

Charging *ATM* Services: Introduction

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Why Charge for Telecommunication Services ?

- In order for the Network (or Service) Provider to:
 - Recover costs
 - Make profits and save capital for future expansion
 - Control the system:
 - examples: charging of applications for admission to U.S. universities
 - charging for street-parking in Athens
 - Obtain information from users:
 - examples: special long-distance call packages in U.S.A.
 - => their adoption is indicative of user's *future* behavior

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Terminology

- Price:
 - money paid per unit
 - example: Drachmas/sec, EUROS/Mbyte, \$/call
- Charge:
 - total payment for the service, determined on the basis of prices
 - example: amount of money paid in a restaurant, determined on the basis of the prices of portions
- Tariff:
 - parameterised class of formulae for determining charges
 - example: Athens taxis have 2 tariffs

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Terminology (continued)

- Accounting:
 - the gathering of all information necessary to
 - compute the charge of a service
 - attribute the charge to the customer liable to pay
- Billing:
 - the procedures associated with issuing and delivering the bill of a customer of telecommunication services
- B-ISDN and ATM will be treated as synonyms, although:
 - B-ISDN (Broadband - Integrated Digital Services Network) is a class of *networks*, while
 - ATM (Asynchronous Transfer Mode) is the *technology* adopted to offer B-ISDN services

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Types of Charge

- There are four types of charge:
 - Fixed charge
 - Usage charge
 - Congestion charge
 - Quality charge
- A charge of a telecommunication service constitutes a combination of the above components, which may overlap

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Fixed Charge

- Is independent of *usage*
- Examples:
 - monthly subscription to a telephone service
 - membership fee to a private club
- Some services charged exclusively on fixed charges:
 - examples: all-you-can-eat restaurants
 - monthly flat rate charging of Internet access

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Usage Charge

- Depends on the amount of *resources used*
- Examples:
 - telephony is charged on time and distance
 - a fish portion in a restaurant is charged proportionally to the weight of fish
- Theoretically, in a competitive environment
 - usage charge = cost of additional resources required to offer the additional instance of service
- *Difficulty*: Define and measure parameters that reflect resource usage => to be used as *charging* parameters

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Congestion Charge

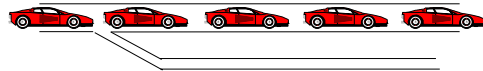
- Depends on congestion *during* service
- Applies to cases where:
 - there is *infinite* capacity => everyone can be served, but
 - congestion results in service quality *degradation*
- Example: Charging access to highways, bridges etc.



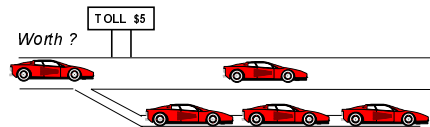
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Congestion Charge (continued)

- *Free access* => traffic in highway is *heavy*



- *Paid Access* => traffic in highway is *lighter*



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Congestion Charge (continued)

- Congestion charge influences users' *demand*, according to their *utilities* => Should not be:
 - very *high* => leads to *under-demand*
 - very *low* => leads to *over-demand*
- ➔ Theoretically:
 - congestion charge = social cost of serving the additional user, due to the congestion caused
 - may be *irrelevant* to actual costs
- Hard to *define* and measure *on-line* => Can be *approximated*:
 - a priori congestion charge => example: highway toll
 - time-of-use charge => example: *time-of-day* pricing of telephony

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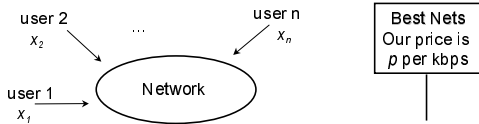
Quality Charge

- Differentiates instances of a service with different quality
- Often included in usage charge
- Examples:
 - overnight and first-class delivery by Post
 - luxurious restaurants
 - collective items

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Charge as Control Mechanism

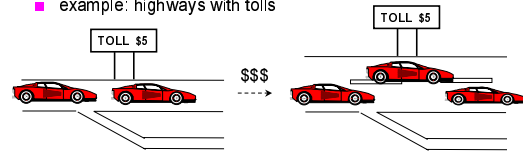
- Charges can be used as an *internal control* mechanism of the system provider-users to reach the social optimum
- Example:
 - Network Provider sells bandwidth at the equilibrium price p per kbps, determined by *demand = supply*
 - given this price, each user i selects amount x_i of kbps purchased
 - provider pays for capacity with the revenue collected
 - equilibrium price p also leads to social optimum



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Capacity Expansion

- A network provider should expand capacity when:
 - congestion arises
 - social welfare can be further increased, *despite* the cost for additional capacity
- Economic theory suggests that expansion can be funded by re-investing the revenue from *congestion* charges
 - example: highways with tolls



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Incentives

- A charging scheme influences users' *demand* and behavior, according to the *incentives* it offers to the user, regarding how to maximise his *own utility* (benefit from service vs charge)
- Each individual user's behavior influences the *global* well-being (social welfare) of the society (users and network)
- A charging scheme is *incentive compatible* if individual user utility optimisation *also* results in social welfare optimisation

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Examples of *Wrong* Incentives

- Free use of Internet:
 - congestion everywhere
- Sole monthly flat charge for Internet access (U.S.A.):
 - blocking: connections with modems were left permanently open
- Free night use of mobile telephones (U.K.):
 - blocking: telephones were left open for long hours
- All-you-can-eat restaurants:
 - food quality drops: higher costs encountered because customers tend to take larger portions

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Examples of *Right* Incentives

- Usage-based charging of Internet:
 - considered as the *only* way to avoid congestion
- Time-of-day charging in telephony:
 - shifting of non-business calls off peak period
 - satisfaction of both business and non-business users
- Special tariffs offered by Mobile Operators: for business users, for users calling mostly within city etc.
- The above charging schemes are *incentive compatible* and result in more efficient operation of the network

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Incentive Compatibility (revisited)

- In *competitive* environments: a provider should aim for incentive compatible charging
- Otherwise, users would migrate to a competitor who
 - charges according to an incentive compatible scheme
 - leads to a *more* satisfied (as a whole) user society

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Factors Determining Charges of Telec. Services

- Cost to Provider
- Market Issues and Marketing Decisions
- Regulatory Constraints
- Technological Issues

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Costs

- A network provider faces costs for:
 - equipment and software
 - operation, management, and maintenance
 - include accounting and billing costs, which may (but should *not*) be *high*:
 - were 6.5% of AT&T revenue in 1984
 - labor
- The level of costs in telecommunication environments is highly uncertain

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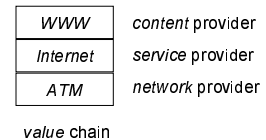
Costs per Call - Relation to Charges

- For each call, costs are incurred for:
 - set-up of call
 - transmission of information
 - switching of information
- It is hard to accurately estimate the cost of individual calls, due to the complexity of the system
- Under perfect competition charges should reflect costs
 - hard to achieve accurately, even with elaborate cost models

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Market and Marketing

- Charging schemes and charges depend on:
 - users' demand
 - competition
 - complementary and/or substitute services offered:
 - by the *same* provider
 - by *other* providers
 - distinction *not* always clear
 - example: ATM or Internet ?
or both ?



- strategy on resale

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Other Factors Determining Charges

- Regulatory constraints
- Technological issues determine
 - service supply
 - types
 - quantity
 - quality
 - service mix offered
 - costs
 - resource usage parameters
 - feasibility and cost of accounting

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User Requirements on Charging Schemes

- According to market surveys (for ATM services), users *prefer* charging schemes that :
 - are simple - example: flat rate charging
 - are fair => pay *less* when using the service *less*
 - are predictable - *counterexample*: charges depending on network state
 - reflect some measurable notion of *usage*
 - same *usage* at same time=> same *charge*
 - lead to simple and *auditable* bills
- Users do *not* like congestion-based charging, particularly if charges vary without *warning*

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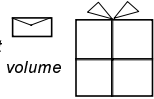
Advantages of Usage-based Charging

- Appealing to *users*
- Can offer the right *incentives*, and lead to an *efficiently* operating network
 - the incentives should be *explained* to users
 - example: flat rate vs usage-based charging of local telephones (USA)
- Can also charge for congestion in a sensible way
 - example: time-of-day pricing of telephony
- Usage charges can reflect costs better than flat-rate
- Economic theory suggests that usage-based charging be employed under *perfect competition*
 - otherwise, users can switch provider !

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Difficulties with Usage-based Charging

- *Definition* of resource usage *not* always clear
 - examples:
 - *telephony*: call duration and distance
 - *leased lines*: bandwidth and distance
 - *ATM*: ?
 - *postage service*: letters charged on *weight*
big objects also charged on *volume*
- *Measurement* of (theoretical) resource usage can be:
 - technologically hard (or even infeasible)
 - costly



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Why is ATM Hard to Charge ?

- A large variety of combinations of *parameterised* bearer services should be charged under a *unified* framework
- It is hard to define and measure *resource usage* due to:
 - its dependence on QoS
 - statistical multiplexing
 - burstiness of traffic
- It is hard to quantify and apportion *costs*, due to:
 - sophisticated technology
 - statistical multiplexing

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Why is ATM Hard to Charge ?

- Users can select from different ATM bearer services
 - Market should be *segmented* appropriately
- ATM is a *new* service:
 - ◆ it is hard to predict *user* response to charges
- ▼ Complex and/or costly charging of ATM may *impede* its market penetration and growth

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Concluding Remarks

- What is needed for charging ATM successfully ?
 - Understand *all* sides
 - Respect *complexity*, *technology*, and *users*
 - Comply with *standards*
 - Compromise between *user* and *s*
- What should we avoid ?
 - Do charging ad-hoc
 - A prohibitive accounting cost
 - Ignore incentives
 - Consider that charging is only a marketing issue
 - Think of charging as being independent of the technology
 - Add the charging component in the last minute

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