Submarine fibre-optic cables & the Internet-based World-Wide Web (WWW) are innovations that started to change the infrastructure of global telecommunications less than 25 years ago.

Complementing each other perfectly, they have together revolutionized:

- Communications
- Education
- Business
- Commerce
- Entertainment
Contents

- Evolution of submarine cables
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Evolution of Submarine Cables

- Before mid 1950s: telegraph cables carried just a few hundred words per minute
- Mid 1980s: submarine coaxial cables could carry up to 5000 telephone channels
- 1988: 1st transoceanic fibre-optic cable [TAT-8] had capacity equivalent to 7680 telephone channels
- 2001: some transoceanic fibre-optic cables had the ability to carry up to 30 million telephone channels
- Capacity of submarine cables continues to grow
Change in Technology & Capacity

Source: UK Cable Protection Committee
In 1988, TAT-8 became the 1st transoceanic fibre-optic cable to be installed.

Voice & data capacity across the Atlantic greatly increased.

The project was led by AT&T, BT & France Telecom on behalf of a consortium of over 20 telecommunications companies.

Thus began an era of rapid transfer of large amounts of voice & data traffic world-wide.
Submarine Cables & the Internet

- 1988: First transoceanic fibre-optic cable installed
- 1991: Internet-based World-Wide Web (WWW) introduced
- The two new technologies complimented each other perfectly:
  - The growing network of fibre-optic submarine cables enabled large volumes of voice & data traffic to be rapidly carried around the globe
  - The Internet made data & information accessible & usable for many purposes
- The world changed!

Source: Internet World Statistics
Today, the fibre-optic submarine cable network is growing rapidly to meet the demands of the Internet.

Source: Global Marine Systems Ltd
Significance of Submarine Cable Networks

Fibre-optic submarine cables:

- transfer large volumes of telecommunications traffic with speed, reliability & security
- are very cost effective for major routes such as those between Europe, SE Asia & USA
- provide quality communications without the delays that are associated with satellite systems

Submarine cables now carry >95% of all transoceanic telecommunications traffic
Satellite Communications

Although satellites carry < 5% of international traffic, they have an essential role in providing telecommunications services to remote or disaster-prone areas of the World.

Scott Base, Antarctica – a remote site that relies on satellite communication
The importance of international communications to humanity has been recognized & enshrined in international law since 1884.


They have a priority status under UNCLOS, particularly in international waters.

Ships engaged in the laying or repair of submarine cables have protected status under rules of the sea.
International Status of Submarine Cables

UNCLOS provides:

- Freedom to lay, maintain & repair cables outside of a Nation’s 12 nautical mile territorial sea
- Obligations on Nations to impose criminal and civil penalties for intentional or negligent injury to cables
- Special status for ships laying & repairing cables
- Indemnification for vessels that sacrifice anchors or fishing gear to avoid injury to cables
- Obligations on owners with new cables that are laid over existing cables and pipelines to indemnify repair costs for any damage caused
- Universal access to national courts to enforce treaty obligations
Cable Networks as Critical Infrastructure

- Since introduction of UNCLOS in 1982, submarine cables have gained greater significance as the “backbone” of the Internet & international telecommunications.
- Emerging recognition of this fact has led some governments to class submarine fibre-optic networks as Critical Infrastructure.
Government Recognition of Infrastructure

Cable Protection

- Australian Government formally recognizes importance of submarine cables
- Protection zones designated for Southern Cross & Australia-Japan cable systems
- Zones are 3.7km wide & run to 2000m water depth
- High risk operations banned & low risk activities restricted
- Criminal penalties up to $A330,000 and/or 10 years prison

Source: Australian Communications & Media Authority

www.iscpc.org
Australian Protection Zones Introduced in 2007

Source: Australian Communications & Media Authority
Disruption of Telecommunications Networks

Critical nature of networks is clear when disrupted:

- >70% of cable faults caused by external aggression
- >80% of external aggression faults result from fishing and shipping activities
- <10% of faults caused by natural forces such as earthquakes, waves & sea currents

Base data provided by Tyco Telecommunications & Global Marine Systems
Damage to Fibre-Optic Cables

- [A] Cable snagged by trawl gear
- [B] Resultant damage to cable
- [C] Cables pulled out of position

Network delays, expensive repairs and cable replacement followed.

Source: Transpower NZ & Seaworks
Network Disruption – Case 1

Boumerdes (Algeria) Earthquake: 21st May, 2003

- 6.8 magnitude earthquake 7km offshore at boundary between 2 tectonic plates
- 2,266 dead, 10,261 injured, extensive damage
- Extensive submarine landslides that generated sediment charged turbidity currents
- Tsunami 2 metres high traveled across the Mediterranean Sea
- Caused damage estimated at US$100 million

Source: US Geological Survey
Case 1 – What Happened?

- 5 telecommunications cables were extensively damaged by sediment charged turbidity currents caused by an earthquake.

- The repair of 1 of these cables involved replacement of a 120 km long section.

- 4 cableships undertook the repairs with the last completed 6 weeks after the earthquake.
Case 1 - Repercussions

- All Algerian voice, mobile & Internet traffic disrupted
- Major interruption of Middle East and European traffic
- Interruption of general communications, banking & commerce
- Traffic to Algeria restored to 60% within 48 hrs via re-routing
Network Disruption – Case 2

Hengchun Earthquake: 26th December 2006

Source: Global Marine Systems Ltd
Case 2 – What Happened?

- Earthquake triggered submarine landslide near junction of 2 tectonic plates
- Landslide and resultant turbidity current traveled over 330 km & broke 9 cables in sequence
- From the timing of breaks, the average speed of the turbidity current was ~20 km/hr
- Damage was located in water depths to 4000m & cable locally mud covered
- Cable repair work involved 11 ships & took 49 days

Modified from Source: Anderson M., U. Arizona Geosciences
Case 2 - Repercussions

- Internet linking China, Hong Kong, Vietnam, Taiwan, Singapore, Japan & the Philippines was seriously impaired.

- Banking, airline bookings, email & other services were either stopped or delayed.

- Financial markets & general commerce were disrupted.

- Although most traffic was quickly re-routed via undamaged cables, some delay was still apparent even 2 months after the earthquake.
Network Disruption – Case 3

Vietnam – human activities, March 2007

- Closely following impacts of the Hengchun earthquake, Vietnam’s cable links were again threatened
- Depredation of active fibre-optic cables
- Possibly mistaken for coaxial cables and recovered for scrap without the cable owners’ authorisation
- 11KM of Thailand-Vietnam-Hong Kong and 32 KM Asia Pacific Cable Network taken, including housings that contained expensive equipment with long manufacturing lead times
- Vietnam forced to rely on one submarine cable for 82% voice/data traffic; rest carried by land lines & satellite
Recognizing the gravity of the situation, the Prime Minister of Vietnam is quoted as saying:

that this serious violation of the law “directly affects Vietnam’s socio-economic development, national security and the country’s prestige in the region as well as in the world”

Source: VNUNet News

- Internet delays continued until cables repaired 3 months later
- No official report published, however there have been press reports of criminal prosecutions
- Public education on significance of submarine cables started
- Claim for compensation remains ongoing
Despite sometimes serious cable breakages and disruption to traffic, the global cable network continues to function.

This resilience results from:

- immediate re-routing of traffic via spare capacity on other submarine cables
- cable repair operations that are fast and reliable

Damage to SEA-ME-WE 4 & another cable off landing site #5 affected traffic to the Middle East & India on 30th January 2008.

Despite a very brief break followed by slow Internet speeds, basic communications were quickly restored attesting to the network’s resilience.
To speed repairs to the submarine cable network, cable repair ships are on standby at strategically located ports [●] around the world.

*Chart Source USGS & [www.wavemetrics.com](http://www.wavemetrics.com); Data Source Alcatel-Lucent Submarine Networks*
Concluding Remarks

- Submarine fibre-optic cables underpin the global telecommunications network, the Internet and E-Commerce
- They carry >95% of all transoceanic voice & data traffic in an economic, fast & secure way without loss of quality
- Any disruption of the telecommunications network has huge economic, social & strategic repercussions
- The entire submarine cable network must therefore be regarded as Critical Infrastructure and given the highest standard of protection
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Sharing the seabed in harmony