

# Emergency Communications and Disaster Management

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## What's the Problem?

- We need resilient telecommunications networks for socio-economic development and disaster planning/response.
- How to measure resilient infrastructure?
- How to link network characteristics with economic impacts?
  - All broadband connections are equal but some connections are more equal than others!

## Data Source

- Users around the world opt-in to conduct tests of their internet connections.
  - Pro: Actual measurement of user conditions
  - Con: Potential selection bias to be noted
- Because they are within 300 miles, measurements reflect local speeds, unlike data available from Caching Services like Akamai.



## What do we have already?

- What data do we have?
- ITU country reported DSL Speeds
- Problematic data, does not report

1	Series Name	2008	2009	2010	2011	2012
2	Fixed (wired)-broadband speed, in Mbit/s					
3	Fixed (wired)-broadband speed, in Mbit/s					
4	Fixed (wired)-broadband speed, in Mbit/s					
5	Fixed (wired)-broadband speed, in Mbit/s					
6	Fixed (wired)-broadband speed, in Mbit/s					
7	Fixed (wired)-broadband speed, in Mbit/s					
8	Fixed (wired)-broadband speed, in Mbit/s					
9	Fixed (wired)-broadband speed, in Mbit/s					
10	Fixed (wired)-broadband speed, in Mbit/s					
11	Fixed (wired)-broadband speed, in Mbit/s					
12	Fixed (wired)-broadband speed, in Mbit/s					
13	Fixed (wired)-broadband speed, in Mbit/s					
14	Fixed (wired)-broadband speed, in Mbit/s					
15	Fixed (wired)-broadband speed, in Mbit/s					
16	Fixed (wired)-broadband speed, in Mbit/s					
17	Fixed (wired)-broadband speed, in Mbit/s					
18	Fixed (wired)-broadband speed, in Mbit/s					
19	Fixed (wired)-broadband speed, in Mbit/s					
20	Fixed (wired)-broadband speed, in Mbit/s					
21	Fixed (wired)-broadband speed, in Mbit/s					



# Quality of Broadband Services in the EU

March 2012

Technology	Europe Advertised (Mbps)	Europe Actual (Mbps)	Europe Actual vs Advertised	USA Advertised (Mbps)	USA Actual (Mbps)	USA Actual vs Advertised
xDSL	12.87	7.19	63.3%	6.19	5.29	85.4%
Cable	37.50	33.08	91.4%	17.21	17.03	99.0%
FTTx	50.58	41.02	84.4%	25.92	30.20	116.5%

Figure EU.1-39: Comparison of Average Actual and Advertised Download speed between Europe and the USA, split by technology

Technology	Europe Advertised (Mbps)	Europe Actual (Mbps)	Europe Actual vs Advertised	USA Advertised (Mbps)	USA Actual (Mbps)	USA Actual vs Advertised
xDSL	0.88	0.69	82.8%	0.87	0.89	102.6%
Cable	3.80	3.68	99.4%	2.41	2.64	109.8%
FTTx	25.28	19.80	88.1%	22.03	23.18	105.2%

Figure EU.1-40: Comparison of Average Actual and Advertised Upload speed between Europe and the USA, split by technology



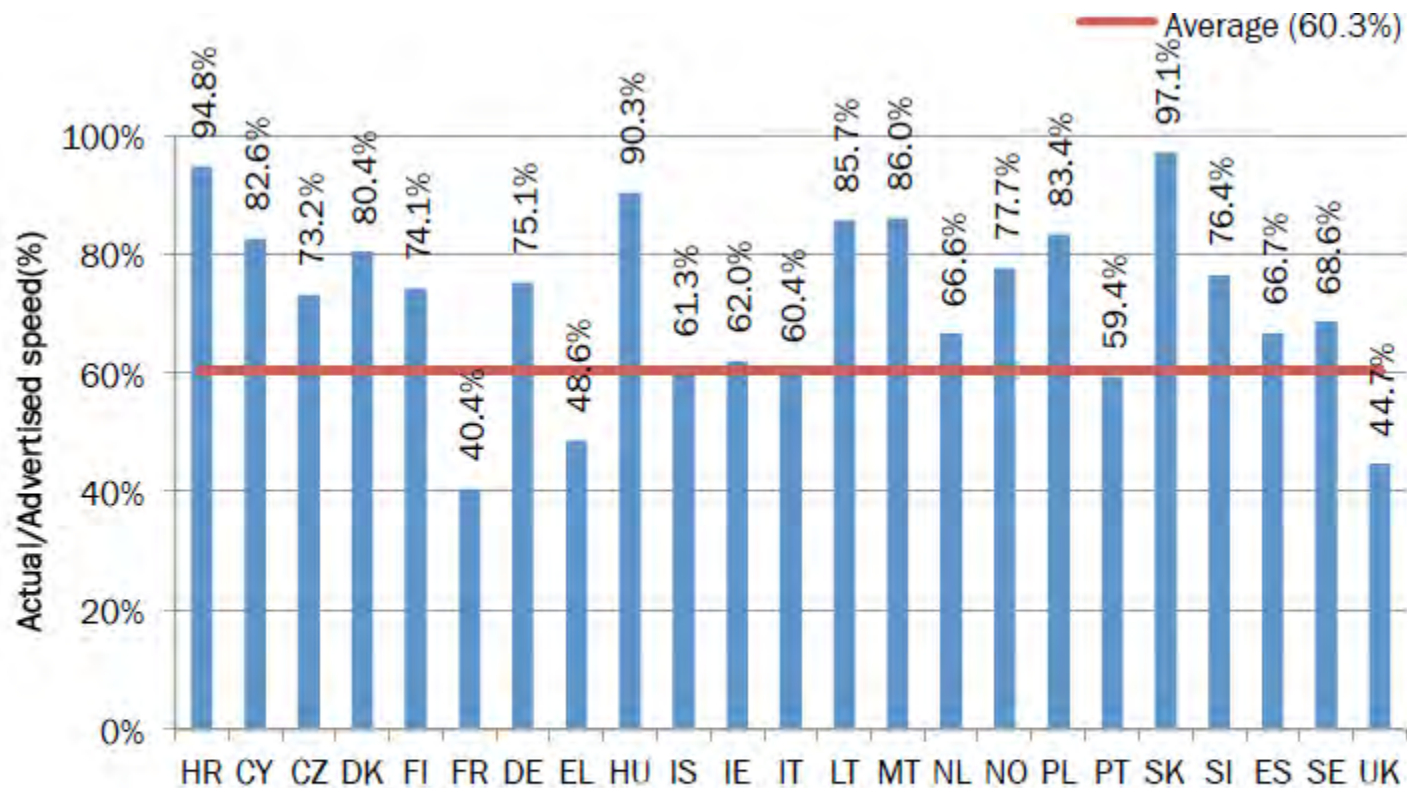
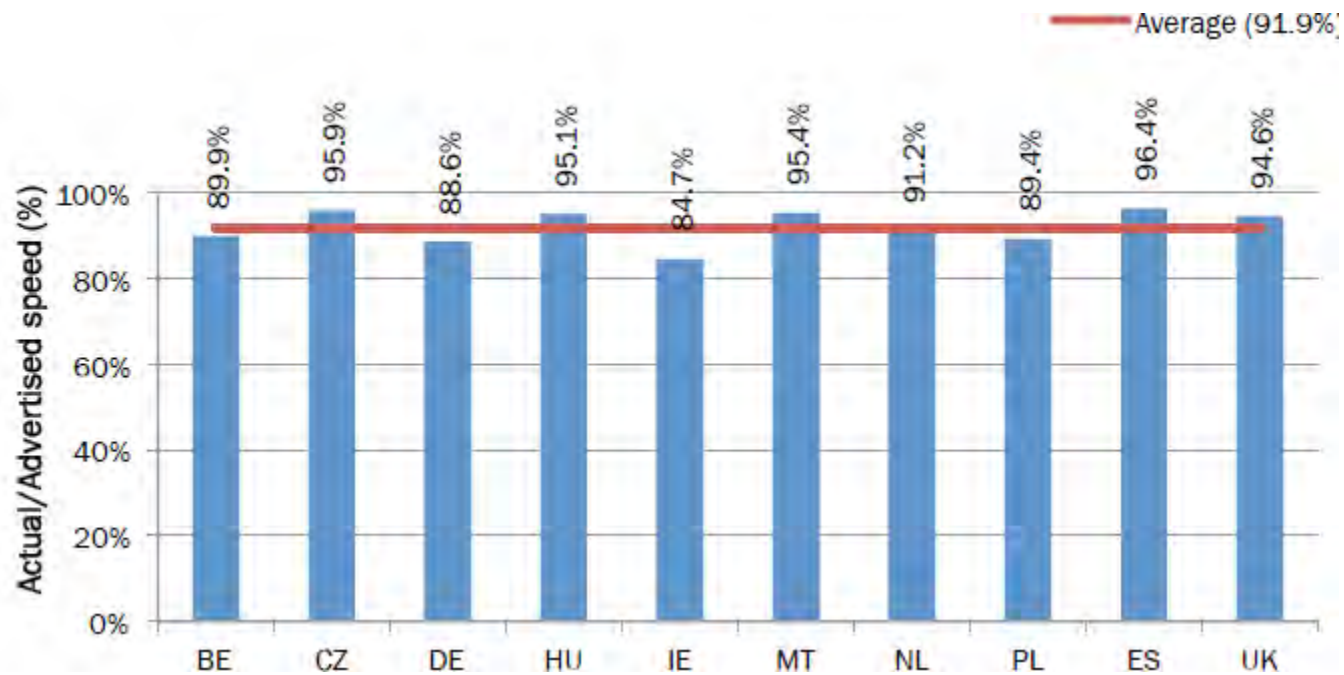


Figure EU.2-1: Actual Download Speed of xDSL technology as a Percentage of Advertised Speed during peak periods, split by country







## How to Measure What is Really Happening?

- How to measure what is really happening?
- Data obtained by direct measurement
- Speedtest.net, mlab, SamKnows
  - Speed test, initiated by users
  - MLab installed software run by administrators
  - SamKnows, dedicated boxes
- ESCAP has obtained and partially analysed the data from speedtest and mlab.

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## Access Network Speed Tests

OECD

**ANNEX 2.1: Actual speed indicators developed by private measuring entities**

(Mbit/s)	Average peak connection speed by Akamai						Average connection speed by Akamai						Median download throughput by M-Lab						Average download speed by Ookla					
	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2
Australia	16.63	21.68	22.83	23.43	26.39	29.10	3.55	4.41	4.29	4.20	4.30	4.84	4.97	4.95	5.23	5.06	4.72	4.97	10.36	10.86	11.86	12.37	12.48	13.00
Austria	20.17	22.40	24.67	25.93	29.54	31.64	5.70	6.32	6.55	6.58	7.39	8.11	5.10	5.37	5.59	5.73	6.05	5.78	11.60	11.97	12.88	13.27	13.76	15.23
Belgium	29.20	29.51	32.71	33.38	36.93	39.92	7.10	6.53	6.66	6.68	7.59	8.39	10.94	13.74	14.97	14.13	14.79	15.54	16.99	19.55	21.96	20.61	21.55	24.21
Canada	25.37	25.23	27.18	28.65	33.50	34.44	6.47	6.52	6.71	6.81	7.56	8.22	5.40	5.47	5.83	6.20	6.17	8.04	12.25	12.73	13.60	15.09	16.14	17.23
Chile	19.66	19.50	20.59	20.12	19.83	19.34	3.41	2.98	3.03	2.93	2.84	2.94	1.59	1.56	1.64	1.78	1.72	1.74	7.23	7.95	8.36	8.93	9.40	9.28
Czech Republic	24.47	25.83	27.25	30.44	34.62	35.38	7.14	7.19	7.59	8.13	9.01	9.79	4.96	5.55	6.02	6.07	6.06	6.88	14.97	15.45	16.11	17.31	16.99	18.08
Denmark	21.54	22.80	26.45	26.11	28.59	29.87	6.71	6.68	7.25	7.02	7.67	8.11	9.91	10.09	10.41	10.74	12.30	13.19	17.60	18.16	19.54	21.86	24.48	26.60
Estonia	21.57	21.14	22.44	23.46	26.23	27.94	5.16	4.83	5.03	5.20	5.64	6.16	4.80	5.55	5.46	5.23	5.98	6.28	32.05	14.79	14.24	16.85	17.08	17.70
Finland	23.54	22.58	24.97	26.53	30.11	31.03	6.85	6.57	6.82	7.12	7.85	8.12	7.83	8.22	8.20	7.75	8.48	9.02	15.76	15.91	17.07	18.31	19.32	21.70
France	19.09	18.29	19.63	21.05	22.72	24.18	4.89	4.64	4.80	4.80	5.00	5.68	4.94	5.28	4.73	3.50	3.71	4.50	12.76	12.18	12.79	14.06	15.59	17.24
Germany	23.43	24.04	26.05	27.04	31.24	32.62	5.78	5.78	5.91	6.04	6.87	7.31	6.49	7.03	7.08	7.29	7.83	8.67	14.98	14.92	16.00	16.98	18.34	19.73
Greece	20.93	20.63	21.71	22.20	25.89	26.00	4.03	3.94	3.98	3.98	4.63	4.77	5.40	5.50	5.20	5.45	5.44	5.95	5.90	5.98	5.93	6.43	7.11	7.28
Hungary	27.95	28.03	29.98	30.96	35.11	36.31	5.93	5.64	5.80	5.86	6.38	6.48	5.77	6.63	6.96	7.50	7.98	9.37	14.47	15.18	15.67	16.92	16.99	18.21
Iceland	23.90	24.55	24.19	25.18	31.69	32.16	5.37	5.50	5.26	5.41	6.97	7.17	4.66	5.82	5.85	5.89	5.61	7.17	20.43	20.88	21.74	24.87	27.08	27.44
Ireland	25.24	22.40	26.43	26.96	30.48	30.92	7.34	6.22	6.70	6.61	7.24	8.00	5.37	5.75	5.92	6.36	6.32	7.50	8.08	8.25	10.34	10.82	10.89	12.45
Israel	23.55	26.13	30.89	32.25	37.67	40.08	4.61	4.98	5.64	5.79	6.93	7.35	2.15	3.18	3.17	3.57	4.57	4.91	9.09	9.47	9.78	10.15	12.29	15.91
Italy	17.68	17.37	19.18	19.41	22.01	23.25	4.15	4.03	3.93	4.00	4.43	4.94	3.41	3.78	3.85	3.57	2.67	3.72	4.94	5.30	5.50	5.62	5.85	6.37
Japan	39.54	40.50	42.17	44.77	47.37	48.84	10.92	10.74	10.51	10.80	11.23	11.96	9.55	11.04	15.99	21.23	18.76	19.04	14.55	19.46	29.28	36.42	34.84	29.46
Korea	47.79	46.90	48.75	49.25	44.93	53.31	15.75	14.21	14.68	13.97	14.18	13.29							30.92	27.76	33.30	33.95	34.30	32.70
Luxembourg	16.72	16.60	18.40	18.92	21.32	24.97	4.73	4.54	4.65	4.66	5.15	6.09	4.93	4.86	4.75	4.87	5.35	7.12	21.22	30.31	27.00	30.49	32.86	33.61
Mexico	13.53	13.75	14.35	15.13	17.34	18.90	2.79	2.73	2.80	2.94	3.22	3.56	1.97	2.42	2.66	2.70	2.37	2.43	4.77	5.23	6.17	6.89	7.31	9.29
Netherlands	29.39	27.91	30.65	31.95	36.49	38.82	8.82	7.97	8.55	8.55	9.52	10.11	9.64	9.63	9.80	10.67	11.72	12.40	24.25	25.22	27.41	29.79	29.95	32.48
New Zealand	16.06	16.50	17.78	19.23	20.27	20.98	3.86	3.85	3.92	4.04	4.29	4.61	5.23	5.21	5.41	5.24	5.21	6.06	8.92	9.15	10.47	11.13	11.31	12.60
Norway	20.07	19.69	23.15	24.85	28.05	28.74	5.73	5.49	6.20	6.60	7.21	7.35	7.51	8.46	8.88	8.52	8.66	8.81	16.66	19.24	17.64	19.87	19.97	20.61
Poland	22.03	22.69	25.06	26.85	31.25	30.96	4.95	4.95	5.34	5.57	6.01	6.29	4.20	4.33	4.60	4.52	4.37	5.59	9.18	10.39	11.46	11.85	11.80	13.12
Portugal	28.24	27.82	29.79	31.54	33.67	35.07	5.37	4.70	4.83	4.99	4.99	5.42	5.71	6.24	6.59	6.20	6.87	7.39	16.46	21.34	22.34	23.06	23.26	23.19
Slovak Republic	24.19	23.39	26.21	27.04	29.40	29.79	5.74	5.46	5.83	5.77	6.06	6.39	2.76	3.32	4.11	4.75	4.51	5.40	13.80	12.82	13.01	15.05	14.85	16.35
Slovenia	19.83	19.41	21.53	23.51	25.56	26.41	4.82	4.57	4.91	5.18	5.33	5.77	4.23	4.22	4.20	4.83	5.43	5.52	9.96	10.65	11.60	11.63	11.80	12.96
Spain	23.96	23.76	26.00	27.79	30.11	32.05	4.62	4.64	4.83	4.93	5.00	5.87	4.44	4.56	4.71	4.75	4.97	5.38	11.55	11.93	11.70	12.61	13.63	14.82
Sweden	24.13	23.58	26.95	28.36	33.02	33.73	6.34	5.85	6.77	7.27	8.39	8.45	8.95	9.67	10.08	9.68	9.56	10.49	24.91	24.03	26.51	26.43	27.65	30.28
Switzerland	28.66	29.91	32.41	34.15	39.88	41.42	8.10	8.43	8.69	8.74	10.09	11.01	7.55	8.71	9.35	9.86	10.41	11.02	19.75	19.63	20.75	23.36	30.49	30.98
Turkey	18.50	17.37	19.59	19.25	24.08	26.67	2.85	2.73	2.85	2.75	3.19	3.70	2.43	1.41	2.49	2.52	2.56	2.68	6.65	5.88	6.72	7.03	7.47	8.07
United Kingdom	23.67	24.49	28.14	30.49	35.26	37.14	5.58	5.66	6.30	6.47	7.59	8.40	5.20	5.80	6.39	6.76	7.16	7.94	12.26	15.15	17.56	18.19	19.39	21.09
United States	28.86	29.14	30.98	32.77	35.88	36.31	6.75	7.11	7.46	7.61	8.39	8.68	6.07	6.64	7.00	6.87	6.59	7.37	12.54	12.59	14.53	15.37	15.79	17.57



## ANNEX 2.2: Country ranks according to the private speed indicators.

Highlighted cells indicate fastest five countries.

	Average peak connection speed by Akamai						Average connection speed by Akamai						Median download throughput by M-Lab						Average download speed by Ookla					
	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2	2012Q1	2012Q2	2012Q3	2012Q4	2013Q1	2013Q2
Australia	32	23	24	26	24	23	31	28	28	28	30	29	19	23	21	22	25	27	24	24	23	24	24	26
Austria	24	22	21	21	20	17	17	11	13	14	13	12	18	20	18	18	17	22	22	22	21	22	22	23
Belgium	4	4	3	4	5	5	7	9	12	11	11	9	1	1	2	2	2	2	9	8	7	10	10	9
Canada	9	11	12	12	12	12	11	10	10	10	12	10	13	19	17	15	15	11	21	19	19	19	18	20
Chile	27	27	28	29	33	33	32	32	32	33	34	34	33	32	33	33	33	33	30	30	30	30	30	31
Czech Republic	11	10	11	11	10	10	6	5	5	5	5	5	20	16	14	16	16	18	14	13	14	14	17	16
Denmark	22	18	14	20	22	21	10	7	7	9	9	13	2	3	3	3	3	3	8	11	10	9	8	8
Estonia	21	24	25	25	25	25	21	22	22	22	22	22	23	17	19	21	18	19	1	17	18	17	15	17
Finland	18	20	20	19	18	18	8	8	8	8	8	11	6	8	8	8	8	8	12	12	13	12	13	11
France	28	29	29	28	29	30	23	25	26	26	25	26	21	21	24	30	29	29	18	21	22	21	20	19
Germany	19	14	17	15	16	14	14	14	16	16	18	17	9	9	9	10	10	10	13	16	15	15	14	14
Greece	23	25	26	27	26	28	29	30	29	31	28	30	14	18	22	19	20	21	32	31	33	33	33	33
Hungary	8	6	8	9	9	8	13	16	18	17	19	19	11	11	11	9	9	7	16	14	16	16	16	15
Iceland	15	12	22	22	14	15	20	17	21	21	16	18	24	13	16	17	19	16	6	6	8	6	7	7
Ireland	10	21	15	17	17	20	5	12	11	12	14	14	15	15	15	13	14	13	29	29	28	28	29	29
Israel	17	9	6	6	4	4	27	20	19	18	17	15	31	30	30	28	26	28	27	27	29	29	25	22
Italy	30	30	31	30	30	31	28	29	30	30	29	28	28	28	29	29	30	30	33	33	34	34	34	34
Japan	2	2	2	2	1	2	2	2	2	2	2	2	4	2	1	1	1	1	15	9	2	1	1	6
Korea	1	1	1	1	2	1	1	1	1	1	1	1							2	2	1	2	2	2
Luxembourg	31	32	32	33	31	29	25	27	27	27	24	23	22	24	23	23	22	17	5	1	4	3	3	1
Mexico	34	34	34	34	34	34	34	34	34	32	32	33	32	31	31	31	32	32	34	34	32	32	32	30
Netherlands	3	7	7	7	6	6	3	4	4	4	4	4	3	5	5	4	4	4	4	3	3	4	5	3
New Zealand	33	33	33	32	32	32	30	31	31	29	31	31	16	22	20	20	23	20	28	28	27	27	28	28
Norway	25	26	23	23	23	24	16	18	15	13	15	16	8	7	7	7	7	9	10	10	11	11	13	
Poland	20	19	19	18	15	19	22	21	20	20	21	21	27	26	26	27	28	23	26	26	26	25	26	25
Portugal	7	8	9	8	11	11	19	23	24	24	27	27	12	12	12	14	12	14	11	5	6	8	9	10
Slovak Republic	12	17	16	16	21	22	15	19	17	19	20	20	29	29	28	25	27	25	17	18	20	20	21	21
Slovenia	26	28	27	24	27	27	24	26	23	23	23	25	26	27	27	24	21	24	25	25	25	26	27	27
Spain	14	15	18	14	19	16	26	24	25	25	26	24	25	25	25	26	24	26	23	23	24	23	23	24
Sweden	13	16	13	13	13	13	12	13	9	7	7	7	5	4	4	6	6	6	3	4	5	5	6	5
Switzerland	6	3	4	3	3	3	4	3	3	3	3	3	7	6	6	5	5	5	7	7	9	7	4	4
Turkey	29	31	30	31	28	26	33	33	33	34	33	32	30	33	32	32	31	31	31	32	31	31	31	32
United Kingdom	16	13	10	10	8	7	18	15	14	15	10	8	17	14	13	12	11	12	20	15	12	13	12	12
United States	5	5	5	5	7	9	9	6	6	6	6	6	10	10	10	11	13	15	19	20	17	18	19	18

## Insight

- What can this data tell us that we didn't know before?
  - Describe the user experience at the country, city and ISP levels
  - What does the digital divide look like?
  - How identification of marginalized communities



## Download Speed in Kbps

Country	2010	2014	Percent Change
Hong Kong	19264.51	74296.16	386%
Singapore	9214.67	61576.71	668%
Korea, Republic of	31995.05	51276.05	160%
Japan	18755.31	41611.84	222%
Macau	4830.30	40264.75	834%
France	11460.32	28868.21	252%
United Kingdom	7885.97	24952.25	316%
United States	9992.86	22044.22	221%
Russian Federation	9517.44	22035.94	232%
New Zealand	6164.45	18032.93	293%
China	3282.21	17971.60	548%
Thailand	4453.23	16408.95	368%
Australia	6906.01	14226.61	206%
Kazakstan	5669.85	13821.82	244%
Georgia	6352.80	13796.73	217%
Mongolia	5597.04	13575.54	243%
Vietnam	3853.00	13220.94	343%
Tajikistan	1286.74	12736.99	990%
Turkey	4855.47	10622.58	219%
Guam	3252.52	10004.56	308%
Armenia	1705.59	9810.64	575%
Kyrgyzstan	7565.63	9339.74	123%
Papua New Guinea	1500.46	8892.47	593%
New Caledonia	2207.38	8119.84	368%
Fiji	3247.81	6406.18	197%
Nepal	443.59	5773.92	1302%
Cambodia	1354.76	5437.38	401%
Brunei Darussalam	1362.27	5363.21	394%
Malaysia	2169.50	5273.77	243%
Myanmar	2986.39	5008.62	168%
Bhutan	1309.96	4887.83	373%
Maldives	3016.97	4708.09	156%
India	1300.37	4484.34	345%
Azerbaijan	2768.24	4419.49	160%
Bangladesh	769.00	4043.25	526%
Indonesia	1107.63	4026.21	363%
Lao PDR	1107.25	3950.33	357%
Philippines	2598.91	3302.97	127%
Sri Lanka	1180.49	3291.41	279%
Iran, Islamic Republic of	621.34	2850.65	459%
Uzbekistan	1625.54	2629.41	162%
Pakistan	1388.13	2357.29	170%
Afghanistan	813.15	1071.98	132%

### Download Speed in Kbps

Country	2010	2014	Percent Change
Nepal	443.59	5773.92	1302%
Tajikistan	1286.74	12736.99	990%
Macau	4830.30	40264.75	834%
Singapore	9214.67	61576.71	668%
Papua New Guinea	1500.46	8892.47	593%
Armenia	1705.59	9810.64	575%
China	3282.21	17971.60	548%
Bangladesh	769.00	4043.25	526%
Iran, Islamic Republic of	621.34	2850.65	459%
Cambodia	1354.76	5437.38	401%
Brunei Darussalam	1362.27	5363.21	394%
Hong Kong	19264.51	74296.16	386%
Bhutan	1309.96	4887.83	373%
Thailand	4453.23	16408.95	368%
New Caledonia	2207.38	8119.84	368%
Indonesia	1107.63	4026.21	363%
Lao PDR	1107.25	3950.33	357%
India	1300.37	4484.34	345%
Vietnam	3853.00	13220.94	343%
United Kingdom	7885.97	24952.25	316%
Guam	3252.52	10004.56	308%
New Zealand	6164.45	18032.93	293%
Sri Lanka	1180.49	3291.41	279%
France	11460.32	28868.21	252%
Kazakstan	5669.85	13821.82	244%
Malaysia	2169.50	5273.77	243%
Mongolia	5597.04	13575.54	243%
Russian Federation	9517.44	22035.94	232%
Japan	18755.31	41611.84	222%
United States	9992.86	22044.22	221%
Turkey	4855.47	10622.58	219%
Georgia	6352.80	13796.73	217%
Australia	6906.01	14226.61	206%
Fiji	3247.81	6406.18	197%
Pakistan	1388.13	2357.29	170%
Myanmar	2986.39	5008.62	168%
Uzbekistan	1625.54	2629.41	162%
Korea, Republic of	31995.05	51276.05	160%
Azerbaijan	2768.24	4419.49	160%
Maldives	3016.97	4708.09	156%
Afghanistan	813.15	1071.98	132%
Philippines	2598.91	3302.97	127%
Kyrgyzstan	7565.63	9339.74	123%

## Domestic Networks Growing at Faster Rates

### Metro and Long-Haul Traffic, 2013–2018

	2013	2014	2015	2016	2017	2018	CAGR 2013–2018
<b>Metro-Only (PB per Month)</b>							
North America	12194	15573	19634	24298	29790	36148	24%
Asia and the Pacific	6740	8672	11246	14321	18128	23110	28%
Western Europe	4569	5706	7137	8986	11342	14438	26%
Central and Eastern Europe	720	978	1414	1984	2818	3901	40%
Latin America	637	844	1210	1638	2150	2793	34%
Middle East and Africa	148	206	298	431	602	812	41%
<b>Long-Haul (PB per Month)</b>							
Asia and the Pacific	11210	13447	15623	18063	20958	24163	17%
Central and Eastern Europe	2933	3438	4029	4682	5514	6322	17%
Latin America	2851	3517	4108	4724	5426	6137	17%
North America	4413	4720	4965	5079	4761	4397	0%
Western Europe	3827	4033	4198	4458	4709	4819	5%
Middle East and Africa	926	1341	1876	2596	3507	4512	37%
Source: CISCO, VNI 2014							

## Fixed Broadband Speeds, Mbps, 2013–2018

### Fixed Broadband Speeds, Mbps, 2013–2018

Region	2013	2014	2015	2016	2017	2018	CAGR
Global	11.3	16.1	20.3	25.6	31.10	36.7	42.2
Asia and the Pacific	10.4	18	23.2	29.7	36.40	42.5	48.1
Latin America	5.4	6.4	7.8	9.6	11.60	13.9	16.4
North America	12.9	17.6	21.8	27	32.30	37.7	43.2
Western Europe	13	19.3	23.8	29.3	35.40	42.1	48.9
Central and Eastern Europe	12.3	17.5	22.2	28.3	34.60	40	45.3
Middle East and Africa	2.5	5.7	7.1	8.8	10.80	12.8	14.9

## Broadband Speed Greater than 10 Mbps, 2013–2018

Region	Greater than 10 Mbps		Greater than 50 Mbps		Greater than 100 Mbps	
	2013	2018	2013	2018	2013	2018
Global	45%	55%	12%	22%	2%	3%
Asia and the Pacific	43%	53%	13%	23%	2%	4%
Latin America	24%	34%	3%	5%	1%	2%
North America	57%	62%	12%	20%	2%	4%
Western Europe	50%	52%	14%	24%	4%	6%
Central and Eastern Europe	47%	73%	12%	25%	1%	3%
Middle East and Africa	18%	23%	2%	4%	0%	1%
Source: CISCO, VNI 2014						

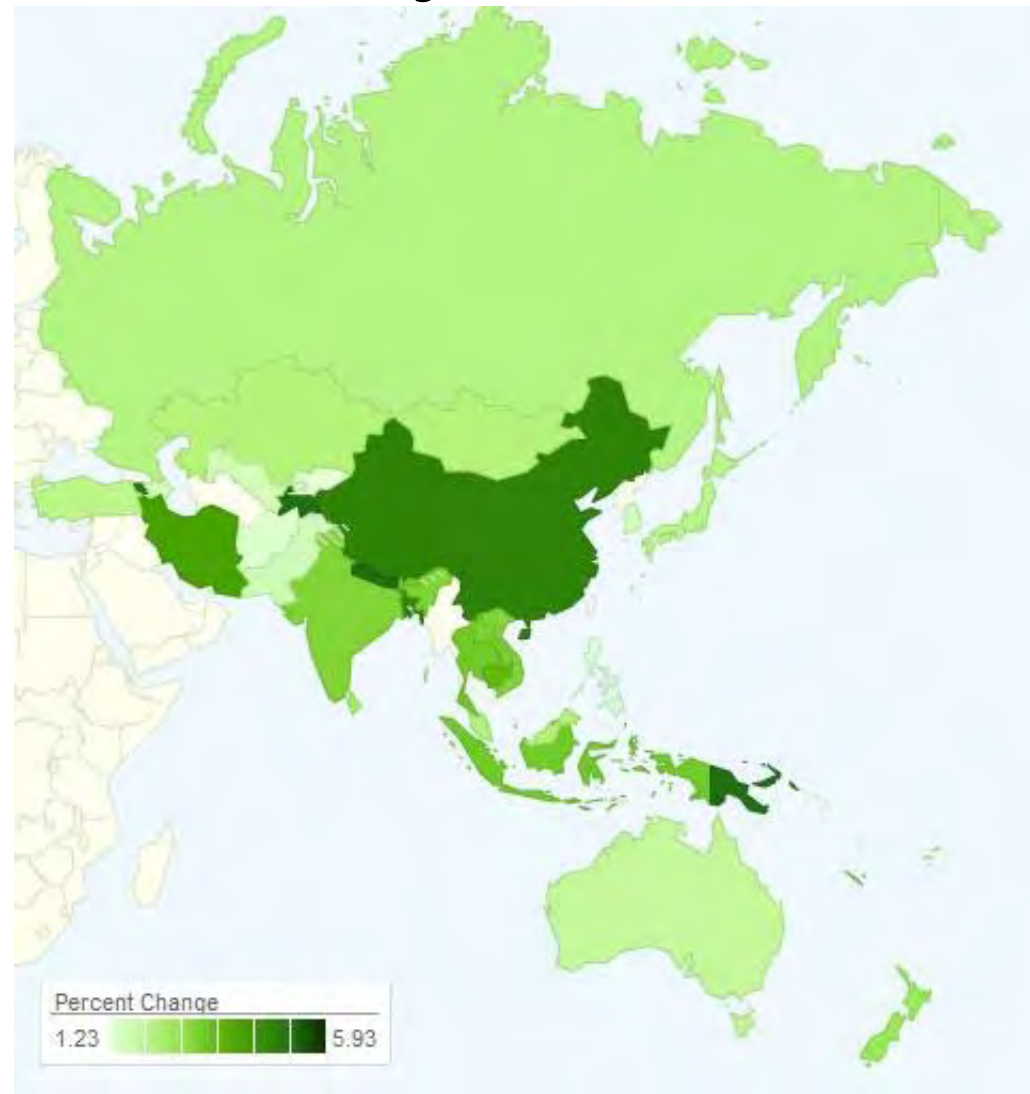


# HOW MUCH GROWTH IS ENOUGH?

## Countries growing at 400% or more



## Country Growth Rates



## Countries Delivering 10 Mbps



## Delivered Download Speeds 2014





## Policy Implications

- Policy implications:
  - Specific identification of underserved communities – policy makers can target investments
  - Shortlist areas for the AI superhighway
  - Understand levels of investment necessary in national networks

**THANK YOU**



**What's the next level?**

Part 2

## Network Concepts

- Latency:

Network latency in a packet-switched network is measured either one-way (the time from the source sending a packet to the destination receiving it), or round-trip delay time (the one-way latency from source to destination plus the one-way latency from the destination back to the source)

## Networking Concepts

- Jitter:

In the context of computer networks, jitter is the variation in latency as measured in the variability over time of the packet latency across a network. A network with constant latency has no variation (or jitter)



## Networking Concepts

- R Factor

R-value is a number, or score, that is used to quantitatively express the subjective quality of speech in communications systems, especially digital networks that carry voice over IP (VoIP) traffic, or for which VoIP service is under consideration.

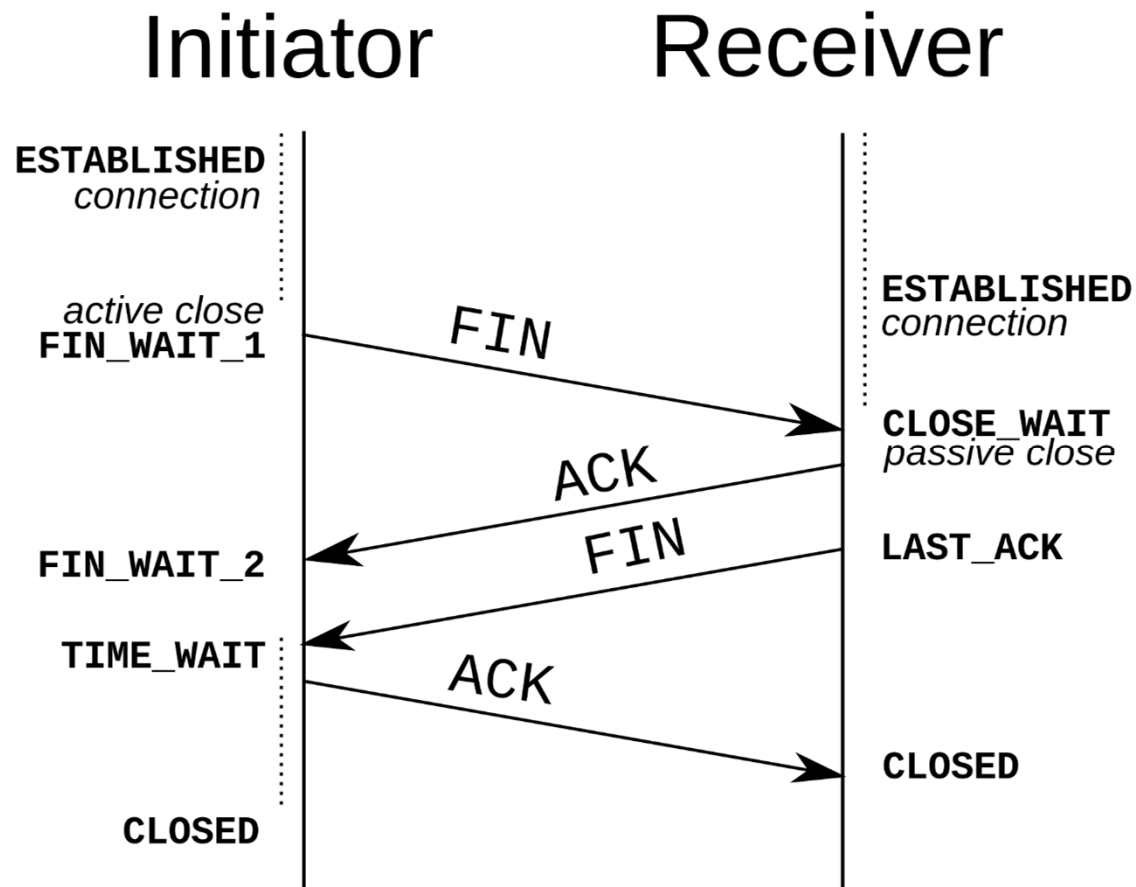
Desirability Scale	R-factor	MOS Value
Desirable	94 – 80	4.4 – 4.0
Acceptable	80 – 70	4.0 – 3.6
Reach Connection	70 – 50	3.6 – 2.6
Not Recommended	50 – 0	2.6 – 0

## General Observations

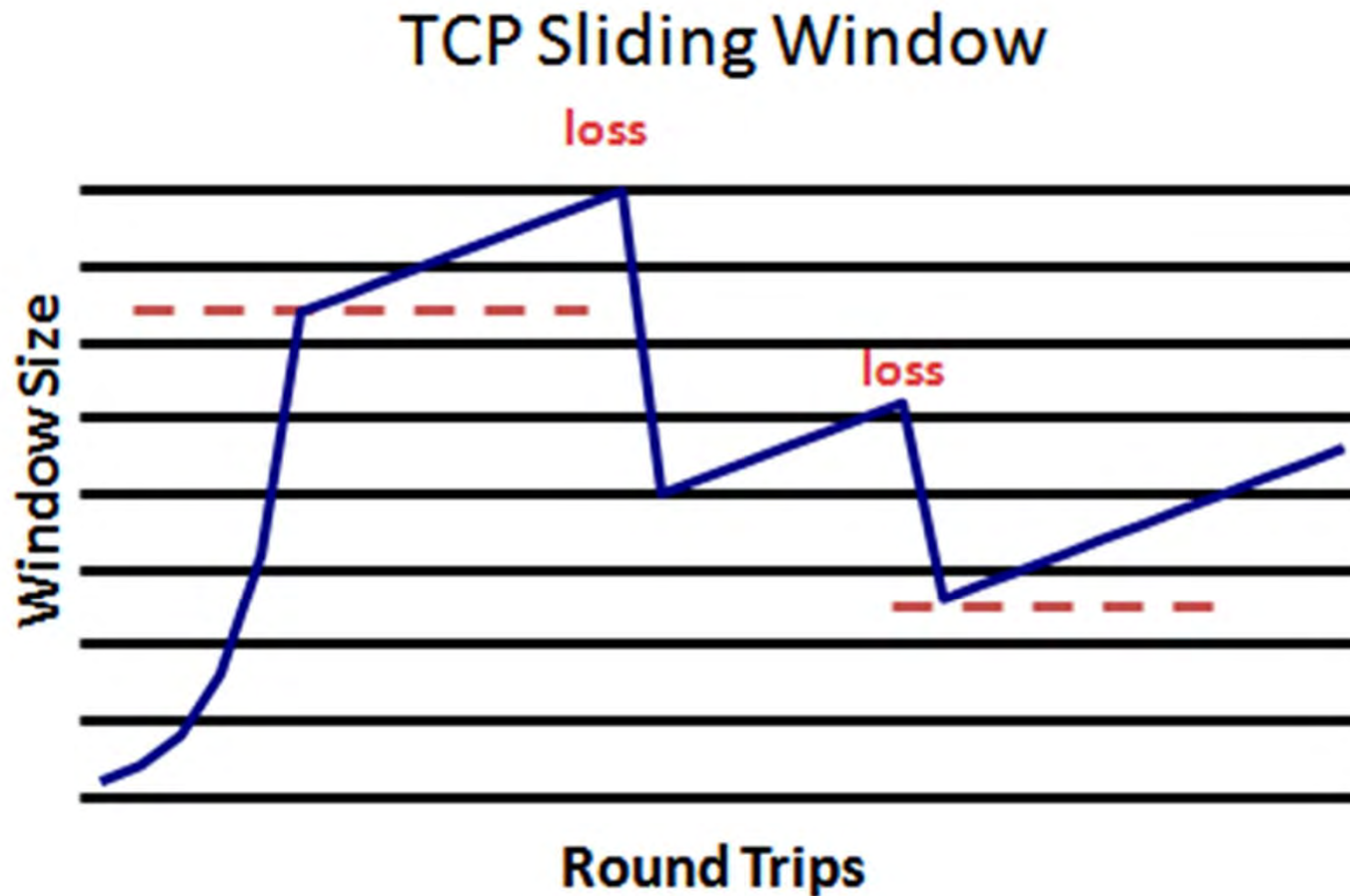
- Data available for hard to measure countries such as CAS, LDCs
- Good time series information
- Provides detailed breakdown of upload/download speeds
- Provides meta-data such as number of measurements, facilitating weighting



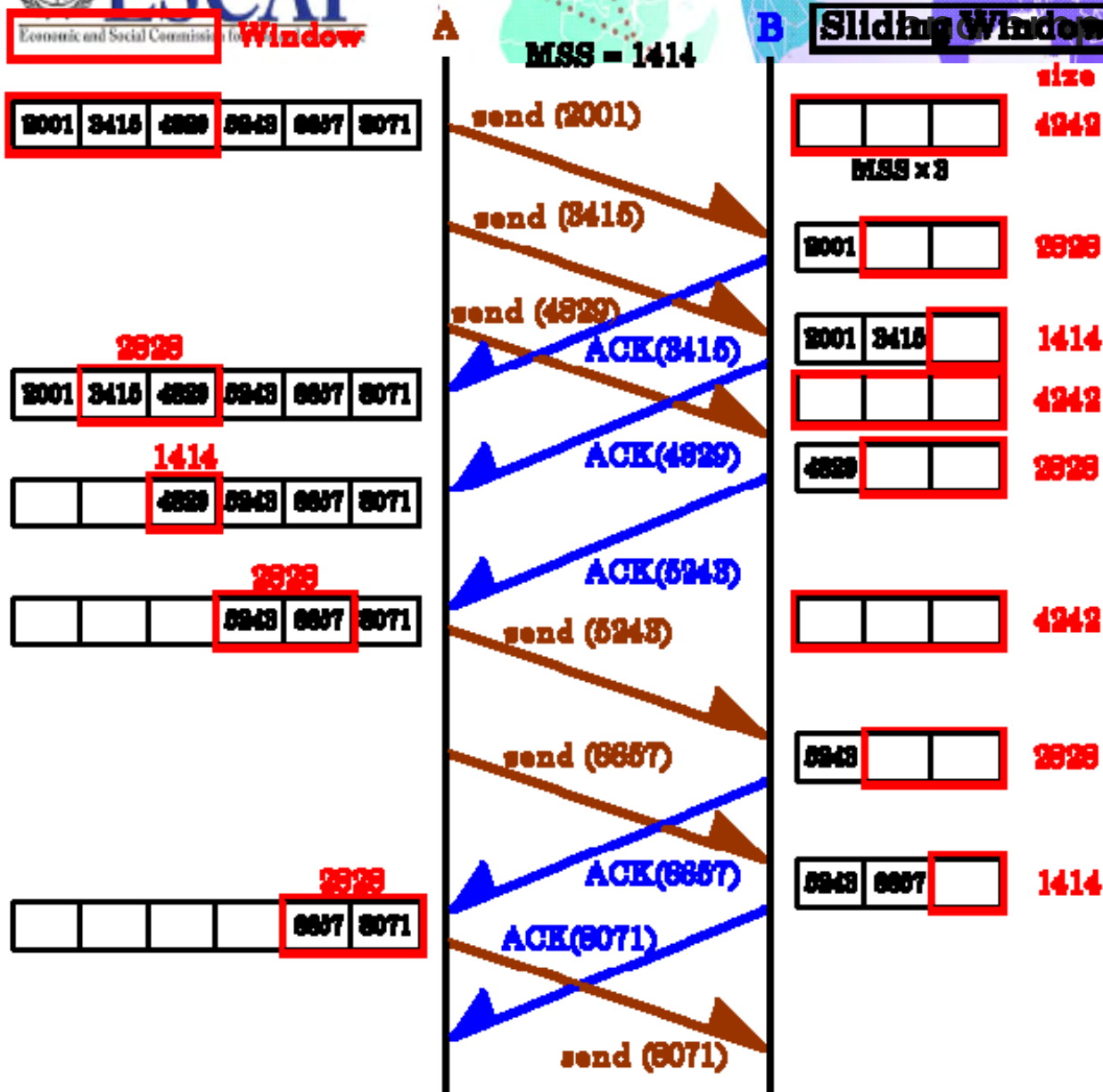
## How does the Internet Handle Congestion?



## Matching Speeds Between Sender and Receiver



# Connecting economies Sliding Window Empowering people





Let's look at mlab

# SOURCE DATA BREAK

# Source File Layout

```

2009/02/18/PaxHeader/20090218T17:57:28.176375000Z-76.16.0.76:581
71.s2c_snaplog          000444  000000  000000
000000000062 11147046010 023014
x
                                ustar 00m-
lab                          m-
lab                          000000  000000

                                16 SCHILY.dev=0
16 SCHILY.ino=0
18 SCHILY.nlink=0

                                2009/02/18/20090218T17:57:28.176375000Z-76.16.0.76
:58171.s2c_snaplog          000444  000000
000000  00000300635 11147046010 021054
0
                                ustar 00m-
lab                          m-
lab                          000000  000000

                                <[ ] (LœI  l_snaplog-76.16.
0.76.58171.1234979848 iy œ||Å&?~÷Ï'3(Š^0^~È9E'

```

# Why should this be considered 'Big Data'?

The screenshot displays the Google BigQuery web interface. The browser address bar shows the URL: [https://bigquery.cloud.google.com/results/verdant-descent-746;job\\_kFU5D2K5w8WrGwHGZCdGv\\_J3Td](https://bigquery.cloud.google.com/results/verdant-descent-746;job_kFU5D2K5w8WrGwHGZCdGv_J3Td). The interface includes a 'COMPOSE QUERY' button, a 'New Query' editor with the following SQL code:

```
1 SELECT AVG(web100_log_entry.snap.LimCwnd) AS LimCwnd,  
2 STRING (connection_spec.client_geolocation.country_name) AS country,  
3 FROM [measurement-lab:m_lab.2009_07]  
4 GROUP BY country;
```

Below the query editor, there are buttons for 'RUN QUERY', 'Save Query', 'Save View', and 'Show Options'. A status message indicates 'Query complete (22.9s elapsed, 0 B processed)'. The 'Query Results' section shows the following table:

Row	LimCwnd	country
1	4.2826631048019013E9	
2	4.294965858353933E9	Greece
3	4.294965845743532E9	Germany
4	4.2949658626215043E9	United Kingdom
5	4.294965836E9	Korea, Republic of
6	4.294965856643102E9	United States
7	4.294965846575903E9	France

Navigation links at the bottom of the results table include 'First', '< Prev', 'Rows 1-7 of 58', 'Next >', and 'Last'. The Windows taskbar at the bottom shows the time as 10:28 PM on 11/16/2014.