NewArch: Future Generation Internet Architecture Project

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..and, we hope, a broad group of experts, visionaries, and excessively opinionated souls

A (cough) modest objective

- Develop and evaluate, from as clean a slate as required, a strengthened Internet architecture for the 10-20 year time frame
- Build a “patent office” prototype

What (we mean by) architecture

"High level design principles that guide the technical design of a system, especially the engineering of its protocols and algorithms"

Two levels:

- Structuring principles
- Functional decomposition and system modularity

In the network case..

- Where and how state is maintained, and how it is removed
- What entities are explicitly named
- How naming, addressing, and routing functions are performed, and how they are related
- Modularity of the protocol stack
- The strategy used to manage limited network resources (fairness and congestion control)
- Where security boundaries are drawn and how they are enforced
- How management boundaries are drawn and selectively pierced
- How (and if) differing QoS is requested and achieved

Why does it matter?

- Generality
  - Coherent architecture helps general-purpose systems stay that way
- Evolution
  - Coherent architecture allows different components of complex systems to evolve, at different rates, as technology and understanding changes
- Religion
  - Coherent architecture captures and institutionalizes strong, tested design principles

So what're the problems?

- New requirements
- Technical arteriosclerosis
  - Good point-problem solutions with bad long-term consequences
  - "Feature interactions"
- Increasingly limited sub-architecture synergy
  - Repetitive implementation of similar mechanisms
  - Failure to utilize related information

Requirements

- Requirements drive architecture drives technical design
- Fundamental underpinning of a new-arch research effort is wise identification of high level requirements & goals
  - Choice of requirements possibly most critical issue determining ultimate usefulness of a new architecture
  - But a simple laundry list won't do
- Significant portion of current project

The original requirements

1: Internetworking - existing networks interconnected
2: Robustness - communication continues despite loss of networks or routers
3: Heterogeneity - architecture must accommodate a variety of networks
4: Distributed Management - architecture must permit distributed management of its resources
5: Cost Effective
6: Ease of Attachment - must permit host attachment with a low level of effort
7: Accountability - resources used in the Internet must be accountable

Key new requirement

- Crucial point - transition of Internet from oddball project to mainstream infrastructure
  - Fewer and fewer requirements truly global - applying with same importance everywhere.
  - Many requirements will apply with different force, or not at all, in some parts of the network
- Single, ordered list is deeply problematic
- Instead, multi-ordered requirement set, with support for differing requirement importance
  - At different times
  - In different places
- This “meta-requirement” significantly impacts architecture design

Potential new technical requirements

- Commercial environment concerns
  - Richer inter-provider policy controls
  - Support for variety of payment models
- Trustworthiness
- Ubiquitous mobility
- Policy driven self-organization (“deep auto configuration”)
- Extreme short-time-scale resource variability
- Capacity allocation mechanisms
- Speed, propagation delay, D*BW issues (?)
- Etc...

Non-technical “requirements”

- Legal and policy drivers:
  - Privacy and free/anonymous speech
  - Intellectual property issues
  - Encryption export controls
  - Law enforcement surveillance regulations
  - Charging and taxation issues
- Reconciling national variations and consistent operation in a world-wide infrastructure

Themes

Theme - trustworthiness

- Holy grail: robust, secure system from individually untrusted components - “trustworthiness amplifiers” (Schneider)
- Balance of rights and constraints
  - Increasing rights of objects in the system can increase trustworthiness
  - Must be matched by increased, more sophisticated constraints
    - Example: end-system selection of diversity of resources
- Wide range of trustworthiness amplification strategies
  - “Intentional diversity”, constraint-based monitoring, detection, response, etc.
- Appropriate for core architecture? Per domain?
- Exporting per-domain trustworthiness information

Theme - mobility

- Ubiquitous?
  - Current arch: small # of mobile devices incur extra cost
  - Ubiquitous - all devices potentially mobile, lower overall cost
- Generalized?
  - Any difference between moving a device in the topology and changing the topology around a device?
  - Strong implications for ease, timescale of changing providers
- Integrated?
  - Now: link-level, IP, TCP, application/session
  - Is a more integrated approach more effective, or just over-coupled?

Theme - economic and market forces

- Making value visible - maximizing revenue in the context of an open network
- Making choice practical - exposing the customer to a range of possible options
  (interestingly related to trustworthiness)
- Can economics reinforce architectural consistency?
- (An oddly related question) can economics foster super-economically flexible systems?

Meta-theme - new architectural structuring abstractions & techniques?

- Are the techniques used by network architects & protocol designers today sufficient?
  - Abstractions from other domains of system design?
- Are the techniques available to network architects today sufficient?
  - Does the network architecture problem lead to inventing new abstraction techniques?
- Examples
  - Explicit consistency minimization
  - Semantic protocol wrapping

Path forward

- Assumptions
  - Community involvement - domain experts, customers, interested others
  - Iterative process
- Plan
  - Evaluate requirements and define architectural goals
    - Requirements and approaches workshop
    - Draft architecture document
  - Examine available technologies, and missing pieces
  - Architectural synthesis and evaluation, prototyping
    - Architectural rock-throwing event (workshop)
    - “Key idea” protocol and sub-architecture documents, prototypes
    - Complete architecture description

Info

- NewArch Project webpage: http://www.isi.edu/newarch
  - Initial whitepaper
  - Background papers
  - Bibliography
  - Draft proposals
  - Workshop CFP's, agendas and schedules, summaries
  - Simulation descriptions and results
  - Code