Network Neutrality, FIA and Mobility First

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Network Neutrality, FIA & Mobility First

Goal : "Preserve open Internet"

- #1: Access ("last-mile") bottleneck
- #2: Other potential threats to "open" Internet?
    - Bottlenecks elsewhere in e2e architecture?
    - Coordination failures? e.g., interoperability, connectivity, quality.

Q1: How do FIA change the threat to "openness"?

- How does MF impact "last-mile" competitive options? E.g., empowers end-user/edge to be "mobile."
- Does MF create new bottlenecks? E.g., GNS.
- How does MF impact other threats? E.g., coordination failures.

Q2: How do FIA change regulatory options for ensuring NN?

- Measurement/monitoring options: what's reasonable net mgmt?
- Open access options? Definition broadband? Jurisdiction? Title II/Section 706 mandates?

Last-mile "access" bottleneck

Q1: Is last-mile a bottleneck?

- Access is essential input to producing valuable "Internet" goods.
- Competition argued inadequate (e.g., natural/terminating monopoly)
- Market power to extract excess rents and harm competition (which includes harm to innovation, investment)

Solutions?

- Competition: how do FIA affect entry?
- Regulate: Open access ➔ Title II Common Carriage – what is BB?
  - Reasonable Network Management standard (no harmful discrimination)
  - Ex ante v. Ex post regulation (are harms reversible? Detection/enforcement?

Q2: Do FIA create new potential bottlenecks?

- Addressing/routing? E.g., GNS
- DTN & in-network storage? E.g., Caches
- Wireless? E.g., Spectrum access

Mobility First

Mobility = granular, dynamic, flexible resource allocation
- End-users, services, and networks can move in all dimensions...
- Empowers end-user choice and self-provisioning
  - E.g., multihoming, source-based routing, ad hoc networking (wireless)

Benefits
- Uncork last-mile with new vector for competition
- End-user autonomy/freedom: choice to have it your way
- Edge-based innovation: decoupled, viral, "let 1000 flowers bloom"
- (Depends on small cell arch – who will controls network choice?)

Risks
- Coordination failures? Interoperability, interconnection, connectivity
- E.g., Source-based routing unbundles ISP offers/optimization.
- E.g., End-to-end QoS/reliability: fault assessment.
- Accentuates "roaming" challenge – cost-recovery shared costs.

NN & FIA: research challenges?

More knobs for causing mischief
  -- coordination failures
  -- complexity
  -- discrimination control points

More user control
  -- multi-homing
  -- options for arbitrage and work-around

Expanded definition of "Internet."
  -- What's a service? What's an application?
  -- Control of data or meta-data? Identity/naming

Metrics for evaluation, monitoring, and enforcement
  -- data access (privacy, security)
  -- transparency

Regulatory Tool Kit:
  -- Property rights (rights & obligations)
  -- Enforcement (jurisdiction)
  -- Information (markets, search, matching supply/demand)

Slides Not Used/Back-up

History of NN Debate

- **Long history of last-mile open access rules…**
  - Title II: Computer I,II, III; CEI; TA96 UNEs; etc.
- **Tim Wu (2003)** "Network Neutrality and Broadband Discrimination"
- **Powell (2004) and FCC (2005) 4 Internet Freedoms**
  - Madison River (2005), Comcast-BitTorrent (2007)
- **FCC (2009) NPRM #1**
- **Appeals Court (2010):** set aside Comcast Order, wrong jurisdiction
- **FCC (2010) R&O**
- **Appeals Court (Jan 2014):** reclassify BB as Title II or Sec706
- **FCC (2014) NPRM #2**:
  - Sec706, but maybe Title II
  - Transparency
  - Let's re-argue… market power, options, etc…; empirical & theory…

Network Neutrality : understanding the sides

Pro
-- Google, Skype, Netflix, CDNs, OTT
-- Wu, van Schewick, Lessig, Crawford

Open Internet good
Free speech, access for all
Application/content innovation
End-to-end

Con
-- Access ISPs (AT&T, Comcast, VZ)
-- Yoo, Farber, most economists

Investment in infrastructure
Regulation bad, property rights
Network innovation
Smart networks

-- From central-planning regulation to market-based competition…
   - retail regulation to wholesale regulation to no regulation (?)

-- From open access/equivalent interconnection to platform competition
   - unbundling access rules deter investment => relax open access
   - v. BB facilities (FTTx, 4G+) a new "natural monopoly"?
   - Reclassify BB as "information service" (exempt from Title II obligations)

Network Neutrality: what are the core questions?

Regulatory Jurisdiction: who regulates Internet?
- who is an ISP? Where is bottleneck? Is last-mile the only possible one?
- mandate for FCC/European regulatory authority? (FTC? DoJ?)
- standardization?
- Internet governance…

Broadband v. Internet v. Mobile: what's the essential service?
- "BB is basic infrastructure" -- Universal service
- Other services: TV (over-the-air, DBS), Telephony (VoIP, cable telephony)
- Fixed v. Mobile (wireless)

Preserving an Open Internet: what is open to whom?
- to innovation: application, content, or infrastructure?
- to access/use: reachability (network externalities), affordability, usage limits
- to interconnection: content, apps, end-points (on-net/off-net)

Cost-recovery (or monopoly profits?)
- Price discrimination or cost-based pricing?
- Allocation of shared/fixed costs, investment risk/return
- Social v. Private returns? Public subsidies?

Network Neutrality: what is debate about?

Regulatory rules limiting broadband ISPs scope for network management
  -- No blocking
  -- No discrimination (traffic shaping or pricing)
  -- No charging "upstream" for differential treatment/QoS
  -- Treat all packets the same (application agnostic Internet)
  -- All "best effort" (or only user-selected, application agnostic QoS)
  -- no DPI
  -- Transparency/disclosure

-- Goals of regulation?
  -- Broadband Internet is the "new PSTN" => basic infrastructure
  -- Preserve (open) Internet as platform for (application) innovation
  -- Protect against abuse of market power by last-mile access providers
  -- Promote efficiency (lowest cost, social welfare, optimal investment)
  -- Promote competition

Outline: Network Neutrality, FIA and Mobility First

Understanding the debate
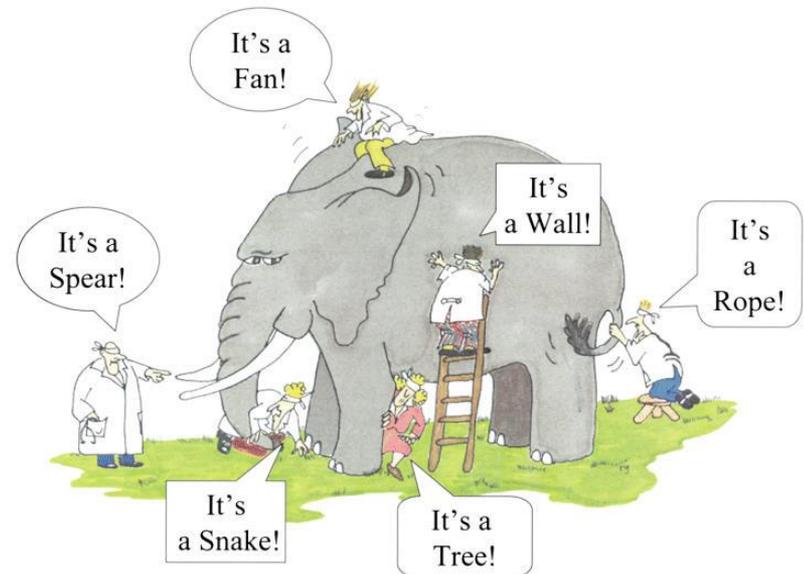
Economic/policy responses

FIA and Mobility First: challenges and opportunities

Network Neutrality: what is debate about?

Implicit assumptions, ignorance, gaming → low SNR

Goal:

- **Promote open Internet**
- **Protect against harmful discrimination**
- **Regulate access to last-mile bottleneck**
- **Reasonable network management? Interconnection?**
- **Toward framework for Internet (future PSTN) regulation**
- **??**

Network Neutrality: history of the recent debate…

- Wu (2003) "Network Neutrality and Broadband Discrimination"

- Powell (2004) "Internet Freedoms" & FCC (2005) Policy Statement
  Consumers are entitled to…
  (1) Access lawful content of their choice
  (2) Use applications of their choice (subject to needs of law enforcement)
  (3) Connect devices of their choice (that do not harm network)
  (4) Competition among network, application & service, and content providers

- Madison River (2005): small ISP blocks Vonage
- Comcast-Bittorrent (2007)

- FCC (Oct 2009) "Open Internet & Broadband Practices" NPRM
  (1)-(4) + (5) No unreasonable discrimination, (6) Transparency

- Court denies FCC authority in Comcast Order (April 2010)

- FCC (Dec 2010) "Open Internet & Broadband Practices" R&O
  (i) Transparency
  (ii) No Blocking (of legal content/apps)
  (iii) No unreasonable discrimination
- Level 3/Comcast (Nov 2010): "mandate settlement free peering for CDN"

Network Neutrality : current

Appeals Court vacates FCC (2010) R&O (Jan 2014)
•FCC Title I authority not sufficient for regulating BB Net Mgmt.
•Roadmap: (a) reclassify BB as Title II "telecom service"; (b) authority under Sec706 to "promote advanced telecom services"

Wheeler prefaces upcoming FCC NN Rules (April 23, 2014)
•3rd try, this time with Sec706 authority as basis.
•"Fast-lane" proposal to allow content to pay for bit prioritization
•Planned release of NPRM on May 15, 2014

Netflix, Level 3, Cogent v. Comcast – dueling blogs (April 25, 2014)
•CDNs pay for priority delivery?
•NN supporters:
    • End of NN, retreat of FCC, end of open Internet
    • Access ISPs have monopoly and certainly terminating monopoly
•NN opponents:
    • NN supporters want free-lunch
    • Investment in BB threatened by regulation

Evolving Internet ecosystem

-- Factors driving Internet ecosystem….
- Internet more embedded in society, more important to more people
- More global, diverse uses, traffic, infrastructure investment
- Increasingly regarded as essential/basic socio-economic infrastructure
- More security, trust needed
- More mobility & wireless
- Dynamic industry value-chain (more/less competition?)

-- Market-based regulation is still regulation, only different
- Internet will be regulated
- Tools: price regulation, interconnection mandates, wholesale mandates (unbundling), structural remedies (line-of-business restrictions/divestiture), licensing, antitrust, transparency (disclosure), standards (best-practices), preferences (subsidies), liability, purchasing, tariffs, taxes, …..

-- As technology is embedded in society, society and technology co-evolve
- Technology-aware policy-making, *and,*
- Policy-aware technology

Evolving Internet Architecture: smarter networks

How are FIA proposing to change Internet?

- Context-aware/policy-aware routing
- Trust/security/reliability (fault tolerance, Byzantine robustness)
- Dynamic flexibility => fault tolerance, customization, resource sharing
- Mobility => users, apps, devices, networks… seemless e2e service
- Content support (& DRM)
- Network Management (Profiling & DPI) & Programmability
- Capabilities for richer expression of user desires/control, (and control of middle-boxes)

What regulatory challenges are exacerbated?

- Trust/security => threat to openness, connectivity (back to silos?)
- Network intelligence => threat to privacy
- Dynamic control => usage/context-aware pricing=>discrimination
- User control => multi-homing
- Distributed intelligence/control (competition) => coordination failures

NN in a CDN architecture?

-- e.g., FIA a la van Jacobson, Netflix-Level 3/Comcast flap

-- future issues?
- Liability (if you cache content, are you liable for it?)
- Who maintains/controls the caches?
- Digital Millennium Copyright Act (1998)
    * sanctions against technologies that facilitate infringement
    * ISP liability exemption

(Today, is CDN a value-added provider? Vulnerable to last-mile bottleneck, or OTT free-rider?)

NN in Mobility First?

-- e.g., Mobile/Fixed broadband convergence/interconnection
            FIA a la *MobilityFirst* (Rutgers)

-- Connections much more dynamic
-- Access networks move (wireless access)
-- DTN and in-network storage (who controls what is stored?)
-- Context-aware networking

Who controls RF spectrum?
 -- Spectrum management: licensed v. unlicensed, cognitive radios
 -- Cross-layer wireless access issues
 -- Integrating Internet & wireless…what's the bottleneck?

NN in interconnection?

e.g., Interconnection (L3/Comcast flap over peering/transit)
    IETF ConEX (Briscoe et al, QoS → re-ECN/ECN)
    FIA a la *Nebula* ("cloud computing")

What's "reasonable" network management?

Regulation of carrier interconnection?
  -- Inter-domain peering/transit (and everything in-between)
  -- What is service (Internet v. managed service)?
  -- Crossing sovereign boundaries….
  -- SLAs: How do you ensure physical path diversity?

Incentives and Hyper-reliable Systems
  -- Ensuring compliance with reliability obligations
  -- Public goods problem….

Regulatory Policy Questions

Market failure?

- What's failure? Understand problem to better craft remedy.
- Harm of failure? Actual or risk? Temporary or long-term? Reversible?
- Cost of remedy? (regulation is second best alternative)

Jurisdiction: structure of institutions

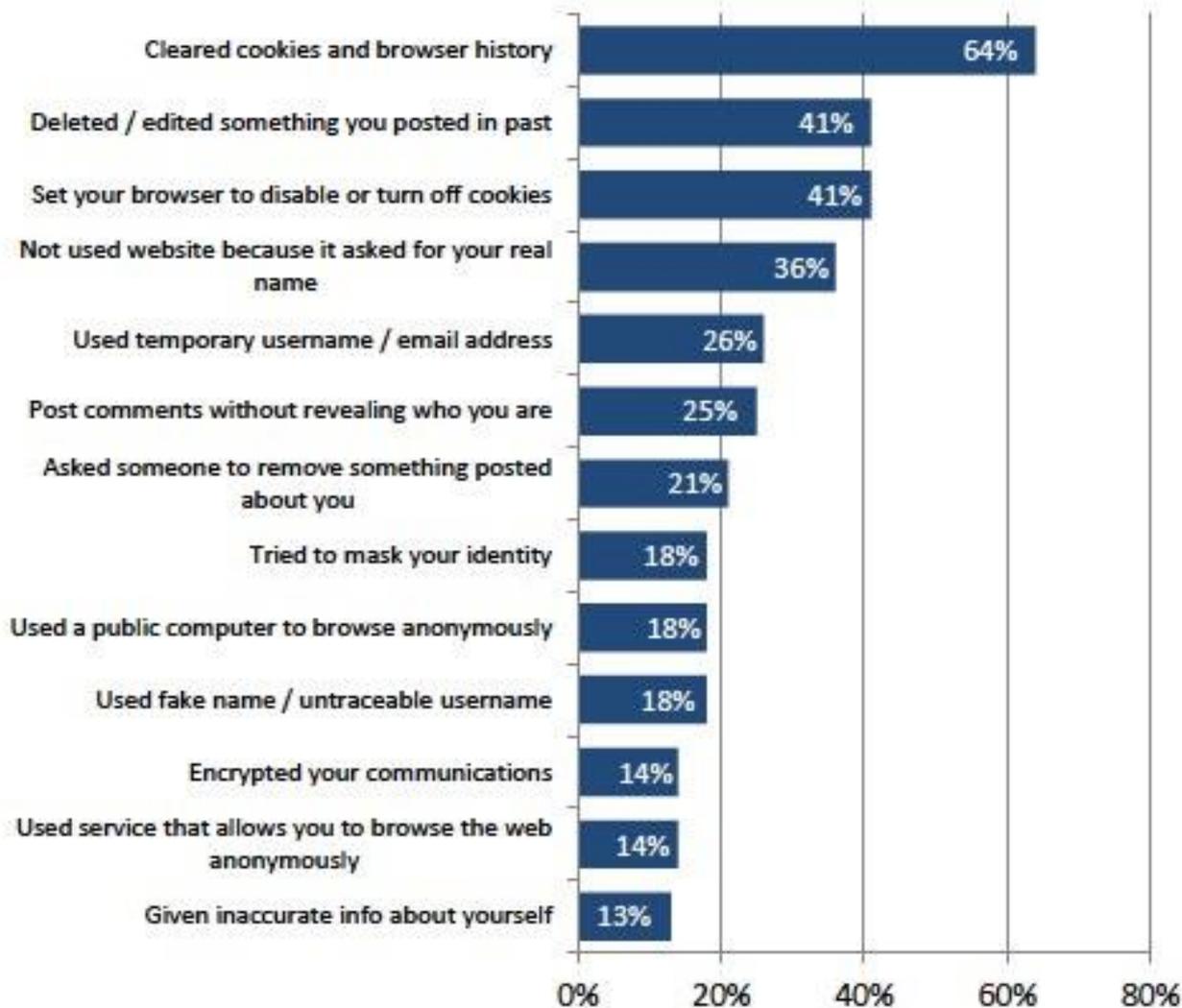- Expert agency v. Specific legislation?

Ex ante v. Ex post rules

Competition v. Open Access

- Competition feasible? If not, then open access if essential facility.
- If open access, how to limit scope of regulation (distortions)?
- If open access, how to price?

The strategies people use to be less visible online

% of adult internet users who say they have done these things online

Strategy	%
Cleared cookies and browser history	64%
Deleted / edited something you posted in past	41%
Set your browser to disable or turn off cookies	41%
Not used website because it asked for your real name	36%
Used temporary username / email address	26%
Post comments without revealing who you are	25%
Asked someone to remove something posted about you	21%
Tried to mask your identity	18%
Used a public computer to browse anonymously	18%
Used fake name / untraceable username	18%
Encrypted your communications	14%
Used service that allows you to browse the web anonymously	14%
Given inaccurate info about yourself	13%