Quaking Tables:

The Taiwan Earthquakes and the Internet Routing Table

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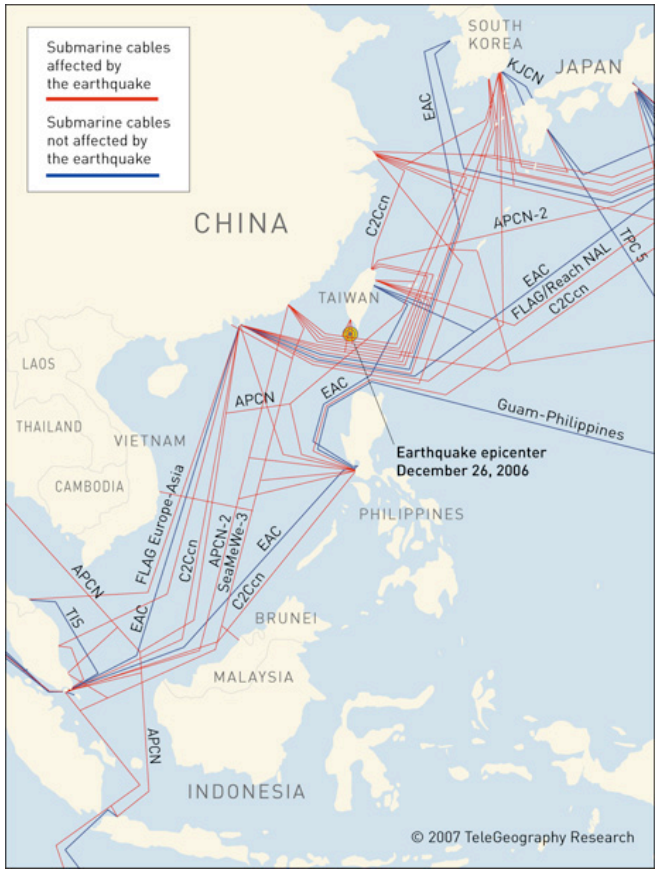
Acknowledgement

- Presentation based on:
  - Todd Underwood, Renesys, Bali 2007
- Including material from:
  - Sylvie LaPerrière, VSNL-Teleglobe, Toronto 2007
  - Geoff Huston, APNIC, Tallinn 2007

Overview

- Large earthquakes hit Luzon Strait, south of Taiwan on 26 December 2006
- Seven of nine cables passing through the straight were severed
- We review the event from a perspective of the Internet Routing tables
  - Routing outages occurred, significant congestion was reported, instability persisted
  - Recovery was delayed and uneven

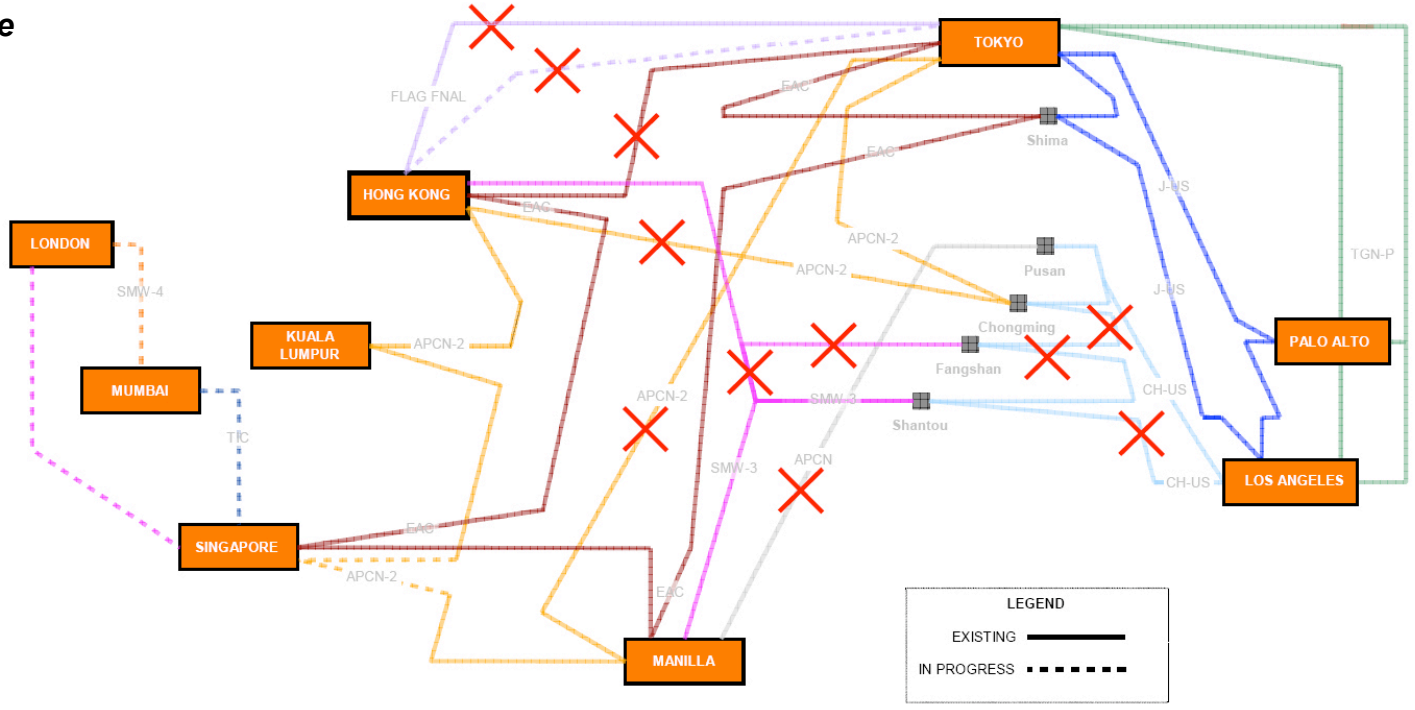
Submarine cables in East Asia



- Two of nine cables **not** impacted:
  - Asia Netcom's EAC
  - Guam-Philippines
- All cables reported repaired as of February 14, 2007 (source: Office of the Telecommunications Authority of Hong Kong)

Which cables broke?

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	19:42
APCN Sys 2, Seg B5	20:44
FLAG FEA Sub-Sys B	20:56
China-US W1	02:07



Source: VSNL-Teleglobe

Timeline

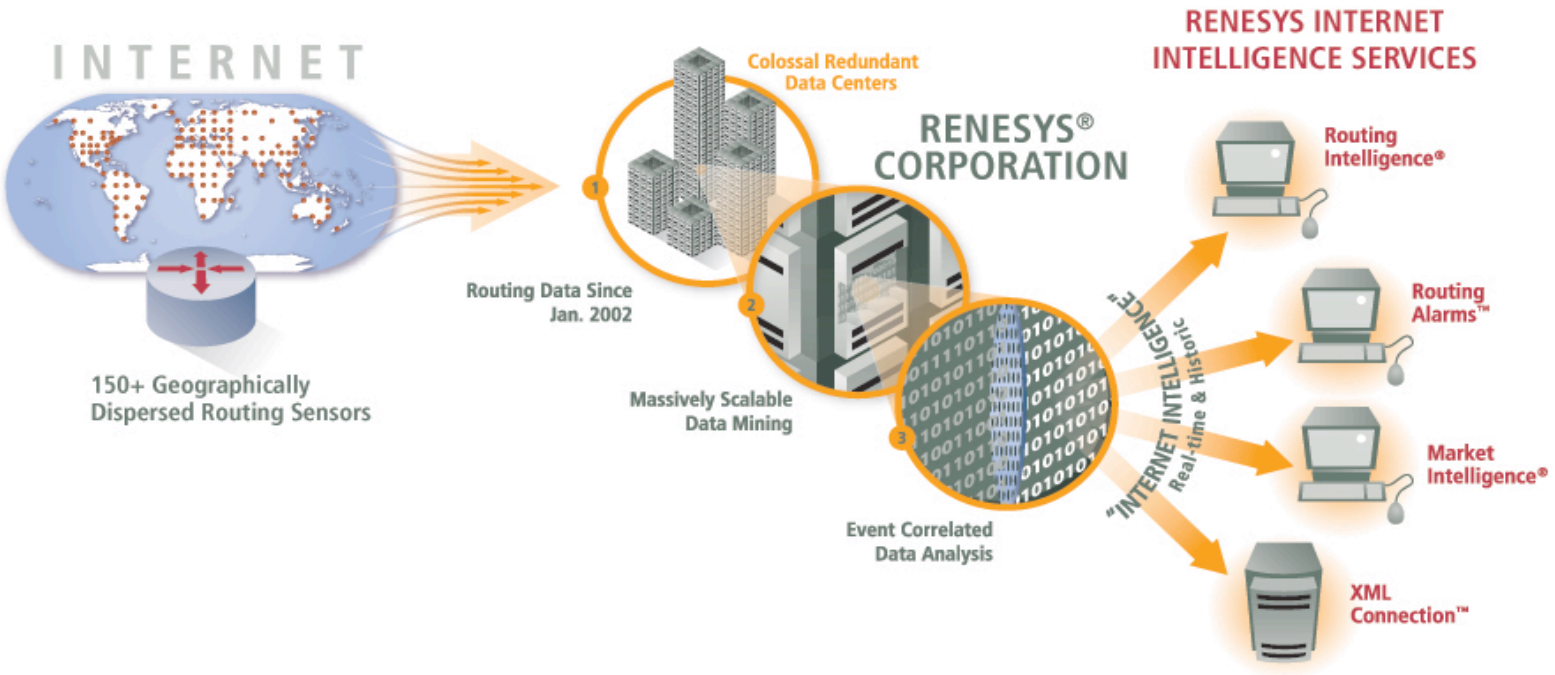
- Six earthquakes of magnitude 5.0 or higher hit the Taiwan region (all times UTC):
  - **12/26 12:26:21** **7.1** -- main quake
  - 12/26 12:34:14 6.9
  - 12/26 12:40:22 5.5
  - 12/26 15:41:44 5.4
  - 12/26 17:35:10 5.4
  - 12/27 02:30:39 5.6
  - 12/28 16:51:16 4.4
- Outaged prefixes ramp up from 400 to almost 1200 from the first quake through seventh

Timeline (2)

- 03:31 27 Dec 2006: 60 mins after the last quake, outaged network count spikes to 4k
- The “spike” is short-lived (< 2 hrs) but > 2k prefixes out for 6 hours.
- 31 Dec 2006 12:00: Outages return to pre-quake levels.
- Instability level remains high into January.

Data Collection Infrastructure

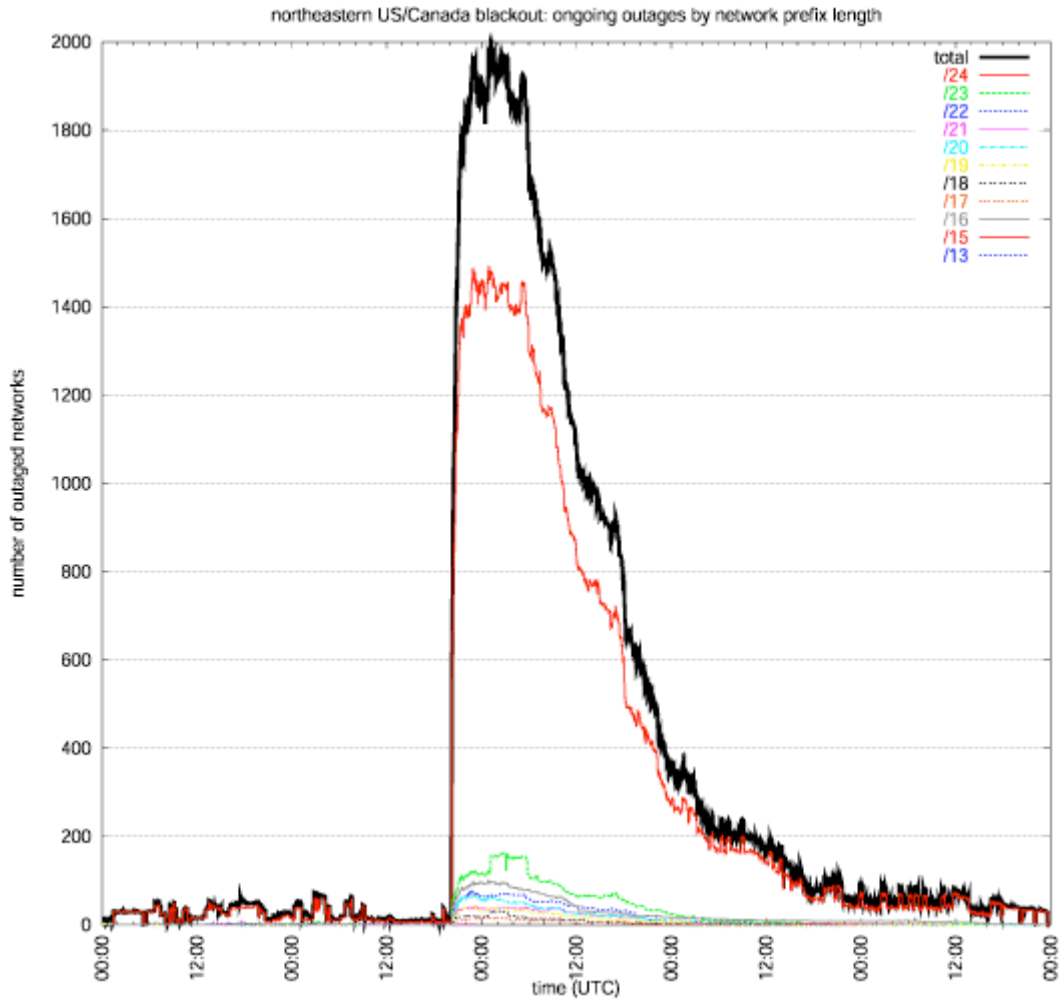
- 200+ peering sessions from 130+ different ASNs
- In this talk, we focus on East Asian prefixes only



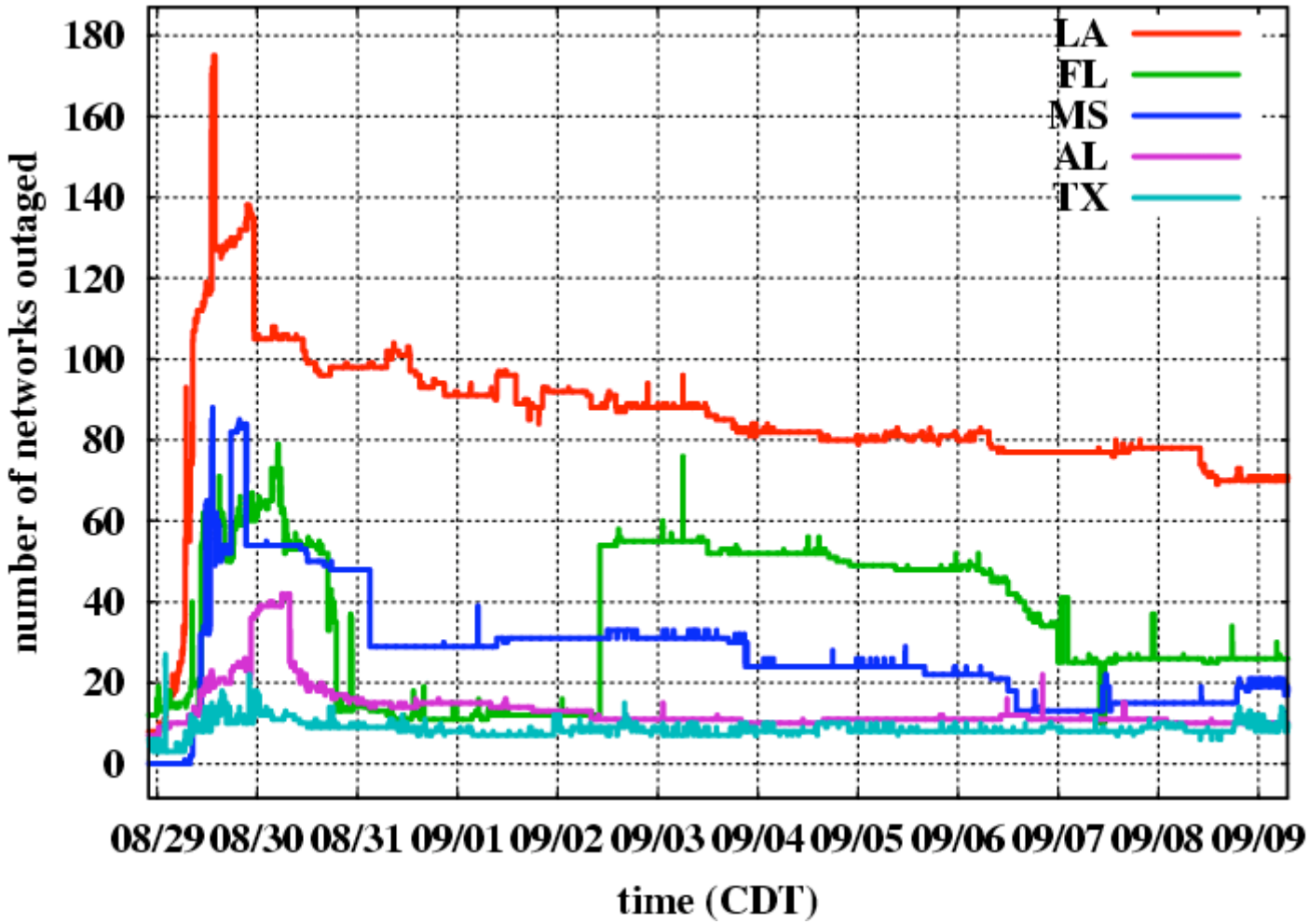
•Disasters Have Signatures

- Sharp onset associated with some real-world event
- Slow return to baseline
  - Varies considerably
  - Power outages: fast
  - Major natural disasters, **much** slower
- Noise in the recovery (not in the onset)

•Power (Northeast US, 2003)



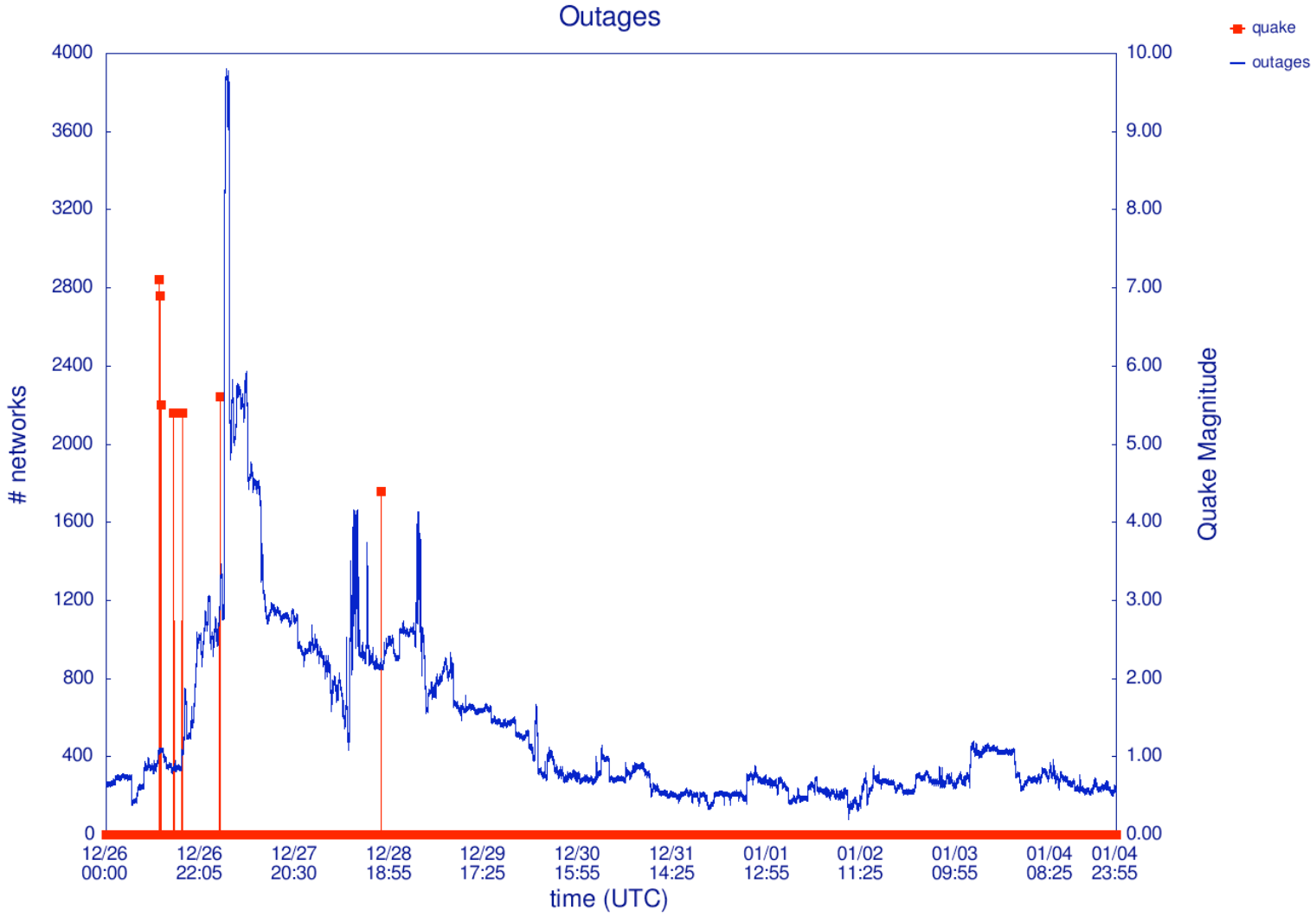
•Hurricane (Katrina, 2005)



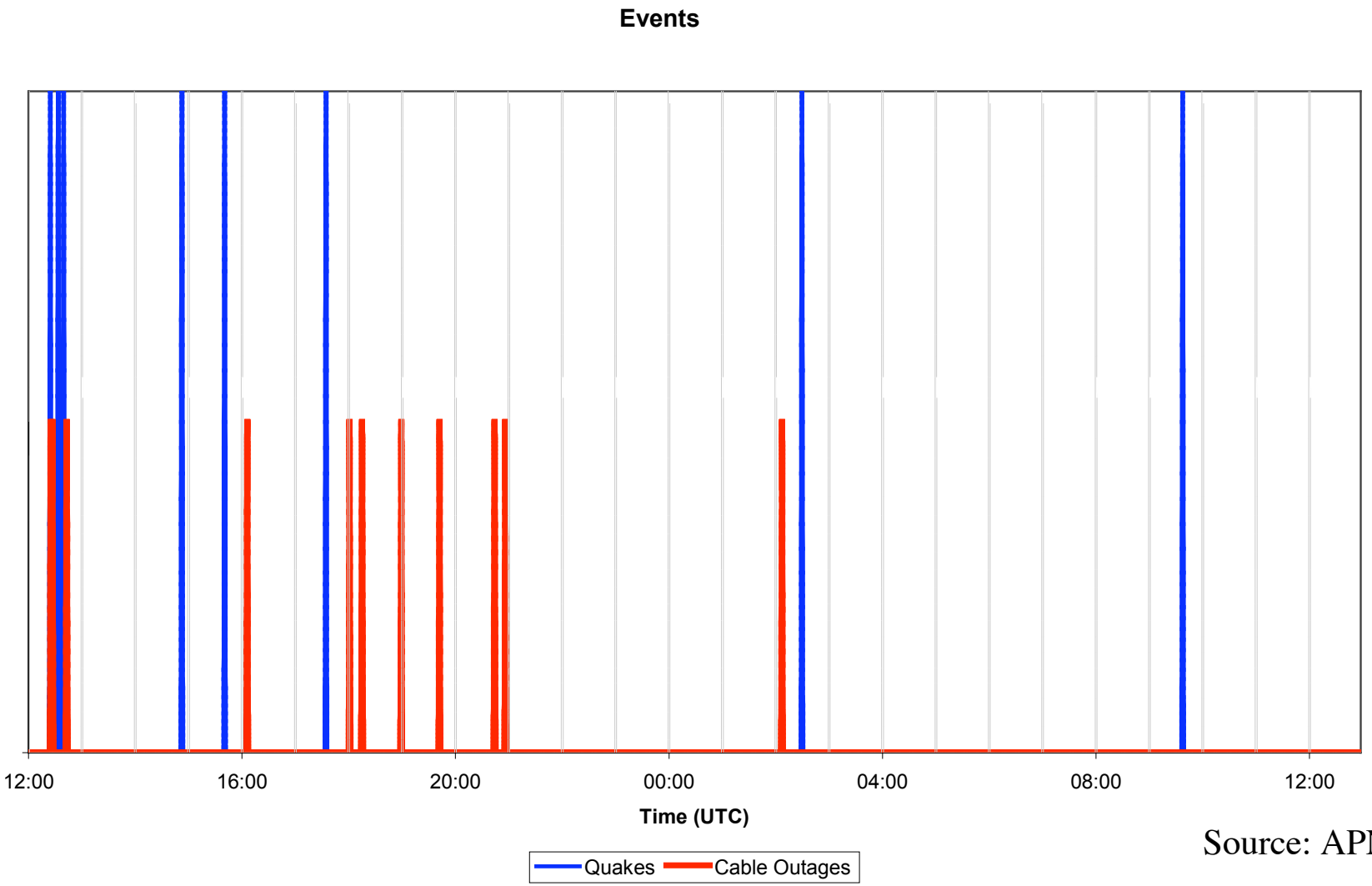
The Pattern of the Taiwan Quakes

- Ramping up outages and spikes in instabilities
- Gradual increase in number of outages after major quake in Dec. 26
- Big spike in outages/unstables associated with smaller quake on Dec. 27
- Recovery typically noisy
- Pattern was probably affected by the number of different cable systems involved – this is not really one event but at least seven.

•Outages & Quakes – 10 Day

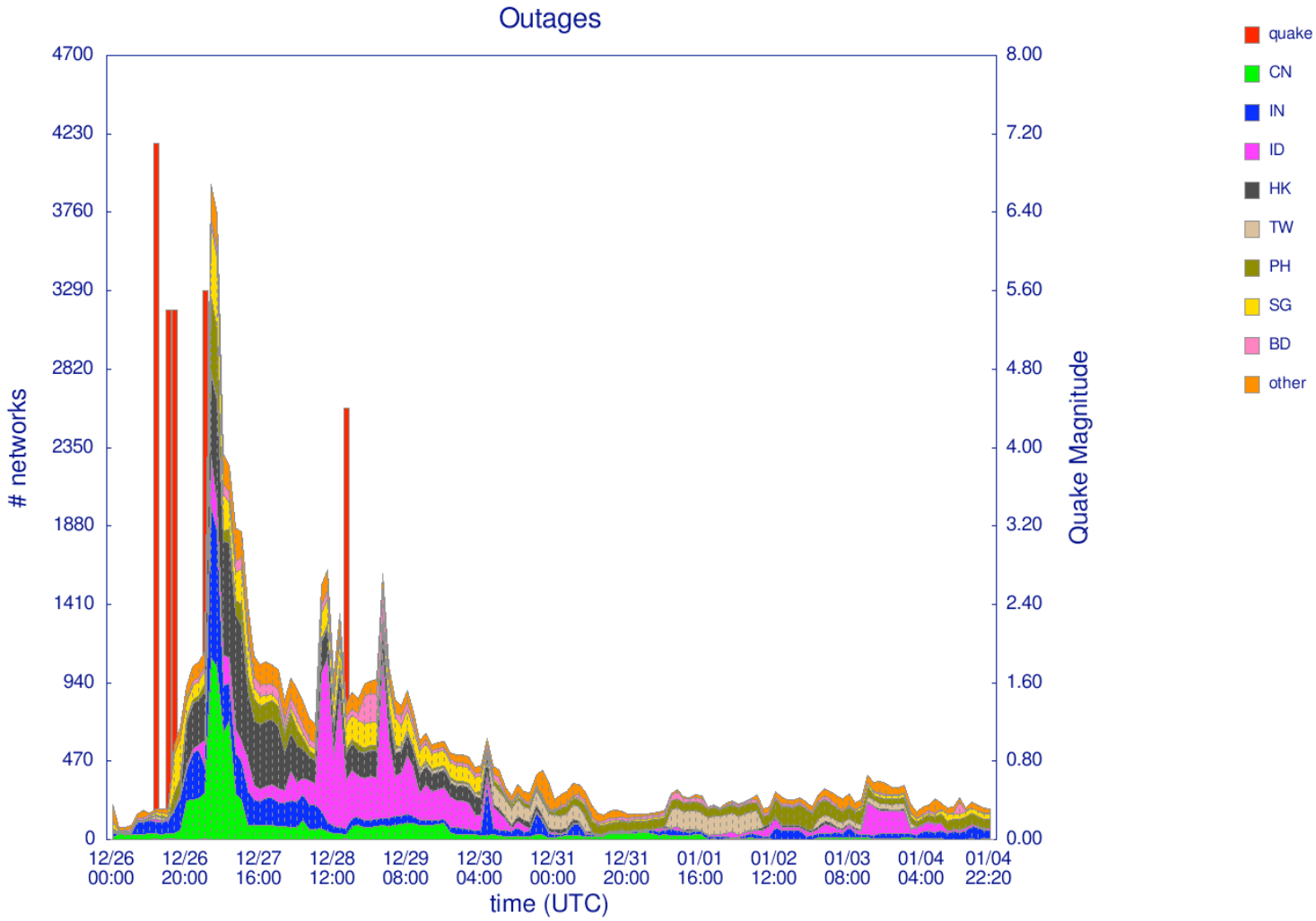


•Cable Breaks & Quakes

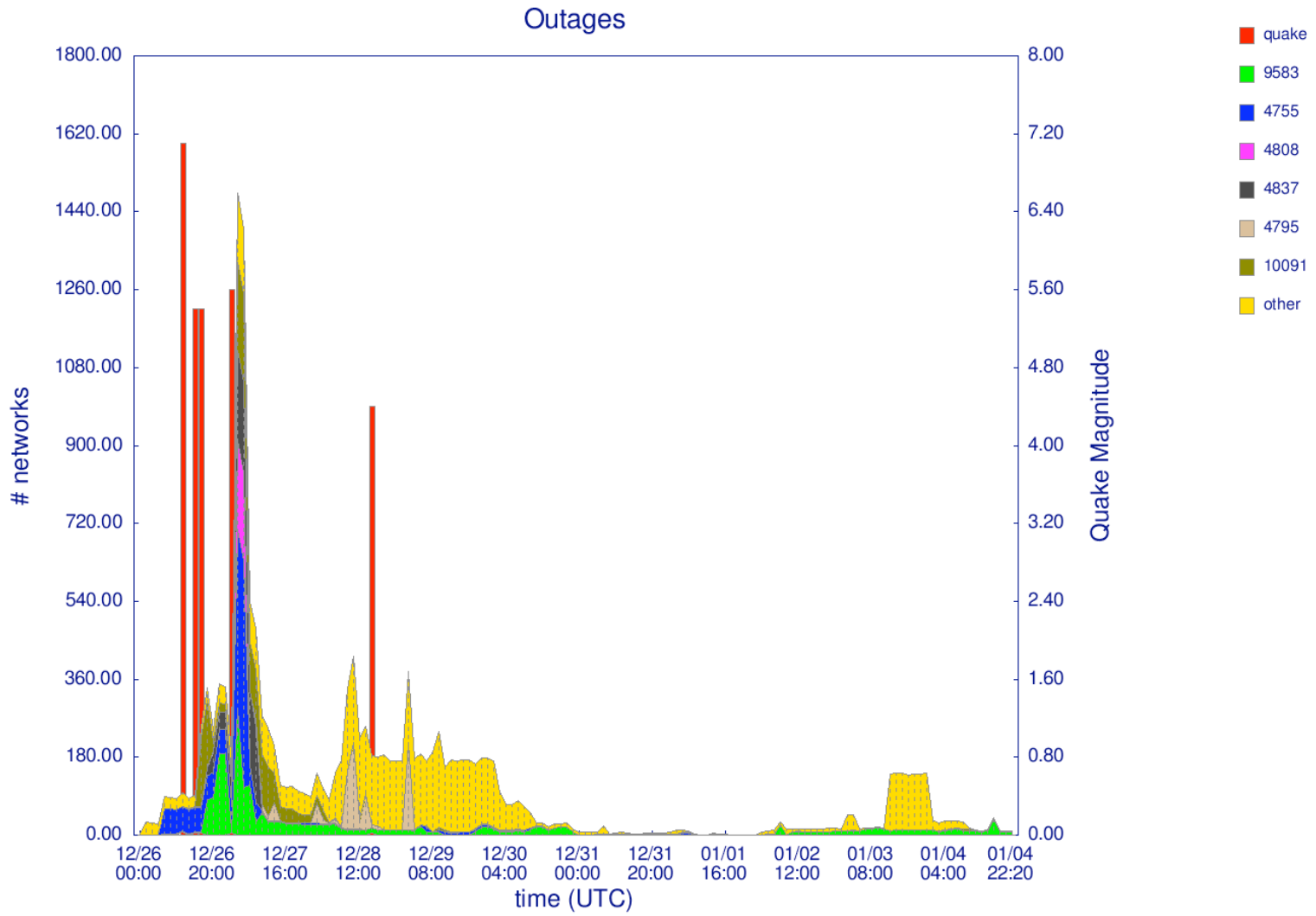


Source: APNIC

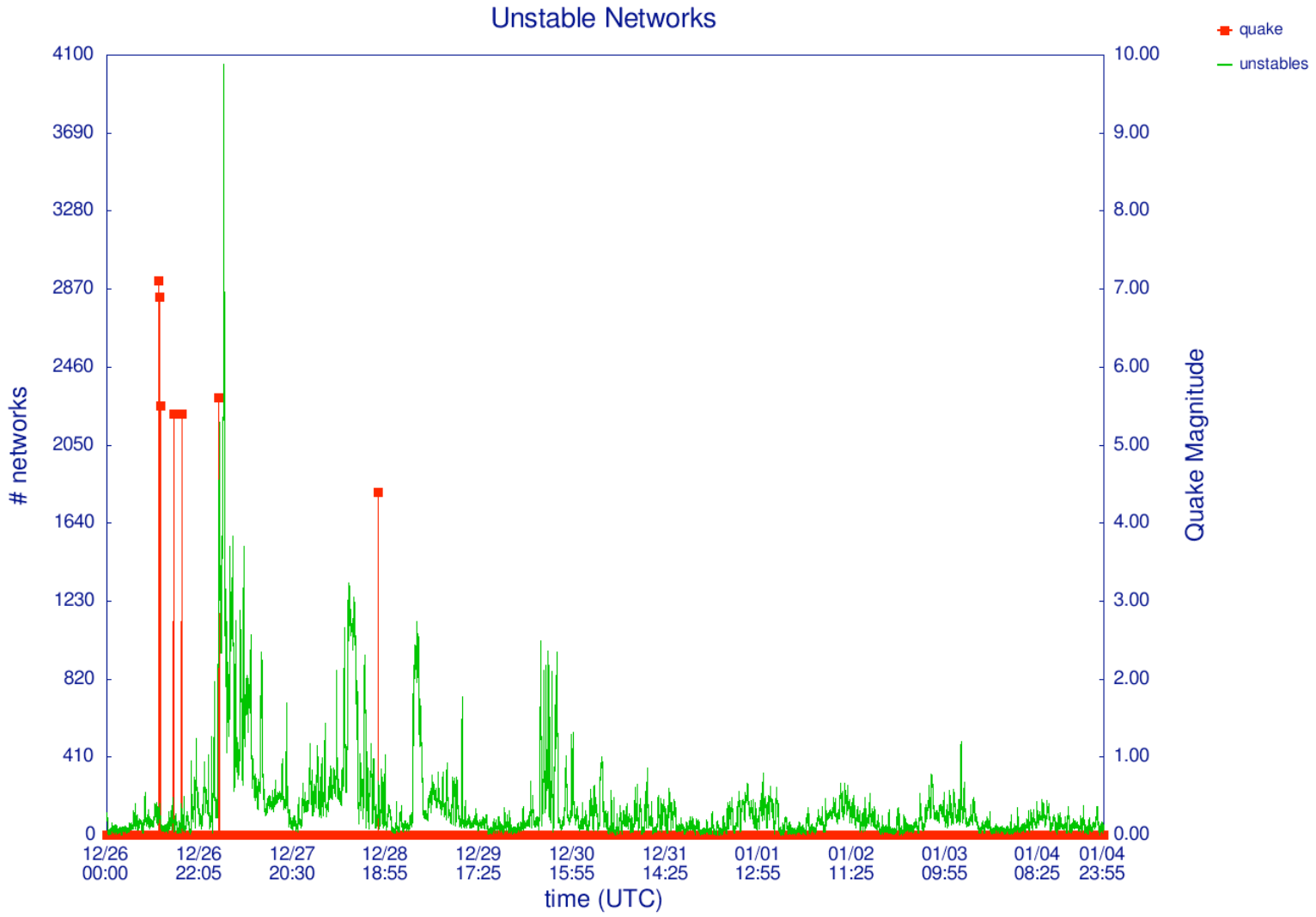
•Outages by Country – 10 Day



Outage by Origin ASN – 10 day



•Unstables & Quakes – 10 Day



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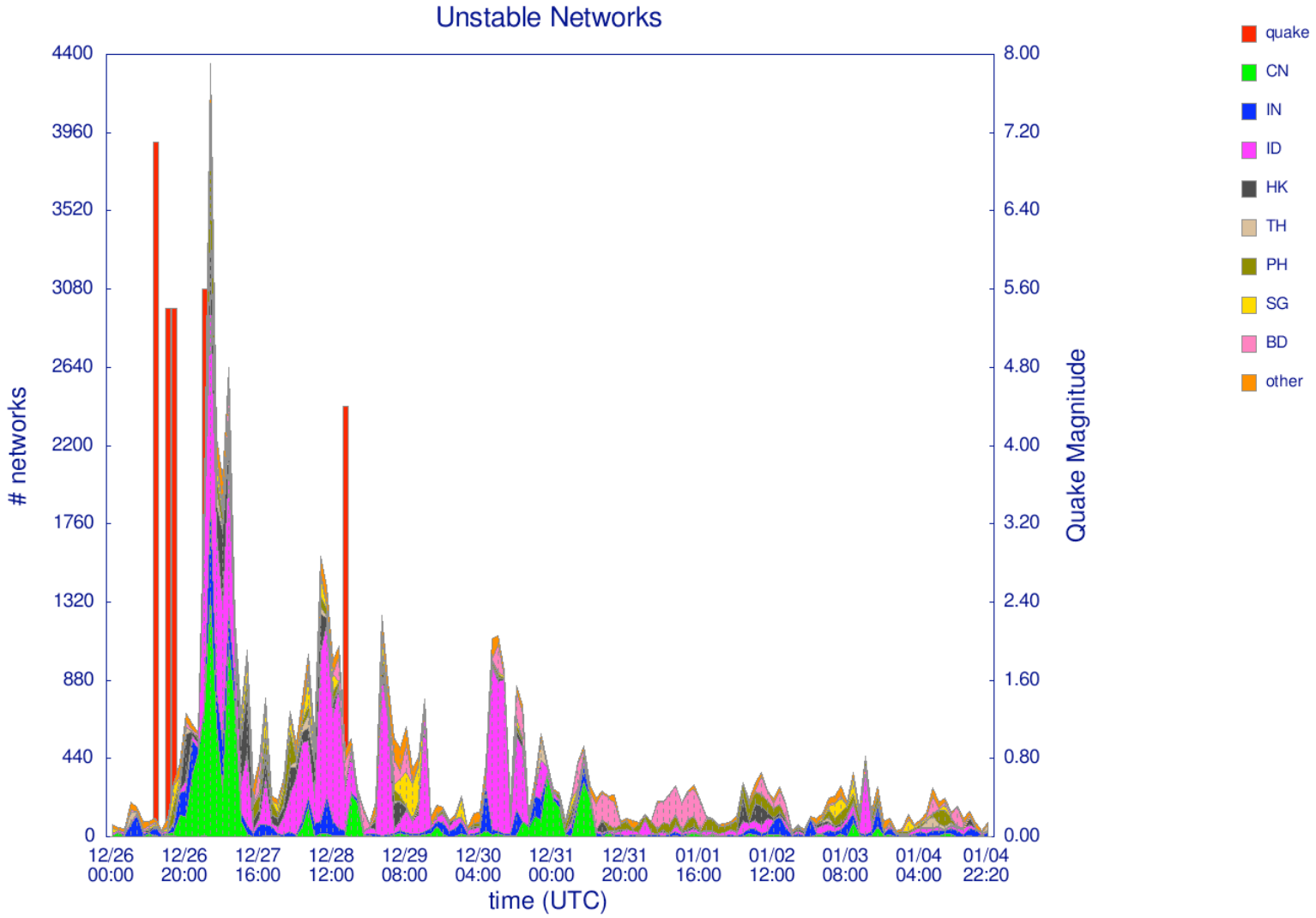
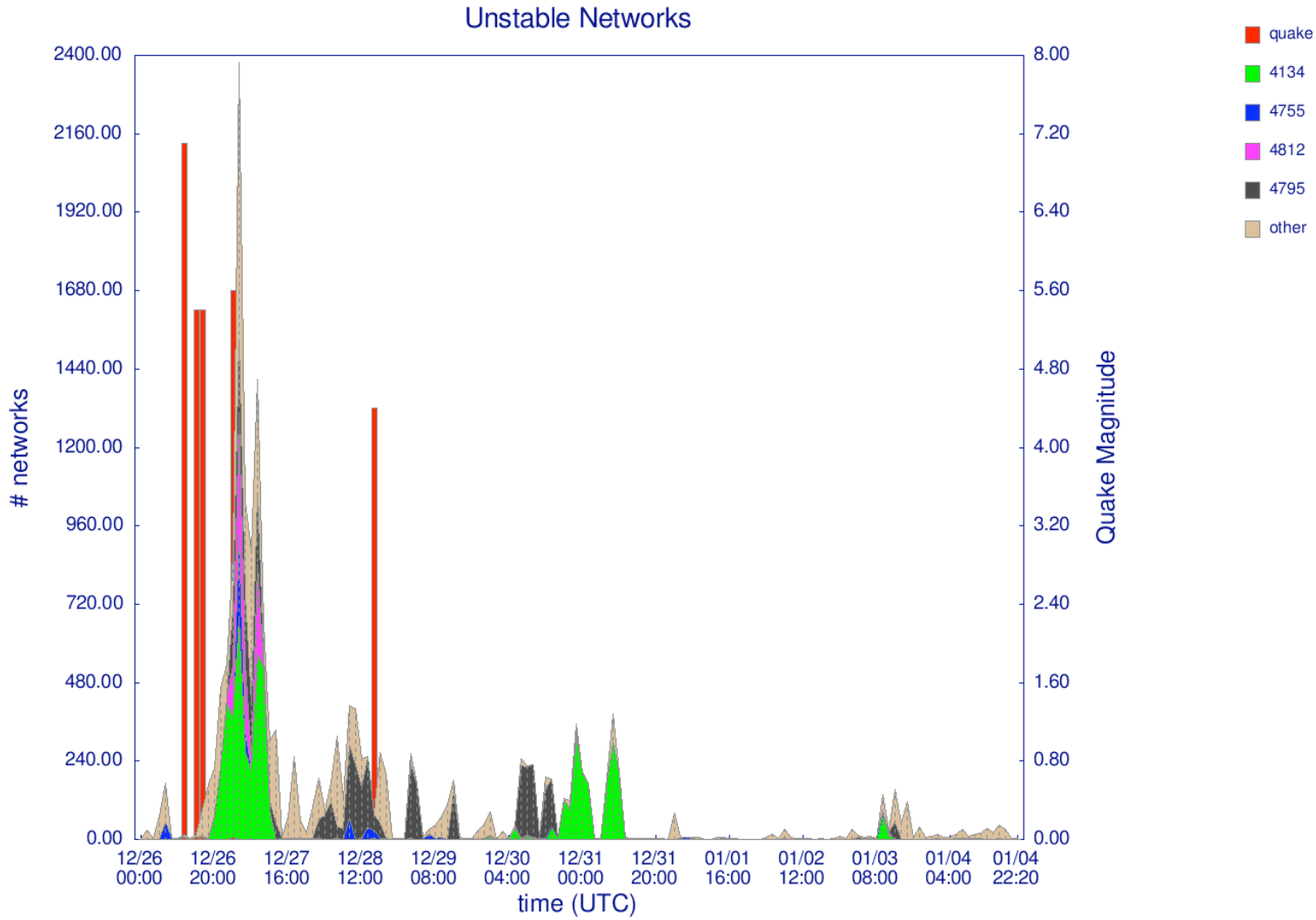


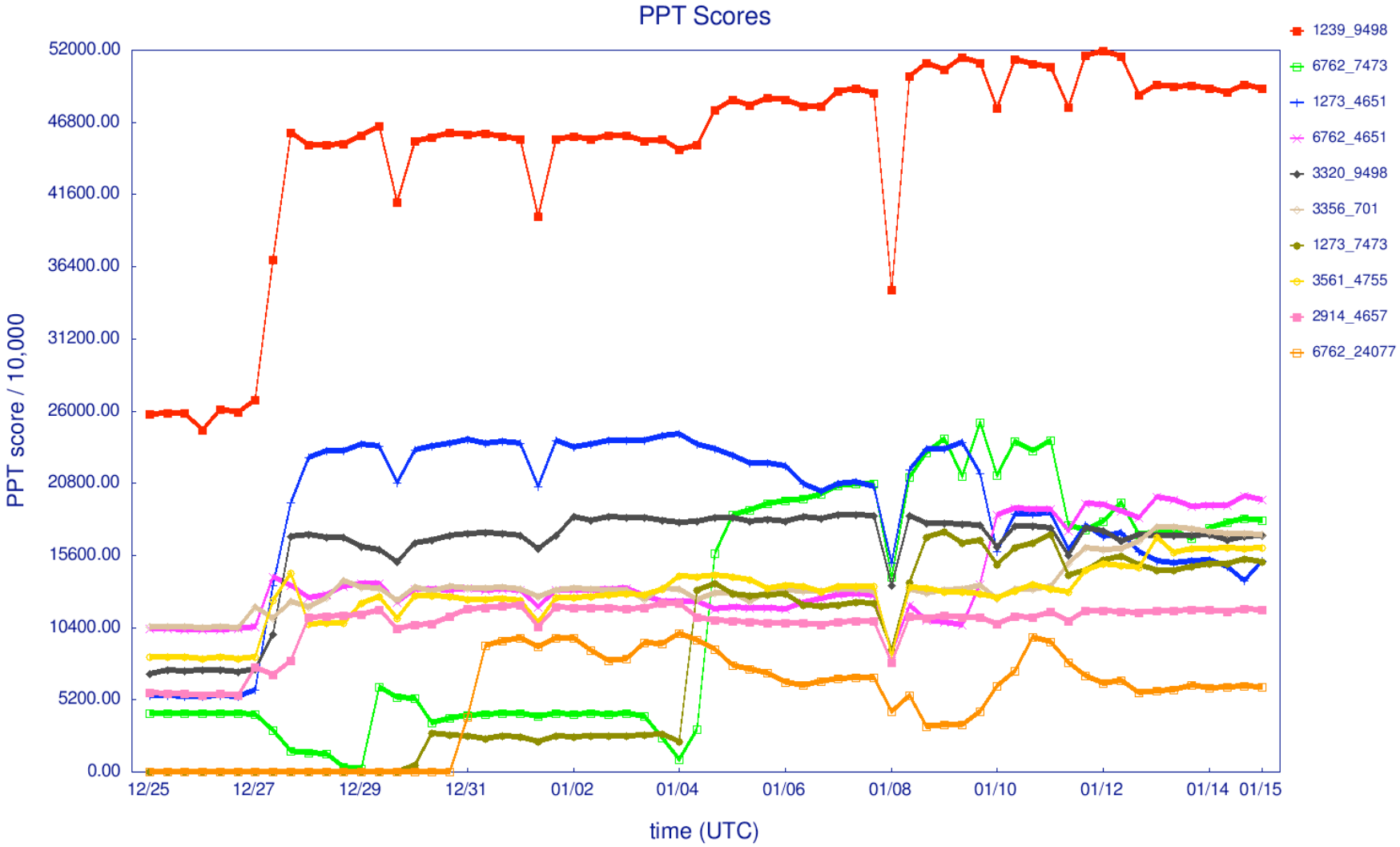
Unstables by Origin ASN – 10 day



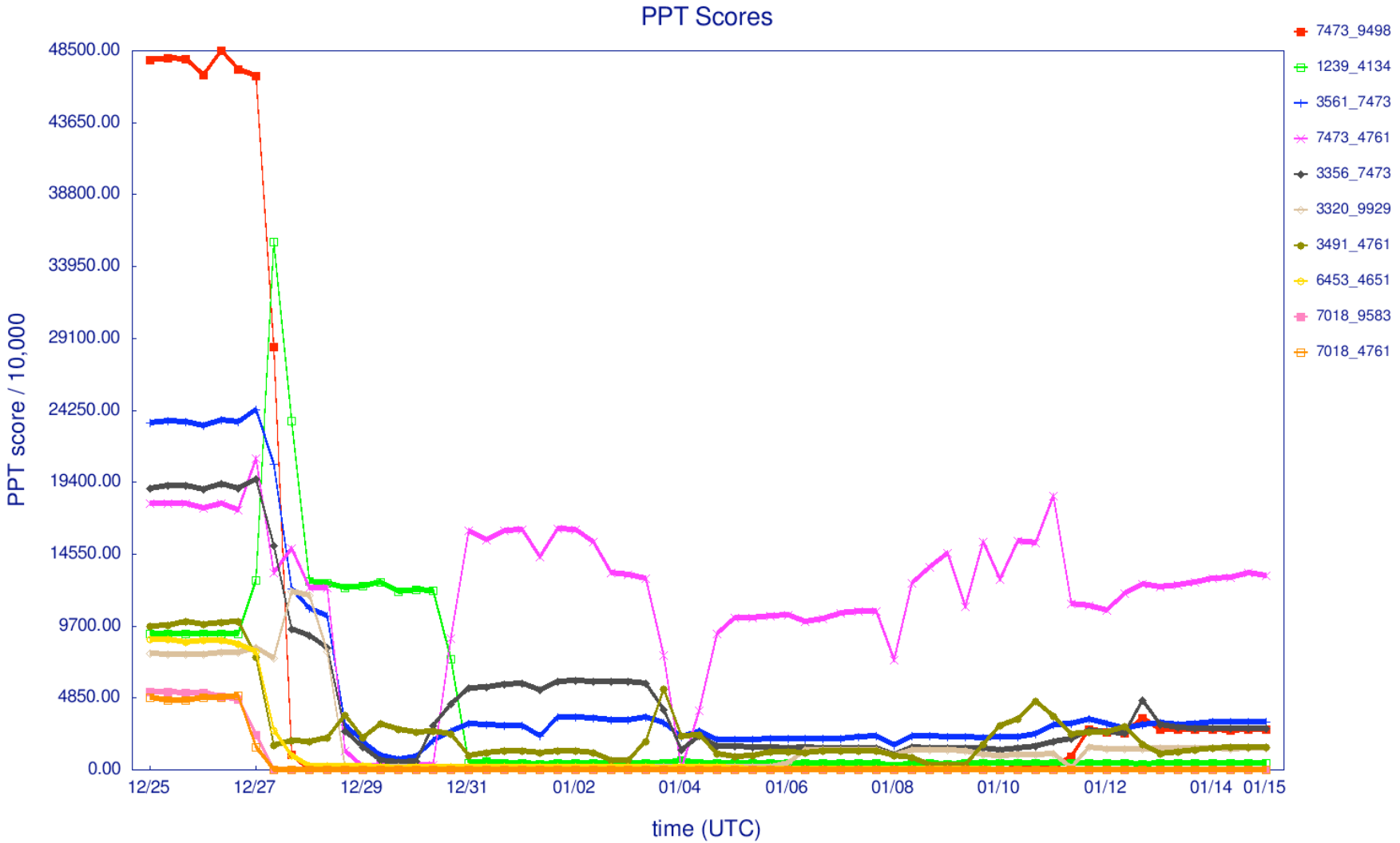
Edge Analysis

- PPT (Prefix, Peer, Time) score for each edge: for each prefix, for each peer, sum the amount of time the peer saw the prefix routed on the edge during a time interval
- Caveats:
  - All prefixes have the same weight
  - Cannot distinguish **between** an edge with a lot of prefixes seen by only few peers, **and** an edge with few prefixes seen by a lot of peers

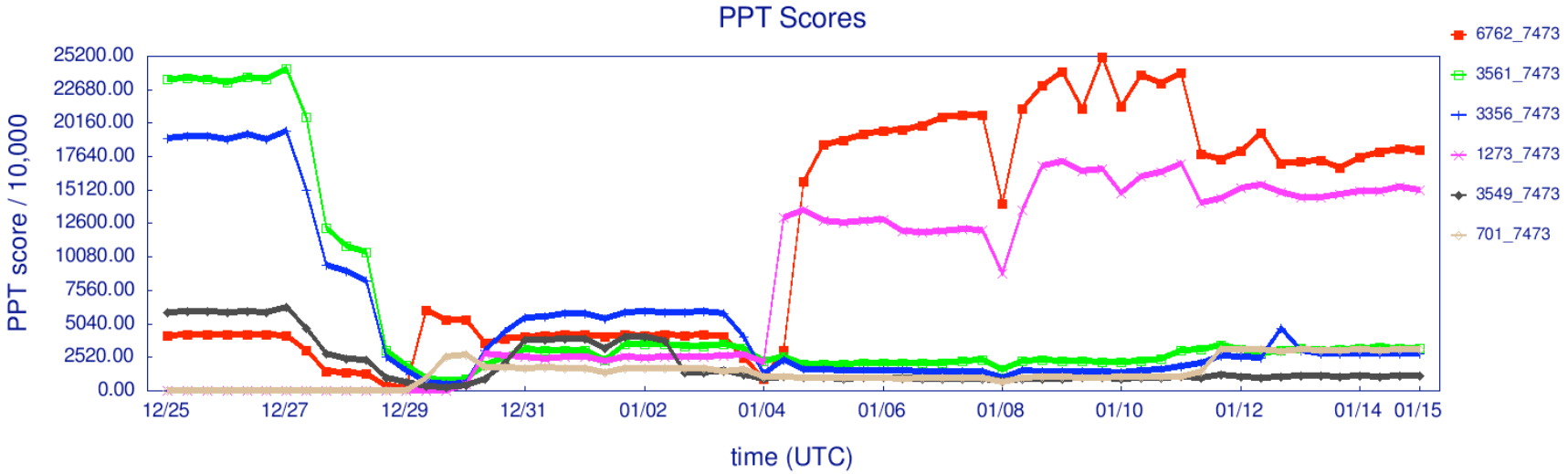
Top 10 Edge Winners

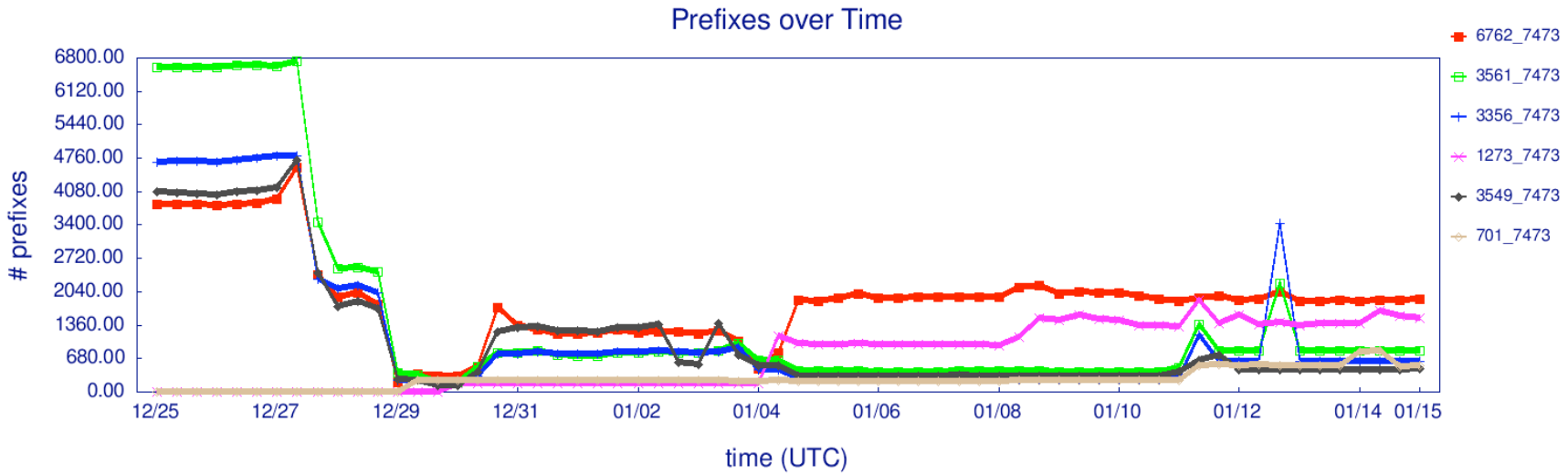


Top 10 Edge Losers

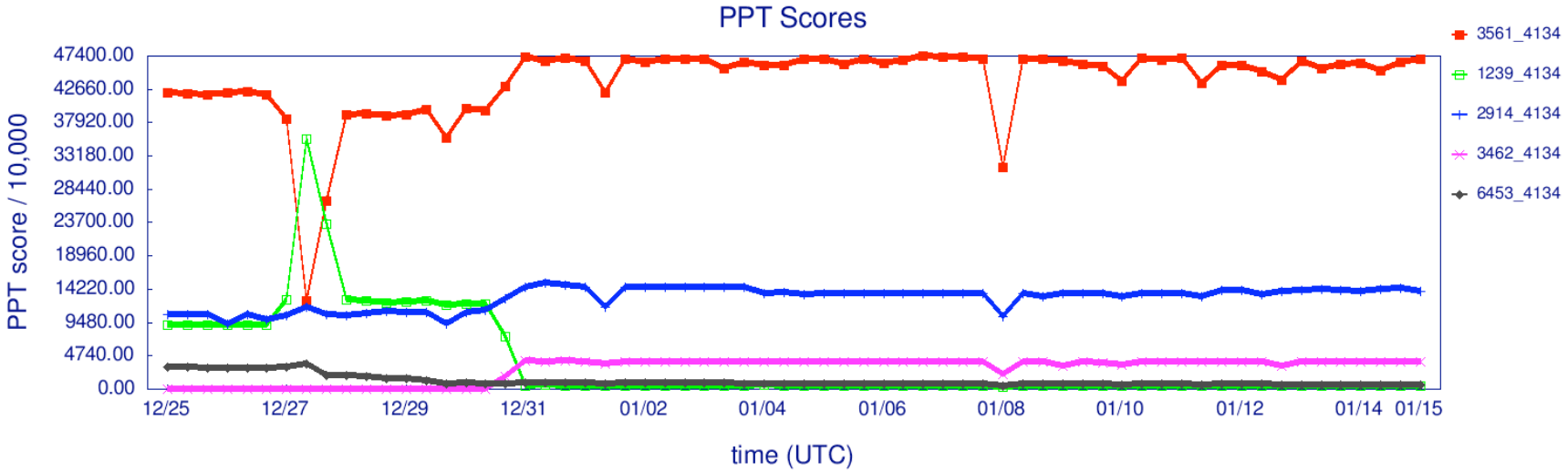


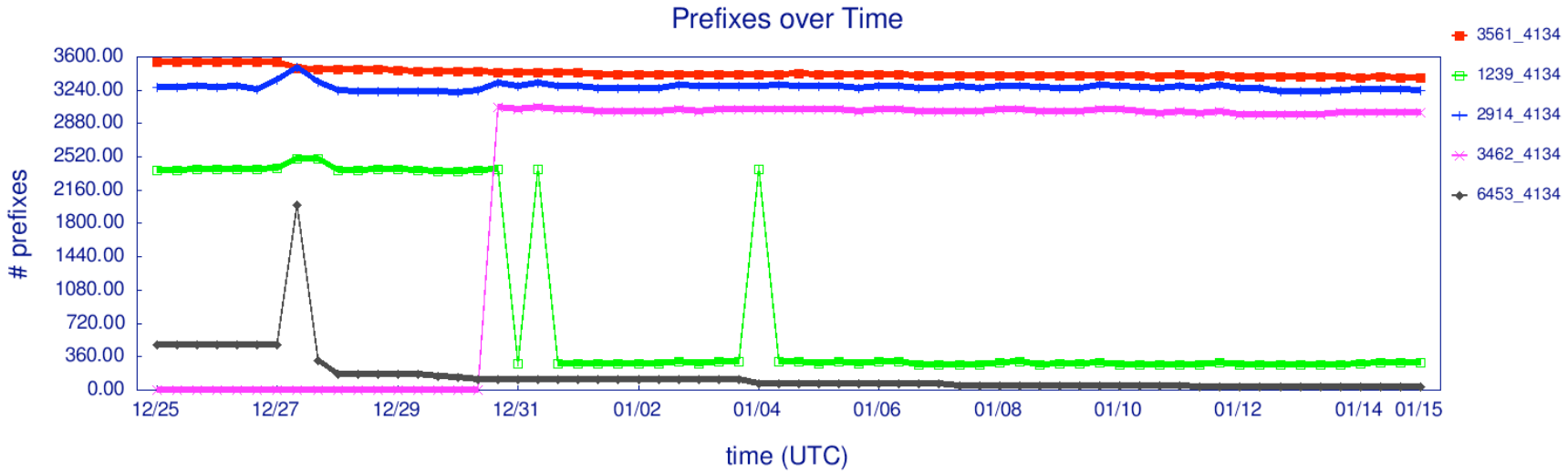
Singapore Telecom (AS7473)



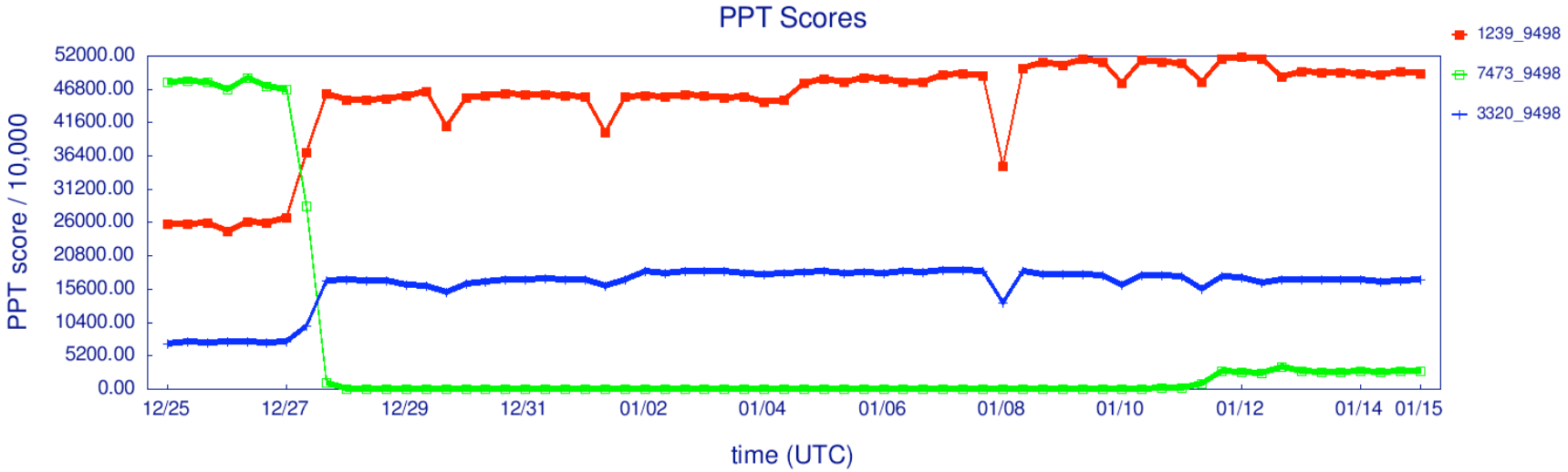


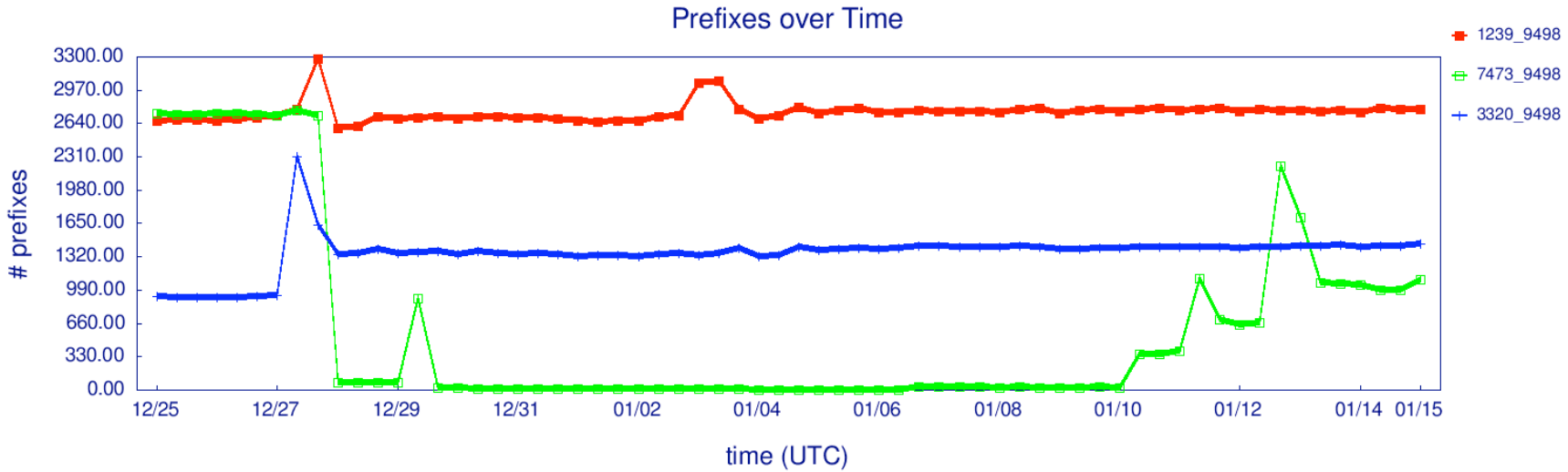
China Telecom (AS4134)



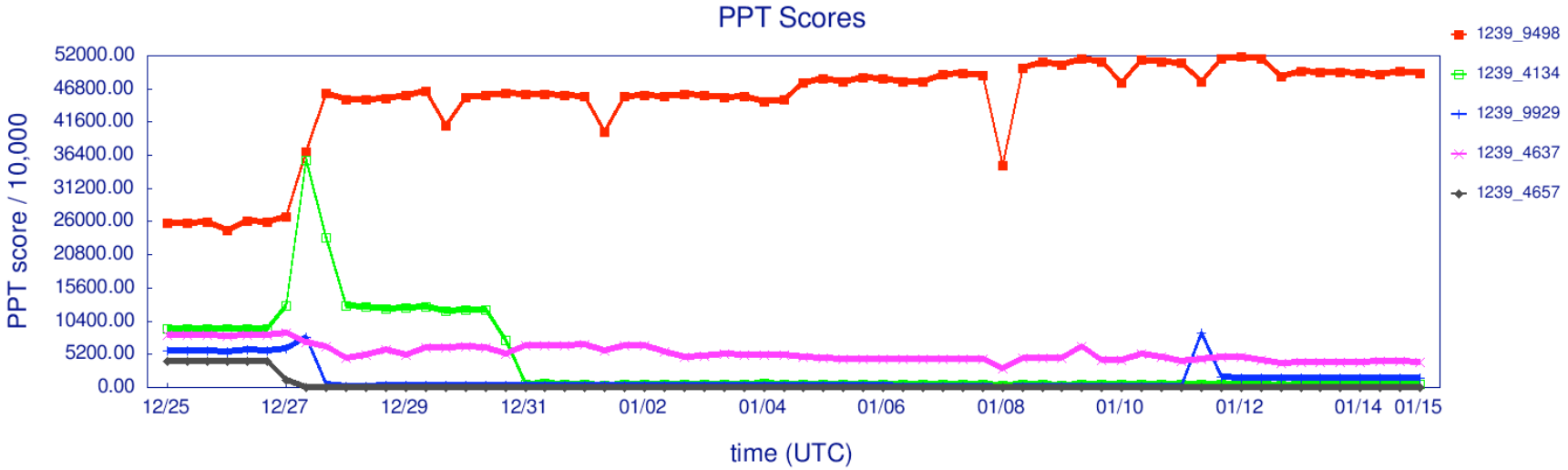


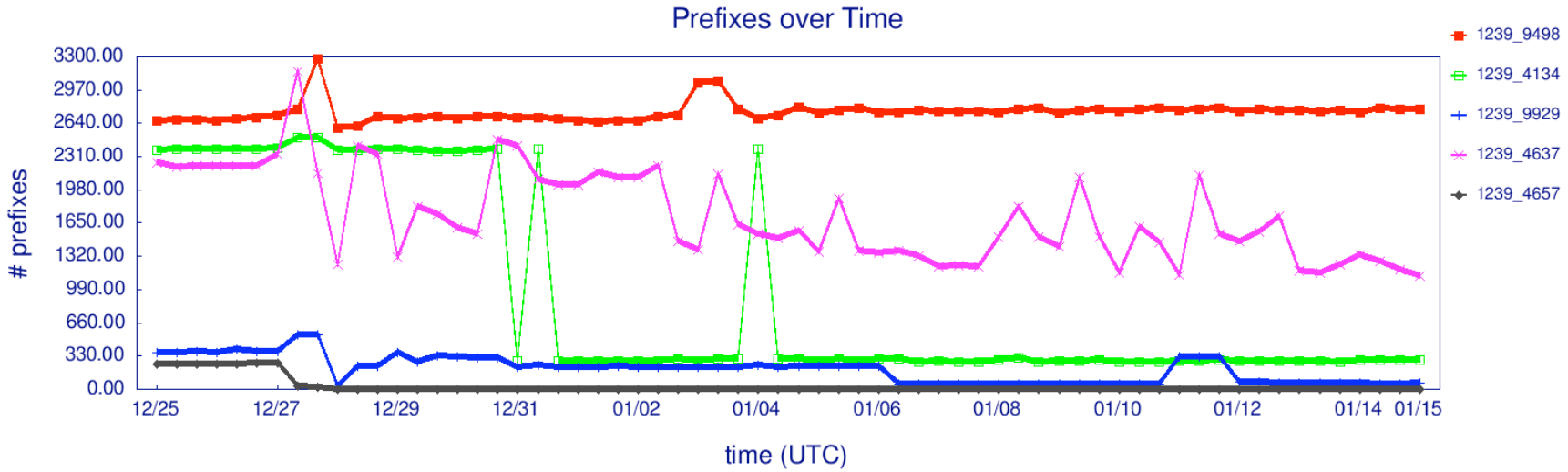
Bharti BT Internet (AS9498)



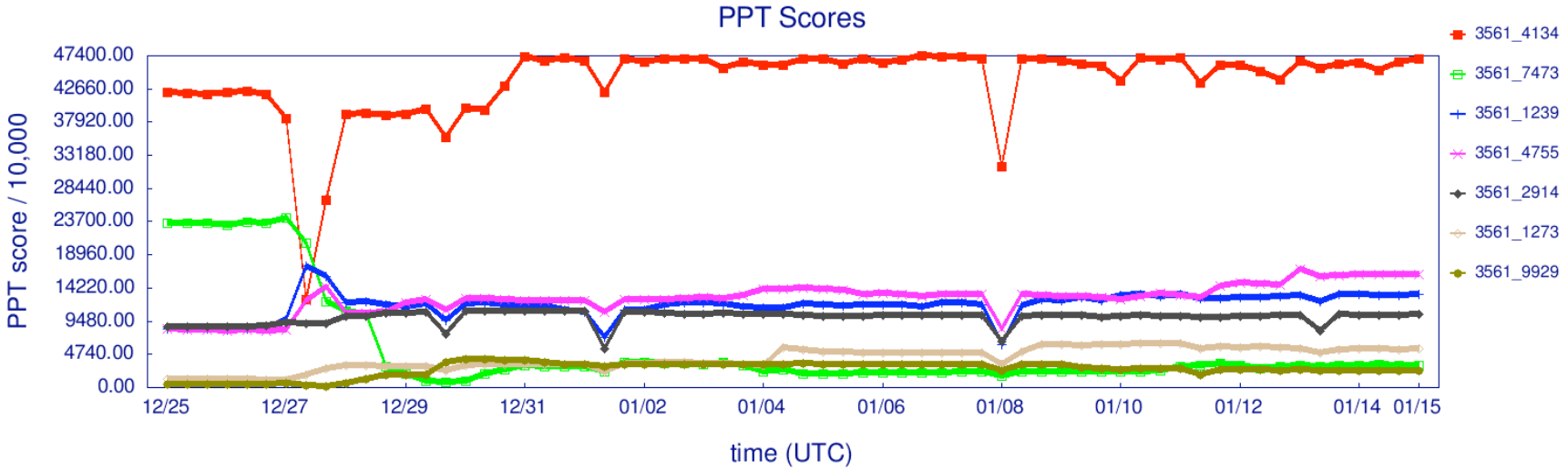


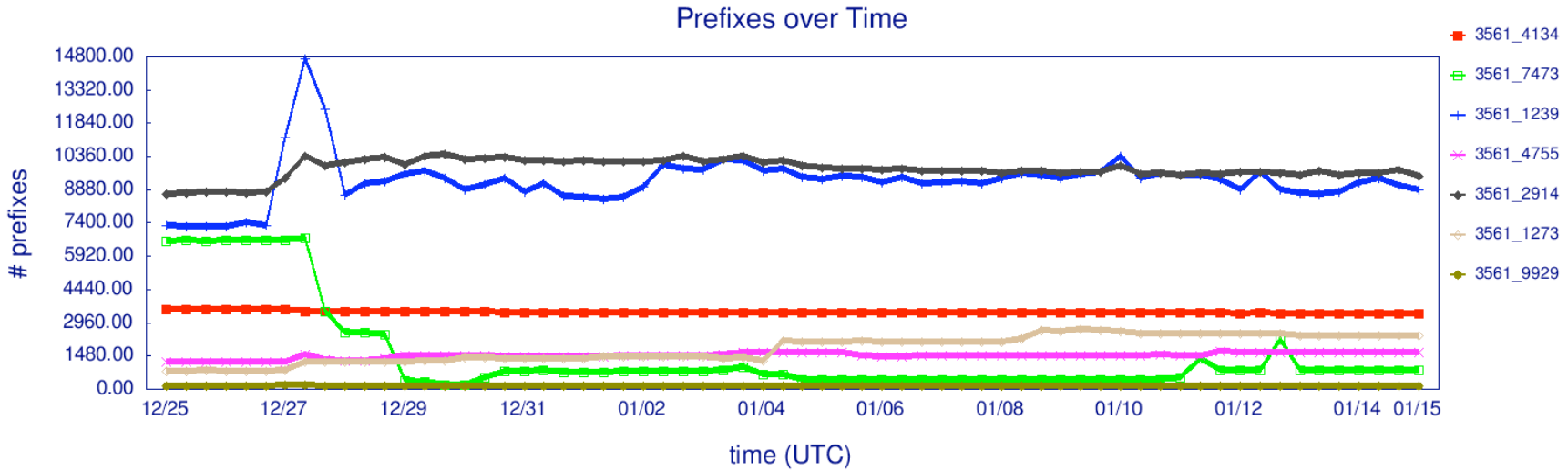
Sprint (AS1239)



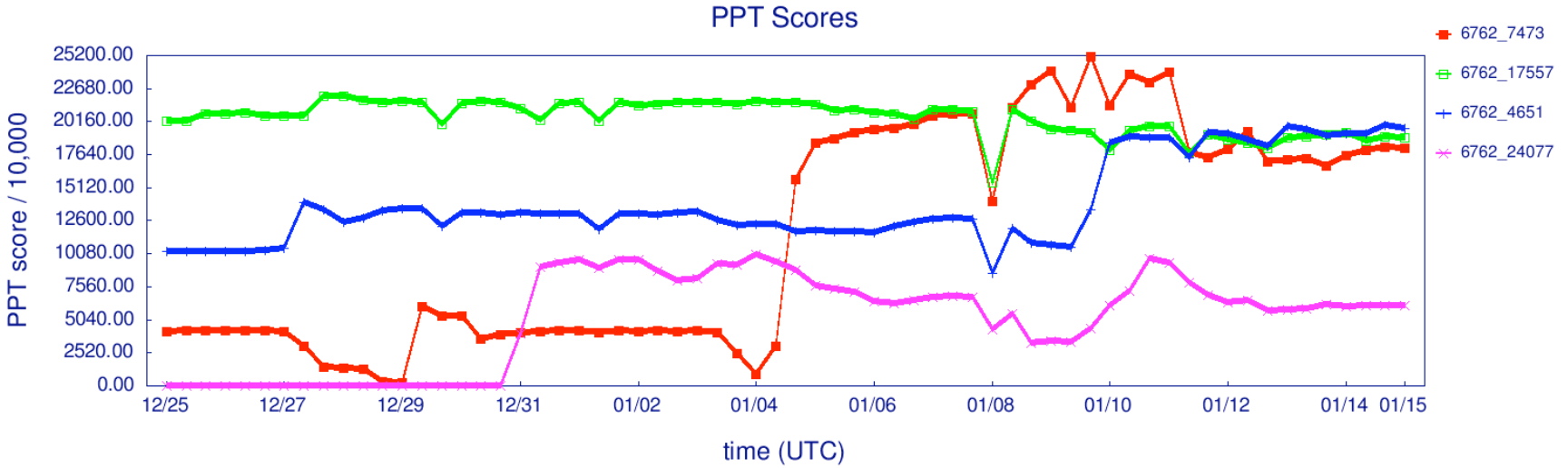


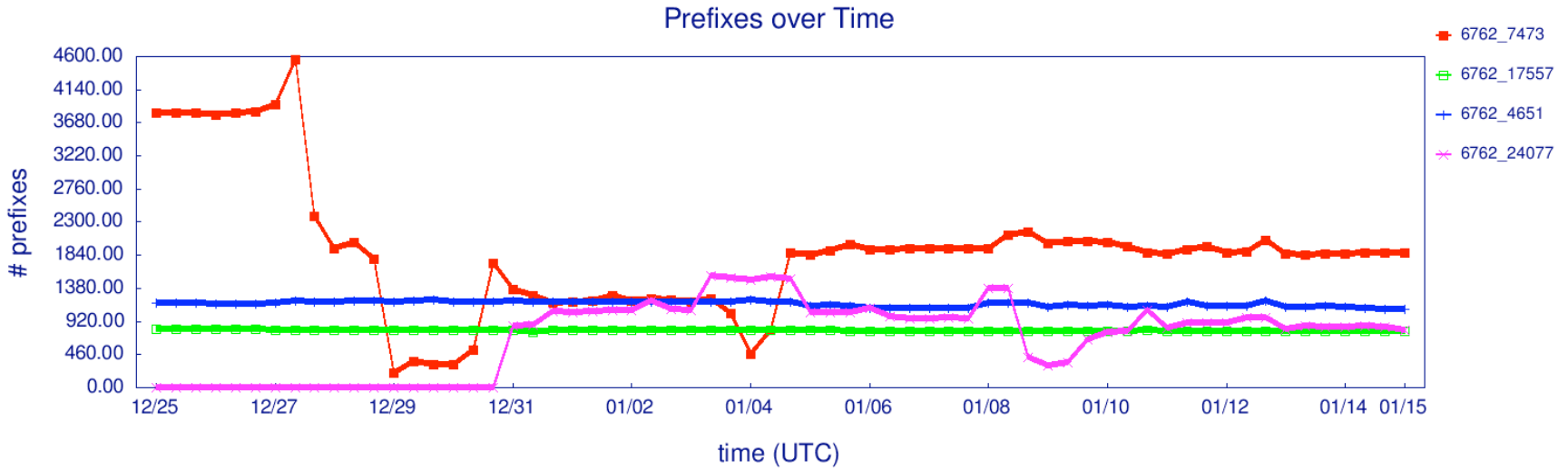
Savvis (AS3561)



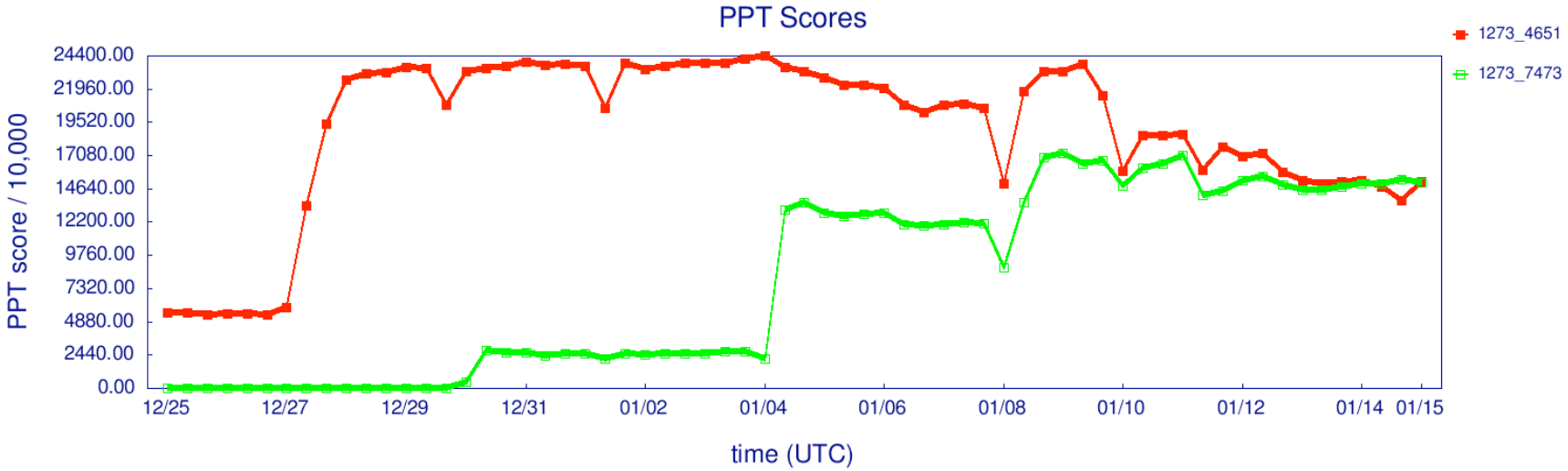


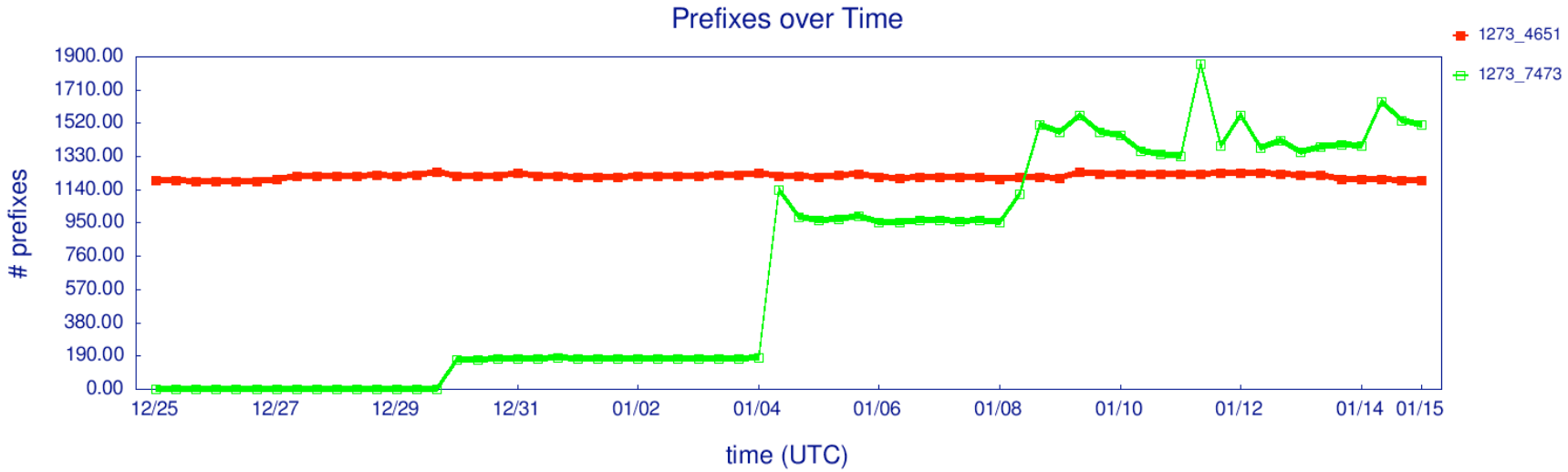
Telecom Italia (AS6762) – Winner





Cable & Wireless (AS1273) – Winner





Interesting Stories During Quake

- France Telecom (AS5511) provided temporary transit to Bharti (AS9498) from Dec 27 to Jan 5
- Indonesian routes move to INDOSAT (AS4761, AS4795) with transit mostly from DTAG (AS3320)
- China Netcom (AS9929) uses temporarily Sprint (AS1239) and DTAG (AS3320) as transits then drops them in favour of UUNet (AS701) and Savvis (AS3561)
- China Telecom (AS4134) routes move temporarily from Savvis to Sprint on Dec. 27

Interesting Stories After Quake

- Telecom Italia (AS6762) and Cable & Wireless (AS1273) are big winners adding Singapore Telecom (AS7473) and the Communication Authority of Thailand (AS4651) as customers
- Sprint (AS1239) gets to China Telecom (AS4134) through HiNet (AS9680) and Chunghwa Telecom (AS3462), i.e., 1239 9680 3462 4134

Conclusions

- Quake illustrates fragility of the global Internet
  - Ø “Local” events can have broad impact
  - Ø Physical failures can be difficult to remedy
- Asia is particularly vulnerable
- Impact will be felt long after the repairs are complete
  - Ø New business relationships
  - Ø New cable systems
  - Ø Renewed interest in redundancy

Thank You

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