An Information Model for Basic Network Policy
draft-hares-i2rs-info-model-policy-03

Abstract

   This document contains three information Models: Basic Network Policy
   (BNP IM), Policy-Based Routing (PBR), I2RS Local-Config (I2RS-LC IM).
   The I2RRS-LC IM provides both an I2RS store of Policies plus a store
   of Policy Templates. The BNP IM has the following levels of Policy
   Hierarchy: Policy Set, Policy Group, Policy Rule, and conditional
   actions within the policy rule (conditional match and Action). The
   PBR IM, I2RS LC IM, BGP Information Model (BGP IM), Service Topology
   Information Model (SF-Topo IM), and the Service Forwarding Chaining
   IM (SFC IM) utilize and extend the BNP IM. This draft lists the
   extensions to the BNP IM that support these information models (PBR
   IM, I2RS LC IM, BGP IM, SSF-Topo IM and SFC-Policy IM).

   The BNP IM is based on the concept of an extensible information model
   for representing policies. This concept is also found in the Policy
   Core Information Model (PCIM) (RFC3060) and the Quality of Service
   (QoS) Policy Information Model (QPIM)(RFC3644) and policy based
   routing.

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1. Introduction

   The Interface to the Routing System (I2RS) provides read and write
   access to the information and state within the routing process within
   routing elements. The I2RS client interacts with one or more I2RS
   agents to collect information from network routing systems.

   Processing of collected information at the I2RS agent may require the
   I2RS Agent to filter certain information or group pieces of
   information in order to reduce the data flow through the network to
   the I2RS client. Some applications that that utilize the services of
   I2RS client may also wish to require specific data in response to
   network events or conditions based on pre-established rules. This
   functionality is necessary to meet the requirements of i2rs enabled
   services which include service-layer routing improvements, and
   control of traffic flows and exit points.

   This document introduces a Basic Network Policy information model
   (BNP IM) to handle policies related to the network. This basic
   policy model can be easily extended beyond the basic functions. The
   [I-D.ietf-i2rs-architecture] suggests that associated with the i2RS
   RIB model there will be "Policy-based Routing (ACLs)" and RIB "policy
   controls". These basic policy functions can operate as part of this
   functional blocks providing the basic model for policy operators.
   This model can also be considered as the substance of the policy
   templates.

   The BNP IM is extensible allowing other extensions to make the BNP IM
   policy adaptable to specific I2RS protocol features. This policy
   model can be linked with other information models such as the
   following:

   o Policy Base Routing Information model (PBR-IM) (Model in section
      4),

   o I2RS RIB Informational Model (RIB IM) (see section 6)
      ([I-D.ietf-i2rs-rib-info-model])

   o BGP Informational Model (BGP IM) (see section 6)
      ([I-D.hares-i2rs-bgp-im])

   o Service Topology (see section 6)
      ([I-D.hares-i2rs-info-model-service-topo])

   o Service Forwarding Chaining Filters Information Mode (SFC IM) (see
      section 6) (ietf-hares-dunbar-i2rs-sfc-policy-im-00.txt)

   The BNP IM model is a product of the industry approach to I2RS that
   standardizes on a few basic functions network functions to obtain
   quick deployment of initial I2RS RIB modules, and build on this
   success to create network functions. Additional I2RS modules add
   I2RS interfaces to policy-based routing, BGP, Service topology
   creation, Service Chaining functions, and policy templates.

   This information model leverages previous work done on extensible
   information model for representing policies, for example, the Policy
   Core Information Model (PCIM) [RFC3060] [RFC3060], and an extension
   to this model to address the need for QoS management, called the
   Quality of Service (QoS) Policy Information Model (QPIM) [RFC3644]
   [RFC3644].

   Most policy within routing and forwarding systems has become
   hierarchical with individual specific policies being grouped as a set
   policy. The hierarchical policy rule definition enhances policy
   readability and reusability. Groups of network policies have labels
   to aid operational use. Named groups of policy are easily identified
   and reused as blocks.

   The Basic Network Policy information model contains the following
   three components:

   Policy Group

      Policy is described by a set of policy rules that may be grouped
      into subsets. A Policy group is used to provide a hierarchical
      policy definition that provides the model context or scope for
      sub-rule actions. The model context includes identity, scope,
      role, precedence, priority and security model. In a policy group
      policy rules and policy groups can be nested within other policy
      rules.

   Policy Set

      is a set of Policy Groups identified by a Policy Set Name.

   Policy Rule

      Policy Rule is represented by semantics "If Condition then
      Action", therefore condition and action comprise Policy Rule
      model.

   This draft contains the following Informational Models

   Basic Network-Policy Information Model (BNP IM)

      is generic network policy model. It can be thought of as a
      coherent set of rules to administer, manage, and control access to
      network resources and defines a network policy at its most general
      level of abstraction. It models aspects such as actions and
      conditions that constitute a policy element relationship, as well
      as operators contained in the both condition and action that can
      either be used to overwrite an old value of the variable or imply
      match relationship.

   Policy Based Routing Information Model (PBR IM)

      defines information that allows the network administer to forward
      the packet based on other criteria than the destination address in
      the packet.

   I2RS Local Config Information Model (I2RS-LC IM)

      defines I2RS Local Configuration database kept in the I2RS Agent
      that can be leveraged to quickly set-up policies via the I2RS
      Agent. This local configuration store contains basic network
      policies and network templates, and provides quick local access to
      polies rather than transfer the policies down from the I2RS Client
      prior to enacting a policy via I2RS interface.

2. Definitions and Acronyms

      IGP: Interior Gateway Protocol

      Information Model: An abstract model of a conceptual domain,
      independent of a specific implementations or data representation

      CLI: Command Line Interface

      SNMP: The Simple Network Management Protocol

      NETCONF: The Network Configuration Protocol

      RBNF: Routing Backus-Naur Form

3. Basic Network Policy Information Model (BNP IM)

3.1. BNP IM Overview

   I2RS needs its own implicit and explicit policy. This section
   provides an overview of the network policy model. The network policy

model is defined by the following components, whose relationship is
roughly depicted in the figure below.

```
            +-----------------------+
            |    Network-Policy      |
            +-----------+-----------+
                        ^
                       /|\
                        | "extends"
            +-----------^-------------+
            |     Policy Set          |
            +--+-----------------+--+
             ^                    ^            +--------------+
            /|\                  /|\       ---|PBR Policy-Rule|
             |                    |        |  |  Additions    |
             |                    |        |  +--------------+
             | "extends"          | "extends" |  +--------------+
   +--------^-------+   +--------^-------+  |--|LP Policy-Rule |
   | Policy Group   |   |  Policy Rule   |<---|  |Additions     |
   +---------------+   +---------------+  |  +--------------+
                          :           :   |     . . .
                          :           :   |  +--------------+
                  ......:          :.....  ---|RIB Policy-Rule|
                       :                :   |  Additions    |
                       :                :     +--------------+
                       :                :
                       :                :
        +---------V---------+    +-V-------------+
        | Policy Condition  |    | Policy Action |
        +-------------------+    +--------------+
           :     :     :              :     :     :
        ......:     .    :.....     .....:     .     :.....
           :         :     :          :         :       :
   +----V---+  +---V----+ +--V---+ +-V------++--V-----++--V---+
   |  Match  |  |Policy  | |Policy| |  Set    || Policy ||Policy|
   |Operator|  |Variable| |Value | |Operator||Variable|| Value|
   +--------+  +--------+ +------+ +--------++-------++------+
```
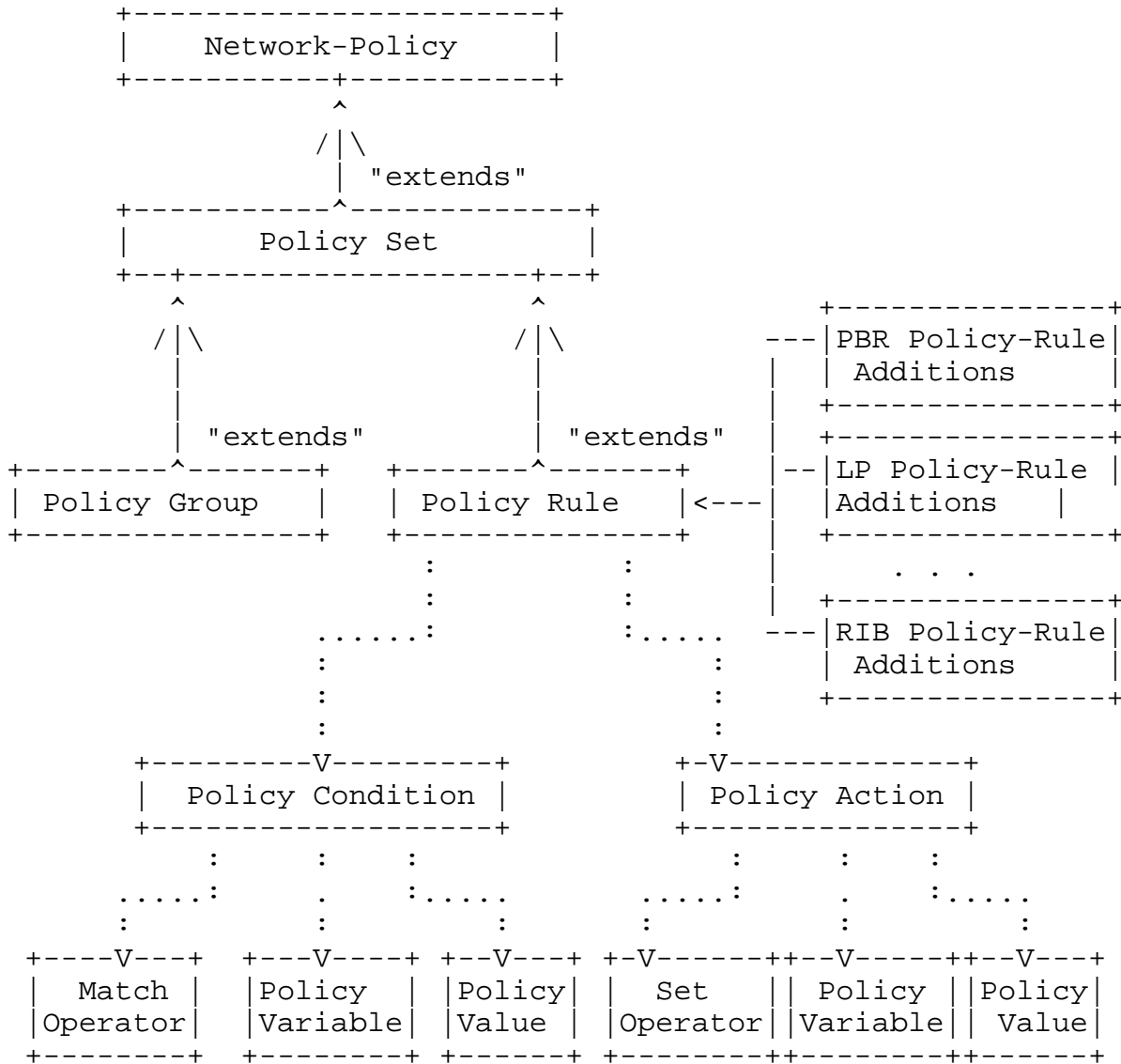
                Figure 1: Overall model BNP IM structure

   Network_policy - contains sets of policies.

   Policy-Set - is introduced to provide an abstraction for a set of
   rules. it is inserted into the inheritance hierarchy above both
   Policy-Group and Policy-Rule.

   Policy-Group -defines the basic network policy Group model which
   combines the a list of Policy-Rules.

Policy Rule is represented by semantics "If Condition then Action", therefore condition and action comprise Policy Rule model.

o Condition models the elementary match operation "<variable> match <value>".

o Action models the elementary set operation. "SET <variable> TO <value>".

In Condition model, the 'Match' operator is usually implied while in the action model, the 'Set operator is explicitly used.

Policy-Sets, Policy-Groups, and Policy-Rules have basic functionality (Policy-Basic IM) plus extensions defined by specific Information Models such as:

the PBR Information Model (PBR IM) (contained in this document),

the I2RS_Local_Policy Model (LP IM) (contained in this document),

the RIB Information Model (RIB IM) ([I-D.ietf-i2rs-rib-info-model]),

the BGP Information Model (BGP-IM) ([I-D.hares-i2rs-bgp-im]),

the Traffic Steering Information Model ([I-D.hares-i2rs-info-model-service-topo]),

the SFC Information Model (SFC IM) (ietf-hares-dunbar-i2rs-sfc-policy-im-00.txt)

the MPLS LDP Information Model (MPLS LDP IM) as templates for policy.

I2RS Client-Agents Information Models MAY support only the Policy-Basic IM, or MAY support any additional specific information models.

Each level of the Policy hierarchy (Policy-Set, Policy-Group, and Policy-Rules have both a read and write scope

3.2. The Policy Set

3.2.1. Policy Set Overview

The PolicySet structure has the following elements:

o Policy-Set_Name - Unique Name for Policy Set

   o Policy-Group is introduced to provide an abstraction for a set of
      rules. It is derived from Policy, and it is inserted into the
      inheritance hierarchy above both PolicyGroup and PolicyRule. This
      reflects the additional structural flexibility and semantic
      capability of both subclasses.

3.2.2. Policy-Set RBNF

                 Figure 2 - Policy Set RBNF

        <Network_policy> ::= (<Policy_Set> ...)
        <Policy-Set> ::= <Policy-Set-Name>

        <Policy-Group_list> ::=
                              (<Policy-Group> ...)
                              (<Policy-Rule> ...)
                              (<local_Config>)
                              (<PBR_rule>)

3.3. The Policy Group

3.3.1. Policy Group Overview

   In order to provide hierarchical policy definition and associate
   policy rule with other constraint, the basic policy group model needs
   to be defined. The corresponding extensions are introduced in a
   component, whose structure is informally depicted in the following
   diagram.

```
          Figure 3 - Policy Group
    +---------------------------------+ (optional)
    |            Policy Group         |....
    +---------------------------------+   :
       *        *        *     *      *  ^    :
       |        |        |     |      |  :....:
       |        |        |     |      |
       |        |        |     |      |
       |        |        |     |      |
    +--------+ +--------+ +--------+|  +-----------+
    |Identity| | Role   | |Priority||  |Policy Rule|
    +--------+ +--------+ +--------+|  +-----------+
       *        *                  |     *      *    *
       |        |                  |     |      |    |
     +---       |                  |  +---+---+  |  ++-----+
       |        |                  |  |Enabled|  |  |Usage|
       |        |                  |  +-------+  |  +-----+
    +-----+----+ +------+          |            |
    | Resource | |Scope |          |            |
    +----------+ +------+          |            |
              *      *             |            |
              |      |             |          +--+------+
              |      |    +----+------+        |Mandatory|
              |      |    | Precedence|        +---------+
              |      |    +-----------+
              |      |
           +-----++-----+
           | Read||Write|
           |Scope||Scope|
           +-----++-----+
```
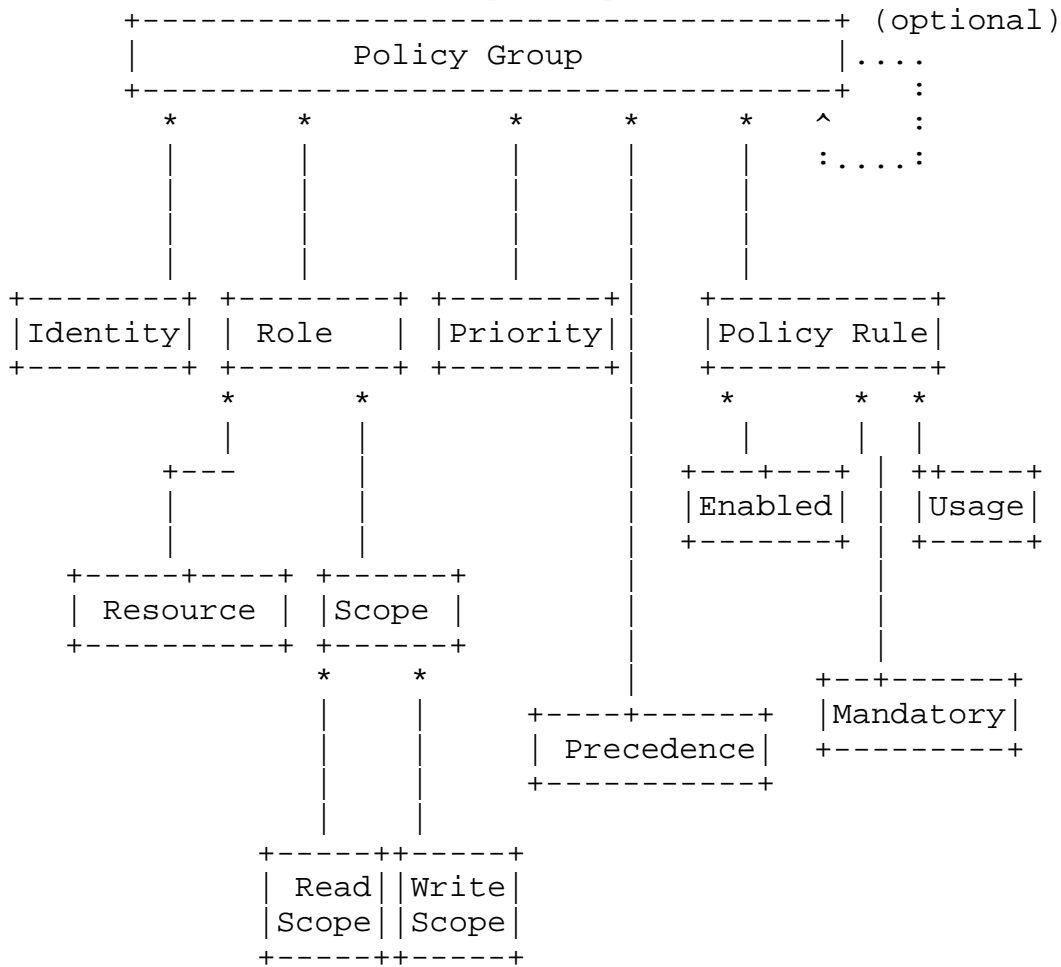
The basic information model works as follows: Within the policy group
information model, hierarchy is used to model context or scope for
the sub-rule actions. A policy group contains Identity, scope,
priority,precedence, and policy rule. Optionally, the policy group
can contain a list of policy groups.

The elements of the Policy Group information model are as follows:

o Each policy group is captured in its own list, distinguished via a
   identity, role, priority, precedence.

o A policy group has a certain role, such as resource or scope. A
   policy group can even have multiple roles simultaneously. The
   role, are captured in the list of "role" component.

o A policy role has a certain Scope, such as read scope or write
   scope. A policy group can even have multiple scope

simultaneously. The scope, or scopes, are captured in the list of "scope" components.

o A policy has a certain priority, such as priority 0-255. A policy can only have one priority. The priority is captured in the list of "priority" component.

o A policy rule can inherit properties (e.g., identity, role, priority, precedence) from policy group. A policy rule also can have its own properties, e.g., enabled, mandatory, usage.

o The policy, policy group elements can be extended with policy-specific components (policy-extensions, policy-group-extension respectively).

3.3.2. Policy-Group RBNF

A more formal depiction in RBNF format follows below

        Figure 4 - Policy-Group RBNF

     <Policy-Group> ::= <Policy-Group_Identity>
                   <Policy-Group_Roles>
                   <Policy-Group_priority>
                   <Policy-Group_precedence>
                   (<Policy-Rule-list>)
                   [<Supporting-Policy-Group>]
                   [<Policy-Group-Extension>]

     <Policy-Group_Identity> ::= <Policy-Group-Name>
                        [<Policy-Group-Secure-Identity>]
     <Policy-Group-priority> ::= INTEGER (0..255);
     <Policy-Group-precedence> ::= INTEGER (0..250);
     <Policy-Rule-list> ::= ((<Policy-Rule> <Policy-Rule-Status>) ...)

     <Policy-Rule-Status> ::= <POLICY-RULE-ENABLE>
                                 [<POLICY-RULE-MANDATORY>]
                                 [<Policy-Rule_usage>]

     <Policy-Rule_usage> ::== <Policy-Rule-REFCNT>

     <Policy-Group-Roles> ::= (<Policy-Group-Role> ...)
     <Policy-Group-Role> ::=<Node-RESOURCES> | <Policy-Group-Scope>
     <Node-RESOURCES> ::= [<I2RS_AGENT_RESOURCE>]

     <Policy-Group-Scope> ::= (<READ_SCOPE> <Policy-Group_Read_Scope>)
                     | (<WRITE_SCOPE> <Policy-Group_Write_Scope>)

```
        <Policy-Group_Read_Scope> ::= <Policy-Group_Read_Scope_Type>
                                 [<RIB-IM_READ_list>]
                                 [<BGP-IM-READ_list>]

        <Policy-Group_Read_Scope_Type> ::= <RIB-IM_READ_SCOPE_TYPE>
                                 |  <BGP-IM_READ_SCOPE_TYPE>

        <Policy-Group_Write_Scope> ::= <Policy-Group_Write_Scope_Type>
                                  [<RIB-IM_WRITE_list>]
                                  [<BGP-IM-WRITE_list>]

        <Policy-Group_Write_Scope_Type> ::= <RIB-IM_WRITE_SCOPE_TYPE>
                                 | <BGP-IM_WRITE_SCOPE_TYPE>

        <Supporting-Policy-Group> ::= <SUPPORT-POLICY-GROUP> (
                                    <Policy-Group> ...)

        <Policy-Group-Extension> ::= ...    /* Vendor Specific Policy */
```

3.4. The Policy Rule

3.4.1. Policy-Rule Overview

   The following diagram contains an informal graphical depiction of the
   main elements of the information model:

           Figure 5 - Policy Rule

```
            +----------------+
            |  Policy Rule   |<...
            +----------------+    :
              *          *   :    :
              |          |   :...:
              |          |
      +---------+     +--------+
 ...>|Condition|<.......| Action |<...
  :   +---------+<.......+-------+    :
  :    :   *                *   :     :
 :..... |                   :   :... :
        |                   :
    +--------+...........:
    |Operator|
    +--------+
```

Roughly speaking, the basic information model works as follows: A
policy rule contains conditions and actions. Each condition or each
action in turn contains operator. A operator connects variable and
value in the action or condition. Condition can map onto and be
supported by other condition, while action can map onto and be
supported by other actions. Policy rule can map onto other, policy
rules.

The elements of the Policy Rule information model are as follows:

o A policy can in turn be part of a hierarchy of policies, building
   on top of other policies. Each policy is captured in its own
   level, distinguished via a policy-identity.

o Policy rule inherit scope from policy group. A policy role has a
   certain Scope, such as read scope or write scope. A policy rule
   can even have multiple scope simultaneously. The scope, or
   scopes, are captured in the list of "scope" components.

o Furthermore, a policy rule contains conditions and actions, each
   captured in their own list.

o A condition contains a variable and a value and use a match
   operator, to connect variable with value. An examples of an
   operator might be a" IP ADDRESS AS RESOLVED BYDNS" or "Set to a
   member". Also, a condition can in turn map onto other condition
   in an underlay policy. This is captured in list"supporting-
   condition".

o An action contains a variable and a value. An action uses Set
   operator to connect variable with value. Analogous to a node, an
   action can in turn map onto other actions in an underlay policy.
   This is captured in list "supporting-action".

o The policy, condition, action and operator elements can be
   extended with policy-specific components (policy-extensions,
   condition-extension, action-extension and operator-extension
   respectively).

3.4.2. Policy-Rule RBNF

The information model for the Network-policy component is more
formally shown in RBNF below:

        Figure 6 Policy Rule RBNF

    <Policy-Rule> ::= <Policy-Rule_identity>
                          <Policy-Rule_priority>

```
                                   <Policy-Rule_precedence>
                                   <Policy-Rule_Roles>
                                   (<Policy-Rule_Condition>
                                   <Policy-Rule_Action> ...)
                                   <Policy-Rule_Security_model>
                                   [<Policy-Rule_rule_extensions>]

        <Policy-Rule_identity> ::= <Policy-Rule-Name>
                                    [<Policy-Rule-Secure-Identity>]
        <Policy-Rule_priority> ::= INTEGER (0..250);
        <Policy-Rule_precedence> :;= INTEGER (0..250);

        <Policy-Rule_Roles> ::= (<Policy_Rule_Role> ...);
        <Policy-Rule_Role> ::=<RESOURCES> |
                                <Policy_Rule_Scope>

        <RESOURCES> ::= [<I2RS_AGENT_RESOURCE>]
        <Policy-Rule_Scope> ::= (<READ_SCOPE>
                                    <Policy-Rule_Read_scope>)
                                 | (<WRITE_SCOPE>
                                    <Policy-Rule_Write_scope>)

        <Policy-Rule_Read_scope> ::= ((<BNP_READ_SCOPE_TYPE>
                                        <BNP_READ_SCOPE_list>) ...)
                                     | [<Policy-Rule_Read_Scope_External>]

        <Policy-Rule_Write_scope> ::= ((<BNP_WRITE_SCOPE_TYPE>
                                        <BNP_WRITE_SCOPE_list>)...)
                                       [<Policy-Rule_Write_Scope_External>]


        <Policy-Rule_Condition> ::= <Policy-Rule_Match_node>
                                    (<Policy-Rule_Match_value> ...)
                                    [<Policy-Rule_mode>]
                                    [<Policy-Rule_Match_Operator>]
                                    [<Policy-Rule_Condition_extension>]

        <Policy-Rule_Match_node> ::=  [<Policy-Rule_Match_Node_BNP-IM>]
                                    | [<Policy-Rule_Match_node_external]

        <Policy-Rule_Match_value> ::=  [<Policy-Rule_Match_Value_BNP-IM>]
                                    | [<Policy-Rule_Match_Value_external]

        <Policy-Rule_mode> ::= PERMIT | DENY ;
        <Policy-Rule_Match_operator_external> ::=
                                    [<Policy-Rule_Match_Operator_BNP-IM>]
                                    | [<Policy-Rule_Match_Operator_external]
```
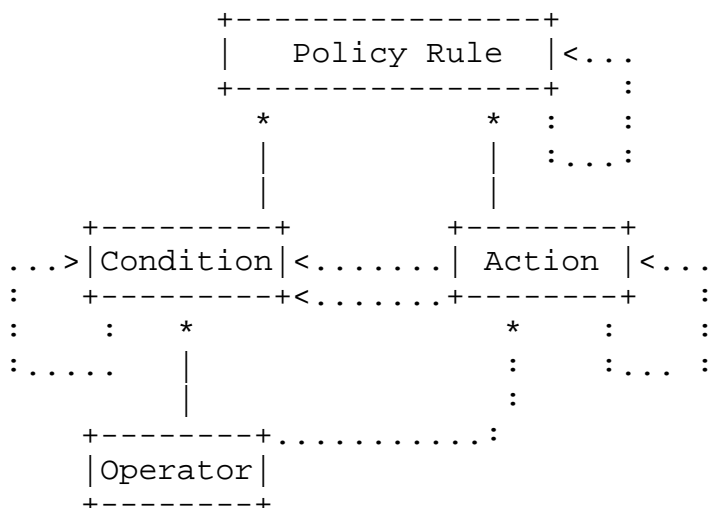
```
     <Policy-Rule-action> ::= <Policy-Rule_Action_variable>
                            <Policy-Rule_Action_value>
                            <Policy-Rule_Set-Operator>
                            [<Policy-Rule_action-extension> ]

     <Policy-Rule_Security-Model> ::= <First-Matching
                                     |<All-Matching>]

     <Policy-Rule_rule_extension> ::=
                        <I2RS-LC-policy_rule_extensions>

     <Policy-Rule-action> ::= <Policy-Rule_Action_variable>
                              <Policy-Rule_Action_value>
                              <Policy-Rule_Set-Operator>
                              [<Policy-Rule_action-extension> ]

     <Policy-Rule_Action_variable> ::= <Policy-Rule_Action_var>
                              (<Policy-Rule_Action_value> ...)
                              [<Policy-Rule_Set_Operator>]
                              [<Policy-Rule_Action_extension>]

     <Policy-Rule_Action_var> ::=  [<Policy-Rule_Action_Vars_BNP-IM>]
                              | [<Policy-Rule_Action_external>]

     <Policy-Rule_Action_value> ::=  [<Policy-Rule_Action_Vars_BNP-IM>]
                              | [<Policy-Rule_Action_external>]

     <Policy-Rule_Set_Operator> ::=  [<Policy-Rule_Set_Operator_BNP-IM>]
                              | [<Policy-Rule_Set_Operator_external>]

     <Policy-Rule-action-extension> ::=
                              [<Policy-Rule_act_ext_BNP-IM>]
                              | [<Policy-Rule_act_ext_external>]

     <Policy-Rule-Match-Operator-Policy-IM> ::= <IS-SET-MEMBER'>
                   |<IN-INTEGER-RANGE>
                   |<IP-ADDRESS-AS-RESOLVED-BY-DNS>
                   |<Policy_IM-Match-Operator-extension>

     <Policy-Rule_condition_extension> ::=
                   <Policy_Rule_condition_ext-BNP-IM>
                   [<Policy-Rule_Condition_ext_external>]


     /* these scopes besides RIB IM are defined in each IM */

     <PR_Read_Scope_RIB_IM> ::=<RIB-IM_READ_SCOPE_TYPE>
                              <RIB-IM_READ_list>
```

```
        <PR_Read_Scope_RIB_IM> ::=<RIB-IM_READ_SCOPE_TYPE>
                                  <RIB-IM_READ_list>

        <RIB-IM_READ_list> ::= [<RIB-IM-Tree-Match> ...]
        <RIB-IM_WRITE_list> ::= [<RIB-IM-Tree-Match> ...]
        <RIB-IM-Tree-Match> ::= <RIB-IM-Match-routing-instance>
                                    <RIB-IM-Match-interface-list>
                                    <RIM-IM-Match-rib_list>
                                    <RIB-IM-match-route-list>

        /* extensions to other IM */

        /* External Read and Write Scope */
        <Policy-Rule_Read_Scope_External> ::=
                            [<PR_Read_Scope_RIB_IM>]
                            [<PR_Read_Scope_BGP_IM>]
                            [<PR_Read_Scope_PBR_IM>]
                            [<PR_Read_Scope_I2RSLC_IM>]
                            [<PR_Read_Scope_STopo_IM>]
                            [<PR_Read_Scope_SFC-Policy_IM>]

        <Policy-Rule_Write_Scope_External> ::=
                            [<PR_Write_Scope_RIB_IM>]
                            [<PR_Write_Scope_BGP_IM>]
                            [<PR_WriteScope_PBR_IM>]
                            [<PR_Read_Scope_I2RSLC_IM>]
                            [<PR_Read_Scope_STopo_IM>]
                            [<PR_Read_Scope_SFC-PolicyIM>]

        /* External Rule Conditionals */
        <Policy-Rule_Match_node_external> ::=
                           [<Policy-Rule_Match_Node_RIB-IM>]
                         | [<Policy-Rule_Match_Node_PBR-IM>]
                         | [<Policy-Rule_match_Node_I2RSLC-IM>]
                         | [<Policy-Rule_Match_Node_BGP-IM>]
                         | [<Policy-Rule_Match_Node_STopo-IM>]
                         | [<Policy-Rule_Match_Node_SFC-Policy-IM>]

        <Policy-Rule_Match_Value_external> ::=
                           [<Policy-Rule_Match_Value_RIB-IM>]
                         | [<Policy-Rule_Match_Value_PBR-IM>]
                         | [<Policy-Rule_Match_Value_I2RSLC-IM>]
                         | [<Policy-Rule_Match_Value_BGP-IM>]
                         | [<Policy-Rule_Match_Value_STopo-IM>]
                         | [<Policy-Rule_Match_Value_SFC-Policy-IM>]

        <Policy-Rule_Match_operator_external> ::=
                           [<Policy-Rule_Match_Operator_RIB-IM>]
```

```
                        | [<Policy-Rule_Match_Operator_PBR-IM>]
                        | [<Policy-Rule_Match_Operator_I2RSLC-IM>]
                        | [<Policy-Rule_Match_Operator_BGP-IM>]
                        | [<Policy-Rule_Match_Operator_STopo-IM>]
                        | [<Policy-Rule_Match_Operator_SFC-Policy-IM>]


        <Policy-Rule_Action_value_external> ::=
                        [<Policy-Rule_Action_Values_RIB-IM>]
                        | [<Policy-Rule_Action_Values_PBR-IM>]
                        | [<Policy-Rule_Match_Operator_I2RSLC-IM>]
                        | [<Policy-Rule_Action_Values_BGP-IM>]
                        | [<Policy-Rule_Set_Operator_STopo-IM>]
                        | [<Policy-Rule_Set_Operator_SFC-Policy-IM>]


        <Policy-Rule_Set_Operator_external> :==
                        [<Policy-Rule_Set_Operator_RIB-IM>]
                        | [<Policy-Rule_Set_Operator_PBR-IM>]
                        | [<Policy-Rule_Match_Operator_I2RSLC-IM>]
                        | [<Policy-Rule_Set_Operator_RIB-IM>]
                        | [<Policy-Rule_Set_Operator_BGP-IM>]
                        | [<Policy-Rule_Set_Operator_STopo-IM>]
                        | [<Policy-Rule_Set_Operator_SFC-Policy-IM>]



        <Policy-Rule_act_ext_external> ::=
                        [<Policy-Rule_extension_RIB-IM>]
                        | [<Policy-Rule_act_ext_PBR-IM>]
                        | [<Policy-Rule_act_ext_I2RSLC-IM>]
                        | [<Policy-Rule_act_ext_RIB-IM>]
                        | [<Policy-Rule_act_ext_BGP-IM>]
                        | [<Policy-Rule_act_ext_STopo-IM>]
                        | [<Policy-Rule_act_ext_SFC-Policy-IM>]
                        | [<I2RS_Vendor-Rule_act_ext>]/* other I2RS IM */
```

3.5. BNP IM Grammar

This section specifies the network policy information model in
Routing Backus-Naur Form (RBNF, [RFC5511]). It also provides
diagrams of the main entities of which the information model is
comprised.

```
        <basic-network_policy_in> ::= (<policy-set> ...)
        <basic-network_policy_out> ::= (<policy-set> ...)
        <network-policy_rules_list> ::= (<policy-rule>...)
```

4. The Policy Based Routing Information Model

4.1. Policy Based Routing Overview

   Policy based Routing is a technique used to make routing decisions
   based on policies set by the network administrator. PBR enables
   network administrator to forward the packet based on other criteria
   than the destination address in the packet, which is used to lookup
   an entry in the routing table.

   The policy based routing problem can be viewed as a resource
   allocation problem that incorporates business decision with routing.
   Policy based routing provides many benefits, including cost saving,
   load balancing and basic QoS.

   Routing decisions in policy based routing are based on several
   criteria beyond destination address, such as packet size,
   application, protocol used, and identity of the end system. Policy
   constraints are applied before applying QoS constraints since policy
   constraint overrides QoS constraint. Policy constraints may be
   exchanged by routing protocols while updating routing information.

   The I2RS use cases which benefit from PBR are:
   [I-D.white-i2rs-use-case] and
   [I-D.krishnan-i2rs-large-flow-use-case],

   PBR-Rules extends from Policy Basic Rule with a set of condition,
   action and attributes. Routing decisions in policy based routing are
   based on several criteria beyond destination address, such as packet
   size, application, protocol used, and identity of the end system.

4.2. PBR-RIB definition

   One routing instance (named by an INSTANCE_NAME) can contain multiple
   PBR RIBs, and is associated with a set of interfaces, and a ROUTER-
   ID. The entries associated with each routing instance relating to
   the PBR are:

   o   INSTANCE NAME

   o   interface_list

   o   PRB RIB list - with each entry having an order set of routes

   o   PRB Default RIB - default forwarding FIB.

   o   ROUTER-ID

Each PBR RIB has the following:

o   PRB RIB NAME

o   PBR Route-entry

The Route entry in a PRB has the following information:

o   match field - as in the RIB IM route

o   order_list PBR route list with each entry having: a) next-hops, b)
    PBR route attributes, and c) vendor-attributes

The PRB route attributes include QOS Attributes as show in the policy
list below.

4.3. PBR Rule Component

A PBR rule is constructed using condition, action and attributes that
are inherited from Policy Group Component.
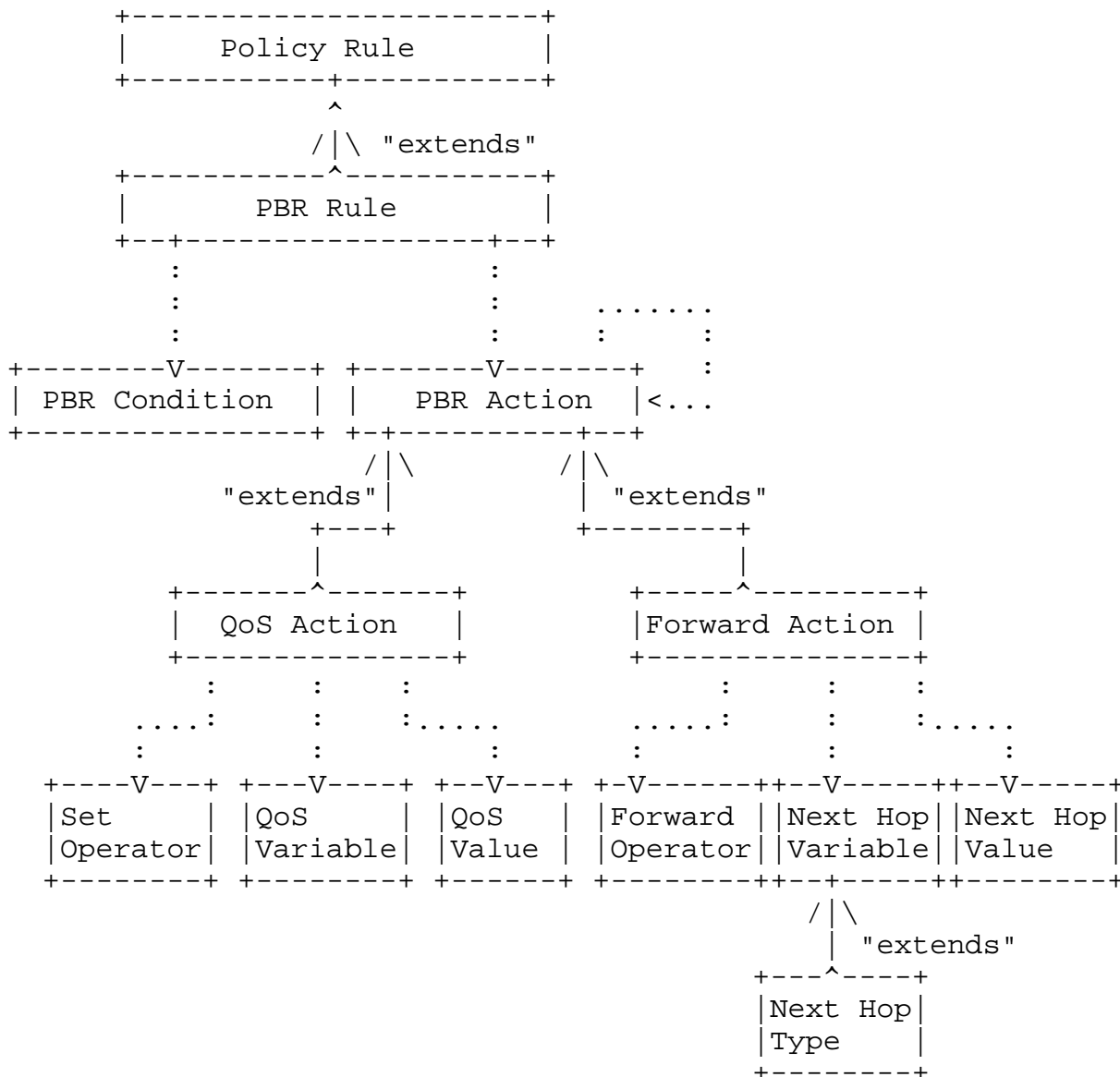
Figure 7 - PBR Policy Rule

```
                 +----------------------+
                 |      Policy Rule     |
                 +----------+-----------+
                            ^
                       /|\ "extends"
                 +----------^----------+
                 |       PBR Rule      |
                 +--+----------------+--+
                    :                :
                    :                :
                    :                :      .......
                    :                :     :     :
          +--------V-------+ +-------V-------+   :
          | PBR Condition  | |   PBR Action  |<...
          +---------------+ +-+----------+--+
                         /|\          /|\
               "extends"|            | "extends"
                   +---+              +--------+
                   |                          |
          +--------^-------+         +-----^---------+
          |   QoS Action   |         |Forward Action |
          +---------------+         +---------------+
              :     :     :              :     :     :
          ....:     :     :....      ....:     :     :.....
              :     :     :              :     :         :
          +----V---+ +---V----+ +--V---+ +-V------++--V-----++--V-----+
          |Set     | |QoS     | |QoS   | |Forward ||Next Hop||Next Hop|
          |Operator| |Variable| |Value | |Operator||Variable||Value   |
          +--------+ +--------+ +------+ +--------++--+-----++--------+
                                                   /|\
                                                   | "extends"
                                              +---^----+
                                              |Next Hop|
                                              |Type    |
                                              +--------+
```
              Figure 3: Policy based routing IM structure

4.4. PBR QOS RBNF

   The PBR QOS RBNF is below

         Figure 8 - PRB QOS RBNF

      /* policy rules */
      <Policy-Rule_Match_Node_PBR-IM> ::= <IPv4_QoS_Node_Matches>
                  | <IPv6_QoS_Node_Matches>

```
<Policy-Rule_Match_Value_PBR-IM> ::= <IPv4_QoS_Value_Matches>
              | <IPv6_QoS_Value_Matches>

    <IPv4_QoS_Node_matches> = <IPv4-QOS_Matches>
    <IPv6_QoS_Node_matches> = <Pv6-QOS_Matches>
    <IPv4_QoS_Value_matches> = <IPv4-QOS_Matches>
    <IPv6_QoS_Value_matches> = <IPv6-QOS_Matches>

    <IPv4-QOS_Matches> ::= [<IPv4-SRC>]
              [<IPv4_DST>]
              [<IPv4_Proto>]
              [<IPv4_TOS-DSCP>]
              [<IPv4_ICMP_field>]
              [<IPv4_length>]

    <IPv6-QOS_Matches> ::= [<IPv6-SRC>]
              [<IPv6_DST>]
              [<IPv6_Proto>]
              [<IPv6_Flow>]
              [<IPv6_length>]

<Policy-Rule_Match_Operator_PBR-IM> ::= [<Longest-prefix>]
           | [<Exact>]
           | [(<IPv4-RANGE> <IPv4-Low> <IPv4-High>)]
           | [(<IPv6-RANGE> <IPv6-Low> <IPv6-High>)]
           | [(<LENGTH-Range> <LENGTH_Low> <LENGTH_High>)]

        <IPv4_low> ::= <IPv4-Prefix>
        <IPv4_high> ::= <IPv4-Prefix>
        <IPv6_low> ::= <IPv6-Prefix>
        <IPv6_high> ::= <IPv6-Prefix>

<Policy-Rule_Action_value_PBR-IM> ::= [<QOS_action>]
                [<FWD_action>]

        <QOS_action> ::= <QOS_IP-TOS_Set>
                    | <QOS_DSCP>

        <FWD_action> ::= <Drop_packet>
                    | <Drop_Packet_ICMP>
                    | (<Forward_Specific> <next-hop>)
                    | (<Forward_Default>)

<Policy-Rule_Set_Operator_PBR-IM> ::= [<SET_QOS_BITS>]
                    | [<SET_FWD_ACTION<]
```

4.5. Relationship between PBR Rule Model and RIB Information Model

   As described in [I-D.ietf-i2rs-rib-info-model], each Routing instance
   contains a collection of RIBs, interfaces, and routing parameters
   including the following:

   o The set of interfaces indicates which interfaces are associated
      with this routing instance.

   o The RIBs specify how incoming traffic is to be forwarded based on
      destination.

   o the routing parameters control the information in the RIBs/PIBs.

   PIB and RIB can not be used at the same time, which means:

   o If a router doesn't support policy based routing, a router MUST
      use rib and MUST not use PIB.

   o If a router supports policy based routing,

      * PIB is used if several criteria beyond destination address is
         matched.

      * RIB is used if several criteria beyond destination address is
         not matched.

   Policy constraints information either comes from RSVP,BGP/IGP, or
   comes from manual configuration or policy configuration tool.
   Therefore PBR uses from the RIB IM:

   o Interface-list: The interface list contains a list of identifiers,
      with each identifier uniquely identifying an interface.

   o Origin: an indication used to identify from which protocols (e.g.,
      ISIS, OSPF, BGP, I2RS, CLI etc.) the policy based route is.

4.6. PBR RBNF

```
         Figure 9 - PBR RBNF
       /* pbr defintion */

     <pbr-routing-instance> ::= <PBR_INSTANCE_NAME>
                             [<interface-list>] <pbr-rib_list>
                             [<prb-default-rib>]
                             [<Router-ID>]

    <pbr-rib-list> ::= <PRB_RIB_NAME>
                             <PRB_rib_family>
                             (<prb_rib> ...)

     <PRB_rib_family> ::=<IPv4_PRB_FAMILY>
                           | <IPV6_PRB_FAIMILY>

     <prb_rib> ::=  <PRB_RIB_NAME>
                             <PRB_rib_family>
                             <prb_policy_set>

     <prb_policy_set< ::= <BNP_policy_set>
               <RIB_policy_set_extensions>
               <PRB_policy_set_extensions>
               <BGP_policy_set_extensions>
               <QOS_policy_set_extensions>

     <prb_policy_set_exetensions> ::=
               <Policy-Rule_Match_Node_PBR-IM>
               <Policy-Rule_Match_Value_PBR-IM>
               <Policy-Rule_Match_Operator_PBR-IM>
               <Policy-Rule_Action_value_PBR-IM>
               <Policy-Rule_Set_Operator_PBR-IM>
```

4.7. Remaining PRB Issues

   Policy based routing MUST tackle the following difficult questions:

   o How is policy management strategy selected? Centralized or
      distributed.

   o At which point in a network domain are policy constraints checked
      and enforced? i.e., policy coverage, here policy constraint can be
      exchanged by routing protocol?

   o How are policy constraints exchanged within a domain?

   o How is policy data stored, refreshed and retrieved from policy
      repository?

      o How are policy rule conflicts avoided?

5. The I2RS Local Policy Information Model

5.1. I2RS Local Policy IM Overview

   The Local Policy Information Model (LB IM) stores I2RS policy and
   policy templates that are used across many I2RS modules. The LB IM
   stores a set of policy and a set of policy templates. This section
   defines the LB IM extensions needed to the Basic Policy set at the
   Policy-set, Policy-Group, and Policy-Rule level. It also defines the
   optional extensions to this LP policy model as:

   o PBR IM,

   o RIB IM,

   o BGP IM,

   o Traffic Steering (TS IM)

   o SFC Filter (SFC-F IM),

   o Basic Route Templates IM

   The key benefit of the I2RS Local Configure Information Model (Local-
   is that it provides a place to store I2RS policy, and I2RS templates.
   The LB IM MAY allow for: a) re-use of these policy templates across
   multiple I2RS client-I2RS agent sessions, b) storing of some policy
   into permanent configuration store

5.2. I2RS Local Policy IM RBNF

     Figure 10 - Local I2RS Policy Story extensions

   <i2rs-Local-Policy> ::= <I2RS_LOCAL_POLICY_STORE>
                                  <Policy-Set>
                                  <Policy-Templates>

   <i2rs-condition-extension> :== [<I2RS-Client-Agent_transport_list>]
                                  [<I2RS_IPADRESS_DNS_resolve>]
                                  [<Policy-Template_match>]

   <I2RS-Client-Agent_transport_list> :== (< i2rs_transport > ...)
   <i2rs_transport< ::= [TCP][SCTP][SSL];

   /* these actions allow local I2RS configure store could
    * write to local Node policy store */

   <i2rs-action-extension> ::= [<i2rs_write_policy_config_store>]
                               [<i2rs_write_bgp_config_store>]
                                       ...

The model extends the original network-policy model as follows:

o A local policy rule can in turn be part of a hierarchy of
   policies, building on top of other policies. Each local
   configuration policy is captured in its own level, distinguished
   via a policy identity.

o A local policy rule inherit scope from policy group. A local
   policy rule has a certain Scope, such as read scope or write
   scope. A local policy rule can even have multiple scope
   simultaneously. The scope, or scopes, are captured in the list of
   "scope" components.

o Furthermore, a local policy contains conditions and actions, each
   captured in their own list.

o A condition contains a variable and a value and use a match
   operator, to connect variable with value. An examples of an
   operator might be a" IP ADDRESS AS RESOLVED BYDNS" or "Set to a
   member". Also, a condition can in turn map onto other condition
   in an underlay policy. This is captured in list in "supporting-
   condition".

o An action contains a variable and a value. An action uses Set
   operator to connect variable with value. Analogous to a node, an
   action can in turn map onto other actions in an underlay policy.
   This is captured in list "supporting-action".

   o The local policy, condition, action and operator elements can be
      extended with policy-specific components (condition-extension,
      action-extension and operator-extension respectively).

6. Extensions to the Policy IM

6.1. Extension to the RIB IM

          Figure 11 - RIB Information Model Extensions

          <RIB-IM_READ_list> ::= [<RIB-IM-Tree-Match ...]
          <RIB-IM_WRITE_list> ::= [<RIB-IM-Tree-Match ...]
          <RIB-IM-Tree-Match> ::= <RIB-IM-Match-routing-instance>
                                  <RIB-IM-Match-interface-list>
                                  <RIM-IM-Match-rib_list>
                                  <RIB-IM-match-route-list;

          /* BGP Info Module Tree Match */
          <BGP-IM_READ_list> ::= [<BGP-IM-Tree-Match ...]
          <BGP-IM_WRITE_list> ::= [<BGP-IM-Tree-Match ...]

          <BGP-IM-Tree-Match> ::= <BGP-IM-Tree-Match-protocol-instance>
          <BGP-IM-Match-Protocol-instance> ::= (<BGP_protocol> ...)

          <prb_rib> ::= <bgp_route_list>

          <bgp_route_list> ::= (<bgp_route> ...)
          <bgp_route> ::= <BGP_ROUTE_TYPE>
                          <bgp_route_prefix>
                          <bgp_attribute_list>
                          <bgp_route_create>
                          <bgp_rt_state_info>

          <basic-network_policy_in> ::= (<policy-set> ...)
          <basic-network_policy_out> ::= (<policy-set> ...)
          <network-policy_rules_list> ::= (<policy-rule>...)

6.2. Extension from the BGP IM

          Figure 12 - BGP Information Model Extensions

          <BGP-IM_READ_list> ::= [<BGP-IM-Tree-Match ...]
          <BGP-IM_WRITE_list> ::= [<BGP-IM-Tree-Match ...]
          <BGP-IM-Tree-Match> ::= <BGP-IM-Tree-Match-protocol-instance>
          <BGP-IM-Match-Protocol-instance> ::= (<BGP_protocol> ...)

6.3. Extension from SFC Topology IM

         Figure 13 - SFC Topology Information Model Extensions

      /* what part of the STopo Model can access */

      <STopo-IM_READ_list> ::= [<STopo-IM-Tree-Match ...]
      <STopo-IM_WRITE_list> ::= [<STopo-IM-Tree-Match ...]
      <STopo-IM-Tree-Match> ::= <STopo-IM-Tree-Match-protocol-instance>
      <STopo-IM-Match-Protocol-instance> ::= (<STopo_protocol> ...)

6.4. Extension from the SFC Traffic Filters

         Figure 14 - Traffic Steering Information Model Extensions

    /* what part of the STopo Model can access */

    <SFC-Policy-IM_READ_list> ::= [<SF-Policy-IM-Tree-Match ...]
    <SFC-Policy-IM_WRITE_list> ::= [<SF-Policy-IM-Tree-Match ...]
    <SFC-Policy-IM-Tree-Match> ::= <SF-Policy-IM-Tree-Match-protocol-instanc
e>
    <SFC-Policy-IM-Match-Protocol-instance> ::= <SF_instance_list>

7. IANA Considerations

    This draft includes no request to IANA.

8. Security Considerations

    TBD.

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