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 A YANG Model for SRv6 Mobile User Plane

Abstract

This document defines a YANG data model for configuration and management of SRv6 for the mobile network.

Status of This Memo

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Table of Contents

- [1. Introduction](#)
 - [1.1. Requirements Language](#)
- [2. Terminology](#)
 - [2.1. Acronyms](#)
- [3. Tree Diagram](#)
- [4. YANG Model](#)
- [5. IANA Considerations](#)
- [6. Security Considerations](#)
- [7. References](#)
 - [7.1. Normative References](#)
 - [7.2. Informative References](#)
- [Appendix A. Appendix 1 Complete Tree Diagram](#)
- [Acknowledgements](#)
- [Contributors](#)
- [Authors' Addresses](#)

1. Introduction

In mobile networks, mobility systems provide connectivity over a wireless link to stationary and non-stationary nodes. The user-plane establishes a tunnel between the mobile node and its anchor node over IP-based backhaul and core networks.

When SRv6 is applied to mobile networks, it enables a source routing architecture, where operators get to explicitly specify a route for the packets to traverse both to and from a mobile node. The SRv6 Endpoint nodes serve as mobile user-plane anchors.

For example, in an Enhanced mode topology, the intermediate waypoints, SIDs, can be used for Traffic Engineering. For more details, see [Segment Routing IPv6 for Mobile User Plane \[I-D.ietf-dmm-srv6-mobile-uplane\]](#), Section 5.2. The gNB and UPF are SR-aware, and there are two service segments, one for traffic engineering to support a low latency path, and the other for service programming. In such a topology the operator routes the traffic through these SRv6 nodes, so they can perform their Endpoint functionality and forward the packet. Further, in the uplink direction, when the gNB receives a packet from a UE, it adds the segments of the SR policy to route the traffic through those two segments, while doing something similar in the downlink direction.

This document describes a [YANG 1.1 \[RFC7950\]](#) data model for the Segment Routing IPv6 (SRv6) user plane of mobile networks.

The model conforms to the [NMDA \[RFC8342\]](#) architecture.

1.1. Requirements Language

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.

2. Terminology

This document references terms defined in other documents. In particular, it imports definitions for the following terms from [Segment Routing Architecture](#) [[RFC8402](#)], and [IPv6 Segment Routing Header \(SRH\)](#) [[RFC8754](#)].

*Active Segment

*BGP-Prefix Segment

*Prefix SID

*Segment

*SID

*SRH

*SRv6

*SRv6 Endpoint nodes

*SRv6 SID

*Segment Routing domain (SR domain)

*SR Global Block (SRGB)

*SR Local Block (SRLB)

2.1. Acronyms

This document uses a few acronyms. Some of them are defined here for reference.

Acronym	Definition
gNB	gNodeB, a 5G Base Station using New Radio technology
MUP	Mobile User Plane
SR	Segment Routing
SRv6	Segment Routing over v6

Acronym	Definition
UE	User Equipment
UPF	User Plane Function

Table 1: Acronyms

3. Tree Diagram

An abridged version of the tree diagram is shown here. Annotations used in the diagram are defined in [YANG Tree Diagrams](#) [RFC8340].

```

module: ietf-srv6-mobile

augment /rt:routing/rt:control-plane-protocols
    /rt:control-plane-protocol/bgp:bgp/bgp:global:
    +--rw route-distinguisher?    rt-types:route-distinguisher
    +--rw label-allocation-mode?  identityref
    +--rw sid-allocation-mode?    identityref
    +--rw srv6
        +--rw locator?            leafref
        +--ro sid-manager-connected? boolean
        +--ro locator-registered? boolean
        +--ro micro-segment-enabled? boolean
        +--rw mobile
            +--rw encapsulation
            |    ...
            +--rw decapsulations
            |    ...
            +--rw decapsulation-source-prefix? inet:ipv6-prefix
augment /rt:routing/rt:control-plane-protocols
    /rt:control-plane-protocol/bgp:bgp/bgp:global
    /bgp:route-selection-options:
    +--rw selection-deferral-time? uint16
    +--rw med-missing-as-worst?    boolean
    +--rw multipath-as-path-relax? boolean
    +--rw multipath-nexthop-relax? boolean
augment /rt-pol:routing-policy/rt-pol:defined-sets
    /bp:bgp-defined-sets:
    +--rw n4-interface-sets
        +--rw interface-set* [name]
            +--rw name        string
            +--rw member*    identityref
augment /rt-pol:routing-policy/rt-pol:policy-definitions
    /rt-pol:policy-definition/rt-pol:statements
    /rt-pol:statement/rt-pol:conditions/bp:bgp-conditions:
    +--rw match-n4-network-interface-set
        +--rw n4-network-instance-set? leafref
        +--rw match-set-options?       match-set-options-type
augment /rt-pol:routing-policy/rt-pol:policy-definitions
    /rt-pol:policy-definition/rt-pol:statements
    /rt-pol:statement/rt-pol:actions/bp:bgp-actions:
    +--rw set-network-interface
        +--rw apply-policy
            +--rw import-policy*    leafref
            +--rw default-import-policy? default-policy-type
            +--rw export-policy*    leafref
            +--rw default-export-policy? default-policy-type

```

Figure 1: Tree Diagram for SRv6 YANG Model

4. YANG Model

The YANG model is divided into two parts. The first part of the model augments the BGP model in [BGP Model for Service Provider Network](#) [I-D.ietf-idr-bgp-model] for the BGP configuration, while the second part augments the BGP Routing Policy model in [BGP Model for Service Provider Network](#) [I-D.ietf-idr-bgp-model].

The BGP model is augmented both at a global level to add SRv6 configuration, and at the route selection option. The BGP policy model is augmented to add a defined set, a set of match options, and a set of actions.

The model imports [Common YANG Data Types](#) [RFC6991], [A YANG Data Model for Routing Management\(NMDA Version\)](#) [RFC8349], [A YANG Data Model for Routing Policy](#) [RFC9067], [YANG Data Model for Segment Routing](#) [RFC9020], [YANG Data Model for SRv6 Base and Static](#) [I-D.ietf-spring-srv6-yang], and [BGP Model for Service Provider Network](#) [I-D.ietf-idr-bgp-model].

```

<CODE BEGINS> file "ietf-srv6-mobile@2022-03-03.yang"
module ietf-srv6-mobile {
  yang-version "1.1";
  namespace "urn:ietf:params:xml:ns:yang:ietf-srv6-mobile";
  prefix "srv6-mob";

  import ietf-inet-types {
    prefix "inet";
    reference
      "RFC 6991: Common YANG Data Types.";
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349, A YANG Data Model for Routing Management
      (NMDA Version).";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Types for the Routing Area.";
  }
  import ietf-routing-policy {
    prefix rt-pol;
    reference
      "RFC 9067: A YANG Data Model for Routing Policy.";
  }
  import ietf-bgp {
    prefix bgp;
    reference
      "I-D.ietf-idr-bgp-model: BGP Model for Service Provider
      Network.";
  }
  import ietf-bgp-policy {
    prefix bp;
    reference
      "I-D.ietf-idr-bgp-model: BGP Model for Service Provider
      Network.";
  }
  import ietf-bgp-types {
    prefix bt;
    reference
      "I-D.ietf-idr-bgp-model: BGP Model for Service Provider
      Network.";
  }
  import ietf-segment-routing {
    prefix sr;
    reference
      "RFC 9020: YANG Data Model for Segment Routing.";
  }

```

```

}
import ietf-srv6-base {
    prefix srv6;
    reference
        "I-D.ietf-spring-srv6-yang: YANG Data Model for SRv6 Base
        and Static.";
}
import ietf-srv6-types {
    prefix srv6-types;
    reference
        "RFC 9020: YANG Data Model for Segment Routing.";
}

organization
    "IETF SPRING Working Group";

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

    Editor: Mahesh Jethanandani (mjethanandani at gmail dot com)
    Author: Tetsuya Murakami (tetsuya at arccus dot com);

description
    "This module augments the BGP YANG model to add support for
    configuration in mobile networks.

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    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 "2022-03-03" {
    description
        "Initial Version.";

```

```

        reference
            "RFC XXXX, A YANG Model for BGP configuration in mobile
            networks.";
    }

/*
 * Features
 */

/*
 * Typedefs
 */
typedef srv6-mobile-function-type {
    type union {
        type identityref {
            base "srv6-types:srv6-endpoint-type";
        }
        type uint16;
    }
    description
        "Type definition for SRV6 mobile function. Unknown
        values are represented as the numeric value.";
    reference
        "draft-ietf-dmm-srv6-mobile-uplane";
}

/*
 * Identities
 */
identity srv6-mup {
    base bt:afi-safi-type;
    description
        "Segment Routing for Mobile User Plane (AFI,SAFI = ?,?)";
    reference
        "RFC XXXX: A YANG Model for BGP configuration in mobile
        networks.";
}

identity label-allocation-mode {
    description
        "Base identity to be used to express types of label allocation
        strategies to be used within a network instance";
}

identity label-per-prefix {
    base label-allocation-mode;
    description
        "A label is to be allocated per prefix entry in the RIB for the
        network instance";
}

```

```

}

identity label-per-nexthop {
    base label-allocation-mode;
    description
        "A label is to be allocated per nexthop entry in the RIB for
        the network instance";
}

identity label-instance {
    base label-allocation-mode;
    description
        "A single label is to be used for the instance";
}

identity sid-allocation-mode {
    description
        "Base identity to be used to express types of SRv6 segment ID
        allocation strategies to be used within a network instance.";
}

identity sid-per-nexthop {
    base sid-allocation-mode;
    description
        "A segment ID is to be allocated per nexthop entry in the RIB
        for the network instance";
}

identity sid-instance {
    base sid-allocation-mode;
    description
        "A single segment ID is to be used for the instance";
}

identity sid-per-nexthop-no-transportation {
    base sid-allocation-mode;
    description
        "A segment ID is to be allocated per nexthop entry in the
        RIB for the network instance";
}

identity sid-instance-no-transportation {
    base sid-allocation-mode;
    description
        "A single segment ID is to be used for the instance";
}

identity mobile-interface-type {
    description
        "Base identity for different mobile interfaces.";
}

```

```

}

identity n4 {
    base mobile-interface-type;
    description
        "N4 interface.";
}

/*
 * Groupings
 */

/*
 * BGP configuration
 */
augment "/rt:routing/rt:control-plane-protocols" +
    "/rt:control-plane-protocol/bgp:bgp/bgp:global" {

    description
        "Augmentation of the BGP global configuration to add srv6
        mobile configuration.";

    leaf route-distinguisher {
        type rt-types:route-distinguisher;
        description
            "The route distinguisher that should be used for the local
            VRF or VSI instance when it is signalled via BGP.";
    }

    leaf label-allocation-mode {
        type identityref {
            base label-allocation-mode;
        }
        must "not(..sid-allocation-mode)" {
            error-message "label-allocation-mode and sid-allocation-mode"
                + "cannot co-exist";
        }
        must "not(/rt:routing/rt:control-plane-protocols" +
            "/rt:control-plane-protocol" +
            "/bgp:bgp/bgp:global/srv6/mobile/encapsulation/config" +
            "/locator | " +
            "/rt:routing/rt:control-plane-protocols" +
            "/rt:control-plane-protocol/bgp:bgp/bgp:global" +
            "/srv6/locator)" {
            error-message "SRV6 configurations must be removed first";
        }
        description
            "The label allocation mode to be used for L3 entries
            in the network instance";
    }
}

```

```

}

leaf sid-allocation-mode {
    type identityref {
        base sid-allocation-mode;
    }
    must "not(../label-allocation-mode)" {
        error-message "label-allocation-mode and sid-allocation-mode "
            + "cannot co-exist";
    }
    must "boolean(/rt:routing/rt:control-plane-protocols" +
        "/rt:control-plane-protocol" +
        "/bgp:bgp/bgp:global/srv6/mobile/encapsulation/locator|" +
        "/rt:routing/rt:control-plane-protocols" +
        "/rt:control-plane-protocol/bgp:bgp/bgp:global/srv6" +
        "/mobile/decapsulations/decapsulation/locator|" +
        "/rt:routing/rt:control-plane-protocols" +
        "/rt:control-plane-protocol/bgp:bgp/bgp:global/srv6" +
        "/locator)" {
        error-message "SRv6 locator name must be configured";
    }
    description
        "The segment ID allocation mode to be used for L3 entries
        in the network instance";
}

container srv6 {
    description
        "SRv6 mobile container.";

    leaf locator {
        type leafref {
            path "/rt:routing/sr:segment-routing/" +
                "srv6:srv6/srv6:locators/srv6:locator/srv6:name";
        }
        description
            "Locator configuration.";
    }

    leaf sid-manager-connected {
        type boolean;
        config false;
        description
            "Connection with segment ID manager is active";
    }

    leaf locator-registered {
        type boolean;
        config false;
    }

```

```

    description
        "Locator name is registered";
}

leaf micro-segment-enabled {
    type boolean;
    config false;
    description
        "Locator has enabled micro-segment behavior";
}

container mobile {
    when "derived-from-or-self(/rt:routing" +
        "/rt:control-plane-protocols" +
        "/rt:control-plane-protocol/bgp:bgp/bgp:global" +
        "/bgp:afi-safis/bgp:afi-safi/bgp:name, 'srv6-mup')\" {
        description
            "This augmentation is valid only for a MUP SAFI.";
    }

    description
        "Mobile configuration of SRv6.";

    container encapsulation {
        description
            "Encapsulation configuration.";

        leaf locator {
            type leafref {
                path "/rt:routing/sr:segment-routing/" +
                    "srv6:srv6/srv6:locators/srv6:locator/srv6:name";
            }
            description
                "Reference to SRv6 locator key";
        }

        leaf function {
            type srv6-mobile-function-type;
            must "boolean(current()/../locator)" {
                error-message
                    "SRv6 Mobile Locator name must be configured";
            }
            description
                "One of the SRv6 function types.";
        }

        leaf source-adress {
            type inet:ipv4-address;
            description

```

```

        "GTP source IP address";
    }

    leaf source-position {
        type uint8;
        description
            "Bit position of GTP source IP address";
    }

    container n4-network-instance {
        description
            "Definitions for the N4 interface.";

        leaf routing-policy {
            type leafref {
                path "/rt-pol:routing-policy/" +
                    "rt-pol:policy-definitions/" +
                    "rt-pol:policy-definition/rt-pol:name";
            }
            must "boolean(current()/../access)" {
                error-message
                    "SRv6 Mobile access instance name must be " +
                    "configured";
            }
            description
                "Reference to routing-policy";
        }

        leaf access {
            type string;
            description
                "Mobile access instance.";
        }
    }
}

container decapsulations {
    description
        "SRv6 mobile decapsulation configuration.";

    list decapsulation {
        key "id";
        description
            "SRv6 mobile Decapsulation config";

        leaf id {
            type uint16;
            description
                "SRv6 mobile decapsulation entry id";
        }
    }
}

```

```

    }

    leaf locator {
        type leafref {
            path "/rt:routing/sr:segment-routing/" +
                "srv6:srv6/srv6:locators/srv6:locator/srv6:name";
        }
        description
            "Reference to SRv6 locator key";
    }

    leaf function {
        type srv6-mobile-function-type;
        must "boolean(current()/../locator)" {
            error-message
                "SRv6 Mobile Locator name must be configured";
        }
        description
            "One of SRv6 function types.";
    }

    container n4-network-instance {
        description
            "Definitions for the N4 interface.";

        leaf core {
            type string;
            description
                "Core instance";
        }
    }
}

leaf decapsulation-source-prefix {
    type inet:ipv6-prefix;
    description
        "IPv6 prefix for GTP source address";
}
}
}

augment "/rt:routing/rt:control-plane-protocols" +
    "/rt:control-plane-protocol/bgp:bgp:bgp:global" +
    "/bgp:route-selection-options" {

    description
        "Augmentation of the BGP global configuration for
        route selection options to add srv6 mobile configuration.";
}

```

```

leaf selection-deferral-time {
    type uint16 {
        range 1..3600;
    }
    default 300;
    description
        "An upper-bound on the time (in seconds) that the best-path
        selection is deferred";
}

leaf med-missing-as-worst {
    type boolean;
    description
        "A route without MED is treated as with highest MED value";
}

leaf multipath-as-path-relax {
    type boolean;
    default true;
    description
        "Paths with different AS-Path but of same length can form
        ECMP";
}

leaf multipath-nexthop-relax {
    type boolean;
    default false;
    description
        "Enable BGP multi-path for paths with same next-hop";
}
}

augment "/rt-pol:routing-policy/rt-pol:defined-sets" +
    "/bp:bgp-defined-sets" {
    description
        "Augmentation of the Routing Policy module to add
        mobile interface defined sets.";

    container n4-interface-sets {
        description
            "Enclosing container for list of n4 interface sets.";

        list interface-set {
            key "name";
            description
                "List of defined interface sets.";

            leaf name {
                type string;
            }
        }
    }
}

```

```

        description
            "Name of interface set. This is used to reference
            the set in match conditions.";
    }

    leaf-list member {
        type identityref {
            base "mobile-interface-type";
        }
        description
            "Members of interface set.";
    }
}
}
}

augment "/rt-pol:routing-policy/rt-pol:policy-definitions" +
    "/rt-pol:policy-definition/rt-pol:statements" +
    "/rt-pol:statement/rt-pol:conditions/bp:bgp-conditions" {
    description
        "Augmentation of the Routing Policy module to add conditions.";

    container match-n4-network-interface-set {
        description
            "Match a referenced network instance.";
        leaf n4-network-instance-set {
            type leafref {
                path "/rt-pol:routing-policy/rt-pol:defined-sets/"
                    + "bp:bgp-defined-sets/n4-interface-sets/"
                    + "interface-set/name";
            }
            description
                "References a defined community set.";
        }
        uses rt-pol:match-set-options-group;
    }
}

augment "/rt-pol:routing-policy/rt-pol:policy-definitions" +
    "/rt-pol:policy-definition/rt-pol:statements" +
    "/rt-pol:statement/rt-pol:actions/bp:bgp-actions" {
    description
        "Augmentation of the Routing Policy module to add actions.";

    container set-network-interface {
        description
            "Set a referenced network instance.";
        uses rt-pol:apply-policy-group;
    }
}

```

```
}  
}  
<CODE ENDS>
```

Figure 2: SRV6 YANG Model for Mobile User Plane

5. IANA Considerations

This memo registers the following namespace URIs in the IETF XML in the "IETF XML Registry" [[RFC3688](#)]:

URI: urn:ietf:params:xml:ns:yang:ietf-srv6-mobile

Registrant Contact: The IESG.

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

This document registers the following YANG modules in the "YANG Module Names" registry [[RFC6020](#)]:

Name: ietf-srv6-mobile

Namespace: urn:ietf:params:xml:ns:yang:ietf-srv6-mobile

Prefix: srv6-mob

Reference: RFC XXXX

6. Security Considerations

The YANG module specified in this document defines 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 [Network Configuration Access Control Model \(NACM\)](#) [[RFC8341](#)] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in this YANG module 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. These are the subtrees and data nodes and their sensitivity/vulnerability:

Some of the readable data nodes in this 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. These are the subtrees and data nodes and their sensitivity/vulnerability:

Some of the RPC operations in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus

important to control access to these operations. These are the operations and their sensitivity/vulnerability:

7. References

7.1. 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>>.
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Appendix A. Appendix 1 Complete Tree Diagram

Here is a complete tree diagram for the configuration and operational part of the model.

module: ietf-srv6-mobile

```
augment /rt:routing/rt:control-plane-protocols
    /rt:control-plane-protocol/bgp:bgp/bgp:global:
    +--rw route-distinguisher?    rt-types:route-distinguisher
    +--rw label-allocation-mode?  identityref
    +--rw sid-allocation-mode?    identityref
    +--rw srv6
        +--rw locator?            leafref
        +--ro sid-manager-connected? boolean
        +--ro locator-registered? boolean
        +--ro micro-segment-enabled? boolean
        +--rw mobile
            +--rw encapsulation
                | +--rw locator?            leafref
                | +--rw function?            srv6-mobile-function-type
                | +--rw source-adress?       inet:ipv4-address
                | +--rw source-position?     uint8
                | +--rw n4-network-instance
                |     +--rw routing-policy?  leafref
                |     +--rw access?          string
            +--rw decapsulations
                | +--rw decapsulation* [id]
                |     +--rw id                uint16
                |     +--rw locator?          leafref
                |     +--rw function?
                |         | srv6-mobile-function-type
                |     +--rw n4-network-instance
                |         +--rw core?         string
            +--rw decapsulation-source-prefix? inet:ipv6-prefix
augment /rt:routing/rt:control-plane-protocols
    /rt:control-plane-protocol/bgp:bgp/bgp:global
    /bgp:route-selection-options:
    +--rw selection-deferral-time?  uint16
    +--rw med-missing-as-worst?     boolean
    +--rw multipath-as-path-relax?  boolean
    +--rw multipath-nexthop-relax?  boolean
augment /rt-pol:routing-policy/rt-pol:defined-sets
    /bp:bgp-defined-sets:
    +--rw n4-interface-sets
        +--rw interface-set* [name]
            +--rw name          string
            +--rw member*       identityref
augment /rt-pol:routing-policy/rt-pol:policy-definitions
    /rt-pol:policy-definition/rt-pol:statements
    /rt-pol:statement/rt-pol:conditions/bp:bgp-conditions:
    +--rw match-n4-network-interface-set
        +--rw n4-network-instance-set?  leafref
        +--rw match-set-options?         match-set-options-type
```

```
augment /rt-pol:routing-policy/rt-pol:policy-definitions
    /rt-pol:policy-definition/rt-pol:statements
    /rt-pol:statement/rt-pol:actions/bp:bgp-actions:
+--rw set-network-interface
+--rw apply-policy
+--rw import-policy*           leafref
+--rw default-import-policy?   default-policy-type
+--rw export-policy*           leafref
+--rw default-export-policy?   default-policy-type
```

Figure 3: Complete tree diagram

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