

S-38.3180:Quality of Service in Internet

Lecture I: Quality and/or Differentiation

2.11.2006

Exercises

- Selected topics from the course
 - **Simulations**
 - **Analysis**
- All exercises **must** be passed to get grade from the course
- Course grading is (tentatively)
 - 40% of exercises
 - 60% of exam
- Deadlines
 - **Each exercise has individual DL**
 - Usually week or two from the start
 - Late submission lowers the grade
 - Final DL is one week after last exercise
 - Late submissions are not graded

Material

- **The course textbook**
 - Zheng Wang: "Internet Quality of Service: Architectures and Mechanisms "
 - ISBN: 1-55860-608-4
- **Lecture slides** to support the lectures
 - these are NOT to be taken as a standalone material or as a replacement for the book
- **Additional reading**
 - A selected set of related journal and conference papers and articles
- **Exercise material** to aid in completing the exercise and to provide background information

What is this course about

- We are going to try and try and try to get you to understand basics of
 - **Differentiation and Quality of Service**
 - What is the difference between these two
 - What have been standardized on these areas
 - Why to choose this or that for particular application
 - What is the big picture behind all of this
 - What are the small pieces that form the big picture
 - Are there any sense to make these things
 - Is there any sense to keep these lectures

Keep in mind through out the course

- **Money talks and bullshit walks**
 - ISPs are there for the money
 - They don't care about your needs
 - They don't care what you are using the net for
 - They care about your money
 - Therefore,
 - » They care your opinions
 - » They care that you are satisfied

Integration

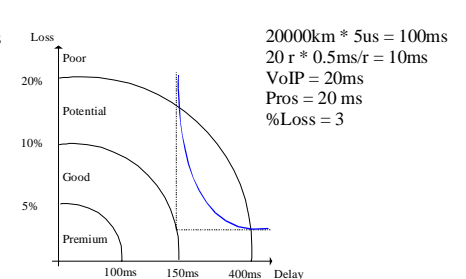
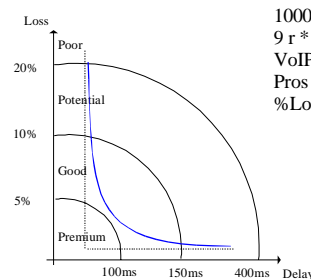
- IP is the next try for ubiquitous integration platform
 - All services are going to be delivered by using it (at least it is going to be tried)
 - Integration means that different media streams share common transmission system (IP)
 - Different medias have different requirements but there is only one IP
 - Which suits basically for nothing but bulk datagram service

Increasing the revenue

- **ISP want to increase their revenue, two options:**
 - **More money from the infrastructure**
 - More customers to the current infrastructure
 - Lower quality for individual customer
 - Cost for the individual bit is lower
 - Price for the individual bit is same
 - **Differentiation of bits and packets**
 - Same customer population with different categories
 - Different quality for individual customers
 - Cost per bit is higher
 - Price for individual bit is higher

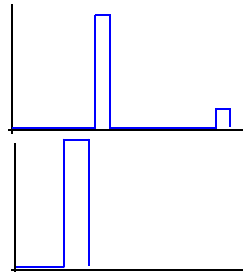
VoIP

- With real-time conversational services delay plays essential role
 - 200ms one-way delay is absolute maximum for tolerable operation
 - Also they expect to have their packets on steady intervals



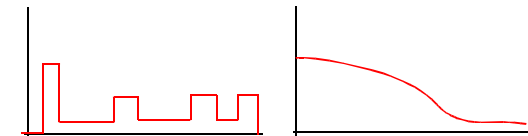
VoIP

- Way they send their information is controlled by the fact that information is generated from sampling of analog information
 - PCM-codec uses 125us sampling interval with 7/8 -bit samples
 - VoIP software usually buffers these samples for 10-30ms to produce decent packages (100-300 bytes)
 - Therefore there is a peak in
 - Time spectrum due to framing period
 - Packet size spectrum due to almost non-existing compression
 - » Change in this has happened with certain new codecs which have been designed specially for Internet voice



Data services

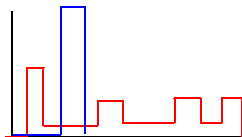
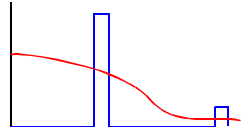
- Data services are usually based on TCP-protocol, which by its nature tries to maximize network utilization while keeping packet losses on tolerable level
- There is no clear expectation on service level as there are no easily measurable quantities
 - Other than throughput, latency and packet loss
- To maximize utilization one expects to see as large packets as possible with as high rate as possible



- Large number of this kind of processes lead to high burstiness as individual connections come and go

Integration

- Mixing these two service types in a single network leads to certain problems
 - Which is more important small delay (required by real-time connections) or high utilization (starting point of TCP based dataservices)
 - In packet level this shows out as differences
 - In sending process (frequency of packet sending is very different)
 - In quantity of information



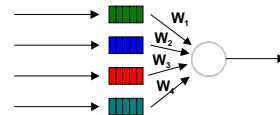
Integration

- To overcome this we add quality and/or differentiation
 - Network capacity is divided into fragments - one for each service quantity
 - In connection based system this fragment is size of the connection and number of parallel fragments is dependent on number of simultaneous connections
 - In connectionless system this fragment is size of the aggregate and number of parallel fragments is dependent on number of service classes



Integration

- Dividing network into the fragments actually means that scheduling of network services is changed from First Come First Served (FCFS) to some other which can cope with multiple parallel service requests
 - Each request have weight that represents share of the network resources that are dedicated to individual request



QoS - Differentiation

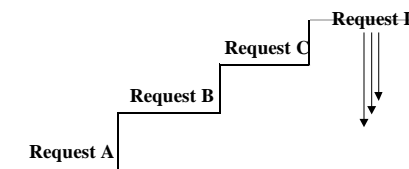
- Small but remarkable difference:
 - **QoS**
 - Pre-negotiated boundaries for the traffic and service which are used for individual packets over the time lifetime of the connection
 - **Differentiation**
 - Pre negotiated numerical boundaries for the traffic and service which are pursued over the lifetime of subscription

So this course is about

- How network resources can be connected to individual users, applications
 - **Resources:**
 - **Network capacity**, bits that flow through the links and routers
 - **Buffer space**, memory that is used to store contending packets
 - **Forwarding capacity**, how many pps a router is capable of delivering

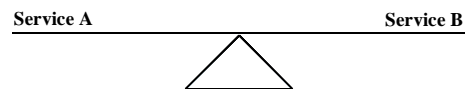
QoS

- **Goal is to devise a service which could fulfill the demand**
 - Resources are connected to individual service requests
 - Numerical service descriptors of requests are used as basis for resource reservation
 - New service requests are blocked if there are no resources available



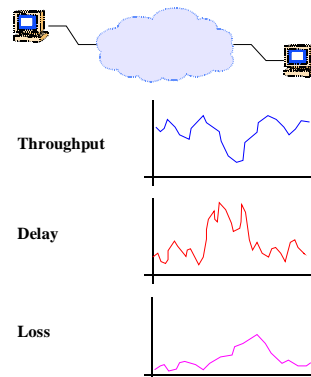
Differentiation

- **Current situation in Internet**
 - No differentiation
 - Equal opportunities -- equal misery
 - Depends on where are you looking ;-)



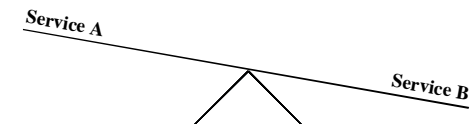
IP-service

- **Internet service is connectionless datagram service**
 - It roughly resembles normal snailmail
 - Each packet carries enough information to pass through the network
 - Each packet flows through independent route
 - Each packet experiences delay, loss and throughput which is dependent on network status and selected route



Differentiation

- **Differentiation means that resources are targeted to certain services or groups of users**
 - Overall resources do not increase
 - One gets better service than before
 - Other get worse service than before
 - Analogy: Try to shake hands with people both side of you - which gets first



Differentiation

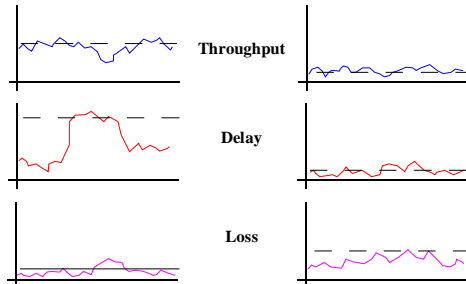
- **Snailmail has operated for years with differentiation based on money or status**
- Differentiation can change the
 - **Speed of service**
 - Delivery time
 - Express mail, normal mail
 - **Quantity of service**
 - Physical size of the letter
 - Weight of the letter

Differentiation

- IP routers have two resources to differentiate with the effect on three measurable dimensions:

Network Capacity – Capacity

- How many bits per second one can send into the net



Buffer Space – Delay

- What is the delay between sender and receiver

– Loss

- On what probability packets are delivered

QoS

- **IP QoS is Russian roulette**
 - IP is connectionless and does not control the delivery
 - Sudden increase in number of packet to be delivered
-> more processing -> more delay
 - Sudden link overload
-> buffering -> more delay
 - Long term link overload
-> overflowing buffers -> packet loss

QoS in IP networks

- **Not trendy at the moment**
 - QoS requires a lot from the ISP
 - Competence to run the network (strict provisioning)
or
 - Lot of spare capacity (poor utilization)
- Used in marketing to increase revenue
 - Promising is cheap (differentiation)
 - Marginal increase in expenses
 - Guaranteeing is expensive (QoS)
 - Will this ever work economically ???