# Quaking Tables:

## The Taiwan Earthquakes and the Internet Routing Table

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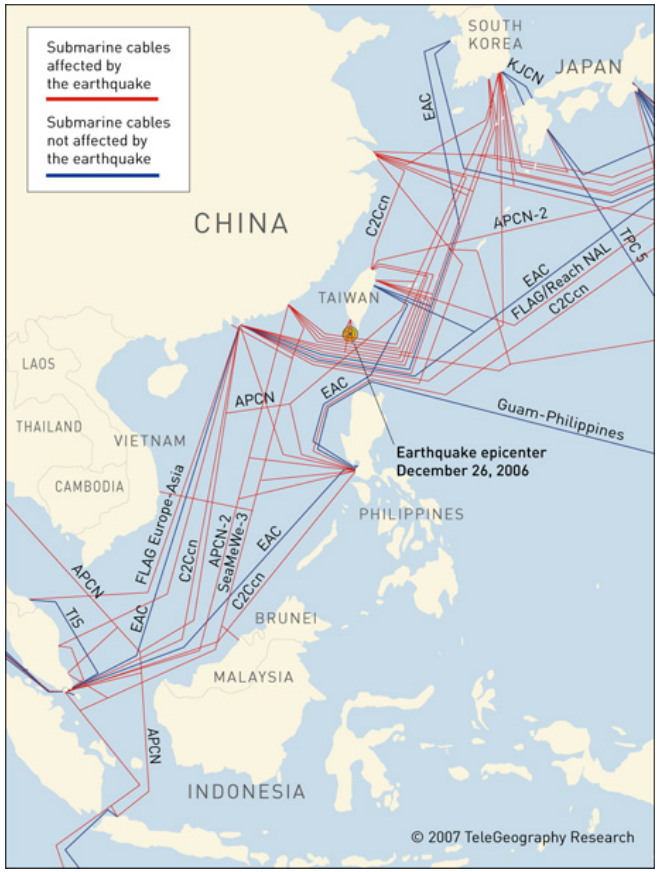
# Overview

- 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)

# Definitions: Outage, unreachable, unstable

- A **network outage** occurs when routes to the network are withdrawn by a large number of BGP routers worldwide.
- In this case if no less specific route is available, the network is **unreachable** and effectively disconnected from all or parts of the Internet.
- **Unstable networks** are not completely disconnected, but show frequent changes in network routing paths or alternating announcements and withdrawals (**route flapping**) – serious packet losses.

# Timeline

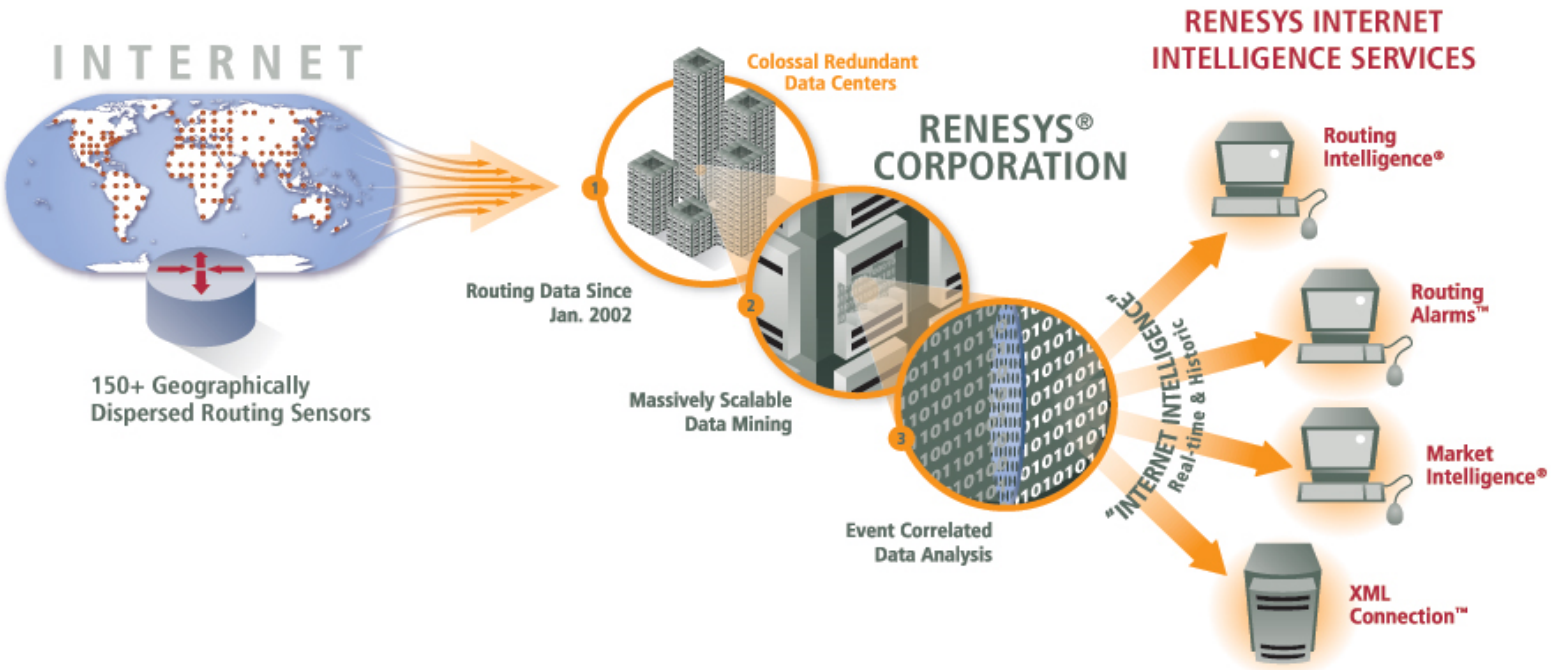
- Six earthquakes of magnitude 5.0 or higher hit the Taiwan region (all times UTC):
  - **12/26 12:26:21** **7.1** -- main quake
  - 12/26 12:34:14 6.9
  - 12/26 12:40:22 5.5
  - 12/26 15:41:44 5.4
  - 12/26 17:35:10 5.4
  - 12/27 02:30:39 5.6
  - 12/28 16:51:16 4.4
- Outaged prefixes ramp up from 400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

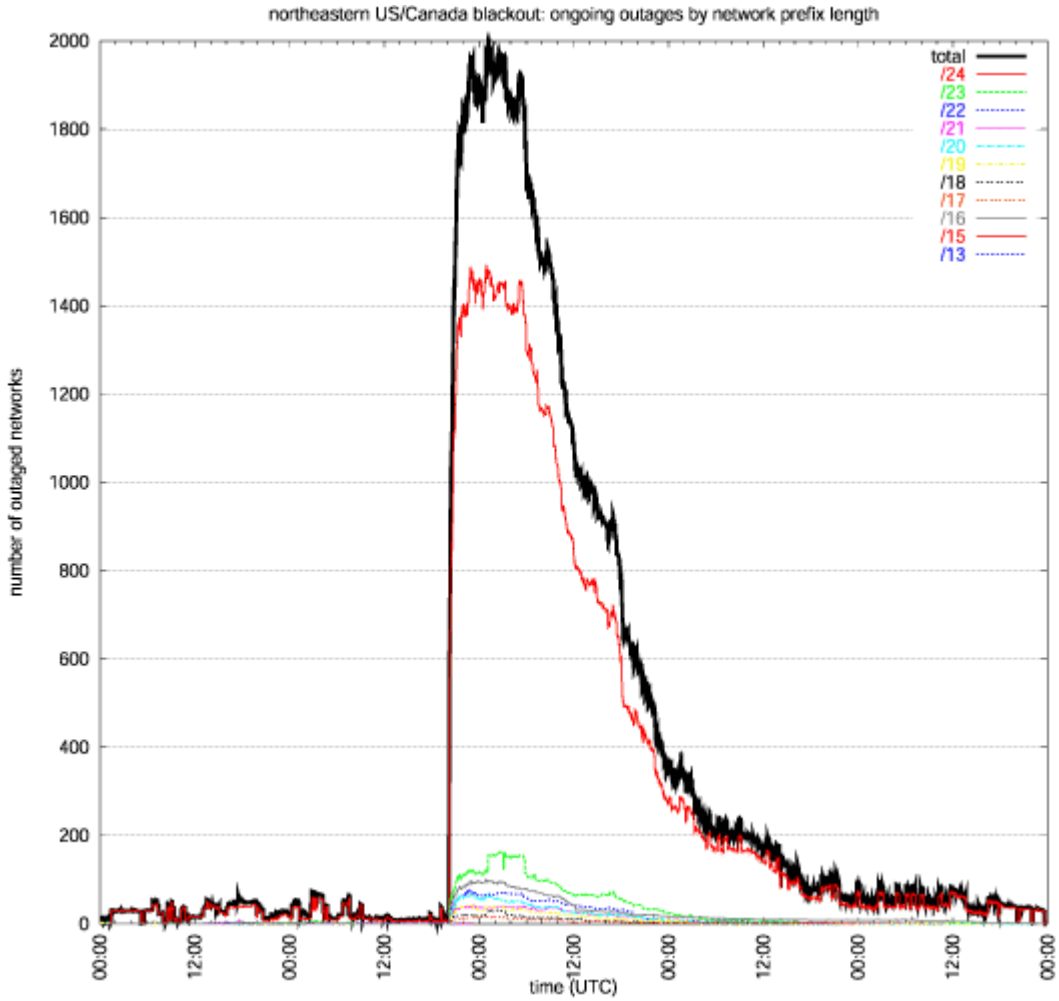
- 165+ peering sessions from 105+ different ASNs
- In this talk, we focus on East Asian prefixes only



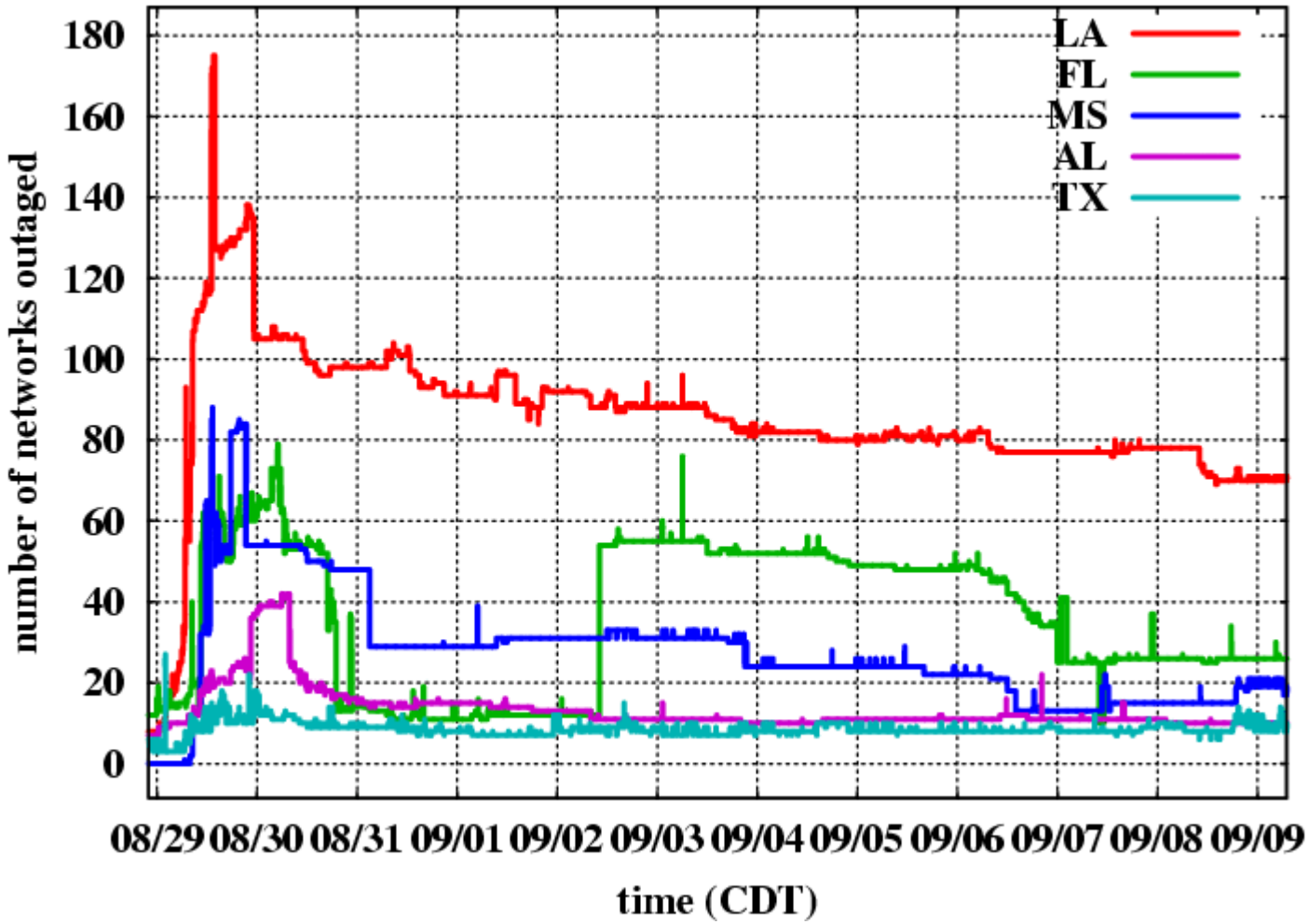
# •Disasters Have Signatures

- 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)



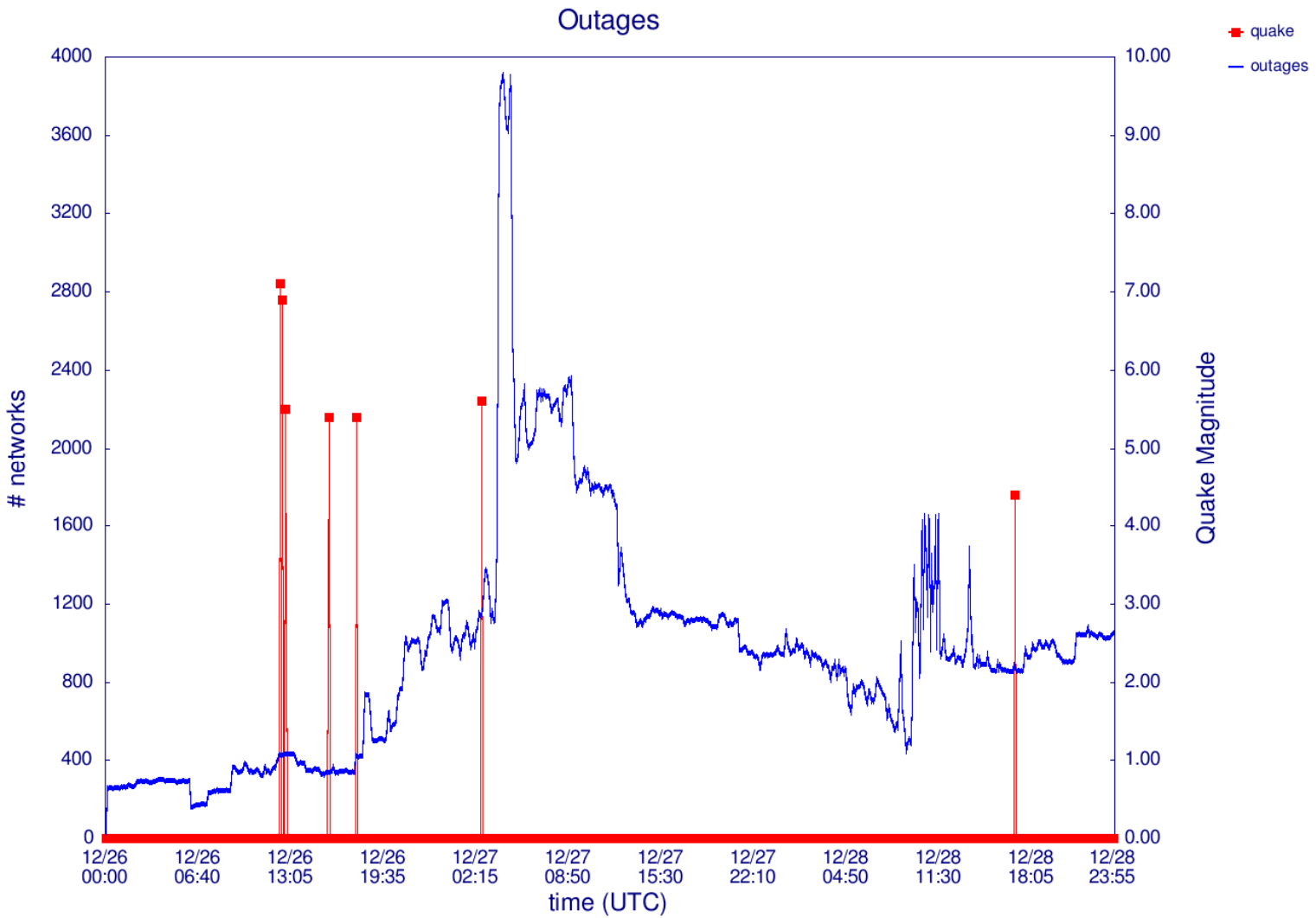
# •Hurricane (Katrina, 2005)



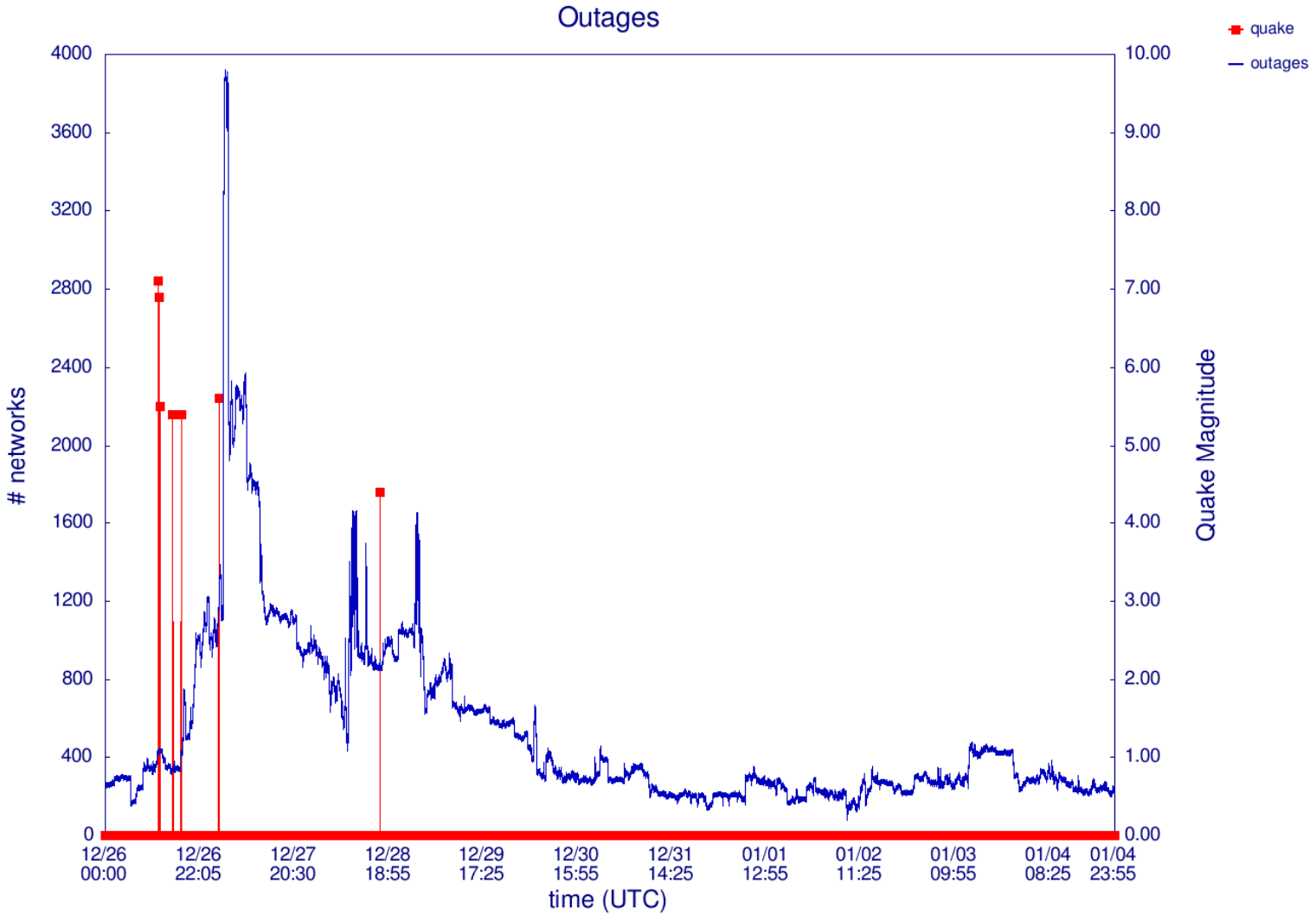
# The Pattern of the Taiwan Quakes

- 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.

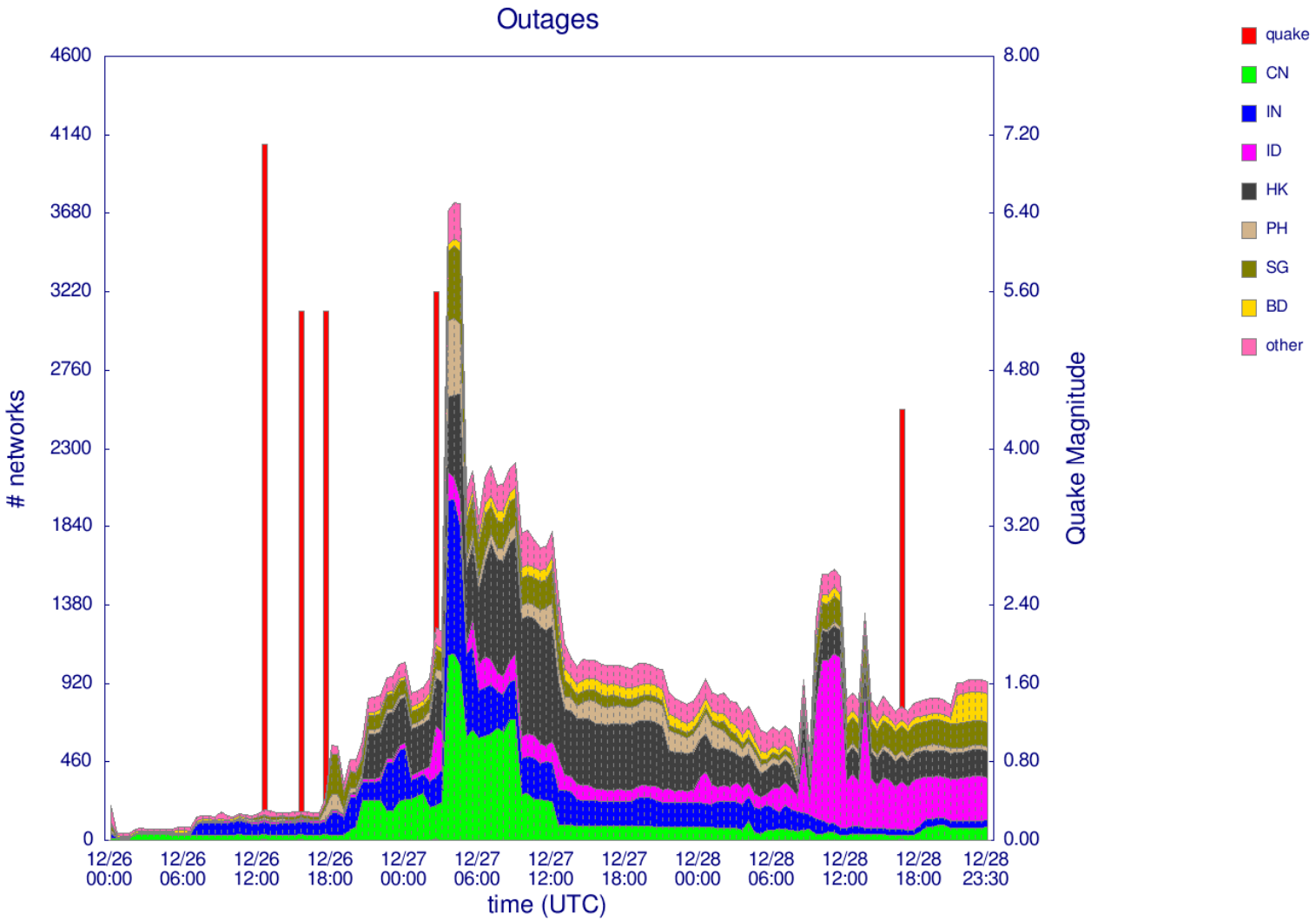
# •Outages & Quakes – 3 Day



# •Outages & Quakes – 10 Day



# •Outages by Country – 3 Day



# Why India?

## *Major subcontinent bandwidth heads East*

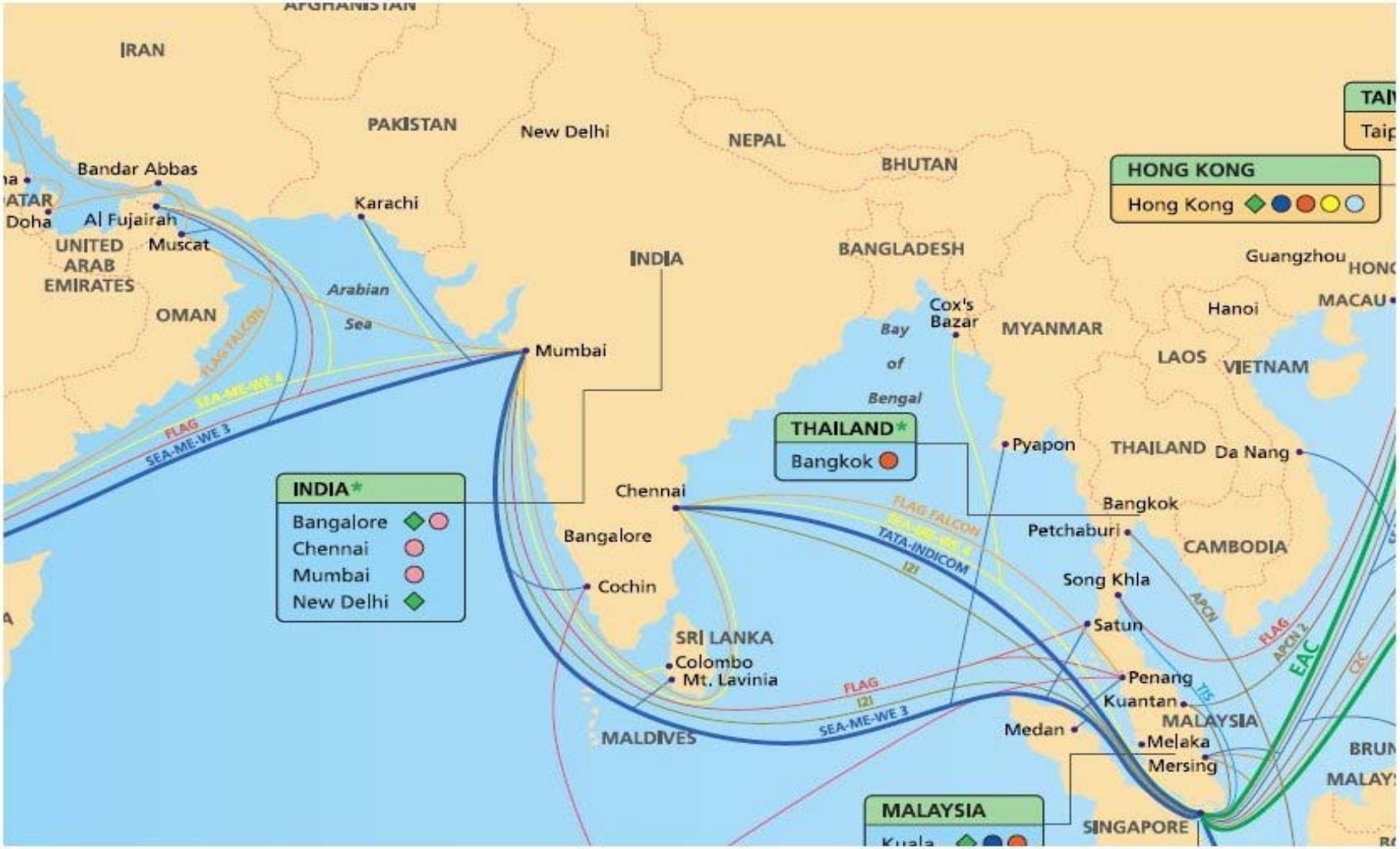



Image credit: Asia Netcom

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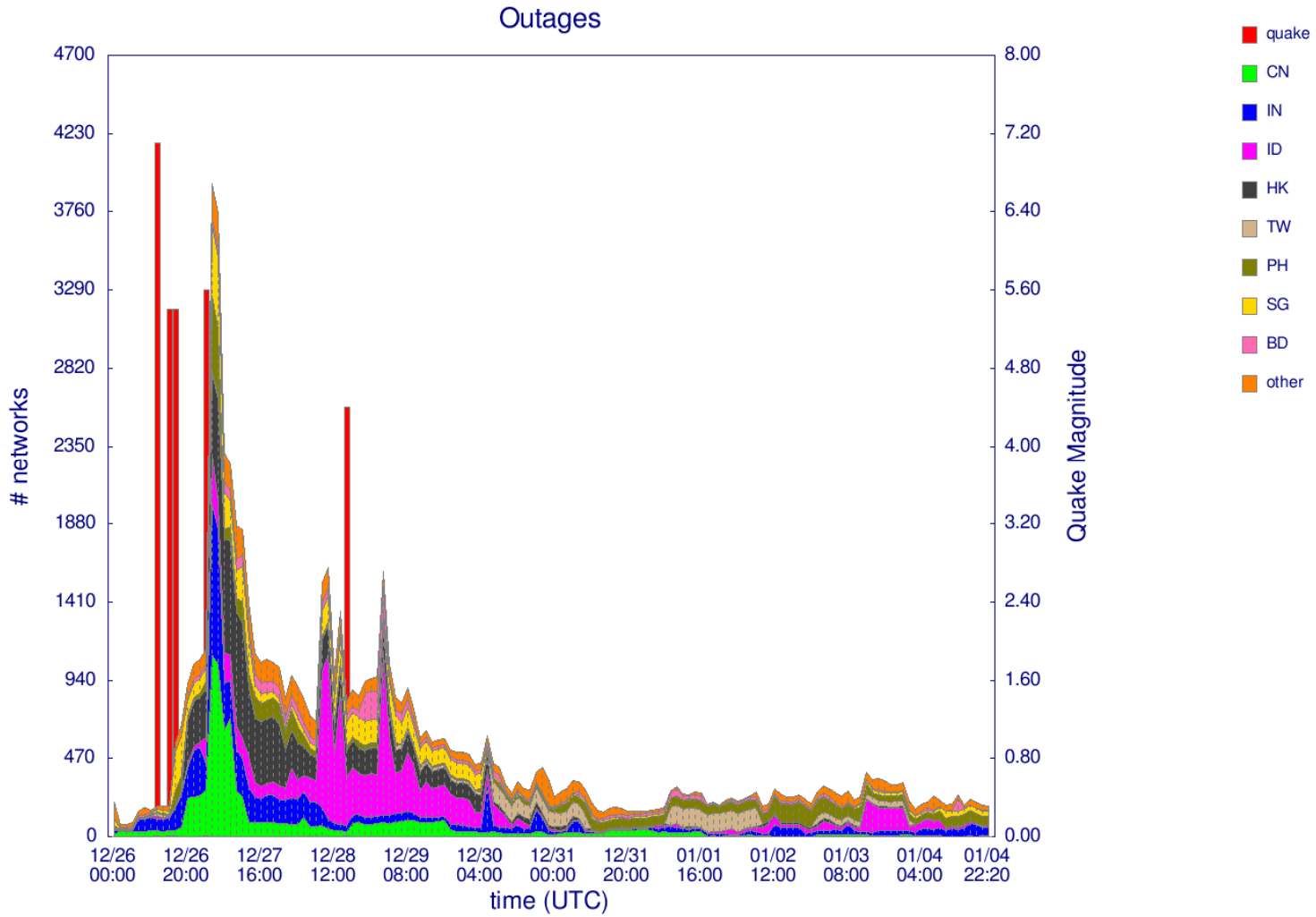
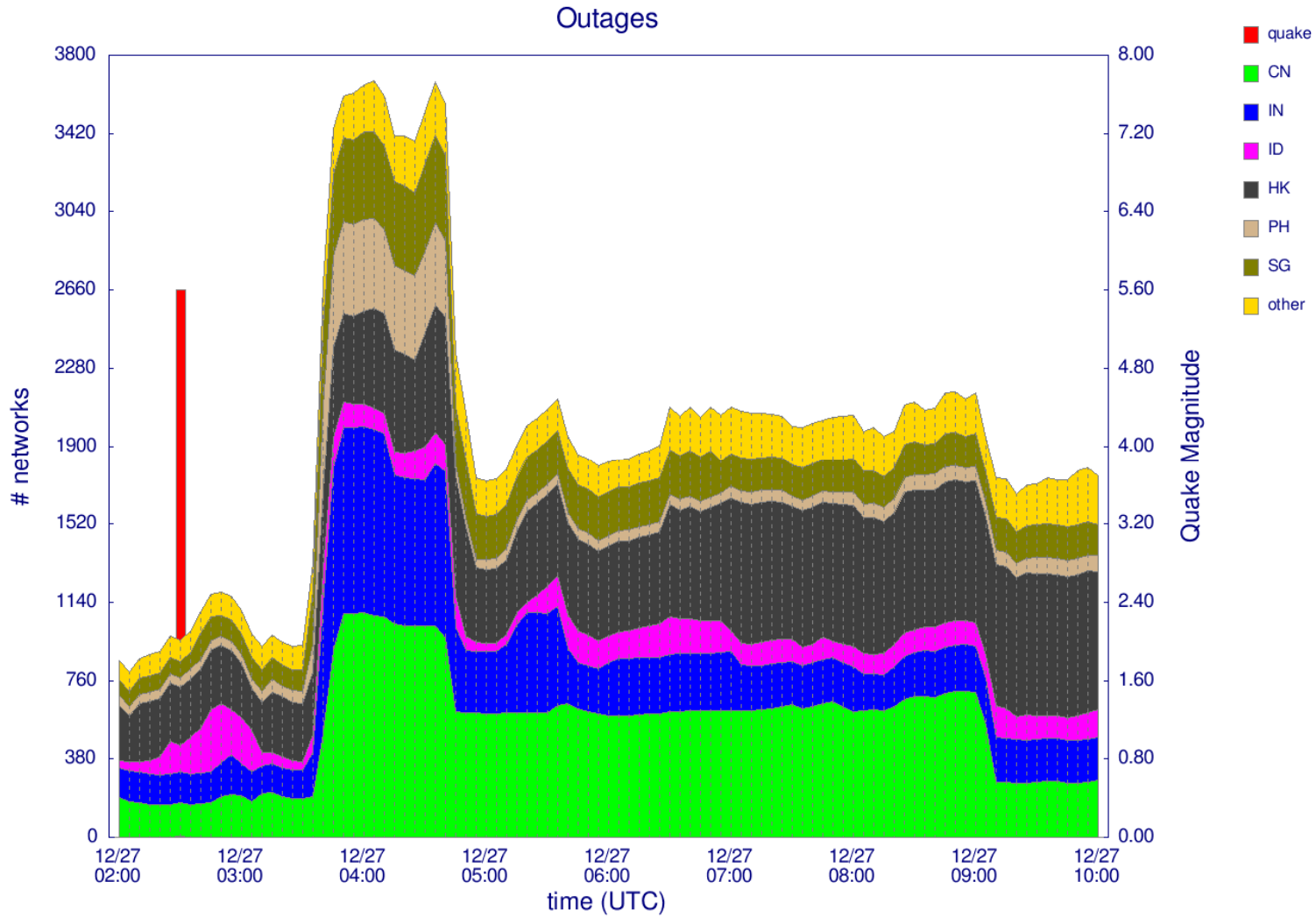


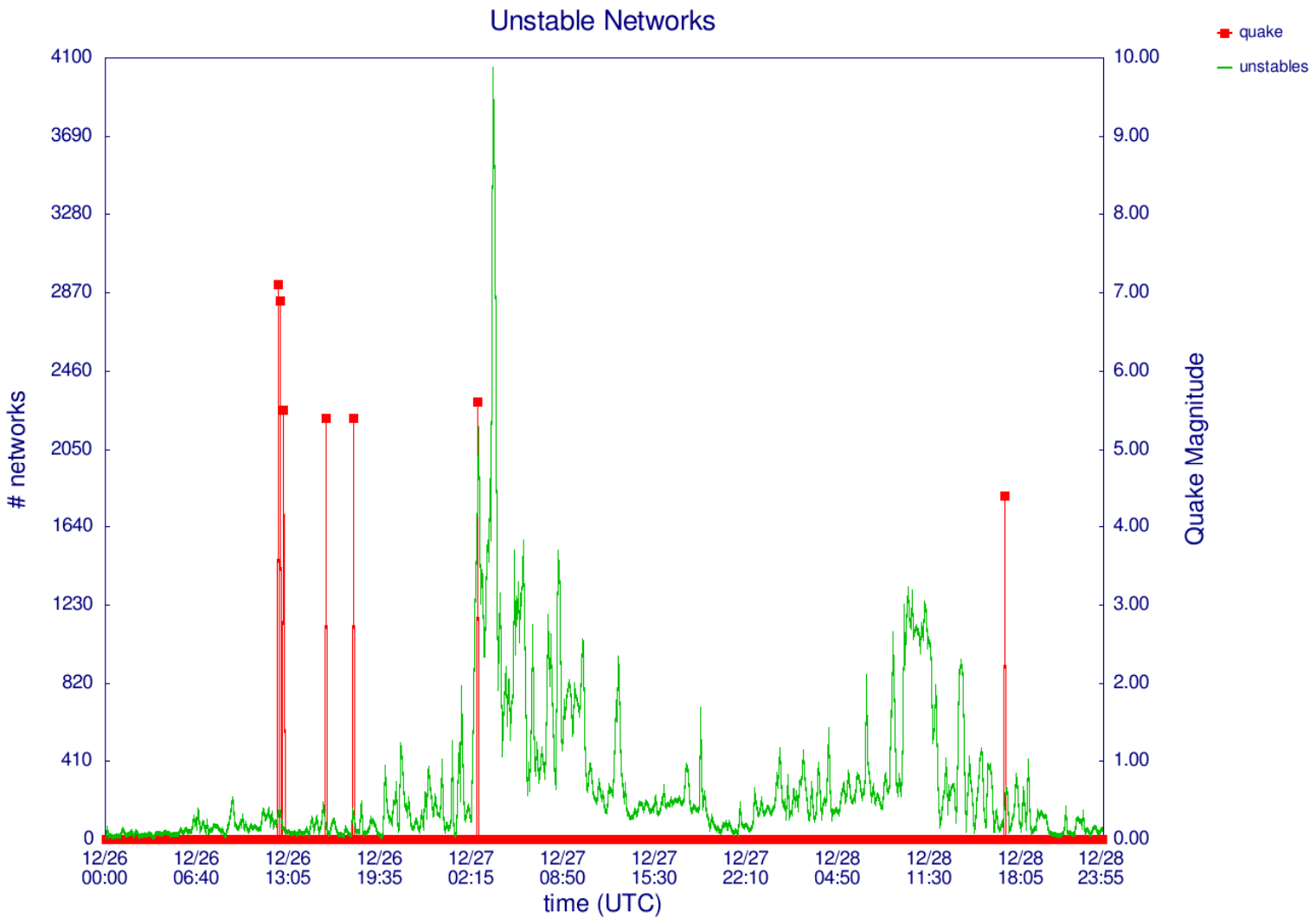
# •Outages by Country – Peak



# •Instability Metrics

- Use algorithm described in http://www.nanog.org/mtg-0402/ogielski.html
- PenaltyBox(T,K,H,C): the number of globally routable prefixes at time T that have flap penalty K, using the classic flap dampening algorithm with half-life of H and ceiling of C.
- Reasonable: H=600s, C=15, K={0,…,C}.
- (Basically flap-dampening algorithm for scoring the “penalty” of a prefix).
- **Shown in graphs are pfxs w/ inst >= 3**

# •Unstables & Quakes – 3 Day



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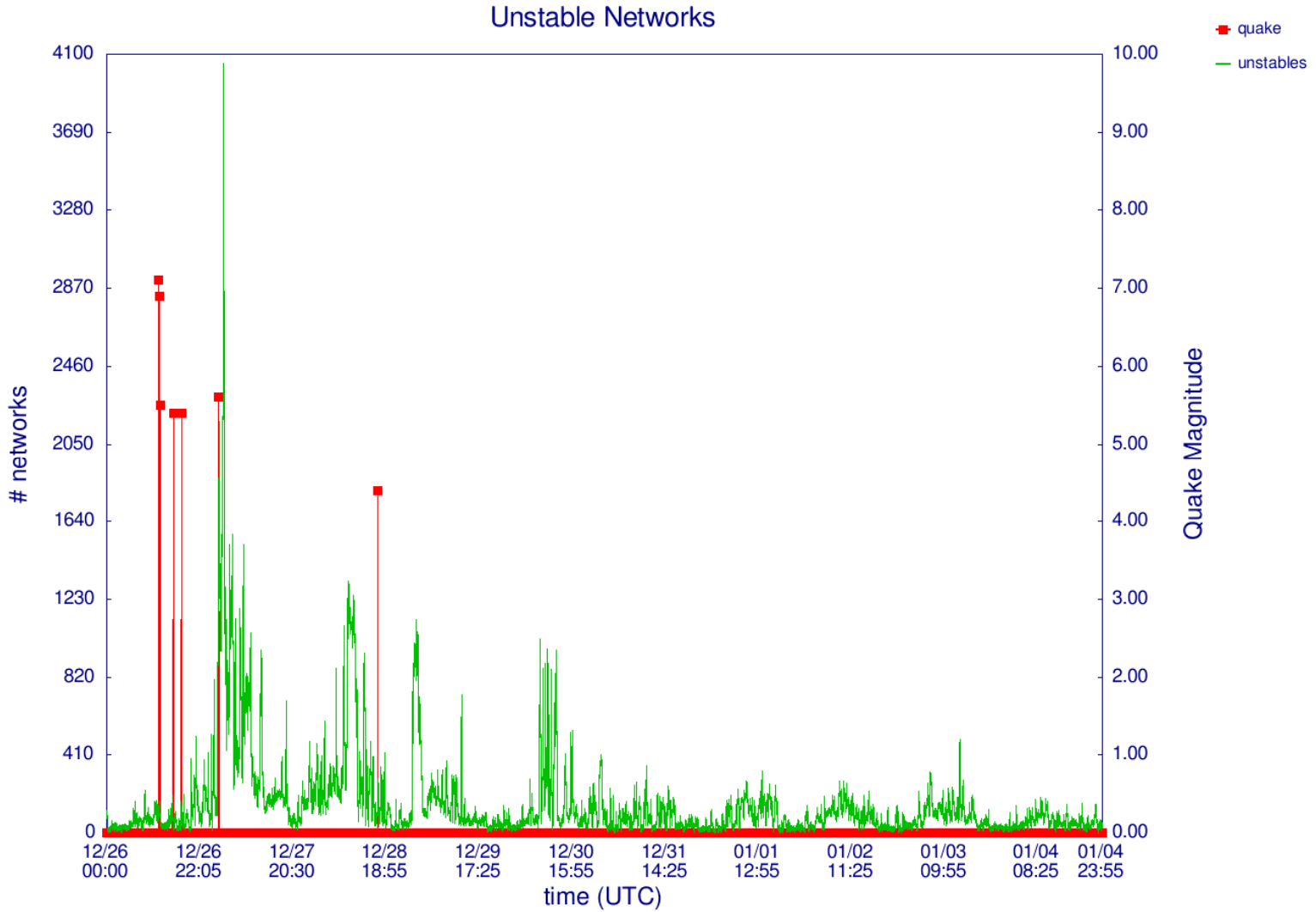

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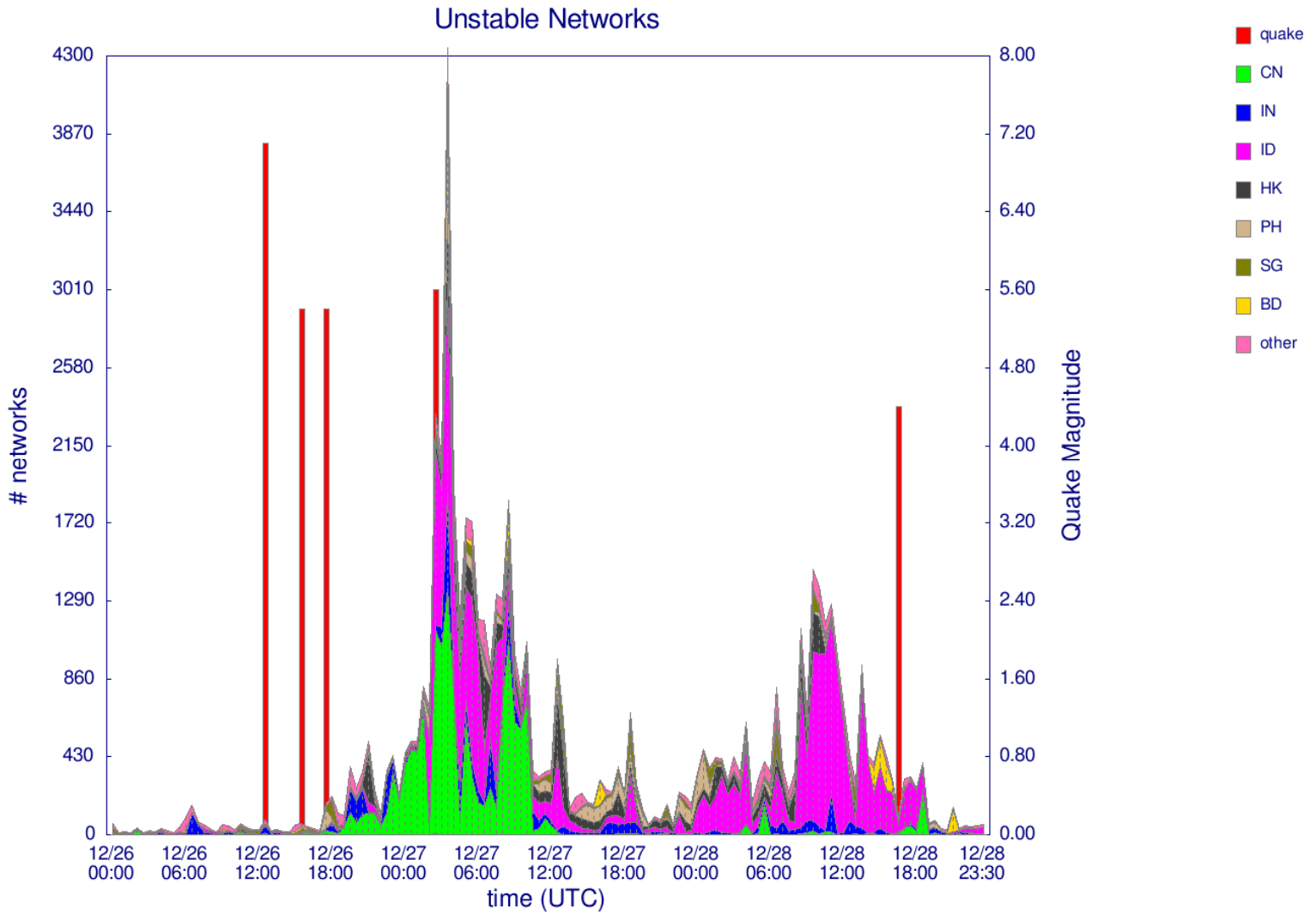

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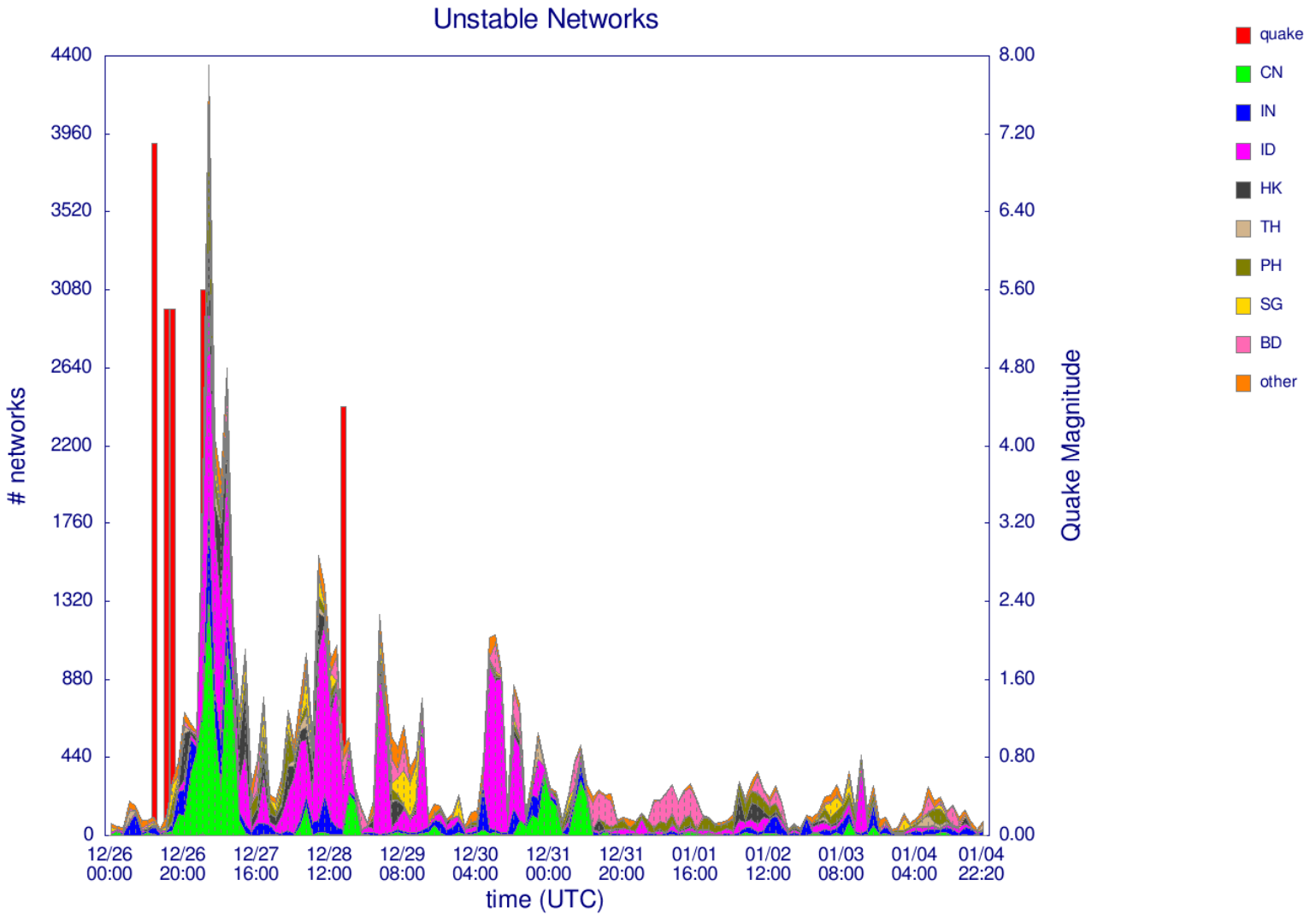
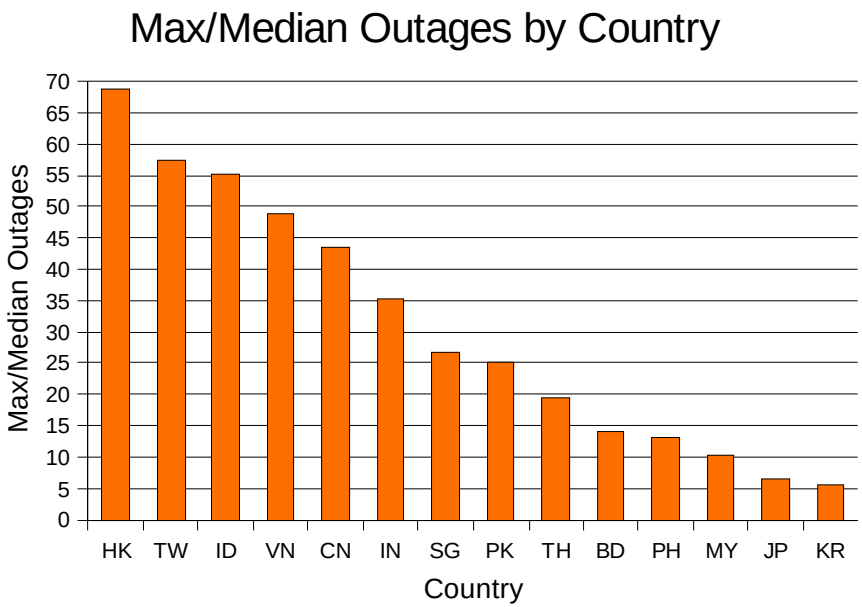
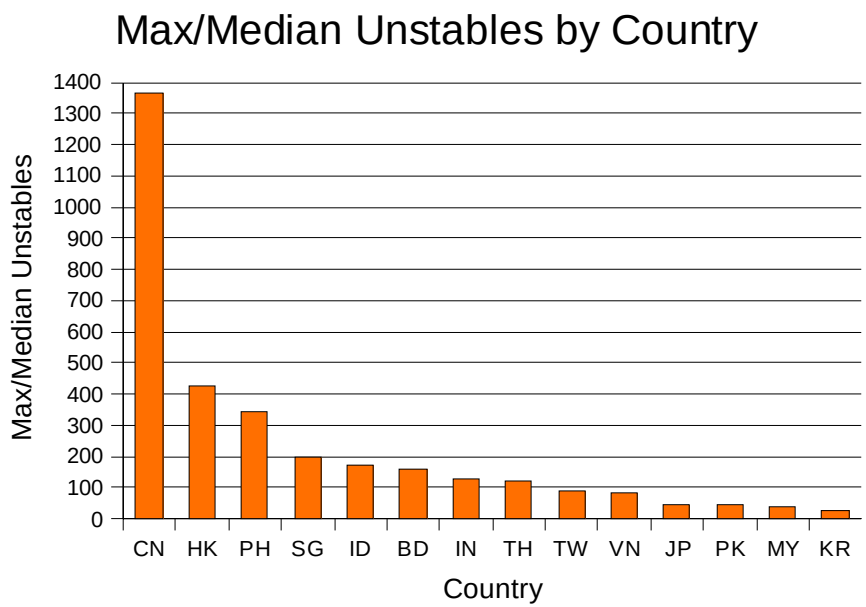


# •Winners & Losers: By Country

- Used maximum to median ratio of outages and unstable networks
- Worst Impacted:
  - China, Hong Kong
- Least Impacted:
  - Korea, Japan, Malaysia

# •Winners & Losers: By Country (cont'd)

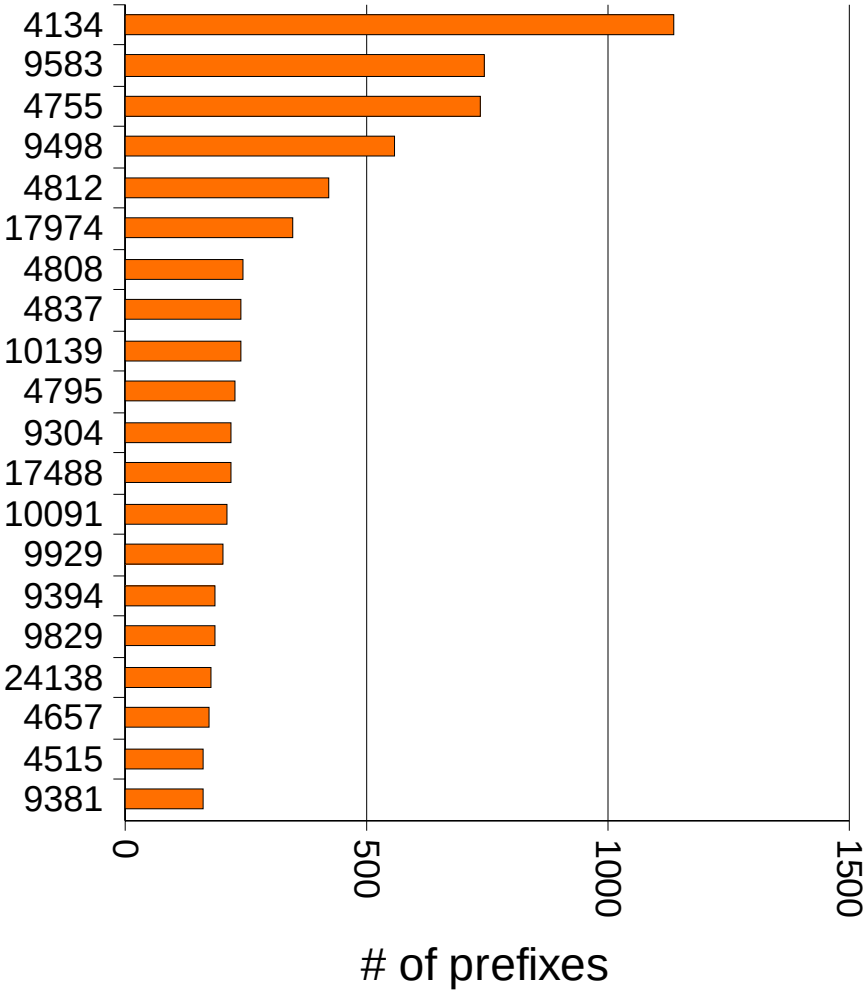


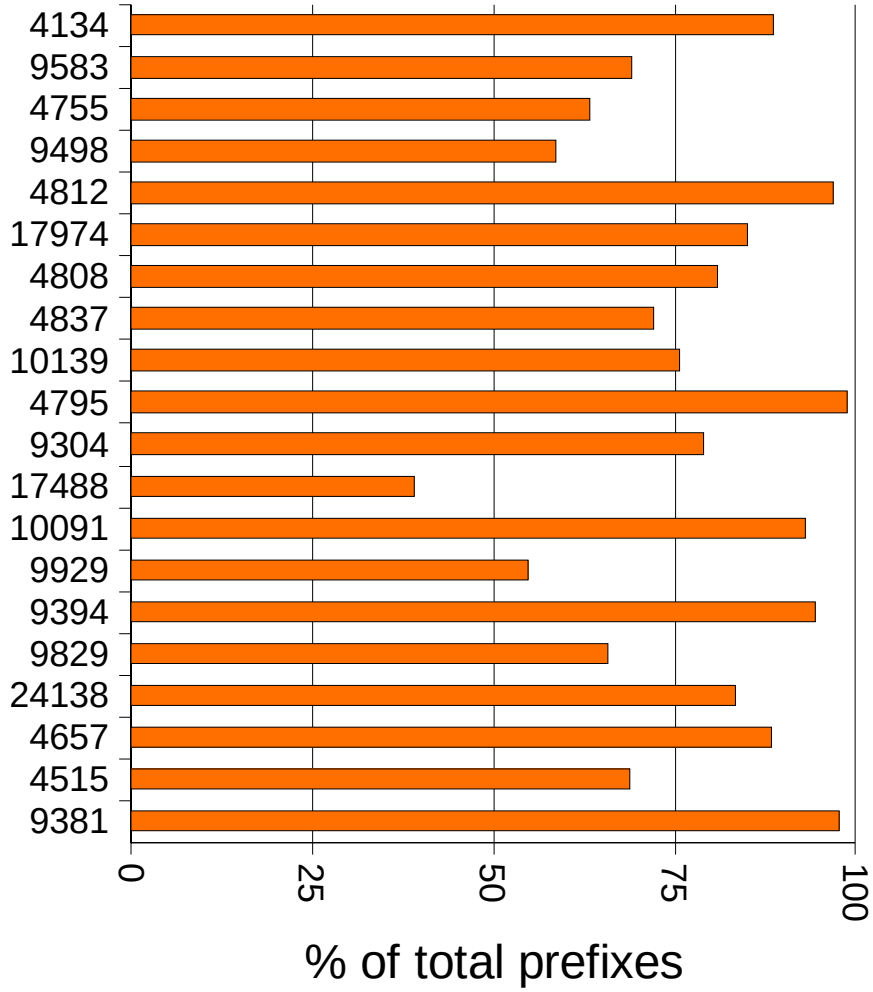



# Impacted ASNs

- Examined Asian prefixes outaged and/or unstable by origin AS – 1667 ASNs impacted:
  - China Telecom: AS4134, AS4812 (CN)
  - Sify: AS9583 (IN)
  - VSNL: AS4755 (IN)
  - Bharti BT Internet: AS9498 (IN)
  - PT Telekomunikasi: AS17974 (ID)
  - CNC Group (AS4808, AS4837) (CN)
  - Smart Broadband: AS10139 (PH)
  - INDOSAT: AS4795 (ID)

# •Winners & Losers by ASN (cont'd)



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

# Thank You

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