Internet Speculations

Vint Cerf

February 2011
The Original ARPANET
Dec 1969
Interplanetary Internet

- End-to-end information flow across the solar system
- Layered architecture for evolvability and interoperability
- IP-like protocol suite tailored to operate over long round-trip light times
- Integrated communications and navigation services
777,994,517
(ftp.isc.org/www/survey/reports/current/
Oct 2010)

1,966 Million Users
(InternetWorldStats.com, Jun 30, 2010)

(approx. 5.0 B mobiles and >1 Billion PCs)
## Regional Internet Statistics 6/30/2010

<table>
<thead>
<tr>
<th>Region</th>
<th>Internet Population</th>
<th>% penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>825.1 Mil.</td>
<td>21.5 %</td>
</tr>
<tr>
<td>Europe</td>
<td>475.18 Mil.</td>
<td>58.0 %</td>
</tr>
<tr>
<td>North Am.</td>
<td>266.2 Mil.</td>
<td>77.4 %</td>
</tr>
<tr>
<td>LATAM/C</td>
<td>204.7 Mil.</td>
<td>34.5 %</td>
</tr>
<tr>
<td>Mid-East</td>
<td>63.2 Mil.</td>
<td>29.8 %</td>
</tr>
<tr>
<td>Oceania/Aus</td>
<td>21.3 Mil.</td>
<td>61.3 %</td>
</tr>
<tr>
<td>Africa</td>
<td>110.9 Mil.</td>
<td>10.9 %</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,966.0 Mil.</td>
<td>28.7 %</td>
</tr>
</tbody>
</table>
IPv4 Address Space Exhaustion

- February 4, 2011: IANA allocates last IPv4 blocks to RIRs
- Likely runout in 2012 in Regional Internet Registry Level
- Need ISP and Application Service Provider cooperation
- 6/8/11 target for major (inter)national IPv6 demonstration
- Issues: parallel operation of IPv4 and IPv6; catering to IPv6-only modes (and IPv4 only?)
### Internationalized country codes

<table>
<thead>
<tr>
<th>IDN ccTLD</th>
<th>DNSSEC</th>
<th>Country</th>
<th>ASCII form</th>
<th>Transliteration</th>
<th>Other ccTLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>.中国</td>
<td>No</td>
<td>China</td>
<td>.xn–fjq8s</td>
<td>zhōngguó</td>
<td>.cn</td>
</tr>
<tr>
<td>.中国</td>
<td>No</td>
<td>China</td>
<td>.xn–fjq9s</td>
<td>zhōngguó</td>
<td>.cn</td>
</tr>
<tr>
<td>مصر</td>
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<td>Egypt</td>
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<td>masr [3]</td>
<td>.eg</td>
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<tr>
<td>香港</td>
<td>No</td>
<td>Hong Kong</td>
<td>.xn–j6w193g</td>
<td>hoeng1 gong2</td>
<td>.hk</td>
</tr>
<tr>
<td>.рф</td>
<td>No</td>
<td>Russia</td>
<td>.xn–p1ai</td>
<td>RF (Russian Federation)</td>
<td>.ru</td>
</tr>
<tr>
<td>السعودية</td>
<td>No</td>
<td>Saudi Arabia</td>
<td>.xn–mgberp4a5d4ar</td>
<td>as-sa‘diyyah</td>
<td>.sa</td>
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<tr>
<td>台湾</td>
<td>No</td>
<td>Taiwan</td>
<td>.xn–kprw13d</td>
<td>táiwān</td>
<td>.tw</td>
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<tr>
<td>台灣</td>
<td>No</td>
<td>Taiwan</td>
<td>.xn–kpry57d</td>
<td>táiwān</td>
<td>.tw</td>
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<td>امارات</td>
<td>No</td>
<td>United Arab Emirates</td>
<td>.xn–mgbaam7a8h</td>
<td>emarat</td>
<td>.ae</td>
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</tbody>
</table>
## Proposed Internationalized Domain Names

<table>
<thead>
<tr>
<th>IDN ccTLD</th>
<th>Country</th>
<th>ASCII form</th>
<th>Transliteration</th>
<th>Script</th>
<th>Current ccTLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>.bg</td>
<td>Bulgaria</td>
<td>xn--90ae</td>
<td>bg</td>
<td>Cyrillic</td>
<td>.bg</td>
</tr>
<tr>
<td>.jo</td>
<td>Jordan</td>
<td>xn--mgbayh7gpa</td>
<td>al-ordon</td>
<td>Arabic</td>
<td>.jo</td>
</tr>
<tr>
<td>.ps</td>
<td>Palestine</td>
<td>xn--ygbisammx</td>
<td>filastin</td>
<td>Arabic</td>
<td>.ps</td>
</tr>
<tr>
<td>.qa</td>
<td>Qatar</td>
<td>xn--wgb16a</td>
<td>qatar</td>
<td>Arabic</td>
<td>.qa</td>
</tr>
<tr>
<td>.sy</td>
<td>Syria</td>
<td>xn--mgbtf8fl</td>
<td>sūryā</td>
<td>Arabic</td>
<td>.sy</td>
</tr>
<tr>
<td>.tn</td>
<td>Tunisia</td>
<td>xn--pgbs0dh</td>
<td>tunis</td>
<td>Arabic</td>
<td>.tn</td>
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<td>.lk</td>
<td>Sri Lanka</td>
<td>xn--fzc2c9e2c</td>
<td>lanka</td>
<td>Sinhala</td>
<td>.lk</td>
</tr>
<tr>
<td>.lk</td>
<td>Sri Lanka</td>
<td>xn--xkc2al3hye2a</td>
<td>ilangai</td>
<td>Tamil</td>
<td>.lk</td>
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<tr>
<td>.th</td>
<td>Thailand</td>
<td>xn--o3cw4h</td>
<td>thai</td>
<td>Thai</td>
<td>.th</td>
</tr>
<tr>
<td>.ua</td>
<td>Ukraine</td>
<td>xn--jlamh</td>
<td>ukr</td>
<td>Cyrillic</td>
<td>.ua</td>
</tr>
</tbody>
</table>
Example Security Responses

- Open Source Software (Linux, Chrome, Android, …)
- Domain Name System Security Extensions (DNSSEC)
- Routing System Security: Resource Public Key Infrastructure
- Virtual Private Networks (Transport Level Security - various)
- Certificate authentication: Certificate Authorities (using PKI)
- Two-Factor Authentication (e.g. crypto-generated passwords)
- WWW Index ("crawl") and malware site detection
  - cf: StopBadWare
- Virus, worm and trojan horse detection products
- Intrusion Detection Systems, Source Address Validation
Internet-enabled Devices
Woodhurst sensor net

2008-09-21 4:16:38 pm EDT

Deployment started on 2008-07-11 12:35:48 pm EDT, running for 72d 3h 40m 51s.

Deployment Map

Network Devices
15 Devices
- einstein
- 10.0.1.202
  - 10.0.1.203
  - 4:15:01 pm
  - 4:15:00 pm

1st Floor
- Dining Room
  - 4:15:05 pm
  - 71 °F 55.3 % 10 lux 1 lux
- Kitchen
  - 4:12:03 pm
  - 72.9 °F 51 % 21 lux 1 lux
- Library
  - 4:12:36 pm
  - 73.3 °F 50.1 % 10 lux 0 lux
- Living Room
  - 4:12:57 pm
  - 70.4 °F 51.5 % 7 lux 0 lux
- Master Bedroom
  - 4:13:03 pm
  - 70.1 °F 56 % 14 lux 2 lux

2nd Floor
- Bedroom1
  - 4:12:16 pm
  - 74 °F 48 % 14 lux 1 lux
- Bedroom2
  - 4:13:10 pm
  - 74.4 °F 49 % 80 lux 17 lux
- Bedroom3
  - 4:13:13 pm
  - 73.5 °F 47.9 % 14 lux 1 lux
- Bedroom4
  - 4:18:06 pm
  - 70.7 °F 56.7 % 3 lux 0 lux
Internet Transport Infrastructure
Circa 2011

NStar (electricity)

Comcast (hybrid fiber/coax, TV/Net)

RCN (fiber, TV/Net)

Verizon landline phone

Verizon FiOS (fiber, TV/Net)
Circa July 1889 (NYC)
Broadband Access

• Local Exchange Carriers (e.g. VZ, ATT, MANY Independents)

• Cable Carriers (e.g. Comcast, Cox, Time-Warner, MANY MORE)

• Wireless Internet Service Providers (MANY!)

• Satellite (e.g. DirecTV, Iridium, O3B, …)

• Economics: Capex, Opex, Interconnect

• Business Models (pure carriage? Value add?)
Economics of Internet Access/Connection?

- Original model: build a piece of Internet and connect it with willing partners

- Evolved model: Add Internet to existing infrastructure (dial up, DSL, Fiber, Coax) and augment revenue with (telephone, TV, …)

- Speculative model: Build layer 2 transport structure, recover costs, open access to any ISP?

- Speculative model: consumer-owned infrastructure (fiber? Wireless?)

- Speculative model: municipal networks (some exist)
Policy Considerations

- Broadband and wireless infrastructure
- Non-discriminatory access ("net neutrality")
- Common Carriage style safe harbors regarding content
- Permissionless innovation
- Cloud computing
- Domestic and International Privacy, Security, Law Enforcement
- Multi-lateral legal frameworks
- Forums for policy development, debate, implementation
- New TLDs (non-Latin, generic)