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
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**
  - MFS/Worldcom & CW, $500m
  - 1/2 Ready: 12/97; Completion: 12/98

- **Columbus III**
  - 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**
  - 25,000km, $1.2b, Japan & USA
  - 5Gb/sec

- **TPC-6**
  - 100Gb/sec

- **APCN - Asia Pacific Cable Network**
  - 12,000km, $650m, 9 countries
  - 5Gb/sec

- **US/China Fiber Cable**
  - 27,000km, $1.4b, ready: 12/99
  - 80Gb/sec
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
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