# Rule-based Modular Representation of QoS Policies

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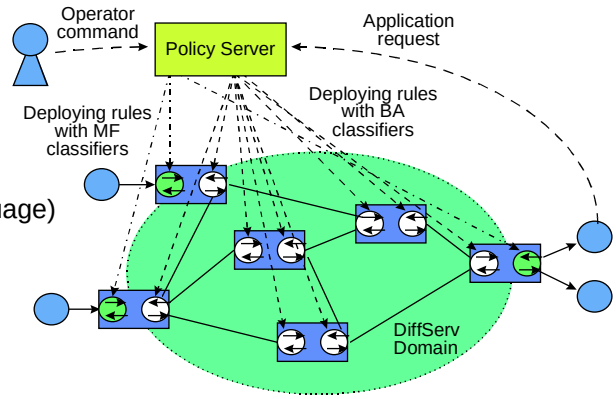
## Internet QoS Guarantee and Its Approaches

- **Needs of QoS guarantee in the Internet**
  - Mission-critical communications are increasing.
  - Multi-media traffics are increasing.
- **IntServ and DiffServ from IETF**
  - Integrated services (IntServ)
    - Flow-based QoS control architecture
    - High overhead and not scalable
  - Differentiated services (DiffServ)
    - Class-based QoS control architecture
    - Low overhead and scalable — practical in large-scale networks

## A Model of A DiffServ-ready Network

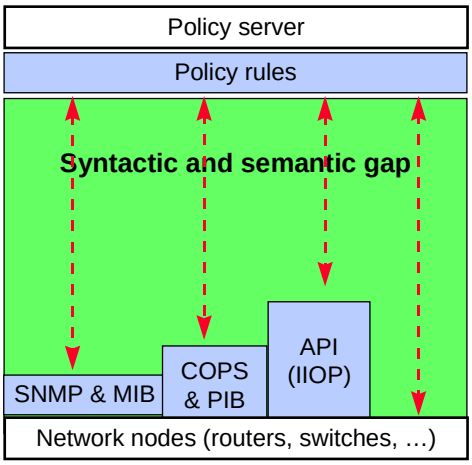
- **A QoS policy server**
  - Required for controling QoS conditions or routers.
- **QoS-ready routers (and QoS-ready switches)**
- **Interface between a policy server and network nodes**
  - SNMP
  - COPS
  - API (CORBA IIOP)
  - CLI (command language)






## Problems of conventional PS-Router Interfaces

- **Poor syntax**
  - SNMP: get/set a single value.
  - API: function calls only.
  - No structuring methods (control structures).
- **Poor semantics**
  - No relation nor constraints can be described.
  - Protocols specify only very limited part of the semantics.
  - Semantics must be specified formaly for interoperability.
    - Standard protocols do not guarantee interoperability any longer.



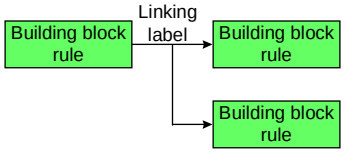
## An Alternative Interface: A Rule-based Programming Language

- **Why a language?**
  - Because a language is a combination of syntax and semantics.
- **Why programming?**
  - Policy-based control is programming.
    - Network nodes have been configured only using parameters (data).
    - We need programs for configuration, because the function to be configured is so complex.
- **Why rule-based?**
  - Because a policy is a rule-based program.
  - This language may be similar to languages for expert systems, such as OPS5 or Nexpert Object.



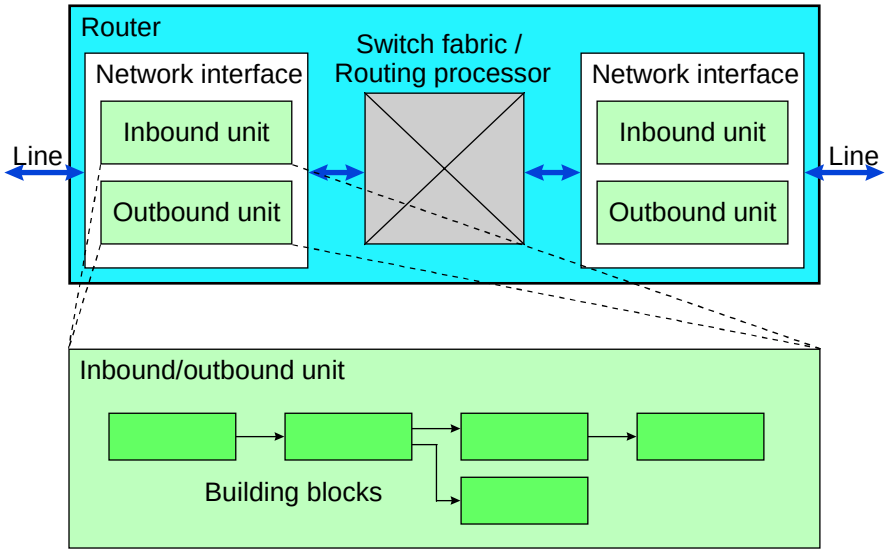
## Elements of the Rule-based Language

- **The language consists of**
  - Building block rules
    - Primitive rules to construct policy rules.
  - Linking labels
    - Connections between building blocks.




- **What is linking labels?**
  - A linking label is something like a DSCP.
  - The number of linking labels is almost not limited.
    - The number of DSCPs is only 64 — not sufficient!
  - The linking label is not put on a packet.
    - The linking label never goes out from a router — it is internal to the router.
    - The linking label may exist out of a packet, or it may be virtual.

## A Model of DiffServ-ready Routers






## Required Primitives: Building Block Rule Types

- **Matching rules**
  - Rules for flow classification.
  - Example: if (Source_ip == 192.168.1.*) …;
- **Policing rules (Metering rules)**
  - Rules for policing (bandwidth control, etc.).
  - Example: if (Average_rate <= 1Mbps) …;
- **Marking rules**
  - Rules for writing a DSCP.
  - Example: if (…) DSCP = 46;
- **Discarding rules**
  - Rules for discarding packets.
  - Example: if (…) discard_all;
- **Scheduling rules**
  - Rules for shaping and/or scheduling packets.
  - Example: if (…) queue_priority = 6;

## Outline of the Rule-based Language

■ **A policy rule example — a procedural description**

- if (Source_ip == 192.168.1.*) {
  if (Average_rate <= 1Mbps) {
  DSCP = 46; // EF
  queue_priority = 6;
  } else {
  discard_all;
  };
  };



## Outline of the Rule-based Language (cont'd)

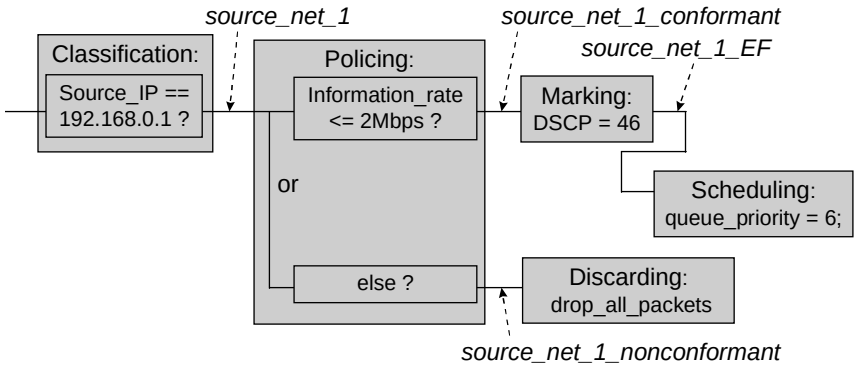
■ **Representation of the policy in the language**

- Matching rule
  - if (Source_ip == 192.168.1.*) Label = s1;
- Policing rules
  - if (Label == s1 && Average_rate <= 1Mbps)
    Label = s1_conformant;
    if (Label == s1 && Average_rate > 1Mbps)
    Label = s1_non_conformant;
- Marking rule
  - if (Label == s1_conformant) {
    DSCP = 46; Label = s1_EF; };
- Discarding rule
  - if (Label == s1_non_conformant) discard_all;
- Scheduling rule
  - if (Label == s1_EF) queue_priority = 6;

## Outline of the Rule-based Language (cont'd)

■ **Are decomposed rules too complicated?**

- The program not much complicated.






## Building Blocks on Top of Conventional Protocols and/or APIs

■ **The language can be implemented on top of**

- SNMP (using a MIB)
- PIB (using a PIB)
- API (using function calls)

■ **A MIB/PIB for the building block approach**

- A preliminary version was proposed to 46th IETF (November 1999)
  - Draft name: draft-kanada-diffserv-qospifmib-00.txt
  - Presented at:
    - RAP WG (Resource Allocation Protocol WG)
    - CFGMGMT BOF (Configuration Management BOF)
    - Diffserv WG — Q&A only

## Concluding Remarks

- **Most policy rules for DiffServ can be described using**
  - Five types of building block rules: matching, policing, marking, discarding, and scheduling.
  - Linking labels.
- **Building block rule architecture is not restricted to DiffServ.**
  - Applicable to other QoS services.
  - Applicable to Active Networks (programming networks).
- **Future work**
  - Definition and implementation of the rule-based language
    - Including an implementation for Hitachi GR2000.