# 1st Thesis Presentation: Routing in Wireless Mesh Networks

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DissSE 2007-04-19

## Overview

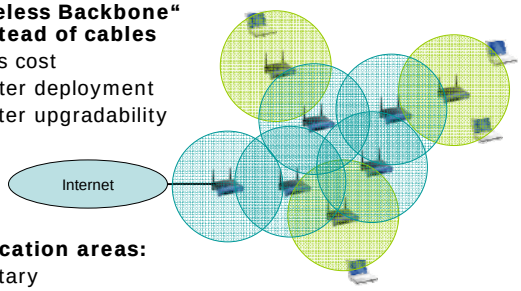
- Definition
- State-of-the-Art
- Approach
- Time Plan



## Definition / 1: Wireless Mesh Network

**"Wireless Backbone" instead of cables**

- Less cost
- Faster deployment
- Better upgradability



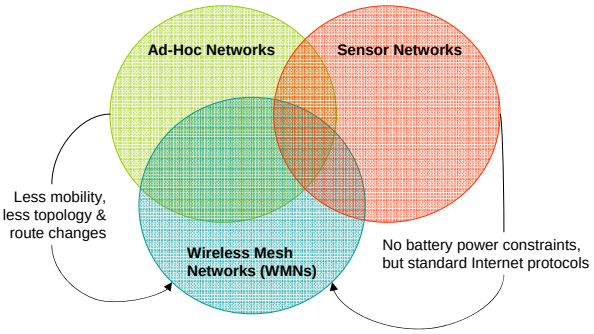

**Application areas:**

- Military
- Disaster areas / emergency response
- Civilian: access network to the Internet

Wireless Station
WLAN Router/AP



## Definition / 2: Field of Research

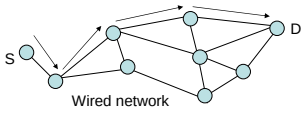





## Definition / 3: The Problem

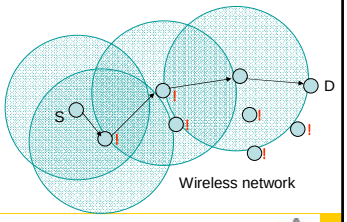
**Routing:**

- Hop-count is a bad metric:
  - Links vary over time
  - Far links are usually worse than short links




**MAC Interaction:**

- Hidden node problem
- Exposed terminal problem
- Flow-in-the-middle problem






## State-of-the-Art / 1: Protocol types

- Reactive (on-demand)
  - Build route when flow starts
  - Destroy route when flow ends
  - Drawback: route setup delay
  - Good for frequent route changes
- Pro-active
  - Build route in advance
  - Keep routes up-to-date (communicate changes)
  - Drawback: communication overhead
  - Good when routes change seldom
- Hybrid

## State-of-the-Art / 2: Protocols

**"Classical":**

- **OLSR** - Optimized Link State Routing protocol
  pro-active, *RFC 3626* (Clausen, Jaquet, 2003), used in firmwares
- **AODV** - Ad-hoc On-Demand Distance Vector
  reactive, *RFC 3561* (Perkins, Royer, Das, 2003)
- **DSDV** - Dynamic Destination-Sequenced Distance Vector
  pro-active, one of the oldest (Perkins, 1994)
- **DSR** - Dynamic Source Routing
  reactive (Johnson, 1994)

**Nature inspired:**

- Eg. Ant Hoc Net
  hybrid (DiCaro et al, 2004)

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## Ant-based Algorithms / 1

- Inspired by nature: behavior of ants
- Single ants are quite stupid, but the whole system exhibits "intelligent" behavior
- Ant Colony Routing (ACR) – distributed version of Ant-based Algorithm, eg.: **AntNet** by Di Caro and Dorigo, 1998
- **AntHocNet** for MANETs by Di Caro, Ducatelle, Gambardella, 2004:
  - AntNet concept + Extensions
  - Hybrid routing approach: reactive/pro-active

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## Ant-based Algorithms / 2

1. Whenever an ant moves, it lays a pheromone trail
2. To find its way, an ant:
   - Follows existing trails if there are any.
     Probability for choosing a trail is proportional to amount of pheromone on the trail.
   - Walks randomly if there are no trails.
3. Pheromone evaporates over time -> unused trails vanish.

- **Trail following (state transition rule)**
  determines how the ant chooses its way depending on link cost and amount of pheromone found on the trails
- **Trail laying (pheromone update rule)**
  determines how the pheromone is updated
- **Evaporation (evaporation rule)**
  determines how fast pheromone evaporates

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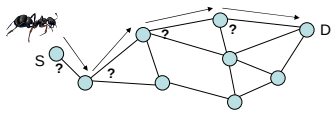
## Ant-based Algorithms / 3

- Forward ants: regularly created, choose next link based on transition rule:

  P = Trans(pheromone, link cost)

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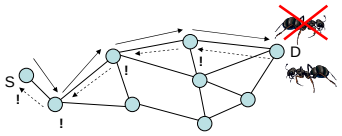
## Ant-based Algorithms / 4

- Backward ants:
  created when forward ant reaches destination node, travels back to from where it came, updates pheromone amounts and measured link costs at all nodes on way back

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## My Approach

- Simulation with ns-2 simulator

**Find new algorithm:**

- Based on ant concept
- Probably hybrid between classical and ant-based
- Probably hybrid proactive/reactive routing approach – WMNs are less mobile than MANETs
- Use better cross-layer info to determine link costs
- Reduce number of ants by observing TCP traffic in the network (possible?)

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## Time Plan

- **04/2007:** WTS'07 conference – RNG-paper
- **05/2007:** Evaluation of ns-2 wireless models (several available; lab student available)
- **-08/2007:** Define and implement algorithm in ns2; write chapter that describes algorithm
- **-12/2007:** performance evaluation; publish 2 papers about algorithm
- **-05/2008:** Finish Thesis



# Thank You!