Hot Topics for the Future Internet

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... for the Internet, much of the creative energy is at or near the edge of the network. It is at the edge that most applications are created. It is at the edge that most devices are connected. It is at the edge where we usually see the development of new networking technologies. It is at the edge of the network where the economic conditions most favor innovation, as the barrier to entry (for applications, devices, and networking technologies) is typically lower at the edge. So if we want to think about where networking might be in 10 or 15 years, it behooves us to look at (r)evolution at the edge.

Clark et al, ‘Making the world (of communications) a different place’
http://portal.acm.org/citation.cfm?id=1070873.1070887
Internet for Everyone
Digital Britain

• EPSRC “Digital Economy” Programme:
  • Digital Economy Hubs
  • Indo-UK Advanced Technology Centre
  • Connecting Communities for the Digital Economy

http://www.epsrc.ac.uk/ResearchFunding/Programmes/DE/

• Lord Carter’s Interim Report “Digital Britain” recommendations include:
  • next generation networks
  • universal access to broadband
  • digital delivery of public services

http://www.culture.gov.uk/what_we_do/broadcasting/5944.aspx

Internet Access For All Citizens
What does the Future Internet need?

• RFC3869 (2004)  
IAB Concerns and Recommendations Regarding Internet Research and Evolution  
http://www.ietf.org/rfc/rfc3869.txt

• IAB suggestions for research that is **needed** for the Internet's evolution and development.

• List of topics:
  - naming, routing, architecture, security, network management, quality of service, congestion control, middleboxes, measurement, infrastructure, applications.

• **Experimentation and sharing of code and data.**

• **These research topics are disruptive!**
What other people think ...

  http://portal.acm.org/citation.cfm?id=1070873.1070887

  http://portal.acm.org/citation.cfm?id=1517480.1517490
New World Order?

- The **Old** Internet:
  - A co-operative experiment
- The **Current** Internet:
  - A landscape of competitive services
- The **Future** Internet:
  - **incentives** of the (commercial) stakeholders are key
    - [http://portal.acm.org/citation.cfm?id=633025.633059](http://portal.acm.org/citation.cfm?id=633025.633059)
What’s Hot and What’s Not?

• Different people have different ideas of what is considered “Hot”.
• Indeed, for some people something is “Hot” because it is “Cool” ... :-)
• I am now too old (and boring) to:
  • know what is “Hot” or “Cool”
  • be considered either “Hot” or “Cool”
• But that’s OK ... I can live with that ... :-(
What I think ...

• My “Hot” topics are based on what I think are challenging research areas.

• My selection criteria:
  1. Impact (on people)
  2. Scale (of deployment)
My selection of “Hot”

• Seeing Red!
  Dealing with Malware

• Going Green.
  Energy and ICT

• Grey Future?
  Internet Architecture
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Faith in Human Nature

http://www.denialinfo.com/
New Opportunities Threats


Spy chiefs fear Chinese cyber attack

http://www.timesonline.co.uk/tol/news/uk/article5993156.ece
Global Scale Disruption

http://www.ietf.org/rfc/rfc4948.txt

http://www.jump.org.uk/caida_code_red_animations/newframes-small-log.gif

Denial of Service (DoS)
Worms
Viruses
Botnets
Junk email, spam

Personal privacy
Protecting online services
Identity protection
Online trust

Internet increasingly use by individuals and businesses:
Critical National Infrastructure
Whose problem?

- The users are affected ...
- ... but they have no control over the core infrastructure.
- What is the cost-benefit trade-off?
  - e.g. online fraud
  - overall “customer satisfaction”?
  - “just enough” security?
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  Internet Architecture
The Cost of “Always On”

http://www.socitm.gov.uk/socitm/Library/Green+IT+report.htm

http://www.ncc.co.uk/research/reports_papers/GreenIT/GreenIT_surveyreport_finalv2.pdf
Networks running Hot

http://www.theregister.co.uk/2007/10/19/bt_wind_farms/

http://news.bbc.co.uk/1/hi/technology/7823387.stm
“Always on” systems and services have high energy cost.

A lot of individual pieces of equipment are already energy aware.

What about whole networks and services?

http://www.itpro.co.uk/609659/green-it-gaining-importance-says-hp
Energy and ICT

• Whole systems approach not just component-oriented.

• Energy efficient routing & traffic engineering.

• Exploit virtualisation of systems, services, and networks:

• Tension between:
  • redundancy for robustness and to support “always on” for users
  • reduction for efficiency
My selection of “Hot”

- Seeing **Red!**
  Dealing with Malware

- Going **Green.**
  Energy and ICT

- **Grey Future?**
  Internet Architecture
How To Scale The Internet?

RFC4984 (2007) Report from the IAB Workshop on Routing and Addressing
http://www.ietf.org/rfc/rfc4984.txt

Internet users in the world by geographic regions

Source: Internet World Stats - www.internetworldstats.com/stats.htm
Estimated Internet users is 1,574,313,184 for year 2008
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http://www.internetworldstats.com/stats.htm
http://inetcore.com/project/ipv4ec/index_en.html

Internet scaling is now a critical issue.
New Services?

• Ubiquitous connectivity
• Multi-homing and traffic engineering:
  • resilience and robustness
• Mobile networks (not just mobile hosts)
• Localised networks:
  • home networks, body-area networks ...
• (And all without causing additional entropy in the core network?)
A refinement to Rekhter's Law, then, is that for the Internet routing system to scale, an IP address must be assigned in such a way that it is congruent with the Internet's topology. However, identifiers are typically assigned based upon organizational (not topological) structure and have stability as a desirable property, a "natural incongruence" arises. As a result, it is difficult (if not impossible) to make a single number space serve both purposes efficiently.

Following the logic of the previous paragraphs, workshop participants concluded that the so-called "locator/identifier overload" of the IP address semantics is one of the causes of the routing scalability problem as we see today. Thus, a "split" seems necessary to scale the routing system, although how to actually architect and implement such a split was not explored in detail.
So why not change?

- IPv4 already widely deployed:
  - cost of change is high
  - no perceived benefit to end users
  - many “workaround” solutions available
- Incremental roadmaps favoured in industry:
  - well-defined transition for customer base
  - disruption is bad for business!
Summary

• My view of the three major challenges for the future Internet:
  • “security” (for users and systems)
  • efficiency in energy usage
  • scalability of the Internet architecture
• Incentives for change?
  • when and how?
Questions?