Introduction to Internet pricing

Lecture slides for S-38.3192
22.2.2007
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Goals of this lecture

• After this lecture you will be able to
  – Know the different options of realizing Internet pricing
    • What data to collect?
  – Discuss the problems in bringing pricing/billing functionality to Internet
  – Know what goals can be achieved with pricing
  – List and detail different pricing schemes
PSTN vs. Internet

• Telephone networks
  – offered same service quality to all customers
  – Form one connection for a call
  – Have analytically analyzable traffic patterns

• Future Internet
  – Will provide different types of service levels according to customer needs
  – Delivers packets one by one
  – Has very complex traffic patterns at packet level
  – Therefore, telephone network charging is not sufficient

Definition of pricing

• From an ISP point of view, for any service to survive, it has to collect its costs from its users
  – This includes both capital costs and operational costs
  – Pricing means the way these costs are collected from users

• Aka charging, accounting
• From the user point of view the payment is paid to receive service (at a certain quality).
• Therefore, the overall goal is to get ROI and to control user service level (avoid congestion).
Input & output in pricing

- Network measurements reveal use of network resources
- May indicate need for network update
- Reveals user population and their usage
  - Early indicators of problems!

Billing systems

- From Hartanto & Carle: Policy-based billing architecture for Internet Differentiated Services, 1999
Pricing architecture

• Pricing location
  – User – ISP interface
  – ISP – ISP interface (check the lecture on peering)

• Pricing is about collecting data

• Pricing is always contract-based
  – Check the SLA-lecture
  – Users specify their traffic and performance requirements; network admits only traffic that is within specifications; other traffic is policed at the network ingress

Pricing architecture: Edge pricing

• By Shenker et al.

• An example of an architectural solution aiming to support various pricing models

• All pricing mechanisms are set up at the edge of the network
  – Complexity is reduced to local problems
  – Does not support pricing models that charge receivers
  – Does not support multicast
Pricing of what?

• From the user point of view: A major role of prices is to present information to people about the true costs of their actions. If prices accurately reflect costs then individuals can compare the benefits of their actions to the costs of their actions and make informed decisions (benefit/cost –ratio).

• ISPs are expanding to
  – Providing access (the usual thing)
  – Providing applications (ASP)
  – Providing content (CSP)
  – Providing services on the move (MSP)

• Peering is becoming more difficult

• Flat-rate pricing may not be enough
  – Especially in a QoS network

• Do you link the price to the cost that customer’s use of network creates or to the value that the customer’s service produces (to himself)?

Pricing basics

• ROI is the prime objective of an ISP
  – Incoming money should cover both the capital and operational costs of running and maintaining the network

• What is the marginal cost of an individual packet? Or a byte?
  – Average cost, marginal cost etc.
  – Data volume, burstiness, streaming, elastic

• Pricing of the ISP should first result in a fair way of sharing the networking costs
  – Those who use more, pay more. Is this reality today? To what extent it is/is not?
Fundamentals of pricing

• Collect & measure pricing data to accounting databases
  – Remember different time scales
    • Subsecond for packets, minutes for flows/sessions, hours and days
      and weeks and months for data, BW usage etc.

• What are the things you can measure?
  – Access
    • As you register into the network
  – Data content (processing intensive)
    • Information/content related
      – May include copyright fees etc.
  – Transported data
    • Network usage based
      – Volume or BW-based
  – Congestion data
    • Buffer levels, processor usage (pkts)
    • Price the services/traffic that are congested

Discrimination by pricing

• Pricing can also be used to discriminate users
  – If different users are willing to pay different prices
    for the same/better service
  – Price discrimination means that price difference
    between two services is (much) higher than the
    cost of providing these services
  • QoS
  – Is there a way to prove that one service is always
    distinctly different from another service (think for
    example DiffServ AF and BE in an unloaded
    network)?
    • However, people buy different types of cars, airline
      tickets, cell phones, clothes…
Pricing alternatives

• Access pricing (flat rate)
  – Depending on access rate, mostly flat-rate
    (depending on access rate, naturally)

• Traffic pricing/Usage pricing
  – Price according to data sent/received

• Content pricing

• Or a combination of the alternatives
  – Like access charge+traffic charge

Pricing schemes based on traffic properties

• Flat rate (access rate)
  – Independent of any user or network status

• Usage based (traffic based)
  – Depends on the users action, use of bandwidth or
    amount of transmitted/received data

• Congestion based (resource usage)
  – Depends on network/service status
  – Is not directly dependent on individual user action
  – Remember, usage causes congestion and (heavy)
    congestion reduces usage (eventually)
Access pricing – flat fee billing

- Easy on the surface: Determine costs per access and divide them per user per access
- Key question: How to determine the _actual_ marginal cost of adding one more customer?
  - Due to the nature of traffic in the Internet, this depends on the traffic profile of the user.
    - Is the new user going to use the whole access or only parts of it?
      - > Volume/BW-usage pricing
    - Does the user require rt-services or not?
      - > Congestion pricing, QoS-pricing

Charging flat fee for access

- Charge the user daily/weekly/monthly/per annum for her access
  - Provides no incentives for increase or decrease of access usage
  - Does not provide any info on network status and its development (see lecture on Network planning)
  - Based on the single-service best effort model
  - Low-usage customers support high-usage ones
  - Flat fee is easy to implement and provides predictable income.
Usage sensitive pricing

- User consumes certain amount of resources for a certain amount of time
  - Price either datavolume (or packets) or the duration of usage
  - The amount of sent/received data
    - Needs metering, ticketing or some such system
      - Is therefore susceptible to scaling problems
    - Volume-based or possibly duration-based (flow)
      - Note volume/duration gives average BW-usage
  - Price unit (per byte, per second) may be either static or dynamic.
    - Dynamic pricing examples: Smart market, feedback pricing
      - f(?)=price

Case: Users vs. traffic sent

- Top 0.008% users (~30 servers!) produce 20% of datavolume (bytes).
  - Let’s assume 400 000 users sending traffic and 20 /month = 8M /month (this will be our target billing)
  - Let’s assume 1200Gbytes/month from all users -> 0.0000067 /bytes evenly divided (static price).
  - If we used static volume-pricing (per data sent) then the Top 0.008% of the users would have to pay 1600000 /month ~ 53300 /user -> Yeah, right!!
    - And the least using 10% of the customers who produce 5% of the traffic would have to pay 400000 ~ 10 /user
Case: Users vs. traffic received

- Top 0.04% users (~400 receivers) receive 20% of datavolume (bytes)
- This time ~800 000 users (same network though as in the previous slide)
  - If we aim for the same 8M this means 10 /month for all users if evenly shared
  - Top users pay now 4020 /month, still too much (but a tenfold cheaper than in the previous slide)
  - The least 10% of the receivers produce 0.5% of traffic should now pay 0.50 /user.

Case: Users vs. total traffic

- Top 0.02% of all users (~160) send and receive 20% of traffic.
  - Evenly shared costs still mean 10 /user.
  - Top users pay now 10050 /user.
- The final 10% see 2% of the sent and received traffic and should pay 2 /user.
Notes on usage based pricing

• There are less senders than receivers (1 sender:10 receivers (duh!)) so always account for both.
  – Internet is about Inter-acting, after all
• Also, account for both sent and received data
• Traffic profiles are still so diversified that linear cost allocation (per byte) is not feasible.
• Further enhancements:
  – Dynamic pricing (e.g., exponential weighing of sent/received data)
  – Other methods of smoothing the differences…

Congestion based pricing

• Prioritize usage of a congested resource
  – Such as a server or a link
• Those who value access to the resource the most (are willing to pay the most) get the highest priority
• Usage based prices produce revenue that can be targeted to increasing the service level of the congested resource
Charging scheme: Smart Market

– By Mackie-Mason & Varian
  • Uses auction mechanism
  • Calculates packet prices as they arrive to a congested router
  • Equilibrium price is the bid of the marginal user and revenue equals the optimal investment to expand network capacities
  • Non-congested router offers _free_ packet forwarding -> well provisioned network has no revenue gain

Congestion pricing feasibility

• Network resources are not (usually) very scarce (no congestion – no revenue)
  – If they are, the users will find another operator
• How does the user know what prices will be bid and what will be charged for the service?
  – Congestion pricing may produce unpredictable results from a user point of view
• Congestion pricing implementation is more complex than, for instance, simple volume-based pricing with admission control
Final remarks: Pricing guidelines

- Internet is a simple network that works with simple ideas, so KISS (+even if it might not be not the cheapest solution)
  - Datavolume/Flow based vs. congestion pricing
  - Remember that you can always combine different pricing models: flat fee + congestion pricing of service X + volume charge after threshold Z
- Make money based on true costs (capital and operational)
  - Remember that sometimes price discrimination works
- And remember: Eventually, quality will rise, prices will decrease and revenues will increase (you do the math! 😊)