Declarative DSL: A Declarative Networking Perspective

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Introduction

- Declarative framework for specifying and implementing network protocols
- Utilizes a distributed recursive query language (Network Datalog)
- Use cases to date:
  - Routing protocols, distributed hash tables, sensor networks protocols, replication, resilient overlay network, indirection (i3), mobile networks, ….

Main Selling Points

- Ease of Programming
  - Compact specifications, orders of magnitude reduction in code sizes
  - Routing protocols (few lines of code), Chord DHT in 47 lines
  - Many routing protocols are minor variants of one another
  - Group of trial users outside of core research group
- Protocol analysis:
  - Protocol convergence = query safety
  - Other efforts: Meta-Routing [SIGCOMM '05], Mace [NSDI 07]
- Optimizations
  - Magic sets rewrite: Wired to wireless protocol, hybrid protocols
  - Multi-query optimizations

Shortcomings

- Ease of programming:
  - Learning curve for network programmers
    - Event-condition-action vs Database views
  - Network churn handling and optimized link-state protocol
  - User-defined functions (path computation, Chord identifiers, etc?)
- Protocol analysis work on declarative protocols is preliminary
- Limited optimizations to-date:
  - Magic sets + predicate reordering for reachability queries
  - Multi-query optimizations
  - Need to generalize beyond simple examples

Ongoing Efforts

- Overlay network selection and composition
  - Users supply high-level declarative requirements
  - System composes new networks from component networks
- Declarative trust management + networks
  - Unify logic-based access control languages and declarative networks
- Declarative MANET protocols:
  - WNaN (Wireless Network After Next) DARPA program
  - Proliferation of wireless protocols (DSR, AODV, LS, HSLS, OLSR, DTN, APLS), yet no one-size-fits-all
  - Policy-driven protocol switching (e.g. reactive/proactive/epidemic)

Declarative Languages in Industry

- SPINDLE Delay Tolerant Networking (BBN)
  - http://www.ir.bbn.com/projects/spindle/index.html
  - XSB and Flora-2 for decision plane policies
  - Integrated with DTN reference implementation
- SSC – Shared Spectrum Company (http://www.sharedspectrum.com/)
  - Dynamic Spectrum Access (DSA) policies for smart software-defined radios
  - Utilize OWL language
- LogicBlox (http://www.logicblox.com)
  - Datalog engine for enterprise software for data manipulation, spreedsheeting, business logic, etc.