Failures in the current Internet

“Network Resilience” PhD Course, Sep. 26-28th 2011

Failures in the current Internet

1. Topology Failures
2. Overload
3. Lack of Integrity
4. Software Faults
5. Domino Effects

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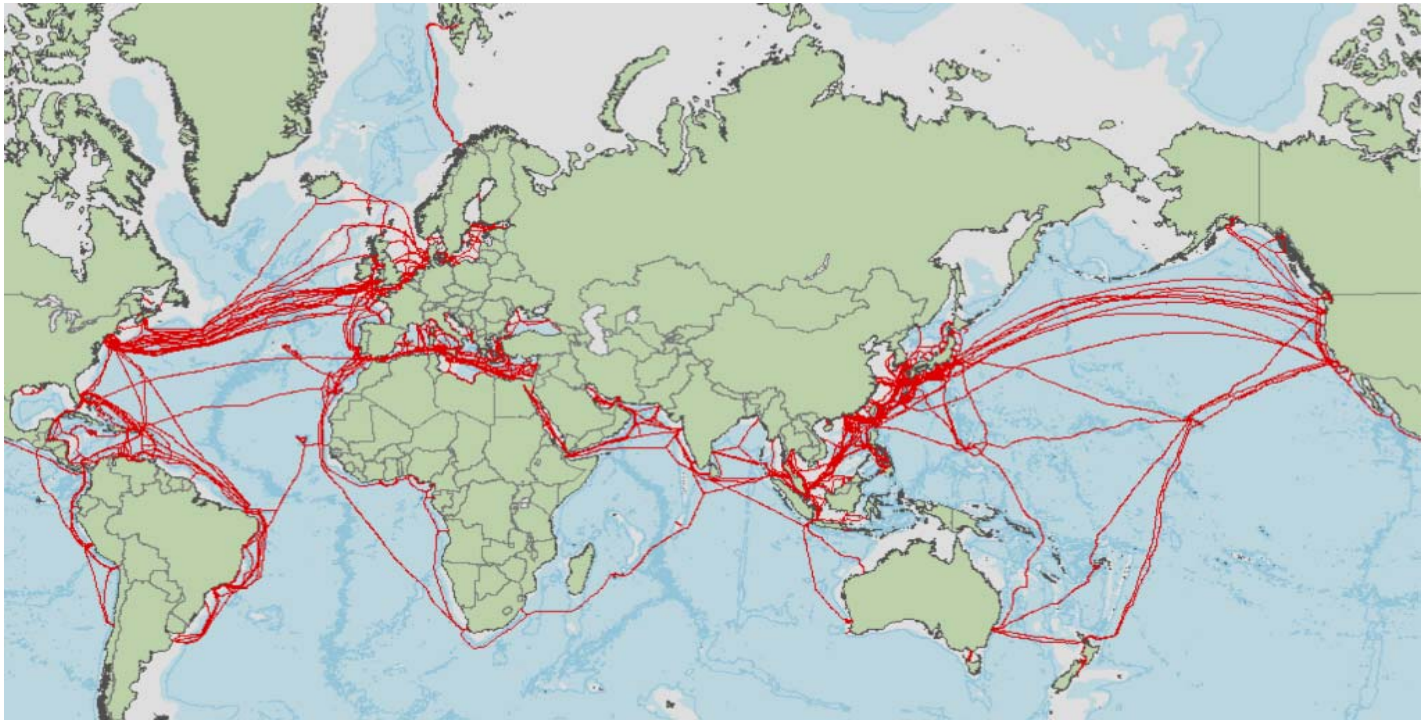
Topology Failures

- Failures in the “network graph”
- Network graph
  - Physical topology
  - Logical topology including service dependencies, e.g., DNS
    - ☞ *Dependency graphs*

Topology Failures; Sub-Marine Cables



- ~99% of inter-continental Internet traffic (less than 1% using satellites)
- High redundant
- But vulnerable to
  - Fishing and anchoring (70% of sub-marine cable failures)
  - Natural disasters (12%)
  - Cable theft

Submarine Cables; Natural Disasters

- Hengchun earthquake (December 2006)

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Asian Internet, Phone Services Hit by Taiwan Quakes (Update2)

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By Tim Culpan and Andrea Tan

Dec. 27 (Bloomberg) -- Internet and telephone services across Asia were disrupted, hampering financial transactions, after earthquakes near Taiwan damaged undersea cables.

``The repairs could take two to three weeks,'' said Leng Tai-feng, president of Chunghwa Telecom Co.'s international business. The Taipei-based company, Taiwan's largest phone operator, said two of its undersea cables were cut.

Submarine Cables; Natural Disasters

- Hengchun earthquake (December 2006)
- Impact
  - Affected countries: China, Taiwan, Hong Kong, Philippines
  - China‘s Internet connectivity reduced by 70%
  - Hong Kong‘s Internet access completely disabled
- Recovery
  - BGP automatic re-routing helped to reduce disconnectivity
  - But resulted into congested links
  - Manual BGP policy changes + switch port re-configuration were necessary
  - Hong Kong‘s Internet users were still experiencing slow Internet connections 5 days after the earthquake

Submarine Cables; Failures in the Mediterranean Sea

- In Jan. + Feb. 2008, 3 successive events

- Impact
  - Affected countries: Egypt, Iran, India and a number of other middle east countries
  - Disruption of
    - 70% in Egypt
    - 60% in India

Submarine Cables; Cable Theft

- In March 2007, pirates stole an 11 kilometers section of the submarine cable connecting Thailand, Vietnam and Hong Kong,
- Impact: significant downgrade in Internet speed in Vietnam.
- Intention: The thieves wanted to sell 100 tons of cable as scrap.

Topology Failures; Routing

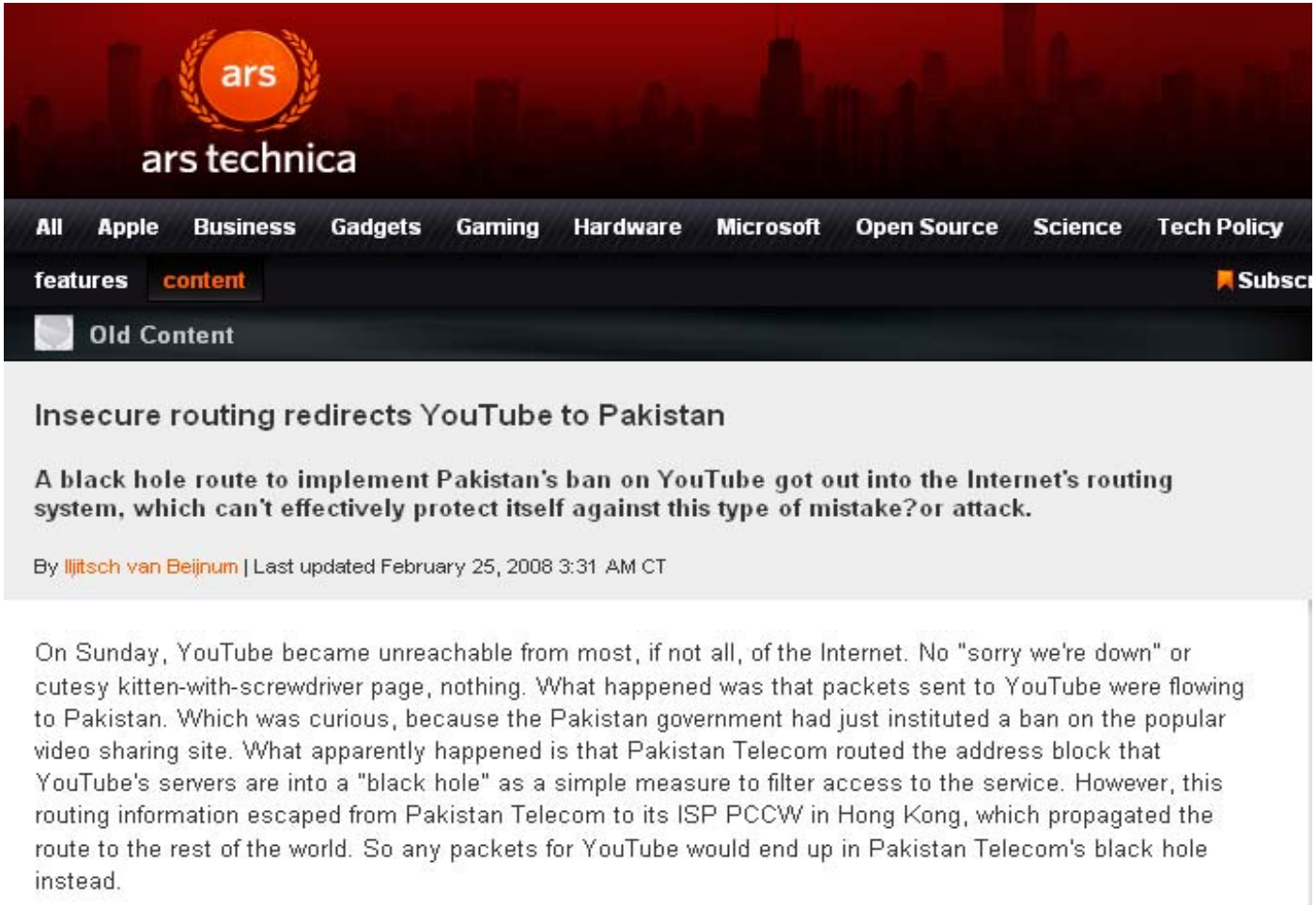
- Failures in the IP topology graph
  - Failures of routers (nodes)
  - Failure of links between routers
- Failure of links between routers generally caused by disconnection at lower layers
- Failure of routers
  - DoS attacks
  - Failures due to software bugs
  - Examples of reported bugs
    - Vulnerability to too long AS (BGP Autonomous Systems) paths
    - Long passwords to login to the router
    - Overflow of connection tables in some commercial firewalls

Topological Failures; Routing

- Time to Recovery
  - Intra-domain routing (OSPF, RIP, IS-IS, EIGRP): up to several 100ms
  - Inter-domain routing (BGP): up to several minutes

Topological Failures; Routing

- Other reasons
  - Misconfiguration which leads to false modification of the Internet topology



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Overload

- Topology failures are binary (link or node is up or down)
- But equipment in the network (routers, servers, etc.) have limited capacity
  - Queue length
  - CPU power
  - etc.

☞ Overload (congestion) is not rare

Lack of Congestion at the Network Layer

- Routing protocols react to the failure of a link or a router.
- But not to network congestions
- ARPANET had some mechanisms to react to congestions
- But they resulted into oscillations
- Congestion control was introduced in the Internet as enhancement of TCP
- But TCP has
  - no knowledge about the network topology
  - no way of re-wiring the traffic path in case of congestion

DoS Attack vs. Flash Crowds

- Big challenge
  - Ambiguous differentiation between DoS attacks and *flash crowds*
  - *Flash crowds*: unusual but legitimate traffic
  - Even if attacks are identified as such, it remains difficult to separate between malicious and legitimate traffic and to eliminate the malicious traffic

DoS Attacks

- Some DoS attacks have a political or ethnical reasons

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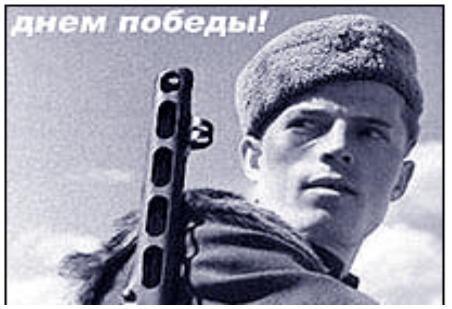
The cyber raiders hitting Estonia

As Estonia appeals to its Nato and EU partners for help against cyber-attacks it links to Russia, the BBC News website's Patrick Jackson investigates who may be responsible.

Estonia, one of the most internet-savvy states in the European Union, has been under sustained attack from hackers since the ethnic Russian riots sparked in late April by its removal of a Soviet war memorial from Tallinn city centre.



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Lack of Integrity

- Majority of Internet traffic (signaling and data) is not integrity-protected
- This leads to several security vulnerabilities
  - ARP poisoning
  - Forged BGP announcements
  - Forged DNS responses
  - SPAM SPAM SPAM SPAM SPAM SPAM SPAM SPAM SPAM SPAM
  - etc.

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Software Faults

- Developments faults
  - Introduced during the development phase
- Configuration faults
  - Introduced during the deployment phase

Software Faults

- Examples
  - Development faults: Lack of bound checking in the code
    - Leads to buffer overflows in server or router implementation
    - Leads to router or server failure
  - BGP Youtube misconfiguration
  - On Jan. 31st 2009, Google search engine marked every search result with "This site may harm your computer";

    Root cause: Database of suspected sites was mistakenly extended by ‚/‘
  - Software update of the Authentication Server (Home Location Register HLR) of T-Mobile on April 21st 2009
    - Impact: phone calls and text messaging were not possible for 4 hours

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Domino Effects (Cascading Failures)

- Any kind of challenges mentioned above may lead to other challenges
  - E.g., failure of a server in a server pool may lead to overload of neighboring servers
  - Router failures may lead to congestion of neighboring links and routers
  - DNS failure may lead to unavailability of other services,

Domino Effects

- E.g., DoS attack on Microsoft router on 24th + 25th Jan. 2001 lead to unavailability of DNS and thus of services located in other MS sites