Assessing Broadband Reliability:

Measurement and Policy Challenges

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39th Research Conference on Communications, Information and Internet Policy
www.tprcweb.com

George Mason University
Alexandria, VA Septmber 23-25, 2011

Paper overview

- Motivation
- Definitions
- Econ/policy challenges
- Empirical evidence, metrics, and measurement issues
- Conclusions & future directions

Defining broadband reliability

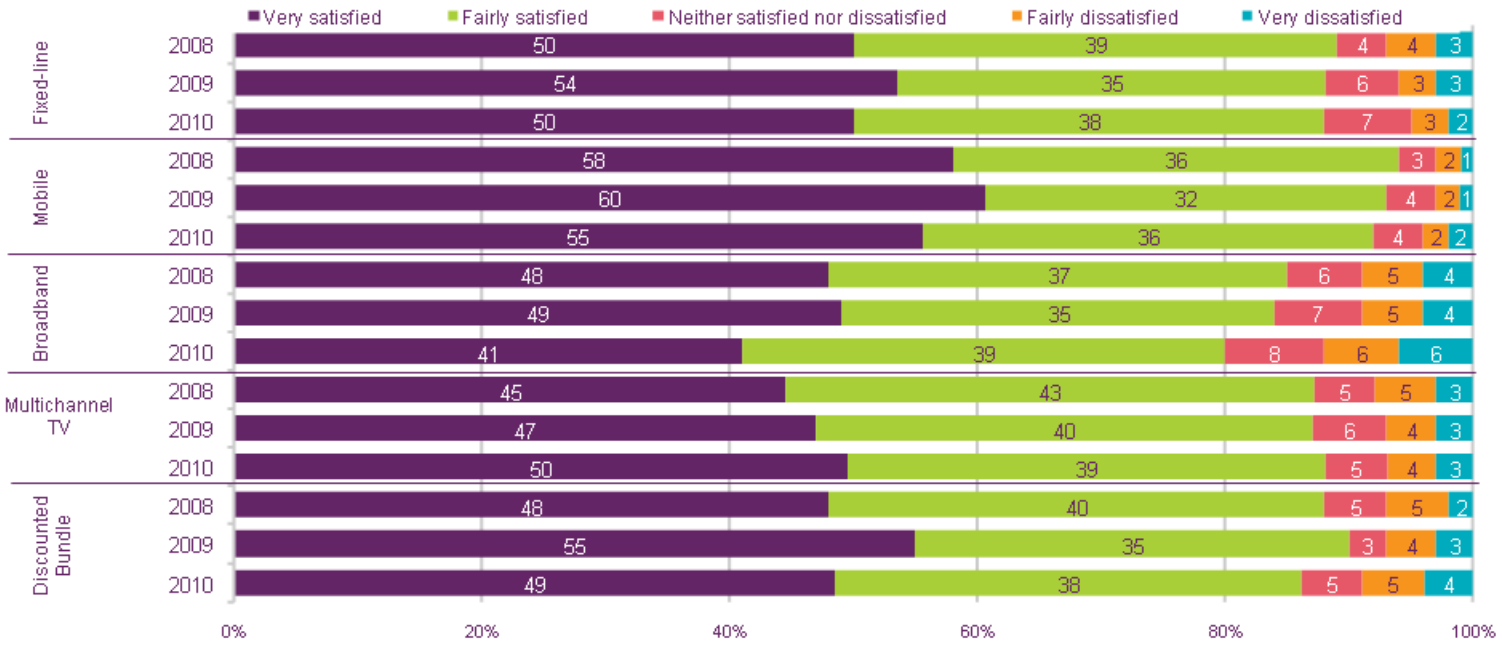
- Define Broadband
  - An (a) always-on/available connection offering (b) speeds of at least 4Mbps (down) and 1Mbps(up), and….
- Define Reliability
  - "capable of being relied on; dependable; trustworthy"
  - "consistency & validity of performance, predictable outcomes"
  - "Probability that item will perform required function *without failure* under stated conditions for a stated period of time."

FCC survey of broadband users (2010)

- **59% are very satisfied with the reliability of their service and 33% are somewhat satisfied.**
- 50% of broadband users are very satisfied with the speed of their service and 41% are somewhat satisfied.
- 51% of broadband users are very satisfied with service overall and 42% are somewhat satisfied.

http://transition.fcc.gov/Daily_Releases/Daily_Business/2010/db1206/DOC-303263A1.pdf

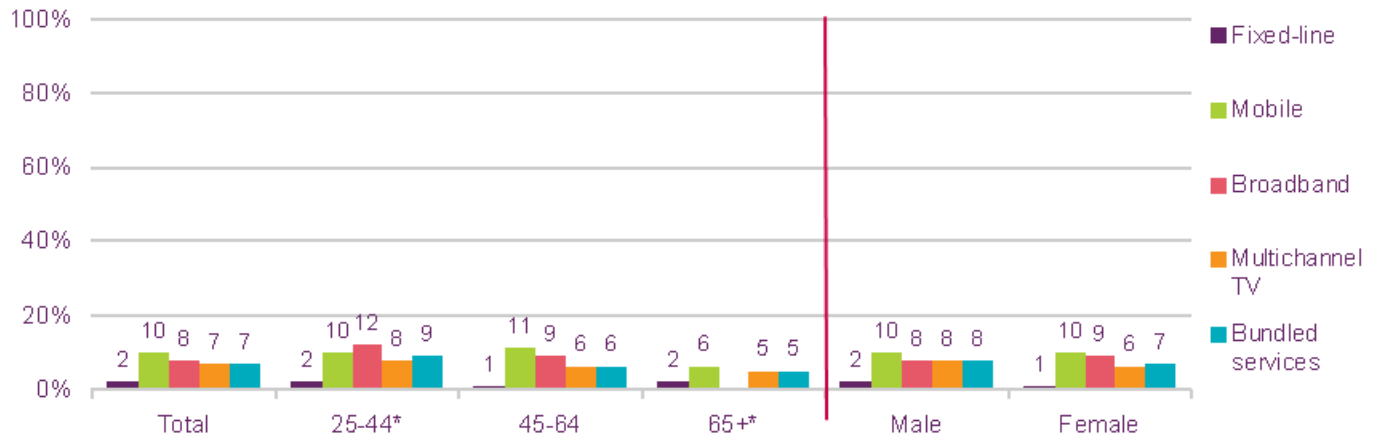
Satisfaction with overall services from communications supplier, over time



QL5/QM5/QI5/QT5/QB5 - How satisfied are you with the overall service provided by [SERVICE PROVIDER]?
Source: Ofcom decision making survey carried out by Saville Rossiter-Base in July to August 2008, 2009 and 2010
Base: All adults aged 16+ who are the decision maker and express an opinion on fixed line (2008, 771) (2009, 660) (2010, 617), mobile (2008, 1251) (2009, 1205) (2010, 1189), broadband** (2008, 302) (2009, 275) (2010, 222), multichannel TV (2008, 797) (2009, 760) (2010, 768), discounted bundled services (2008, 534) (2009, 631) (2010, 566). *Don't know responses have been excluded from the base. **Base for broadband in 2010 represents those with fixed broadband rather than fixed or mobile broadband as in previous years. Too few interviews were conducted with those with mobile broadband to report these separately. Trend data may be affected by this change.

(Source: Ofcom, 2010)

Dissatisfaction with reliability of service, by age and gender



QL5B/QI5B/QT5B/QB5B - How satisfied are you with the reliability of your service from [SERVICE PROVIDER]?/ QM5B – How satisfied are you with the reception or ease of accessing the [SERVICE PROVIDER] network?
Source: Ofcom decision making survey carried out by Saville Rossiter-Base in July to August 2010
Base: All adults aged 16+ who are the decision maker and express an opinion on fixed line** (2010, 620), mobile** (2010, 1195), broadband** (2010, 220), multichannel TV** (2010, 765), bundled services (2010, 567). *Caution: Low base. Base for 16-24 years olds and 75+ too small to analyse. Base for 65+ for broadband too small to analyse. Don't know responses have been excluded from the base. **NB Base amended in 2010 to exclude those who receive this service along with another service from the same supplier without receiving a discount. Base for broadband in 2010 represents those with fixed broadband rather than fixed or mobile broadband as in previous years. Too few interviews were conducted with those with mobile broadband to report these separately. Trend data may be affected by these changes.

(Source: Ofcom, 2010)

Main problems experienced when accessing the Internet

Are there any problems using (X) to access the Internet?	Fixed line (WiFi)	Fixed line (no WiFi)	Laptop via dongle/ USB at home	Laptop via dongle/ USB out of home	Mobile phone at home	Mobile phone out of home
Speed of connection is too slow	18%	24%	22%	34%	27%	22%
The internet connection is unreliable	7%	7%	12%	13%	12%	12%
Poor coverage – it's hard to get a connection	3%	2%	7%	9%	6%	12%

Source : Q.43 Are there any problems using (main device at Q.14) to access the Internet?
Base: 2,001 All respondents

(Source: Ofcom, 2010)

Incorrect attribution of faults

- Users often attribute any failure of a network dependent activity to their broadband provider
- Some non-trivial percentage of problems are not the responsibility of the broadband provider
- Problems arise along all parts of the network that are critical to the user activity and experience
  - old computers
  - access points
  - wiring problems
  - wireless interference

Achieving reliable service

- Network architecture:
  - Redundancy all the way until the "last mile”
  - Backup power
  - Example: Verizon' s SONET networks: two redundant paths are not located within 25 feet from each other beyond 500 feet from the central office
- Operational practices:
  - Hundreds of possible best practices for network operations
  - Staging of replacement parts
  - Network operation center monitoring
  - Configuration validation and update methodology
  - Etc…

Different perspectives on reliability

- Consumer's perspective
  - Generally adequate reliability, but can be a source of frustration
- Critical infrastructure providers (Electrical, gas, and other utilities) perspective on broadband reliability
  - Insufficient overall system reliability
  - lack of adequate backup power, or fuel for backup power
  - Insufficient priority service
  - Reliability in rural areas (where there stations, equipment, facilities exist) tend to have less redundancy/reliability

Different perspectives on reliability

- Broadband providers' perspective
  - "Providing a reliable network is a competitive necessity"
    - Enterprise market in particular demands dependable broadband services
    - Balancing costs and reliability
  - "Verizon endeavors to maintain well over 99 percent availability for its broadband network infrastructure and regularly achieves this that goal"

How reliable are broadband networks?

Edge/User based data

- Users reported
  - Survey data
  - Online discussion forums
  - Twitter
- Anecdotal and self-diagnosis/monitoring
- Dedicated measurement infrastructure
  - FCC/Samknows study

Broadband provider data

- Something like:
  - Network Outage Reporting System (NORS)
  - Disaster Information Reporting System (DIRS)

Key questions in outage reporting

Interconnected VoIP

- What constitutes outages for a service provided by an interconnected VoIP provider?
- Would an outage reporting requirement based on some threshold also be appropriate for interconnected VoIP service providers?
- What would be a reasonable reporting threshold?

Broadband Internet Access

- Should reportable outages include events that result in significant degradations to performance as perceived by end-users?
- How should a significant degradation that triggers the reporting requirement be defined?

Reliability metrics

1. Reliability of basic connectivity
2. Reliability of performance
3. Reliability of core services

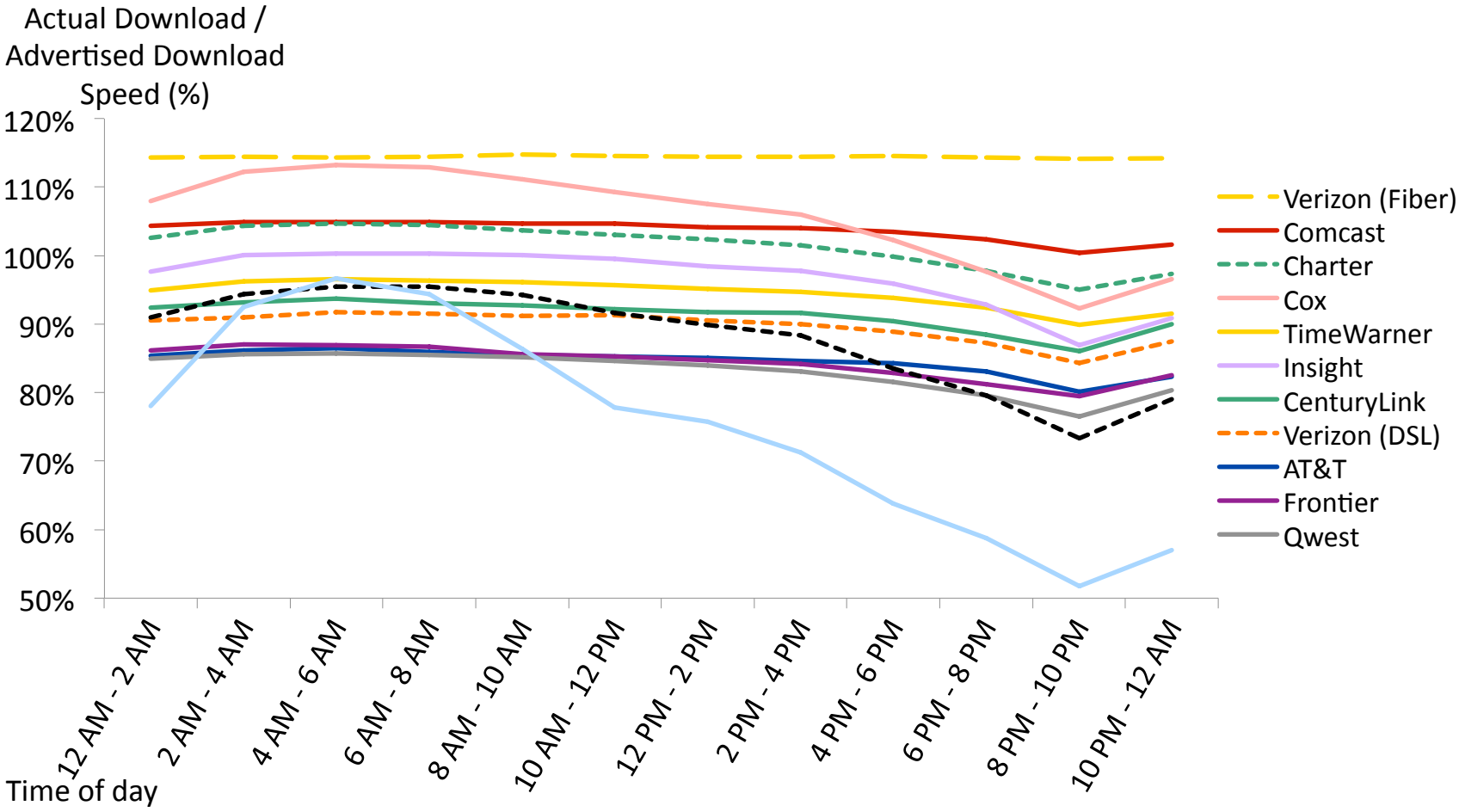
Reliability (connectivity)

- Reliability – whether or not a destination or set of destinations are reachable with a basic level of service
  - E.g. a ping/traceroute test
- FCC/Samknows “availability” test
  - Continuously tests (30 second interval) to three servers, failure recorded if all three simultaneously can’t be reached
- FCC/Samknows UDP latency test
  - Continuously tests (10 second interval) UDP latency to target server

Reliability (level of performance)

- Reliability – the probability with which a given rate is met or exceeded at a given point in time
- Time intervals over which performance is measured are key
  - Many applications are robust to both variable performance and some periods of poor performance
  - Just can't have too many of those poor periods in a row.

Average download speed as a percentage of advertised over a 24 hour period



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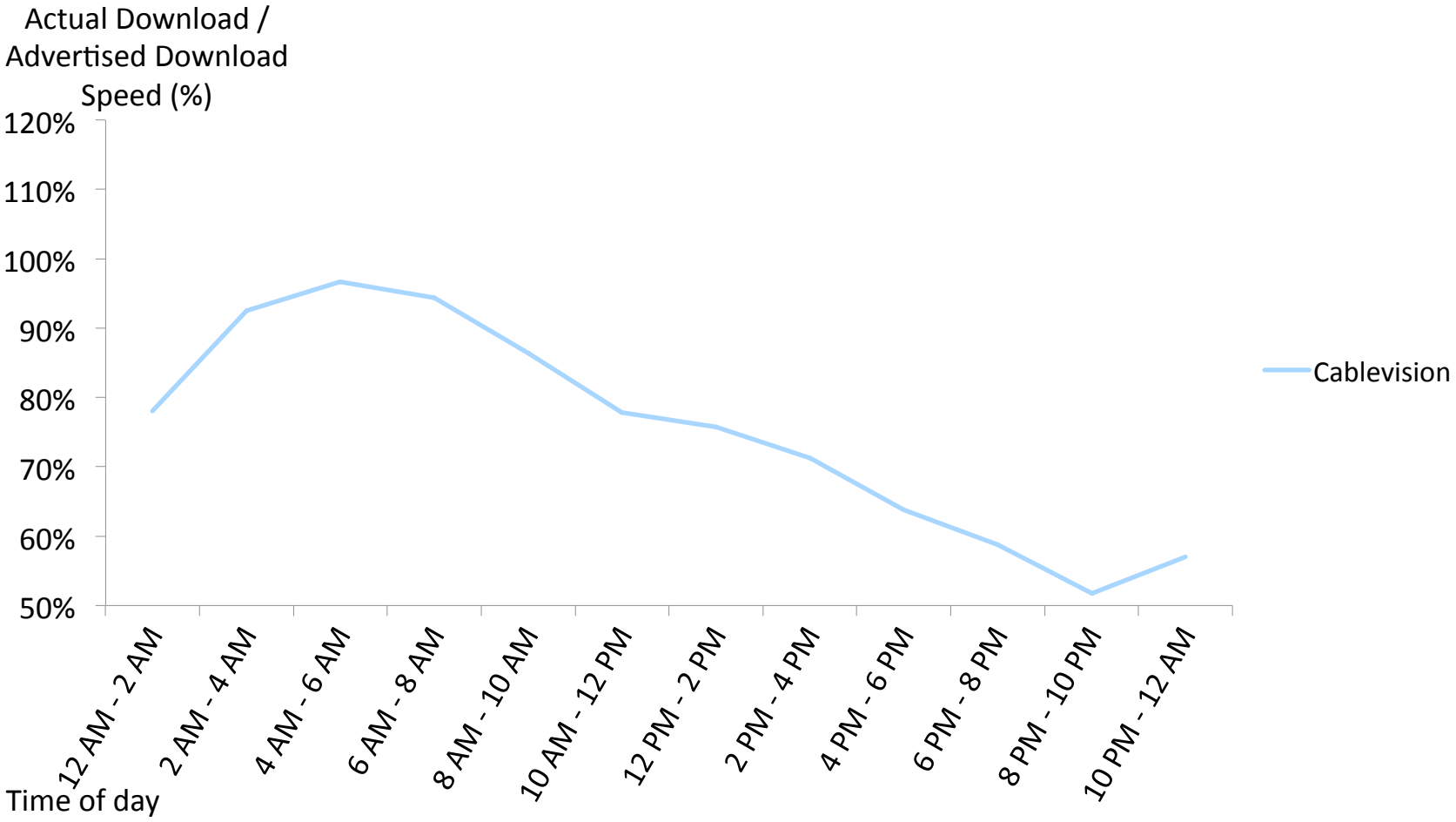
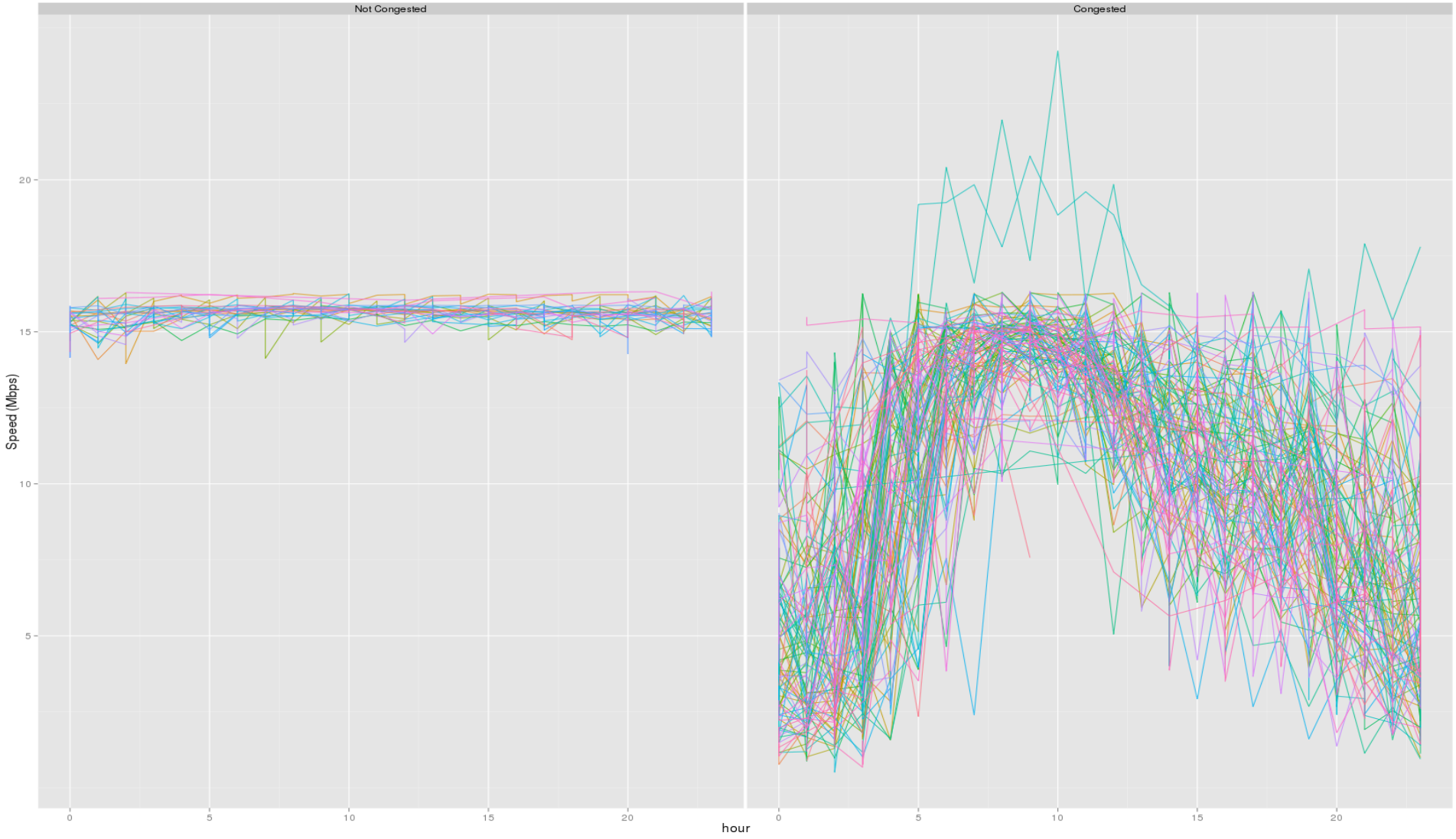


Cablevision (March 2011)

Not congested: 27 units Congested: 102 units



Consistent measurements are not necessarily a desirable objective

- Consistently low latency measurements are desirable
- But for speed, give me all you can… even if it varies
  - Speeds above a threshold are what is important
  - But arguing for consistent speeds is essentially arguing for clamps on performance

Reliability (core services)

- Reliability – a measure of whether not 'essential' network services are operating properly
  - VoIP
  - Video (Network neutrality driven concerns)
  - DNS
  - Email
  - Web
- Samknows box records failure percentages for different tests

Conclusions and future work

- Need to evolve and refine the FCC/Samknows testing to better inform reliability discussion
  - Better way, at this point in time, to gather data on reliability of broadband performance
- Unnecessary to mandate best practices for providers of consumer broadband
  - Market appears to be largely meeting needs of consumers
  - Flexibility to evolve and adapt operational practices is desirable
  - Awareness of evolving and more stringent reliability requirements is important
- Some form of outage reporting for loss of basic connectivity is likely
  - Best to design appropriate metrics and characterizations of outages now in joint process