Integrating Goal Specification in Policy-based Management

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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

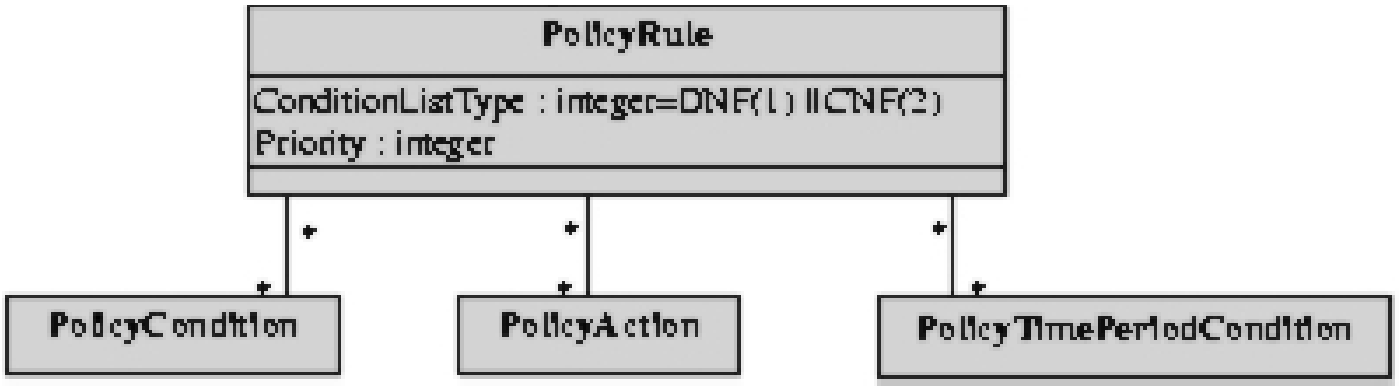
- **Sample (application level) Goal**
  - Jack, a call center agent, needs customer data to load within 2 seconds (99% of the time)
- **System Administrator derives if/then policy rules:**
  - Jack has IP address J.J.J.J
  - Call center app has address/port C.C.C.C:8080
  - Generate rules such as:
    - 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

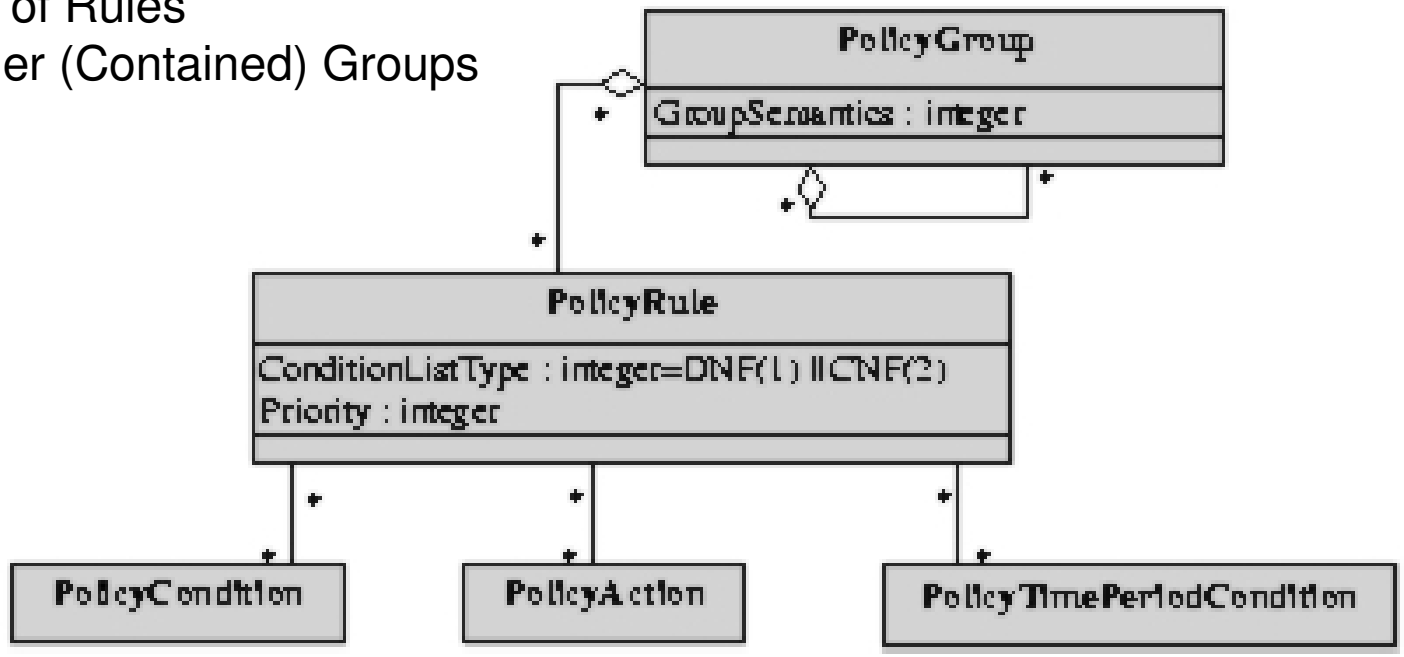
Semantics: *If* <PolicyCondition(s) TRUE> *Then Do* <PolicyAction(s)>



IETF/DMTF Policy *Core* Info Model

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

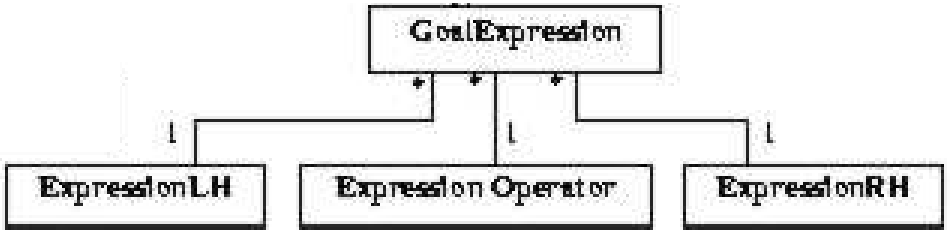
Policy Goals *Core* Info Model

Goal Expression:

- Left and Right hand parts
- Operator
- Either *satisfied* or *not-satisfied*

Example: 99%CCLoadDelay < 2 seconds

LH **operator** **RH**



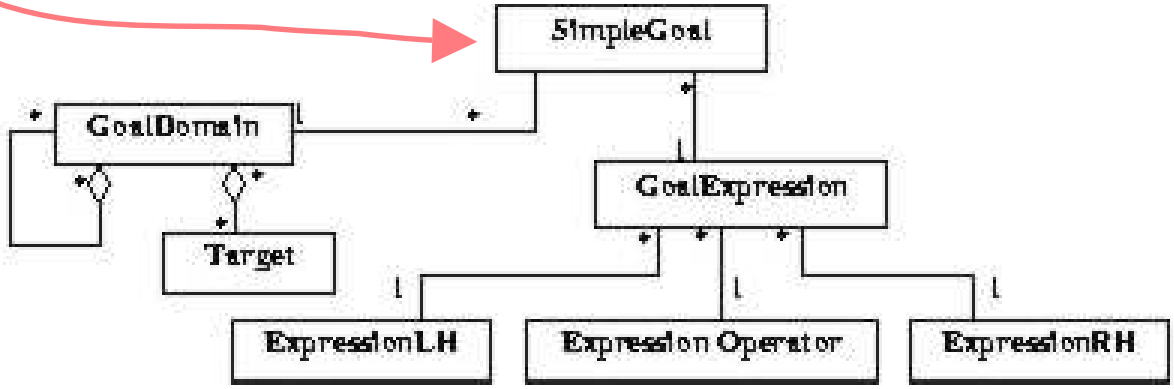
Policy Goals *Core* Info Model

Simple Goal:

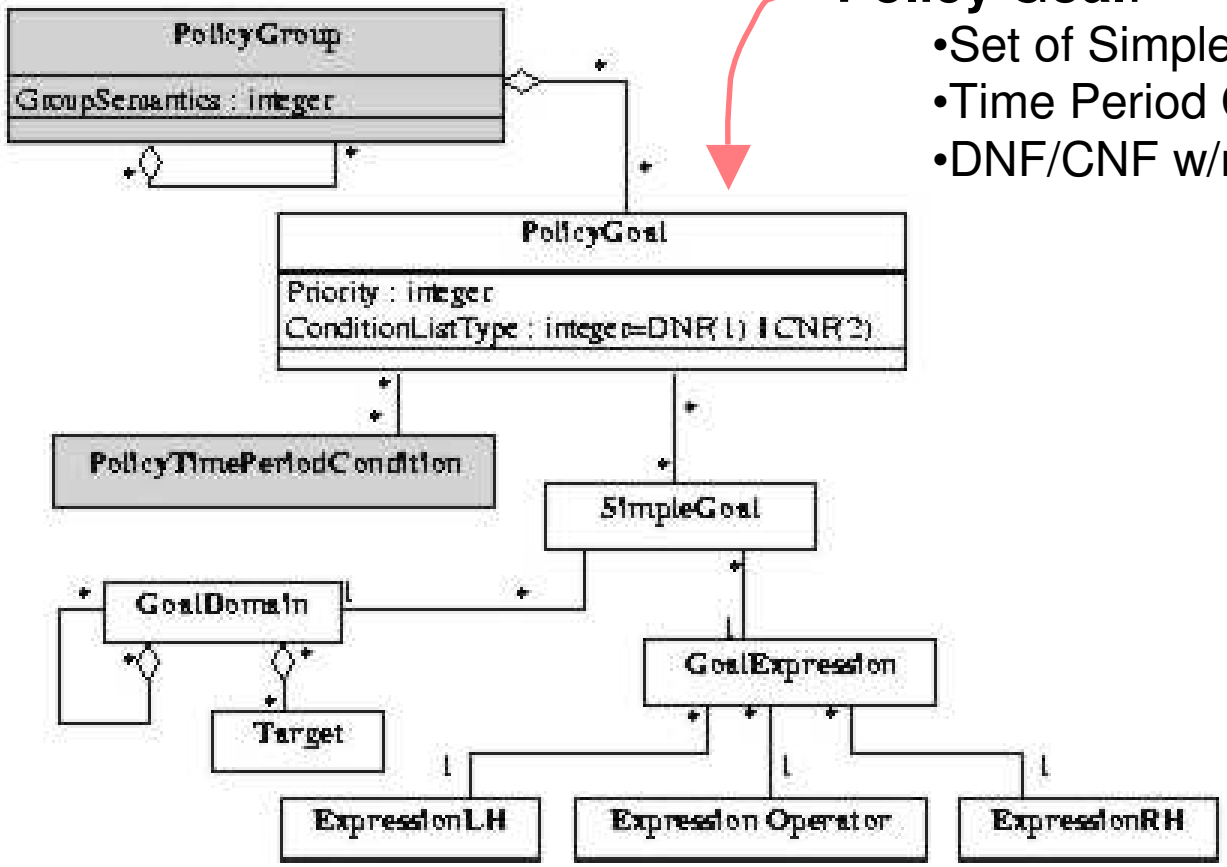
- Goal Expression
- Goal Domain = Set of Targets
- Either *satisfied* or *not-satisfied* w.r.t. Targets in Domain

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

LH	operator	RH		$Target_1$		$Target_2$
Goal Expression				**Goal Domain**		



Policy Goals *Core* Info Model

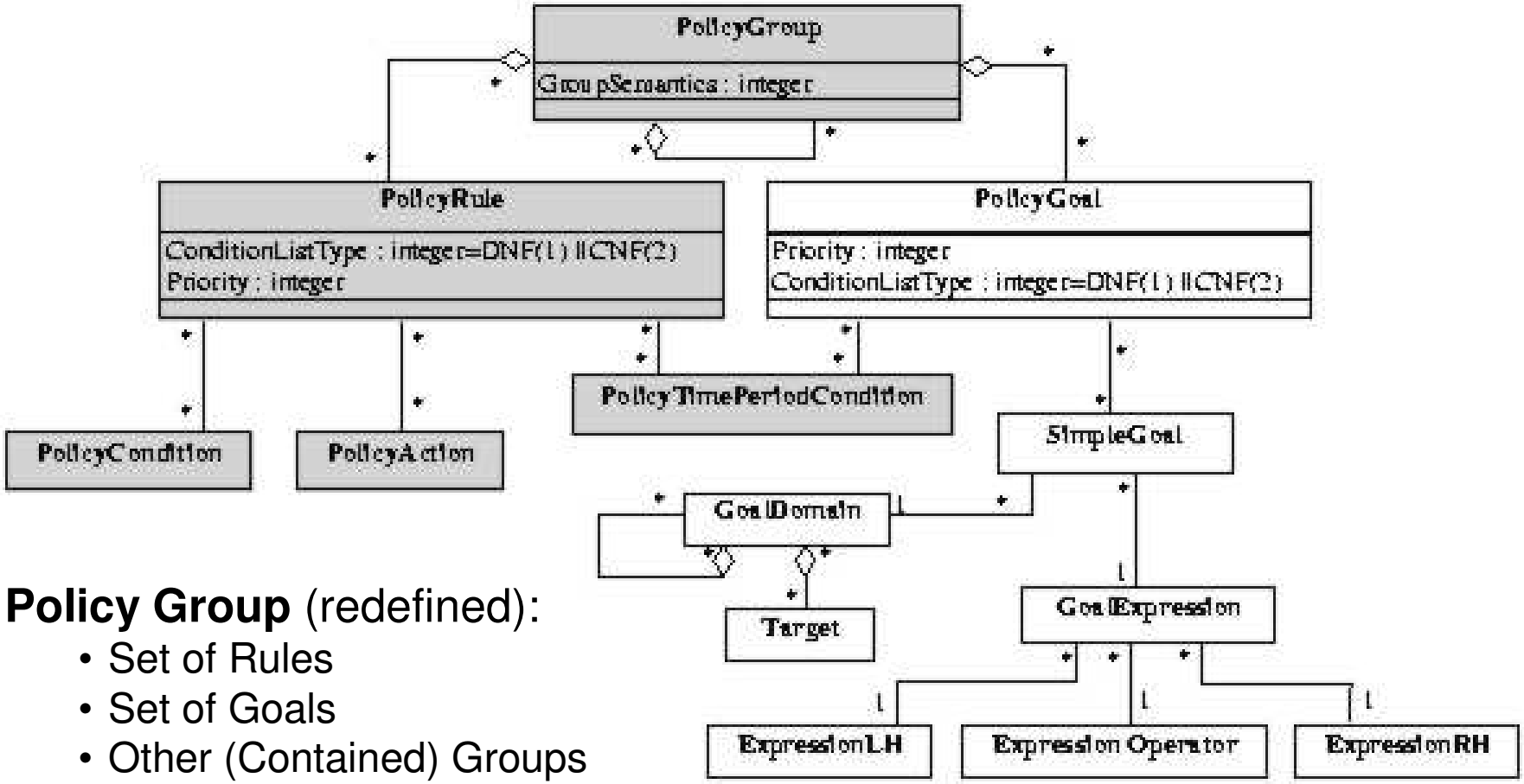


Policy Goal:

- Set of Simple Goals
- Time Period Condition
- DNF/CNF w/negation

AVAYA communication

"Horizontal" Extension of Core Model



Policy Group (redefined):

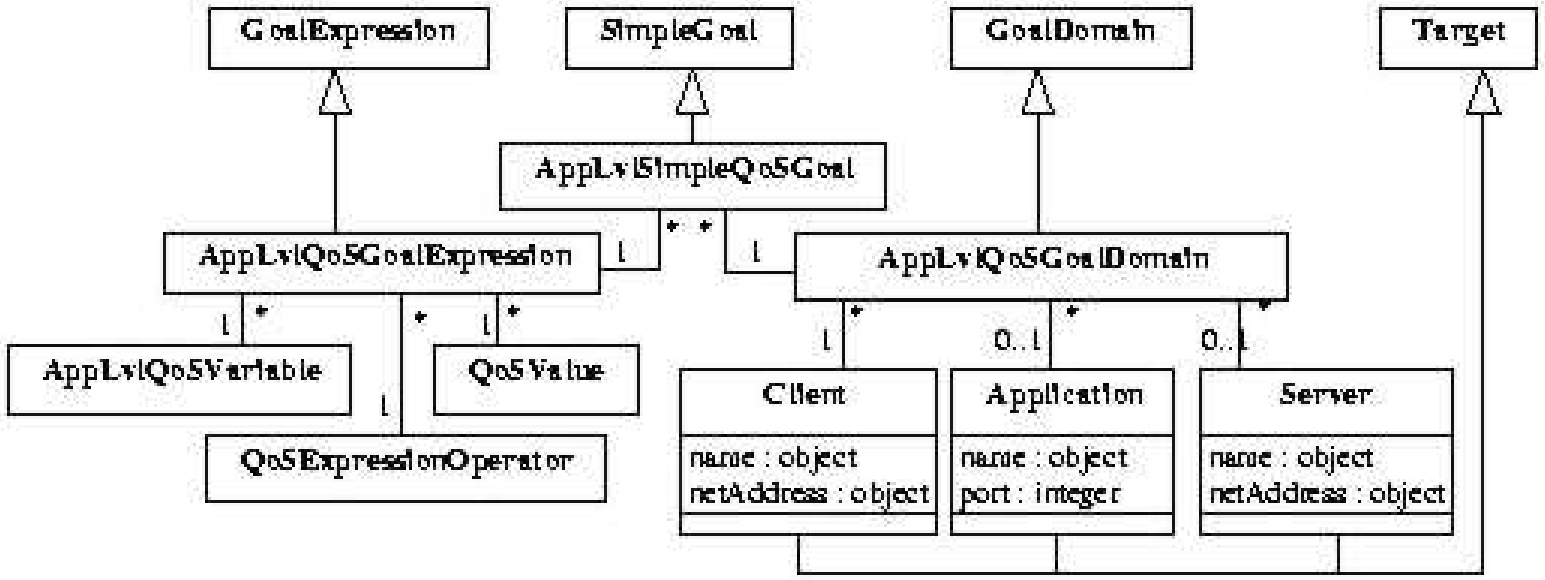
- Set of Rules
- Set of Goals
- Other (Contained) Groups
- *GroupSemantics* flag for PolicyGroup indicates relationship between Rules/Goals

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)

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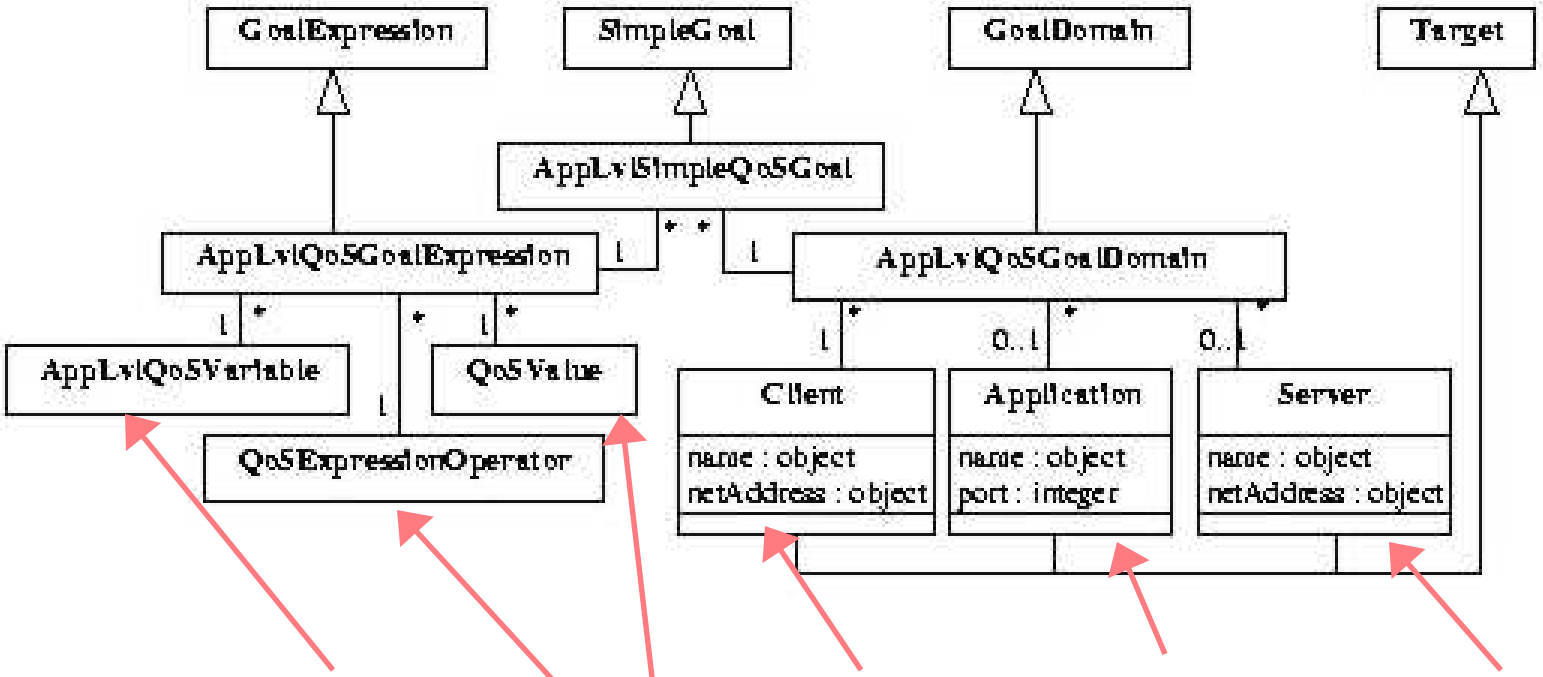


Example: 99%CCLoadDelay < 2 sec for Jack using CallCenter (at Server C)

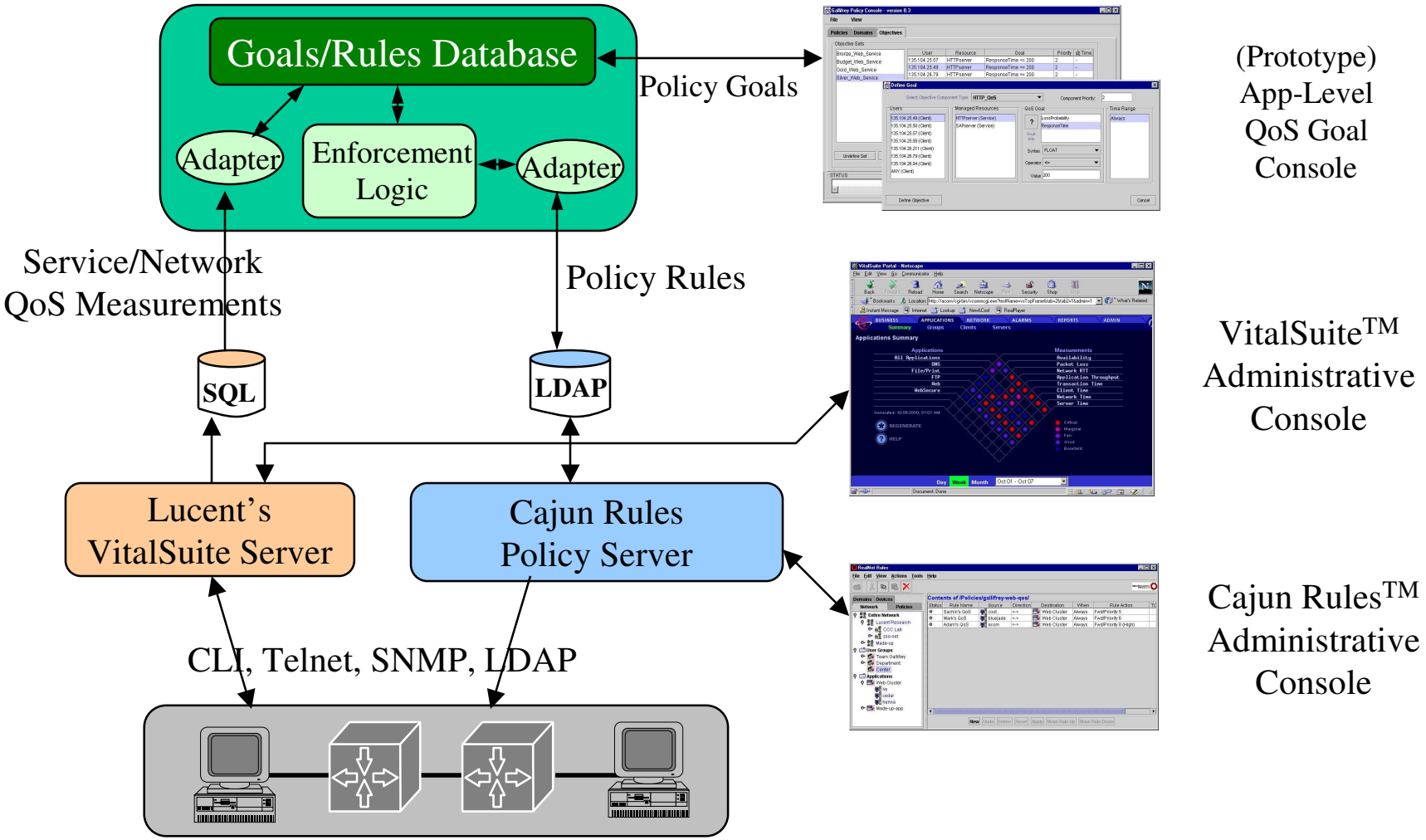
Core Goals Schema Refinements

- **Network-Level QoS Goals**
  - Example: NIC_Throughput = 20 KB/s for Stephan accessing ANY host
- **Resource Utilization Goals**
  - Example: 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. feecback 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

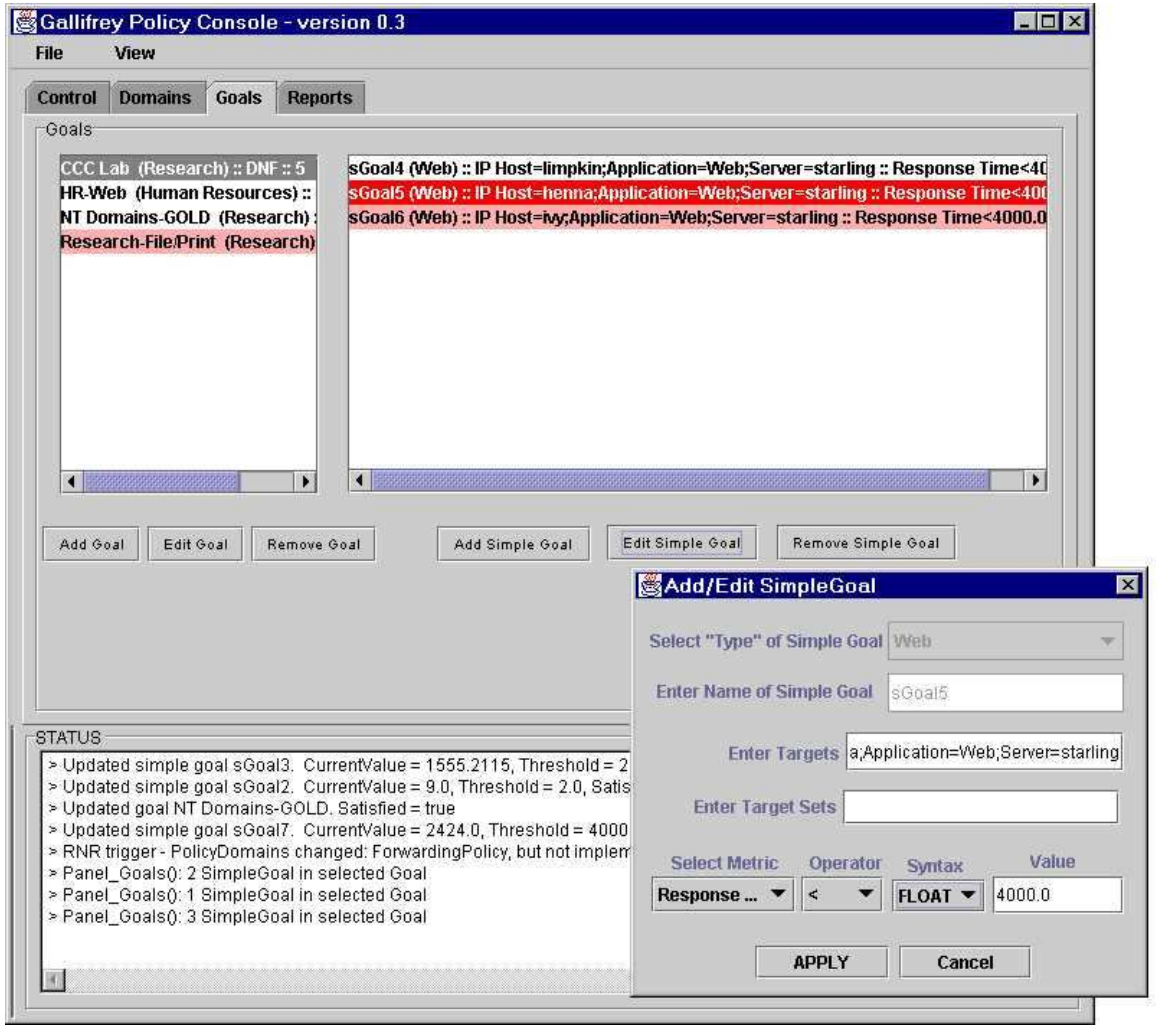


AVAYA communication

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?