Service Level Specifications and the Mapping to Differentiated Services Configurations

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Outline

- Introduction to Internet QoS
- Problem statement (management issues)
- IP services and its specification
- QoS mapping and admission control
- Conclusion

Traditional IP: Limited QoS support

- **TOS field (precedence & service selector)**
  - hardly used
- **Reliable transport (TCP)**
- **Fairness**
  - packets are treated equally
  - TCP back-off
- **Provider guaranties**
  - e.g., guaranteed average round trip for UUNET SLA: 120ms transatlantic

Problems of IP with Regard to QoS

- Packet-orientation
- Dynamic Routing
- No priorities (or very limited use of priorities)
- Unspecified dropping procedure
- Unpredictable queuing delays
- No separation of traffic specified

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Approaches to QoS in IP networks

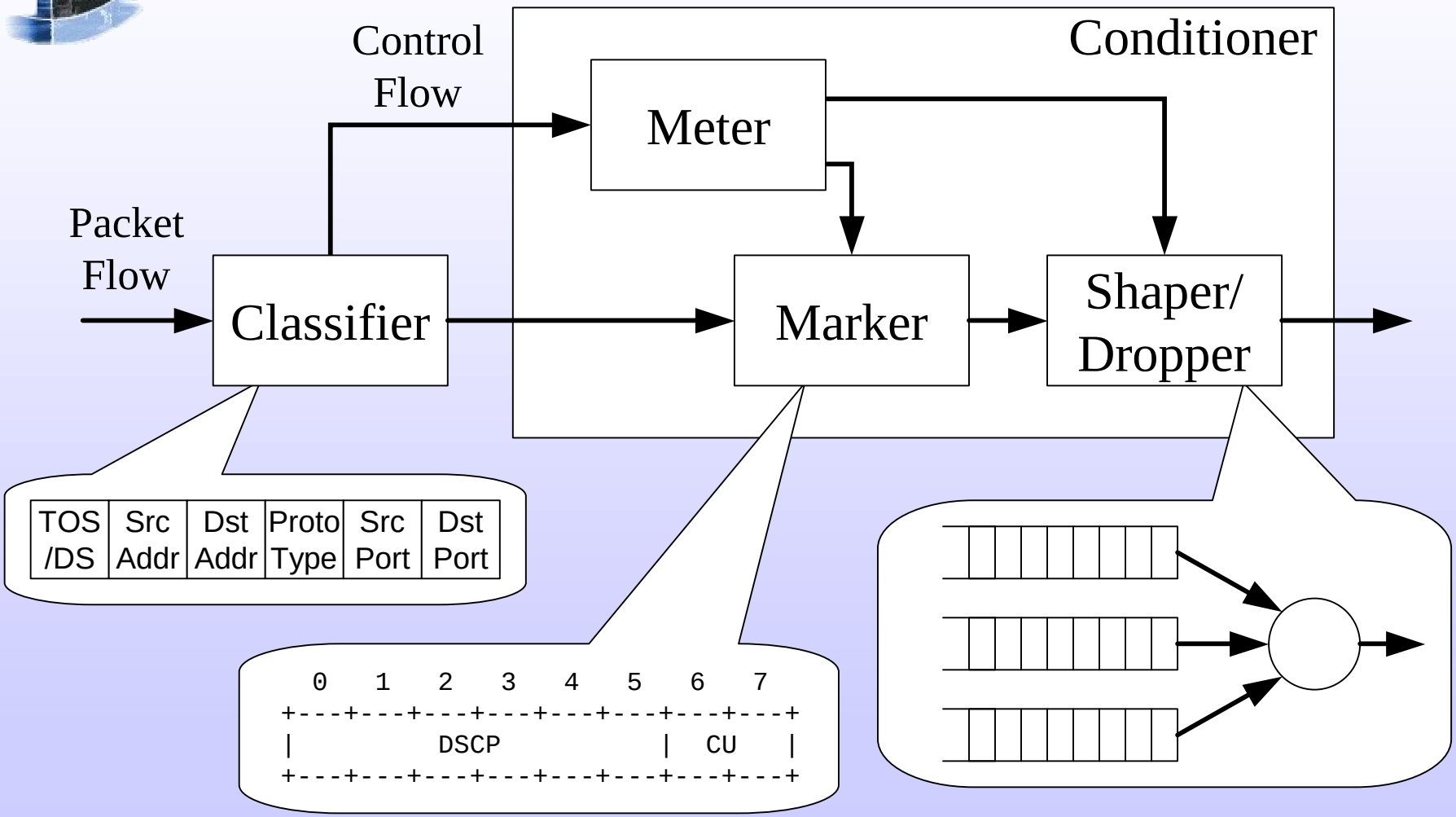
- **Packet classification**
  - fine grained: (Micro-)flow classification, five-tuple
  - coarse grained: Classes of Service
- **Differentiated routing and scheduling**
- **Reservation-based**
- **Priority-based**

- **Alternative: over-provisioning**

Differentiated Services

- **Counterpoint to IntServ: much less complex**
  - hop-by-hop instead of end-to-end
  - fast processing on core routers
  - less state signaling, processing, storing
- **Approach**
  - at ingress router
    - packet classification into few classes
    - packet marking with DiffServ Code Point (DSCP)
    - packet queuing and scheduling per DSCP
  - at core and egress router
    - packet queuing and scheduling per DSCP

DiffServ Building Blocks



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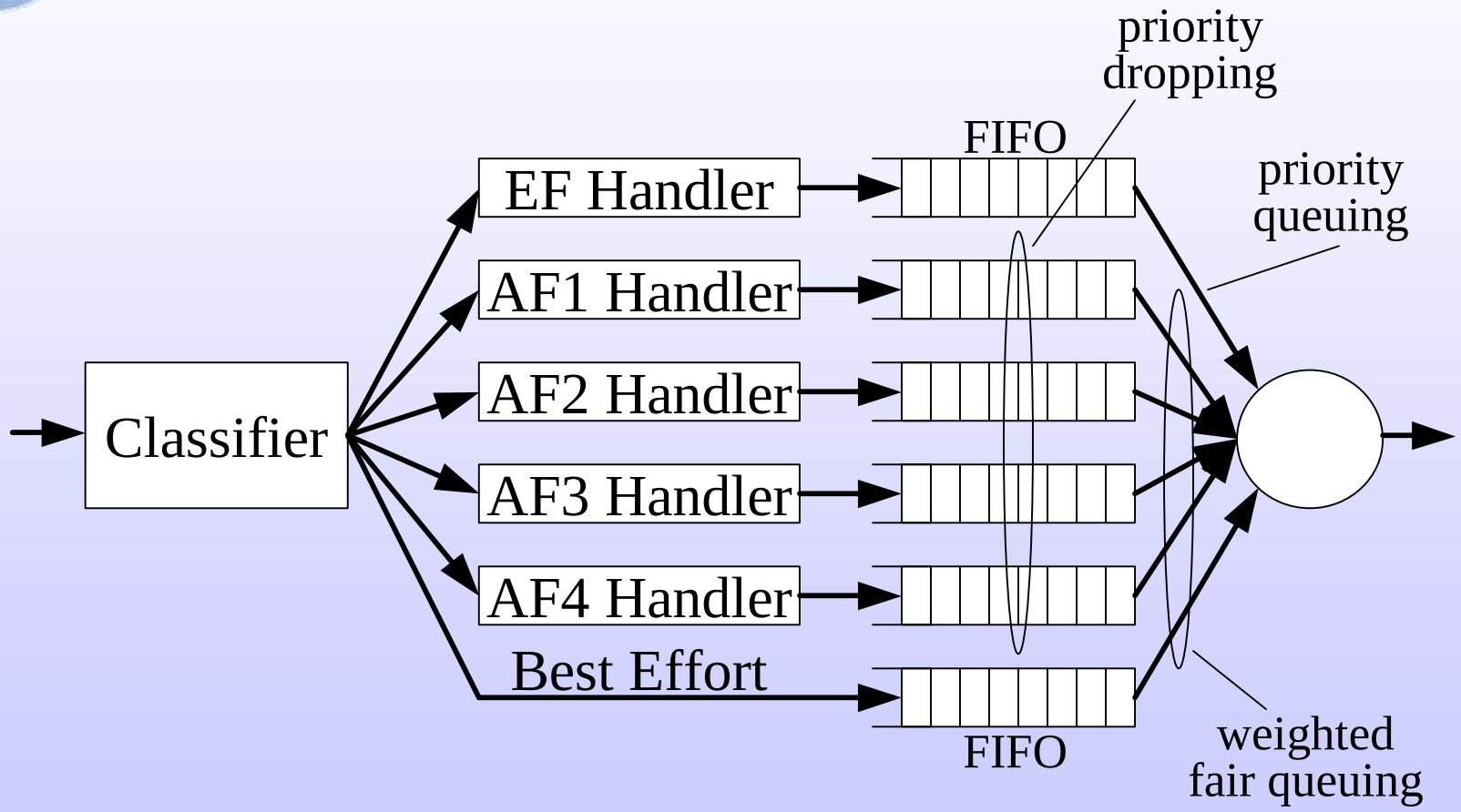
Per-Hop-Behavior (PHB)

- **Class Selector PHB**
  - (limited) compatibility to IPv4 TOS precedence
  - eight priority classes (DSCP 000000 - 111000)
- **Expedited Forwarding PHB (DSCP 101110)**
  - rate shaping or policing at ingress router
  - prioritised packet-servicing at each node
- **Assured Forwarding PHB**
  - four packet service classes
  - each with three dropping priorities
  - DSCP xxxyy0: xxx=class, yy=precedence

Typical Node Configuration



IntServ vs. DiffServ

- **IntServ**
  - provides resource guarantees per flow
  - supports signaling for short-living reservations
  - soft-state does not scale with number of flows
  - replication of functionality (e.g. classification)
- **DiffServ**
  - provides traffic treatment per class of service
  - only per-hop guaranties
    - no per-domain behavior or end-to-end behavior defined
    - hard guaranties require additional control of admission and routing
  - better match with IP network architecture
  - simpler to implement

Management Issue 1: Edge-to-Edge

(intra-domain)

- **What services are provided?**
- **Per-Domain Behavior (PDB)**
  - Modeling?
  - Specification?
  - Implementation?
- **Different management requirements**
  - edge vs. core)

Management Issue 2: Resource Management

- **Admission control**
  - over-booking?
  - choice of granularity
    - per-user
    - per-customer
    - per-aggregate
- **Resource reservation**

Management Issue 3: Control Loop versus Provisioning

- **Control Loop**
  - usage of network feedback for control
  - just react on the network behavior
  - no analytical model needed
  - problem of closed control systems (oscillations, difficult to dimension for right reaction time)
  - reaction may go into the wrong direction
  - gathering enough and the right network information is difficult

Management Issue 3: Control Loop versus Provisioning

- **Provisioning**
  - needs analytical model to predict the behavior
  - in the model bound, provisioned behavior remains constant
  - difficult to find the analytical model

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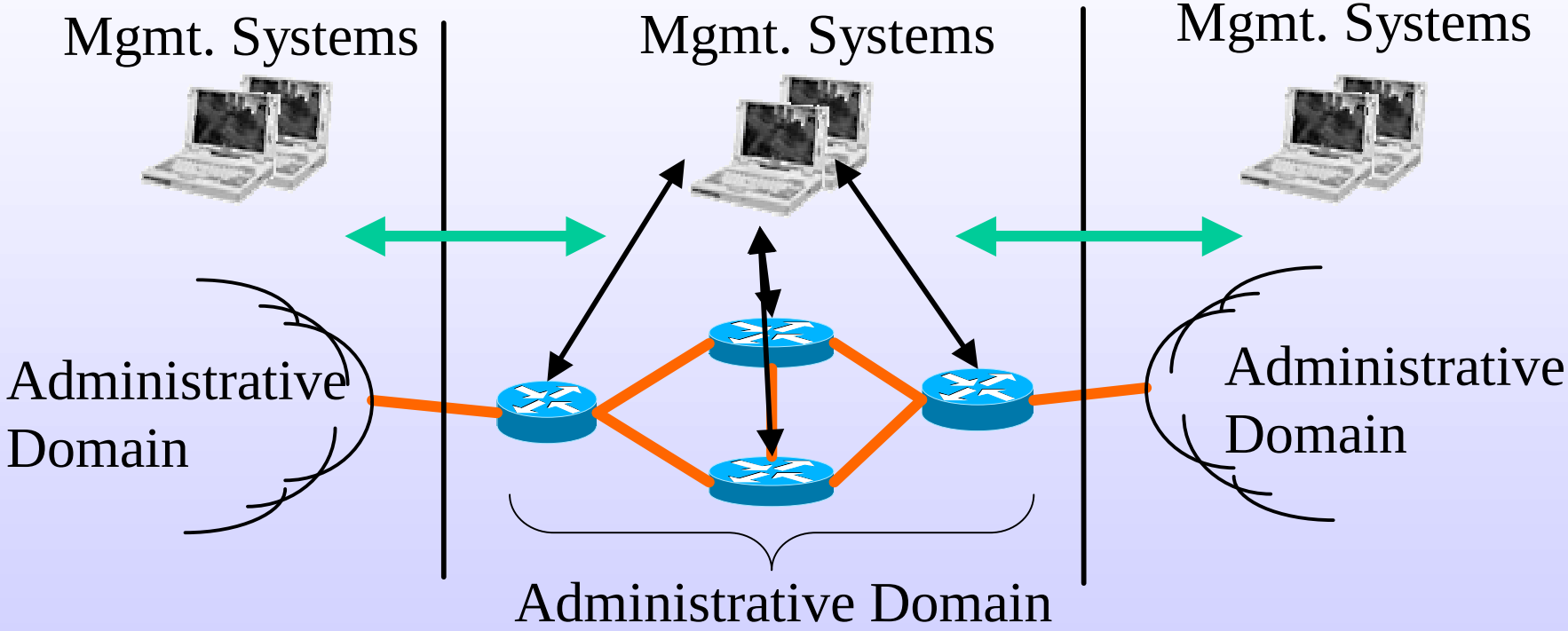
Framework for QoS Control in the Internet



DiffServ Routers
Physical Connections

Service request, negotiation & agreement

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Inter-Domain QoS Management

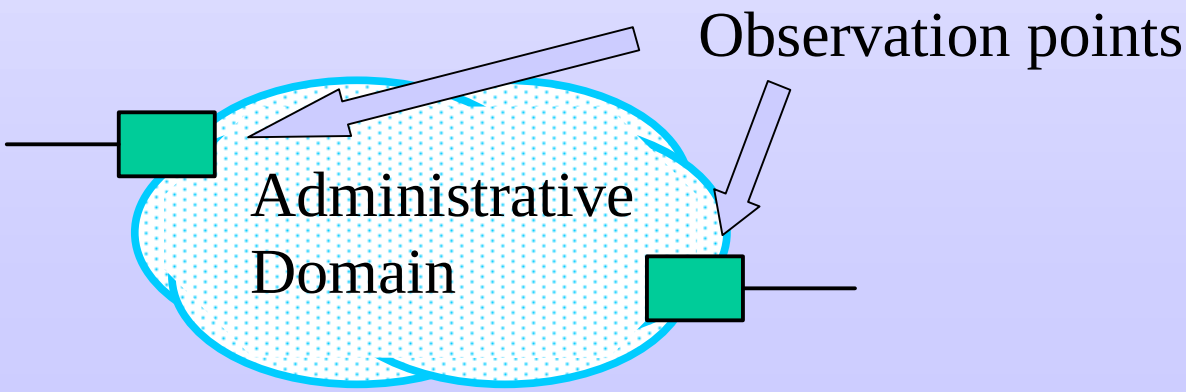
- **Service Level Agreement (SLA)**
  - contract between two organizations
  - end-to-end or edge-to-edge service contract
  - contains legal, administrative, prizing information
  - includes service level specification
  - e.g. what happens if the service was not provided (pay fine (money, access for free))

Service Level Specification

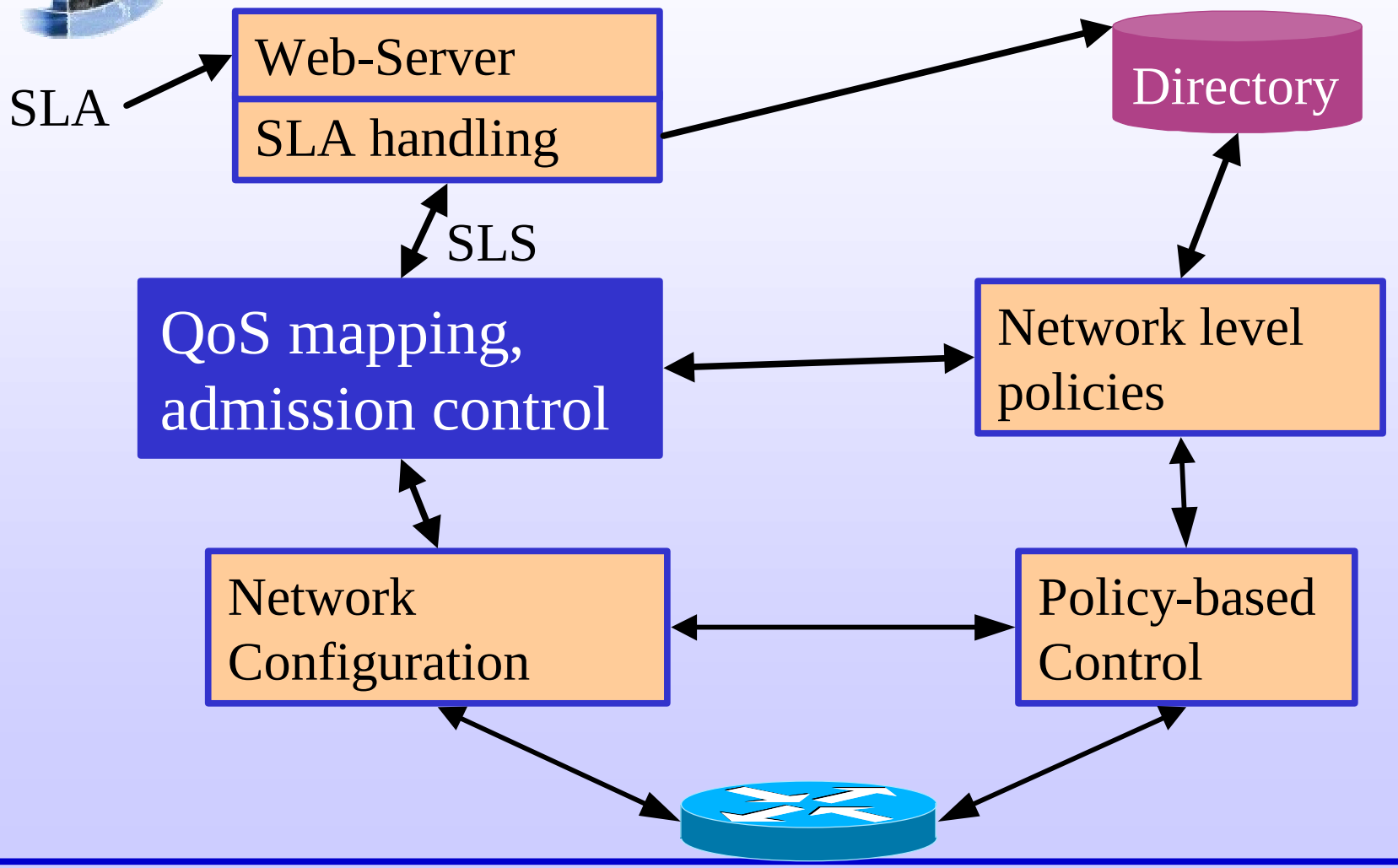
- **Service Level Specification**
  - scope (where)
  - flow description (which IP packet QoS is enforced)
  - traffic parameters (characteristics of packet stream)
  - excess treatment (what happens to non-conforming traffic)
  - performance guarantee (for conformant traffic)
  - schedule
  - reliability, availability

Per-Domain Behavior (PDB)

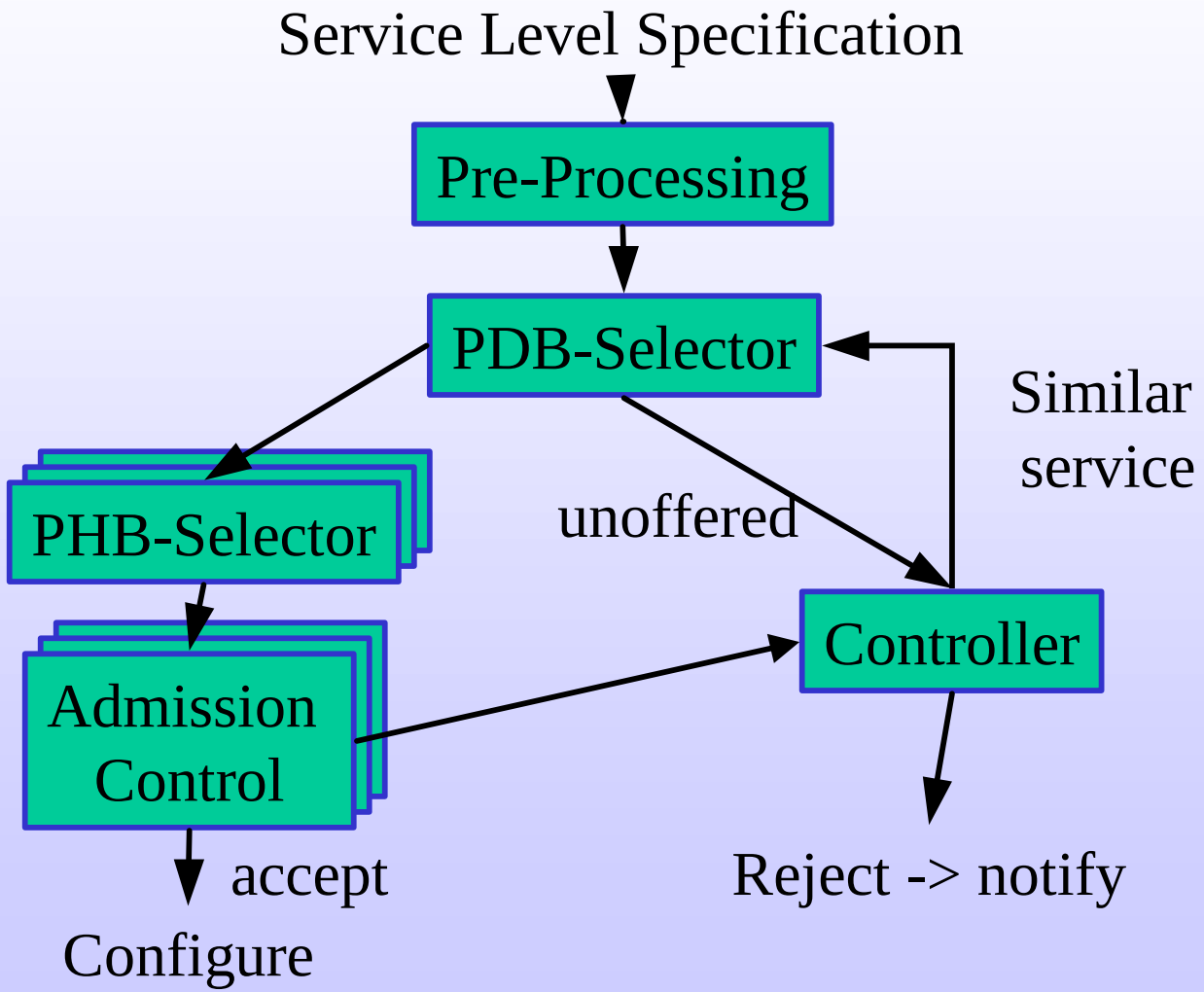
- **Edge-to-edge behavior of traffic**
  - from ingress routers to egress routers
  - Service Level Specification is mapped to PDBs available in the domain
  - Providers task to define and configure a defined behavior in the DiffServ domain



Management System (the big picture)



QoS Mapping & Admission Control



Mapping steps

- **Pre-processing**
  - pre-defined services?
  - Qualitative to quantitative mapping
- **PDB selector**
  - based on N-dimensional graph (parameters in SLS)
  - various graphs (pre-evaluation of some parameters e.g. one-to-one, one-to-any, etc.)
- **Admission Control**
  - per PDB and per PHB
  - assume fixed routing

Conclusion

- SLS to DiffServ configuration mapping system
- One part in an overall IP QoS Mgt. System
- Policy-based control of the system
- Implementation on top of NEC Linux-DiffServ routers

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Additional Information

- Differentiated Services (diffserv), http://www.ietf.org/html.charters/diffserv-charter.html
- Kalevi Kilkki, “Differentiated Services for the Internet”, MacMillan Technical Publishing, 1999, ISBN 1-57870-132-5.
- Grenville Armitage, “Quality of Service in IP Networks”, MacMillan Technical Publishing, 2000, ISBN 1-57870-189-9.

- EU IST project: Next Generation Networks Laboratory (NGN-Lab), www.ngnlab.org.