Pricing by Timing:
Innovating Broadband Data Plans

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Bandwidth Hoggers

AT&T hikes rates on smartphone plans

COMPUTERWORLD.in

Mobile growth driving out unlimited data
By Stephen Lawson on Oct 22, 2011

c|net

Comcast to throttle some customers' Web speeds
The Driving Forces

- Video is becoming the dominant traffic
- Capacity-hungry apps vs. limited network resource
- Cloud service automation and synchronization

* Monthly basic mobile phone data traffic
Source: Cisco VNI Mobile, 2011
“...the importance of business innovation to promote network investment and efficient use of networks, including measures to match price to cost, such as usage-based pricing”
Heavy Traffic, but not all the time...

Distribution

Bandwidth consumption

ISP’s revenue

ISP’s cost

"Daily" Graph (5 Minute Average)

Peak demand > 99%

Average demand < 30%
Use pricing/discounts to exploit the time-elasticity of traffic

Volume

Streaming videos, Gaming
Weather, Finance

Time Elasticity

Email, Social Network updates
Cloud
Software Downloads
Movies & Multimedia downloads, P2P
Time Elasticity: Our Survey

Many applications are time-elastic
Time Dependent Pricing (TDP)

Network Measurement

User Profiling

Price Determination

User Response

User Interface

Large scale ISP cost optimization, taking user reaction into account
Proposition 1: The ISP’s optimization problem for time-varying rewards can be formulated as

\[
\min \sum_{i=1}^{n} p_i \left( \sum_{k=1, k \neq i}^{n} \sum_{j \in k} v_j w_j(p_i, i - k) \right) - f(x_i - A_i)
\]

(1)

s. t. \( x_i = X_i - \sum_{j \neq i}^{n} \sum_{k=1, k \neq i}^{n} w_j(p_k, k - i) + \sum_{k=1, k \neq i}^{n} \sum_{j \in k} v_j w_j(p_i, i - k) \),

(2)

\[ \text{var. } p_i; i = 1, \ldots, n. \]
Waiting Function Estimation

\[ w_{\beta_{ji}}(p, k - i) = C_{\beta_{ji}} \frac{p_i}{(k - i + 1)^{\beta_{ji}}} \]

Economic modeling

Network Measurement

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User Interface

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User Response

waiting function

reward

delay

patience index
TDP: Architecture
TUBE’s Scope

Ongoing trials in **US and abroad**

- **TUBE**
  - Wired
    - Windows
    - Mac
    - Residential Gateways
  - Wireless
    - iOS
    - Android
    - Windows
Princeton Trial: Data Flow

Trial with 20 iPad and 30 iPhone users
Screenshots: Princeton Trial

a) Price offers and Usage

b) Monthly budget.

c) Delay tolerance.
TDP Simulation Results

TDP achieves Valley filling & Peak reduction
Peak-to-average ratios **decrease** with TDP
TUBE Summary

Current Practice Trends

Flat Rate → Capped, Prepaid, Throttling, Usage Based, Price Wars

MAP Measurement, Analytics & Profiling → Time-Dependent Pricing (TDP)

Intelligent Flat Rate (IFR) → Time-dependent demand shaping
Offering Prices

- **Users schedule** based on explicit prices
- **Automated scheduling** based on implicit prices
- Either way, traffic shifted from peak hours

### Pricing Plan

<table>
<thead>
<tr>
<th>UI Design</th>
<th>TDP (Explicit pricing)</th>
<th>IFR (Implicit pricing)</th>
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<tbody>
<tr>
<td>User reactions</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Auto-Pilot</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Benefits to ISPs</td>
<td>Benefits to Consumers</td>
<td>Bridging the Digital divide</td>
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<tr>
<td>Reduce cost</td>
<td>Reduce monthly charge</td>
<td>Ultra-affordable new service class</td>
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<tr>
<td>Manage congestion</td>
<td>Have choices when to use</td>
<td>Reduce middle mile capacity need</td>
</tr>
<tr>
<td>Monetize bandwidth</td>
<td>Auto-pilot</td>
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Thank You!

Questions?