re-feedback
opening a new chapter of Internet innovation?

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how to share a cloud

- anyone can use any capacity anywhere on the Internet, as much as they like, without asking
  - fantastic ideal
  - but when freedoms collide, what share do you get?

- decades of misunderstanding
  - about accountability for usage costs of pooled bandwidth

- freedom without accountability?
  - operators would rather carve up resources than pool them

- proposed solution shares a cloud and caters for
  - self-interest & malice
    - of users and of providers
  - evolvability
    - of new application behaviours
    - of new business models
  - viability of supply chain
  - simplicity
how classic Internet sharing ‘works’
endemic congestion & voluntary restraint
(increasingly overridden in practice)

- aka. those who take most, get most
  - technical consensus until Nov ‘06
    voluntarily polite algorithm in endpoints – ‘TCP-friendliness’:
      - a game of chicken – taking all and holding your ground pays
        (VolP, VoD Joost 700kbps)
      - or starting more ‘TCP-friendly’ flows than anyone else (Web: x2, p2p: x5-100)
      - or for much much longer than anyone else (p2p file-sharing x200)
    - poss. net effect of both (p2p: x1,000-20,000 higher traffic intensity)
cost-shifting between services

- scenario
  - NGN sells unlimited Internet service at an average cost
  - NGN also a higher level service provider (TV, video phone)
  - competing with independent service providers (Skype, YouTube)

- who pays for capacity & QoS costs of higher value services?
  - NGN service layer must pay these costs internally
  - higher than average delivery cost of independent service
    - shifted to NGN's lighter users
    - because of how Internet sharing 'works'
blame our choices not the customers'

- network operator's knee-jerk reaction
  - throttle p2p or independent services
- but first, any CEO of a network business should be able to answer this question
  - Q. what is the cost of network usage?
  - A. volume? NO; bit-rate? NO
  - A. 'congestion-volume' (next slide)
- cannot be measured in current Internet protocol (IP) networks
- we haven't designed our contracts & our technology for machine-powered customers
  - attack customers' choices?
  - or attack the cost accountability deficiencies of IP?
a new metric for accountability – a bandwidth trading unit

- congestion-volume
  - your volume weighted by congestion when it was sent
  - distinguishes friendly & hostile volume

- intuition
  - some ISPs count volume during peak like counting (100% x volume) during peak and (0% x volume) otherwise
  - congestion-volume = \( p \times x_i \) over time

- how to measure
  - volume discarded from your traffic
  - more interesting: volume marked with explicit congestion notification (ECN)

- a resource accountability metric
  - of customers to ISPs (too much traffic)
  - and ISPs to customers (too little capacity)

1. cost to other users of your traffic
2. marginal cost of equipment upgrade
   - so it wouldn’t have been congested
   - so traffic wouldn’t have affected others

- competitive market matches 1 & 2

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note: diagram is conceptual
congestion volume & capital cost of equipment would be accumulated over time
if incoming congestion were visible

congestion policing

- only throttles traffic when your contribution to congestion in the cloud exceeds your allowance

Acceptable Use Policy
Your 'congestion-volume' allowance: 1GB/month (= 3kb/s continuous)
Only limits excess traffic above the Internet 'high-water-mark'
Under typical conditions this will allow you to transfer about 70GB per day

but the Internet wasn't designed this way
- path congestion only visible to end-points, not to network
**re-ECN = standard ECN + re-inserted feedback**

or re-feedback

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1. Congested queue debit marks some packets

2. Receiver feeds back debit marks

3. Sender re-inserts feedback (re-feedback) into the forward data flow as credit marks

4. Outcome:
   - End-points still do congestion control
   - But sender has to reveal congestion it will cause
   - Then networks can limit excessive congestion

5. Cheaters will be persistently in debt
   - So network can discard their packets
   - (In this diagram no-one is cheating)

- **No changes required to data forwarding**
interconnect aggregation
simple internalisation of externalities 'routing money'

just two counters at border meter monthly bulk volume of marked packets
= aggregate downstream congestion-volume in flows
without measuring flows
there are better solutions than fighting

- light usage can go much faster
- hardly affecting completion times of heavy usage
- only requires bulk congestion policer incentives
  - evolution path to simpler quality of service, with multipath, multi-site, roaming,...
  - denial of service mitigation

NOTE: weighted sharing doesn't nec. imply differentiated services
- can be weighted aggressiveness of end-point rate control
- 'Design for Tussle' advises allow both
openness – a tactic not a strategy

- once true usage costs visible at ingress control point
- retailers can choose
  - how tightly to control their customers' choices vs cost
  - their market position between open and closed
- changing your mind
  - involves changing a policy
  - not new technology
- truly converged architecture
  - for vendors & wholesalers
  - but no need for retail monoculture
- designed for tussle
a new chapter of innovation

- applications & services
  - opens whole new space

- transport layer on end-points
  - usage costs currently visible here

- internetwork layer
  - once usage costs revealed here
  - ISPs won't need deep packet inspection for cost control

- link layer
  - once network layer can limit congestion
  - can remove bit-rate limits in shared access networks: passive optical networks, cable, wireless, cellular...
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clarification questions?
spare slides
## Problems using Congestion in Contracts

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<th>2. ECN</th>
<th>3. Re-ECN</th>
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<td>Can’t justify selling an impairment</td>
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<td>Absence of packets is not a contractible metric</td>
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<td>Congestion not visible to upstream network nodes</td>
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<td>Congestion is outside a customer's control</td>
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<td>Customers don’t like variable charges</td>
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### 1. Loss
- Used to signal congestion since the Internet's inception
  - Computers detect congestion by detecting gaps in the sequence of packets
  - Computers can hide these gaps from the network with encryption

### 2. Explicit Congestion Notification (ECN)
- Standardised into TCP/IP in 2001
  - Approaching congestion, a link marks an increasing fraction of packets
  - Implemented in Windows Vista (but off by default) and Linux, and IP routers (often off by default)

### 3. Re-inserted ECN (re-ECN)
- Standards proposal since 2005 (later slides)
  - Packet delivery conditional on sender declaring expected congestion
  - Uses ECN equipment in the network unchanged
main steps to deploy re-feedback / re-ECN

- protocol
  - assign one bit in Internet protocol to re-ECN

- network (incremental)
  - turn on explicit congestion notification in routers (already available)
  - deploy simple policing functions at customer interfaces around participating networks
  - passive metering functions at inter-domain borders

- terminal devices (incremental)
  - (minor) addition to TCP/IP stack of sending device
    - or sender proxy in network

- contracts (incremental)
  - congestion-volume allowance in customer contracts
  - use congestion-volume in interconnection contracts