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Policy-Based Management Framework for the Simplified Use of Policy Abstractions (SUPA)

Abstract

The Simplified Use of Policy Abstractions (SUPA) policy-based management framework defines base YANG data models to encode policy. These models point to device-, technology-, and service-specific YANG data models developed elsewhere. Policy rules within an operator's environment can be used to express high-level, possibly network-wide, policies to a network management function (within a controller, an orchestrator, or a network element). The network management function can then control the configuration and/or monitoring of network elements and services. This document describes the SUPA basic framework, its elements, and interfaces.

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1. Introduction

Traffic flows over increasingly complex enterprise and service provider networks are becoming more and more important. Meanwhile, the rapid growth of this variety makes the task of network operations and management applications deploying new services much more difficult. Moreover, network operators want to deploy new services quickly and efficiently. Two possible mechanisms for dealing with this growing difficulty are 1) the use of software abstractions to simplify the design and configuration of monitoring and control operations and 2) the use of programmatic control over the configuration and operation of such networks. Policy-based management can be used to combine these two mechanisms into an extensible framework.

There is a set of policy rules within an operator's environment that defines how services are designed, delivered, and operated.

The SUPA (Simplified Use of Policy Abstractions) data model represents a high-level, possibly network-wide policy, which can be input to a network management function (within a controller, an orchestrator, or a network element). The network management function can then control the configuration and/or monitoring of network elements and services according to such policies.

SUPA defines a Generic Policy Information Model (GPIM) [SUPA-INFO] for use in network operations and management applications. The GPIM defines concepts and terminology needed by policy management independent of the form and content of the policy rule. The Event-Condition-Action (ECA) Policy Rule Information Model (EPRIM) [SUPA-INFO] extends the GPIM by defining how to build policy rules according to the ECA paradigm.

Both the GPIM and the EPRIM are targeted at controlling the configuration and monitoring of network elements throughout the service development and deployment life cycle. The GPIM and the EPRIM can both be translated into corresponding YANG [RFC6020] [RFC7950] modules that define policy concepts, terminology, and rules in a generic and interoperable manner; additional YANG modules may also be derived from the GPIM and/or EPRIM to manage specific functions.

The key benefit of policy management is that it enables different network elements and services to be instructed to behave the same way, even if they are programmed differently. Management applications will benefit from using policy rules that enable scalable and consistent programmatic control over the configuration and monitoring of network elements and services.

Some typical and useful instances for authors to understand the applicability of SUPA, such as SNMP blocking upon load of link reaching a threshold and virtual matching migration upon the changing of user location, are described in [SUPA-APP].

2. Terminology

2.1. Requirements Language

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

2.2. Abbreviations and Definitions

SUPA: The Simplified Use of Policy Abstractions is a policy-based management framework that defines a data model to be used to represent high-level, possibly network-wide policies. This data model can be input to a network management function (within a controller, an orchestrator, or a network element).

YANG: An acronym for "Yet Another Next Generation". YANG is a data modeling language used to model configuration and state data manipulated by the Network Configuration Protocol (NETCONF), NETCONF remote procedure calls, and NETCONF notifications [RFC6020]

ECA: Event-Condition-Action is a shortcut for referring to the structure of active rules in event-driven architecture and active database systems.

EMS: An Element Management System is software used to monitor and control network elements (devices) in telecommunications.

NMS: A Network Management System is a set of hardware and/or software tools that allow an IT professional to supervise the individual components of a network within a larger network management framework.

OSS: An Operations/Operational Support System is a computer system used by telecommunications service providers to manage their networks (e.g., telephone networks).

BSS: A Business Support System is used to support various end-to-end telecommunication services.

GPIM: A Generic Policy Information Model defines concepts and terminology needed by policy management independent of the form and content of the policy rule.

EPRIM: An ECA Policy Rule Information Model extends the GPIM by defining how to build policy rules according to the ECA paradigm.

GPDM: Generic Policy Data Models [SUPA-DATA] are created from the GPIM. These YANG data model policies are used to control the configuration of network elements that model the service(s) to be managed. The relationship between the information model (IM) and data model (DM) can be founded in [RFC3444].

Declarative Policy: Policies that specify the goals to be achieved but not how to achieve those goals (also called "intent-based" policies). Please note that declarative policies are out of scope for the initial phase of SUPA.

3. Framework for Generic Policy-Based Management

This section briefly describes the design and operation of the SUPA policy-based management framework.

3.1. Overview

Figure 1 shows a simplified functional architecture of how SUPA is used to define policies for creating snippets of network element configurations. SUPA uses the GPIM to define a consensual vocabulary that different actors can use to interact with network elements and services. The EPRIM defines a generic structure for imperative policies. The GPIM, and/or the combination of the GPIM and the EPRIM, is converted to generic YANG modules.

In one possible approach (shown with asterisks in Figure 1), SUPA Generic Policy and SUPA ECA Policy YANG modules together with the Resource and Service YANG data models specified in the IETF (which define the specific elements that will be controlled by policies) are used by the Service Interface Logic. This Service Interface Logic creates appropriate input mechanisms for the operator to define policies (e.g., a web form or a script) for creating and managing the network configuration. The operator interacts with the interface, and the policies input by operators are then translated into configuration snippets.

Note that the Resource and Service YANG data models may not exist. In this case, the SUPA generic policy YANG modules serve as an extensible basis to develop new YANG data models for the Service Interface Logic. This transfers the work specified by the Resource

and Service YANG data models specified in the IETF into the Service Interface Logic.

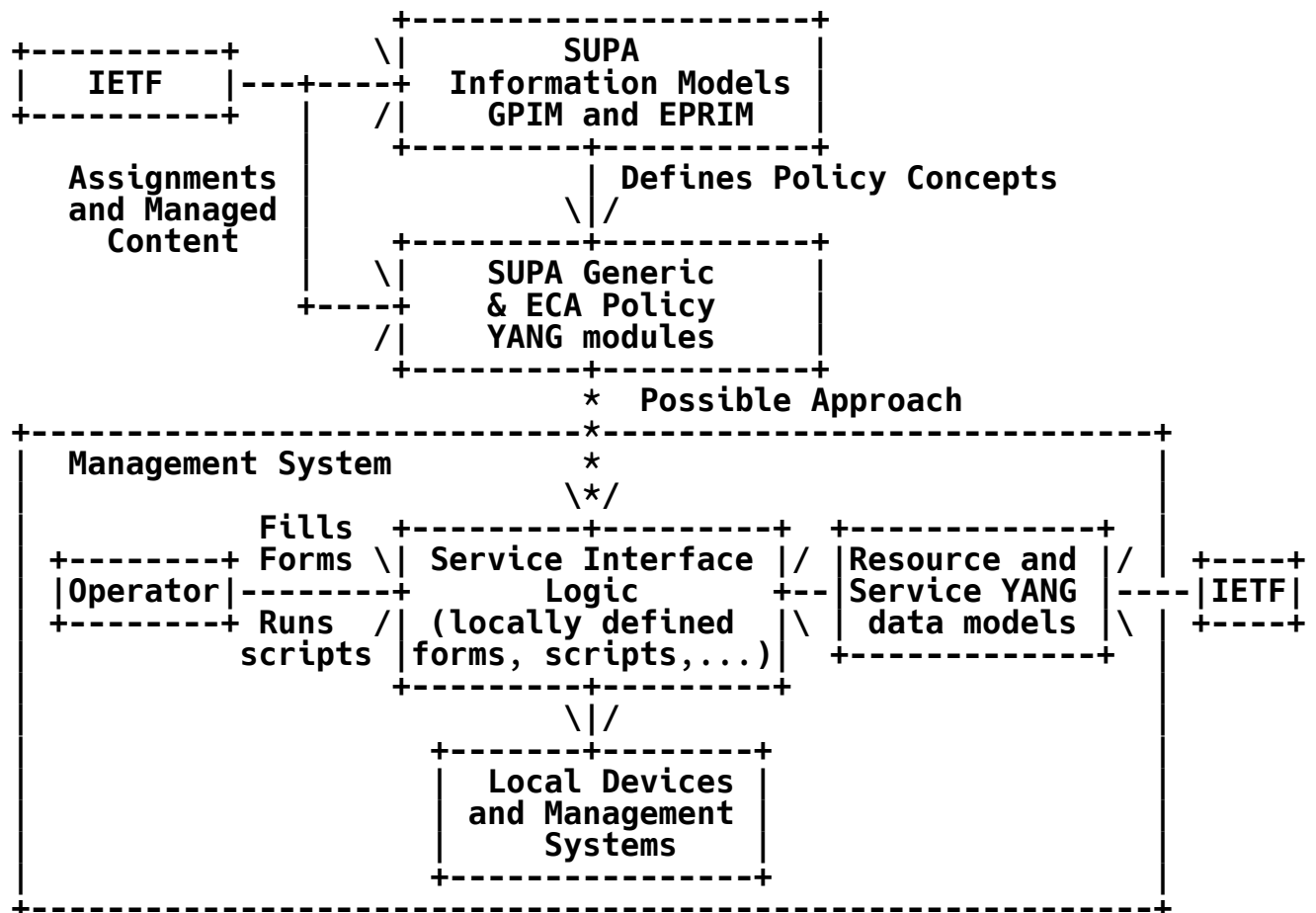


Figure 1: SUPA Framework

Figure 1 shows the SUPA Framework at a high level of abstraction. The operator actor can interact with SUPA in other ways not shown in Figure 1. In addition, other actors (e.g., an application developer) that can interact with SUPA are not shown for simplicity.

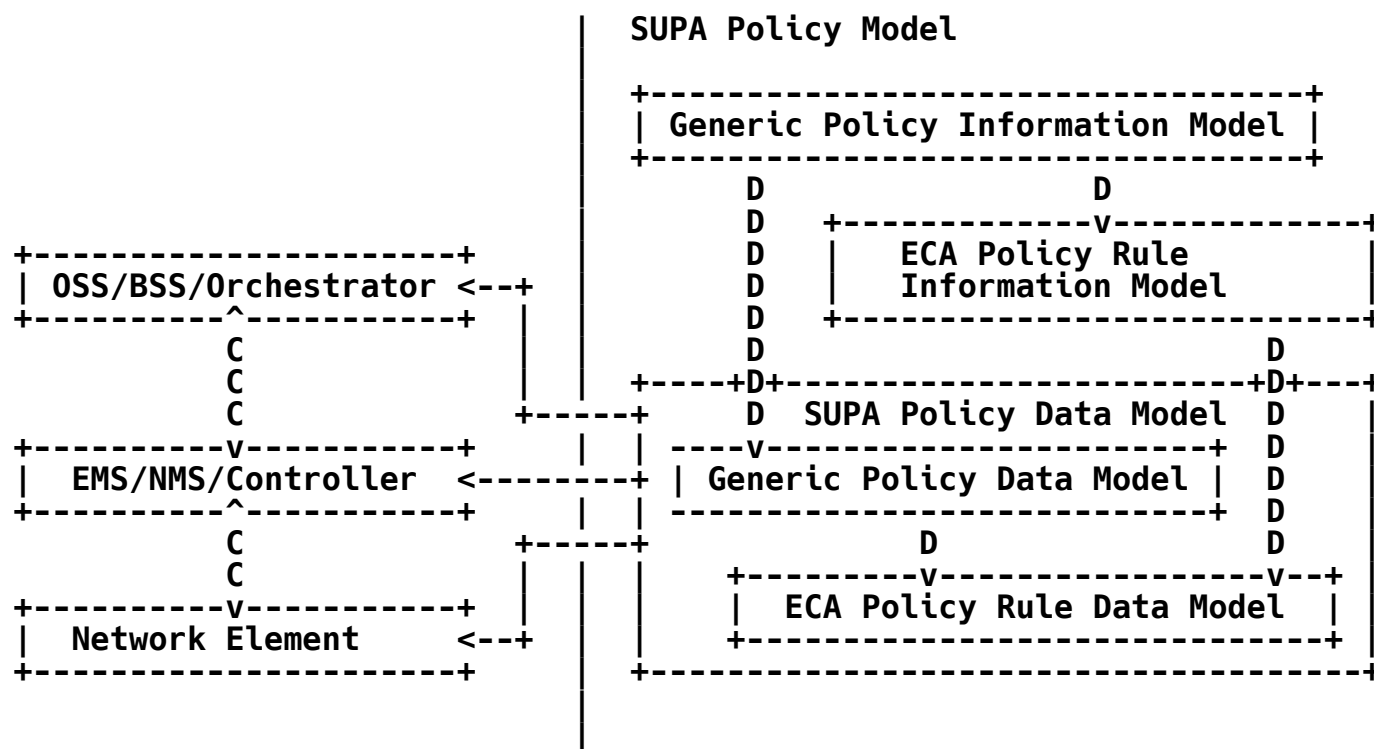
The EPRIM defines an ECA policy as an example of imperative policies. An ECA policy rule is activated when its event clause is true; the condition clause is then evaluated and, if true, signals the execution of one or more actions in the action clause. This type of policy explicitly defines the current and desired states of the system being managed. Imperative policy rules require additional management functions, which are explained in Section 3.2.

Figure 2 shows how the SUPA Policy Model is used to create policy data models step-by-step and how the policy rules are used to communicate among various network management functions located on different layers.

The GPIM is used to construct policies. The GPIM defines generic policy concepts as well as two types of policies: ECA policy rules and declarative policy statements.

A set of Generic Policy Data Models (GPDM) are then created from the GPIM. These YANG data model policies are then used to control the configuration of network elements that model the service(s) to be managed.

Resource and Service YANG Data Models: Models of the service as well as physical and virtual network topology including the resource attributes (e.g., data rate or latency of links) and operational parameters needed to support service deployment over the network topology.



Legend:

The double-headed arrow with Cs = "communication"

The arrow with Ds = "derived from"

Figure 2: SUPA Policy Model Framework

SUPA Policy Model: This model represents one or more policy modules that contain the following entities:

Generic Policy Information Model: A model for defining policy rules that are independent of data repository, data definition, query, implementation language, and protocol. This model is abstract and is used for design; it **MUST** be turned into a data model for implementation.

Generic Policy Data Model: A model of policy rules that are dependent on data repository, data definition, query, implementation language, and protocol.

ECA Policy Rule Information Model (EPRIM): This model represents a policy rule as a statement that consists of an event clause, a condition clause, and an action clause. This type of policy rule explicitly defines the current and desired states of the system being managed. This model is abstract and is used for design; it **MUST** be turned into a data model for implementation.

ECA Policy Rule Data Model: A model of policy rules, derived from EPRIM, where each policy rule consists of an event clause, a condition clause, and an action clause.

EMS/NMS/Controller: This represents one or more entities that are able to control the operation and management of a network infrastructure (e.g., a network topology that consists of network elements).

Network Element (NE): An element that can interact with the local or remote EMS/NMS/Controller in order to exchange information, such as configuration information, policy-enforcement capabilities, and network status.

Relationships among Policy, Service, and Resource models are illustrated in Figure 3.

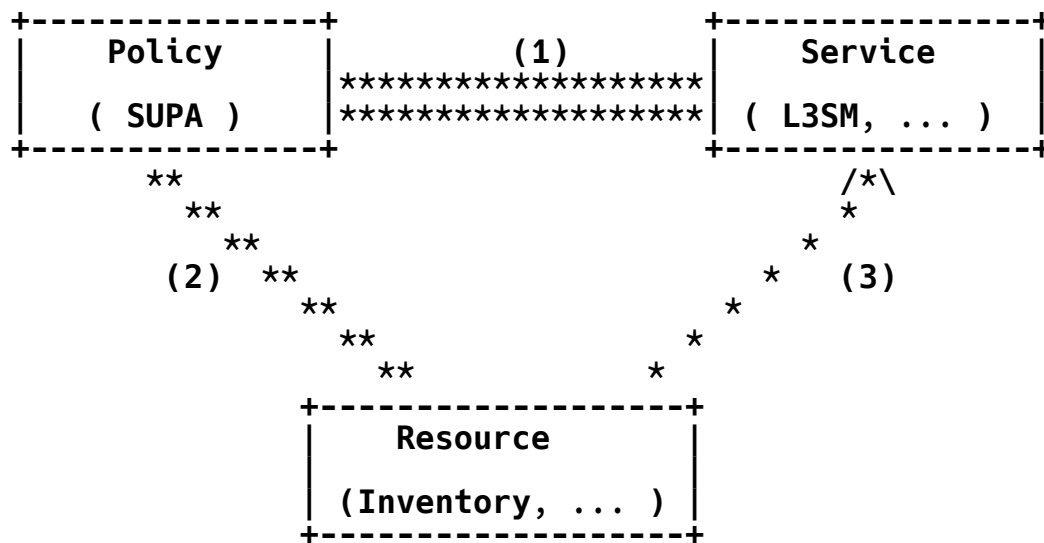


Figure 3: Relationship among Policy, Service, and Resource Models

In Figure 3:

- (1) The policy manages and can adjust service behavior as necessary (1:1..n). In addition, data from resources and services are used to select and/or modify policies during runtime.
- (2) The policy manages and can adjust resource behavior as necessary (1:1..n).
- (3) Resource hosts service; changing resources may change service behavior as necessary.

Policies are used to control the management of resources and services, while data from resources and services are used to select and/or modify policies during runtime. More importantly, policies can be used to manage how resources are allocated and assigned to services. This enables a single policy to manage one or multiple services and resources as well as their dependencies. The use of (1:1..n) in point (1) and (2) above show that one policy rule is able to manage and can adjust one or multiple services/resources. Lines (1) and (2) (connecting policy to resource and policy to service) are the same, and line (3) (connecting resource to service) is different as it's navigable only from resource to service.

3.2. Operation

SUPA can be used to define various types of policies, including policies that affect services and/or the configuration of individual network elements or groups of network elements. SUPA can be used by a centralized and/or distributed set of entities for creating, managing, interacting with, and retiring policy rules.

The SUPA scope is limited to policy information and data models. SUPA does not define network resource data models or network service data models; both are out of scope. Instead, SUPA makes use of network resource data models defined by other working groups or Standards Development Organizations (SDOs).

Declarative policies are out of scope for the initial phase of SUPA.

3.3. The GPIM and the EPRIM

The GPIM provides a shared vocabulary for representing concepts that are common to different types of policies, but which are independent of language, protocol, repository, and level of abstraction. Hence, the GPIM defines concepts and vocabulary needed by policy management systems independent of the form and content of the policy. The EPRIM is a more specific model that refines the GPIM to specify policy rules in an ECA form.

This enables different policies at different levels of abstraction to form a continuum, where more abstract policies can be translated into more concrete policies and vice versa. For example, the information model can be extended by generalizing concepts from an existing data model into the GPIM; the GPIM extensions can then be used by other data models.

3.4. Creation of Generic YANG Modules

An information model is abstract. As such, it cannot be directly instantiated (i.e., objects cannot be created directly from it). Therefore, both the GPIM and the combination of the GPIM and the EPRIM are translated into generic YANG modules.

SUPA will provide guidelines for translating the GPIM (or the combination of the GPIM and the EPRIM) into concrete YANG data models that define how to manage and communicate policies between systems. Multiple imperative policy YANG data models may be instantiated from the GPIM (or the combination of the GPIM and the EPRIM). In particular, SUPA will specify a set of YANG data models that will consist of a base policy model for representing policy management concepts independent of the type or structure of a policy; it will

also specify an extension for defining policy rules according to the ECA paradigm. (Note: This means that policies can be defined using the GPIM directly, or using the combination of the GPIM and the EPRIM. If you use only the GPIM, you get a technology- and vendor-independent information model that you are free to map to the data model of your choice; note that the structure of a policy is NOT defined. If you use the GPIM and the EPRIM, you get a technology- and vendor-independent information model that defines policies as an ECA policy rule (i.e., imperative).)

The process of developing the GPIM, the EPRIM, and the derived/translated YANG data models is realized following the sequence shown below. After completing this process and, if the implementation of the YANG data models requires it, the GPIM and EPRIM and the derived/translated YANG data models are updated and synchronized.

$(1) \Rightarrow (2) \Rightarrow (3) \Rightarrow (4) \Rightarrow (3') \Rightarrow (2') \Rightarrow (1')$

Where:

(1)=GPIM

(2)=EPRIM

(3)=YANG data models

(4)=Implementation

(3')=update of YANG data models

(2')=update of EPRIM

(1')=update of GPIM

The YANG module derived from the GPIM contains concepts and terminology for the common operation and administration of policy-based systems as well as an extensible structure for policy rules of different paradigms. The YANG module derived from the EPRIM extends the generic nature of the GPIM by representing policies using an ECA structure.

The above sequence allows for the addition of new model elements, as well as the editing of existing ones, in the GPIM and EPRIM. In practice, the implementation sequence may be much simpler. Specifically, it is unlikely that the GPIM will need to be changed. In addition, changes to the EPRIM will likely be focused on fine-tuning the behavior offered by a specific set of model elements.

4. Security Considerations

This informational document presents the framework and workflow of SUPA as well as an explanation on the relationship of policy, service and resources. This document does not introduce any new security issues, and the framework has no security impact on the Internet. The same considerations are relevant as those for the base NETCONF protocol (see Section 9 in [RFC6241]).

5. IANA Considerations

This document has no IANA actions.

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