



Undersea Cables and their affect on Internet bandwidth

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History, part 1

- ❖ **1840, Samuel Morse, Manhattan with Governor's Island**
- ❖ **Press was driving usage**
- ❖ **Western Union, AT&T of then, tried to end transatlantic cables**
 - **Had grand plan to go via Alaska and Siberia**

History, part 2

- ❖ **By July 1858 cable laid from Ireland to Newfoundland**
- ❖ **Aug 27, 1858 first words came across**
 - **25 words in hours**
- ❖ **Voltage was 600 volts on cable and press was furious about slow rate**

History, part 3

- ❖ **Dr. Whitehouse from UK raised the voltage**
 - **William Thomson had reservations but the chief electrician was given the go ahead**
 - **Voltage raised to 2000 volts, and cable's insulation failed, destroying the cable**
- ❖ **1866, first successful trans Atlantic cable**
 - **8 words/minute; \$100 for 20 words**
- ❖ **1867 - Western Union buys Anglo-American**

History, part 4

- ❖ **1874 - Baudot invents TDM for telegraph line (90bps)**
- ❖ **1884 - First telephone call over undersea cable**
- ❖ **1928 - 21 telegraph trans-Atlantic cables**
 - **2,800 characters/minute**
- ❖ **1956 - TAT-1 begins operation**
 - **Sept 25th first call placed via TAT-1**
 - **Capacity – 51 calls**

History, part 5

- ❖ **First generation fiber cables carried 280Mb/sec**
- ❖ **Second generation carried 560Mb/sec**
- ❖ **Third generation carries 5Gb/sec**
 - **Really 60,000 circuits x 64kb = 3.84Gb/sec**
 - **1.4Gb/sec used for overhead and error correction**

TransAtlantic cables

- ❖ **CANTAT-3** **2.5Gb/sec**
- ❖ **TAT-12, TAT-13** **5Gb/sec**
 - **Trans Atlantic Telephone**
 - **100,000km**
- ❖ **Atlantis-2** **10Gb/sec**
 - **12,000km, South America, Europe & Africa**
 - **\$270m**
 - **Ready: 6/99**

TransAtlantic Cables, part 2

- ❖ **Gemini** **30Gb/sec**
 - **MFS/Worldcom & CW, \$500m**
 - **1/2 Ready: 12/97; Completion: 12/98**
- ❖ **Columbus III** **10Gb/sec**
 - **US & Southern Europe, Ready: 7/99, 11,000km,\$300m**
- ❖ **Atlantic Crossing Submarine Cable System (AC-1)**
 - **14,000km, Ready: 3Q98, AT&T lead**

TransPacific cables

- ❖ **TPC-5** **5Gb/sec**
 - **25,000km, \$1.2b, Japan & USA**
- ❖ **TPC-6** **100Gb/sec**
 - **Soliton technology, Ready: 6/2000**
- ❖ **APCN - Asia Pacific Cable Network** **5Gb/sec**
 - **12,000km, \$650m, 9 countries**
- ❖ **US/China Fiber Cable** **80Gb/sec**
 - **27,000km, \$1.4b, ready: 12/99**

SEA-ME-WE-3

- ❖ **South East Asia - Middle East - Western Europe cable**
- ❖ **38,000km, due to be in service in 1999 for 40 countries**
- ❖ **2.5Gb/sec using WDM to boost capacity to 40Gb/sec**
- ❖ **Status unknown for Israel**

FLAG

- ❖ **Fiberoptic Link Around the Globe**
- ❖ **www.flag.bm**
- ❖ **27,000km, 12 countries, \$1.5b**
- ❖ **NOC located in Dubai**
- ❖ **UK, Spain, Sicily, Alexandria, Jedda, Dubai, Bombay, Thailand, Hong Kong, Shanghai, Korea, Japan**



FLAG

- ❖ **Part overland**
 - **170km in Thailand and parts in Egypt**
- ❖ **FLAG and SEA-WE-ME-3 direct competitors**
 - **FLAG (Nynex), SEA-WE-ME-3 (AT&T)**
- ❖ **First privately owned cable - based in Bermuda**
- ❖ **38% owned by Bell Atlantic, 18% by C&W**
- ❖ **AT&T tried to discourage smaller telecoms from signing on**

FLAG Economics

- ❖ **66 carriers have bought 7% of capacity**
- ❖ **25 year lifespan**
- ❖ **Hopes to be profitable within 4 years - once 20% is sold**

Egypt

- ❖ **Satellites can no longer serve as backup - competing cables have to have restoration agreements**
- ❖ **FLAG, SEA-ME-WE 1, 2 & 3, AFRICA-1 all converge on one building**
- ❖ **Alexandria - center of the fiber world**
- ❖ **Single cross-connect for all traffic between Africa, Europe and Asia**

Alexandria

- ❖ **Building built in 1933 by British to house PTT**
- ❖ **Wrought iron elevator and broken windows**

Israeli cables

- ❖ **EMOS-1: from 1990, 2880km at 280Mb/sec - to Palermo, Italy**
- ❖ **CYOS: from 1993, 257km at 565Mb/sec to Ayanapa, Cyprus from Nahariya**
- ❖ **FLAG: Bezeq & Jordan Telecom - \$28m**
 - **2/3 cost covered by Bezeq**
- ❖ **MED-1: Kavei Zahav - \$80m**
- ❖ **SEA-ME-WE-3: ??**



MED-1

- ❖ **Expected in-service 3Q98**
- ❖ **Owned by: Bezek (21.25%), Telecom Italia (18.25%), Clalcom (18.25%), KAMA (9.25%), Telrad (9.25%), AUREC (8.25%), Globescom (8.25%), Cyprus Telecom Authority (7.25%)**
- ❖ **2400km of 10Gb/sec to Sicily**
- ❖ **Interconnection to Gemini, Columbus III and FLAG possible**

MED-1, part 2

- ❖ **75% of cost funded by bank loans**
 - **Bank Leumi & Hapoalim**
- ❖ **Already \$25-\$30m of capacity sold**

Project Oxygen

- ❖ **Neil Tagare - founder of FLAG**
- ❖ **Internet driven**
- ❖ **\$14 billion**
 - **compared to FLAG's \$1.5 billion**
 - **Teledesic raised \$9-10b**
- ❖ **174 countries, 275,000 km, 100Gb/sec**
- ❖ **Recently (9/97) revised to be 320Gb/sec**
 - **320Gb/sec only attained in lab**

Cables vs satellite costs

❖ **LEO (Low Earth Orbit)**

- **Globestar, 48 satellites, \$2.6b (max 7.2k/sec)**
- **Iridium, 66 satellites, \$5b (max 2.4k/sec)**
- **Skybridge, 64 satellites, \$3.5b**
- **Teledesic, 288 satellites, \$9b (max 64Mb/sec)**

Cable vs Satellite costs

- ❖ **GEO: Geostationary Earth Orbit**
 - **Hughes Expressway, 14 sats, \$3.85b**
 - **Hughes Spaceway, 8 sats, \$3b (max 6Mb/sec)**
 - **Cyberstar, 3 satellites, \$1.6b (max 30Mb/sec)**
 - **PanAmSat, 16 satellites, \$6b**
- ❖ **Celestri, 63 GEO & LEO satellites, \$12.9b**
 - **max thruput - 155Mb/sec**

Project Oxygen

- ❖ **May be used to pass data between satellite earth stations**
- ❖ **Requires 60 cable maintenance ships - only 29 exist today - new ships needed to be built**
- ❖ **\$100m contract signed last week for marine survey work**
- ❖ **Scheduled to be operational in 2003**
- ❖ **www.oxygen.org**

Middle East



Project Oxygen

Beyond Internet...

Land based alternatives

- ❖ **TAE - Trans-Asia-Line**
 - 17,000km, Frankfurt to Shanghai, 20 countries
 - \$571m
- ❖ **TEL - Trans-European-Line**
 - 28,000km

R&D Internet bandwidth

- ❖ **Ebone - 33Mb/sec**
- ❖ **DFN (Germany) - 90Mb/sec (DT)**
- ❖ **SuperJanet (UK) - 57Mb/sec (Teleglobe)**
- ❖ **Surfnet (Netherlands) - 16Mb/sec**
- ❖ **Nordunet - 50Mb/sec (ICM)**
- ❖ **\$265 million/yr for Internet research networks
- national and international bandwidth (19
countries)**

Commercial Internet bandwidth

- ❖ **ICM/Sprint recently installed its second OC3 (155Mb/sec) from USA to Europe (344Mb/sec)**
- ❖ **Telia (Sweden) has an OC3 to the USA**
- ❖ **IIJ (Japan) has an OC3 to USA - totals 245Mb/sec (2xT3 + OC3)**
- ❖ **UUnet planning on upgrading its 2xT3 (90Mb/sec) to OC3 or OC12 by 2Q98**
- ❖ **Sea-bone (Italy) - 79Mb/sec (Teleglobe)**

Data vs. Voice

- ❖ **Voice traffic grows at 12% per year**
- ❖ **Data traffic grows at 90% per year**

Ramifications

- ❖ **F/o shortage - prices stable at \$0.06/meter**
 - **Corning, Lucent, Alcatel building plants to meet demand by 1999**
 - **1996 - 30 million kilometer of fiber sold - led by Siemens, Lucent, Pirelli, and Alcatel**
- ❖ **Carriers moving to undersea cable**
 - **no problems with right-of-way**
 - **major urban centers are near the sea**
 - **no backhoe problems**

T1 Economics

- ❖ **12,000km cable - \$650m**
- ❖ **10 year lifetime - 10Gb (half cable is spare)**
- ❖ **5Gb is really 3.84Gb = 2487 T1 lines**
- ❖ **50% sold over lifetime of cable**
- ❖ **T1 line = \$240K/yr x 10 = \$2.4m**
- ❖ **\$2.4m x 2487 x 50% = \$3.0b**
- ❖ **\$650m - 10% interest over 10 years = \$1.7b**

T3 Economics

- ❖ **12,000km cable - \$650m**
- ❖ **10 year lifetime (half cable reserved for spare)**
- ❖ **5Gb is really 3.84Gb = 85 T3 lines**
- ❖ **50% sold over lifetime of cable**
- ❖ **T3 line = \$3.6m/yr x 10 = \$36m (15x T1 cost)**
- ❖ **\$36m x 85 x 50% = \$1.5b**
- ❖ **\$650m - 10% interest over 10 years = \$1.7b**

Per minute Economics

- ❖ **Today: \$.24/UK; \$.32/DE; \$.34/FR - Callback**
- ❖ **\$.10/minute - avg over next 10 years**
- ❖ **64kb line can carry 8 voice circuits with excellent clarity (8kb/sec per circuit)**
- ❖ **525,600 minutes/year = \$52K/yr/circuit**
- ❖ **60,000 voice circuits x 8 = 480,000 circuits**
- ❖ **\$24.9b/yr x 10% = \$2.5b/yr x 10yr = \$25b**

Conclusion

- ❖ **Internet telephony will radically change phone tariffs (as if we didn't know that)**
 - **Telephone monopolies are running scared**
- ❖ **Investments in undersea cables is a good investment for venture capitalists**
- ❖ **Israel lags far behind in undersea cable infrastructure**