Undersea Cables
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IDC Seminar

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Agenda

• History
• Trans-Atlantic and Trans-Pacific cables
• Our area – Egypt & Israel
• Economics
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
  - TAT-8 – 1988
- Second generation carried 560Mb/sec
- Third generation carries 2.5-5Gb/sec (1998)
  - 2.5Gb/sec – STM16
  - 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
- **TAT-14** 16x10Gb/sec
  - 15,000km, 4/2001
- **Atlantis-2** 5Gb/sec
  - 8500km, South America, Europe & Africa
  - $231M
  - Ready: 6/99
TAT-14
TransAtlantic Cables, part 2

- **Gemini**  
  - MFS/Worldcom & CW, $500m, 6000km  
  - 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-5CN** 5Gb/sec
  - 25,000km, $1.2b, Japan & USA, 1996
- **APCN - Asia Pacific Cable Network** 5Gb/sec
  - 12,000km, $650m, 9 countries, 1997
- **US/China Fiber Cable** 20Gb/sec
  - 27,000km, $1.4b, 2001
- **Tyco Transpacific** 96x10Gb/sec
  - 2002
SEA-ME-WE-3

- South East Asia - Middle East - Western Europe cable
- 38,000km, in service in 1999 for 33 countries
- 2.5Gb/sec using WDM to boost capacity to 10Gb/sec
- SEA-ME-WE-4 – 21,000km, 14 countries
  - 80Gbps
  - Operational in 2005
Fiberoptic Link Around the Globe – 1997
- Install cost - $1.5B
- Bought out by Indian Reliance Telecom (10/2003) for $207M
- 27,000km, 22 countries, $1.5b, 5Gbp/sec
- NOC located in UK and backup in Dubai
- UK, Spain, Sicily, Alexandria, Aqaba, Jeddah, Dubai, Mumbai, Thailand, Hong Kong, Shanghai, Korea, Japan
- www.flagtelecom.com
Optical fibre submarine systems

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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
- Built on the ruins of the Great Library of Alexandria
- Coordinates: 31° 11.738' N, 29° 54.108' E
  - Intersection of El Horreya and El Nabi Streets
**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
- **LEV**: from 1999, 2600km at 2.5Gb/sec - $60-80M
- **Med-Nautilus**: 2001, 7000km
LEV

• In-service 3Q98
• Initially 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%)
  • Now called Med-Nautilus and majority owned by Telecom Italia (51%) with Globescom, Clalcom, KAMA and AUREC
  • Med-1 valued at $240M
• Landing on Rechov HaYarkon
**Med-1**

- 7000km, 92 repeaters, 6 fiber pairs, 10Gb/sec for each fiber pair
- Landing in Petach Tikve and Tirat HaCarmel
- Operational December 2001
- Part left in ocean (Egypt)
## Price comparison over time

<table>
<thead>
<tr>
<th>Cable</th>
<th>Bandwidth</th>
<th>Length/km</th>
<th>Date</th>
<th>Cost</th>
<th>Cost/km</th>
<th>Cost/Gbps/km</th>
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<tbody>
<tr>
<td>TAT-9</td>
<td>565Mb</td>
<td>9310</td>
<td>1992</td>
<td>$450M</td>
<td>$48355</td>
<td>$85548</td>
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<tr>
<td>TPC-4</td>
<td>560Mb</td>
<td>9860</td>
<td>1992</td>
<td>$373M</td>
<td>$37830</td>
<td>$67553</td>
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<tr>
<td>CIOS</td>
<td>622Mb</td>
<td>261</td>
<td>1993</td>
<td>$10M</td>
<td>$38314</td>
<td>$61598</td>
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<tr>
<td>TPC-5</td>
<td>5Gb</td>
<td>25000</td>
<td>1996</td>
<td>$1.12B</td>
<td>$44800</td>
<td>$8960</td>
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<tr>
<td>FLAG</td>
<td>10Gb</td>
<td>27000</td>
<td>1997</td>
<td>$1.5B</td>
<td>$56000</td>
<td>$5600</td>
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<tr>
<td>Columbus-III</td>
<td>10Gb</td>
<td>11000</td>
<td>1999</td>
<td>$300M</td>
<td>$27000</td>
<td>$2700</td>
</tr>
</tbody>
</table>
Cables vs satellite costs

- LEO (Low Earth Orbit)
  - Globestar, 48 satellites, $2.6b (max 7.2k/sec) - nope
  - Iridium, 66 satellites, $5b (max 2.4k/sec) - nope
  - Skybridge, 80 satellites, $3.5b - nope
  - Teledesic, 288 satellites (1999), $9b (max 64Mb/sec)
    - Signed contracts in 2002 to build 2 satellites
    - Revised design to be 30 satellites
Cable vs Satellite costs

- GEO: Geostationary Earth Orbit
  - Hughes Expressway, 14 sats, $3.85b - nope
  - Hughes Spaceway, 8 sats, $3b (max 6Mb/sec) - nope
  - Cyberstar, 3 satellites, $1.6b (max 30Mb/sec) - nope
  - PanAmSat, 23 satellites, $6b

- Celestri, 63 GEO & LEO satellites, $12.9b
  - max thruput - 155Mb/sec - nope
Satellite vs Fiber

- 1999 costs from Western Europe to USA
  - Satellite – Mbps/sec - $3000
  - Fiber – Mbps/sec - $4100

- 2004 costs from Western Europe to USA
  - Satellite – Mbps/month - $1200
  - Fiber – Mbps/month - $140
Ramifications

• Fiber became cheaper than satellite around 2000
• Fiber prices stable at $0.06/meter to fabricate
  • Submarine cables go for $20/meter
  • Pre-1997 has 2 fibers be cable – now 4 fibers
• 1996 - 30 million kilometer of fiber sold - led by Siemens, Lucent, Pirelli, and Alcatel
• Carriers have moved to undersea cable
  • no problems with right-of-way
  • major urban centers are near the sea
  • no backhoe problems
T3 (45Mb/sec) Economics

- 11,000km cable - $300M
- 10 year lifetime
- 10Gb is really 7.68Gb = 170 T3 lines
- 50% sold over lifetime of cable
- T3 line = $75K/yr x 10 = $750K
- $750K x 170 x 50% = $64M
- Carriers losing money on every circuit due to glut of undersea cables currently on market
Per minute Economics

- Today: $.20 (direct dial); $.04 (VoIP)
- $.02/minute - avg over next 10 years
- 64kb line can carry 8 voice circuits with excellent clarity (8kb/sec per circuit)
- 525,600 minutes/year x $.02 = $10K/yr/voice circuit
- 10Gb/sec can carry 9,600,000 voice circuits
- 9.6M voice circuits could generate $96M/yr x 10 years = $960M
Economics of 10Gb/sec cable

- Cost - $300M
- Revenue via T3 lines over 10 years - $64M
- Revenue via VoIP circuits over 10 years - $960M
- Which would you be selling?
Conclusion

• Internet telephony will radically change phone tariffs (as if we didn’t know that)
  • **Telephone monopolies are running scared**

• Investments in undersea cables used to be a good investment for venture capitalists until the market became saturated around 2000

• Israel used to lag far behind in undersea cable infrastructure until Med-1 came along