What we mean by “architecture”

- Objectives
- Requirements
- Organizing principles
- Core design features

- Not detailed design
- Not implementation
Examples

- Traveling employee (enterprise support)
- Distributed applications (peering)
- Zero-day low-volume worms (local/collaborative aggregation)
Network management: the desired functionality

- Analysis of network behavior
- Diagnosis of network misbehavior
- Prediction of behavior
- Analysis and prediction of use
- Mitigation/repair of misbehavior
- Improvement of behavior
Enhancing the network architecture

- Data Plane
- Control Plane
- Management (Knowledge) Plane
The context of network management

- Network management administrative domains: scope of control and responsibility is local
- Clientele are mobile and removed from network managers
- Services provided to clientele are a composite, with individual network management
Objectives

◆ Provide the service the customers’ want, i.e. maintain and improve transport service for:
  ➤ Users
  ➤ Distributed applications
  ➤ Other networks

◆ Operate local network effectively
Requirements

◆ Recognize that local managers only have local control
◆ Local boundaries also reflect policy boundaries
◆ Problems faced by “customers” reach beyond local boundaries
◆ Minimize impact
  ➤ Performance
  ➤ Duplication of effort
  ➤ Security
Organizing principles

- Divide-and-conquer
  - Partition and subdivide, but not necessarily strictly hierarchically
- As much as possible explicit rather than implicit definitions, relations, controls, etc.
  - Support time and location independence
- Distinct layering
  - Computation and reasoning
  - Information
Information challenge

- Storage
- Discovery
- Finding information
- Sharing information
- Reasoning over information
- Extensibility of lifetime
- Policy formation/composition
Computation and reasoning challenges

- Dealing with the nature of the information
- Efficiency and performance
- Decomposition
- Composition
- Extensibility
- Organizing framework
Core proposed architectural design components

- Information Plane
- Knowledge Plane
The Information Plane

- Collection
- Storage
- Location
- Definitions: Ontology
- Metadata
- Identity
- Policies

- Announcements or publish
- Requests or subscriptions
- Rendezvous
- Delivery
- Regionalization
The Knowledge Plane

- Ontology for knowledge
- Regionalization
- Function library and definitions
- Probabilistic programming
- Agent system
- Reasoning organization framework
Several hard research challenges

- Understanding organizational constraints
- Evaluating the impact on the network
- Managing information:
  - Exposing and supporting tussles: who has incentives for what and whether compromise is possible
- Statistical machine learning in pervasively distributed scaled environment of Internet
- Pervasive efficient delivery
Value of common architecture: framework for common design

- Shared cost of measurement and monitoring
- Complementary capabilities
- Ability to understand, evaluate and control amount and types of cooperation and sharing to meet local constraints
- Framework to manage performance and evolution of network management functions
Questions?