

6-Year of Broadband Performance in Korea

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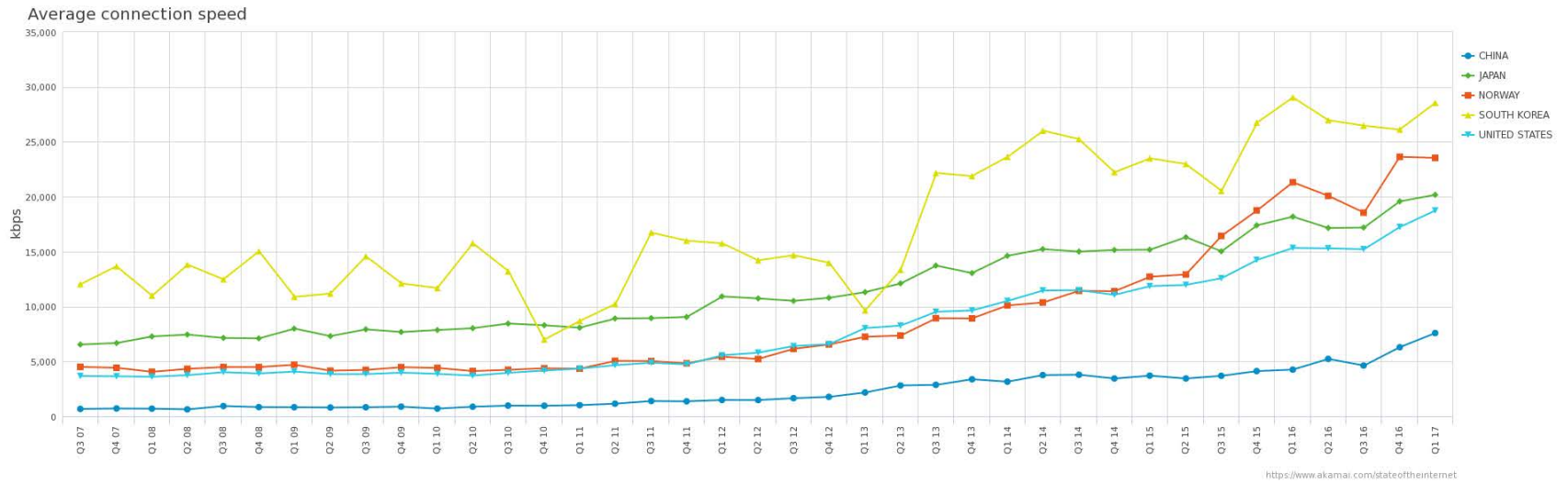
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What is the broadband speed in Korea?

- Broadband test websites in Korea
 - NIA: Speed <http://speed.nia.or.kr/>
 - Benchbee <http://www.benchbee.co.kr/>
- Global broadband test websites
 - Ookla Speedtest.net
 - <http://www.speedtest.net/awards/us/isp>
 - Akamai
 - <https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-connectivity-visualization.jsp>
 - Cisco visual network index
 - <https://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html>
 - FCC broadband report
 - https://www.fcc.gov/reports-research/reports/measuring-broadband-america/measuring-fixed-broadband-report-2016#_Toc458762523
 - Samknows in UK
 - <https://availability.samknows.com/broadband/>

Akamai



Broadband Statistics in Korea

Table 1 Subscription ratio of broadband services in Korea over 6 years (%) [8].

Year	2006	2007	2008	2009	2010	2011
DSL	46	34	27	22	17	15
Cable	35	35	33	32	31	29
Fiber	19	30	40	46	52	57

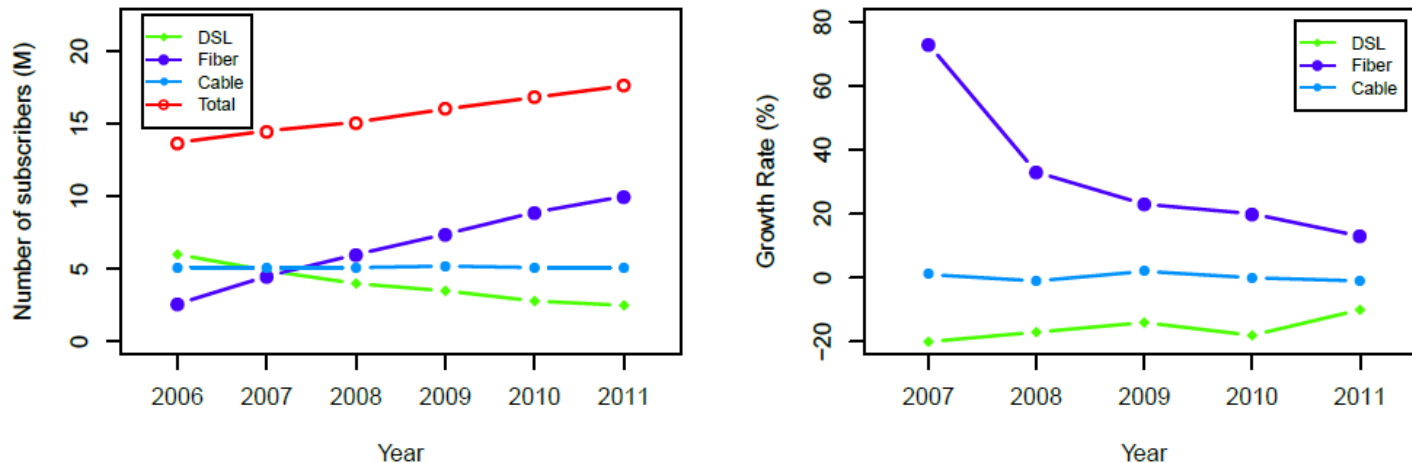
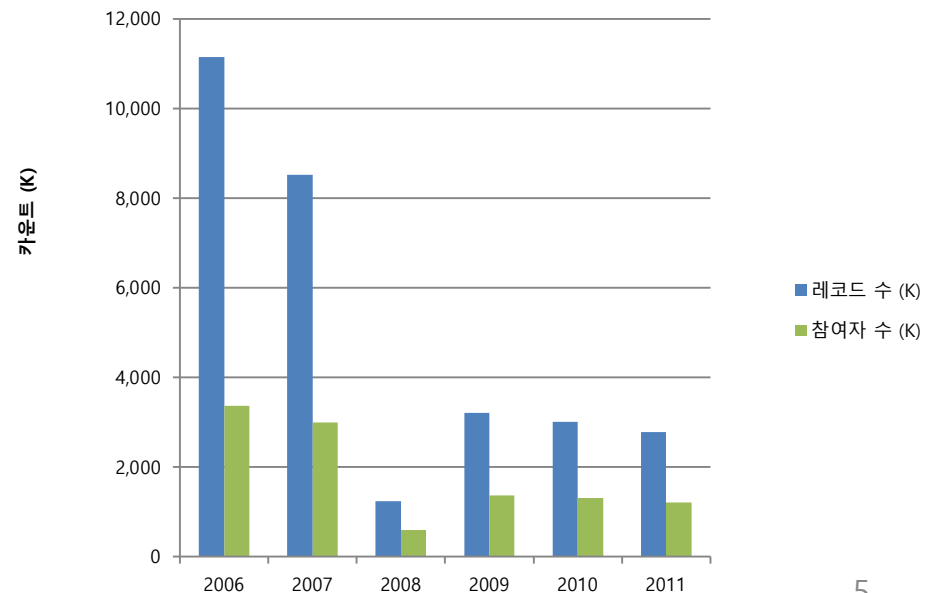
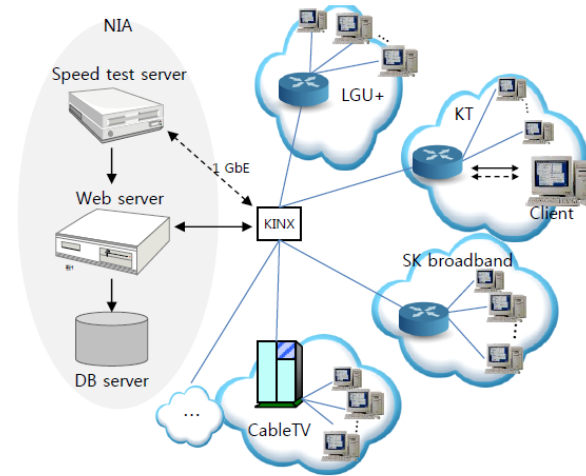


Fig. 1 The number of broadband service subscribers in Korea (2006 - 2011) [8].

NIA Speed Data

- 2006 ~ 2011
- 24 million data records
 - 475,000 per month
- 10 millions of IP addresses
 - 172,000 per month
- Raw data volume: 118 GB
- Processed data volume: 45 GB
- Methodology
 - 1 TCP connection
 - Average TCP throughput for 10 seconds
- Who?
 - Wired broadband subscribers: desktop or laptop

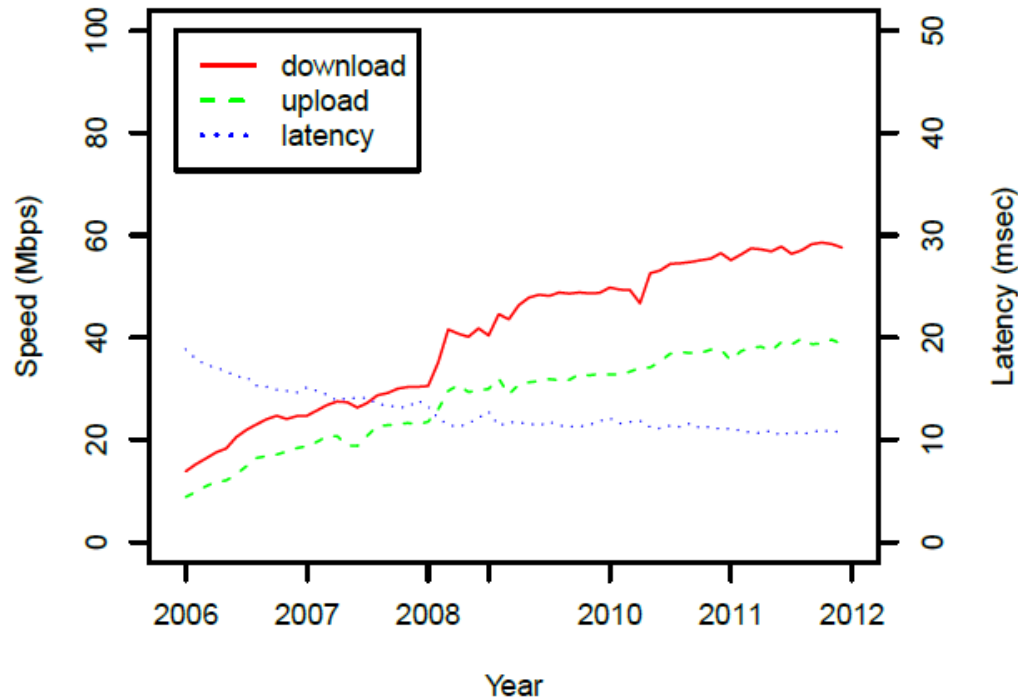


Observation over 6 Years (2006 – 2011)

1. Improved throughput over 6 years
 - Download: 2.9 times (20 → 57 Mbps)
 - Upload: 2.8 times (14 → 38 Mbps)
2. Two factors of speed enhancement
 - High-speed FTTH broadband subscribers: 19% → 57%
 - Speed increase in cable modem: 8 → 51 Mbps
3. Asymmetry
 - 0.68 → 0.67
4. Reduced latency
 - 16 ms → 11 ms
5. Cost performance improved: 1Mbps
 - \$1.06 → \$0.47

Monthly Speed Trend

(2006-2011)



- Download
 - 2.9 times
 - 20 → 57 Mbps
- Upload
 - 2.8 times
 - 14 → 38 Mbps
- Latency
 - 16 → 11 ms

Fig. 10 The monthly trends of estimated download speed, upload speed, and latency over 6 years (2006 - 2011).

Scatterplot

2006 vs. 2011

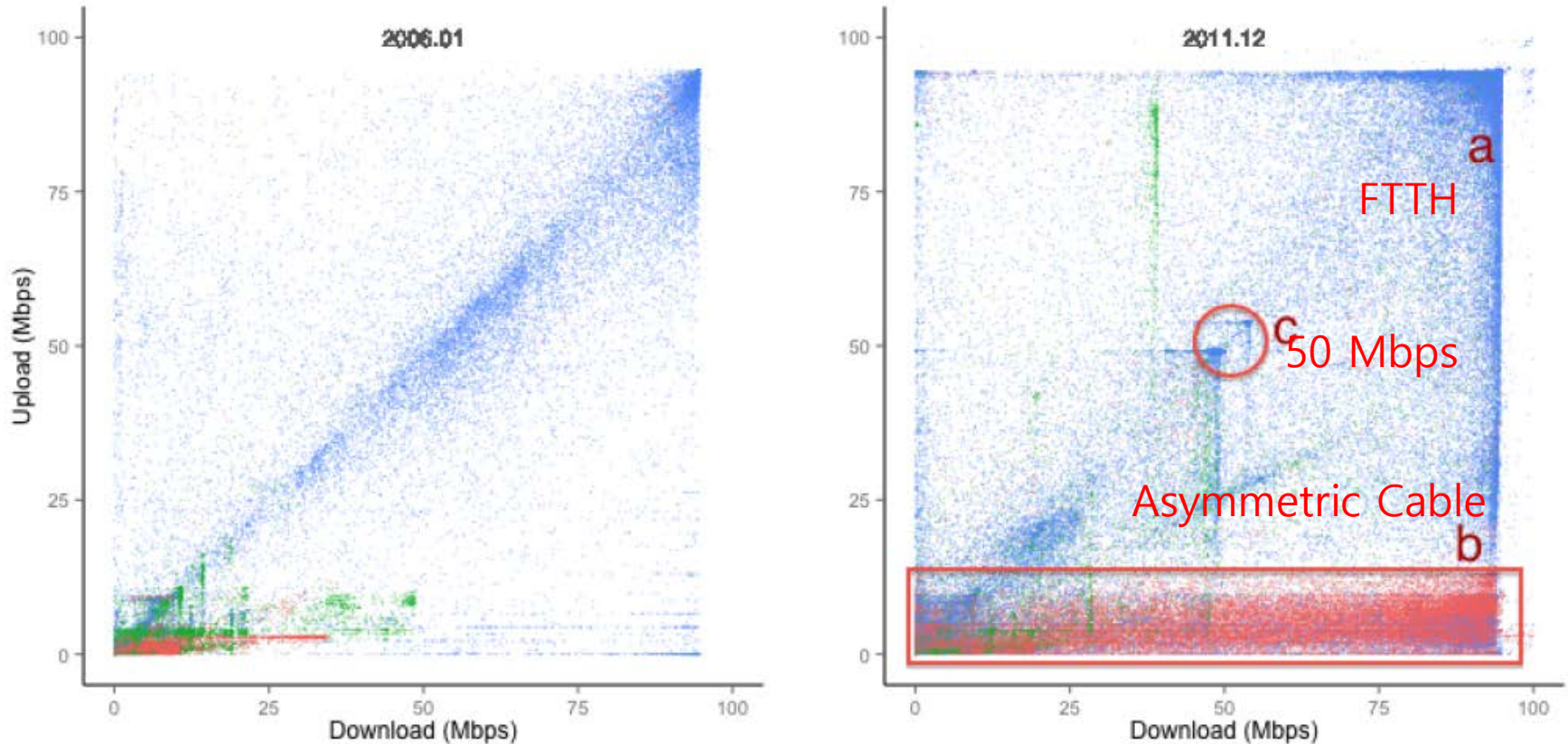


Fig. 11 Scatter plots of download vs. upload speed in Jan. 2006 and Dec. 2011. (The color of dot differentiates broadband services. red: DSL, green: Cable, blue: Fiber)

Speed by FTTH/Cable/DSL (2006-2011)

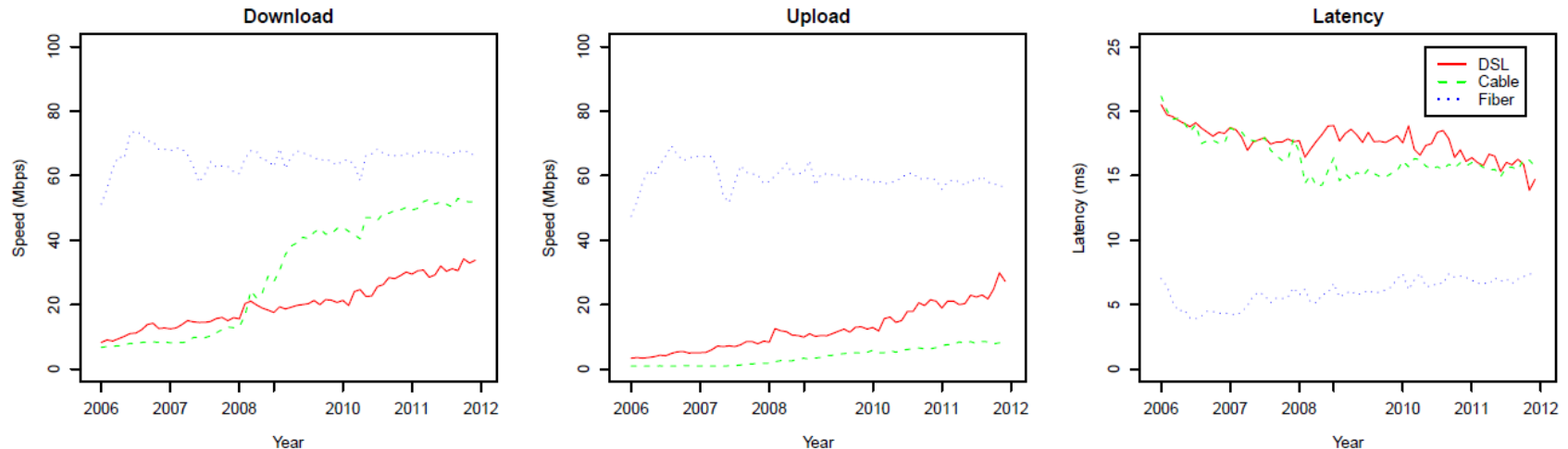


Fig. 12 The monthly average trends of download speed and upload speed per service over 6 years (2006 - 2011)

1. Fiber

- D: 67 Mbps, U: 62 → 58 Mbps

2. Cable, DSL

- Cable: 8 → 51 Mbps (1 → 8 Mbps)
- DSL : 11 → 31 Mbps (4 → 23 Mbps)

3. Asymmetry in Cable

- 0.13 → 0.16 (DSL: 0.39 → 0.73)

4. Latency in Fiber

- 4.8 → 7 ms

ISP

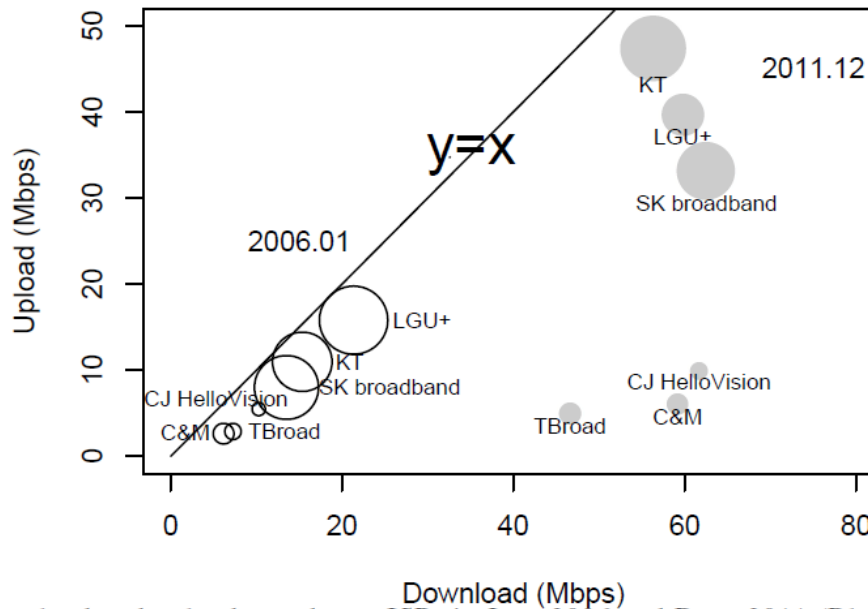


Fig. 14 Download and upload speeds per ISPs in Jan. 2006 and Dec. 2011 (Blank circles indicate 2006 data and filled circles indicate data for 2011. The circle size is in proportion to the number of test records.).

- KT, SK broadband, LGU+
- Asymmetry in Cable

Region

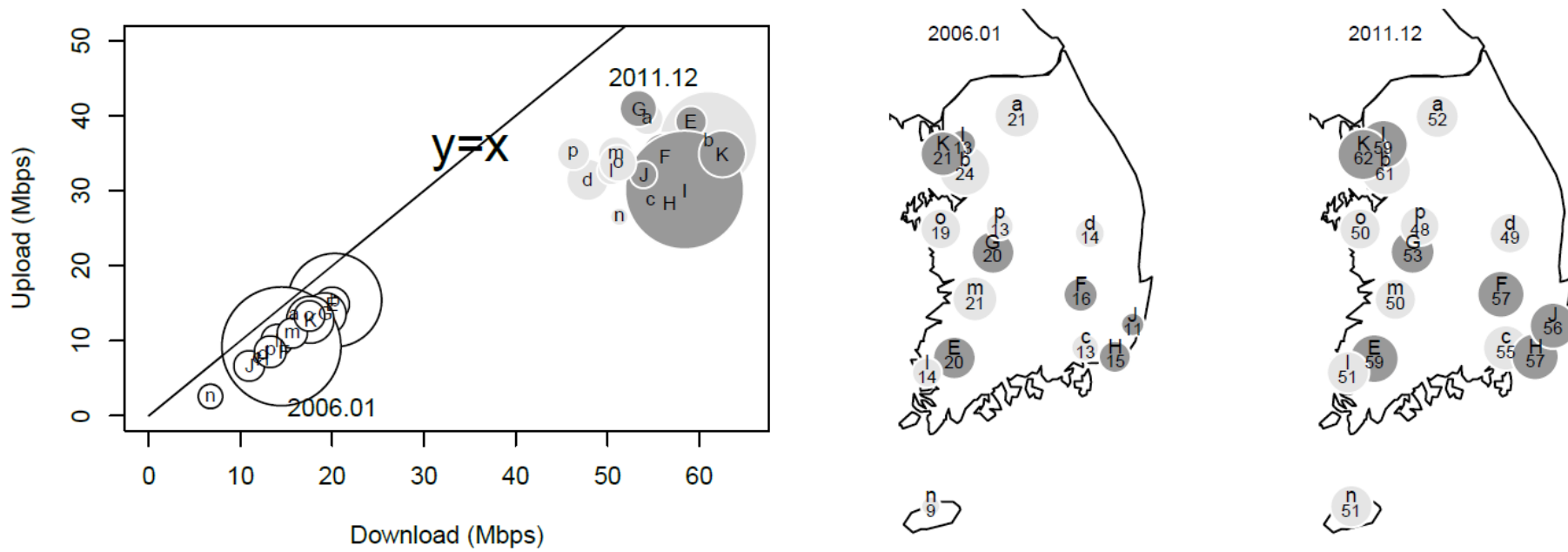
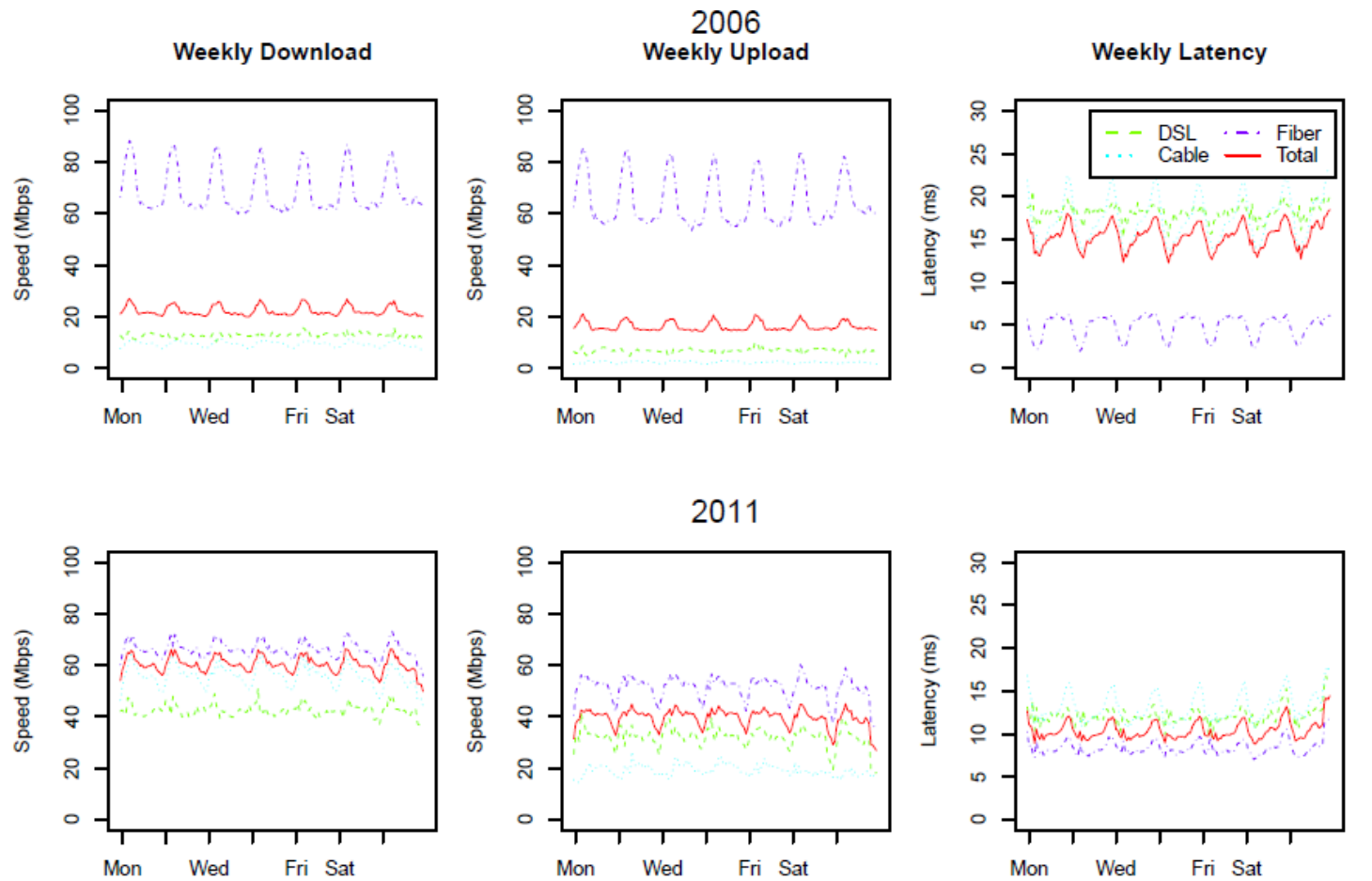


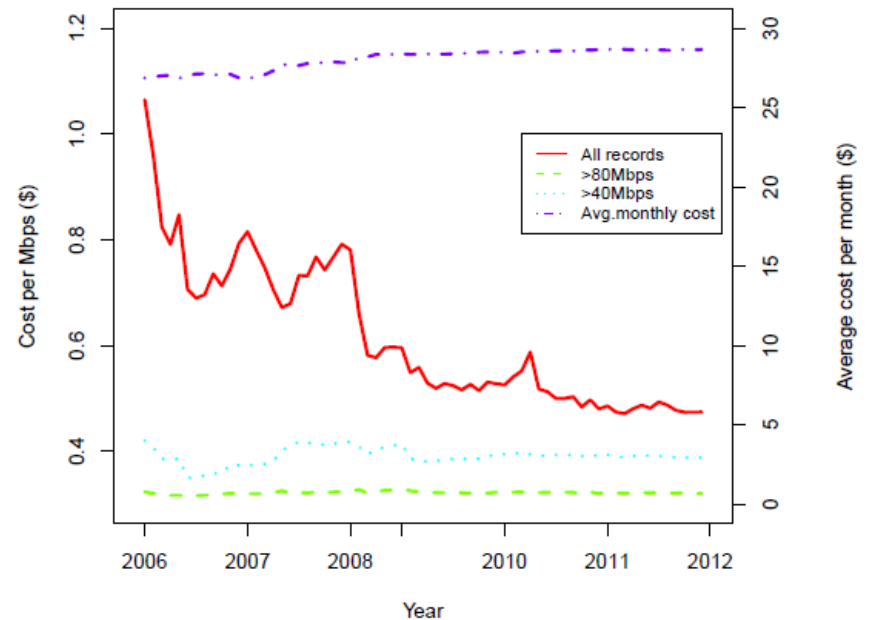
Fig. 17 Average download speed and upload speed per region between January 2006 and December 2011.

Weekly Pattern



Cost Performance

- Monthly payment
 - \$27.3 → \$28.6
- 1Mbps
 - \$0.87 → \$0.49



Moore's and Nielsen's Law

- Moore's Law
 - the number of transistors on integrated circuits doubles approximately every 18 months (the annual growth rate of 59 %)
- Nielsen's Law
 - the Internet bandwidth available to users increases 50 % annually

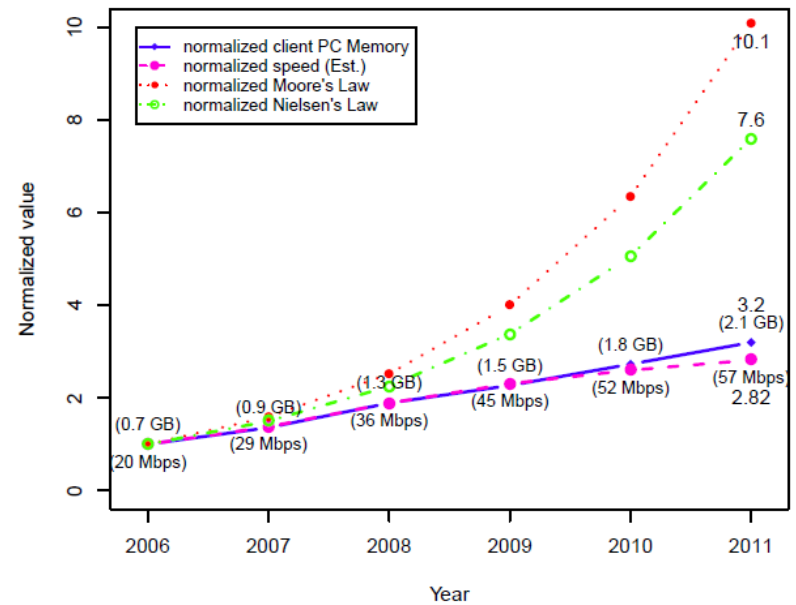


Fig. 25 Normalized values of estimated speed, Nielsen's Law, memory size, and Moore's Law.

Contribution to Speed

- Both subscriber population and service speed!
- Fiber: 71%
- Cable: 30%

Table 5 Contribution of each service to the estimated growth in download and upload speed.

Year	2007	2008	2009	2010	2011	Total	
D	DSL	-2%	0%	-8%	-1%	6%	-1%
	Cable	12%	34%	62%	29%	14%	30%
	Fiber	90%	65%	47%	72%	80%	71%
U	DSL	6%	6%	-12%	11%	15%	5%
	Cable	1%	6%	16%	11%	18%	10%
	Fiber	93%	88%	96%	79%	67%	84%

$$C_i(t) = \frac{\overline{P}_i(t) \cdot S_i(t) - \overline{P}_i(t-1) \cdot S_i(t-1)}{P_{total}(t) - P_{total}(t-1)} \times 100 \quad (2)$$

, where $\overline{P}_i(t)$ is the measured average speed and $S_i(t)$ is the subscription ratio of a service i at time t , and $P_{total}(t)$ is the estimated speed for the total subscribers at time t .

Summary

- Crowd-sourced broadband speed measurement and analysis
- 6 years of data

Rerference

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6. <http://www.broadband.gov/>
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