

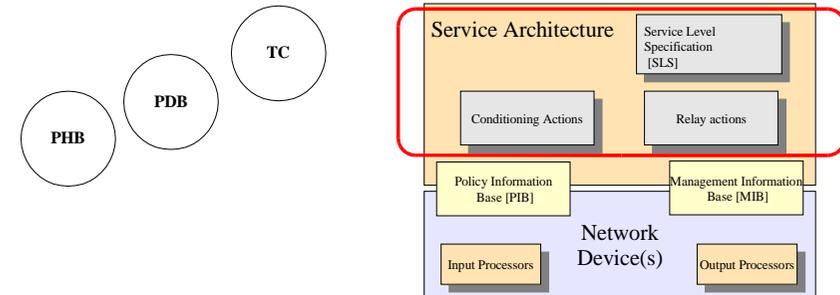
S-38.3180: Quality of Service in Internet

Lecture I: Differentiated Services

24.11.2005

Today's Topic

- This part of the lecture is about Differentiated Services architecture



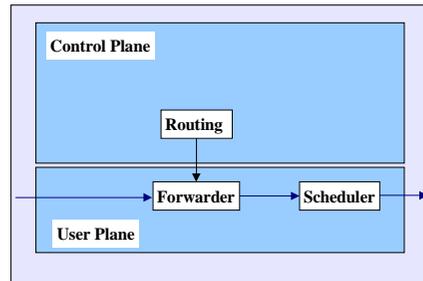
Best Effort Service

- Current Internet:
 - 'Best Effort'-service
 - Equal opportunities (competitive resource sharing)
 - Equal missories (uncontrolled delays and packet losses)
- Trend:
 - Internet is becoming commercial network with services leveling the commercial incentives

- Ideological background
 - Network is used only with good intent and need
- Turned to battle field
 - As fast and soon as possible
- Customer model
 - Access to the 'Internet'
 - Possibility to use shared information resources
- Basis
 - Connectionless packet forwarding

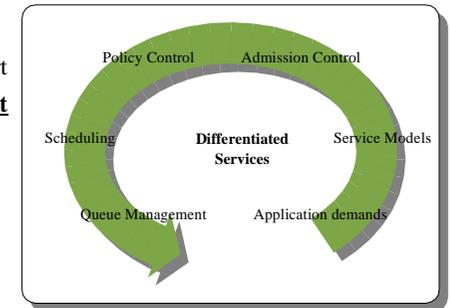
Best Effort Router

- Packets are forwarded based on their **destination address**
- Scheduling and queueing
 - FCFS
- Equal treatment



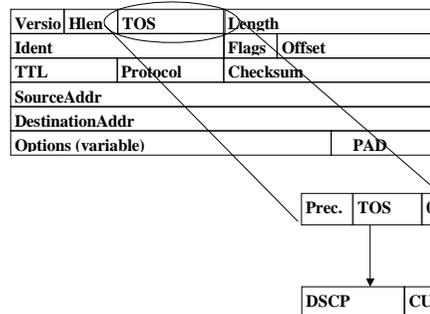
Differentiated Services

- Is combination of mechanisms presented in earlier lectures
- Physically, nothing more than Best Effort
- Logically, number of parallel **Best Effort** networks
- Packet is destined to one of the parallel networks
 - Packet per packet processed quality of service
 - Connectionless architecture is still preserved
- Each parallel network uses same routing topology (not necessarily)



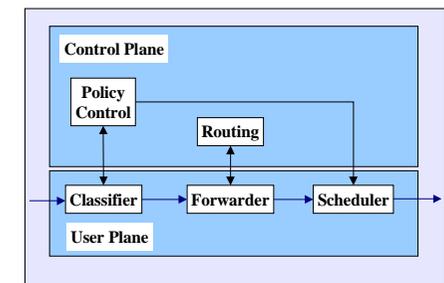
Differentiated Services

- Identification of which parallel best effort network packet is destined, is coded in each packet
 - IPv4 ToS field is reformatted
 - No routing nor precedence
 - Generic class identifier



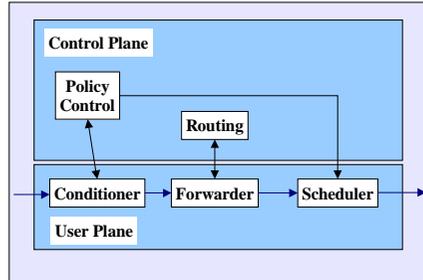
DiffServ Router

- Packets are forwarded based on the **destination address** and **class information**
- Scheduling and queueing are done based on the class information



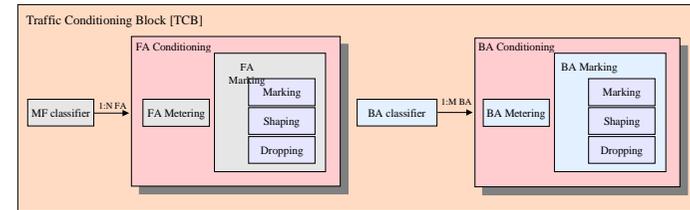
DiffServ Router

- DiffServ router has one additional element in datapath compared to basic Best Effort router:
 - **Conditioner**
- Control plane of a DiffServ router has one extra element ie **policy controller**, which is responsible of internal management and configuration of conditioner and scheduler



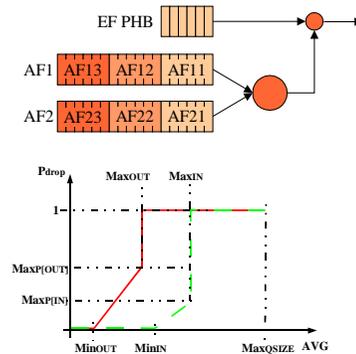
DiffServ Conditioner

- Traffic Conditioner is constructed a set of
 - Classifiers
 - Responsible of logical separation of packet streams
 - Meters
 - Responsible of rate metering of logical streams
 - Markers
 - Responsible of actions based on metering results and predefined thresholds



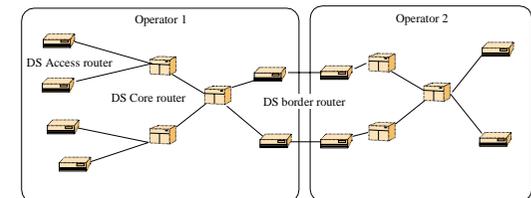
DiffServ PHB

- Per hop behavior is block which contains queue management methods required to implement desired service
 - Queues
 - Queue space management algorithms
 - Schedulers



DiffServ terminology

- Workload in DiffServ is divided between two inherently different types of routers
 - Edge routers
 - Core routers
- Edge routers are on the domain edge interfacing
 - Customer
 - Other ISP
- Edge routers** are responsible of conditioning actions which eventually **determine the logical network** where packet is to be forwarded



DiffServ terminology

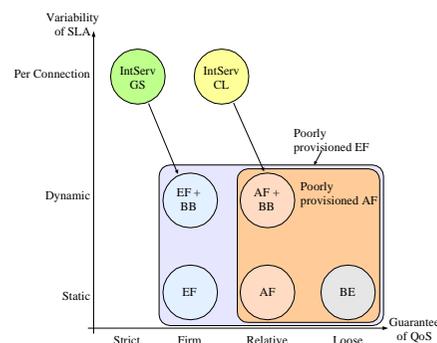
- **Logical network is concatenation of PHBs which interact together.**
- These logical networks have target service called **per domain behavior (PDB)**.
- Target service is loose definition for the goal of the logical network when it is provisioned and configured in a predefined way.
- Edge router chooses PDB for each packet which comes from the customer
 - Marks packet with DSCP of PHB used to implement PDB

DiffServ

- Service decision in edge router can be based on:
 - **Metering result**
 - Rate based
 - **Predefined set of filters**
 - IP address ie customer
 - TCP/UDP port ie application
 - **User request**
 - Preceded DSCP
 - RSVP signaling
- Core routers do nothing but forwarding of packets based on the extra information in DSCP field of packets
- Requires
 - Classifier to detect DSCP fields
 - PHB to implement forwarding behaviors

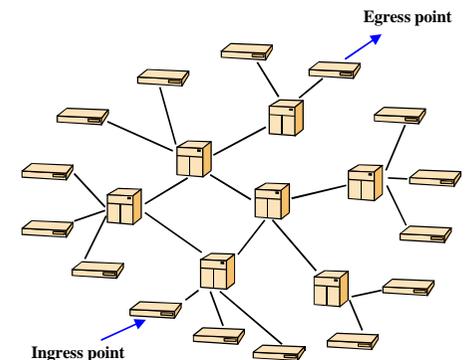
Service classes

- Differentiated Services is aligned between Best Effort and IntServ
- There is counterpart for each IntServ service class in DiffServ
 - Guaranteed Service <-> Expedited Service
 - Controlled Load <-> Assured Forwarding



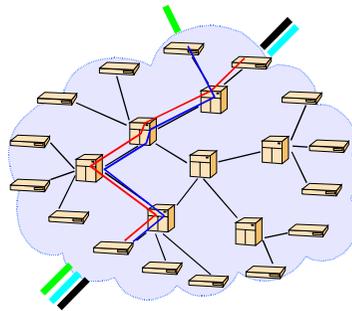
Expedited Forwarding (EF) [RFC2598]

- Leased line emulation
 - From destined ingress point to destined egress point
 - End-to-end service with
 - Low loss
 - Low latency
 - Low jitter
 - Assured bandwidth



EF

- Service commitment is **only** assured
 - Resources inside EF class are shared
 - Amount of other EF traffic influences to the value of delay, jitter and loss
 - Path is freely chosen
 - Delay constraint can not be held as the delay of paths are inherently different
 - No reservation is done
 - **Provisioning is in the key role**

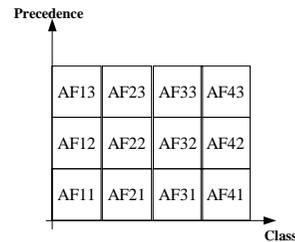


EF

- **Leased Line**
 - Dedicated resources
 - Full isolation
 - No room for overflow
- **Virtual Leased Line**
 - Shared resources
 - Partial isolation
 - From other than leased line traffic
 - Can accommodate overflow
 - Vague service guarantee
- Control of service guarantee
 - Access control
 - Rate control
 - User control
 - Provisioning
 - At least sum of contracted rates is allocated to EF traffic
 - High priority in the network
 - Scheduled ahead of other traffic
 - Starvation of lower priorities ?
 - » Only small fraction of total link capacity (10-30%)

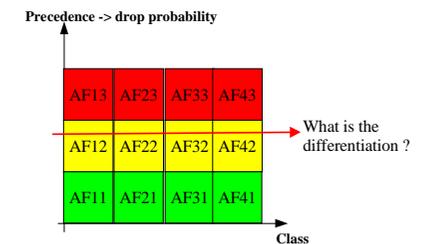
Assured Forwarding (AF) [RFC2597]

- **Four** independent service classes
 - All packets of a flow are destined to one of the classes
 - No association of service level between the classes
- **Three** precedences in each class
 - Flow can have packets with different precedences
 - Order of packets in a flow is not allowed to change
 - Precedence can not be used to scheduling decisions inside the class



AF

- No end-to-end semantics
 - Service can be deployed as any to any service
 - Like today
 - Uncontrollable resource usage inside the network
 - Very vague QoS
 - Class / precedence in contrast to service guarantee ???

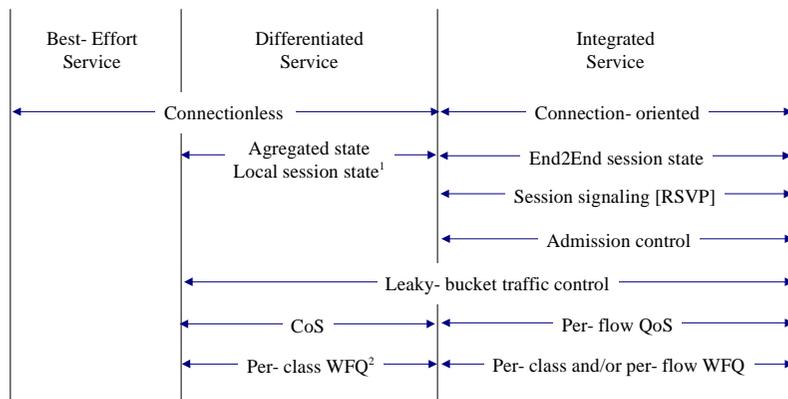


AF

- **Class differentiation**
 - Associate timing
 - Real-time to Bulk
 - Associate money
 - First class to cattle class
 - Associate user
 - CEO to laundry man
 - Associate protocol
 - TCP / UDP
 - Associate application
 - Clustering of similar application types
- **Precende differentiation**
 - Associate rate
 - Under/over subscription
 - The rest same as class based except timing can not be used

AF

- Construct services based on previous aspects
 - Many dimencions of freedom
 - How to make sure that system can not be manipulated
 - User control vs Network control



¹ Border routers may keep track individual sessions if required by policing or multifield classification.

² Scheduling depends on per hop behavior [PHB]. Minimum requirement is FIFO with multilevel RED.