Overview of Largest Data Centers

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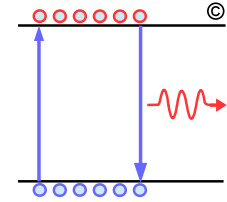
Ghiasi Quantum LLC   **Commscope**

802.3bs Task Force

May 2014 – Interim Meeting

Overview*

❑ **Previously presented overview of some of the largest US data centers**

 – http://www.ieee802.org/3/100GNGOPTX/public/sept11/ghiasi_01_a_0911_NG100GOPTX.pdf

❑ **Several assumption were made in the original study**

  – Building assumed to be square

  – Examining satellite photo indicate most building are rectangular likely due to HVAC requirements so actual length can be little longer

  – 3 Years ago Google Mayes county with ~1000,000 sq-ft was the largest known data center but now there are several comparable size data center

  – SuperNAP Las Vegas with 2,200,000 sq-ft is the largest known operating data center and more than twice largest Google data center
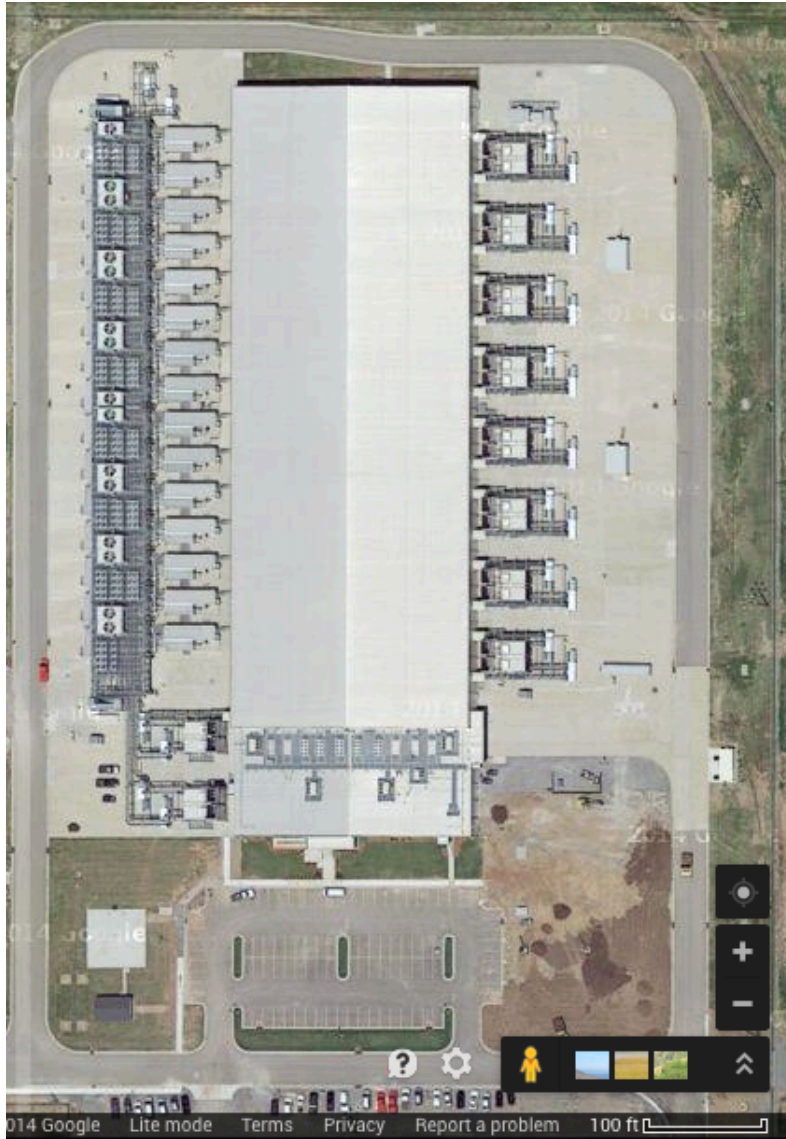
❑ **Bigger building may translate to longer fiber runs!**

* Data provided here is as is, there is no guarantee on their accuracy as it relies on 3rd party articles and/or estimate.
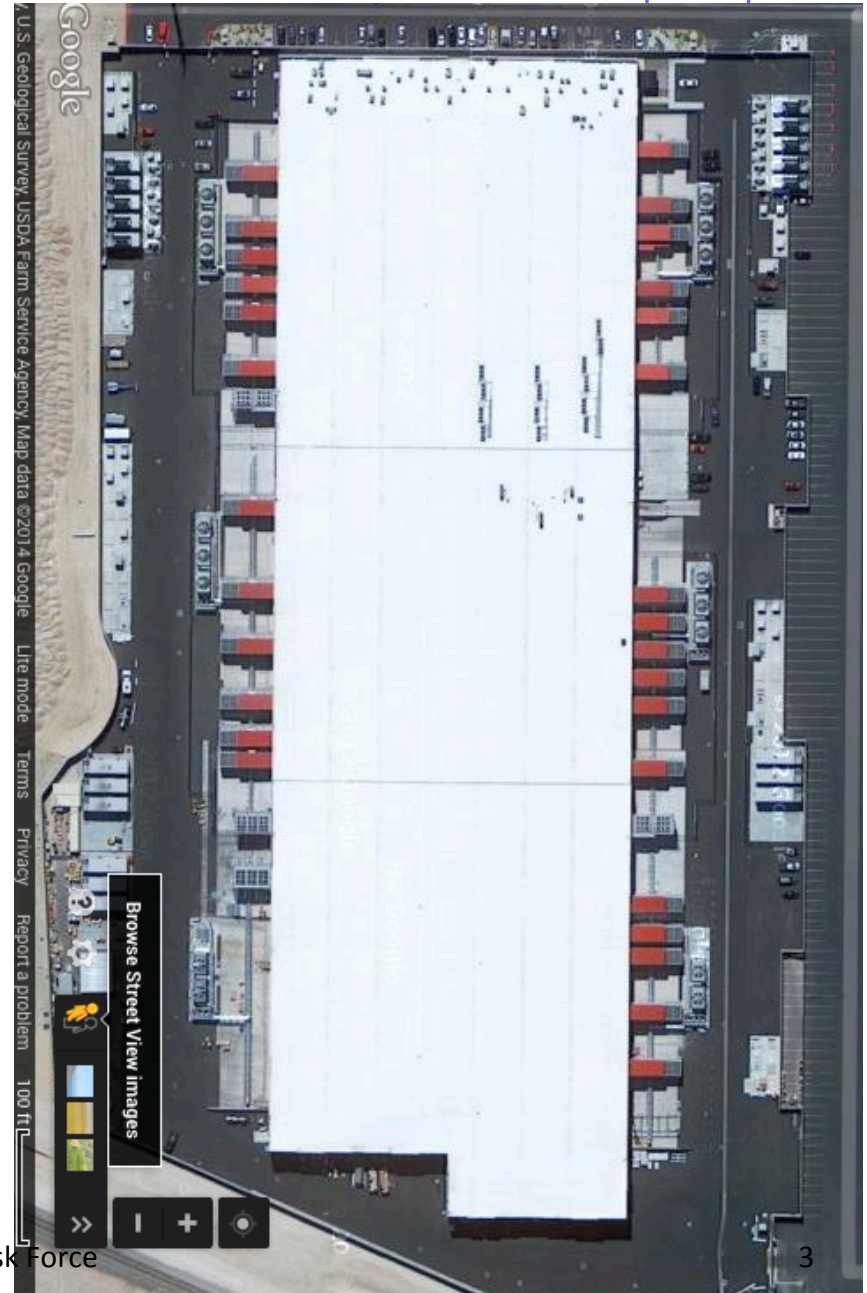
Google Mayes County vs SuperNAP Las Vegas
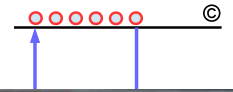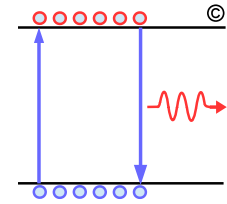
Google Mayes County

Some Facts About Mega Data Center Trend

- **Google has ~14 data centers around the world consuming 260 MW or 0.01% of total power capacity on the planet**
- **As of July 2013 both Google and Microsoft each have in the 900k-1000k servers**
- **SuperNAP Las Vegas based on Dell Scorpion pulling in 35 kW/rack**
  - SuperNAP is located in Las Vegas for having least amount of natural disasters
  - Las Vegas also is a hub for dark dark fiber from .COM era
  - At power density of ~1400 W/sq-ft the challenge is cooling Vegas
- **Standard Facebook storage rack has power capacity of 8 kW**
  - Facebook uses 3 tiered storage with total storage capacity of 100 PB.

Original Study Presented in 2011 .bm
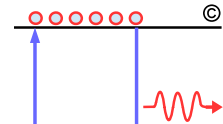
- *** Dana Hull, San Jose Mercury News, April 22 2011**
- **** Status as of April 2011**
- ***** Longest Run Estimated to be = 2*√(area)=603 m**
- **# Tulsa Times May 3 2007 states 1.4M Sq-ft plant assume data center is 70% of plant**
- **## Various media reported likely size to be ~500K Sq-ft**
- **Median size of data centers in US 190000 sq feet**
- **Longest run assuming 190000 sq feet area =√(area)=132.9 m**

| Data Center Location	Status	Square footage	Power (MW)	Longest Run(m)*
Amazon				
Boardman, OR	Not operational	100000	5	192.8
Mcnary, OR	Under Construction	120000	6	211.2
Manasas, VA	Operational	110000	5	202.2
Ashburn, VA	Operational	180000	9	258.6
Stering, VA	Operational	125000	6	215.5
Apple				
Maden, NC	Nearly Completed	500000	100	431.1
Newark	Operational	100000	15	192.8
Facebook				
Princeville, OR	Nearly Completed	307000	40	337.8
Forest City, OR	Under Construction	300000	40	333.9
San Jose, CA	Lease	25000	5	96.4
Santa Clara, CA	Lease	86000	15	178.8
Santa Clara, CA	Lease	50000	8	136.3
Ashburn, VA	Lease	49000	8	134.9
Ashburn, VA	Lease	45000	8	129.3
Google				
Berkely County, SC	Likely Operational	200000	76	272.6
Council Bluff, IA	Likely Operational	200000	76	272.6
Dalles, OR	Operational	200000	70	272.6
Lenoir, NC	Phase 2	337000	76	353.9
Mayers County, OK #	Likely Operational	980000	100.8	603.5
HP				
Atlanta, GA	Operational	200000	20	272.6
Atlanta, GA	Operational	200000	20	272.6
Austin, TX	Operational	100000	20	192.8
Colorado Spring, CO	Operational	250000	10	304.8
Tusla, OK	Operational	250000	20	304.8
IBM				
Boulder, CO	Operational	300000	60	333.9
RTP, NC	Operational	100000	30	192.8
Microsoft				
Boydton, VA ##	Likely Operational	500000	NA	431.1
Chicago, IL	Operational	700000	60	510.0
Quincy, WA	Operational	500000	27	431.1
San Antonio, TX	Operational	477000	27	421.0
Des Moines, IA	Under Construction	NA	NA	
Twitter				
Salt Lake City, UT	Lease	15000	2	74.7
Sacramento, CA	Lease	NA	2	
Yahoo				
Ashburn, VA	Operational	112000	10	204.0
Lockport, NY	Operational	NA	18	
Omaha, NB	Operational	180000	20	258.6
Quincy, WA	Operational	180000	26	258.6
Quincy, WA	Under Construction	NA	72	
		190000		132.9

Updated Data Center Study
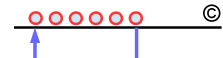
□ **Largest operating data center grow from ~ 1M sq-ft to 2.2M sq-ft**

□ **Longest cable length grow from 600 m to 900 m**

– Longest cable when Langfeng Data Center become operation will be ~1.5 km

□ **Longest Run Estimated to be = 2*√(area)=603 m**

– A typical rectangular building will have slightly longer cables

□ **Median size of data centers grow from 190000 sq-feet tp 225000 sq-ft**

□ **Median longest run assuming square building grow from ~130 m to ~145 m.**

Data Center Location	Status	Square footage	Power (MW)	Longest Run(m)
Amazon				
Boardman, OR	Operational	100000	25	192.8
Mcnary, OR	Operational	120000	30	211.2
Manasas, VA	Operational	110000	27.5	202.2
Ashburn, VA	Operational	180000	45	258.6
Stering, VA	Operational	125000	31.25	215.5
Apple				
Maden, NC	Operational	500000	100	431.1
Newark	Operational	100000	15	192.8
Facebook				
Princeville, OR	Operational	307000	40	337.8
Forest City, OR	Operational	300000	40	333.9
San Jose, CA	Lease	25000	5	96.4
Santa Clara, CA	Lease	86000	15	178.8
Santa Clara, CA	Lease	50000	8	136.3
Ashburn, VA	Lease	49000	8	134.9
Ashburn, VA	Lease	45000	8	129.3
Altoona, IA	Phase I Operational	1400000	117	721.3
Google				
Berkely County, SC	Operational	200000	76	272.6
Council Bluff, IA	Operational	200000	76	272.6
Dalles, OR	Operational	200000	70	272.6
Lenoir, NC	Operational	337000	76	353.9
Mayes County, OK	Operational	980000	100.8	603.5
HP				
Atlanta, GA	Operational	200000	20	272.6
Atlanta, GA	Operational	200000	20	272.6
Austin, TX	Operational	100000	20	192.8
Colorado Spring, CO	Operational	250000	10	304.8
Tusla, OK	Operational	250000	20	304.8
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Microsoft				
Boydton, VA	Operational	500000	21	431.1
Chicago, IL	Operational	700000	60	510.0
Quincy, WA	Operational	500000	27	431.1
San Antonio, TX	Operational	477000	27	421.0
Dublin, Irland	Operational	330000	22	350.2
Des Moines, IA	Under Construction	1160000	NA	656.6
Twitter				
Salt Lake City, UT	Lease	15000	2	74.7
Sacramento, CA	Lease	NA	2	
Yahoo				
Ashburn, VA	Operational	112000	10	204.0
Lockport, NY	Operational	150000	18	236.1
Omaha, NB	Operational	180000	20	258.6
Quincy, WA	Operational	180000	26	258.6
Quincy, WA	Operational	151000	26	236.9
Other				
Switch SuperNAP-Las Vegas, NV	Operational	2200000	200	904.2
NSA-Blufdale UT	Operational	1000000	65	609.6
Lakeside Technology-Chicago, IL	Operational	1100000	100	639.4
QTS Metro - Atlanta, GA	Operational	970000	120	600.4
NAP of America- Miami, FL	Operational	750000		527.9
IO Phoenix, Phoenix, AZ	Operational	538000	40	447.1
International				
China Langfang	Under Construction	6300000		1530.1
Tulip, Bangalore India	Operational	900000	40	578.3
NGD Europe, Wales UK	Operational	750000	90	527.9
Sum		25012000	1915.55	
Median sq-ft		225000	**Median L m**	144.6

A. Ghiasi

Equinix Data Centers
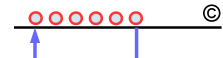
- ❑ **Equinix has 83 data centers world wide head to head in term of area with Microsoft**
  - – Equinix website state 5.8 M sq-ft of data center but adding all the data centers only sums to 3.3 M sq-ft
- ❑ **Equinix are moderate size**
  - – Expect cable distribution to be bi-modal
  - – 100 m within one data center or vault
  - – 1-2 km to adjacent building
- ❑ **Longest Run Estimated to be = 2*√(area)=300 m**
  - – A typical rectangular building will have slightly longer cables

* Total area for each city was only provided to calculate each size of each Bldg it was estimated based on the ratio of Bldg power capacity to total power to calculate the Bldg size.
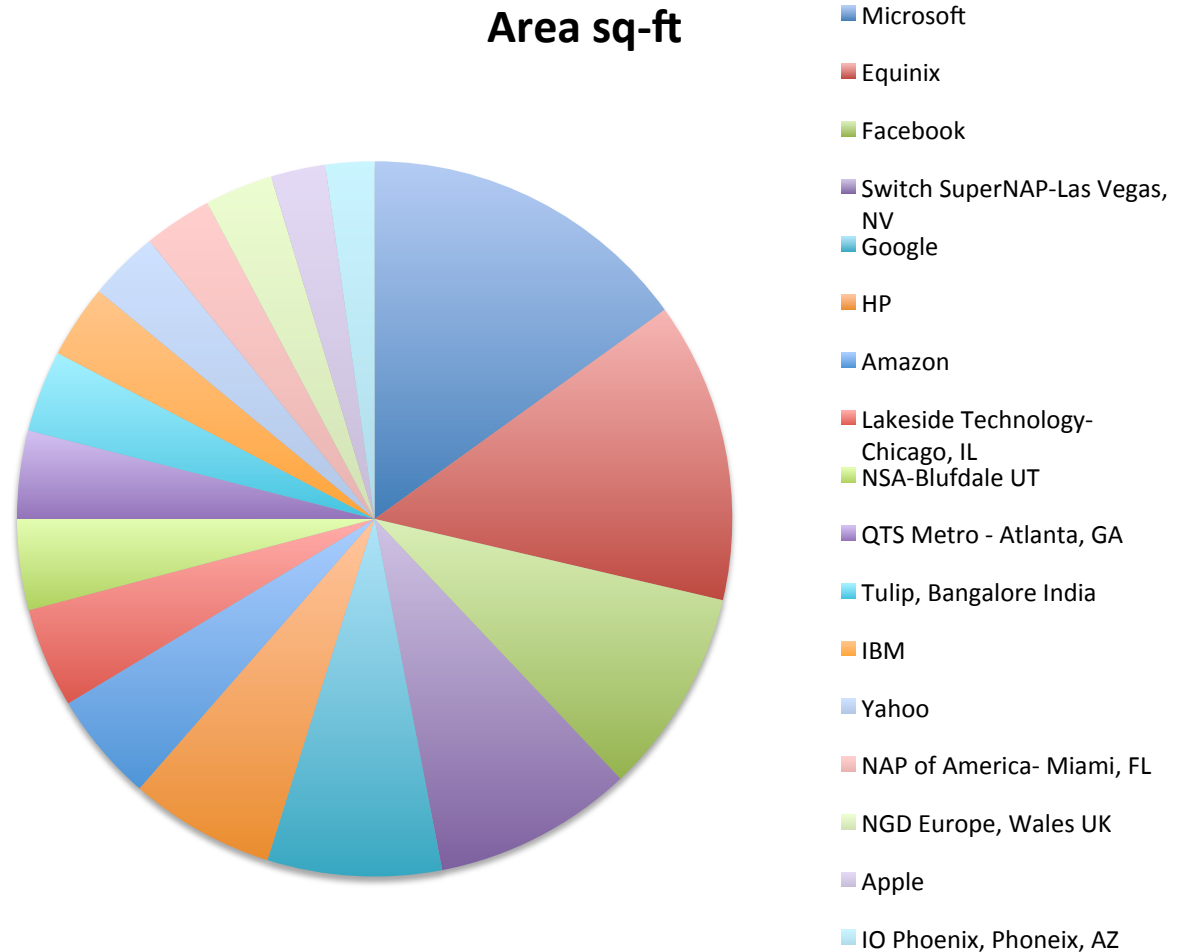
A. Ghiasi

| Equinix Data Center	Square footage*	Power (MW)	Longest Run(m)	Equinix Data Center	Square footage*	Power (MW)	Longest Run(m)
Atlanta	58000	11.05		Amsterdam	137000	54.7	
AT1	44615	8.5	128.8	AM1	30556	12.2	106.6
AT2	9448	1.8	59.3	AM2	30556	12.2	106.6
AT3	3937	0.75	38.2	AM3	75888	30.3	167.9
Boston	13000	2.25	69.5	Dubai	19000	5.6	84.0
Chicago	190000	31.5		Dusseldorf	53000	7.8	
Ch1	54286	9	142.0	DU1	28538	4.2	103.0
CH2	48254	8	133.9	DU2	24462	3.6	95.3
CH3	15079	2.5	74.9	Frankfurt	344230	47.6	
CH4	72381	12	164.0	FR1	10124	1.4	61.3
Dallas	150000	21		FR2	195257	27	269.4
DA1	32143	4.5	109.3	FR3	34712	4.8	113.6
DA2	53571	7.5	141.1	FR4	74487	10.3	166.4
DA3	32143	4.5	109.3	FR5	29650	4.1	105.0
DA4	10714	1.5	63.1	Hong Kong	171000	85.7	
DA6	21429	3	89.2	HK1	76321	38.25	168.4
Washington DC	478000	139.65		HK2	40405	20.25	122.5
DC1	10782	3.15	63.3	HK3	54273	27.2	142.0
DC2	41074	12	123.5	Jakarta	32500	2	109.9
DC3	47920	14	133.4	Geneve	38000	7.5	
DC4	59900	17.5	149.2	GV1	15200	3	75.2
DC5	59900	17.5	149.2	GV2	22800	4.5	92.0
DC6	61611	18	151.3	London	34000	11.44	
DC7	26527	7.75	99.3	LD1	1605	0.54	24.4
DC8	2567	0.75	30.9	LD2	19318	6.5	84.7
DC10	82148	24	174.7	LD3	6538	2.2	49.3
DC11	85571	25	178.3	LD5	6538	2.2	49.3
Denver	12000	2.5	66.8	Mellborne	36000	12.5	115.7
Miami	30000	10.9		Munich	84000	19.41	
MI2	2477	0.9	30.3	MU1	53014	12.25	140.4
MI3	27523	10	101.1	MU2	692	0.16	16.0
Los Angles	215000	44		MU3	30294	7	106.1
LA1	21989	4.5	90.4	Paris	26000	29.6	
LA2	12216	2.5	67.4	PA1	4480	5.1	40.8
LA3	107500	22	199.9	PA2	11946	13.6	66.6
LA4	73295	15	165.0	PA3	9574	10.9	59.6
New York	484000	90.5		Rio de Janeiro	29594	17.1	
NY1	16044	3	77.2	RJ1	3634	2.1	36.8
NY2	74873	14	166.8	RJ2	25960	15	98.2
NY4	240663	45	299.1	Sao Paulo	79500	8.54	
NY5	53481	10	141.0	SP1	27369	2.94	100.8
NY7	98939	18.5	191.7	SP2	52131	5.6	139.2
Philadalphia	39990	3	121.9	Shanghi	52000	14.6	
Seattle	53000	19		SH1	6411	1.8	48.8
SE2	25105	9	96.6	SH2	22795	6.4	92.0
SE3	27895	10	101.8	Sh3	22795	6.4	92.0
Silicon Valley	448500	33.125		Singapore	117000	45.5	
SV1	27079	2	100.3	SG1	55286	21.5	143.3
SV2	27079	2	100.3	SG2	61714	24	151.4
SV3	27079	2	100.3	Sum	3313314	742.865	
SV4	27079	2	100.3	Median Size	29094	Median L	104
SV5	243713	18	300.9				
SV6	42311	3.125	125.4				
SV8	54158	4	141.9				

How Big Are They
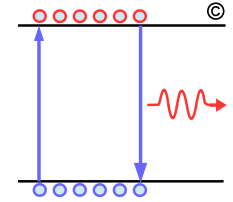
❑ **Total floor space for top operator is ~29 M sq-ft**

– The total power consummation assuming if all operated at 1400 W/sq-ft would be ~41 GW!

– The networking related PD could be ~10 GW and ~ 5 GW could be SerDes+Opics PD and directly impacted with what we do in .bs!

Area sq-ft

- Microsoft
- Equinix
- Facebook
- Switch SuperNAP-Las Vegas, NV
- Google
- HP
- Amazon
- Lakeside Technology- Chicago, IL
- NSA-Blufdale UT
- QTS Metro - Atlanta, GA
- Tulip, Bangalore India
- IBM
- Yahoo
- NAP of America- Miami, FL
- NGD Europe, Wales UK
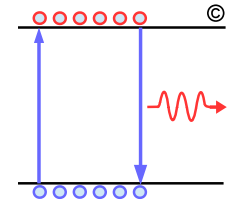- Apple
- IO Phoenix, Phoenix, AZ

Without Efficiency Improvement the Total (PON, Router, Transport) Projected Power Consumption Could be ~1/3 World Power Generation
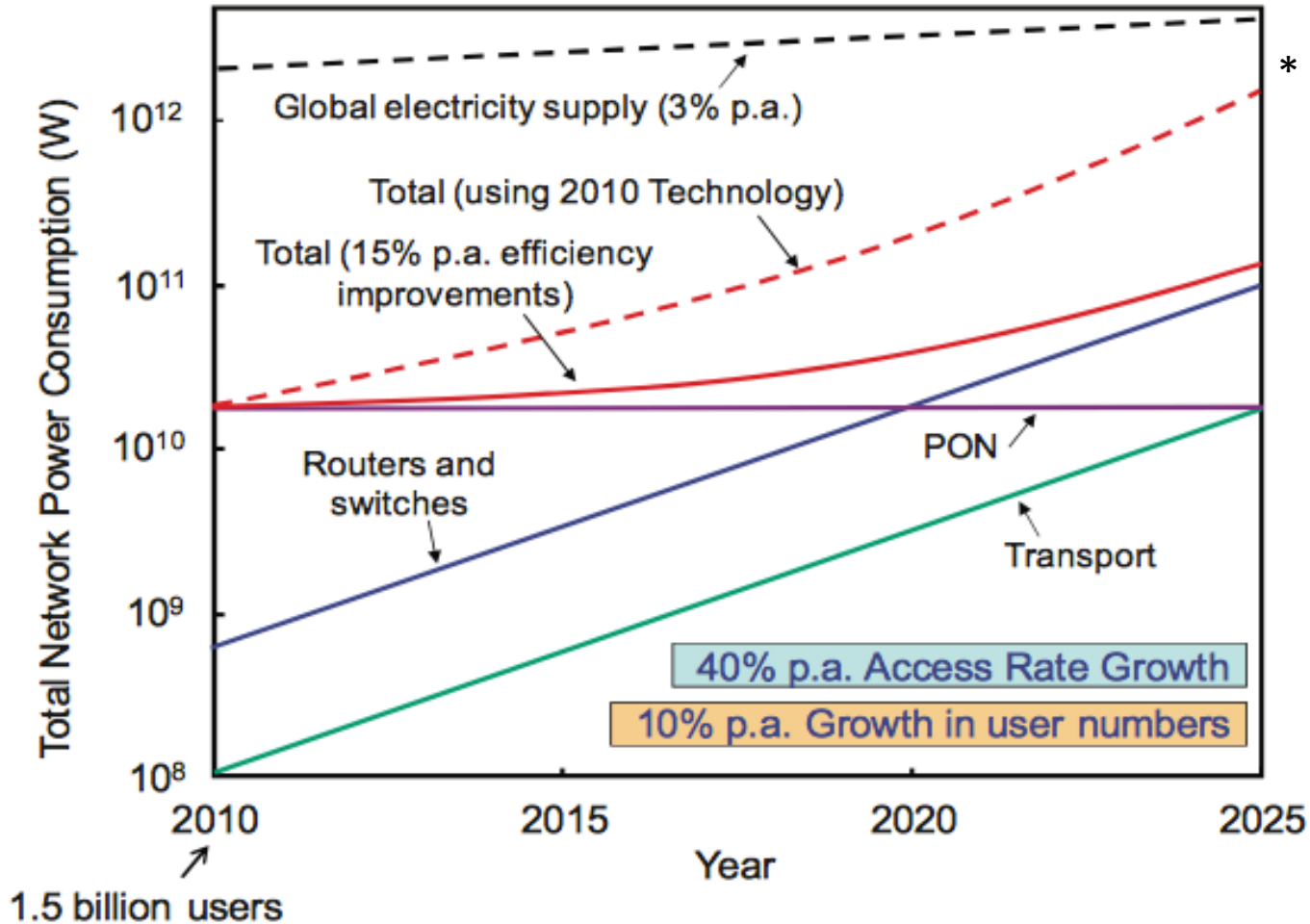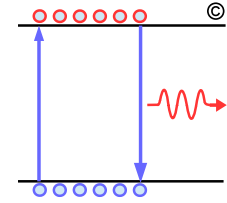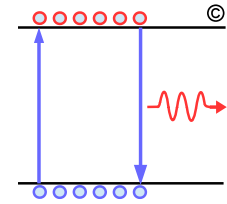

* Energy Consumption, Rodney Tucker, Photonic IO Conference, Santa Fe 2012

Summary

❏ **During 802.3bm study phase an SMF reach of 500 m was more than adequate to address nearly all data center but no longer is the case**

– Minimum reach needs to be 1 km with target of 2 km

– A 2 km reach will also address building to building application

❏ **In 2011 Google was the 1st to build a data center with area of ~ 1M sq-ft several time larger than other operating data centers**

– SuperNAP in Las Vegas with area of 2.2M sq-ft takes the crown

– In 2014 there are numerous data center approaching or even larger than 1 M sq-ft

• Building ~1 M sq-ft data center is now the norm

• Bigger is better

❏ **With data centers power dissipation growing exponentially power dissipation has to be a key metric in .bs.**

References

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