset?         uint32
    +---w limit?          union
    +---w sublist-limit?  union
```

Comments:

*This module augments three NETCONF "rpc" statements: get, get-config, and get-data.

*The "get" and "get-config" augments are against the YANG module defined in [[RFC6241](#)]. The "get-data" augment is against the YANG module defined in [[RFC8526](#)].

4. Error Reporting

When an input query parameter is supplied with an erroneous value, an <rpc-error> MUST be returned containing the error-type value "application", the error-tag value "invalid-value", and MAY include the error-severity value "error". Additionally the error-app-tag SHOULD be set containing query parameter specific error value.

4.1. The "offset" Query Parameter

If the "offset" query parameter value supplied is larger than the number of instances in the list or leaf-list target resource, the <rpc-error> MUST contain error-app-tag with value "offset-out-of-range".

5. YANG Module for List Pagination in NETCONF

The "ietf-netconf-list-pagination-nc" module defines conceptual definitions within groupings, which are not meant to be implemented as datastore contents by a server.

This module has normative references to [[RFC6241](#)], [[RFC6243](#)], [[RFC6991](#)], and [[RFC8342](#)].

<CODE BEGINS> file "ietf-list-pagination-nc@2023-03-11.yang"

```

module ietf-list-pagination-nc {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-list-pagination-nc";
  prefix lpgnc;

  import ietf-netconf {
    prefix nc;
    reference
      "RFC 6241: Network Configuration Protocol (NETCONF)";
  }

  import ietf-netconf-nmda {
    prefix ncds;
    reference
      "RFC 8526: NETCONF Extensions to Support the
        Network Management Datastore Architecture";
  }

  import ietf-list-pagination {
    prefix lp;
    reference
      "RFC XXXX: List Pagination for YANG-driven Protocols";
  }

  organization
    "IETF NETCONF (Network Configuration) Working Group";

  contact
    "WG Web:  https://datatracker.ietf.org/wg/netconf
     WG List:  NETCONF WG list <mailto:netconf@ietf.org>";

  description
    "This module augments the <get>, <get-config>, and <get-data>
     'rpc' statements to support list pagination.
  
```

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(<https://trustee.ietf.org/license-info>).

This version of this YANG module is part of RFC XXXX
(<https://www.rfc-editor.org/info/rfcXXXX>); see the RFC
itself for full legal notices.

The key words 'MUST', 'MUST NOT', 'REQUIRED', 'SHALL',

'SHALL NOT', 'SHOULD', 'SHOULD NOT', 'RECOMMENDED',
'NOT RECOMMENDED', 'MAY', and 'OPTIONAL' in this document
are to be interpreted as described in BCP 14 (RFC 2119)
(RFC 8174) when, and only when, they appear in all
capitals, as shown here.";

```
revision 2023-03-11 {  
  description  
    "Initial revision.";  
  reference  
    "RFC XXXX: NETCONF Extensions to Support List Pagination";  
}
```

```
grouping pagination-parameters {  
  description "A grouping for list pagination parameters.";  
  container list-pagination {  
    description "List pagination parameters.";  
    uses lp:where-param-grouping;  
    uses lp:sort-by-param-grouping;  
    uses lp:direction-param-grouping;  
    uses lp:cursor-param-grouping;  
    uses lp:offset-param-grouping;  
    uses lp:limit-param-grouping;  
    uses lp:sublist-limit-param-grouping;  
  }  
}
```

```
augment "/nc:get/nc:input" {  
  description  
    "Allow the 'get' operation to use content filter  
    parameter for specifying the YANG list or leaf-list  
    that is to be retrieved";  
  uses pagination-parameters;  
}
```

```
augment "/nc:get-config/nc:input" {  
  description  
    "Allow the 'get-config' operation to use content filter  
    parameter for specifying the YANG list or leaf-list  
    that is to be retrieved";  
  uses pagination-parameters;  
}
```

```
augment "/ncds:get-data/ncds:input" {  
  description  
    "Allow the 'get-data' operation to use content filter  
    parameter for specifying the YANG list or leaf-list  
    that is to be retrieved";  
  uses pagination-parameters;
```

}
}

<CODE ENDS>

6. IANA Considerations

6.1. The "IETF XML" Registry

This document registers one URI in the "ns" subregistry of the IETF XML Registry [RFC3688] maintained at <https://www.iana.org/assignments/xml-registry/xml-registry.xhtml#ns>. Following the format in [RFC3688], the following registration is requested:

URI: urn:ietf:params:xml:ns:yang:ietf-list-pagination-nc

Registrant Contact: The IESG.

XML: N/A, the requested URI is an XML namespace.

6.2. The "YANG Module Names" Registry

This document registers one YANG module in the YANG Module Names registry [RFC6020] maintained at <https://www.iana.org/assignments/yang-parameters/yang-parameters.xhtml>. Following the format defined in [RFC6020], the below registration is requested:

name: ietf-list-pagination-nc

namespace: urn:ietf:params:xml:ns:yang:ietf-list-pagination-nc

prefix: pgnc

RFC: XXXX

7. Security Considerations

7.1. The "ietf-netconf-list-pagination" YANG Module

The YANG module defined in this document extends the base operations for NETCONF [RFC6241] and RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF users to a preconfigured subset of all available NETCONF protocol operations and content.

The security considerations for the base NETCONF protocol operations (see Section 9 of [RFC6241]) apply to the new <get-list-pagination> RPC operations defined in this document.

8. References

8.1. Normative References

[I-D.ietf-netconf-list-pagination]

"List Pagination...", <[FIXME](#)>.

- [RFC2119]** Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC3688]** Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC6020]** Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <<https://www.rfc-editor.org/info/rfc6020>>.
- [RFC6241]** Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <<https://www.rfc-editor.org/info/rfc6241>>.
- [RFC6242]** Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <<https://www.rfc-editor.org/info/rfc6242>>.
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- [RFC6991]** Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <<https://www.rfc-editor.org/info/rfc6991>>.
- [RFC8174]** Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.
- [RFC8341]** Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <<https://www.rfc-editor.org/info/rfc8341>>.
- [RFC8342]** Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <<https://www.rfc-editor.org/info/rfc8342>>.
- [RFC8526]** Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "NETCONF Extensions to Support the Network

Management Datastore Architecture", RFC 8526, DOI 10.17487/RFC8526, March 2019, <<https://www.rfc-editor.org/info/rfc8526>>.

8.2. Informative References

- [RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <<https://www.rfc-editor.org/info/rfc8040>>.
- [RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <<https://www.rfc-editor.org/info/rfc8340>>.
- [RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <<https://www.rfc-editor.org/info/rfc8446>>.

Appendix A. Open Issues

Cursors (i.e., stable result sets) are related to the topic of dynamic changing lists between two queries. How cursors can be supported using "feature"?

Appendix B. Example YANG Module

The examples within this document use the "example-social" YANG module defined in [Appendix A.1](#) of [\[I-D.ietf-netconf-list-pagination\]](#).

Appendix C. Example Data Set

The Example Data Set used by the examples is defined in [Appendix A.2](#) of [\[I-D.ietf-netconf-list-pagination\]](#).

Appendix D. Example Queries

D.1. List pagination with all query parameters

This example mimics that [Appendix A.3.7](#) of [\[I-D.ietf-netconf-list-pagination\]](#).

===== NOTE: '\\' line wrapping per RFC 8792 =====

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="42">
  <get-config>
    <source>
      <running/>
    </source>
    <filter type="xpath" select="/es:members/es:member"
      xmlns:es="http://example.com/ns/example-social"/>
      <list-pagination
        xmlns="urn:ietf:params:xml:ns:yang:ietf-netconf-list-paginat\
ion">true</list-pagination>
        <where>//stats//joined[starts-with(@timestamp,'2020')]</where>
        <sort-by>timestamp</sort-by>
        <direction>backwards</direction>
        <offset>2</offset>
        <limit>2</limit>
        <sublist-limit>1</sublist-limit>
      </filter>
    </get-config>
  </rpc>
```

Response from the NETCONF server:

===== NOTE: '\ ' line wrapping per RFC 8792 =====

```
<lp:xml-list xmlns:lp="urn:ietf:params:xml:ns:yang:ietf-restconf-lis\
t-pagination"
```

```
  xmlns="http://example.com/ns/example-social">
```

```
  <member lp:remaining="1">
```

```
    <member-id>eric</member-id>
```

```
    <email-address>eric@example.com</email-address>
```

```
    <password>$0$1543</password>
```

```
    <avatar>BASE64VALUE=</avatar>
```

```
    <tagline>Go to bed with dreams; wake up with a purpose.</tagline>
```

```
    <following>alice</following>
```

```
    <posts>
```

```
      <post>
```

```
        <timestamp>2020-09-17T18:02:04Z</timestamp>
```

```
        <title>Son, brother, husband, father</title>
```

```
        <body>What's your story?</body>
```

```
      </post>
```

```
    </posts>
```

```
    <favorites>
```

```
      <bits lp:remaining="2">two</bits>
```

```
    </favorites>
```

```
    <stats>
```

```
      <joined>2020-09-17T19:38:32Z</joined>
```

```
      <membership-level>pro</membership-level>
```

```
      <last-activity>2020-09-17T18:02:04Z</last-activity>
```

```
    </stats>
```

```
  </member>
```

```
  <member lp:remaining="1">
```

```
    <member-id>bob</member-id>
```

```
    <email-address>bob@example.com</email-address>
```

```
    <password>$0$1543</password>
```

```
    <avatar>BASE64VALUE=</avatar>
```

```
    <tagline>Here and now, like never before.</tagline>
```

```
    <posts>
```

```
      <post lp:remaining="2">
```

```
        <timestamp>2020-08-14T03:32:25Z</timestamp>
```

```
        <body>Just got in.</body>
```

```
      </post>
```

```
    </posts>
```

```
    <favorites>
```

```
      <decimal64-numbers lp:remaining="1">3.14159</bits>
```

```
    </favorites>
```

```
    <stats>
```

```
      <joined>2020-08-14T03:30:00Z</joined>
```

```
      <membership-level>standard</membership-level>
```

```
      <last-activity>2020-08-14T03:34:30Z</last-activity>
```

```
    </stats>
```

```
</member>  
</lp:xml-list>
```

Acknowledgements

This work has benefited from the discussions of RESTCONF resource collection over the years, in particular, [I-D.ietf-netconf-restconf-collection] which provides enhanced filtering features for the retrieval of data nodes with the GET method and [I-D.zheng-netconf-fragmentation] which document large size data handling challenge. The authors would like to thank the following for lively discussions on list:

Andy Bierman Martin Björklund Robert Varga

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