Declarative Toolkit for Rapid Network Protocol Simulation and Experimentation

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http://netdb.cis.upenn.edu/rapidnet/

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**Introduction**

- **RapidNet Toolkit**
  - A development toolkit for rapid network simulation, prototyping, and experimentation
  - Integrates a declarative networking engine with the ns-3 simulator
  - Develop high-level specifications of network protocols, compiled into ns-3 code for simulation and testbed experimentation

- **Motivation**
  - Proliferation of new protocol designs
  - One-size-fits-all protocol does not exist
  - Variability in network connectivity, wireless channels, mobility
  - Wide range of traffic patterns
  - Lack of systematic tools to study protocols under a variety of mobility and traffic settings

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**Overview of RapidNet**


- **Developer Feedback**
- **Simulation Results**

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**Declarative Networking**

- **Declarative Networking**
  - Use a database query language to express declarative specifications of network protocols
  - Declarative specifications are executed by distributed query engine (Click execution model) to implement network protocols

**Protocols at Demonstration**

- **Reactive**
  - DSR (Dynamic Source Routing) (10 rules)
- **Proactive**
  - LS (Link State) (6 rules)
  - HSL (Hybrid Sighted Link State) routing (14 rules)
- **DTN (Delay Tolerant Networks)**
  - Epidemic Routing (15 rules)
- **Wireless Neighbor Discovery**
- **Chord Distributed Hash Table**

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**Example Specifications**

**All-pairs reachability protocol**

- R1 reachable(@S,D) → link(@S,D)
- R2 reachable(@S,D) → link(@S,Z), reachable(@Z,D)

**Link-state flooding**

- LS1 Isln(@S,S,N,C,S,TTL): periodic(@S,T), link(@S,N,C), TTL>pow(2,K)*Te, TTL>pow(2,K), range(S,K)

**Hazy-sighted link-state flooding**

- HSLs1 Isln(@S,S,N,C,S,TTL): periodic(@S,T), link(@S,N,C), TTL>pow(2,K)*Te, TTL>pow(2,K), range(S,K)
- HSLs2 Isln(@S,S,N,C,Z,K): link(@S,N,C,W), link(@Z,M,C), K>0, M=W

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**Ongoing Research**

- **Policy-based Adaptive MANETs**
  - Hybrid link-state
  - HSLS: incurs low bandwidth overhead, scales better
  - LS: quick convergence, perform better in stable network
  - AA: link availability

- **Recent Publications**
  - Declarative Policy-based Adaptive MANET Routing.
  - Hybrid Proactive-Epidemic
  - Verifiable Networking
  - Dynamic Network Composition

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**Recent Publications**

- Declarative Network Verification
  - 11th International Symposium on Practical Aspects of Declarative Languages (PADL 2009)

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**Visualization**

Visualization of ns-3 traces obtained from declarative networking executions within RapidNet

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