Abstract

This document takes as its starting point the object-oriented information model for representing policy information currently under development as part of the Common Information Model (CIM) activity in the Desktop Management Task Force (DMTF). This CIM model defines two hierarchies of object classes: structural classes representing policy information and control of policies, and relationship classes that indicate how instances of the structural classes are related to each other. In general, both of these class hierarchies will need to be mapped to a particular data store.

This draft defines the mapping of these DMTF-defined CIM classes to a directory that uses LDAPv3 as its access protocol. When mapping to an LDAP schema, the structural classes can be mapped more or less directly. The relationship hierarchy, however, must be mapped to a form suitable for directory implementation. Since this mapping of the
relationship classes could be done in a number of different ways, there is the risk of non-interoperable implementations. To avoid this possibility, this document provides a single mapping that all implementations using an LDAP directory as their policy repository SHALL use.

The LDAP schema described in this document consists of five very general classes: policyGroup, policyRule, policyCondition, policyTimePeriodCondition, and policyAction. The schema also contains two less general classes: vendorPolicyCondition and vendorPolicyAction. Finally, to achieve the mapping of the CIM relationships, the schema contains two auxiliary classes: policyGroupContainmentAuxClass and policyRuleContainmentAuxClass.

While these classes are general, they are not abstract: they can all be directly instantiated. Policy solutions for specific areas, such as DiffServ and IPSec, may use the policyGroup, policyRule, and policyTimePeriodCondition classes, as well as the two auxiliary classes, directly, while creating their own subclasses derived from policyCondition and policyAction in order to represent their own application-specific needs.
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This document takes as its starting point the object-oriented information model for representing policy information currently under development as part of the Common Information Model (CIM) activity in the Desktop Management Task Force (DMTF). This CIM model defines two hierarchies of object classes: structural classes representing policy information and control of policies, and relationship classes that indicate how instances of the structural classes are related to each other. In general, both of these class hierarchies will need to be mapped to a particular data store.

This draft defines the mapping of these DMTF-defined CIM classes to a directory that uses LDAPv3 as its access protocol. Two types of mappings are involved:

- For the structural classes in the CIM model, the mapping is basically one-for-one: CIM classes map to LDAP classes, CIM properties map to LDAP attributes.
For the relationship classes in the CIM model, different mappings are possible. In this document the CIM relationship classes and their properties are mapped in three ways: to LDAP auxiliary classes, to attributes representing DN pointers, and to "composite" attributes representing DN pointers with additional data elements.

Implementations that use an LDAP directory as their policy repository SHALL use the LDAP policy schema defined in this document. The use of the CIM information model as the starting point enables the schema and the relationship class hierarchy to be extensible, such that other types of policy repositories, such as relational databases, can also use this information.

These policy classes and their relationships are sufficiently generic to allow them to represent policies related to anything. However, their initial application will be for representing policies related to QoS (DiffServ and IntServ) and to IPSec. Policy models for application-specific areas such as these may extend the core schema in several ways. The preferred way is to use the policyGroup, policyRule, policyTimePeriodCondition, and policyRuleContainmentAuxClass classes directly, as a foundation for representing and communicating policy information. Then, specific subclasses derived from policyCondition and policyAction can capture application-specific definitions of conditions and actions of policies. These subclasses will then fit naturally within the policy framework of the above four classes. This will be explored more thoroughly in Section 7.0, "Extending the Core Schema".

Two subclasses, vendorPolicyCondition and vendorPolicyAction, are also included in this document, to provide a standard escape mechanism for vendor-specific extensions to the core policy schema.

This document fits into the overall framework for representing, deploying, and managing policies being developed by the Policy Framework Working Group. The initial work to define this framework is in reference [1]. More specifically, this document builds on the core policy classes first introduced in references [2] and [3]. It also draws on the work done for the Directory-enabled Networks (DEN) specification, reference [4]. Work on the DEN specification by the DEN Ad-Hoc Working Group itself has been completed. Further work to standardize the models contained in it will be the responsibility of selected working groups of the CIM effort in the Desktop Management Task Force (DMTF). Standardization of the core policy model is the responsibility of the SLA Policy working group.

This document is organized in the following manner:

- Section 2 provides a general overview of policies and how they are modeled.
Section 3 takes a brief look at the DMTF’s CIM policy classes and relationships. The complete CIM policy definitions are available on the DMTF’s web site; see reference [9].

The remainder of the document presents the mapping of the CIM policy classes and relationships into an LDAP schema.

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 RFC 2119, reference [5].

2. Modeling Policies

The classes comprising the Policy Framework core schema are intended to serve as an extensible class hierarchy (through specialization) for defining policy objects that enable application developers, network administrators, and policy administrators to represent policies of different types.

One way to think of a policy-controlled network is to first model the network as a state machine and then use policy to control which state a policy-controlled device should be in or is allowed to be in at any given time. Given this approach, policy is applied using a set of policy rules. Each policy rule consists of a set of conditions and a set of actions. Policy rules may be aggregated into policy groups. These groups may be nested, to represent a hierarchy of policies.

The set of conditions associated with a policy rule specifies when the policy rule is applicable. The set of conditions can be expressed as either an ORed set of ANDed sets of condition statements or an ANDed set of ORed sets of statements. Individual condition statements can also be negated. These combinations are termed, respectively, Disjunctive Normal Form (DNF) and Conjunctive Normal Form (CNF) for the conditions. Please note that it is explicitly NOT a goal of this specification to represent more complicated conditions (such as those that may be found in a procedural language) at this time.

If the set of conditions associated with a policy rule evaluates to TRUE, then a set of actions that either maintain the current state of the object or transition the object to a new state may be executed. For the set of actions associated with a policy rule, it is possible to specify an order of execution, as well as an indication of whether the order is required or merely recommended. It is also possible to indicate that the order in which the actions are executed does not matter.

Policy rules themselves can be prioritized. One common reason for doing this is to express an overall policy that has a general case with a few specific exceptions.
For example, a general QoS policy rule might specify that traffic originating from members of the engineering group is to get Bronze Service. A second policy rule might express an exception: traffic originating from John, a specific member of the engineering group, is to get Gold Service. Since traffic originating from John satisfies the conditions of both policy rules, and since the actions associated with the two rules are incompatible, a priority needs to be established. By giving the second rule (the exception) a higher priority than the first rule (the general case), a policy administrator can get the desired effect: traffic originating from John gets Gold Service, and traffic originating from all the other members of the engineering group gets Bronze Service.

Policies can either be used in a stand-alone fashion or aggregated into policy groups to perform more elaborate functions. Stand-alone policies are called policy rules. Policy groups are aggregations of policy rules, or aggregations of policy groups, but not both. Policy groups can model intricate interactions between objects that have complex interdependencies. Examples of this include a sophisticated user logon policy that sets up application access, security, and reconfigures network connections based on a combination of user identity, network location, logon method and time of day. A policy group represents a unit of reusability and manageability in that its management is handled by an identifiable group of administrators and its policy rules apply equally to the scope of the policy group.

Stand-alone policies are those that can be expressed in a simple statement. They can be represented effectively in schemas or MIBs. Examples of this are VLAN assignments, simple YES/NO QoS requests, and IP address allocations. A specific design goal of this schema is to support both stand-alone and aggregated policies.

Policy groups and rules can be classified by their purpose and intent. This classification is useful in querying or grouping policy rules. It indicates whether the policy is used to motivate when or how an action occurs, or to characterize services (that can then be used, for example, to bind clients to network services). Describing each of these concepts in more detail,

- **Motivational Policies** are solely targeted at whether or how a policy’s goal is accomplished. Configuration and Usage Policies are specific kinds of Motivational Policies. Another example is the scheduling of file backup based on disk write activity from 8am to 3pm, M-F.

- **Configuration Policies** define the default (or generic) setup of a managed entity (for example, a network service). Examples of Configuration Policies are the setup of a network forwarding service or a network-hosted print queue.

- **Installation Policies** define what can and cannot be put on a system or component, as well as the configuration of the mechanisms that
perform the install. Installation policies typically represent specific administrative permissions, and can also represent dependencies between different components (e.g., to complete the installation of component A, components B and C must be previously successfully installed or uninstalled).

- Error and Event Policies. For example, if a device fails between 8am and 9pm, call the system administrator, else call the Help Desk.

- Usage Policies control the selection and configuration of entities based on specific "usage" data. Configuration Policies can be modified or simply re-applied by Usage Policies. Examples of Usage Policies include upgrading network forwarding services after a user is verified to be a member of a "gold" service group, or reconfiguring a printer to be able to handle the next job in its queue.

- Security Policies deal with verifying that the client is actually who the client purports to be, permitting or denying access to resources, selecting and applying appropriate authentication mechanisms, and performing accounting and auditing of resources.

- Service Policies characterize network and other services (not use them). For example, all wide-area backbone interfaces shall use a specific type of queuing.

Service policies describe services available in the network. Usage policies describe the particular binding of a client of the network to services available in the network.

2.1. Policy Scope

Policies represent business goals and objectives. A translation must be made between these goals and objectives and their realization in the network. An example of this could be a Service Level Agreement (SLA), and its objectives and metrics (Service Level Objectives, or SLOs), that are used to specify services that the network will provide for a given client [8]. The SLA will usually be written in high-level business terminology. SLOs address more specific metrics in support of the SLA. These high-level descriptions of network services and metrics must be translated into lower-level, but also vendor- and device-independent specifications. The core policy schema classes are intended to be used as part of the definition of this specification.

It is envisioned that the definition of policy in this draft is generic in nature and is applicable to Quality of Service (QoS), to non-QoS networking applications (e.g., DHCP and IPSEC), and to non-networking applications (e.g., backup policies, auditing access, etc.).
3. Overview of the Schema

The following diagram provides an overview of the five classes that comprise the CIM core schema, and their relationships to each other. Note that the two extension classes VendorPolicyCondition and VendorPolicyAction are not shown.

```
***************
|             |             | 0..n
|             |             | * ContainedPolicyGroup
|             |             | +-----v-----+
| PolicyGroup |             | * 0..n
|             | 0..n         | +-----^-----+
|             | * ContainedPolicyRule
|             | 0..n         | +-----v-----+
| PolicyRule  | ContainedPolicyCondition<***************************
|             | 0..n         | * 0..n
|             | +-----v-----+
| PolicyRuleValidityPeriod | PolicyCondition
| I             | +-----^-----+
| 0..n         | +-----v-----+
| PolicyTimePeriodCondition
| +---------------------------+
| ContainedPolicyAction<***************************
| 0..n         | * 0..n
| +-----v-----+
| PolicyAction
| +---------------------------+
```

Figure 1. Overview of the CIM Policy Classes and Their Relationships

3.1. Relationships

Relationships are a central feature of information models. A relationship represents a physical or conceptual connection between objects. CIM and DEN define the general concept of an association between two (or more) objects. Two types of associations are
aggregations (which express whole-part relationships) and other relationships, such as those that express dependency. Both are used in this model.

3.2. Associations

An association is a class that contains two or more references, where each reference identifies another object. An association is defined using a class. Associations can be defined between classes without affecting any of the related classes. That is, addition of an association does not affect the interface of the related classes.

3.3. Aggregations

An aggregation is a strong form of an association. An aggregation is usually used to represent a "whole-part" relationship. This type of relationship defines the containment relationship between a system and the components that make up the system. Aggregation often implies, but does not require, that the aggregated objects have mutual dependencies.

3.4. Key Relationships in the CIM Policy Model

The following relationships are shown in the preceding figure:

- The ContainedPolicyGroup relationship enables policy groups to be nested. This is critical for scalability and manageability, as it enables complex policies to be constructed from multiple simpler policies for administrative convenience. For example, a policy group representing policies for the US might have nested within it policy groups for the Eastern and Western US.

  In the LDAP schema, the ContainedPolicyGroup relationship is mapped to the policyGroupsAuxContainedSet attribute in the auxiliary class policyGroupContainmentAuxClass. (Other data stores may define a different mapping). This attribute enables a policyGroup to identify another policyGroup as its offspring.

- A policy group may aggregate one or more policy rules, via the ContainedPolicyRule relationship. Grouping of policy rules into a policy group is again for administrative convenience; a policy rule may also be used by itself, without belonging to a policy group.

  In the LDAP schema, the ContainedPolicyRule relationship is mapped to the policyRulesAuxContainedSet attribute in the auxiliary class policyRuleContainmentAuxClass.

- A policy group or policy rule may also be aggregated by an instance of any class to which the policyGroupContainmentAuxClass or policyRuleContainmentAuxClass class has been attached. Again, this is for administrative convenience. If the directory entry to which the policyGroupContainmentAuxClass or policyRuleContainmentAuxClass
has been attached is a policy group, then the pointer in the auxiliary class realizes one of the relationships discussed above; a separate attribute is not needed in the PolicyGroup class. If the directory entry is something other than a policy group, then the pointer in the auxiliary class realizes a Jurisdiction relationship from the CIM model. Note that these relationships are not shown in Figure 1.

A policy rule aggregates zero or more instances of the PolicyCondition class, via the ContainedPolicyCondition association. For all policy rules, at least one condition MUST be specified, either via the ContainedPolicyCondition aggregation, or defined explicitly within a subclass of PolicyRule. These conditions are grouped into two levels of lists: either an ORed set of ANDed sets of conditions (DNF, the default) or an ANDed set of ORed sets of conditions (CNF). Individual conditions in these lists may be negated. The attribute PolicyRuleConditionListType specifies which of these two grouping schemes applies to a particular PolicyRule.

Since conditions may be defined explicitly in a subclass of PolicyRule, the AND/OR mechanism to combine these conditions with other (associated) PolicyConditions MUST be specified by the PolicyRule’s subclass.

In either case, the conditions are used to determine whether to perform the actions associated with the PolicyRule.

One or more policy time periods may be among the conditions associated with a policy rule via the ContainedPolicyCondition association. In this case, the time periods are simply additional conditions to be evaluated along with any other conditions specified for the rule.

A different relationship between a policy rule and a policy time period is represented by the PolicyRuleValidityPeriod association: scheduled activation and deactivation of the policy rule. If a policy rule is associated with multiple policy time periods via this association, then the rule is active if at least one of the time periods indicates that it is active. (In other words, the time periods are ORed to determine whether the rule is active.) A policy time period may be aggregated by multiple policy rules. A rule that does not point to a policy time period via this association is, from the point of view of scheduling, always active. It may, however, be inactive for other reasons.

Time periods are a general concept that can be used in other applications. However, they are mentioned explicitly here in this specification since they are frequently used in policy applications.
A policy rule may aggregate zero or more policy actions. For all policy rules, at least one action MUST be specified, either via the ContainedPolicyAction aggregation, or defined explicitly within a subclass of PolicyRule. The actions associated with a PolicyRule may be given a required order, a recommended order, or no order at all. For actions represented as separate objects, the ContainedPolicyAction aggregation can be used to express an order. For actions defined explicitly in a subclass of PolicyRule, the ordering mechanism must be specified in the subclass definition.

4. Inheritance Hierarchy for the LDAP Core Policy Schema

The following diagram illustrates the class hierarchy for the LDAP policy schema classes:

```
  top
   |    +---policyGroup
   |    |    +---policyGroupContainmentAuxClass
   |    |    +---policyRuleContainmentAuxClass
   |    +---policyRule
   |         |    +---policyCondition
   |         |         |    +---policyTimePeriodCondition
   |         |         |    +---vendorPolicyCondition
   |         +---policyAction
   |               +---vendorPolicyAction
```

5. Class Definitions for the LDAP Schema

The classes described below contain certain optimizations for a directory that uses LDAP as its access protocol. One example of this is the use of an auxiliary class to represent CIM relationships. Other data stores might need to implement these relationships differently.

5.1. Naming Attributes in the Core Schema

Instances in a directory are identified by distinguished names (DNs), which provide the same type of hierarchical organization that a file system provides in a computer system. A distinguished name is a sequence of relative distinguished names (RDNs), where an RDN provides a unique identifier for an instance within the context of
its immediate superior, in the same way that a filename provides a
unique identifier for a file within the context of the folder in
which it resides.

To preserve maximum naming flexibility for policy administrators,
each of the classes defined in this schema has its own naming
attribute. Since the naming attributes are different, the policy
administrator can, by using these attributes, guarantee that there
will be no name collisions between instances of different classes,
even if the same VALUE is assigned to the instances’ respective
naming attributes.

To fit in with existing DEN practice, each of the classes also has
the commonName (cn) attribute that can be used for naming its
instances.

5.2. The Class policyGroup

This class is a generalized aggregation container. It enables either
policyRules or policyGroups, but not both, to be aggregated in a
single container. Loops, including the degenerate case of a
policyGroup that contains itself, are not allowed when policyGroups
contain other policyGroups.

PolicyGroups and their nesting capabilities are shown in Figure 2
below. Note that a policyGroup can nest other policyGroups, and there
is no restriction on the depth of the nesting in sibling
policyGroups.

```
+---------------------------------------------------+
|                    policyGroup                    |
|                                                   |
| +--------------------+       +-----------------+  |
| |    policyGroup A   |       |  policyGroup X  |  |
| |                    |       |                 |  |
| | +----------------+ |  ooo  |                 |  |
| | | policyGroup A1 | |       |                 |  |
| | +----------------+ |       |                 |  |
| +--------------------+       +-----------------+  |
+---------------------------------------------------+
```

Figure 2. Overview of the policyGroup class

As a simple example, think of the highest level policyGroup shown in
Figure 2 above as a logon policy for US employees of a company. This
policyGroup may be called USEmployeeLogonPolicy, and may aggregate
several policyGroups that provide specialized rules per location.
Hence, policyGroup A in Figure 2 above may define logon rules for
employees on the West Coast, while another policyGroup might define
logon rules for the Midwest (e.g., policyGroup X), and so forth.
Note also that the depth of each policyGroup does not need to be the same. Thus, the WestCoast policyGroup might have several additional layers of policyGroups defined for any of several reasons (different locales, number of subnets, etc.). The policyRules are therefore contained at n levels from the USEmployeeLogonPolicyGroup. Compare this to the Midwest policyGroup (policyGroup X), which might directly contain policyRules.

The class definition for policyGroup is as follows. Note that this class definition does not include attributes to realize the ContainedPolicyRule and ContainedPolicyGroup associations from the object model, since a policyGroup object points to instances of policyGroup and policyRule via, respectively, the pointer in policyGroupContainmentAuxClass and the pointer in policyRuleContainmentAuxClass.

5.2.1. The attribute cn

The cn, or commonName, attribute is an X.500 attribute. It stands for commonName. It specifies a user-friendly name by which the object is commonly known. This name may be ambiguous by itself. This name is used in a limited scope (such as an organization). It conforms to the naming conventions of the country or culture with which it is associated. CN is used universally in DEN as the naming attribute for a class.

5.2.2. The Attribute policyGroupName

This attribute provides a user-friendly name for a policy group, and is normally what will be displayed to the end-user as the name of this class. It is defined as follows:
5.2.3. The Attribute policyGroupKeywords

This attribute provides a set of one or more keywords that a policy administrator may define to assist directory clients in locating the policy groups applicable to them. Keywords are of one of two types:

- Keywords defined in this document, or in documents that define subclasses of the classes defined in this document. These keywords provide a vendor-independent, installation-independent way of identifying and locating policy groups.

- Installation-dependent keywords for identifying and locating policy groups. Examples include "Engineering", "Billing", and "Review in December 1999".

This document defines the following keywords for identifying policy groups: "UNKNOWN", "CONFIGURATION", "USAGE", "SECURITY", "SERVICE", "MOTIVATIONAL", "INSTALLATION", and "EVENT". These concepts were defined in Section 2.0.

Documents that define subclasses of the Core Schema classes should define additional keywords to identify policy groups associated with instances of these subclasses. By convention, keywords defined in conjunction with class definitions are in uppercase. Installation-defined keywords can be in any case.

The attribute definition is as follows:

NAME policyGroupKeywords
DESCRIPTION A set of keywords to assist directory clients in locating the policy groups applicable to them.
SYNTAX IA5String
OID <to be assigned>
EQUALITY caseExactIA5Match
MULTI-VALUED

5.3. The Class policyGroupContainmentAuxClass

This auxiliary class provides a single, multi-valued attribute that points to a set of policyGroups. By attaching this attribute to instances of various other classes, a policy administrator has a flexible way of providing an entry point into the directory that allows a client to locate and retrieve the policyGroups relevant to it.
As is the case with policyRules, a policy administrator might have several different pointers to a policyGroup in the overall directory structure. The policyGroupContainmentAuxClass is the mechanism that makes it possible for the policy administrator to define all these pointers.

The class definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyGroupContainmentAuxClass</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>An auxiliary class used to bind policyGroups to an appropriate container object.</td>
</tr>
<tr>
<td>DERIVED FROM</td>
<td>top</td>
</tr>
<tr>
<td>TYPE</td>
<td>auxiliary</td>
</tr>
<tr>
<td>AUXILIARY CLASSES</td>
<td>none</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>MUST</td>
<td>policyGroupsAuxContainedSet</td>
</tr>
</tbody>
</table>

5.3.1. The Attribute policyGroupsAuxContainedSet

This attribute provides an unordered set of DN pointers to one or more policyGroups associated with the instance of a structural class to which this attribute has been appended. The attribute definition is:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyGroupsAuxContainedSet</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>Distinguished names of policyGroups associated in some way with the instance to which this attribute has been appended. No order is implied.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>DN</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>distinguishedNameMatch</td>
</tr>
<tr>
<td>MULTI-VALUED</td>
<td></td>
</tr>
</tbody>
</table>

5.4. The Class policyRuleContainmentAuxClass

This auxiliary class provides a single, multi-valued attribute that points to a set of policyRules. By attaching this attribute to instances of various other classes, a policy administrator has a flexible way of providing an entry point into the directory that allows a client to locate and retrieve the policyRules relevant to it.

A policy administrator might have several different pointers to a policyRule in the overall directory structure. For example, there might be pointers to all policyRules for traffic originating in a particular subnet from a directory entry that represents that subnet. At the same time, there might be pointers to all policyRules related to a particular DiffServ setting from an instance of a policyGroup explicitly introduced as a container for DiffServ-related
policyRules. The policyRuleContainmentAuxClass is the mechanism that
makes it possible for the policy administrator to define all these pointers.

Note that the cn attribute does NOT need to be defined for this class. This is because an auxiliary class is used as a means to collect common attributes and treat them as properties of an object. A good analogy is a #include file, except that since an auxiliary class is a class, all the benefits of a class (e.g., inheritance) can be applied to an auxiliary class.

The class definition is as follows:

- **NAME**: policyRuleContainmentAuxClass
- **DESCRIPTION**: An auxiliary class used to bind policyRules to an appropriate container object.
- **DERIVED FROM**: top
- **TYPE**: auxiliary
- **AUXILIARY CLASSES**: none
- **OID**: <to be assigned>
- **MUST**: policyRulesAuxContainedSet

5.4.1. The Attribute policyRulesAuxContainedSet

This attribute provides an unordered set of DN pointers to one or more policyRules associated with the instance of a structural class to which this attribute has been appended. The attribute definition is:

- **NAME**: policyRulesAuxContainedSet
- **DESCRIPTION**: Distinguished names of policyRules associated in some way with the instance to which this attribute has been appended. No order is implied.
- **SYNTAX**: DN
- **OID**: <to be assigned>
- **EQUALITY**: distinguishedNameMatch
- **MULTI-VALUED**: 5.5

5.5. The Class policyRule

This class represents the "If Condition then Action" semantics associated with a policy. A policyRule condition, in the most general sense, is represented as either an ORed set of ANDed conditions (Disjunctive Normal Form, or DNF) or an ANDed set of ORed conditions (Conjunctive Normal Form, or CNF). Individual conditions may either be negated (NOT C) or unnegated (C). The actions specified by a policyRule are to be performed if and only if the policyRule condition (whether it is represented in DNF or CNF) evaluates to TRUE. Both the conditions and the actions are identified by DN pointers and/or by specific attributes introduced in subclasses of policyRule.
As discussed above in section 3, a policy rule may also be associated with one or more policy time periods, indicating the schedule according to which the policy rule is active and inactive.

A policy rule is illustrated conceptually in Figure 3 below.

```
+------------------------------------------------+
|                    policyRule                  |
|                                                |
| +--------------------+     +-----------------+ |
| | policyCondition(s) |     | policyAction(s) | |
| +--------------------+     +-----------------+ |
|                                                |
|        +------------------------------+        |
|        | policyTimePeriodCondition(s) |        |
|        +------------------------------+        |
+------------------------------------------------+
```

Figure 3. Overview of the policyRule Class

The policyRule class uses the attribute policyRuleConditionListType, to indicate whether the conditions for the rule are in DNF or CNF. The DN pointers from a policyRule to its associated policyConditions also contain an integer to partition the referenced conditions into one or more sets, and a plus ('+') or minus ('-') character to indicate whether the referenced condition is negated. An example shows how the attribute, the grouping integer, and the '+' / '-' provide a unique representation of a set of conditions in either DNF or CNF.

Suppose we have pointers to five policyConditions from an instance of policyRule, grouped as follows:

(C1: groupNumber = 1: unnegated,
C2: groupNumber = 1: negated,
C3: groupNumber = 1: unnegated,
C4: groupNumber = 2: unnegated,
C5: groupNumber = 2: unnegated)

If policyRuleConditionListType = DNF, then the overall condition for the policyRule is:

\[(C1 \text{ AND } \neg C2 \text{ AND } C3) \text{ OR } (C4 \text{ AND } C5)\]

On the other hand, if policyRuleConditionListType = CNF, then the overall condition for the policyRule is:

\[(C1 \text{ OR } \neg C2 \text{ OR } C3) \text{ AND } (C4 \text{ OR } C5)\]

In both cases, there is an unambiguous specification of the overall condition that is tested to determine whether to perform the actions associated with the policyRule. This class also contains several
attributes designed to help directory clients locate the policy rules applicable to them. The class definition is as follows:

NAME policyRule
DESCRIPTION The central class for representing the "If Condition then Action" semantics associated with a policy rule.
DERIVED FROM top
TYPE structural
AUXILIARY CLASSES none
POSSIBLE SUPERIORS policyGroup
OID <to be assigned>
MUST cn policyRuleName
MAY policyRuleEnabled policyRuleConditionListType policyRuleConditionList policyRuleActionList policyRuleValidityPeriodList policyRuleKeywords policyRuleUsage policyRulePriority policyRuleMandatory policyRuleSequencedActions

5.5.1. The Attribute cn

This is the exact same definition as in Section 5.2.1. It is included in this class for the reasons enumerated there.

5.5.2. The Attribute policyRuleName

This attribute provides a user-friendly name for a policy rule. The attribute definition is as follows:

NAME policyRuleName
DESCRIPTION The user-friendly name of this policy rule.
SYNTAX IA5String
OID <to be assigned>
EQUALITY caseExactIA5Match
SINGLE-VALUED

5.5.3. The Attribute policyRuleEnabled

This attribute indicates whether a policy rule is currently enabled, from an ADMINISTRATIVE point of view. Its purpose is to allow a policy administrator to enable or disable a policy rule without having to add it to, or remove it from, the directory.

The attribute also supports the value `enabledForDebug' . When the attribute has this value, the Policy Decision Point is being told to evaluate the conditions for the policy rule, but not to perform the actions if the conditions evaluate to TRUE. This value serves as a debug vehicle when attempting to determine what policies would execute in a particular scenario, without taking any actions to change state during the debugging.

The attribute definition is as follows:
NAME             policyRuleEnabled
DESCRIPTION     A flag indicating whether this policy rule is
                enabled from an administrative point of view.
SYNTAX           INTEGER
OID              <to be assigned>
EQUALITY        integerMatch
SINGLE-VALUED    enabled(1)
DEFAULT VALUE   enabled(1)

The defined values for this attribute are enabled(1), disabled(2),
and enabledForDebug(3).

5.5.4. The Attribute policyRuleConditionListType

This attribute is used to specify whether the list of policy
conditions associated with this policy rule is in disjunctive normal
form (DNF) or conjunctive normal form (CNF). If this attribute is
not present, the list type defaults to DNF. The attribute definition
is as follows:

NAME             policyRuleConditionListType
DESCRIPTION     Indicates whether the list of policy conditions
                associated with this policy rule is in disjunctive
                normal form (DNF) or conjunctive normal form
                (CNF). Defined values are 'DNF (1)' and 'CNF
                (2)'.
SYNTAX           INTEGER
OID              <to be assigned>
EQUALITY        integerMatch
SINGLE-VALUED    1 (DNF)
DEFAULT VALUE   1 (DNF)

5.5.5. The Attribute policyRuleConditionList

This attribute provides an unordered list of DN pointers that
identify a set of policy conditions associated with this policy rule.
There is an integer associated with each pointer, to provide the
grouping of the conditions into first-level groups for the DNF or CNF
representation of the overall policyRule condition. In addition,
each pointer has associated with it a plus ('+') or minus ('-') to
indicate whether the condition is negated: the '+' indicates that
the condition is not negated, and the '-' indicates that it is
negated. To accommodate this grouping, the syntax of this attribute
is a string of the form 'groupNumber:+|-:DN'.

Existing matching rules are built to operate on a single data type.
This attribute is conceptually composed of three data types, an
Integer (groupNumber), an enumeration ('+' or '-'), and a
DistinguishedName (DN). There are three ways to address this.
1. Collapse the three attribute types into a single structured DirectoryString with the format ‘groupNumber:+|-:DN’. This approach has the advantage of not requiring any new support in the directory server implementations, since these servers already support a DirectoryString matching rule. Its disadvantage is that a DirectoryString match works somewhat differently from a DN match with respect to subtleties such as preserving versus ignoring versus removing repeated whitespace characters. Thus DNs that would match with the distinguishedNameMatch matching rule might fail to be found as substrings of ‘groupNumber:+|-:DN’ strings by the DirectoryString matching rules, or vice versa.

2. Define a new syntax ‘<integer>:<+|->:<DN>’, with its own matching rules. With this approach, the matching problems introduced by the DirectoryString could be avoided, since the new type would have its own matching rules. The disadvantage of defining a new type in this way is that a directory server must add new code that recognizes the type and implements its matching rules. A directory server would thus be unable to support the Core Policy Schema until it had added this new code.

3. Use three objects in the directory to represent the three data types, and relate the objects with the Families of Entries model currently being discussed in the LDAP Extensions working group. This approach has the same problem as the previous one: without the addition of new code to support Families of Entries, a directory server would be unable to support the Core Policy Schema at all. There is also the additional complication here, that the Families of Entries model itself may take some time to reach approved status in the LDAP Extensions (LDAPEXT) working group.

For now, this document will move forward with the ‘groupNumber:+|-:DN’ structured DirectoryString approach for mapping ContainedPolicyCondition, as well as with an analogous ‘n:DN’ approach for mapping ContainedPolicyAction. To minimize problems arising from differences in matching rules, this document will provide a series of guidelines for constructing DNs that behave identically with respect to the DirectoryString matching rules and the distinguishedNameMatch. These guidelines are in Appendix A. Note that even if the DNs are chosen so that the matching rules behave the same, automatic processes such as "Modify RDN" that count on finding objects with the DistinguishedName syntax will not find attributes with the structured-string syntaxes.

The attribute definition is as follows:

```
NAME             policyRuleConditionList
DESCRIPTION     An unordered list of strings of the form ‘groupNumber:+|-:DN’, indicating a set of policy conditions that determine when the policyRule is applicable.
SYNTAX           DirectoryString
```
5.5.6. The Attribute policyRuleActionList

This attribute provides an unordered list of strings of the form ‘n:DN’ that identify a set of policy actions associated with this policy rule. (See section 5.4.5 for a discussion of the issues surrounding the use of a syntax of this type.) When ‘n’ is a positive integer, it indicates a place in the sequence of actions to be performed, with smaller integers indicating earlier positions in the sequence. The special value ‘0’ indicates "don’t care". If two or more actions have the same non-zero sequence number, they may be performed in any order, but they must all be performed at the appropriate place in the overall action sequence.

A series of examples will make ordering of actions clearer:

- If all actions have the same sequence number, regardless of whether it is ‘0’ or non-zero, any order is acceptable.

- The values
  
  1:DN-A
  2:DN-B
  1:DN-C
  3:DN-D

  indicate two acceptable orders: A, C, B, D or C, A, B, D, since A and C can be performed in either order, but only at the ‘1’ position.

- The values
  
  0:DN-A
  2:DN-B
  3:DN-C
  3:DN-D

  require that B, C, and D occur either as B, C, D or as B, D, C. Action A may appear at any point relative to B, C, and D. Thus the complete set of acceptable orders is: A, B, C, D; B, A, C, D; B, C, A, D; B, C, D, A; A, B, D, C; B, A, D, C; B, D, A, C; B, D, C, A.

  Note that the non-zero sequence numbers need not start with ‘1’, and they need not be consecutive. All that matters is their relative magnitude.

This attribute indicates the actions of a policyRule and their order (or absence of order). However, another attribute,
policyRuleSequencedActions, indicates whether the indicated order is required, recommended, or not to be used at all.

All actions specified in the policyRuleActionList will be executed as long as the overall policy condition as defined by the policyRuleConditionListType and policyRuleConditionList attributes evaluates to TRUE.

The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyRuleActionList</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>An unordered list of strings of the form ‘n:DN’, indicating an ordered set of policy actions to be performed if the associated condition(s) of the policyRule evaluates to true.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>DirectoryString</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>caseIgnoreSubstringsMatch</td>
</tr>
<tr>
<td>MULTI-VALUED</td>
<td>n:DN</td>
</tr>
</tbody>
</table>

5.5.7. The Attribute policyRuleValidityPeriodList

This attribute provides an unordered set of DN pointers to one or more policyTimePeriodConditions, indicating when the policy rule is scheduled to be active and when it is scheduled to be inactive. The rule is scheduled to be active if it is active according to AT LEAST ONE of the policyTimePeriodConditions pointed to by this attribute.

The attribute definition is:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyRuleValidityPeriodList</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>Distinguished names of policyTimePeriodConditions that determine when the policyRule is scheduled to be active / inactive. No order is implied.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>DN</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>distinguishedNameMatch</td>
</tr>
<tr>
<td>MULTI-VALUED</td>
<td></td>
</tr>
</tbody>
</table>

5.5.8. The Attribute policyRuleKeywords

This attribute provides a set of one or more keywords that a policy administrator may define to assist directory clients in locating the policy rules applicable to them. Keywords are of one of two types:

- Keywords defined in this document, or in documents that define subclasses of the classes defined in this document. These keywords provide a vendor-independent, installation-independent way of identifying and locating policy rules.
Installation-dependent keywords for identifying and locating policy rules. Examples include "Engineering", "Billing", and "Review in December 1999".

This document defines the following keywords for identifying policy rules: "UNKNOWN", "CONFIGURATION", "USAGE", "SECURITY", "SERVICE", "MOTIVATIONAL", "INSTALLATION", and "EVENT". These concepts were defined in Section 2.0.

Documents that define subclasses of the Core Schema classes should define additional keywords to identify policy rules associated with instances of these subclasses. By convention, keywords defined in conjunction with class definitions are in uppercase. Installation-defined keywords can be in any case.

The attribute definition is as follows:

```
NAME             policyRuleKeywords
DESCRIPTION     A set of keywords to assist directory clients in locating the policy rules applicable to them.
SYNTAX           IA5String
OID              <to be assigned>
EQUALITY        caseExactIA5Match
MULTI-VALUED

5.5.9. The Attribute policyRuleUsage
```

This attribute is a free-form string that recommends how this policy should be used. The attribute definition is as follows:

```
NAME             policyRuleUsage
DESCRIPTION     This attribute is used to provide guidelines on how this policy should be used.
SYNTAX           DirectoryString
OID              <to be assigned>
EQUALITY        caseIgnoreMatch
SINGLE-VALUED
```

5.5.10. The Attribute policyRulePriority

This attribute provides a non-negative integer for prioritizing policy rules relative to each other. For policy rules that have this attribute, larger integer values indicate higher priority. Since one purpose of this attribute is to allow specific, ad hoc policy rules to temporarily override established policy rules, an instance that has this attribute set has a higher priority than all instances that lack it.

Prioritization among policy rules provides a simple and efficient mechanism for resolving policy conflicts.
The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyRulePriority</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>A non-negative integer for prioritizing this policyRule relative to other policyRules. A larger value indicates a higher priority.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>INTEGER</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>integerMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td>0</td>
</tr>
</tbody>
</table>

5.5.11. The Attribute policyRuleMandatory

This attribute indicates whether evaluation (and possibly action execution) of a policyRule is mandatory or not. Its concept is similar to the ability to mark packets for delivery or possible discard, based on network traffic and device load.

The evaluation of a policyRule MUST be attempted if the policyRuleMandatory attribute value is True. If the policyRuleMandatory attribute value of a policyRule is False, then the evaluation of the rule is "best effort" and MAY be ignored.

The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyRuleMandatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>A flag indicating that the evaluation of the policyConditions and execution of policyActions (if the condition list evaluates to True) is required.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>Boolean</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>booleanMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td>TRUE</td>
</tr>
</tbody>
</table>

5.5.12. The Attribute policyRuleSequencedActions

This attribute gives a policy administrator a way of specifying how the ordering of the policy actions associated with this policyRule is to be interpreted. Three values are supported:

- mandatory (1): Do the actions in the indicated order, or don’t do them at all.
- recommended (2): Do the actions in the indicated order if you can, but if you can’t do them in this order, do them in another order if you can.
- dontCare (3): Do them -- I don’t care about the order.
When error / event reporting is addressed for the Policy Framework, suitable codes will be defined for reporting that a set of actions could not be performed in an order specified as mandatory (and thus were not performed at all), that a set of actions could not be performed in a recommended order (and moreover could not be performed in any order), or that a set of actions could not be performed in a recommended order (but were performed in a different order). The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyRuleSequencedActions</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>An enumeration indicating how to interpret the action ordering indicated via the policyRuleActionList attribute.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>INTEGER</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>integerMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td></td>
</tr>
<tr>
<td>DEFAULT VALUE</td>
<td>3</td>
</tr>
</tbody>
</table>

The defined values for this attribute are mandatory(1), recommended(2), and dontCare(3).

5.6. The Class policyTimePeriodCondition

This class provides a means of representing the time periods during which a policy rule is valid, i.e., active. At all times that fall outside these time periods, the policy rule has no effect. A policy rule is treated as valid at all times if it does not specify a policyTimePeriodCondition.

In some cases a PDP may need to perform certain setup / cleanup actions when a policy rule becomes active / inactive. For example, sessions that were established while a policy rule was active might need to be taken down when the rule becomes inactive. In other cases, however, such sessions might be left up: in this case, the effect of deactivating the policy rule would just be to prevent the establishment of new sessions. Any such setup / cleanup behaviors on validity period transitions must be specified in a subclass of policyRule. If such behaviors need to be under the control of the policy administrator, then a mechanism to allow this control must also be specified in the subclass.

policyTimePeriodCondition is defined as a subclass of policyCondition. This is to allow the inclusion of time-based criteria in the AND/OR condition definitions for a policyRule.

Instances of this class may have up to five attributes identifying time periods at different levels. The values of all the attributes present in an instance are ANDed together to determine the validity period(s) for the instance. For example, an instance with an overall validity range of January 1, 1999 through December 31, 1999; a month mask of "001100000000" (March and April); a day-of-the-week mask of
"0000100" (Fridays); and a time of day range of 0800 through 1600 would represent the following time periods:

- Friday, March 5, 1999, from 0800 through 1600;
- Friday, March 12, 1999, from 0800 through 1600;
- Friday, March 19, 1999, from 0800 through 1600;
- Friday, March 26, 1999, from 0800 through 1600;
- Friday, April 2, 1999, from 0800 through 1600;
- Friday, April 9, 1999, from 0800 through 1600;
- Friday, April 16, 1999, from 0800 through 1600;
- Friday, April 23, 1999, from 0800 through 1600;
- Friday, April 30, 1999, from 0800 through 1600.

Attributes not present in an instance of policyTimePeriodCondition are implicitly treated as having their value "always enabled". Thus, in the example above, the day-of-the-month mask is not present, and so the validity period for the instance implicitly includes a day-of-the-month mask containing 31 1’s. If we apply this "missing attribute" rule to its fullest, we see that there is a second way to indicate that a policy rule is always enabled: have it point to an instance of policyTimePeriodCondition whose only attributes are its naming attributes.

The class definition is as follows. Note that instances of this class are named with the attributes cn and policyConditionName that they inherit from policyCondition.

NAME policyTimePeriodCondition
DESCRIPTION A class that provides the capability of enabling / disabling a policy rule according to a predetermined schedule.
DERIVED FROM policyCondition
TYPE structural
AUXILIARY CLASSES none
POSSIBLE SUPERIORS policyRule
OID <to be assigned>
MUST
MAY ptpConditionTime ptpConditionMonthOfYearMask
ptpConditionDayOfMonthMask
ptpConditionDayOfWeekMask
ptpConditionDayOfWeekMask
ptpConditionTimeZone

5.6.1. The Attribute ptpConditionTime

This attribute identifies an overall range of calendar dates and times over which a policy rule is valid. It is formatted as a string consisting of a start date and time, then a colon (':'), and followed by an end date and time. The first date indicates the beginning of the range, while the second date indicates the end. Thus, the second date and time must be later than the first. Dates are expressed as substrings of the form "yyyymmddhhmmss". For example:
The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>ptpConditionTime</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>The range of calendar dates on which a policy rule is valid.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>PrintableString</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>caseIgnoreMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td></td>
</tr>
<tr>
<td>FORMAT</td>
<td>yyyymmddhhmms:yyymmddhhmms</td>
</tr>
</tbody>
</table>

### 5.6.2. The Attribute ptpConditionMonthOfYearMask

The purpose of this attribute is to refine the definition of the valid time period that is defined by the ptpConditionTime attribute by explicitly specifying which months the policy is valid for. These attributes work together, with the ptpConditionTime used to specify the overall time period that the policy is valid for, and the ptpConditionMonthOfYearMask used to pick out which months of that time period the policy is valid for.

This attribute is formatted as a string containing 12 ASCII ‘0’ s and ‘1’ s, where the ‘1’ s identify the months (beginning with January) in which the policy rule is valid. The value "000010010000", for example, indicates that a policy rule is valid only in the months May and August.

If this attribute is omitted, then the policy assumes that it is valid for all twelve months. The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>ptpConditionMonthOfYearMask</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>A mask identifying the months of the year in which a policy rule is valid.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>Printable String</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>caseIgnoreMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td></td>
</tr>
<tr>
<td>FORMAT</td>
<td>A string of 12 ASCII ‘0’ s and ‘1’ s.</td>
</tr>
</tbody>
</table>

### 5.6.3. The Attribute ptpConditionDayOfMonthMask

The purpose of this attribute is to refine the definition of the valid time period that is defined by the ptpConditionTime attribute by explicitly specifying which days of the month the policy is valid for. These attributes work together, with the ptpConditionTime used to specify the overall time period that the policy is valid for, and the ptpConditionDayOfMonthMask used to pick out which days of the month that time period the policy is valid for.

---

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This attribute is formatted as a string containing 31 ASCII '0's and '1's, where the '1's identify the days of the month (beginning with day 1 and going up through day 31) on which the policy rule is valid. The value "1110000000000000000000000000000", for example, indicates that a policy rule is valid only on the first three days of each month. For months with fewer than 31 days, the digits corresponding to days that the months do not have are ignored. The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>ptpConditionDayOfMonthMask</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>A mask identifying the days of the month on which a policy rule is valid.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>PrintableString</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>caseIgnoreMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td>A string of 31 ASCII '0's and '1's.</td>
</tr>
<tr>
<td>FORMAT</td>
<td></td>
</tr>
</tbody>
</table>

5.6.4. The Attribute ptpConditionDayOfWeekMask

The purpose of this attribute is to refine the definition of the valid time period that is defined by the ptpConditionTime attribute by explicitly specifying which days of the week the policy is valid for. These attributes work together, with the ptpConditionTime used to specify the overall time period that the policy is valid for, and the ptpConditionDayOfWeekMask used to pick out which days of the week of that time period the policy is valid for.

This attribute is formatted as a string containing 7 ASCII '0's and '1's, where the '1's identify the days of the week (beginning with Monday and going up through Sunday) on which the policy rule is valid. The value "1111100", for example, indicates that a policy rule is valid Monday through Friday.

The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>ptpConditionDayOfWeekMask</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>A mask identifying the days of the week on which a policy rule is valid.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>PrintableString</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>caseIgnoreMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td>A string of 7 ASCII '0's and '1's.</td>
</tr>
<tr>
<td>FORMAT</td>
<td></td>
</tr>
</tbody>
</table>

5.6.5. The Attribute ptpConditionTimeOfDayMask

The purpose of this attribute is to refine the definition of the valid time period that is defined by the ptpConditionTime attribute by explicitly specifying a range of times in a day the policy is valid for. These attributes work together, with the ptpConditionTime used to specify the overall time period that the policy is valid for,
and the ptpConditionTimeOfDayMask used to pick out which range of time periods in a given day of the week of that time period the policy is valid for.

This attribute is formatted as a string containing two times, separated by a colon (':'). The first time indicates the beginning of the range, while the second time indicates the end. Times are expressed as substrings of the form "hhmmss".

The second substring always identifies a later time than the first substring. To allow for ranges that span midnight, however, the value of the second string may be smaller than the value of the first substring. Thus, "080000:210000" identifies the range from 0800 until 2100, while "210000:080000" identifies the range from 2100 until 0800 of the following day.

When a range spans midnight, it by definition includes parts of two successive days. When one of these days is also selected by either the ptpConditionMonthOfYearMask, ptpConditionDayOfMonthMask, and/or ptpConditionDayOfWeekMask, but the other day is not, then the policy is active only during the portion of the range that falls on the selected day. For example, if the range extends from 2100 until 0800, and the day of week mask selects Monday and Tuesday, then the policy is active during the following three intervals:

- From midnight Sunday until 0800 Monday;
- From 2100 Monday until 0800 Tuesday;
- From 2100 Tuesday until 21:59:59 Tuesday.

The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>ptpConditionTimeOfDayMask</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>The range of times at which a policy rule is valid. If the second time is earlier than the first, then the interval spans midnight.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>Printable String</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>caseIgnoreMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td></td>
</tr>
<tr>
<td>FORMAT</td>
<td>hhmms:hmmss[:&lt;UTC offset&gt;]</td>
</tr>
</tbody>
</table>

5.6.6. The Attribute ptpConditionTimeZone

This attribute is used to explicitly define a time zone for use by the ptpConditionTime and the various Mask attributes. If this attribute is NULL, then local time (at the location where the policyRule is enforced -- in other words, at the Policy Enforcement Point) is assumed.

This attribute specifies time in UTC, using an offset indicator. The UTC offset indicator is either a 'Z', indicating UTC, or a substring of the following form:
The attribute definition is as follows:

NAME         ptpConditionTimeZone
DESCRIPTION  The definition of the time zone for the policyTimePeriodCondition.
SYNTAX       PrintableString
OID          <to be assigned>
EQUALITY     caseIgnoreMatch
SINGLE-VALUED
FORMAT       either ‘Z’ (UTC) or ‘+’ | ‘-‘‘hhmm’

5.7. The Class policyCondition

The purpose of a policy condition is to determine whether or not the set of actions (contained in the policyRule that the condition applies to) should be executed or not. For the purposes of the Core Policy Framework, all that matters about an individual policyCondition is that it evaluates to TRUE or FALSE. (The individual policyConditions associated with a policyRule are combined to form a compound expression in either DNF or CNF, but this is accomplished via the groupNumber component of the policyRuleConditionList string and by the policyRuleConditionListType attribute, both of which are discussed above.) A logical structure WITHIN an individual policyCondition may also be introduced, but this would have to be done in a subclass of policyCondition.

+---------------------------------------------------------------+
|                    Policy Conditions in DNF                     |
| +-------------------------+         +-----------------------+ |
| |       AND list          |         |      AND list         | |
| |  +-------------------+  |         |  +-----------------+  | |
| |  |  policyCondition  |  |         |  | policyCondition |  | |
| |  +-------------------+  |         |  +-----------------+  | |
| |  +-------------------+  |         |  +-----------------+  | |
| |  |  policyCondition  |  |   ...   |  | policyCondition |  | |
| |  +-------------------+  |   ORed  |  +-----------------+  | |
| |         ANDed           |         |        ANDed          | |
| |  +-------------------+  |         |  +-----------------+  | |
| |  |  policyCondition  |  |         |  | policyCondition |  | |
| |  +-------------------+  |         |  +-----------------+  | |
| |  +-------------------+  |         |  +-----------------+  | |
| +-------------------------+         +-----------------------+ |
+---------------------------------------------------------------+

Figure 4. Overview of Policy Conditions in DNF

This figure illustrates that when policy conditions are in DNF, there are one or more sets of conditions that are ANDed together to form
AND lists. An AND list evaluates to TRUE if and only if all of its constituent conditions evaluate to TRUE. The overall condition then evaluates to TRUE if and only if at least one of its constituent AND lists evaluates to TRUE.

![Diagram of Policy Conditions in CNF](image)

**Figure 5. Overview of Policy Conditions in CNF**

In this figure, the policy conditions are in CNF. Consequently, there are one or more OR lists, each of which evaluates to TRUE if and only if at least one of its constituent conditions evaluates to TRUE. The overall condition then evaluates to TRUE if and only if ALL of its constituent OR lists evaluate to TRUE. The class definition is as follows:

```plaintext
NAME             policyCondition
DESCRIPTION     A class representing a condition to be evaluated in conjunction with a policy rule.
DERIVED FROM    top
TYPE             structural
AUXILIARY CLASSES none
POSSIBLE SUPERIORS policyRule
OID              <to be assigned>
MUST             cn policyConditionName
MAY
```

5.7.1. The Attribute cn

This is the exact same definition as in Section 5.2.1. It is included in this class for the reasons enumerated there.

5.7.2. The Attribute policyConditionName

This attribute provides a user-friendly name for a policy condition. The attribute definition is as follows:
5.8. The Class vendorPolicyCondition

The purpose of this class is to provide a general escape mechanism for representing policy conditions that have not been modeled with specific attributes. Instead, the two attributes vendorPolicyConstraintData and vendorPolicyConstraintEncoding are used to define the content and format of the condition, as explained below.

As its name suggests, this class is intended for vendor-specific extensions to the Core Policy Schema. Standardized extensions are not expected to use this class.

The class definition is as follows:

- NAME: vendorPolicyCondition
- DESCRIPTION: A class that defines a registered means to describe a policy condition.
- DERIVED FROM: policyCondition
- TYPE: structural
- AUXILIARY CLASSES: none
- POSSIBLE SUPERIORS: policyRule
- OID: <to be assigned>
- MUST: vendorPolicyConstraintData
- MAY: vendorPolicyConstraintEncoding

5.8.1. The Attribute vendorPolicyConstraintData

This attribute provides a general escape mechanism for representing policy conditions that have not been modeled with specific attributes. The format of the OctetString is left unspecified in this definition. It is determined by the OID value stored in the attribute vendorPolicyConstraintEncoding. Since vendorPolicyConstraintEncoding is single-valued, all the values of vendorPolicyConstraintData share the same format and semantics.

A policy decision point can readily determine whether it supports the values stored in an instance of vendorPolicyConstraintData by checking the OID value from vendorPolicyConstraintEncoding against the set of OIDs it recognizes. The action for the policy decision point to take in case it does not recognize the format of this data could itself be modeled as a policy rule, governing the behavior of the policy decision point.
The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>vendorPolicyConstraintData</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>Escape mechanism for representing constraints that have not been modeled as specific attributes. The format of the values is identified by the OID stored in the attribute vendorPolicyConstraintEncoding.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>OctetString</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>octetStringMatch</td>
</tr>
<tr>
<td>MULTI-VALUED</td>
<td></td>
</tr>
</tbody>
</table>

5.8.2. The Attribute vendorPolicyConstraintEncoding

This attribute identifies the encoding and semantics of the values of vendorPolicyConstraintData in this instance. The value of this attribute is a single OID.

The attribute definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>vendorPolicyConstraintEncoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>An OID identifying the format and semantics for this instance’s vendorPolicyConstraintData attribute.</td>
</tr>
<tr>
<td>SYNTAX</td>
<td>OID</td>
</tr>
<tr>
<td>OID</td>
<td>&lt;to be assigned&gt;</td>
</tr>
<tr>
<td>EQUALITY</td>
<td>objectIdentifierMatch</td>
</tr>
<tr>
<td>SINGLE-VALUED</td>
<td></td>
</tr>
</tbody>
</table>

5.9. The Class policyAction

The purpose of a policy action is to execute one or more operations that will affect network traffic and/or systems, devices, etc. in order to achieve a desired policy state. This (new) policy state provides one or more (new) behaviors. A policy action ordinarily changes the configuration of one or more elements.

A policyRule contains one or more policy actions. Unlike a condition, however, only one list of policy actions is contained in a policyRule. A policy administrator can assign an order to the actions associated with a policyRule, complete with an indication of whether the indicated order is mandatory, recommended, or of no significance.

The actions associated with a policyRule are executed if and only if the overall condition(s) of the policyRule evaluates to TRUE.

The class definition is as follows:

<table>
<thead>
<tr>
<th>NAME</th>
<th>policyAction</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>A class representing an action to be performed as a result of a policy rule.</td>
</tr>
</tbody>
</table>
5.9.1. The Attribute cn

This is the exact same definition as in Section 5.2.1. It is included in this class for the reasons enumerated there.

5.9.2. The Attribute policyActionName

This attribute provides a user-friendly name for a policy action.

The attribute definition is as follows:

NAME             policyActionName
DESCRIPTION     The user-friendly name of this policy action.
SYNTAX           IA5String
OID              <to be assigned>
EQUALITY        caseExactIA5Match
SINGLE-VALUED

5.10. The Class vendorPolicyAction

The purpose of this class is to provide a general escape mechanism for representing policy actions that have not been modeled with specific attributes. Instead, the two attributes vendorPolicyActionData and vendorPolicyActionEncoding are used to define the content and format of the condition, as explained below.

As its name suggests, this class is intended for vendor-specific extensions to the Core Policy Schema. Standardized extensions are not expected to use this class.

The class definition is as follows:

NAME             vendorPolicyAction
DESCRIPTION     A class that defines a registered means to describe a policy action.
DERIVED FROM    policyAction
TYPE             structural
AUXILIARY CLASSES none
POSSIBLE SUPERIORS policyRule
OID              <to be assigned>
MUST             vendorPolicyActionData vendorPolicyActionEncoding
MAY
5.10.1. The Attribute vendorPolicyActionData

This attribute provides a general escape mechanism for representing policy actions that have not been modeled with specific attributes. The format of the OctetString is left unspecified in this definition. It is determined by the OID value stored in the attribute vendorPolicyActionEncoding. Since vendorPolicyActionEncoding is single-valued, all the values of vendorPolicyActionData share the same format and semantics.

A policy decision point can readily determine whether it supports the values stored in an instance of vendorPolicyActionData, by checking the OID value from vendorPolicyActionEncoding against the set of OIDs it recognizes. The action for the policy decision point to take in case it does not recognize the format of this data could itself be modeled as a policy rule, governing the behavior of the policy decision point.

The attribute definition is as follows:

| NAME             | vendorPolicyActionData
| DESCRIPTION     | Escape mechanism for representing actions that have not been modeled as specific attributes. The format of the values is identified by the OID stored in the attribute vendorPolicyActionEncoding.
| SYNTAX           | OctetString
| OID              | <to be assigned>
| EQUALITY        | octetStringMatch
| MULTI-VALUED    | 

5.10.2. The Attribute vendorPolicyActionEncoding

This attribute identifies the encoding and semantics of the values of vendorPolicyActionData in this instance. The value of this attribute is a single OID.

The attribute definition is as follows:

| NAME             | vendorPolicyActionEncoding
| DESCRIPTION     | An OID identifying the format and semantics for this instance’s vendorPolicyActionData attribute.
| SYNTAX           | OID
| OID              | <to be assigned>
| EQUALITY        | objectIdentifierMatch
| SINGLE-VALUED    | 


<<text to be added>>
7. Extending the Core Schema

There are three fundamental ways to extend the core schema. These are detailed in sections 7.1 through 7.3 below. A guideline for using the `policyTimePeriodCondition` class is discussed in Section 7.4. Each of these methods may be used separately or in conjunction with other methods.

7.1. Subclassing `policyCondition` and `policyAction`

The simplest way of extending the core schema is to use `policyGroup`, `policyRule`, and `policyTimePeriodCondition` as they are, and simply subclass `policyCondition` and `policyAction`. An instance of `policyRule` ties everything together, with its very simple, invariant semantics:

If the `policyRule` is active, then evaluate the conditions pointed to by `policyRuleConditionList`, in the manner specified by `policyRuleConditionListType`. If the result of this evaluation is TRUE, then perform, possibly in a specified order, all the actions pointed to by `policyRuleActionList`.

With this approach a new schema specifies the conditions it needs in subclasses of `policyCondition` (or, better still, reuses conditions that have already been specified in subclasses of `policyCondition`), and it specifies (or reuses) the actions it needs in subclasses of `policyAction`.

`policyRules` are used to aggregate policy conditions and actions, and `policyGroups` are used to aggregate `policyRules`. The `policyGroupContainmentAuxClass`, `policyRuleContainmentAuxClass`, and `policyTimePeriodCondition` classes can still be used as previously described. Note that the subclassing of `policyCondition` and `policyAction` can also be used in combination with the other methods (discussed below) to extend the schema.

7.2. Subclassing `policyRule`

There are two possible ways to subclass `policyRule`, as described below.

7.2.1. Refining the semantics of `policyRule`

This approach refines the structural and possibly behavioral semantics of what it means to be a policy rule. For example, additional attributes and relationships could be defined in a subclass of `policyRule`. These attributes and relationships could provide extra meaning for how to interpret the set of conditions and actions that a `policyRule` aggregates.

This method can be used in a stand-alone fashion by keeping the semantics of `policyCondition` and `policyAction` as specified and adding semantics to `policyRule`. These `policyRule` semantics can explicitly
specify policyConditions and/or policyActions, or dictate how policyConditions and policyActions are used and interpreted. Finally, these methods can be used with the other methods discussed in this subsection to extend the schema.

7.2.2. Optimizing the computation of a policyRule

All preceding mechanisms for extending the core schema will work in all cases, but they come at a price: in order to fully understand a policy rule, a client must retrieve at least three objects: a policy rule, at least one policy condition, and at least one policy action. A future version of this specification may define how to optimize the evaluation of a policy rule so as to reduce the number of classes that must be instantiated to define a policy.

7.3. Using the Vendor Policy Encoding Attributes

As discussed in 5.8, "The Class vendorPolicyCondition", the attributes vendorPolicyConstraintData and vendorPolicyConstraintEncoding are included in the vendorPolicyCondition to provide an escape mechanism for representing "exceptional" policy conditions. The attributes vendorPolicyActionData and vendorPolicyActionEncoding of the vendorPolicyAction class play the same role with respect to actions. This enables interoperability between different vendors.

For example, imagine a network composed of access devices from vendor A, edge and core devices from vendor B, and a policy server from vendor C. It is desirable for the policy server to be able to configure and manage all of the devices from vendors A and B. Unfortunately, these devices will in general have little in common (e.g., different mechanisms, different ways for controlling those mechanisms, different operating systems, different commands, and so forth). The escape conditions provide a way for vendor-specific commands to be encoded as OctetStrings so that devices from different vendors can be commonly managed by a single policy server.

7.4. Using Time Validity Periods

Time validity periods are defined as a subclass of policyCondition, called policyTimePeriodCondition. This is to allow their inclusion in the AND/OR condition definitions for a policyRule. Care should be taken not to subclass policyTimePeriodCondition to add domain-specific condition properties. For example, it would be incorrect to add IPSec- or QoS-specific condition properties to the policyTimePeriodCondition class, just because IPSec or QoS includes time in its condition definition. The correct subclassing would be to create IPSec or QoS-specific subclasses of policyCondition and then combine instances of these domain-specific condition classes with the validity period criteria. This is accomplished using the AND/OR aggregation capabilities for policyConditions in policyRules.
8. Security Considerations

Security and denial of service considerations are not explicitly considered in this memo, as they are appropriate for the underlying policy architecture. However, the policy architecture must be secure as far as the following aspects are concerned. First, the mechanisms proposed under the framework must minimize theft and denial of service threats. Second, it must be ensured that the entities (such as PEPs and PDPs) involved in policy control can verify each other’s identity and establish necessary trust before communicating. The schema defined in this document MUST not compromise either of these goals.

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10. Acknowledgments

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11. References


12. Authors’ Addresses

John Strassner
Cisco Systems, Bldg 1
170 West Tasman Drive
San Jose, CA 95134
Phone: +1 408-527-1069
Fax: +1 408-527-1722
E-mail: johns@cisco.com

Ed Ellesson
IBM Corporation, JDGA/501
4205 S. Miami Blvd.
Research Triangle Park, NC 27709
Phone: +1 919-254-4115
Fax: +1 919-254-6243
E-mail: ellesson@raleigh.ibm.com
Bob Moore  
IBM Corporation, BRQA/502  
4205 S. Miami Blvd.  
Research Triangle Park, NC 27709  
Phone: +1 919-254-4436  
Fax: +1 919-254-6243  
E-mail: remoore@us.ibm.com

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14. Appendix A - Guidelines for Construction of DNs

To Be Provided