

Workgroup: Internet
Published: 3 March 2024
Intended Status: Standards Track
Expires: 4 September 2024

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YANG Data Model for Scheduled Attributes

Abstract

The YANG model in this document includes three modules, and can be used to manage network resources and topologies with scheduled attributes, such as predictable link loss and link connectivity as a function of time. The intent is to have this information be utilized by Time-Variant Routing systems.

Status of This Memo

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1. Overview

YANG [[RFC7950](#)] is a data definition language used to define the contents of a conceptual data store that allows networked devices to be managed using NETCONF [[RFC6241](#)]. YANG is proving relevant beyond its initial confines, as bindings to other interfaces (e.g., ReST) and encodings other than XML (e.g., JSON) are being defined. Furthermore, YANG data models can be used as the basis for implementation of other interfaces, such as CLI and programmatic APIs.

In some network scenarios, it's possible to predict the times at which one router will be able to establish a link with another router. Links can be predictably lost and re-established, and neighbors may change as a function of time. For examples of such networks and scenarios, please reference TVR (Time-Variant Routing) Use Cases [[I-D.ietf-tvr-use-cases](#)].

The YANG model in this document can be used to manage network resources and topologies with scheduled attributes. There are three YANG modules in this document.

Module `ietf-tvr-schedule.yang` contains the schedule YANG definitions. Module `ietf-tvr-topology.yang` defines a network topology with time-variant availability. Module `ietf-tvr-node.yang` is to be used to manage scheduled attributes of a single node.

The YANG modules in this document conform to the Network Management Datastore Architecture (NMDA) [[RFC8342](#)].

1.1. 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](#)] [[RFC8174](#)].

2. Tree Diagrams

This document uses the graphical representation of data models defined in [[RFC8340](#)].

3. Design of the model

3.1. Schedule Definitions

Module `ietf-tvr-schedule.yang` contains schedule definitions that can be used by other modules.

The grouping "tvr-schedule" consists of a list of schedule, and each schedule consists time periods with recurrence. For each schedule instance, it uses the grouping "recurrence" defined in [[I-D.ma-opsawg-schedule-yang](#)].

The container "attr-value" is a place holder for a model that uses the "tvr-schedule", so attribute values can be augmented.

When an attribute's schedule ends, the "value-default" SHOULD be used, if present.

The following figure provides an illustration of two attributes and their scheduled value changes. The attributes A1 and A2 take on different values at different times. The attribute A1 will take on the value v1 from the time t0 until t1, the value v2 from t1 until t2, and v3 from t2 until t3. The attribute A2 will take on the value vv1 from time t0 until t1 and vv2 from v1 until v3.

Attributes

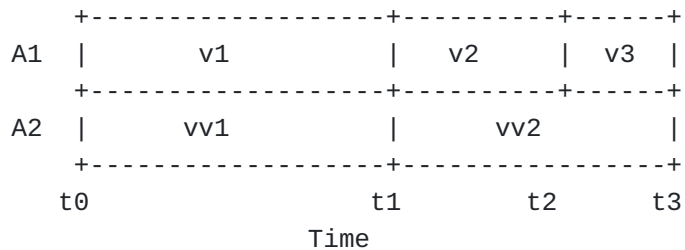


Figure 1: Time Varying Properties

3.2. TVR Node YANG Module

Module `ietf-tvr-node.yang` is a device model and designed to manage a single node with scheduled attributes.

Each node has list of interfaces, and each interface has a list of power up and down schedules.

3.3. TVR Topology YANG Module

Module `ietf-tvr-topology.yang` describes a network topology with a time-variant availability schedule.

The module has a list of nodes, identified by a unique "node-id". Each node has a list of links. Links are modeled as unidirectional. Link availability is described from the viewpoint of a particular source node (the transmitting node) and beginning at a particular time. Each link in the list contains the range of times during which it is available.

The "source-link-id" is a string and used to identify a link as viewed from the source-node. Bandwidth and delay are predicted link attributes. Delay is the link propagation time and does not include any queuing delays.

4. TVR YANG Trees

4.1. TVR Node YANG Tree

The following figure shows the tree diagram of the TVR Node scheduling.

```

module: ietf-tvr-node
  +--rw node-schedule
    +--rw router-id?          yang:dotted-quad
    +--rw power-schedule
      | +--rw power-default?  boolean
      | +--rw schedules* [schedule-id]
      |   +--rw schedule-id    uint32
      |   +--rw recurrence-first
      |     | +--rw date-time-start?    union
      |     | +--rw time-zone-identifier? sys:timezone-name
      |     | +--rw duration?          duration
      |     +--rw frequency?          identityref
      |     +--rw interval?           uint32
      |     +--rw (recurrence-bound)?
      |       | +--:(until)
      |       | | +--rw until?         union
      |       | | +--:(count)
      |       | |   +--rw count?       uint32
      |     +--rw attr-value
      |     +--rw power-state?       boolean
    +--rw interface-schedule
      +--rw interfaces* [name]
        +--rw name                union
        +--rw state-default?      boolean
        +--rw up-down-schedule
          +--rw schedules* [schedule-id]
            +--rw schedule-id      uint32
            +--rw recurrence-first
              | +--rw date-time-start?    union
              | +--rw time-zone-identifier? sys:timezone-name
              | +--rw duration?          duration
            +--rw frequency?          identityref
            +--rw interval?           uint32
            +--rw (recurrence-bound)?
              | +--:(until)
              | | +--rw until?         union
              | | +--:(count)
              | |   +--rw count?       uint32
            +--rw attr-value
              +--rw available?       boolean

```

4.2. TVR Topology YANG Tree

The following figure shows the tree diagram of the TVR Topology scheduling.

```

module: ietf-tvr-topology
+--rw topology-schedule
  +--rw nodes* [node-id]
  | +--rw node-id      inet:uri
  | +--rw available
  |   +--rw default-node-available?  boolean
  |   +--rw schedules* [schedule-id]
  |     +--rw schedule-id      uint32
  |     +--rw recurrence-first
  |       | +--rw date-time-start?      union
  |       | +--rw time-zone-identifier?  sys:timezone-name
  |       | +--rw duration?             duration
  |     +--rw frequency?             identityref
  |     +--rw interval?              uint32
  |     +--rw (recurrence-bound)?
  |       | +--:(until)
  |       | | +--rw until?            union
  |       | | +--:(count)
  |       | |   +--rw count?          uint32
  |     +--rw attr-value
  |     +--rw node-available?        boolean
  +--rw links* [source-node source-link-id]
  +--rw source-node      inet:uri
  +--rw destination-node? inet:uri
  +--rw source-link-id   string
  +--rw available
  +--rw schedules* [schedule-id]
  | +--rw schedule-id      uint32
  | +--rw recurrence-first
  |   | +--rw date-time-start?      union
  |   | +--rw time-zone-identifier?  sys:timezone-name
  |   | +--rw duration?             duration
  | +--rw frequency?             identityref
  | +--rw interval?              uint32
  | +--rw (recurrence-bound)?
  |   | +--:(until)
  |   | | +--rw until?            union
  |   | | +--:(count)
  |   | |   +--rw count?          uint32
  | +--rw attr-value
  +--rw bandwidth
  | +--rw default-bandwidth?  te-types:te-bandwidth
  | +--rw schedules* [schedule-id]
  |   +--rw schedule-id      uint32
  |   +--rw recurrence-first
  |     | +--rw date-time-start?      union
  |     | +--rw time-zone-identifier?  sys:timezone-name
  |     | +--rw duration?             duration
  |   +--rw frequency?             identityref

```

```

|   +--rw interval?          uint32
|   +--rw (recurrence-bound)?
|   |   +--:(until)
|   |   |   +--rw until?      union
|   |   |   +--:(count)
|   |   |   +--rw count?      uint32
|   +--rw attr-value
|   +--rw bandwidth?        te-types:te-bandwidth
+--rw delay
  +--rw default-delay?      uint32
  +--rw schedules* [schedule-id]
    +--rw schedule-id        uint32
    +--rw recurrence-first
      |   +--rw date-time-start?      union
      |   +--rw time-zone-identifier?  sys:timezone-name
      |   +--rw duration?              duration
    +--rw frequency?            identityref
    +--rw interval?            uint32
    +--rw (recurrence-bound)?
      |   +--:(until)
      |   |   +--rw until?          union
      |   |   +--:(count)
      |   |   +--rw count?          uint32
    +--rw attr-value
      +--rw delay?              uint32

```

5. TVR Schedule YANG Modules

5.1. TVR Schedule YANG Module

```
<CODE BEGINS> file "ietf-tvr-schedule@2024-03-03.yang"
module ietf-tvr-schedule {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-tvr-schedule";
  prefix tvr-schd;

  import ietf-schedule {
    prefix "schedule";
    reference
      "RFC XXXX: A Common YANG Data Model for Scheduling";
  }

  organization
    "IETF TVR - Time Variant Routing Working Group";
  contact
    "WG Web: <http://datatracker.ietf.org/wg/tvr>
    WG List: <mailto:tvr@ietf.org>

    Author: Yingzhen Qu
            <mailto:yingzhen.ietf@gmail.com>
    Author: Acee Lindem
            <mailto:acee.ietf@gmail.com>
    Author: Marc Blanchet
            <mailto:marc.blanchet@viagenie.ca>
    Author: Eric Kinzie
            <mailto:ekinzie@labn.net>
    Author: Don Fedyk
            <mailto:dfedyk@labn.net>";

  description
    "The YANG module contains common YANG definitions for
    time-variant schedule.

    This YANG model conforms to the Network Management
    Datastore Architecture (NMDA) as described in RFC 8342.

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```

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reference

"RFC XXXX: YANG Data Model for Scheduled Attributes";

revision 2024-03-03 {

description

"Initial Version";

reference

"RFC XXXX: YANG Data Model for Scheduled Attributes.";

}

grouping tvr-schedule {

list schedules {

key schedule-id;

leaf schedule-id {

type uint32;

description

"Identifies the schedule.";

}

uses schedule:recurrence;

container attr-value {

description

"Attribute value(s). This container should be augmented with attributes that apply to the current interval.";

}

description

"list of schedules.";

}

description

"A common grouping definition of schedules.";

}

}

<CODE ENDS>

5.2. TVR Schedule Node Module

```
<CODE BEGINS> file "ietf-tvr-node@2024-03-03.yang"
module ietf-tvr-node {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-tvr-node";
  prefix tvr-node;

  import ietf-yang-types {
    prefix "yang";
    reference
      "RFC 6991: Common YANG Data Types";
  }

  import ietf-tvr-schedule {
    prefix "tvr-schd";
  }

  organization
    "IETF TVR - Time Variant Routing Working Group";
  contact
    "WG Web: <http://datatracker.ietf.org/wg/tvr>
    WG List: <mailto:tvr@ietf.org>

    Author: Yingzhen Qu
            <mailto:yingzhen.ietf@gmail.com>
    Author: Acee Lindem
            <mailto:acee.ietf@gmail.com>
    Author: Marc Blanchet
            <mailto:marc.blanchet@viagenie.ca>
    Author: Eric Kinzie
            <mailto:ekinzie@labn.net>
    Author: Don Fedyk
            <mailto:dfedyk@labn.net>";

  description
    "The YANG module defines a schedule for changing
    attributes of a single node.

    This YANG model conforms to the Network Management
    Datastore Architecture (NMDA) as described in RFC 8342.

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```

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reference

"RFC XXXX: YANG Data Model for Scheduled Attributes";

revision 2024-03-03 {

description

"Initial Version";

reference

"RFC XXXX: YANG Data Model for Scheduled Attributes.";

}

container node-schedule {

description

"This container defined time variant attributes for node's schedule.";

leaf router-id {

type yang:dotted-quad;

description

"A 32-bit number used to identify a router.";

}

container power-schedule {

description

"Power schedule for the node. The node's power is represented by a boolean value with 'true' indicating the node is powered on and 'false' indicating the node is powered off.";

leaf power-default {

type boolean;

default false;

description

"This indicates the default node power when for time periods when no interval is defined. If unspecified, the node is powered down by default.";

}

uses tvr-schd:tvr-schedule {

augment "schedules/attr-value" {

description

```

        "Augment the power state within each period.";
    leaf power-state {
        type boolean;
        description
            "Indicates whether the node is powered on.";
    }
}
}
}

container interface-schedule {
    description
        "Container for TVR node interface attributes.";

    list interfaces {
        key "name";
        description
            "List of interface with schedules.";
        leaf name {
            type union {
                type yang:xpath1.0;
                type string;
            }
            description
                "Name of the interface.
                If used with the ietf-interfaces module, the xpath name
                is to identify the interface.";
        }
        leaf state-default{
            type boolean;
            default false;
            description
                "By default, the link is not available.";
        }
    }

    container up-down-schedule {
        description
            "Scheduled times that the interface is up. This is to
            work with the leaf 'enabled' for the configured state
            of the interface.";

        uses tvr-schd:tvr-schedule {
            augment "schedules/attr-value" {
                description
                    "Augment scheduled interface state.";
                leaf available {
                    type boolean;
                    description
                        "Link availability.";
                }
            }
        }
    }
}

```


5.3. TVR Toplogy Module

```
<CODE BEGINS> file "ietf-tvr-topology@2024-03-03.yang"
module ietf-tvr-topology {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-tvr-topology";
  prefix tvr-topo;

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
  }

  import ietf-te-types {
    prefix te-types;
  }

  import ietf-tvr-schedule {
    prefix "tvr-schd";
  }

  organization
    "IETF Time-Variant Routing Working Group";

  contact
    "WG Web: <https://datatracker.ietf.org/wg/tvr/>
    WG List: <mailto:tvr@ietf.org>

    Author: Eric Kinzie
            <mailto:ekinzie@labn.net>
    Author: Don Fedyk
            <mailto:dfedyk@labn.net>
    Author: Yingzhen Qu
            <mailto:yingzhen.ietf@gmail.com>
    Author: Acee Lindem
            <mailto:acee.ietf@gmail.com>
    Author: Marc Blanchet
            <mailto:marc.blanchet@viagenie.ca>";

  description
    "This YANG module contains YANG definitions for describing
    network topology with an time-variant availability schedule.

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```

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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 2024-03-03 {
  description
    "Initial revision";
  reference
    "RFC XXXX: YANG Data Model for Scheduled Attributes";
}

container topology-schedule {
  description
    "Network topology schedules.";
  list nodes {
    key "node-id";
    description
      "List of nodes with schedules.";
    leaf node-id {
      type inet:uri;
      description
        "Identifier for a node, uniquely identifies a node. This
        may be the same as the node-id defined in the ietf-network
        module defined in RFC 8345.";
    }
    container available {
      description
        "The time at which this node becomes available.";

      leaf default-node-available {
        type boolean;
        default false;
        description
          "By default, the node is powered off.";
      }
    }

    uses tvr-schd:tvr-schedule {
      augment "schedules/attr-value" {
        description
          "Augment scheduled node availability.";
        leaf node-available {
          type boolean;
        }
      }
    }
  }
}
```

```

        description
            "Node availability.";
    }
}
}
}
}

list links {
    key "source-node source-link-id";
    description
        "List of links.";
    leaf source-node {
        type inet:uri;
        description
            "A name refers to the source node of the link.";
    }
    leaf destination-node {
        type inet:uri;
        description
            "A name refers to the destination node of the link.";
    }
    leaf source-link-id {
        type string;
        description
            "A name refers to the link of the source node.";
    }
    container available {
        description
            "The time at which this link becomes available.";
        uses tvr-schd:tvr-schedule;

        container bandwidth {
            description
                "Scheduled link bandwidth.
                If the value measured by the system is less than this
                value, the system value is used.  If the value measured
                by the system is greater than this value the predicted
                value SHOULD be used.";

            leaf default-bandwidth {
                type te-types:te-bandwidth;
                default "0";
                description
                    "The default link capacity specified in a
                    generic format.";
            }

            uses tvr-schd:tvr-schedule {

```


6. Security Considerations

The YANG modules specified in this document define a schema for data that is designed to be accessed via network management protocols such as NETCONF [[RFC6241](#)] or 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 NETCONF access control model [[RFC8341](#)] provides the means to restrict access for particular NETCONF or RESTCONF users to a pre-configured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in `ietf-tvr-node.yang` module and `ietf-tvr-topology.yang` that are writable/creatable/deletable (i.e., `config true`, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., `edit-config`) to these data nodes without proper protection can have a negative effect on network operations. There are the subtrees and data nodes and their sensitivity/vulnerability:

```
/node-schedule/power-schedule
/node-schedule/interface-schedule
/topology-schedule/nodes/available
/topology-schedule/links/available
Modifications to these
scheduled attributes may result in a denial of service.
```

Some of the readable data nodes in the `ietf-tvr-node.yang` module and `ietf-tvr-topolgy.yang` module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via `get`, `get-config`, or notification) to these data nodes.

7. IANA Considerations

This document registers a URI in the IETF XML registry [[RFC3688](#)]. Following the format in [[RFC3688](#)], the following registration is requested to be made:

```
URI: urn:ietf:params:xml:ns:yang:ietf-tvr-schedule
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.
```

```
URI: urn:ietf:params:xml:ns:yang:ietf-tvr-node
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.
```

URI: urn:ietf:params:xml:ns:yang:ietf-tvr-topology
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

This document registers a YANG module in the YANG Module Names registry [[RFC6020](#)].

name: ietf-tvr-schedule
namespace: urn:ietf:params:xml:ns:yang:ietf-tvr-schedule
prefix: tvr-schd
reference: RFC XXXX

name: ietf-tvr-node
namespace: urn:ietf:params:xml:ns:yang:ietf-tvr-node
prefix: tvr-node
reference: RFC XXXX

name: ietf-tvr-topology
namespace: urn:ietf:params:xml:ns:yang:ietf-tvr-topology
prefix: tvr-topo
reference: RFC XXXX

8. Acknowledgements

The YANG model was developed using the suite of YANG tools written and maintained by numerous authors.

9. Normative References

- [[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>>.
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Appendix A. Example: Add a scheduled cost to OSPF interface

In OSPF (Open Shortest Path First), the interface cost is a metric used to determine the preference or desirability of a particular link or interface. By default, the OSPF interface cost is calculated based on the bandwidth of the interface, and it is also configurable.

This example demonstrates how an OSPF interface can be extended with a cost that changes with a schedule.

```

module ietf-tvr-ospf-schedule {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-tvr-ospf-schedule";
  prefix ospf-schedule;

  import ietf-routing {
    prefix "rt";
    reference
      "RFC 8349: A YANG Data Model for Routing
      Management (NMDA Version)";
  }
  import ietf-ospf {
    prefix "ospf";
    reference
      "RFC 9129: A YANG Data Model for OSPF Protocol";
  }

  import ietf-tvr-schedule {
    prefix "tvr-schd";
  }

  augment "/rt:routing/rt:control-plane-protocols/"
    + "rt:control-plane-protocol/ospf:ospf/ospf:areas/ospf:area/"
    + "ospf:interfaces/ospf:interface" {
    container scheduled-cost {
      description
        "Augment OSPF interface with a scheduled interface cost.";
      uses tvr-schd:tvr-schedule {
        augment "schedules/attr-value" {
          leaf cost {
            type uint32;
            description
              "interface cost";
          }
        }
      }
    }
  }
}

```

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