Towards a novel transport protocol for wireless mobile ad hoc networks

- 1st E-Next WG1 TF Meeting in Wireless Mobile Ad-Hoc Networks

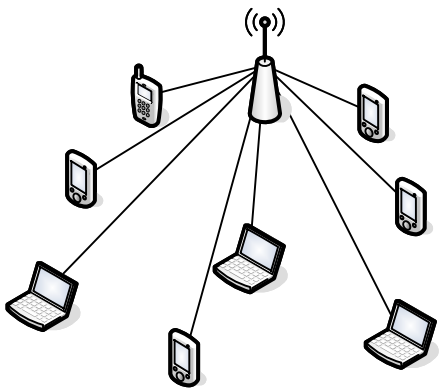
Georgios Parissidis
ETH Zurich
parissid@tik.ee.ethz.ch

Outline

- Wireless mobile networks
- Background knowledge
- Problem statement
- Our Approach-evaluation methodology
- Expected results

Wireless mobile networks

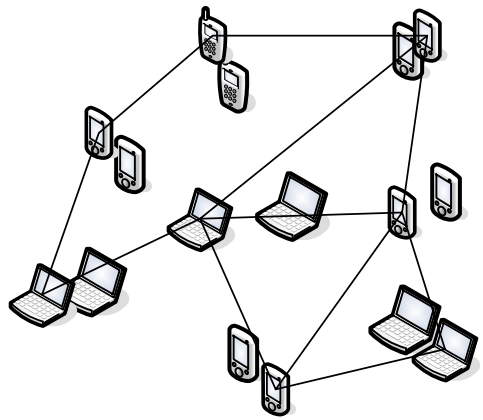
- Infrastructure-based



  - Wi-Fi hotspots. Access to the Internet

    (Airports, train stations, universities, city centres)
  - Home use.

- Infrastructure-less (ad hoc)

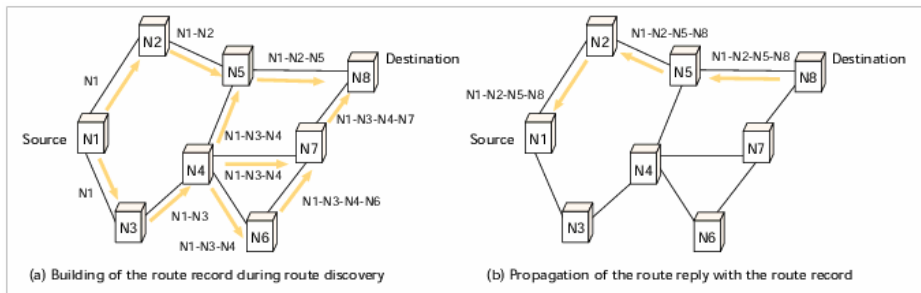


  - Inter-vehicular and disaster networks.
  - In-building networks.

Background knowledge

Routing protocols for mobile ad hoc networks (single-path, multi-path)

- Single-path routing protocols
- Proactive (Routing information maintained for every pair of nodes, updated in constant time intervals.)
  - DSDV, OLSR
- Reactive (On-demand)
  - AODV,DSR
- Hybrid (Combination of proactive and reactive)
  - ZRP



Example: Creation of the source record in DSR

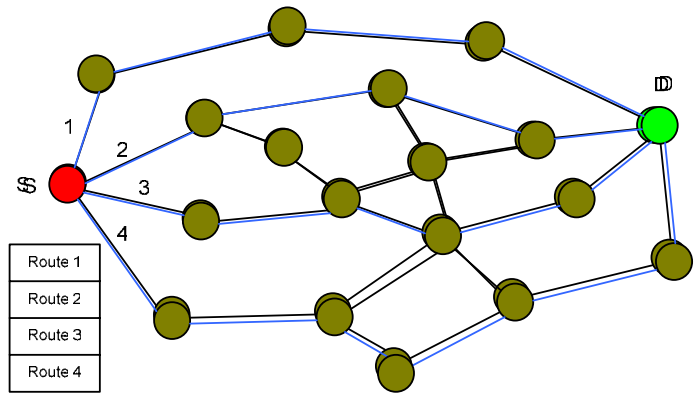
Background knowledge

Routing protocols for mobile ad hoc networks (cont.)

- Multi-path routing protocols
  - AOMDV: Ad hoc On demand Multi-path Distance Vector (*ICNP '01*)
  - MP-DSR: Multi-path Dynamic Source Routing (*LCN '01*)
  - SMR: Split Multi-path Routing (*ICC '01*)
  - MSR: Multi-path Source Routing (*ICC '01*)

Desirable properties of a multi-path routing protocol:

	AOMDV	MP-DSR	SMR	MSR
Multiple complete paths:	Yes	Yes	Yes	Yes
Loop-free paths:	Yes	Yes	Yes	Yes
Node-disjoint paths:	Yes	Yes	Yes	Yes
Complete routes known:	No	Yes	Yes	Yes
Simultaneous use of paths:	Yes	Yes	Yes	Yes



Background knowledge

- Multi-path vs Single-path routing protocols

- P. Pham, *"**Performance analysis of reactive shortest path and multi-path routing mechanism with load balance**."* (INFOCOM '03)
- Y. Ganjali, *"**Load Balancing in Ad Hoc Networks: Single-path Routing vs. Multi-path Routing**."* (INFOCOM'04)

\+ Load balancing
\+ Maintenance of multiple routes from a sender to a destination

\- In general more routing overhead.
\- More complex algorithms

Background knowledge

Single-path routing and TCP

Lower layer feedback control.
1. G. Holland, *"**Analysis of TCP performance over mobile ad-hoc networks**".* (MOBICOM '99)
2. K. Chandran, *"**A Feedback Based Scheme for Improving TCP Performance in Ad Hoc Networks.**"* (PCS '01).
3. Jian Liu, *"**ATCP: TCP for mobile ad hoc networks**" (IEEE J-SAC '01).*

Time-out due to un-ack's, RTO freezes
4. T. Dyer, *"**A comparison of TCP performance over three routing protocols for mobile ad hoc networks.**"* (Mobihoc' 01

Out of order delivery of data/ack's indication of route failure.
5. F.Wang *"**Improving TCP performance over mobile ad-hoc networks with out-of-order detection and response**"*

- Stefano Basagni, Marco Conti et al: *"**Mobile Ad Hoc Networking**", July 2004, Wiley-IEEE Press.*

Multi-path routing and TCP

Multi-path routing detrimental to TCP Performance
1. Haejung Lim, *"**TCP Performance over Multipath Routing in Mobile Ad Hoc Networks**"* , (ICC '03).

Duplication of data, copy on each path. Improves TCP performance in a very lossy environment
2. Ye, Z *"**Effects of Multipath Routing on TCP Performance in Ad Hoc Networks**",* (*GLOBECOM '04).*

Problem Statement

- TCP and Single-path routing
  - Stale routes due to mobility. Nodes remain inactive during route re-establishment.
  - Low performance.
- TCP & Multi-path routing comprises several problems:
  - Average round trip time (RTT) estimation is not accurate under multi-path routing.
  - Window-based: Packets going through different paths may arrive at the destination out of order and trigger duplicate ACK's.
- **A "*novel transport protocol*" *(AMPT)***
  - that exploits multi-path routing,
  - tailored for wireless mobile ad hoc networks,

Our Approach-evaluation methodology

1. Multi-path routing protocols
   - Quantitative comparison of Multi-path routing protocols.
2. AMPT- Ad hoc Multi-Path Transport protocol
   - Design and development of the AMPT protocol.
3. Implementation of the AMPT protocol

Our Approach-evaluation methodology

1. Multi-path routing protocols
   - Quantitative comparison of Multi-path routing protocols:
     - Efficiency.
     - Network overhead.
     - Robustness.
   - Parameters, simulation model
     - Network size: Dimensions, # of nodes.
     - Radio/MAC: IEEE 802.11 standard.
     - Mobility: Node's speed (1,10, 20 m/s), relative motion (random waypoint, Uniform Mobility Model).
     - Traffic load: 1,5, 25 flows, bursty / non-bursty traffic.
     - Transmission/Interference range (250m/ 500m).

Our Approach-evaluation methodology

2. AMPT- Ad hoc Multi-Path Transport protocol

A transport protocol tailored for mobile ad hoc networks and multi-path routing:

- Maximize throughput
- Minimize end-to-end delay

Design space:

- Sender-based transmission scheme.

  End-to-end transport services, flow control, congestion control, congestion avoidance, fairness.

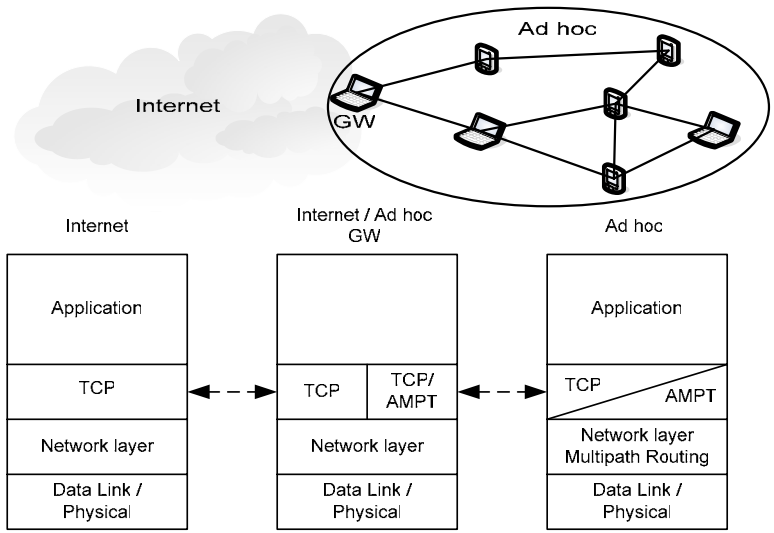
- Scheduling of packets over multiple routes.

  Round Robin, Priority queuing, WFQ.

Our Approach-evaluation methodology

2. AMPT – design goals (cont.)

- Access to the Internet and interconnection over heterogeneous network environments.
  - TCP / AMPT converter



Our Approach-evaluation methodology

2. AMPT vs TCP.
   - Throughput: simulation (various scenarios: sparse/dense populated networks, mobility models)

3. Implementation of the AMPT protocol.
   - Testing with users
   - Setup of a large scale test-bed
   - Validation of simulation results

Expected results

- Quantitative comparison of multi-path routing protocols.
- Design-development of the AMPT protocol.
- Implementation of the AMPT protocol.

Discussion

- Thank you for your attendance