QoS in IPv6

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What is Quality of Service?

- **Quality:** reliable delivery of data “better than normal”.
  - Data loss, latency (jitter), bandwidth ...
  - In general: an efficient use of network resources.

- **Service:** something offered to the final user.
  - End-to-end communication.
  - Client-server applications.
  - Data transport, etc.
  - Concept: *service guarantee, SLA.*

QoS

“Quality of Service is a measurement of the network behavior with respect to certain characteristics of defined services” ¡¡¿?!!

→ an ambiguous term with a difficult interpretation.

- But still some common concepts to all definitions of QoS:
  - Traffic and type of service differentiation.
  - Users may be able to treat one or more traffic classes differently.

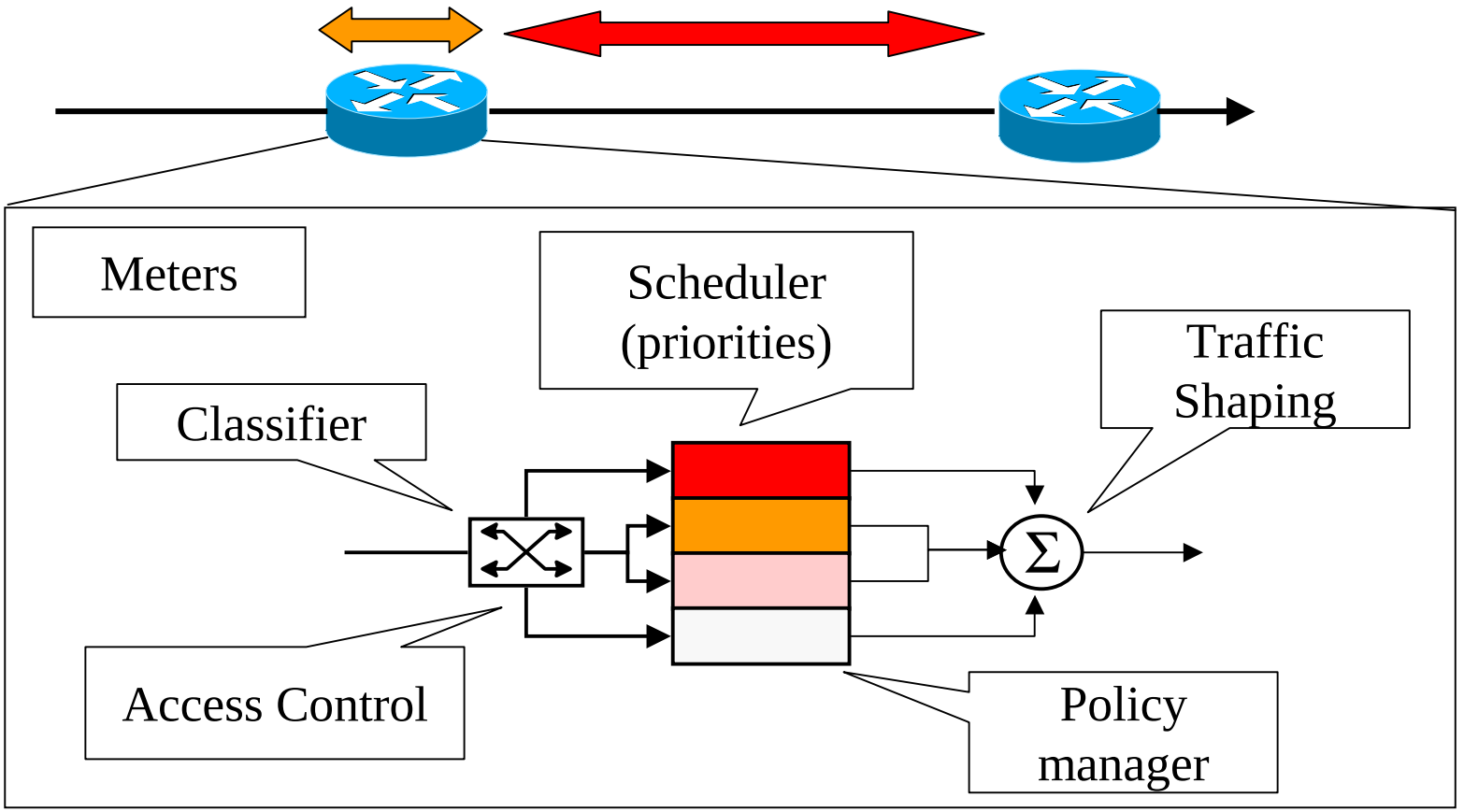
Classes of Service

- It refers to traffic management, not to a global subjective definition of QoS.
- Open questions:
  - ¿What's the minimum complete set of classes of service?
    - Define classes.
  - ¿How to differentiate them?
    - Traffic classification -> differentiation.
  - ¿How to get predictive CoS and not only relative priorities?
    - User seeks for predictive characteristics ("I want to download this file in less that 2 minutes").

Hot to get QoS

Queuing latency may be controlled by QoS mechanisms

Propagation latency is determined by media : it can not be changed



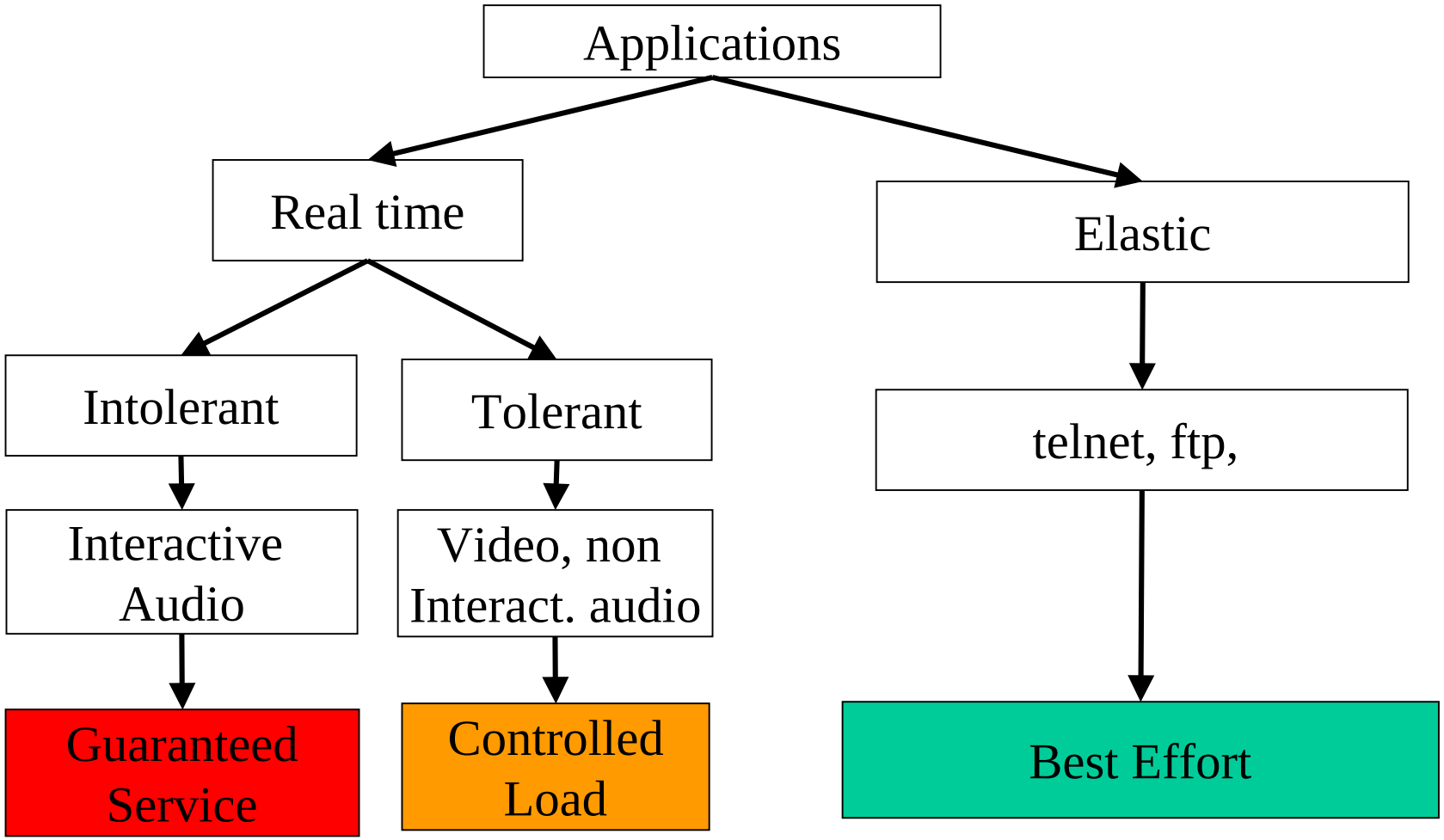
Integrated Services

- IntServ was introduced by IETF in 1994.
  - RFC 1663.
  - It suggest that the actual architecture is enough (with some extensions) to provide QoS.
- Tries to mix the best of two opposed paradigms:
  - **Datagram networks**: maximize network usage by multiplexing traffic: robust, adaptation, multipoint, etc.
  - **Circuit networks:** fixed guarantees.

IntServ Services

- Guaranteed Service:
  - RFC 2212
  - Assured bandwidth and latency. No losses.
- “Controlled Load” Service
  - RFC 2211
  - The network appears like light loaded: less guarantees, predictive service.
- Best Effort Service
  - The actual WWW (World Wide Wait).

Integrated Services



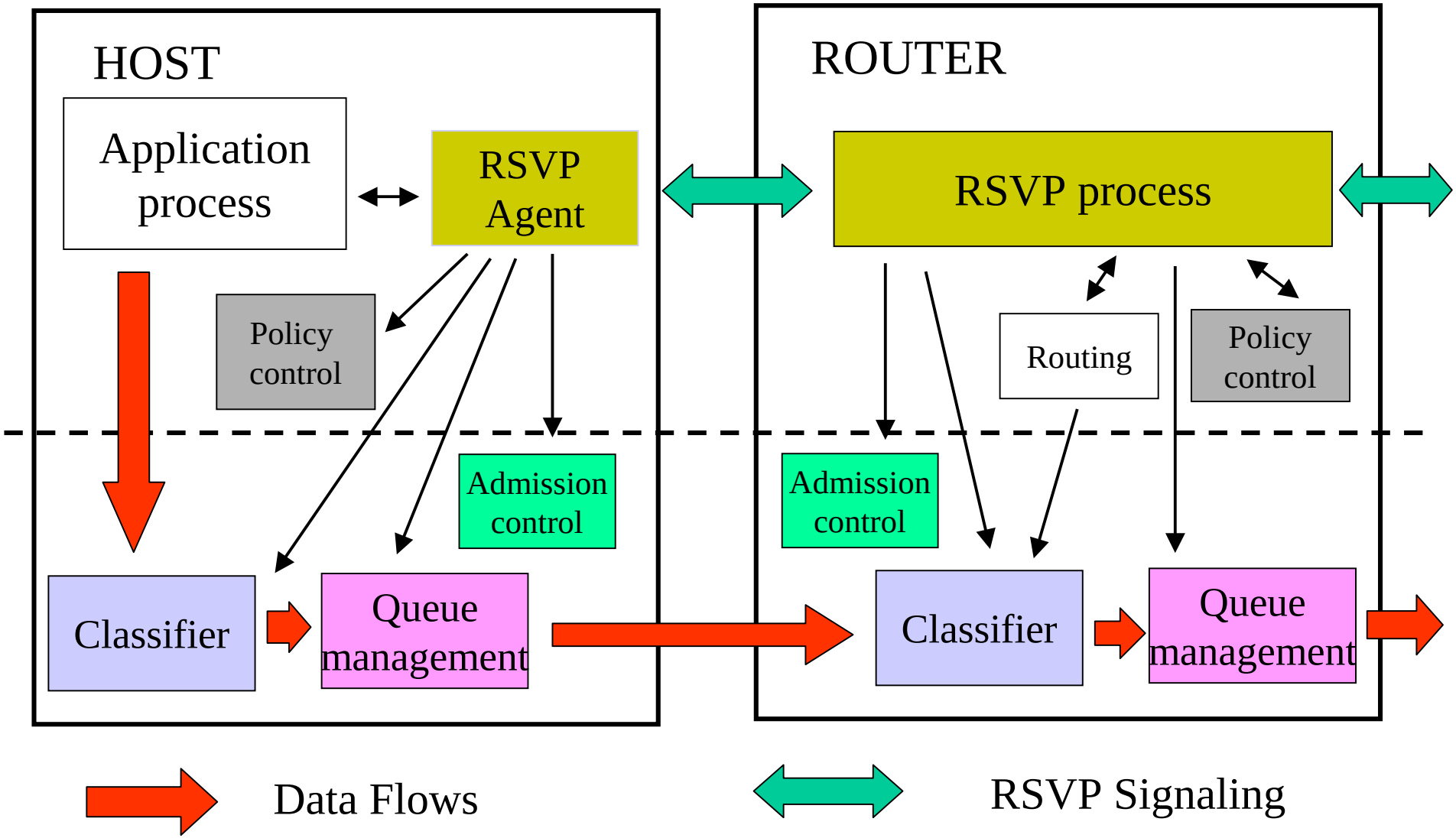
RSVP

- ReSource reserVation Protocol
  - Commonly used by Integrated Services.
  - Generic signaling protocol: it carries object (QoS) transparently.
- References
  - RSVP: RFC2205.
  - RSVP + IntServ: RFC2210.

RSVP (II)

- Requirements:
  - Support for unicast and multicast flows.
  - Support for heterogeneous flows (with different QoS).
  - Based on existing protocols.
- Characteristics:
  - Explicit reservation ***end to end*** model
  - soft-state: adaptation, flexibility, robustness.
  - Receiver initiated.
  - Per-flow management
  - Dynamic access control (in every node)

RSVP


HOST
Application process
RSVP Agent
Policy control
Admission control
Classifier
Queue management
ROUTER
RSVP process
Routing
Policy control
Admission control
Classifier
Queue management
Data Flows
RSVP Signaling

RSVP disadvantages

- Soft-state: Inefficient
- Scalability: possible aggregation.
- Complexity
- Per packet/flow management.

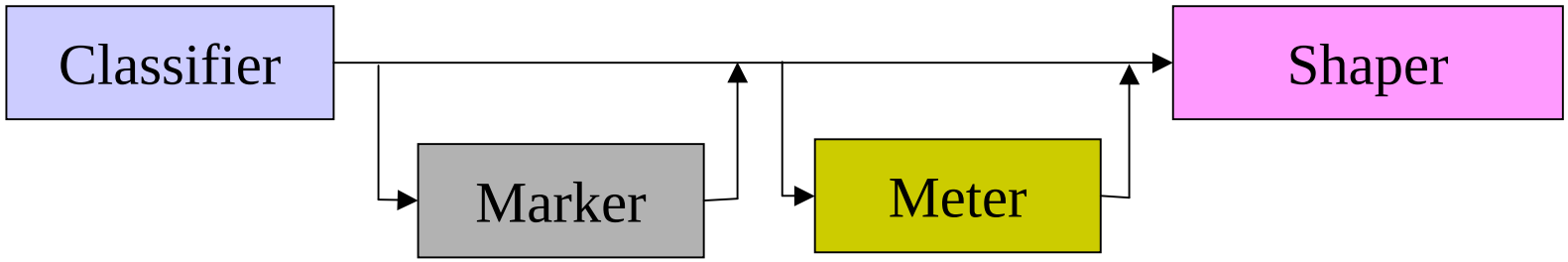
Differenciated Services

- Simplistic philosophy opposed to IntServ + RSVP
  - RFC 2475.
  - No reservations: priorities.
  - No flows.
  - No end to end.

DiffServ

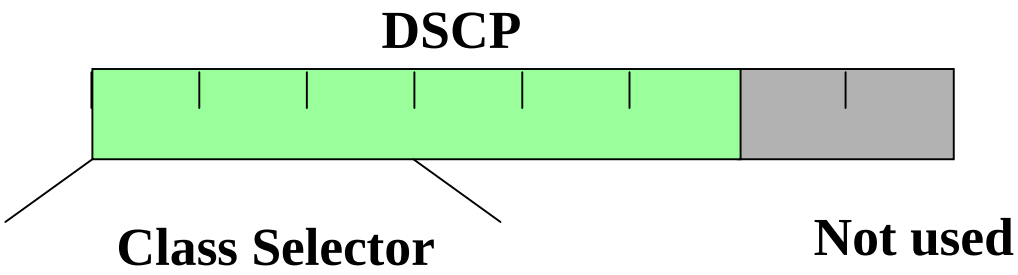
- “Protocol” that implements Differentiated Services.

- It is based on information contained in every packet header, marked with a priority.



DiffServ (II)

- DiffServ field:
  - DSCP (RFC 2474): specifies a reduced, well defined set of traffic classes.



It allows up to 2^64 different contexts → per hop behavior models.

XXXXXXX0 → Internet Assigned Number Authority (IANA)

XXXXXX11 → Experimental / local use

XXXXXX01 → Experimental / local / IANA

DiffServ (III)

- PHB: External visible behavior
  - Indicated by DSCP value.
- PHB Expedited Forwarding
  - RFC 2598.
  - Strict bandwidth and latency guarantees.
  - DSCP = 1011101.
- PHB Assured Forwarding
  - RFC 2597.
  - More relaxed QoS.
  - DSCP xxxyyy0.
  - xxx → class selector (queue).
  - yyy → discard priority selector.

Differentiated services

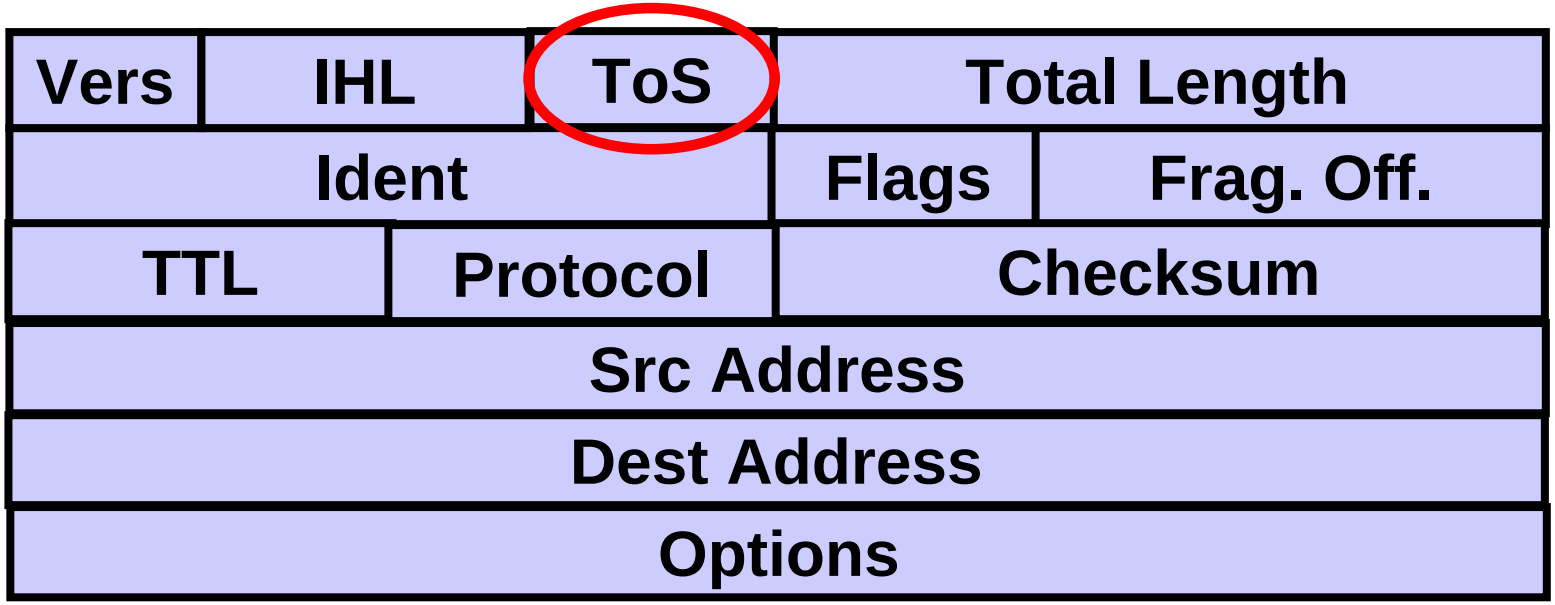
- Advantages:
  - Faster processing in routers: limited complexity in classification and queuing.
  - Less state maintained.
  - No out of band signaling (less overhead).
  - In general improved scalability.
- Disadvantages
  - No end to end .
  - Predictive Services.
  - Access control only in borders (need of bandwidth broker).
  - Relies on over provisioning.

General QoS quiz

- ¿End to end?
- ¿Explicit Reservations?
- ¿Out-of-band / in-band signaling?
- ¿per-flow management vs. aggregation?
- ¿Soft-state or hard-state?
- ¿Sender or Receiver initiated?
- ¿QoS parameters?
- ¿Centralized or distributed?

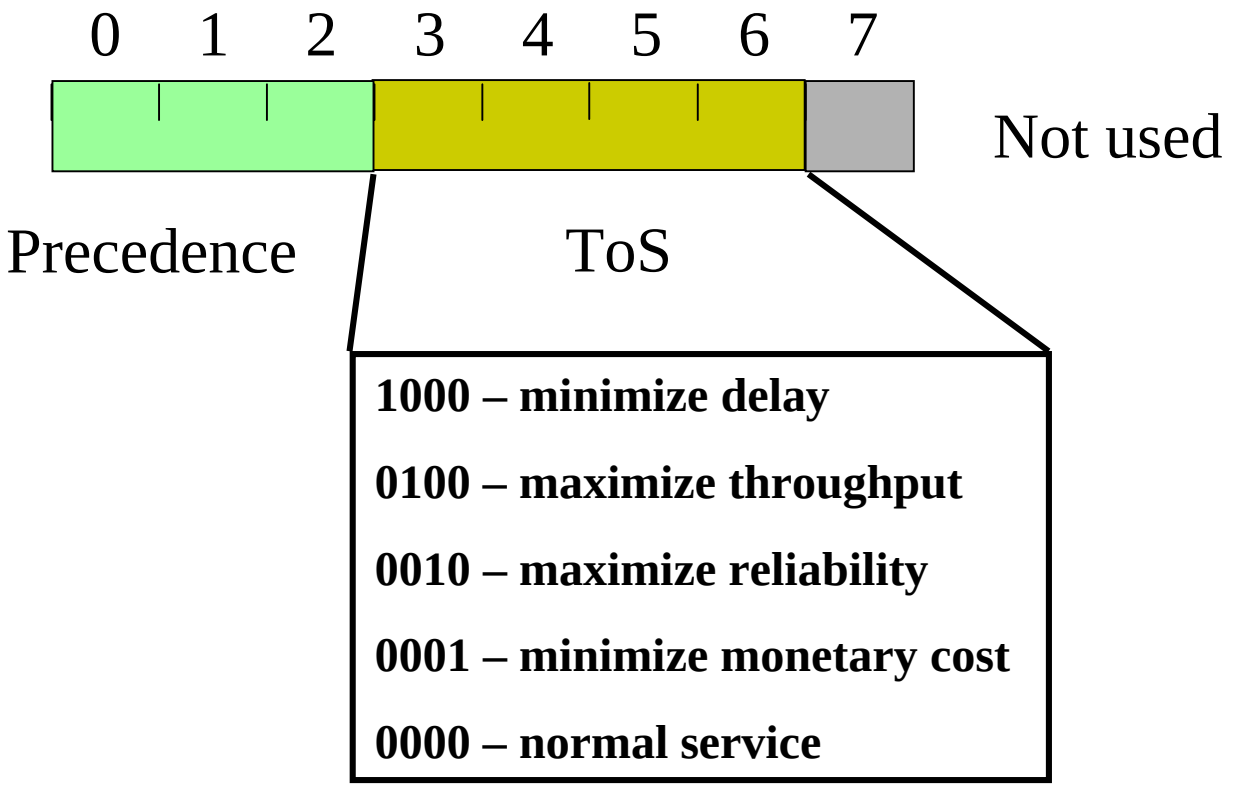
QoS support in IPv4

IPv4 Header


Vers
IHL
ToS
Total Length
Ident
Flags
Frag. Off.
TTL
Protocol
Checksum
Src Address
Dest Address
Options

QoS Support in IPv4

- Type of Service field (ToS):
  - RFC 1349, RFC 1812 (ToS classes)



Problems of ToS Field

- It provides a fixed and limited model for service differentiation.
- Priority field
  - Only codes relative priorities.
- Type of Service field
  - Too small.
  - Not adopted, it is no used by routers.

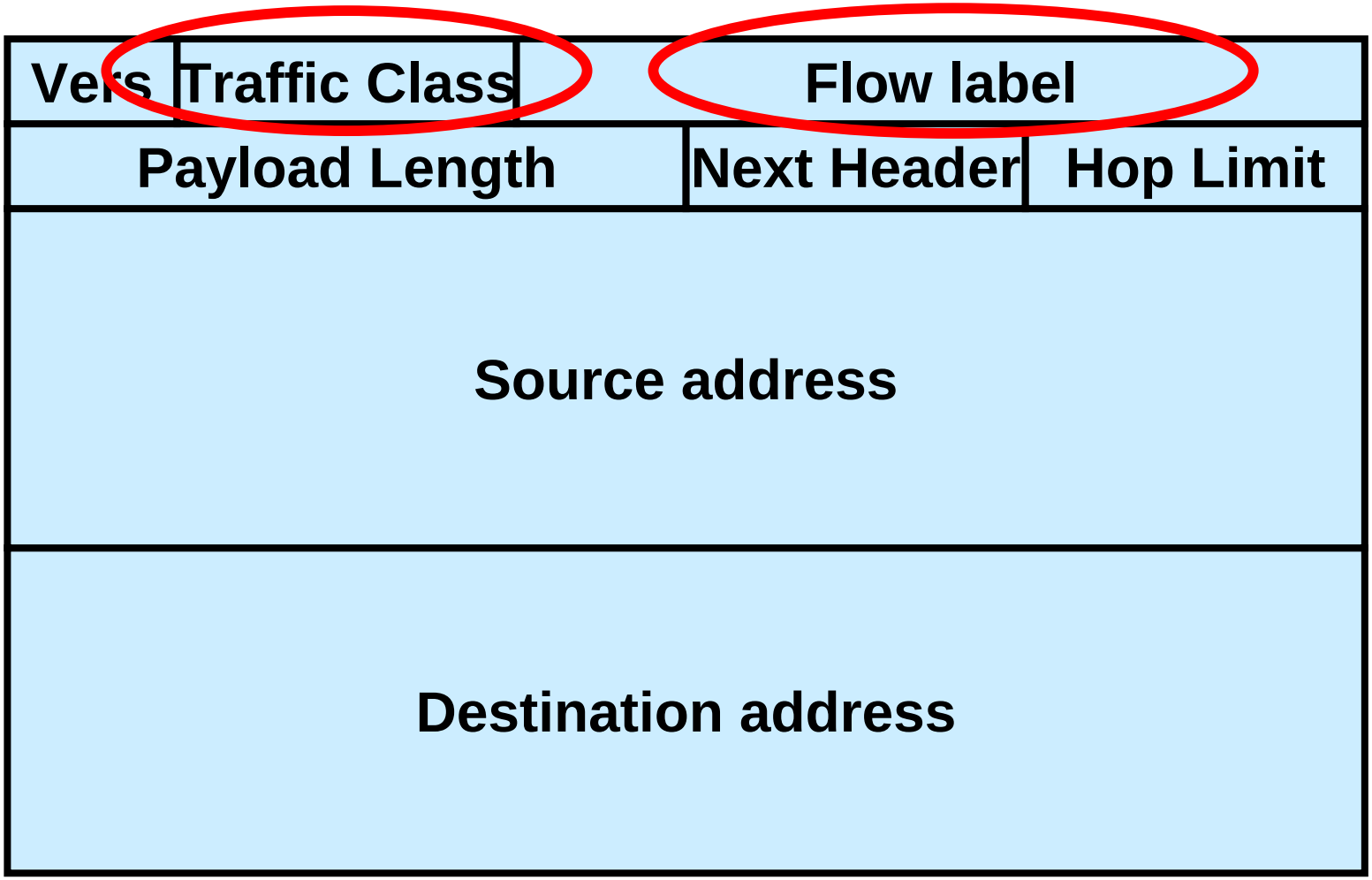
With RFC 2474 ToS field is substituted by DS field.

QoS problems in IPv4

- Fragmentation.
  - Major IPv4 problem.
  - Produces congestion, consumes bandwidth and cpu resources.
- Control Overhead.
  - ICMPv4 has too many options.
- Inefficient routing.
  - It is a direct consequence of fragmentation, but also because an inefficient and uncontrolled address assignment.
- Minimal QoS support.
  - Only an infra-utilized field.

QoS support in IPv6

IPv6 Header


Vers
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit
Source address
Destination address

QoS Support in IPv6

- Inherent IPv6 performance.
- Flow label.
- Priorities.

Performance

- IPv6 packet format was especially designed to be efficiently managed by routers.
  - Less fields.
  - Flow labels is located BEFORE address, in case flow routing is used (route calculated just once).
  - An efficient packet processing permits a fast forwarding, reducing queuing delays.
- ICMPv6 is lighter and more concrete.
- IPv6 provides autoconfiguration.
- Number of hops and not TTL.
  - no router used TTL properly anyway.

Flows

- A flow is traffic (set of packets) with a common semantic.
- Flows are used so packets belonging to the same flow are treated equally.
- Originally thought to be used in reservation (RSVP).

Flow label

- 20 bits field in IPv6 header.
  - Identifies IPv6 packets with the same origin and destination so they can be treated equally.
  - Packets may not be inspected and classified every time → encryption.
  - Packets classified by fields in fixed positions → no digging in upper layers / option headers.
- Rules:
  - Same source and destination (or multidestination).
  - They have to be forwarded to the same next hop.
  - They share routing and hop headers.

Flow labels (II)

- Caveats
  - Much more flows than src/dst pairs.
  - It is not a must (so they introduce a special case in routers)
- Controversy: ¿will flow label be used?
  - It is not clear whether the reservation model will success.
  - Still lacks of a wide adopted architecture for its use.

Flow label (III)

- The future at Feb 2002
  - <draft-ietf-ipv6-flow-label-00.txt>, IETF IPv6 WG
  - Specifies the usage of IPv6 flow labels, requirements of hosts labeling traffic, and requirements for mechanisms that uses flow labels.
- Classification
  - Src add, dst add and flow label.
- Other requirements
  - Keep statistics
  - Hosts may track used flows to avoid conflicts.
- It provides a framework of use.

Priorities

- 8 bits Class of Traffic (CoT) field in IPv6 header.
  - RFC 2640.

RFC 2474 suggest the use of ToS field as a DS field.

Other IPv6 advantages

- Mobility support:
  - Better performance while moving.
  - Less overhead.
- Security.
  - Authentication against QoS agents.
  - Integrity of QoS data.
  - Avoid frauds.

Pending problems

- It is still not clear where to locate QoS functionality.
- It is not clear what QoS support should a protocol provide.
- There isn’t a a clear QoS architecture (ISSLL).
- There isn’t a clear agreement on services.

- However:
  - Some aspects slowly converge.
  - There exists a clear support from the Telco industry to offer traffic differentiation to users.

Conclusions

- The lack of consensus about QoS architecture prevents an adequate support from protocols.
- IPv6 is a step forward, but there are still lots of things to do.

Thanks for your attention!!