Selected WAN/MAN/Long Haul Link Length & Fiber Utilization Data

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Agenda

- "Disclaimer"
- "60,000 ft" view of LAN vs. WAN/MAN Economics
- WAN/MAN (Metro) Data
  - Buildings "served" by CLEC's
  - CLEC route kilometers
  - Wire center/CO data
- Long Haul Data
  - Major fiber builds
  - Estimated fiber utilization

First.....

A few "Disclaimers"

"Disclaimers"

- MAN/Long Haul data is often
  - Proprietary
  - Incomplete
  - "Unique"
- Trying to piece together a complete and accurate picture would be an expensive and ultimately futile exercise
- Therefore, what I'm presenting is "selected" data that I believe is representative of existing networks

"60,000 ft" View of LAN vs. MAN Economics

Example of "Profit Centered" Network Economics:

Number of users on network	150
Avg. cost of laying first mile of fiber[1]	$75,000
Avg. monthly spending on multiple services[2]	$134
Annual potential revenue per plant mile	$241,200
Net annual profit per plant mile	$166,200

[1]Source: Mastech, TeleChoice, KMI (Range is from $25K in rural areas to $500K in certain urban blocks).

[2]RCN for remaining data. RCN also estimated annual/plant mile profits of $10,920 and $17,784 for local telecom and CATV.

"60,000 ft" View of LAN vs. MAN Economics

- A "key" reason why Ethernet "conquered" ATM et. al. in the LAN is that it offered clear cost savings for a "cost centered" network
- For a profit centered network, cost is still a key reason for adopting a technology…but so is reliability, manageability, etc.

"60,000 ft" View of LAN vs. MAN Economics

- LANs - *aggregate* individuals data traffic
- WANs - *aggregate* LAN traffic
- MANs - *aggregate* WAN traffic
- Long Haul/POP-Centers - *aggregate* MAN traffic
- On average, each *aggregation* introduces an increased level of reliability, functionality(?), manageability(?) requirements.

"60,000 ft" View of LAN vs. MAN Economics

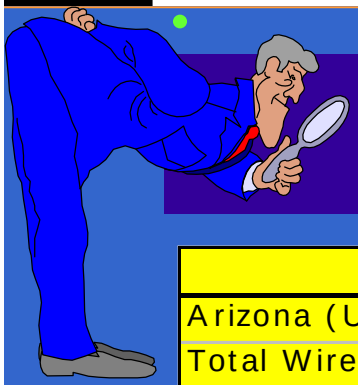
- Therefore, solutions proposed for "profit-centered" networks can be different and more costly than those proposed for "cost-centered" networks
- To put it another way...one size needn't fit all
- The key will be to make these solutions interoperable

MAN Data

- Competitive local exchange carriers (CLECs) and Incumbent Exchange Carriers or RBOCs carry a great majority of MAN traffic.
- RBOCs overwhelmingly dominate as carriers of this traffic.
- CLECs, therefore:
  - measure traffic in numbers of buildings passed (and top customers skimmed)
  - build networks where the top customers are located

MAN Data

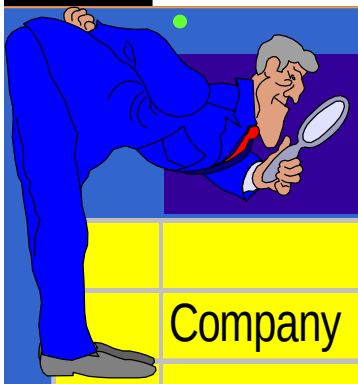
- Ring topologies are ideal for skimming top customers.
- RBOCs, on the other hand, have already invested billions in point-to-point (star) networks based on Central Office, (CO), locations.
- CLECs, therefore:
  - are rapidly constructing rings…
  - …in tandem with attempting to co-locate equipment in RBOC CO's.



Wire Center/CO Data

	Wire Centers		Residential Line Served		Business Line Served	
Arizona (US West)						
Total Wire Centers	144		1,839,576		765,257	
Wire centers with at least one colocation agreement						
Physical	21	(14.6%)	785,909	(47.7%)	488,565	(63.8%)
Virtual	3	(2%)	105,731	(5.7%)	36,527	(4.8%)
California (ParBell)						
Total Wire Centers	633		10,421,775		4,395,954	
Physical	86	(13.6%)	3,389,865	(32.5%)	2,130,183	(48.5%)
Virtual	0	(0%)	0	(0%)	0	(0%)
New York (Bell Atlantic)						
Total Wire Centers	524		7,277,169		3,576,670	
Physical	38	(7.3%)	1,336,996	(18.4%)	1,686,067	(47.1%)
Virtual	1	(< 1%)	21,111	(< 1%)	36,288	(1%)
Texas (SBC)						
Total Wire Centers	1,846		5,659,523		3,089,278	
Physical	14	(< 1%)	414,018	(7.3%)	614,498	(19.9%)
Virtual	22	(1.2%)	217,974	(3.9%)	337,784	(10.9%)

Source: FCC



Buildings "Served" By CLECs

		Buildings Served					
	Company						
		1993	1994	1995	1996	1997	1998
A1	AT&T Local Services					13,510	19,246
A2	e.spire			100	595	1,604	2,912
A3	Electric Lightwave	104	191	282	438	610	766
A4	Hyperion				1,183	1,776	6,460
A5	ICG	97	766	1,539	2,069	3,153	5,397
A6	MCI WorldCom				16,253	27,785	33,000
A7	McLeod					452	452
A8	Time Warner Telecom					1,464	1,919
	TOTAL U.S.	435	1,250	2,301	23,364	58,053	88,134
	TOTAL CANADA	-	-	-	28	153	1,711

Source: KMI

- Montreal

CLEC Route Kilometers

		Route Kilometers Owned					
	Company						
		1993	1994	1995	1996	1997	1998
A1	AT&T Local Services	3,143	4,976	8,736	10,853	15,247	21,263
A2	e.spire	-	-	219	1,122	1,708	2,803
A3	Electric Lightwave	124	571	741	1,356	2,368	2,927
A4	Hyperion	-	1,609	3,219	5,090	7,635	9,637
A5	ICG	270	520	1,025	3,838	4,897	6,848
A6	MCI WorldCom (MCImetro/B	2,887	4,266	9,543	12,118	17,125	20,761
A7	McLeod	195	187	351	946	1,975	3,092
A8	Time Warner Telecom	270	1,416	5,161	8,063	9,516	11,214
	TOTAL U.S.	9,629	17,459	33,822	52,126	74,851	99,211
	TOTAL CANADA	-	-	-	32	3,470	7,829

Source: KMI

- Montreal

CLEC "Stats"

- Number of CLECs: ~40
- Route - deployed: ~106,000 km's
- Fiber - utilized: ~ 5.9 million km's

- "Average" fiber count/CLEC route: ~56
- "Average" number of CO's/network: 1

Key Customer/Large Metro CLEC "Stats"

- "Typical" ring per CLEC network:
  - "bimodal" 20 km or 40 km
- "Typical" number of CO per network: 1
- "Typical" building distance from CO:
  - 10 km or 20 km
- Prototype implementations of GBE noted at these distances
- ***We should, therefore, set 2 distance objectives of 10 km and 20 km***

ILEC / RBOC "Stats"

- Thankfully, data is clearer for metro based ILEC / RBOC networks
- Architecture studies were conducted by AT&T (and Bell Core) in 1964, 1974, and 1983[3]
- Last study showed the following link lengths for the (star) networks:
  - Distance CO-to-Drop (ft)
    - Min.: 186 ft
    - Mean: 10,780 ft
    - Max: 114,000 ft
  - "Drop-In-Distribution"
    - 1,888 ft

[3] Source: Telephony Magazine Loop Survey 10/5/97 (and Bell Core)

ILEC / RBOC "Stats"

- "Outlier" data for the Bell System is almost always located in US WEST territory
- There is good correlation between "outlier" data and least teledensity…
- …Therefore, max data can be "ignored" for calculating link lengths for star metro networks
- Data is still "current" because RBOC's did not consolidate CO's[4]

[4] Source: FCC, DSL deployments

ILEC / RBOC "Stats"

- We should therefore set an additional objective of 3 or 4 km's for single mode fiber

Mean Length (ft)	10,780
Drop (ft)	1,888
Total (ft)	12,668
Total (km)	3.85

[3] Source: Telephony Magazine Loop Survey 10/5/97 (and Bell Core)

MAN/WAN Points To Consider...

- ...As we discuss singlemode lengths
- "Backing-off" from 4 km to 3 km will have minimum negative market impact
- 3 km's will "harmonize" objective with past efforts
- The 10 km objective has been "verified" by several OEM's as an existing market requirement
- 20 km's will address a substantial portion of the Metro market
- Cost is not the over-riding concern of this market segment

Long Haul Fiber Utilization

	Constructed Miles	Target Miles	Conduits	Fibers / Mile	Lit Fiber	Local Build	Int'l Build
AT&T	41,000	41,000	1	35	9	Yes	Yes
Sprint	31,000	31,000	1	20	5	Yes	No
WorldCom	45,000	45,000	1	24	6	Yes	Yes
Qwest	15,000	18,450	2	48	4	No	Yes
Frontier	12,000	13,000	1	24	4	No	No
GTE	11,000	13,000	1	24	2	Yes	No
Williams	18,700	20,000	2.5	120	2	No	No
IXC	10,200	16,400	1	96	4	No	Yes
Enron	1,700	5,500	1	96	2	No	No
Level 3	1,400	16,000	11	96	0	Yes	Yes
Total	*187,000*	*219,350*	*22-25*	*55*			

Source: JP Morgan

LH Points To Consider...

- Fibers will be "lit" only when absolutely necessary
- Strategy has little to do with component cost...
- ...Every thing to do with supply economics

- Given the complexities, "LH" should not be an area that 802.3 should set standards for...

What Does All This Mean?

- Maybe 2 PARS are required to accommodate the increase in complexity & distance of WAN/MAN traffic vs. LAN traffic (?)

Possible PAR 1

10G-FC (as in Fiber Campus)

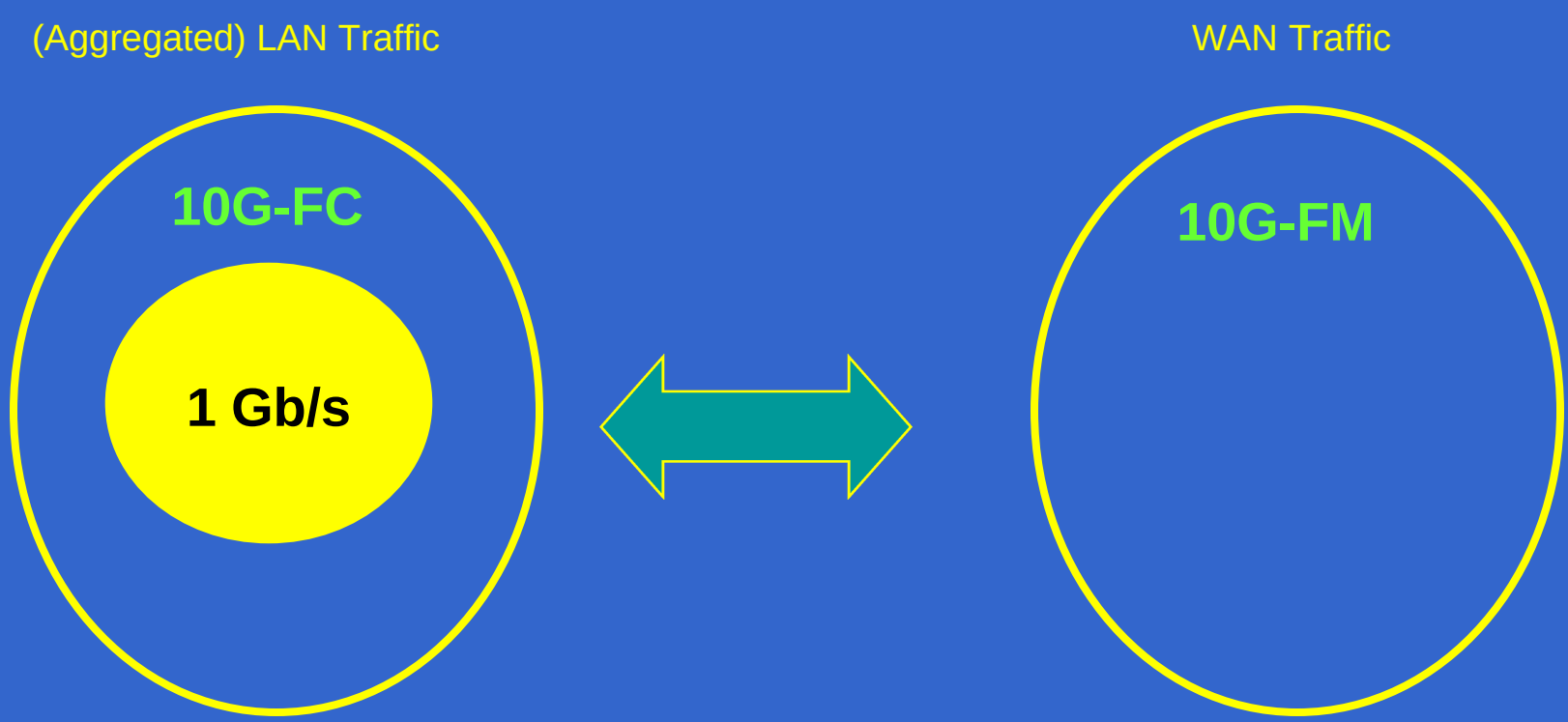
- Possible Features
  - 10.000 line rate
  - truncated temp specs (10C - 70C)
  - various MMF specs
  - >= 2km's SMF spec
  - No L1 management features

Possible PAR 2

10G-FM (as in Fiber Metro)

- Possible Features
  - 9.584640 line rate
  - full temp specs (EG: <0C - 85C)
  - no MMF specs
  - >= 3km's SMF spec
  - Some L1 management features (a subset of OAMP)

Possible Resulting Implementation



- *"Translate"/bridge @ the MAC layer*