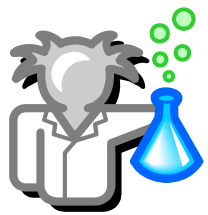
Cable Quakes

May 2007



Geoff Huston
Chief Scientist
APNIC

Acknowledgement

This presentation based on :

Taiwan Earthquake Fiber Cuts: a Service Provider View

Sylvie LaPerrière, Teleglobe - VSNLI NANOG 39, February 2007

The Earthquake Event

Magnitude	**7.1** (Major)
Date-Time	**Tuesday, December 26, 2006 at 12:26:21 (UTC)** = Coordinated Universal Time **Tuesday, December 26, 2006 at 8:26:21 PM** = local time at epicenter Time of Earthquake in other Time Zones
Location	21.825°N, 120.538°E
Depth	10 km (6.2 miles) set by location program
Region	TAIWAN REGION
Distances	90 km (55 miles) SSE of **Kao-hsiung, Taiwan** 120 km (75 miles) SSW of **T'ai-tung, Taiwan** 375 km (235 miles) SSW of **T'AI-PEI, Taiwan** 800 km (495 miles) N of **MANILA, Philippines**
Location Uncertainty	horizontal +/- 4.8 km (3.0 miles); depth fixed by location program
Parameters	Nst=222, Nph=222, Dmin=282.4 km, Rmss=0.93 sec, Gp= 32°, M-type=teleseismic moment magnitude (Mw), Version=Q
Source	USGS NEIC (WDCS-D)
Event ID	uswtai

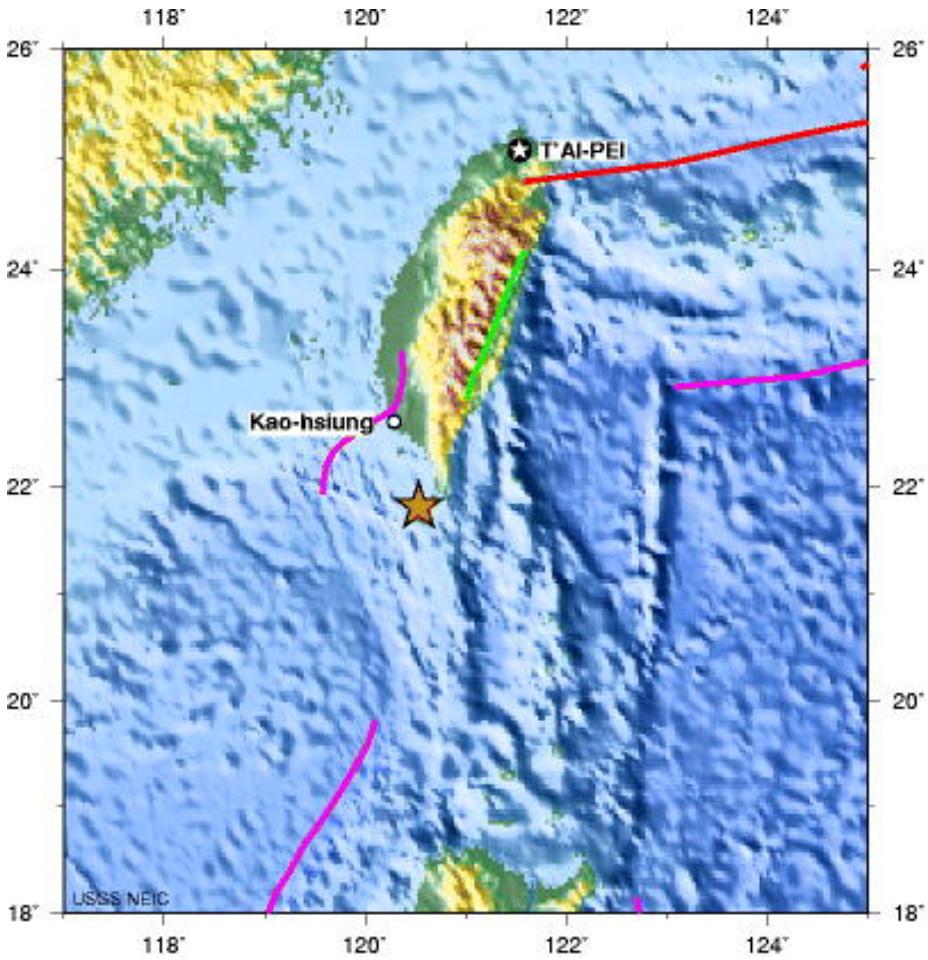
Source: earthquake.usgs.gov

Earthquake Aftershock Log

#	Time	Location	Magnitude
0	December 26, 2006 12:25	21.9°N, 120.56°E, 22.8.6 km southwest of Hengchum	7.1 M_L
1	December 26, 2006 12:34	22.5°N, 120.51°E, 11.6 km northwest of Fangliao	6.4 M_L
2	December 26, 2006 12:40	21.94°N, 120.4E, 35.4 km west of Hengchun	5.2 M_L
3	December 26, 2006 14:53	21.86°N, 120.39°E, 39.8 km southwest of Hengchun	5.2 M_L
4	December 26, 2006 15:41	22.09°N, 120.22°E, 31.6 km southwest of Little Liuchiu Island	5.5 M_L
5	December 26, 2006 17:35	21.78°N, 120.31°E, 50.4 km southwest of Hengchun	5.8 M_L
6	December 27, 2006 02:30	22.03°N, 120.33°E, 35.1 km south of Little Liuchiu Island	5.9 M_L
7	December 28, 2006 09:38	21.96°N, 120.56°E, 54.5 km southwest of Hengchun	5.3 M_L

Source: http://en.wikipedia.org/wiki/2006_Hengchun_earthquake

Earthquake Location



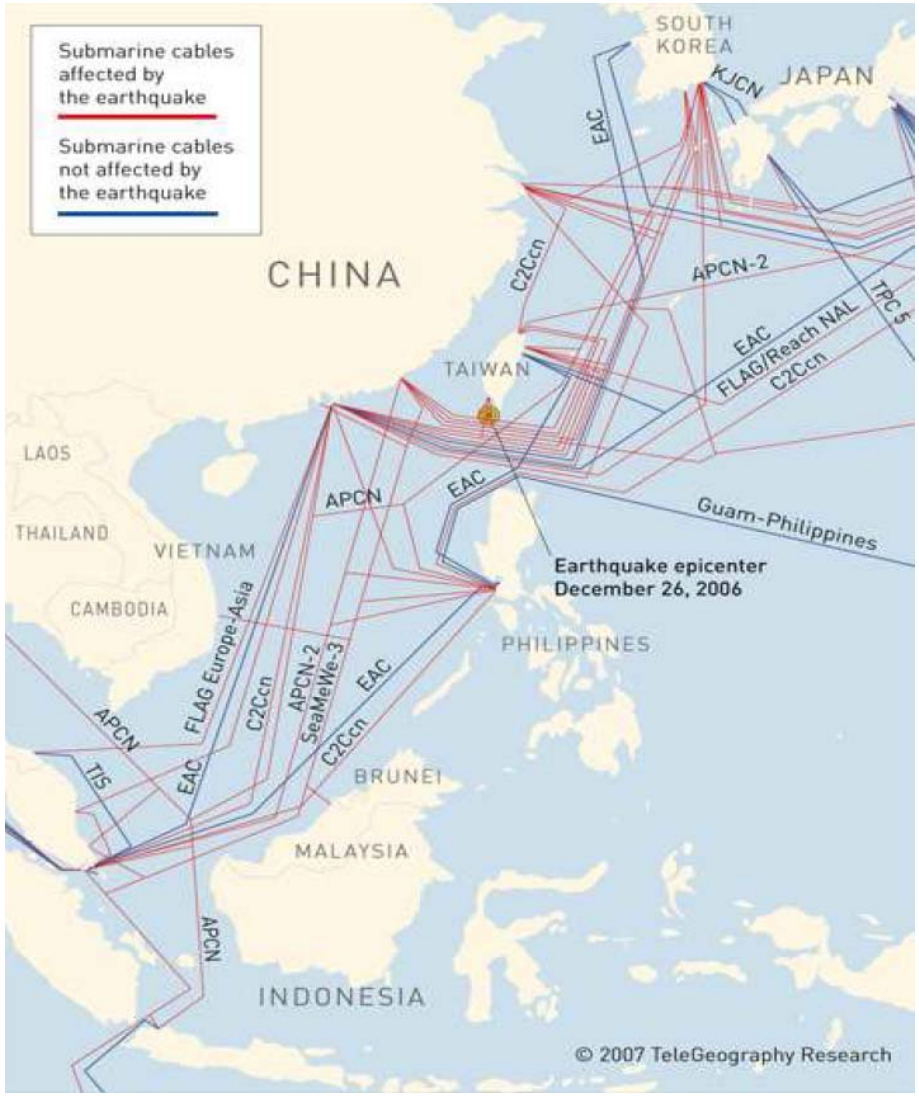
TAIWAN REGION

2006 12 26 12:26:21 UTC 21.82N 120.53E Depth: 10 km, Magnitude: 7.1

Earthquake Location

Source: earthquake.usgs.gov

Luzon Strait Cable Systems



Even though many of these cable systems are SDH rings, both parts of the ring pass through the Luzon Strait, making ring-based restoration impossible when there is a large-scale submarine landslide in the strait

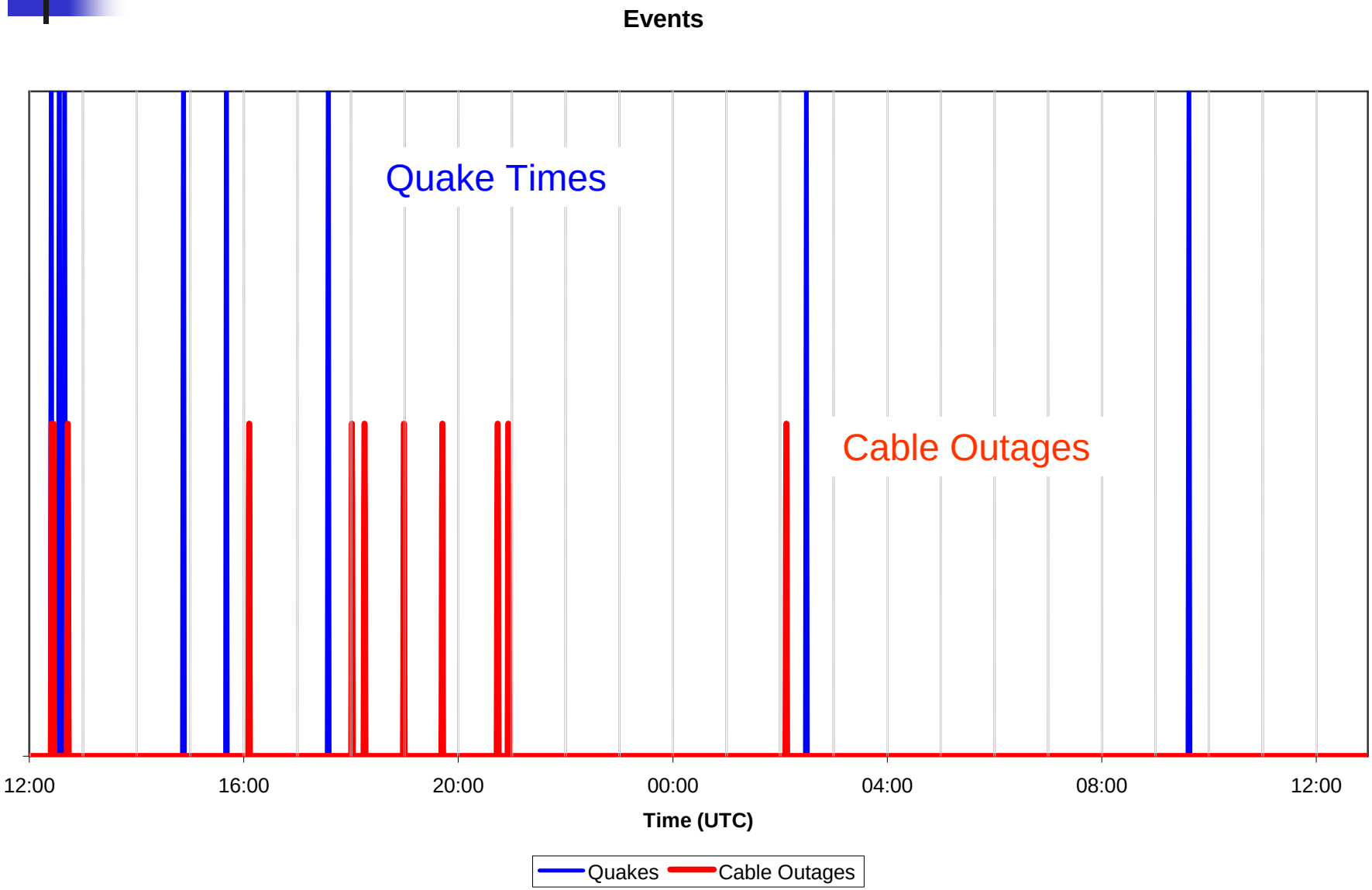
Source: Teleglobe Presentation

Cable Outage Log

Cable	***Outage Time***
SMW3 S1.7 & S1.8	12:25
China-US W2	12:27
RNAL Busan / TongFul	12:43
APCN2, Seg 7	16:06
APCN2, Seg 3	18:01
APCN Sys 1, Seg B17	18:15
China-US S1	18:59
RNAL HongKong / Toucheng	19:42
APCN Sys 2, Seg B5	20:44
FLAG FEA Sub-Sys B	20:56
China-US W1	02:07

Source: http://www.hardwarezone.com.au/news/view.php?cid=8&id=6268

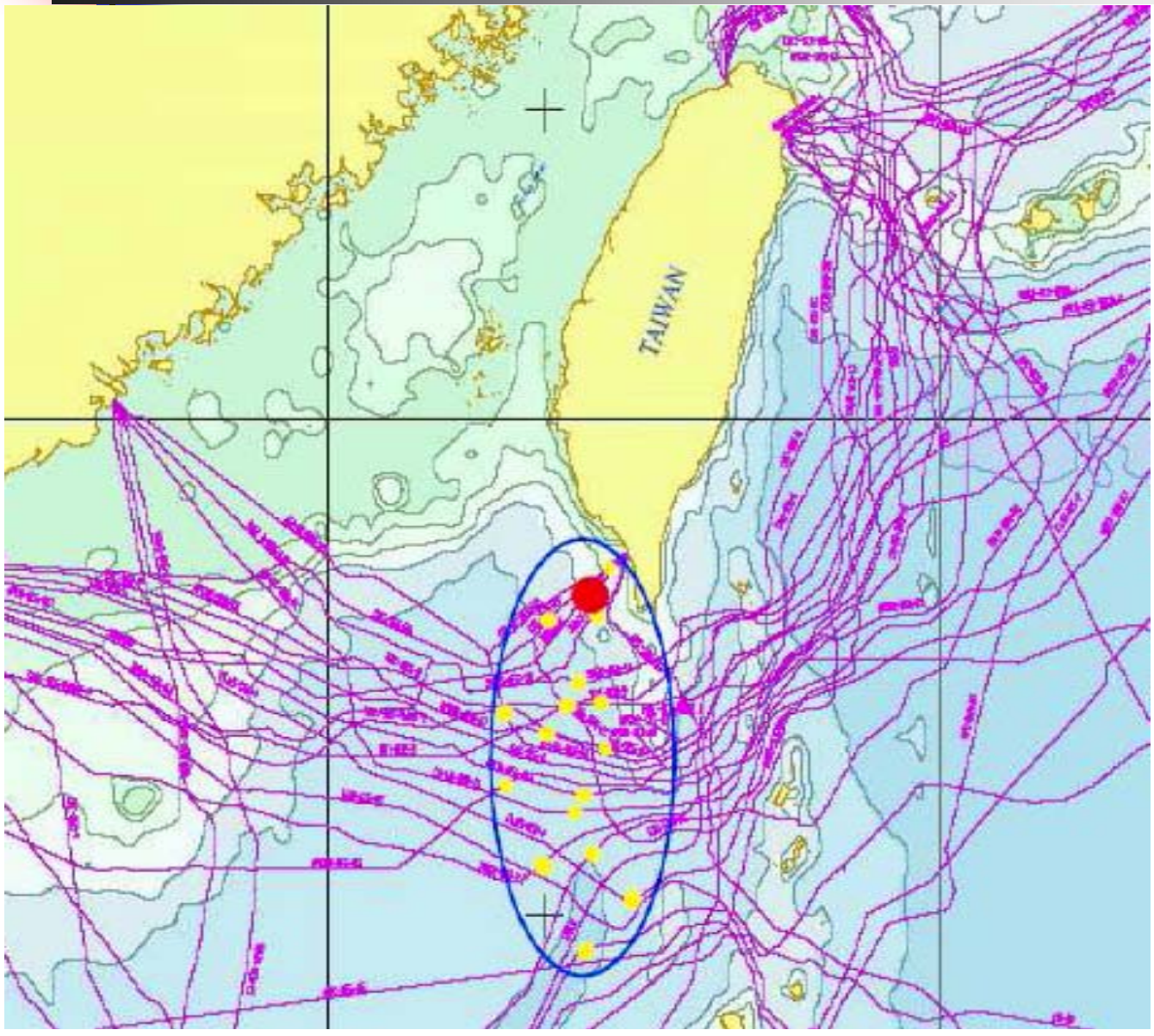
Event Log


Events
Quake Times
Cable Outages
12:00
16:00
20:00
00:00
04:00
08:00
12:00
Time (UTC)
Quakes
Cable Outages

Why the Time Lag?

- Submarine earthquakes trigger submarine landslides which trigger cable breaks
- These slides can last from minutes to hours, with average velocities of around 36km/hour (mundane) to 540 km/hour (catastrophic on a global scale!)
- In this case it appears that the earthquake generated a relatively slow moving submarine landslide that moved south from the earthquake epicentre across the Bashi Channel at a depth of 3,000m

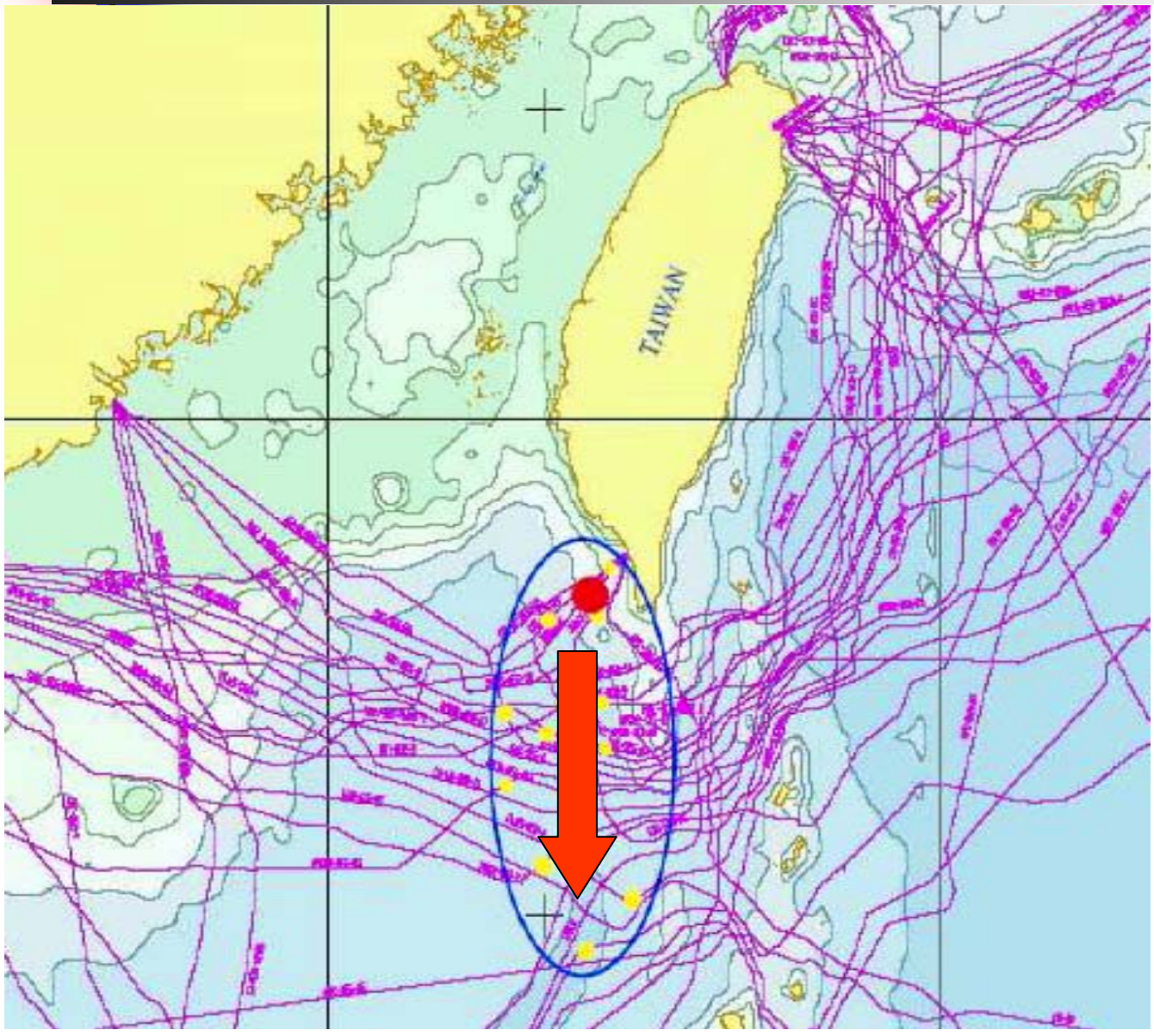
Luzon Strait Cables



Detail of cable routes and cable break points in the strait

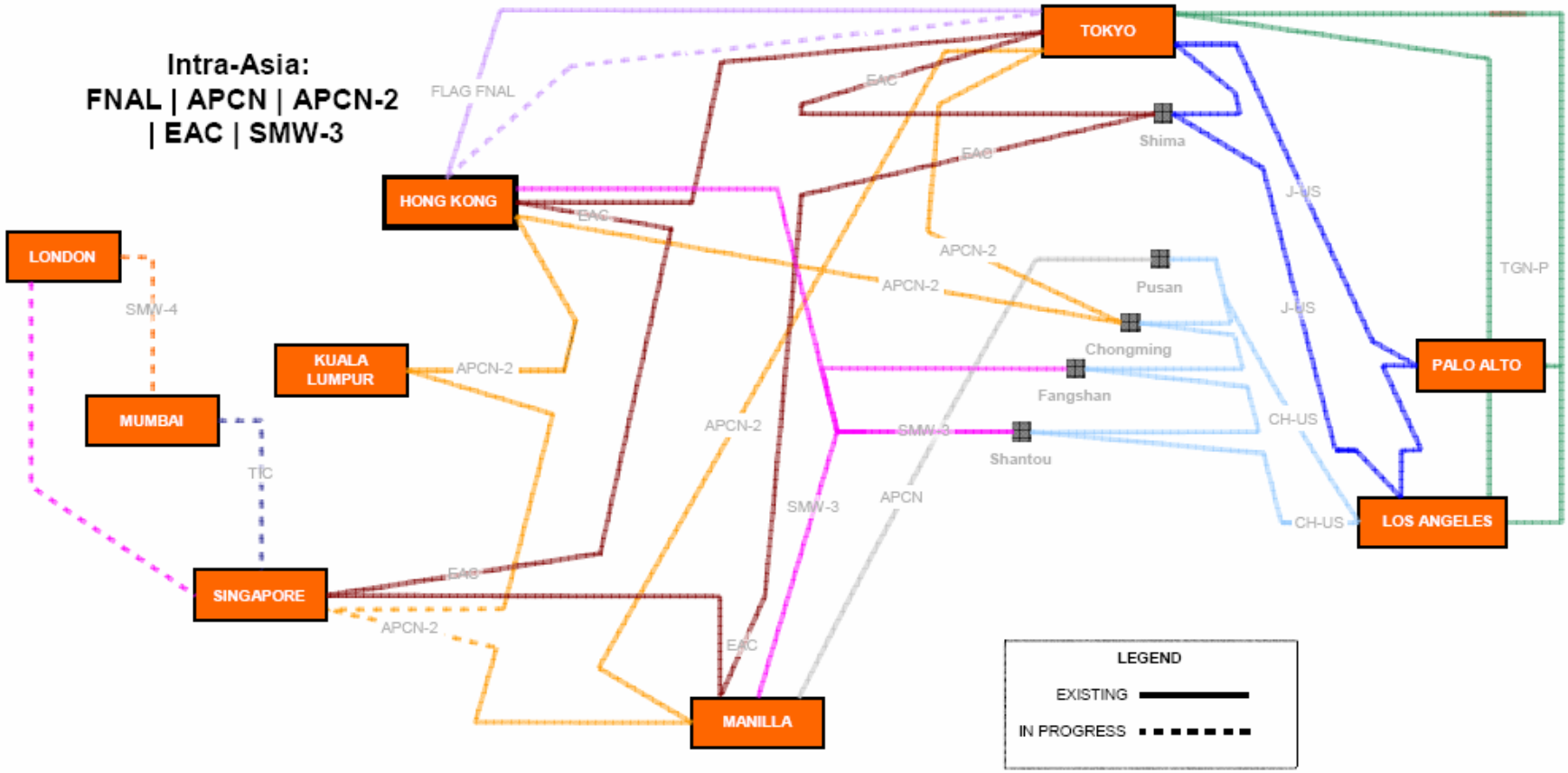
Map courtesy of PCCW

Luzon Strait Cables



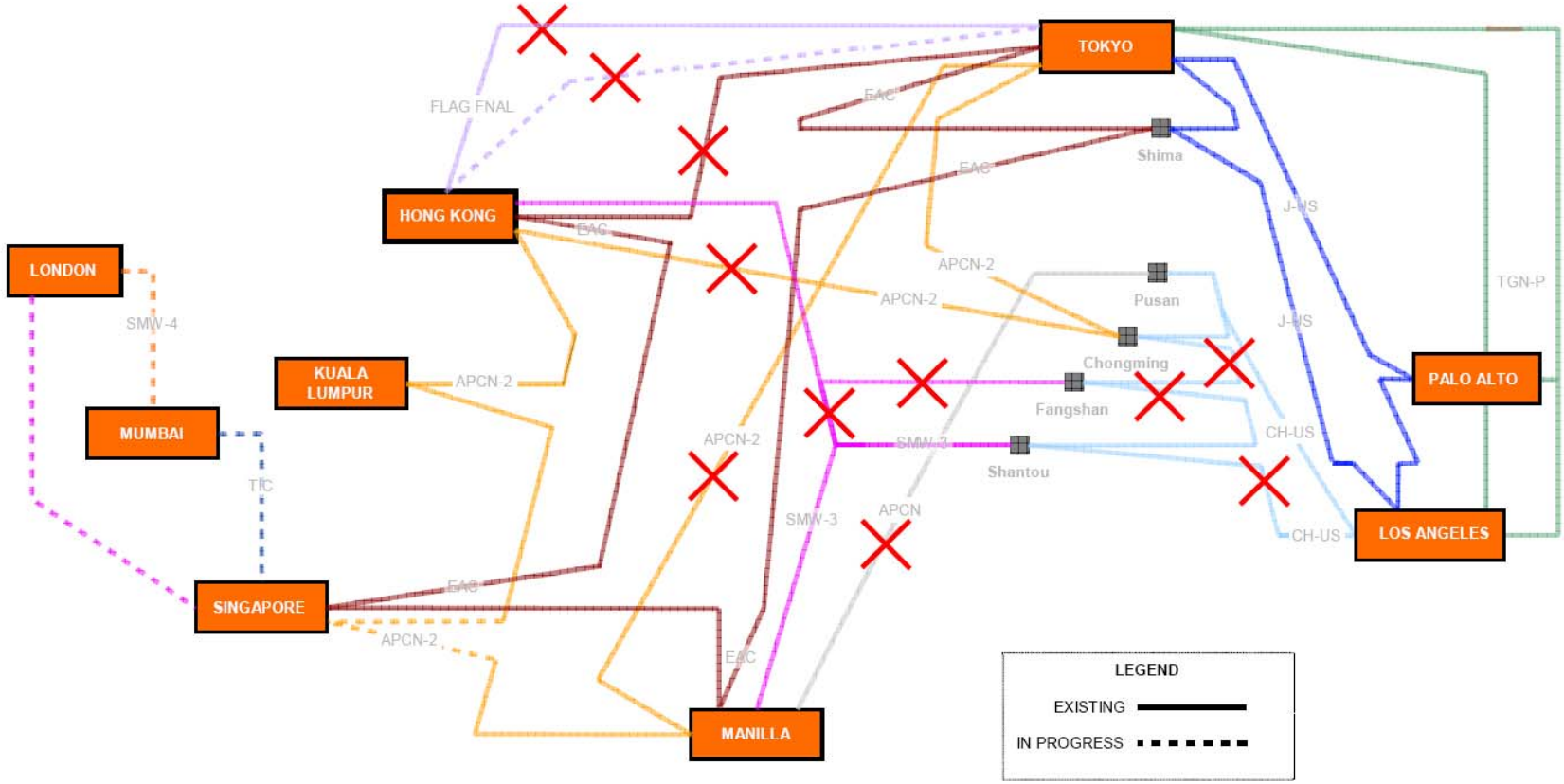
Map courtesy of PCCW

Asian Submarine Cable Systems



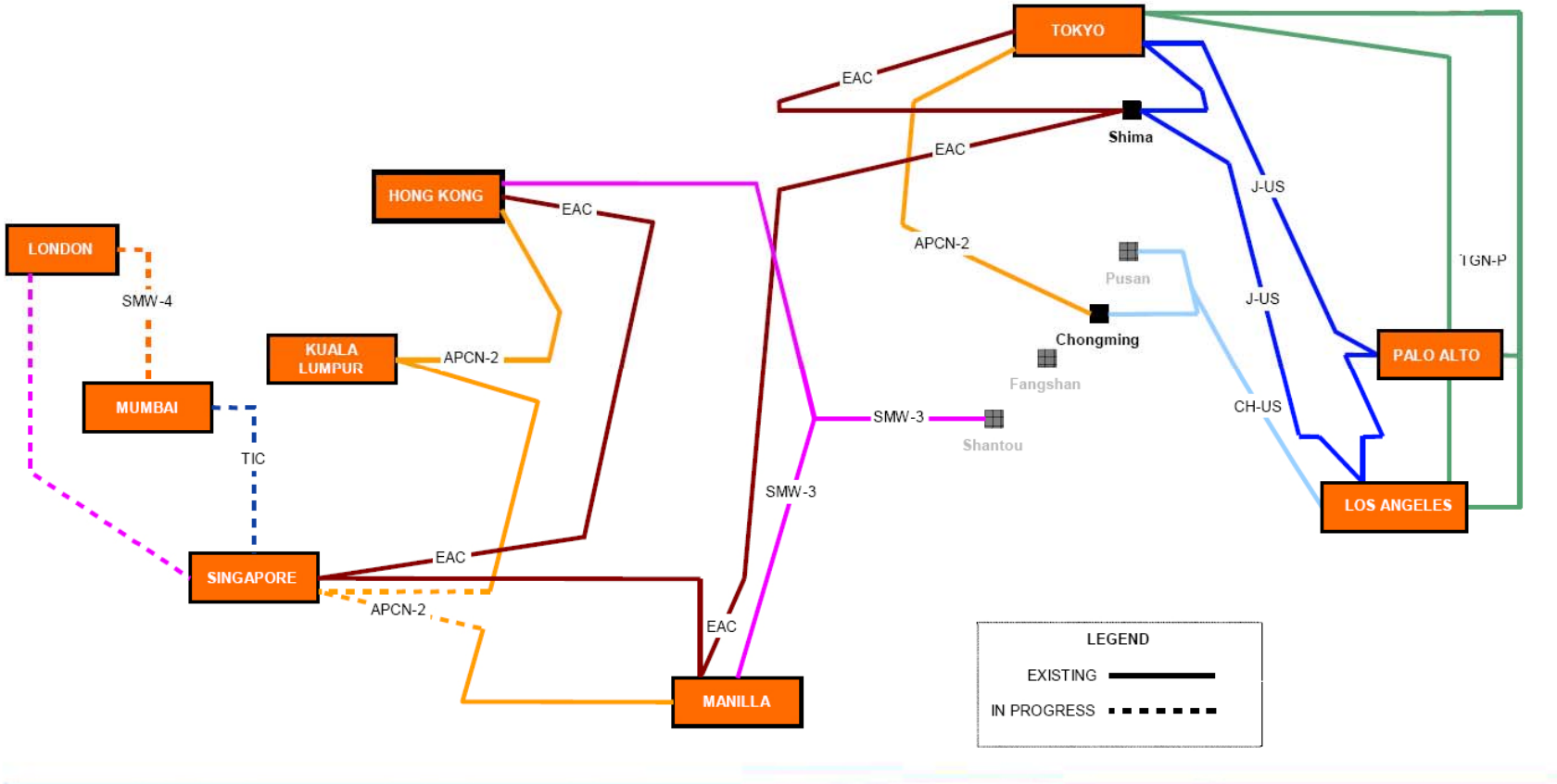
Source: Teleglobe Presentation

What cables broke?



Source: Teleglobe Presentation

What was left in service?



Source: Teleglobe Presentation

Repair Issues

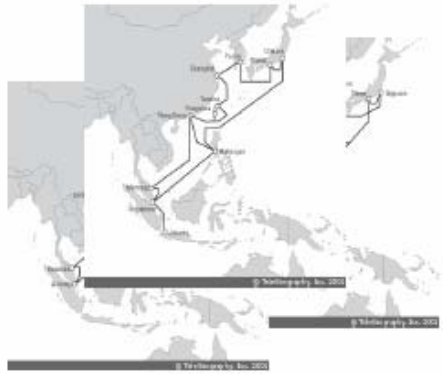
- Extreme depth implies that ROV operation was not possible. Grapnel recovery was required
- 18 cable faults had to be repaired
- Cable location may have been displaced and possibly buried due to the submarine landslide movement
- Each repair takes 7 – 10 days to complete
- Limited number of repair ships in the region
- Complete inventory restored by January 30

Repair

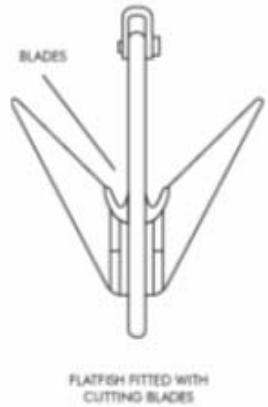
Cable repair ship in the area.

Powerful vessel equipped to maintain station and perform cable repair in rough weather conditions.

All spares, including spare cable, a number of cable bodies and jointing kits.



Not so rough weather



A grapnel fitted with a cutter and a grabbing tool.

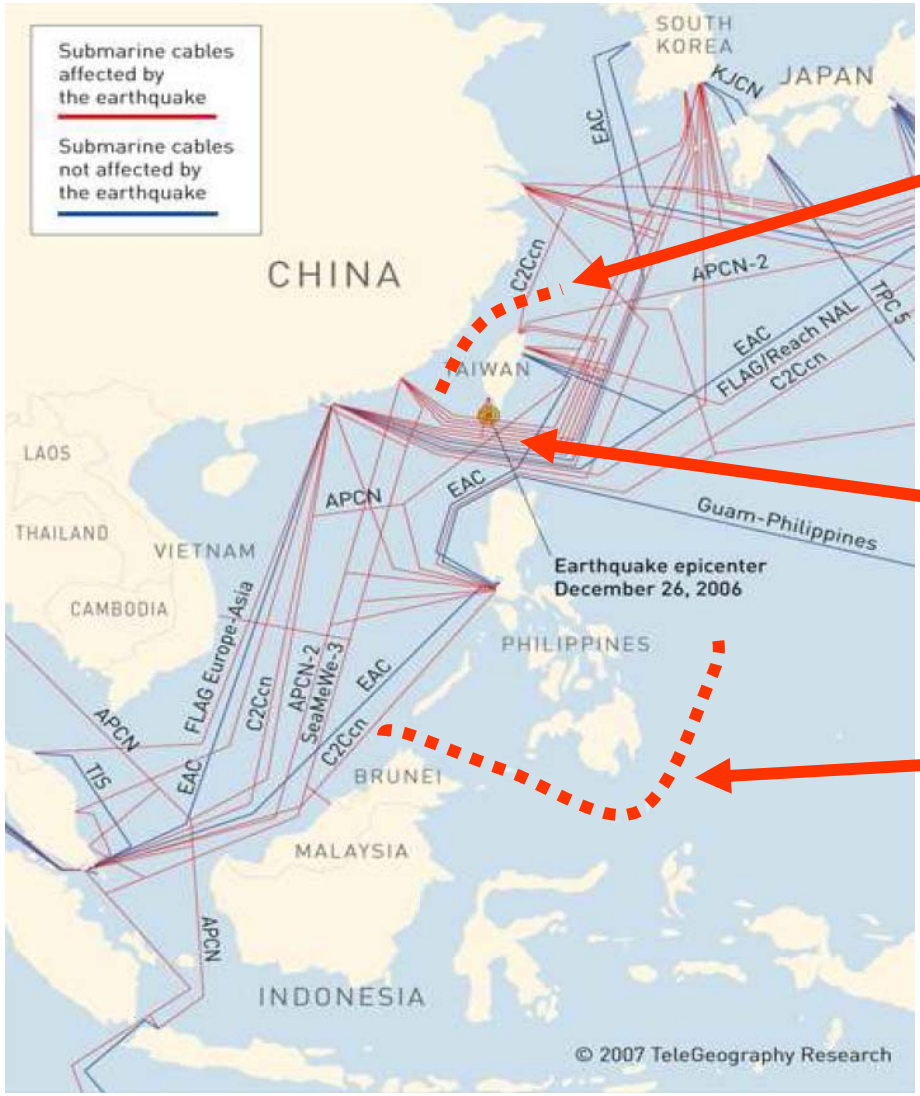
45 by 60 cm (18 by 24 in)

Dropping grapnel + dragging oceanfloor + recover cable = 16 hours

Average repair duration = 7 days

Source: Teleglobe Presentation

Geographical Constraints



Way too shallow!

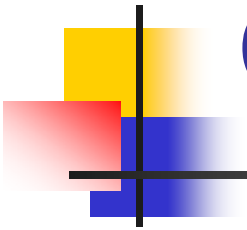
The Formosa strait is 70m in depth and 130 km wide

The Luzon strait is favoured because of its width (320 km) and depth (3000m).

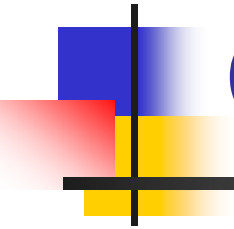
Way too long !

Some Observations

- Undersea cable systems are highly constrained by cost and geography
  - Short, deep, geo-stable paths are best
  - 2 out of 3 is often as good as it gets!
- Cable paths tend to aggregate between major population centres, leading to the construction of critical points of potential failure
- Cost vs resiliency?
  - Cost seems to win



Questions?



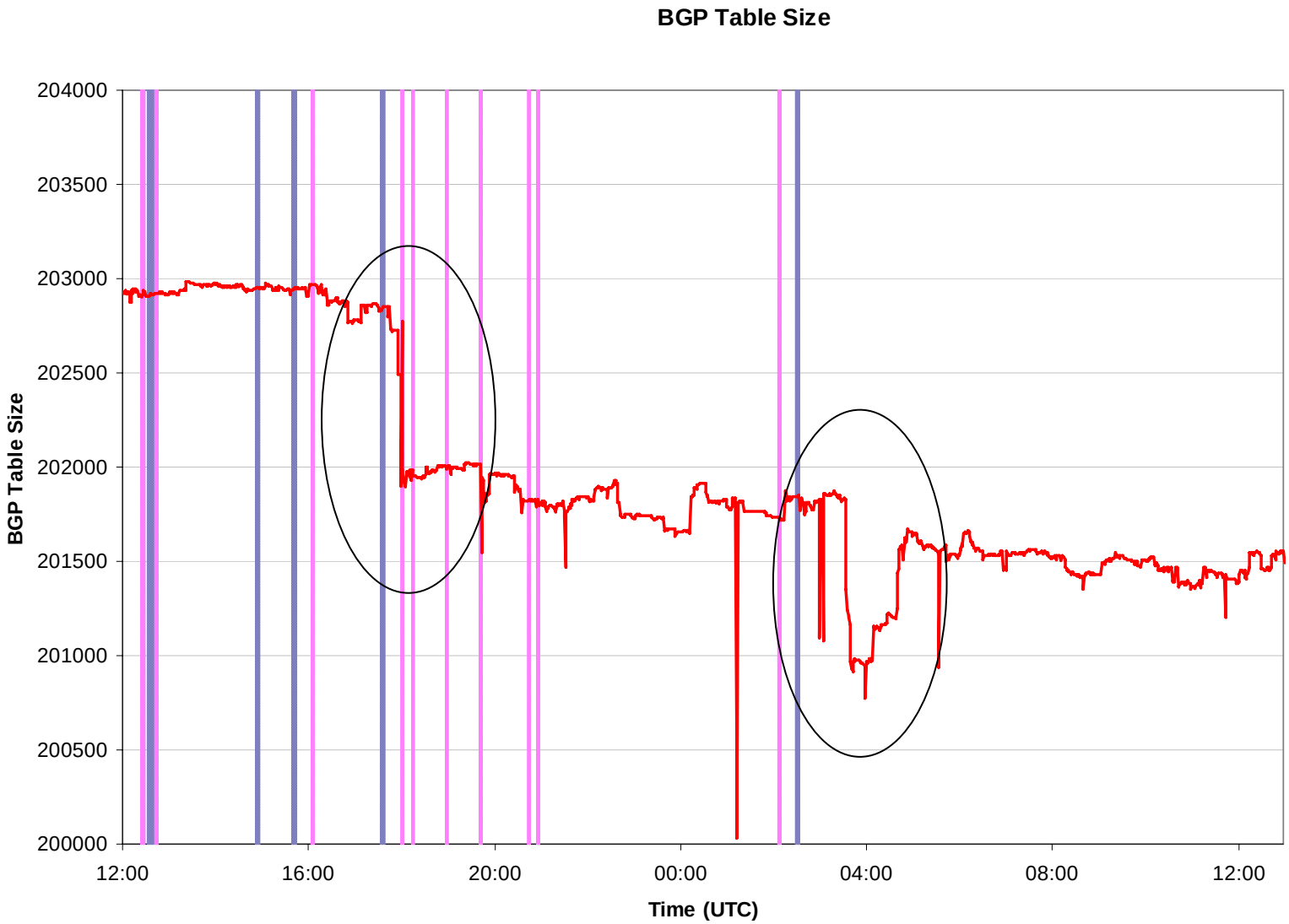
Quaking BGP – Part 1

BGP Measurement

Viewpoint: Reach, Australia (AS4637)

- Extensive Asian Network
- Active Circuits on affected cables
- Hourly Snapshots
- BGP Update Log for the 26th and 27th

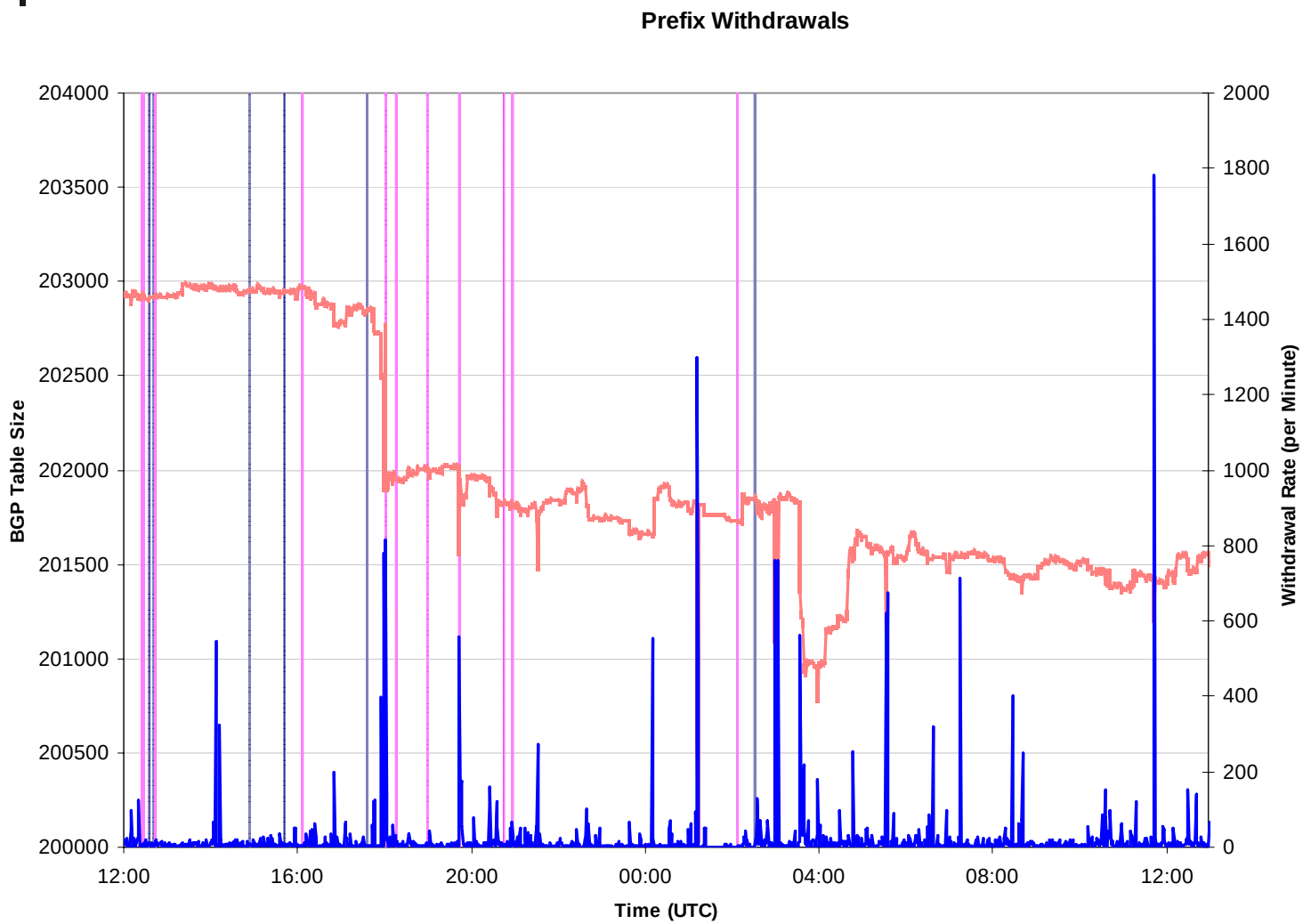
BGP Table Size



Observations

- Some loss of reachability
  - 1% of routes (~ 2,000 routes)
  - Multiple redundant circuitry
  - BGP appears to work!
- BGP event times differ from log of events (?)

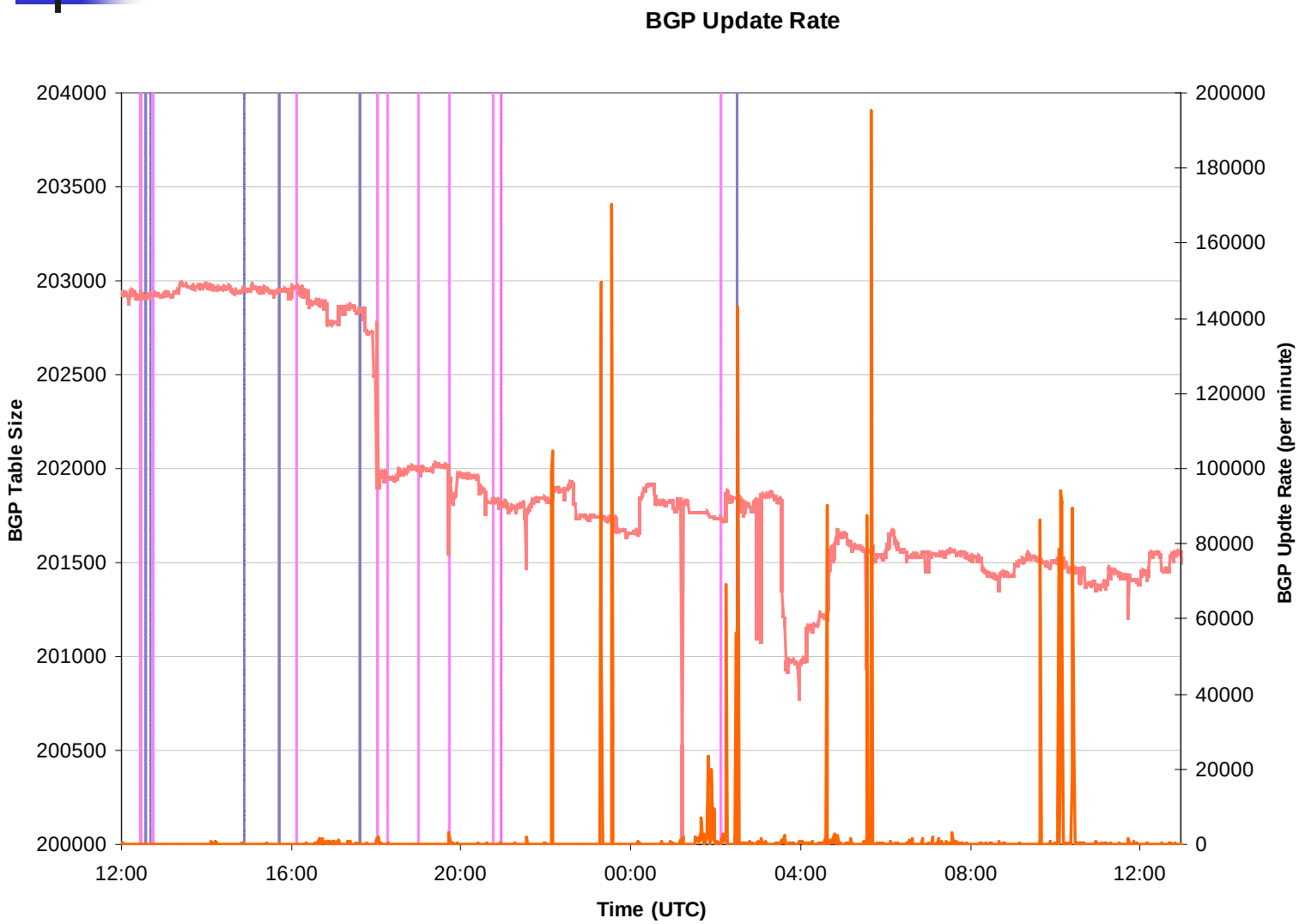
BGP Withdrawal Rate



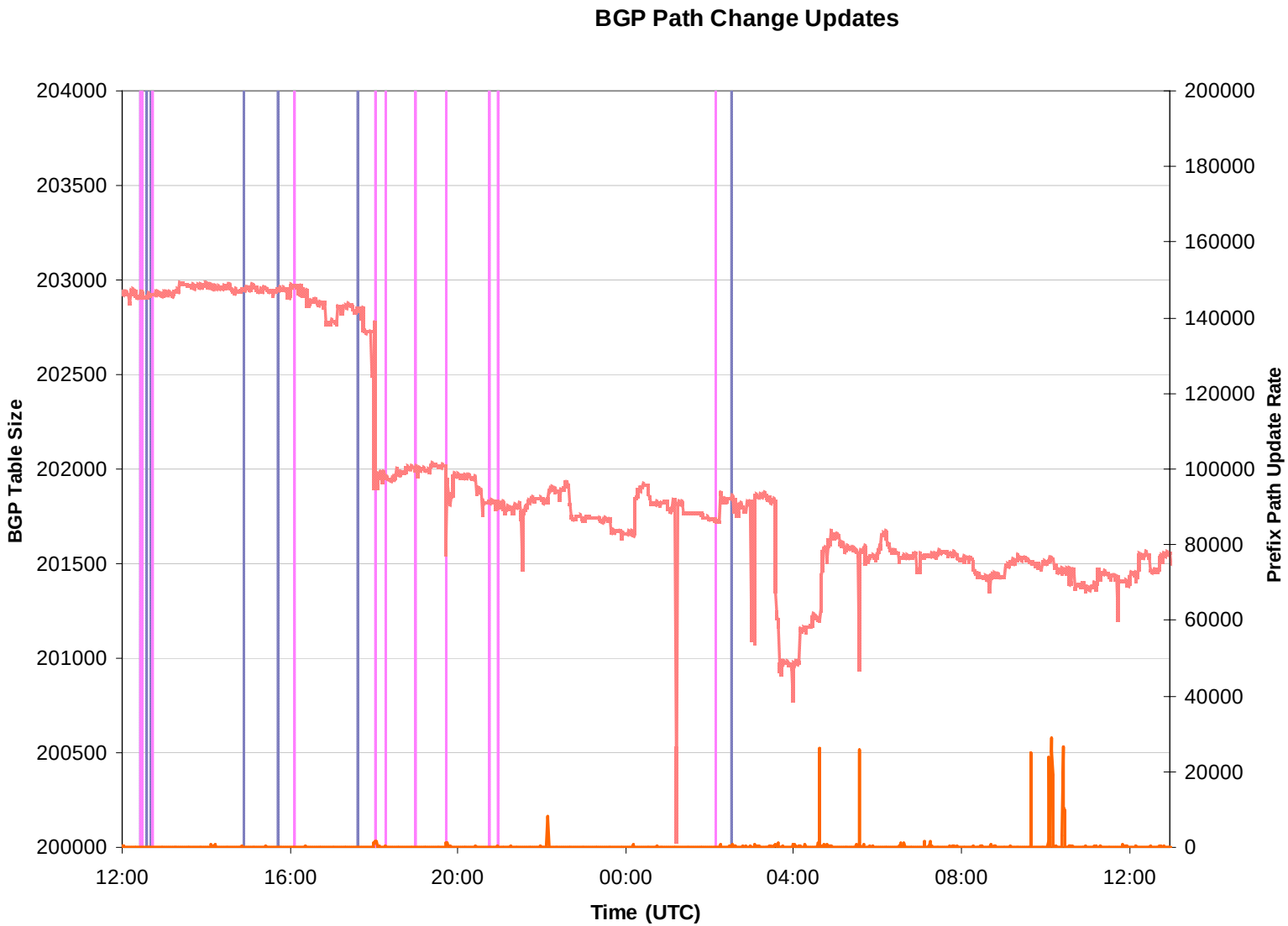
Observations

- Only one withdrawal peak corresponds in time to a listed cable outage
  - But that was a set of routes originated by AS 11830 – in South America!!!
- Are the other withdrawal peaks a result of manual traffic engineering to re-establish a balanced load?

BGP Update Rate



BGP Path Update Rate



Did the net break for AS4637?

- **No** – there were very few (< 200) unreachable prefixes that appear to be a direct result of submarine cable outage
- BGP Updates appear to reflect a set of **community attribute changes** as a result of traffic engineering activities subsequent to the earthquake activity

Was AS4637 “special”?

- In this case, **YES**
- AS4637 has communications paths on a North-South axis between Australia and South East Asia via the Indian Ocean, and on paths that lie east of the Bashi Strait to Japan, and on the Australia – New Zealand – Hawaii – US central Pacific route
- AS4637 saw no direct drop in reachability
  - Other observation points recorded some 1,200 address prefixes dropped in the cable outage period
  - Further 3,800 prefixes dropped at 03:32 27 December
  - Major impact on CN and IN routes
- AS4637 did perform an amount of TE grooming of its connectivity soon after the cable outages in what appeared to be a capacity management exercise

Acknowledgements

- Teleglobe VSNLI, Sylvie LaPierre
  - NANOG 39 presentation: http://www.nanog.org/mtg-0702/presentations/laperriere.pdf