HELSINKI UNIVERSITY OF TECHNOLOGY

Introduction to Internet pricing

Lecture slides for S-38.3192

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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

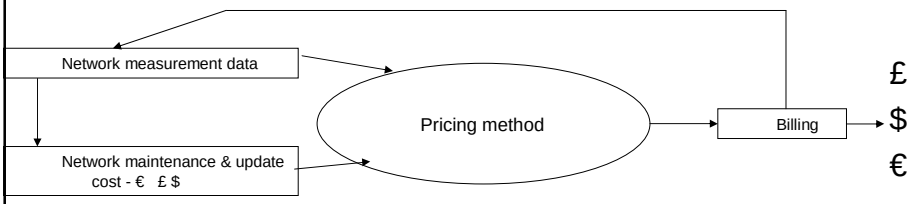
PSTN vs. Internet

- 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).

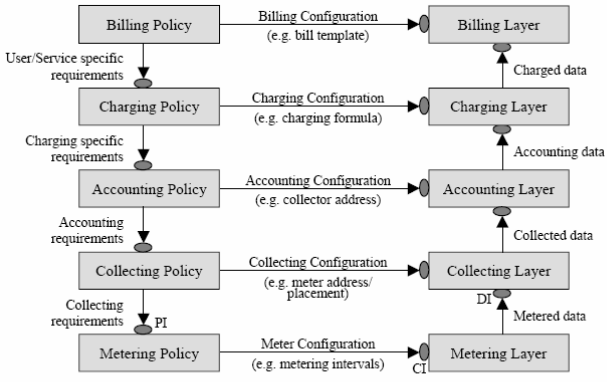
Input & output in pricing



- 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



PI = policy interface; CI = configuration interface; DI = data interface

Figure 1. Billing System Framework

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 the price to the cost that customer's *use of network* creates or to *the value* that the customer's service produces (to himself)?

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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 traffc 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.
  - Inter-net 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 idead, 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! ☺)