Integrating Goal Specification in Policy-based Management

Mark Bearden
Sachin Garg
Avaya Labs Research
Basking Ridge, New Jersey USA

Woei-Jyh Lee
University of Maryland
College Park, Maryland USA
Overview

• **Motivation**
  – Specify Policy Goals
  – Relate Policy Rules to Policy Goals
• (Review) **IETF/DMTF Policy Rules Model**
• **A Schema for Policy Goals**
  – Core Schema
  – Schema Extensions
• **Application to Rules/Goals Integration**
• **Summary & Open Issues**
Introduction

• Problem Addressed:
  – Specifying Goals for Policy-based Management

• Terminology:
  – Consistent with latest IETF and DMTF standards work
  – Policy Goal
    • High-level, business-related objectives
    • a.k.a. “Service Level Objective” (SLO) in an SLA
    • Measurable characteristic; satisfied or not satisfied
  – Policy Rule
    • if CONDITION(s) then ACTION(s)
    • (One form of) Lower-level policy
  – Policy
    • Defined by goals and/or rules
Specifying Goals

- **Motivation:**
  - **Want to specify policy from *end-user view of apps/network***
    - Current rule-based tools capture *sys-admin view*
    - From end-user viewpoint, goals say *what* to do, rules say *how*
    - Fill “perspective gap” between user sys-admin views
    - Policy spec directly comparable to measurements
    - Determine if goals are *satisfied* or *not satisfied*
  
  - **Growing importance of SLA’s**
    - In ASP market, “SLA’s with teeth” will differentiate
    - Billing for QoS, using billing to automate QoS management
  
  - **Policy-enabled architecture that relates “high-level” policy (goal) and “low-level” (e.g., rule)**
    - Rules cause goals to be (or not to be) satisfied
Policy: Goals and Rules

• Goals
  – Intuitive, propositional, measurable
  – Easier for users (or their human agents) to express and prioritize
    • Sys admin setting policy for users
    • IT staff negotiating SLA with an ASP
  – Examples:
    • (Layer 7) Jack, a call center agent, needs customer data to load within 2 seconds (99% of the time)
    • (Layer 4) Stephan needs throughput, on demand, of up to 20 KB/s

• Rules
  – Conditions: identify network traffic flows/PDU’s
  – Actions: Traffic control
    • PDU/Flow Queueing Priority/Scheduling
    • PDU Dropping, Flow Admission Control
    • Route Selection or Redirection
Translating from Goals to Rules

- **Sample (application level) Goal**
  - Jack, a call center agent, needs customer data to load within 2 seconds (99% of the time)

- **System Administrator derives if/then policy rules:**
  - Jack has IP address J.J.J.J
  - Call center app has address/port C.C.C.C:8080
  - Generate rules such as:
    - if (source/dest = J.J.J.J/C.C.C.C:80) then set DiffservCP=3
    - if (source = J.J.J.J) then set CallCenterQueuePriority = 2
  - Rules communicated to Policy Enforcement Points (PEP’s), e.g. routers, switches, gateways, firewalls, load balancers, application servers...

- **How does sys admin know what rules to specify...?**
IETF/DMTF Policy Core Info Model

Policy Rule:
- Set of Conditions, DNF/CNF w/negation
- Set of Actions
- Time Period Condition

Semantics: \( \text{If} \ <\text{PolicyCondition(s)} \ \text{TRUE}> \ \text{Then Do} \ <\text{PolicyAction(s)}> \)
Policy Group:
- Set of Rules
- Other (Contained) Groups
What about “High Level” Rules?

• Consider a “goal” like this?
  – if Client=Jack and Application=CallCenter then 99%Delay < 2s

• Disadvantages:
  – “Delay < 2s” not an action, looks more like a condition
  – Want satisfied or not-satisfied for some point(s) in time
    • What does it mean for “if A then B” to be false?
  – Intuitively, if/then rule has procedural sense (“how”)
    • Condition must be evaluated at some point in time (on event)
    • Explicit in recently proposed PCIM extensions (Brunner/Quittek)
    • Condition true/false at that time…action is “taken/not-taken”?
  – What we want to express is true/false proposition:
    • for Client=Jack using Application=CallCenter,
      it is the case that 99%Delay < 2s
Goal Expression:
- Left and Right hand parts
- Operator
- Either satisfied or not-satisfied

Example: 99%CCLoadDelay < 2 seconds
Simple Goal:
• Goal Expression
• Goal Domain = Set of Targets
• Either satisfied or not-satisfied w.r.t. Targets in Domain

Example:  99% CCLoadDelay < 2 sec for Jack using CallCenter

\[
\begin{align*}
\text{LH} & \quad \text{operator} \quad \text{RH} \\
\text{Target}_1 & \quad \text{Goal Expression} & \quad \text{Goal Domain} & \quad \text{Target}_2
\end{align*}
\]
Policy Goals *Core Info Model*

**Policy Goal:**
- Set of Simple Goals
- Time Period Condition
- DNF/CNF w/negation
“Horizontal” Extension of Core Model

Policy Group (redefined):
- Set of Rules
- Set of Goals
- Other (Contained) Groups
- GroupSemantics flag for PolicyGroup indicates relationship between Rules/Goals
Relationship Between Rules and Goals

• Possible GroupSemantics values:
  – Case 1:
    • Goals given by policy administrator
    • Rules selected (“minimal” set) to satisfy goals
    • Example: Expert system derives/modifies rules over time
  – Case 2:
    • Rules given by policy administrator
    • Goals selected to be (performance “maximal”) set satisfied by rules
    • Example: Benchmark goals for a system by first enforcing “good” set of rules, then deriving goals from service level measurements
  – Case 3:
    • Both goals and rules given by administrator
    • Example: Administrator intuitively derives both rules and goals
Core Goals Schema Refinements

- Approach similar to IETF Policy WG
  - Possible Refinement: **Application-Level QoS Goals**

Example: 99% CCLoadDelay < 2 sec for Jack using CallCenter (at Server C)
Core Goals Schema Refinements

• Approach similar to IETF Policy WG
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Example: 99%CCLoadDelay < 2 sec for Jack using CallCenter (at Server C)
Core Goals Schema Refinements

- **Network-Level QoS Goals**
  - Example: \( \text{NIC\_Throughput} = 20 \text{ KB/s} \) for Stephan accessing ANY host

- **Resource Utilization Goals**
  - Example: \( \text{CPU\_Load} < 50\% \) for HTTPserver on host Samson
  - Note that no client or network is specified

- **Access Permission Goals**
  - Example: Stephan should have no access to application CallCenter
  - Note difference in goal and rule
    - Rule: if (client=Stephan) AND (app=CallCenter) then DENY
    - Is it meaningful for goal to be not-satisfied even in presence of rule?
    - Yes...For instance, rule isn’t properly applied and Stephan is detected to actually access the application
    - With Goals and Rules, can express both concepts in same framework
A Few Observations

• **Core Schema + Extensions seems to work here**

• **Integration of Goals/Rules Enables Rule Provisioning**
  - Benchmark: Try set of rules, measure system, define goals by measurements
  - Tune rules: Compare goals to measured service level, use this info to modify rules (cf. feedback loop using fuzzy logic)

• **Goal to Rule Mapping**
  - Requires mapping of high-level and network-level user and application
    - User --> net Address(es)
    - Application --> net Address(es), Port(s)
  - Is very hard in principle (obviously)
    - One rule may help satisfy multiple goals
    - A goal might be satisfied by any of several rules
    - Goal conflicts may be harder to “see” than rule conflicts
"Closed Loop" Management Server Prototype

Goals/Rules Database

Policy Goals

Adapter

Service/Network QoS Measurements

Enforcement Logic

Policy Rules

Adapter

SQL

LDAP

Lucent’s VitalSuite Server

Cajun Rules Policy Server

CLI, Telnet, SNMP, LDAP

VitalSuite™ Administrative Console

Cajun Rules™ Administrative Console

(Prototype) App-Level QoS Goal Console

January 2001
Administrative Interface

“Real-time” feedback:
- White: Satisfied
- Red: Not Satisfied
Summary and Open Issues

• **Use of two levels of policy specification**
  – **Higher level: Goals**
    • Propositional
    • Measurable
    • “What” to satisfy
  – **Lower level: Rules**
    • Interpretable
    • “How” to achieve goals via actions
  – **Relationships between Rules/Goals in same framework**

• **Questions**
  – Translating from(to) Goals to(from) Rules?
  – Specifying relationships between Goals/Rules?
  – Most useful refinements of Core Goals Schema?