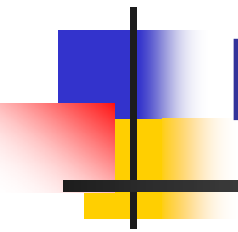


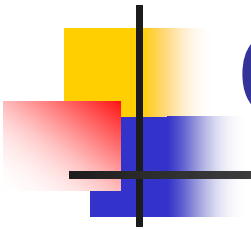
Manageability Track Session

Internet Innovations Workshop

June 20, 2007

Some Manageability Topics

- Rendezvous (sensor-net for the network) information (match people to information wrt storage of the same)
- Trust and/or authorization, authentication of information
- Qualifying and quantifying (theoretical) benefit (validation)
- Existing (e.g. reasoning tools) methods satisfactory to address the problems or management/provisioning
- Lack of rigorous research data sets (e.g., realistic workloads)
  - Assessing bounds/confidence - errors, imprecision, inconsistencies
  - Trusted
- Knobs and controls – policy, configuration
- Ontology and naming of data
- SLA management
- Intermittent connectivity
- Organizing information for the user or entity
- User-based manageability
- Decentralized (coordinated) management
- Remote management (e.g., scaling IT in developing countries)
- Network visualization (comprehension, context-sensitive) (including data mining)
- Managing virtual networks (e.g., VPN, underlying services)
- Root cause analysis
- Manageability modularity
- “It just works” - automation/autonomics across diverse skills, capabilities (home, enterprise, developing)
- Real-time sense-and-respond
  - Dynamic policy-based manageability



Grand Challenges

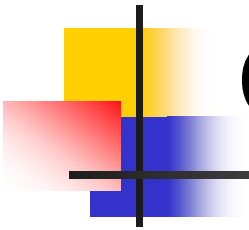
- Grand Challenge #1: Enabling Descriptions - ontology and semantics translation
  - (Meta) Data
  - Policies & control
  - Problem definition
  - Event specification
- Grand Challenge #2: Scoping Management
  - Structures (communities)
  - Multiple entities or organizations
  - Alternative purposes and seamless (de) compose
  - Constraints (e.g., trust, visibility)
- Grand Challenge #3: Understanding and reasoning
- Grand Challenge #4: Self* Internet systems (and subsystems)
- Grand Challenge #5: Information or service rendezvous, location-specific, access, sources (storage) and data context

Experimentation Requirements

- Scaling across a broad set of needs
- Metrics of evaluation and data efficacy
- Repeatability and regeneration and comparative
- Management of GENI facility and services
- Management research itself
- Decentralization of management (federated, interoperability)
- Managing of virtualization entities
- Modularization of management
- Connectivity challenges (intermittencies, mobility, hand-offs, power)
- Remote manageability (e.g., back channeling)

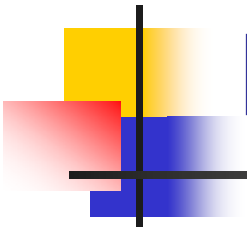
Industry/Academic Relationships

- Real workloads and real policies (efficiency and IP of data)
- Industry network management solutions transfer
- Incentives & boundaries for industrial collaboration and sharing
- Neutral environment for vetting innovations (IETF)
- Ensure broad vertical industry participation



Open Topics

- High-speed, optical networks
- Wireless and sensor-based environments and integration
- Integration of emulation and simulation environments



Backup

Working Session Schedule

- (15mins) 9:00am Session setup
- (20mins) 9:15am Pre-work report-outs
  - Eve Schooler
  - Karen Sollins
  - Petros Maniatis
  - John Mark Agosta
  - S. Felix Wu
- (25mins) 9:35am Brainstorming
- (75mins) 10:00am Discussion & convergence
- (15mins) 11:15am Roll-up

Timekeeper:

“Rat Hole” Monitor:

Session Minutes:

Working Group Charter

Today's Internet greatly benefits from the decentralized multi-administrative structure with heterogeneous scalability, but at the same time, these attributes also lead to frustrating failures that are difficult to overcome in a timely and effective manner. Future Internet must accommodate far more demanding applications and services, and the manageability of the Internet is of key importance. While a number of management solutions, provisioning models, and software tools have been recently proposed and developed, they have so far achieved limited success due to overly simplified assumptions where dynamic complexity and end-to-end challenges are exacerbated.

This track (1) invites active discussions on both the traditional challenges and emerging complexities affecting the Internet network structure, (2) promotes new ideas in management solutions and infrastructures, and (3) seeks identifiable and necessary areas of research for breakthroughs in the Future Internet design.

Framing Questions

- When preparing for the discussion in the Manageability breakout session, consider the following questions:
  - Is a ‘clean-slate’ strategy for Internet Manageability required? (Justification for evolutionary vs. revolutionary approaches)
  - What is fundamentally needed to address the complexities of managing the Internet end-to-end?
  - What new usage models or problems extend beyond the reach of today’s management and provisioning tools and methods?

Session Goals

- Grand Challenges:
  - *Describe your grand challenge in one sentence*
- Experiments Required:
  - *Provide a list of experiments that must be conducted in order to explore solutions to your grand challenge.*
- Industry/Academic Relationship:
  - *Describe interactions between industry and academia that will lead to better solutions that can be deployed more quickly.*
- Identify Opens Issues:
  - *Matters that were tabled (rat-holes) or leading to irreconcilable debates*

Other Considerations

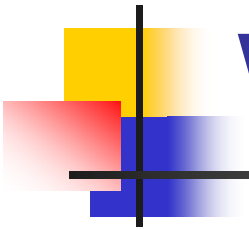
- What's broken in today's Internet for manageability (monitoring, provisioning)
- Key requirements driven by specific future applications; justifications why these requirements can not be effectively satisfied today
- Emerging usage models

Schooler: If We Could Liberate Measurement Data...

- Manageability Grand Challenge:
  - *Support measurement and monitoring -- everywhere*
    - *Prerequisite to a device joining "the net" is a self-measurement capability*
    - *Measurement is the foundation for self-monitoring and self-repair*
      - *Collaborative (composable?) measurement*
      - *Multi-resolution measurement: how much to collect? where to collect?*
      - *Security, privacy, trust*
- Experiments Required: Are there any universal truths?
  - *Comparative study of architectural requirements for measurement collectives*
    - *Bodynet-scale (MyLifeBits), Platform-centric, Whole-house, Enterprise-wide, Internet-level networks*
  - *Scalability of context-aware monitoring:*
    - *Data and event generation and storage, routing of measurement data, aggregation/synthesis architecture*
  - *Context-driven threat model analysis of a distributed measurement infrastructure*
- Industry/Academic Relationship: (re) educate early and often
  - *Jointly develop compelling usage cases*

Sollins' Challenge

- Grand Challenge:
  - *Make it be the case that one no longer requires specialized organizations to manage one's network experience*
- Requirements to address the challenge
  - *End-node driven management*
  - *Local control, expertise*
  - *Distributed cooperation*
  - *Common exchange/invocation model*
  - *Common information/knowledge access model*
  - *Controlled sharing: domains of isolation (privacy, etc) and interchange*
  - *Incentives for cooperation, sharing, etc.*
  - *Extensibility and adaptivity to increasing capabilities*
  - *Dissemination and rendez-vous: supporting functions (capabilities) in accessing or utilizing the resources required for their tasks*
  - *Probabilistic, incomplete, inconsistent, or intentionally incorrect information: statistical reasoning and learning*



What to do

- Criteria for Experiments:
  - *Non-local issues (e.g. path behaviors, wide-spread service behaviors, composed behaviors)*
  - *Local expertise or knowledge*
  - *Individual (e.g. user), application or organization that cares (sees value) in management function*
  - *Issues that scale more than linearly*
  - *Cooperation critical: basis of cooperation may be negotiable*
  - *Services that are useful more broadly than only for themselves (can be integrated into higher level services)*
  - *Dissemination/advertising of resources (information, knowledge, functions)*
- Industry/Academic Relationship:
  - *Finding common ground*
    - *information/knowledge/resource ontology*
    - *ability to describe and negotiate control policies and boundaries*
    - *incentives (may not be money, but may gain other sorts of benefits from controlled sharing/cooperation/exchange*

Maniatis' Challenge

- Grand Challenge:
  - *Accountability interfaces for network service providers, or, "balancing opacity with SLA enforceability in a multi-administrative domain network."*
- Experiments Required:
  - *Demonstrate that a particular interface/language can express most typical compliance requirements*
  - *Demonstrate that accountability information can be maintained at line speed for all traffic, especially in the core*
- Industry/Academic Relationship:
  - *Without provider support, this work is academic at best: we need to know what kinds of compliance enforcement policies providers are willing to put in place*
  - *Much academic research is required to understand what kinds of policies are* computable *given a certain level of domain opacity and misbehavior*

Agosta's Challenge:

Zen koan:

Rebooting never resolves a fault, said the master as he reboots his system.

A theory of troubleshooting

Why does rebooting work (and how to avoid it)?

- Any system is designed to come up in an operational state.
  - *Design & test* is, in part, the process of identifying and eliminating unreliable states.
  - These how these states occur is forgotten , once the system is “good enough” (to ship)—but it is just one of these states that is “rediscovered” when, during the system lifetime, the system fails.

How can failure knowledge, known at design time, be captured and recalled during operation?

A model of troubleshooting

In modeling failures, there are:

- Unobserved things that fail, and can be replaced or repaired
- Observed things, caused by unobserved things.

If we can build a model of the causes (e.g. with probabilities) we can reason from observations to localize failures, and troubleshooting can be "solved."

A failure model, learned from experience at design time, can be used for troubleshooting.

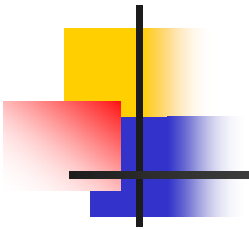
The challenge is in compiling this experience into a usable model.

Building-in troubleshooting

- Remember the failure modes uncovered in the design phase, in a usable model

or

- Design so the system can be restored with “micro-reboots”



S. Felix Wu: Interactive Informatics on Internet Infrastructure

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