Concerns with Network Research Funding

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Internet Architecture Board

Objectives

- Describe a wide range of open networking research topics
  - Note well: research, not engineering
- Document concerns with networking research funding levels
- Advocate increased network research funding

Summary of IAB Concerns

- Ongoing research in networking is important for future Internet health.
- Commercial research funding is necessary and important, but has proven insufficient.
- Non-commercial funding for networking research declined in the mid/late 1990s
  - Probably happened as a side-effect of the bubble
- Some research areas have been underfunded for many years.

Greatly Abridged History
(Before 1996)

- Original work on packet networking in 1960s
  - Primarily sponsored by US ARPA
- In 1980s add'l Internet research support from:
  - US National Science Foundation (NSF)
  - US Dept of Energy (DoE)
- In early 90s, other funding sources switched to Internet (rather than OSI) research:
  - Japanese Government
  - European Union
  - Various other countries

More Recent History

(1996 - Now)

- Non-commercial funding for networking research declined sharply during the “Internet bubble”.
- Commercial funding for networking research declined after the “Internet bubble”.
- Perception since mid-90s has been:
  - Industry will fund everything needed
  - Internet research does not need other funding
  - There are few open Internet-related research topics

Today's Reality

- Industry focus is on applied research
  - Most funding is for near-term products and services
- Longer-term, higher-risk, research significantly less likely to garner industry funding
- Architectural work has had minimal funding for several years
- Non-commercial funding is not restored to the levels before the Internet bubble
- There are many open Internet research topics

Examples of
Open Research Topics

Important Caveats

- IAB is not trying to acquire research funding for itself or IRTF (or IETF).
- IAB is not trying to tell funding organisations what/who to fund.
- IAB is not trying to list each/every open research topic in this document.
- Goal of our list is simply to demonstrate the breadth of the open research topics.

Naming

- Internet has several namespaces at present:
  - IP addresses, Sockets, Domain Names
- Many IRTF NSRG members think additional namespaces desirable
  - NSRG did not reach smooth consensus on details, however
- DNS has various inconvenient limitations and issues
  - What alternative approaches might exist?
  - How can we remove some limitations ?

Unicast Routing

- Concerns about end-to-end BGP convergence times growing as routing table size increases
- Desires for improved, more sophisticated routing metrics
  - Lowest monetary-cost, lowest packet loss, others
- Concerns about site multi-homing
- Desire for additional/improved routing algorithms
  - Something beyond link-state, distance-vector, path-vector
  - Includes work on graph theory applicable to routing

Multicast Routing

- Desires for improved multicast routing architectures
- Desires for new/improved routing algorithms
- Desires for approaches that are easier to deploy
- Desires for approaches that are easier to operate

Mobile & Ad-Hoc Routing

- Current work interesting, but not the final word
- Desire for mobility to be a native property of the Internet
  - rather than mobility via an add-on protocol
- Self-organising and dynamic routing systems create new security challenges
- Desire for alternative approaches to wireless scalability.

Security: Formal Methods & Key Mgmt

- Formal Methods work:
  - Security Models,
  - Trust Models,
  - Cryptographic Protocols, etc.
- Key Management work:
  - Non-hierarchical key management
  - More general approaches to multicast key mgmt

Security: Distributed Computing

- Kerberos is great, but…
  - Not easy to initially deploy
  - Has centralised security model
- Desires include:
  - Improved support for ad-hoc computing
  - Easier-to-deploy approaches
  - Better support for inter-domain authentication
  - Better support for grid computing

Security: Deployment Considerations

- Theoretically perfect security often impractical to deploy
- “Mostly secure” approaches that are easy to deploy might provide greater risk reduction
- Need security mechanisms that are:
  - Easy to implement correctly
  - Easy to deploy correctly
  - Easy to manage

Network Management

- SNMP & MIBs are great, but not the last word
- Monitoring devices has been more successful than managing networks --> need to manage networks

- Funding organisations don't always consider Network Management "legitimate" research
  - Need to change that mindset

Quality of Service

- IETF has several QoS mechanisms:
  - Integrated Services (e.g. RSVP)
  - Differentiated Services (e.g. IP ToS)
- Inter-domain QoS mechanisms available today create easily exploited DDOS vulnerabilities
- Today's de facto QoS deployments rely on over-provisioned network capacity
- IETF lacks an overall QoS architecture
- Need more research on QoS architecture

Congestion Control

- Modifying congestion control for new environments:
  - Streaming media; multicast applications.
  - Wireless; paths with reordering, intermittent connectivity, etc.
  - Very high-bandwidth paths.
- Communication between transport and other layers ?
- Router-based congestion control mechanisms
- Understanding traffic dynamics in large, complex networks.

Evolution of the Internet

- We need to better understand the factors that affect evolution of the Internet:
  - Technical and architectural issues.
  - Changes in the infrastructure over time.
  - The role of standards.
  - Economic and public policy factors.

Obstacles to Evolution

- Need to better understand the obstacles to evolution:
  - Increased complexity
  - Interactions between layers
  - Interventions by middleboxes, etc.
- Need to understand how to accomodate increased complexity without unduly constraining evolution.

Additional Topics

- There are **lots** of good research topics not mentioned in this document.
- Not trying to create a comprehensive list
  - That would be an impossible task
- Our goal is merely to illustrate the broad range of research topics

Conclusions

- Increased research funding, particularly from non-commercial sources is desirable
- Increased support for basic research, including architectural work needed
- Absent additional research funding, future of the Internet might not be as bright

Feedback

- This is just the IAB's first draft.
- More community feedback on the document is helpful and desired
- Mailing list has been setup for discussions of this draft:
  - Postings: research-funding@ietf.org
  - Admin: research-funding-request@ietf.org