

Talking Points

Research Recommendations for the Broadband Taskforce

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Observations

US is 20th in household broadband use

- *Strategy Analytics (June 2009)*

- Number of users **is going up**, consumption of data per user **is going up**
 - Lots of studies already show this
 - Social networking (e.g. micro-blogging), multimedia downloads (e.g. Hulu, YouTube), Gaming (e.g. Xbox Live), 2D video conferencing (e.g. Windows Live), file sharing & collaboration (e.g. SharePoint), Cloud Storage (e.g. Azure),...
- NextGen Applications at Microsoft Research:
 - Immersive video conferencing, 3D Telemedicine, Virtual immersive classrooms, Remote health monitoring,, Augmented reality, Memory assistance, Natural gesture computing, Collaborative development,.....
 - These rich media applications require large amounts of data being shipped between users & between machines
- Wireless use is on the rise: 56% of Americans have accessed Internet via wireless networks (**Pew Internet & American Life Project, April 2009**)
 - 39% of adults access it through wireless laptop; 1/3rd of all Americans through cell phones & SmartPhones; 1/5th of Americans access Internet everyday via a mobile device
- 3G WAN throughput & Latency are not enough for next generation applications

Broadband Definition(s)

Proposals on the Table

Google	5+ Mbps for all Americans
IEEE-USA	20+ Mbps with 90% availability within 5 years; 100+ Mbps to all businesses & households within 10 years
EDUCASE	100 Mbps to every home; 100 Mbps – 1 Gbps for small public institutions (schools & libraries); multi-Gbps to larger institutes (colleges & hospitals)

Microsoft's Baseline Proposal

At least 100 Mbps symmetric to anchor Institutes (K-12 schools, higher education institutions, libraries, hospitals, community hubs) adjusted for the size of the institute

— Distribution from anchor institutes to neighboring communities

All agree definition should be periodically updated to match capabilities & ubiquity

MSR's Broadband Initiatives

- **Community Mesh Networking** (incl. rural Internet, Blanket city-wide coverage)
 - **Mesh Networking Academic Kit 2005 & 2007** – a research & teaching aid for broadband connectivity (**used in over 700+ Universities worldwide**)
 - **Digital Inclusion Program** (incl. financial support for University research on broadband Internet connectivity in rural areas)
- **On-going Financial support for Internet2**
 - Ongoing support for Internet-wide research
- **SORA (Software Defined Radio's) Academic Program**
- Launched in 2009 to further research in Cognitive Wireless Networking (incl. hardware and software kit)
- **KNOWS (Kognitive Networking Over White Spaces)**
- Research effort to demonstrate the power of white spaces, proof-of-concepts and testing of policy decisions,...
- **Financial and Organizational Support for Conference & Workshops**
 - DySPAN, MobiCom, SIGCOMM, MobiSys, INFOCOM, MobiHoc, SIGMETRICS,...
- **Academic Summits (since 2003) & University Sponsorships**
 - An open forum for discussions of research results and for paving the path forward
 - MIT, Wisconsin, UT Austin, Columbia, Waterloo, ...

Pain Points for Researchers

working on broadband networking

- **Limited availability of network traces**
 - Analysis of real data can improve efficiencies and save millions of \$\$ (e.g. rigorous data analysis killed the field of Cooperative Caching)
- **Limited or no access to network stacks**
 - Only unlicensed spectrum has fueled wireless research
- **Limited or no access to wide-area network components**
 - Deployment & testing of new ideas on Internet-scale has been extremely difficult
- **Limited testbeds & experimental work; heavy dependence on industry for hardware innovations**
 - Very little work on next generation wireless and wired networking hardware platforms
- **Limited jobs in networking research**
 - Few industry research labs. (MSR is an exception); University hiring dictated by changing funding priorities (networking not being high in the priority)
- **Few options for longer term (grand vision) research funding**
 - Pressure on academics to produce quick results and focus on publishing papers.
 - Extremely hard to create alternatives (e.g. 100x100 project from CMU et. a. exception)

Recommendations

- Federal agencies (e.g. FCC, NSF,) should **work closely to foster research in future-proof policies, policy enforcement, and potentially breakthrough technologies**
 - Engage deeply with research community (educate researchers on policy implications)
 - Policy has implications on research (e.g. UWB)
 - Research (e.g. *Cooperative Sensing, wide-band sensing, ...*) has policy implications
- **Foster Entry of new broadband providers**
 - Increase competitiveness & innovation
 - Considerations for helping new broadband providers should include:
 - Allowing network monitoring & network trace gathering (after anonymizing them)
 - Allowing experimentation with newer technologies
 - Allowing access to the networking stack & components
- **Finalize rules for unlicensed use of White Space**
 - Will revive community mesh networking, rural connectivity, blanket city-wide coverage,...
 - (Unlicensed spectrum) will lead to innovation (e.g. OFDM, MIMO, Network Coding,...)
 - Will lead to additional research on opportunistic networking
- **Work with NSF on a National Spectrum Telescope with Real-time Updates**
 - Help understand how spectrum is being used (or not used)
 - Provide concrete justification for opening up additional lower (< 1 GHz) frequency bands
 - Research that seeks to understand communications in the lower frequency bands

Recommendations (cont.)

- Encourage fundamental research in **Dynamic Spectrum Access & Cognitive Wireless Networking**
 - Has the potential to become a disruptive technology
- Collaborate with NSF on **National Network Trace Data Repository**
 - Possibly government networks could contribute Petabytes of anonymized network traces
 - Enable researchers to analyze traffic leading to improved network architecture, design, and protocols
- Encourage researchers to build **common reusable platforms**
 - Lead to community building ; Become a teaching resource
 - Sharing of hardware & software accelerates innovations
 - E.g. MSR's Mesh Networking Kit, MSR's SORA Platform, RICE's WARP,...
- Good research takes times. Fund collaborative and **longer term Research**
 - Up to 5 years for 5-10 PIs in multiple institutes (e.g. 100x100 project at CMU et. al.)

Summing up

- Set exciting goals (100+ Mbps to Anchor Institutes is achievable!)
 - Future-Proof National Broadband Plan
 - Make it easier for researchers to deploy monitoring tools to understand network use (will lead to operational efficiencies)
- Researchers are motivated by funding and open platforms
 - Broadband Access must remain a national priority
 - Shepherded targeted funding will lead to innovations in broadband networking while creating next generation thinkers.
- Complete Rule-Making on Unlicensed White Spaces
 - Will lead to new commodity hardware that unleashes research on “opportunistic networks” making spectrum bottleneck a non-issue
- National Spectrum Telescope
 - Identify additional consistently unused sub-GHz spectrum, to be opened up for “opportunistic networking” enabling NextGen Rich media applications.

Reading Material

- *Network Science and Engineering (NetSE) Research Agenda*, Report of the Network Science and Engineering Council (September 2009)
- *NSF Workshop on Future Wireless Communication Networks*, Arlington, VA (November 2-3, 2009)
- *Future Directions in Cognitive Radio Network Research*, NSF Workshop Report, (March 9-10, 2009)
- *Totally Connected Wired and Wireless*, Report by iN2015 Infocomm Infrastructure, Services and Technology Development sub-Committee, (Singapore Science Commission)
- *Work Programme 2009 and Work Programme 2010*, Cooperation Theme3, Information and Communications Technologies European Commission (July 2009)
- *Future Internet Design (FIND) Observer Panel Report*, National Science Foundation (April 2009)

Thanks!



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