Critical Infrastructure

Submarine Telecommunications Cables

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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- Importance of submarine cables
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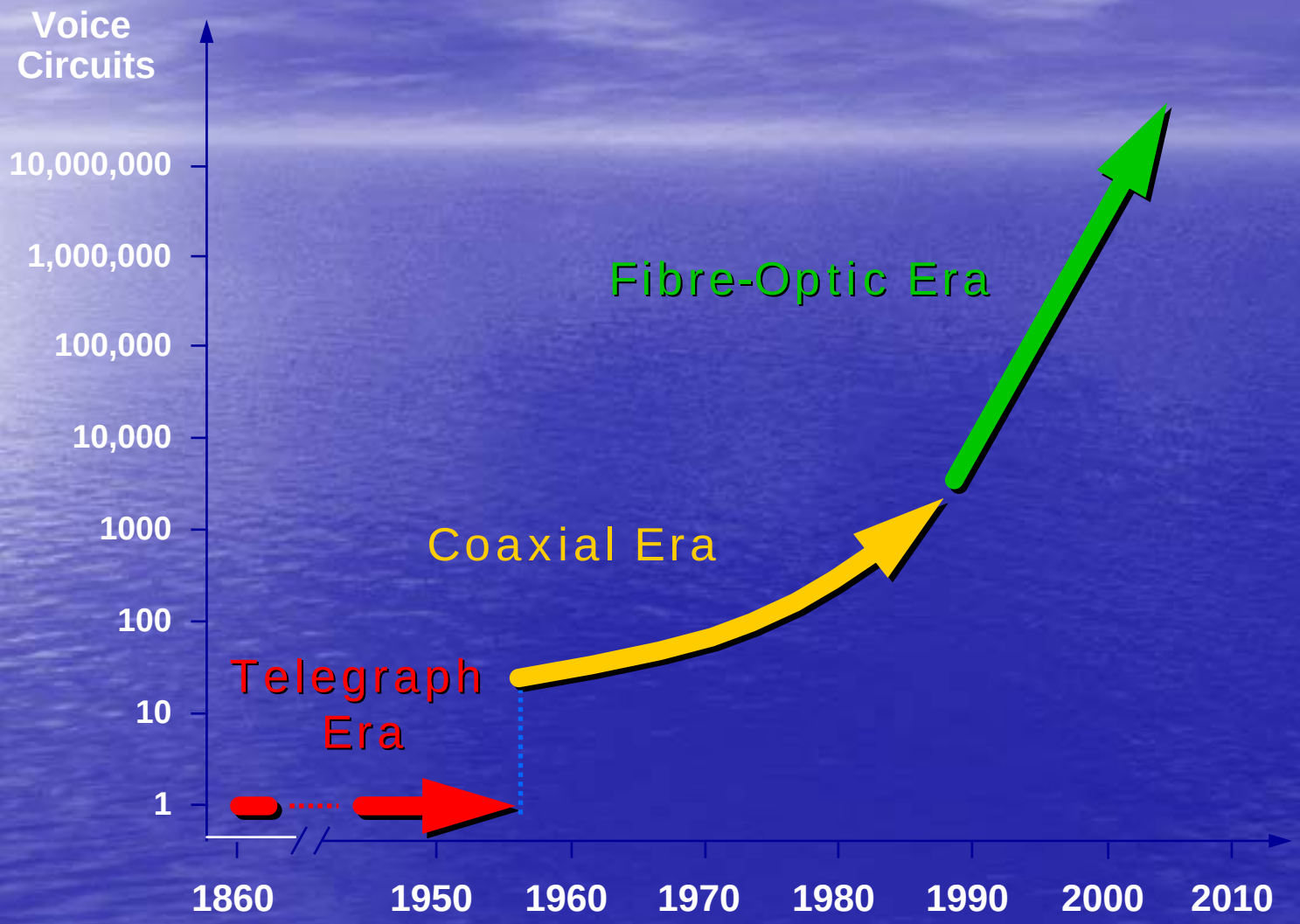
Evolution of Submarine Cables

- 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

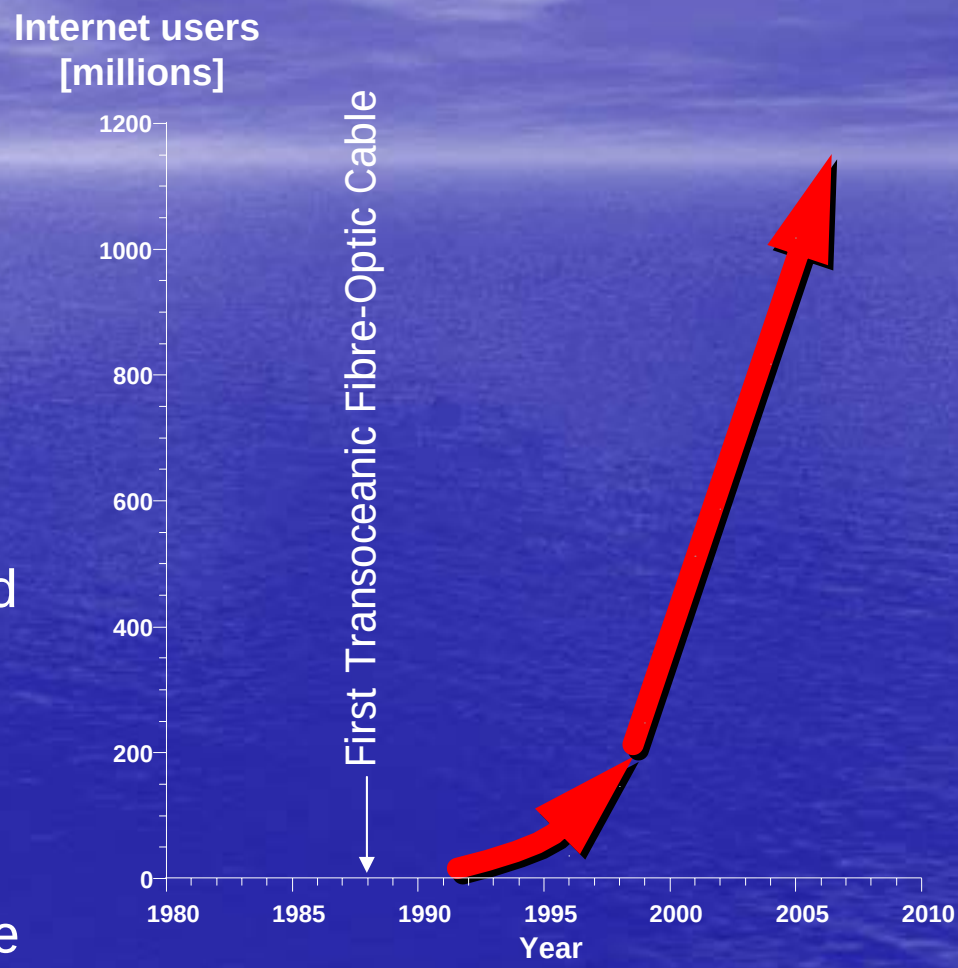
20 Years Ago – A Watershed

- 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

CS Vercors installed TAT-8

Submarine Cables & the Internet

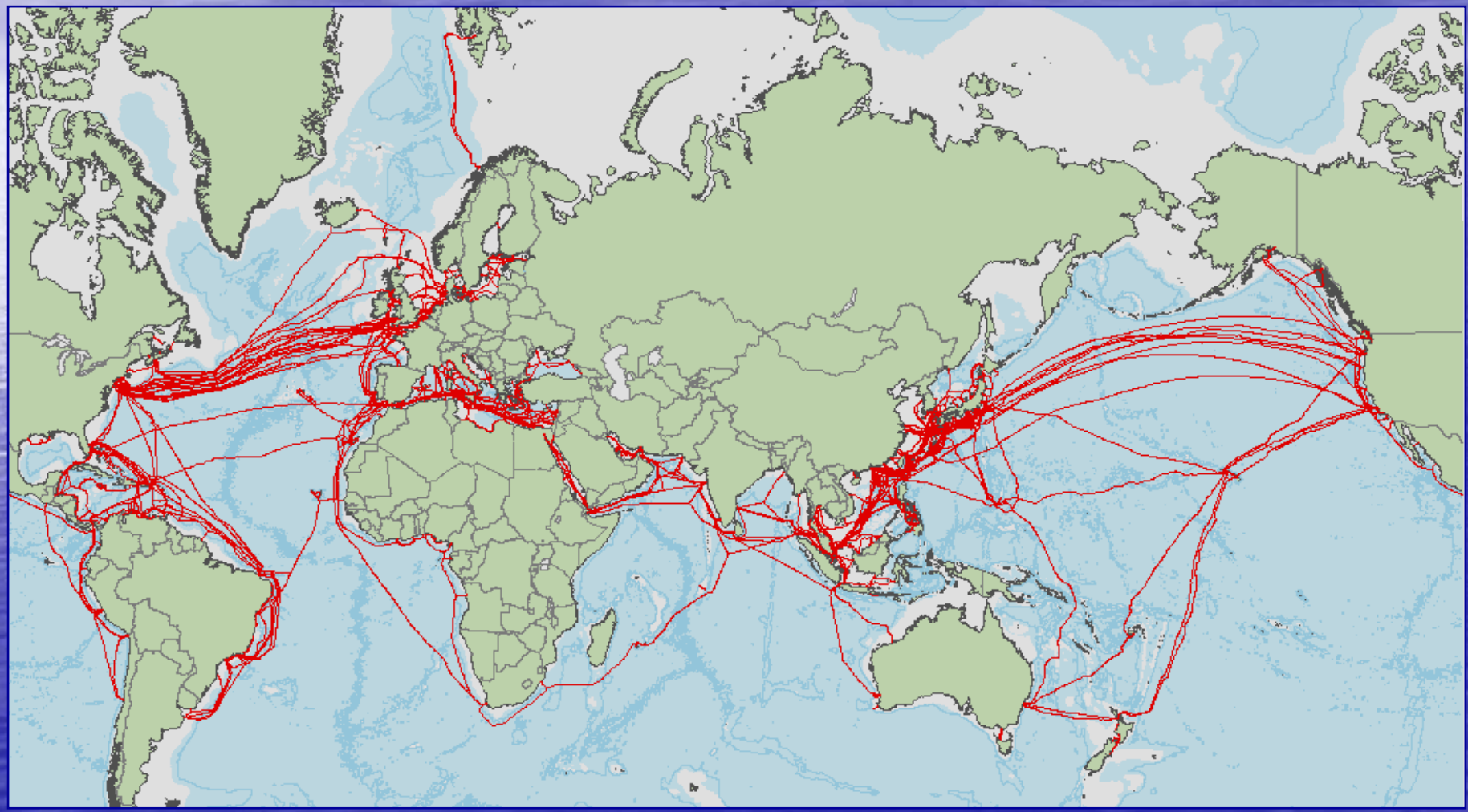
- 1988: First transoceanic fibre-optic cable installed
- 1991: Internet-based World-Wide Web (WWW) introduced
- The two new technologies complimented each other perfectly:
  - The growing network of fibre-optic submarine cables enabled large volumes of voice & data traffic to be rapidly carried around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



Source: Internet World Statistics

Submarine Fibre-Optic Network - 2007

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

International Recognition of Submarine Cables

- The importance of international communications to humanity has been recognized & enshrined in international law since 1884
- Submarine cables are covered by the United Nations Convention on Law of the Sea (UNCLOS)
- 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

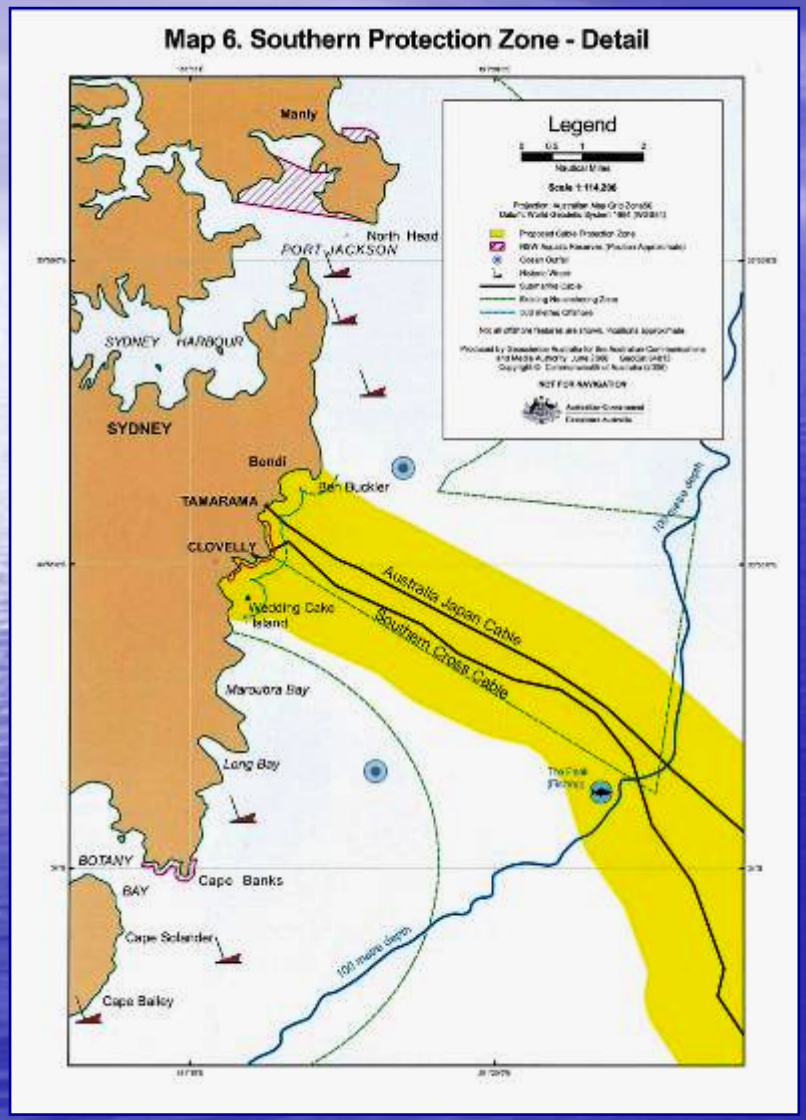
UNCLOS provides:

- 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

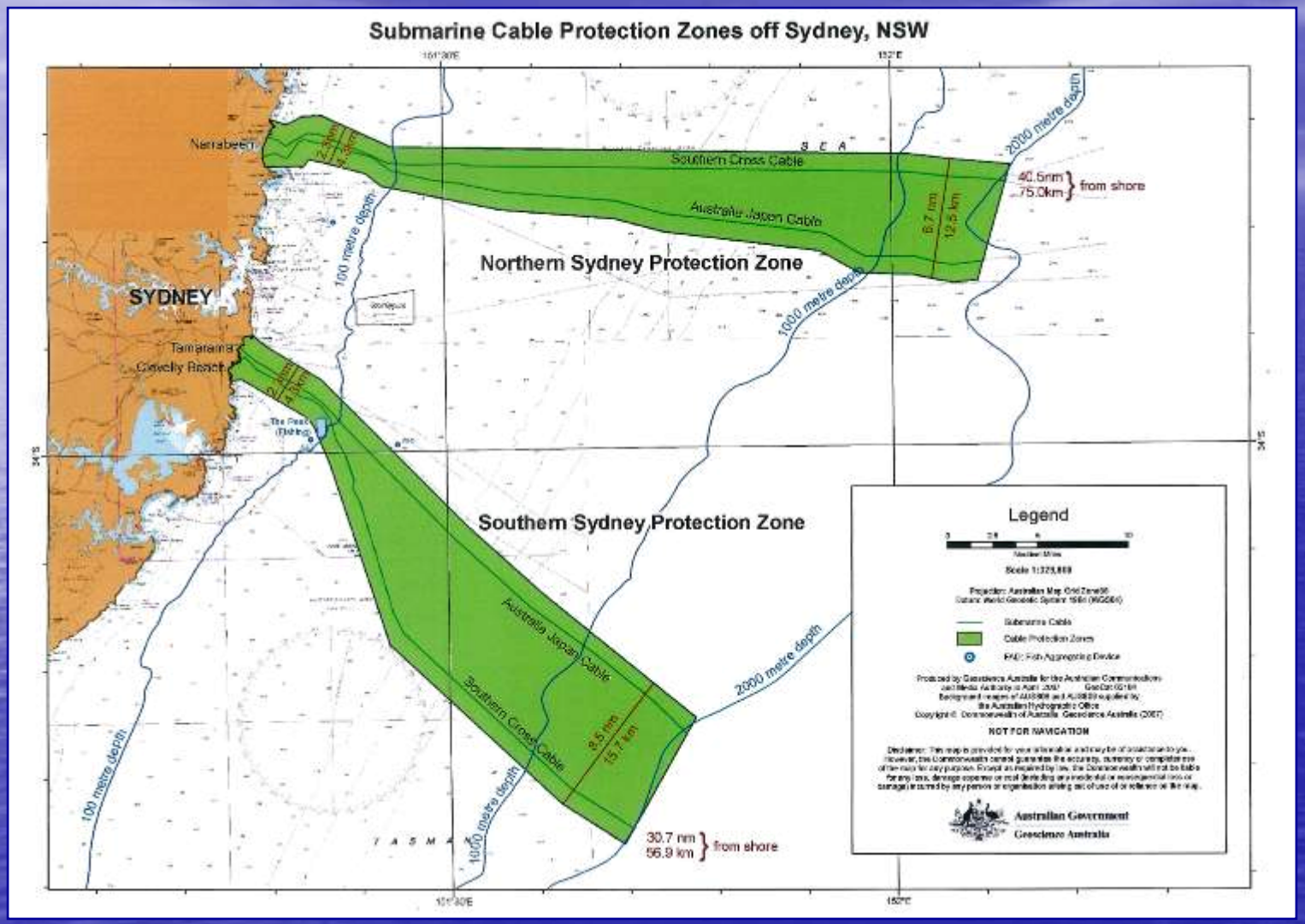


Source: Australian Communications & Media Authority

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

Australian Protection Zones Introduced in 2007

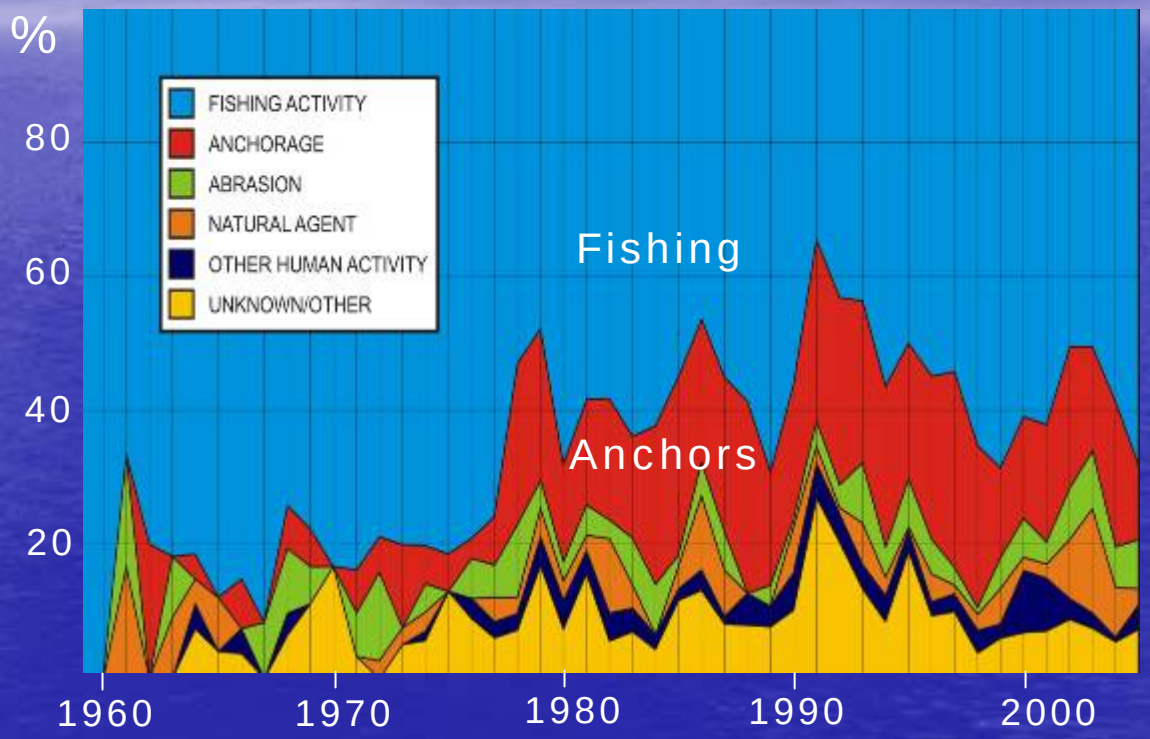


Source: Australian Communications & Media Authority

Disruption of Telecommunications Networks

Critical nature of networks is clear when disrupted:

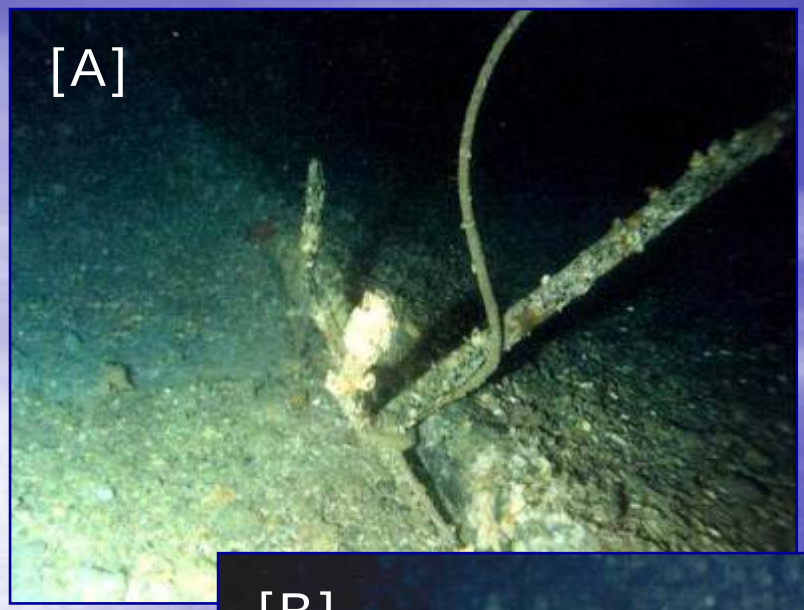
- >70% of cable faults caused by external aggression
- >80% of external aggression faults result from fishing and shipping activities
- <10% of faults caused by natural forces such as earthquakes, waves & sea currents



Cable faults caused by external aggression demonstrate the impact of human activities

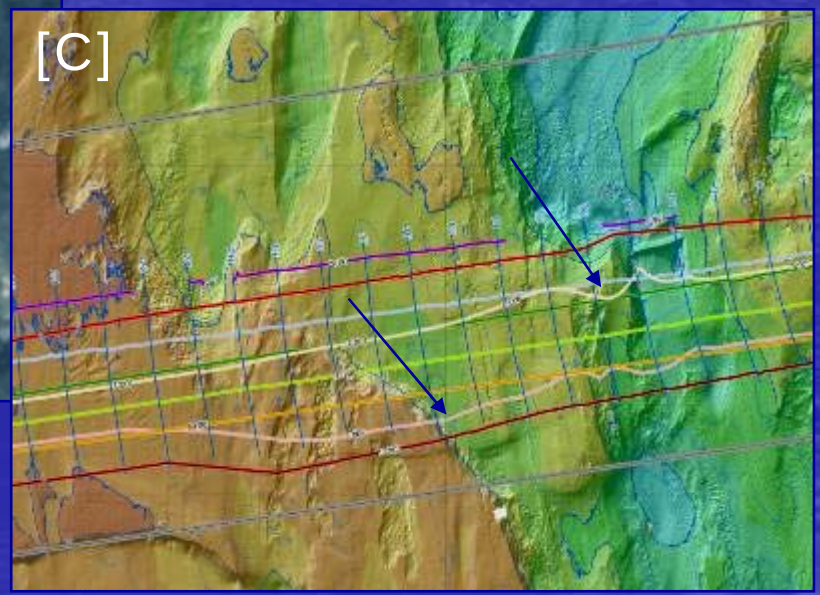
Base data provided by Tyco Telecommunications & Global Marine Systems

Damage to Fibre-Optic Cables



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

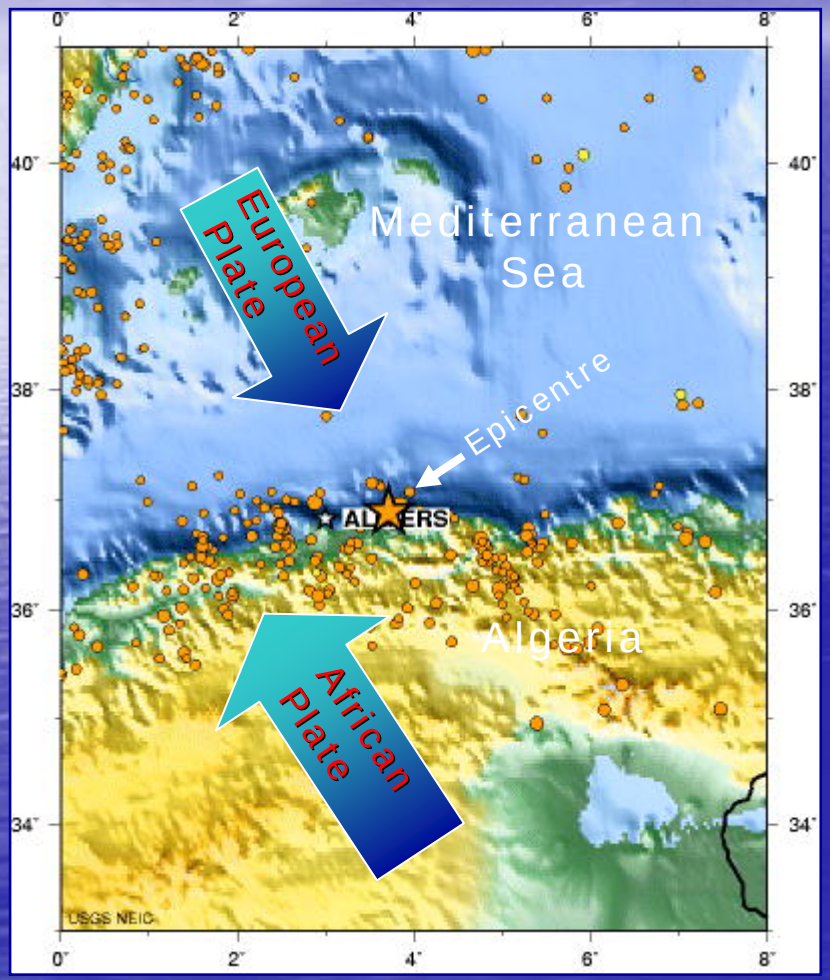
Network delays, expensive repairs and cable replacement followed



Source: Transpower NZ & Seaworks

Network Disruption – Case 1

Boumerdes (Algeria) Earthquake: 21st May, 2003



Source: US Geological Survey

- 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

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

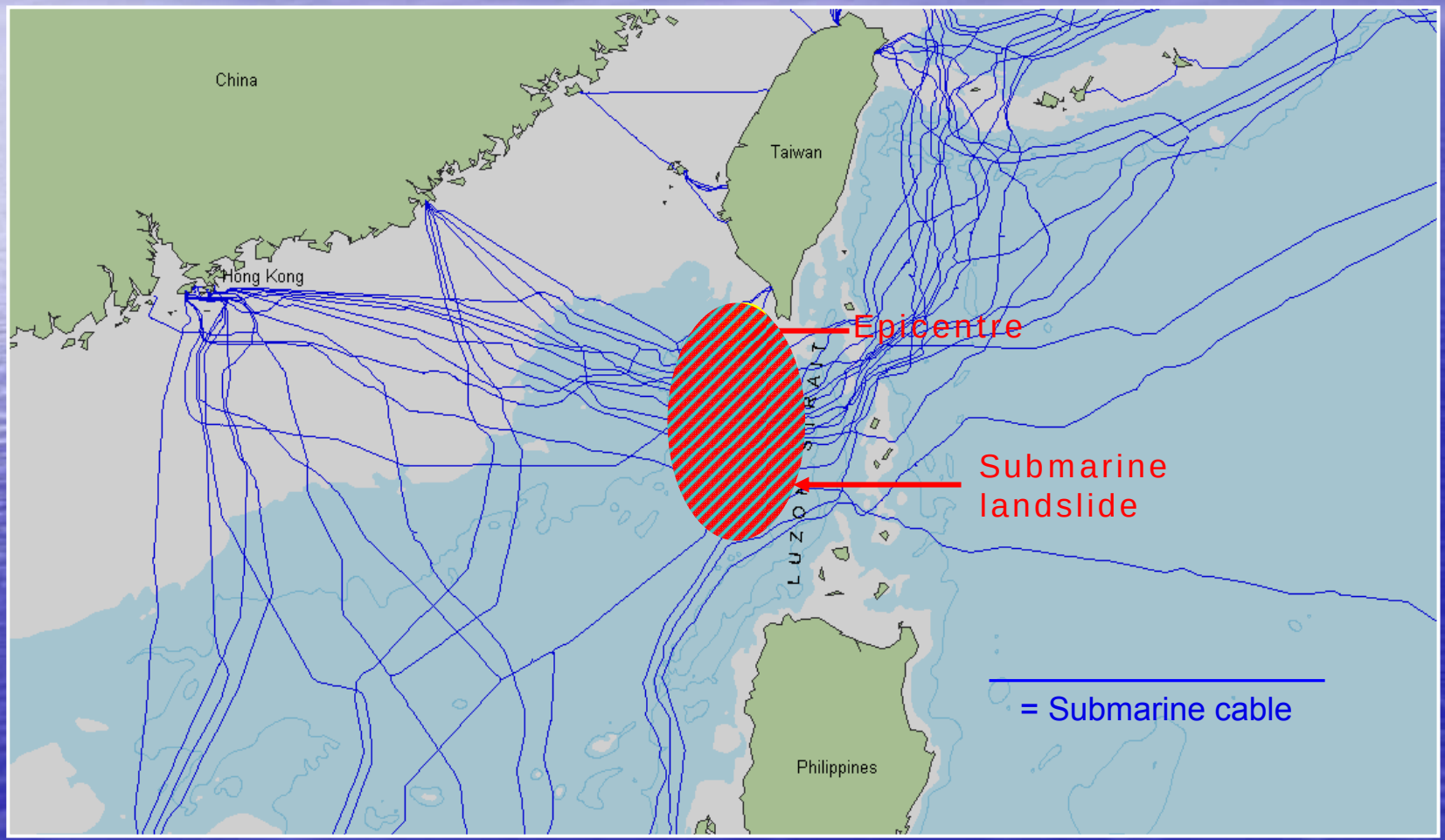
Case 1 - Repercussions

Building Damage in City of Boumerdes
Image: NGDC-NOAA; Credit: Ali Nour, CGS

- 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

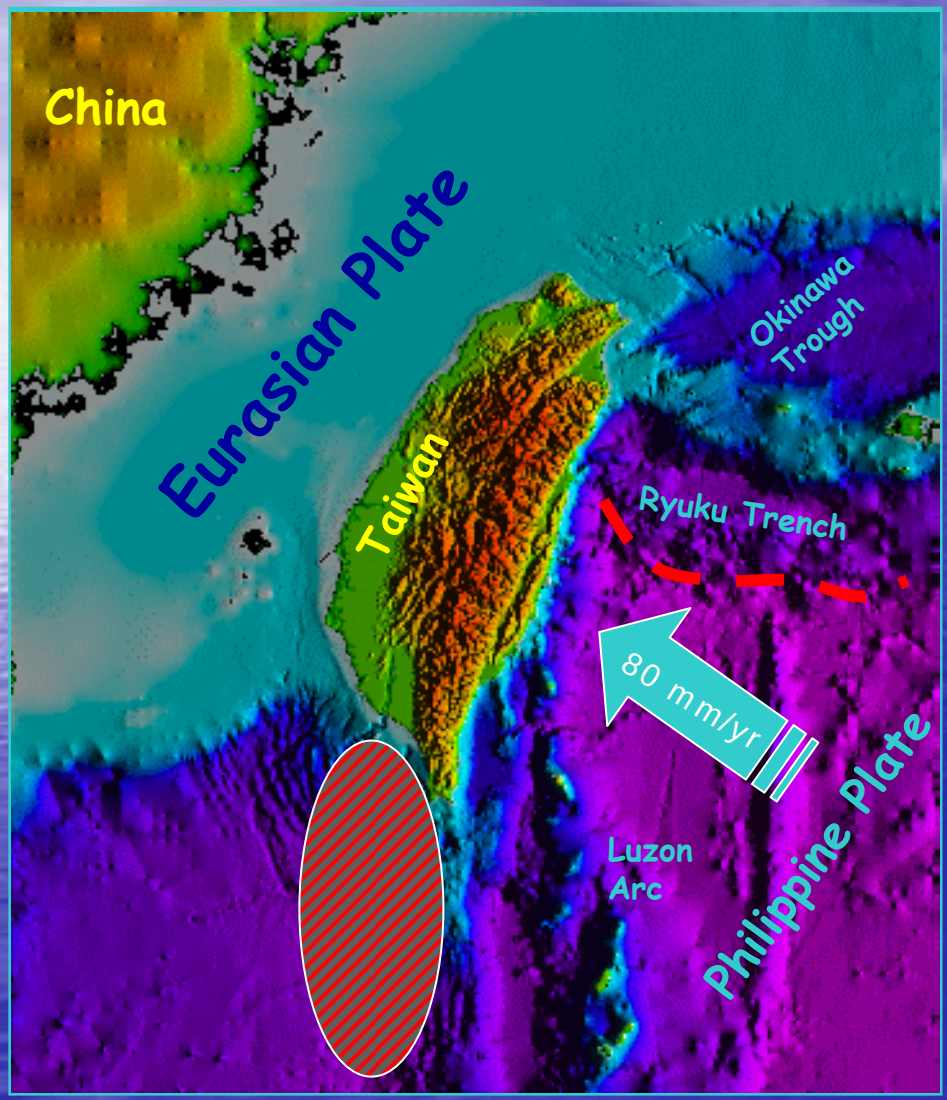
Network Disruption – Case 2

Hengchun Earthquake: 26th December 2006



Source: Global Marine Systems Ltd

Case 2 – What Happened?



Modified from Source: Anderson M., U. Arizona Geosciences

- 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 ~20km/hr
- Damage was located in water depths to 4000m & cable locally mud covered
- Cable repair work involved 11 ships & took 49 days

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

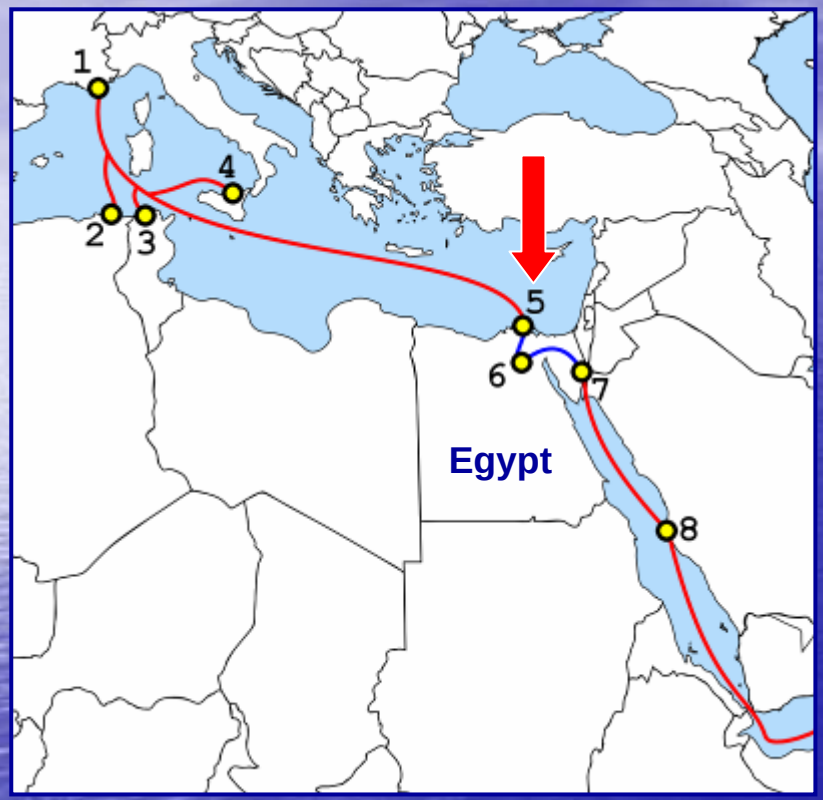
Network Disruption – Case 3

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

Network Resilience



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

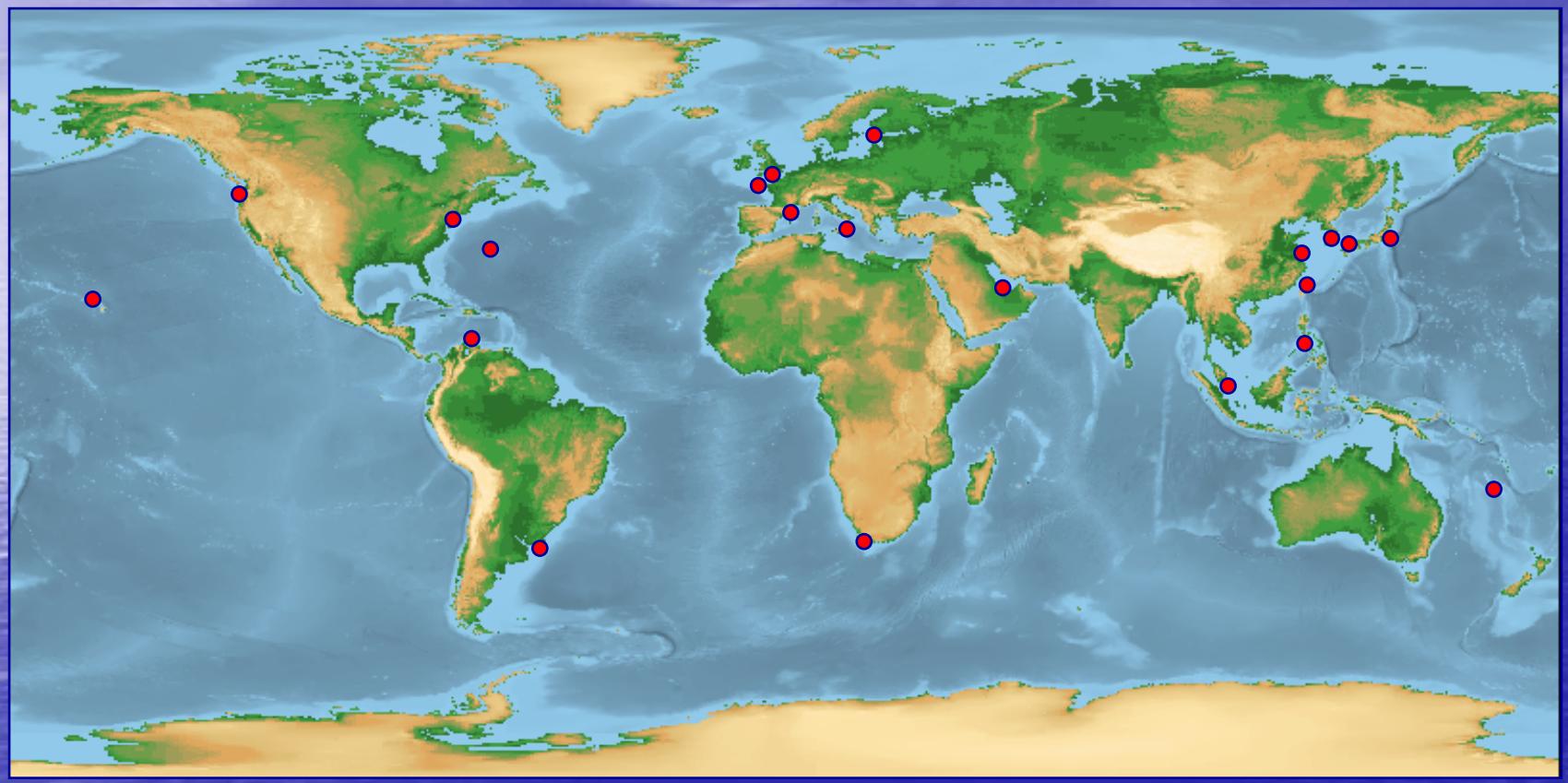
Despite sometimes serious cable breakages and disruption to traffic, the global cable network continues to function

This resilience results from:

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

Network Resilience

Cable Repair Facilities



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 ; 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

Acknowledgements

- Alcatel-Lucent Submarine Networks
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- France Telecom
- Global Marine Systems Ltd
- Seaworks (New Zealand)
- Transpower New Zealand Ltd
- Tyco Telecommunications (US) Inc.
- UK Cable Protection Committee
- Victoria University of Wellington

Sharing the seabed in harmony