Incentive mechanisms for decongesting roads: Results from a pilot program in Bangalore

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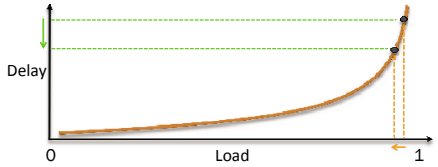
Introduction

- Congestion occurs when many agents simultaneously use a scarce resource; it is a standard feature of networked resources
  - Transportation Networks, Electric Networks, Computer Networks, Telephone Networks, …
- Various methods have been developed for coping with congestion, usually tailored to the situation
  - Carpools, traffic-sensitive signal lights, tolls
  - Differential pricing for peak and off-peak use
  - Congestion control algorithms like TCP in the Internet
  - Congestion control standard for Data Center Ethernet: IEEE 802.1
- These methods usually address congestion, *once it has occurred*
- Incentive mechanisms, the topic of this talk, can postpone or even prevent the occurrence of congestion
- **Main Thesis:** "The right to congest" can be made into a tradable commodity
  - Those who use the roads at congested times pay those who stay away during such times
  - This is incentive compatible: The congestor benefits from the reduced congestion; the decongestor is appropriately compensated

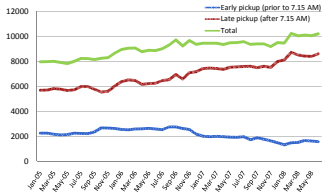


- **Auxiliary Thesis:** Small good deeds don't carry adequate rewards, so they aren't performed
  - A system, which pools individual rewards, but pays out a few large sums through raffles may carry adequate incentives
- In games with low stakes, players are more risk seeking
- Specifically, if *U(.)* is a concave utility function with *U(0)=0*, and assume one of the following two conditions holds:
  1. $-xU''(x)/U'(x) \geq 1$ (This is the well known Relative Risk Aversion function)
  2. $xU'(x)/U(x)$ is a monotonic decreasing function
- If $X \geq 0$ is a random variable representing payoff, then for $0 < \delta < 1$, $E[U(X)] - U(\delta E(X)) \geq 0$ for sufficiently small $E(X)$

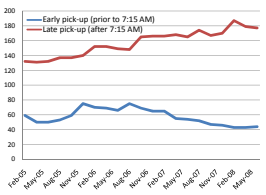
The INSTANT project

- The INSTANT (Infosys-Stanford Traffic) project is a pilot study of using an incentive mechanism to decongest road traffic
  - The goal is to incentivize Infosys commuters to arrive early to work
  - We shall see this leads to shorter commute times, reduced congestion, lower fuel costs and pollution
- Pilot program launched by N.R. Narayanamurthy, co-Founder and Chief Mentor of Infosys on Oct 6, 2008 at Infy, Bangalore
  - Pays commuters money through a lottery mechanism for coming early
  - 14,000 commuters eligible for the scheme
  - Results show that number of early comers has doubled
  - About 1900 employees rewarded as of date

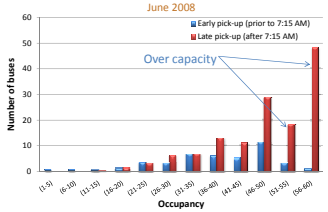
Monthly average number of commuters



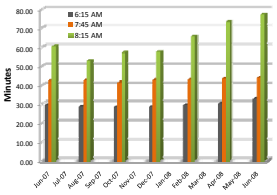
Buses deployed to service demand



Bus occupancy: Early vs. Late
June 2008



Journey times from Jayanagar

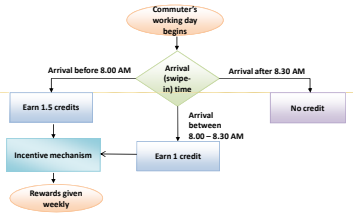


- In summary: *Long time, no seat!*
- There is a huge difference in commute times
  - A 7.15am bus into Infy is at least 30 mins quicker than an 8.15am bus
  - Similarly, a 5pm bus from Infy is at least 30 mins quicker than a 6.15 or 7.15pm bus
- Most Infoscions can benefit by coming in early and leaving early; the benefits are manifold:
  - Shorter commutes by at least 1 hour
  - More comfortable rides (i.e. empty seats)
  - Savings in fuel costs (about Rs. 20,000 per day)

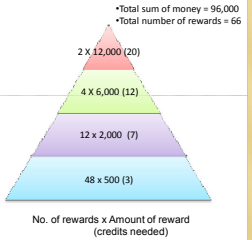
The incentive mechanism

- We propose a monetary incentive mechanism to help transition to earlier commute times!

Flow chart of the scheme

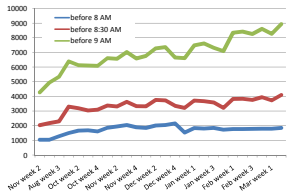


The reward pyramid

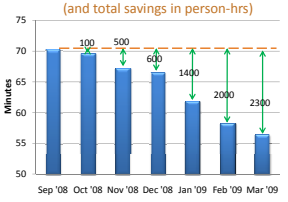


Results

Commuter arrivals



Average morning bus commute time (and total savings in person-hrs)



Summary and next steps

- The INSTANT project advances a strong argument in favor of "charging congestors and rewarding decongestors".
  - This contrasts with current congestion charging schemes which are viewed as "yet another tax", and makes it possible to consider congestion pricing via a "market approach".
- Next steps, interested entities
  - Parking and Transportation Services (P&TS), Stanford University
  - Bangalore: ELCIA and a pilot for the city
  - Cambridge (UK)