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Cross-layer Protocol Design for Wireless Ad-hoc and Mesh Networks

Relazione annuale di attività di ricerca

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Roma, 10 Dicembre 2009

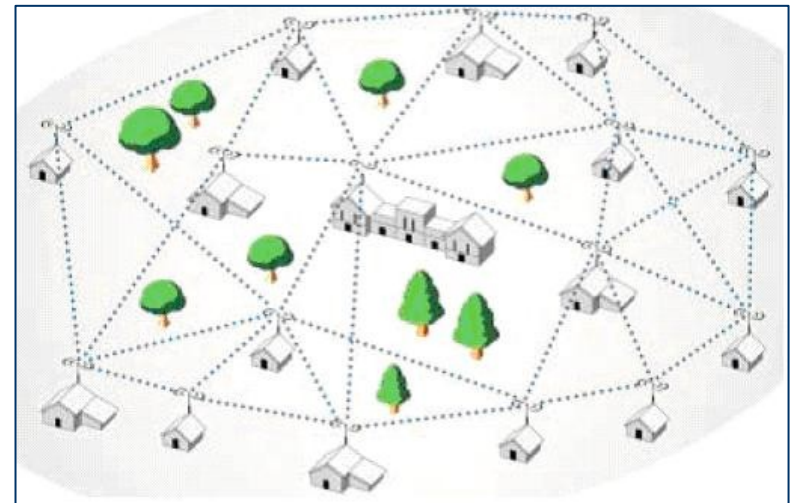
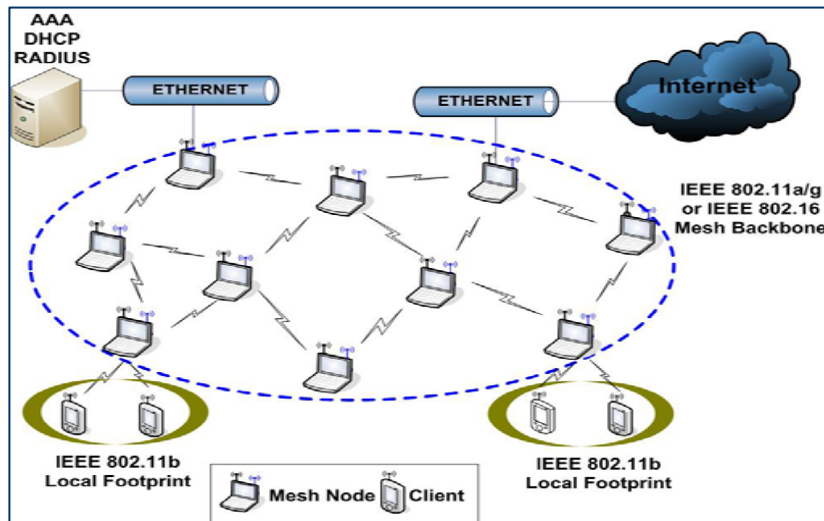
Outline

- Wireless Ad-hoc and Mesh Networks:
general description
- State of the art: protocols and standards
- Hot topics : routing and channel access
- Research activity
- Conclusions

Wireless Ad-hoc and Mesh Networks: Scenario

Topology →

- Redundant
- Dynamic
- Self-organized



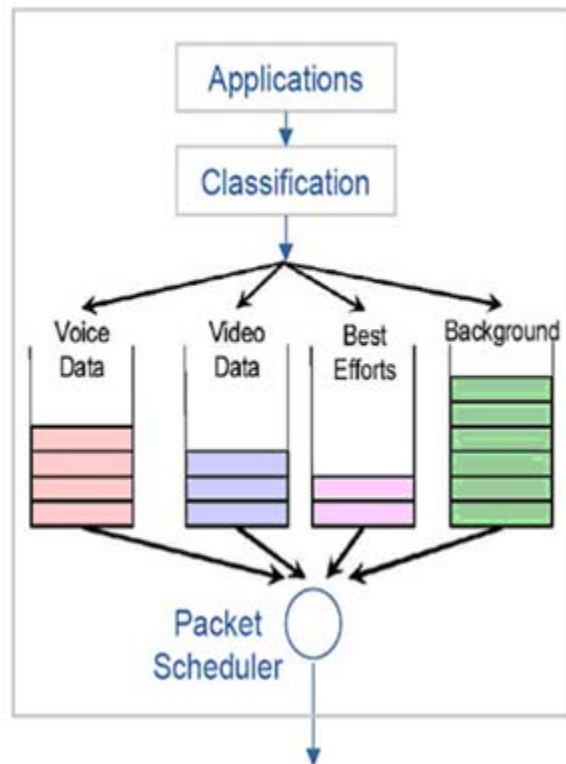
Applications →

- Dynamic coverage extension
- Disaster recovery
- ...

Protocols and Standards

- **802.11s** : IEEE Task Group S is working on the definition of a Standard for Layer 1 (PHY) and Layer 2 (MAC)
 - ↳ The most recent Active Unapproved Draft is dated on March 2009
- **IETF-manet** : IETF has created a working group on Mobile Ad-hoc Network. At present it's working on the definition of a new release of OLSR, OLSRvs2.

Hot topics (1)



RADIO CHANNEL ACCESS

Need of new access paradigms that enforce:

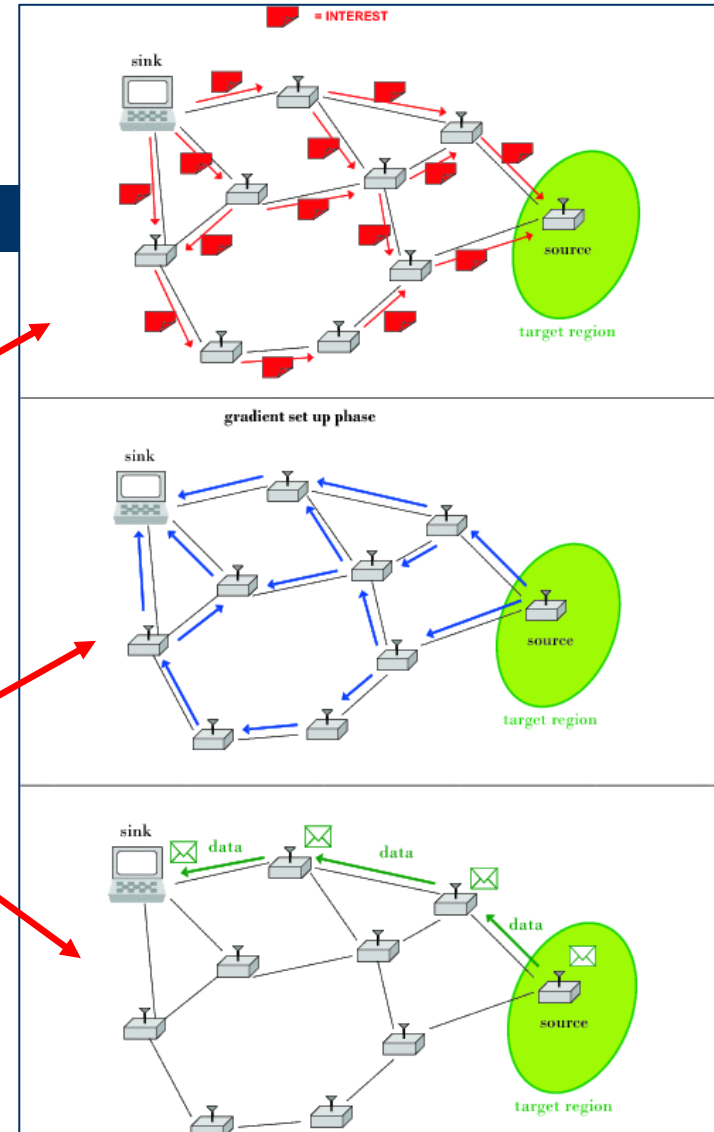
- ✓ interference avoidance
- ✓ mobility resilience
- ✓ cognitive spectrum usage (Particle Swarm)

Hot topics (2)

ROUTING

⇒ **Routing algorithm:** how to discover the path toward the destination?

⇒ **Metric definition:** which path toward the destination?



Routing metric definition (1)

In contrast with classical metric definition (ETX, ETT...), we use a **non-linear function** for combining cross-layer parameters

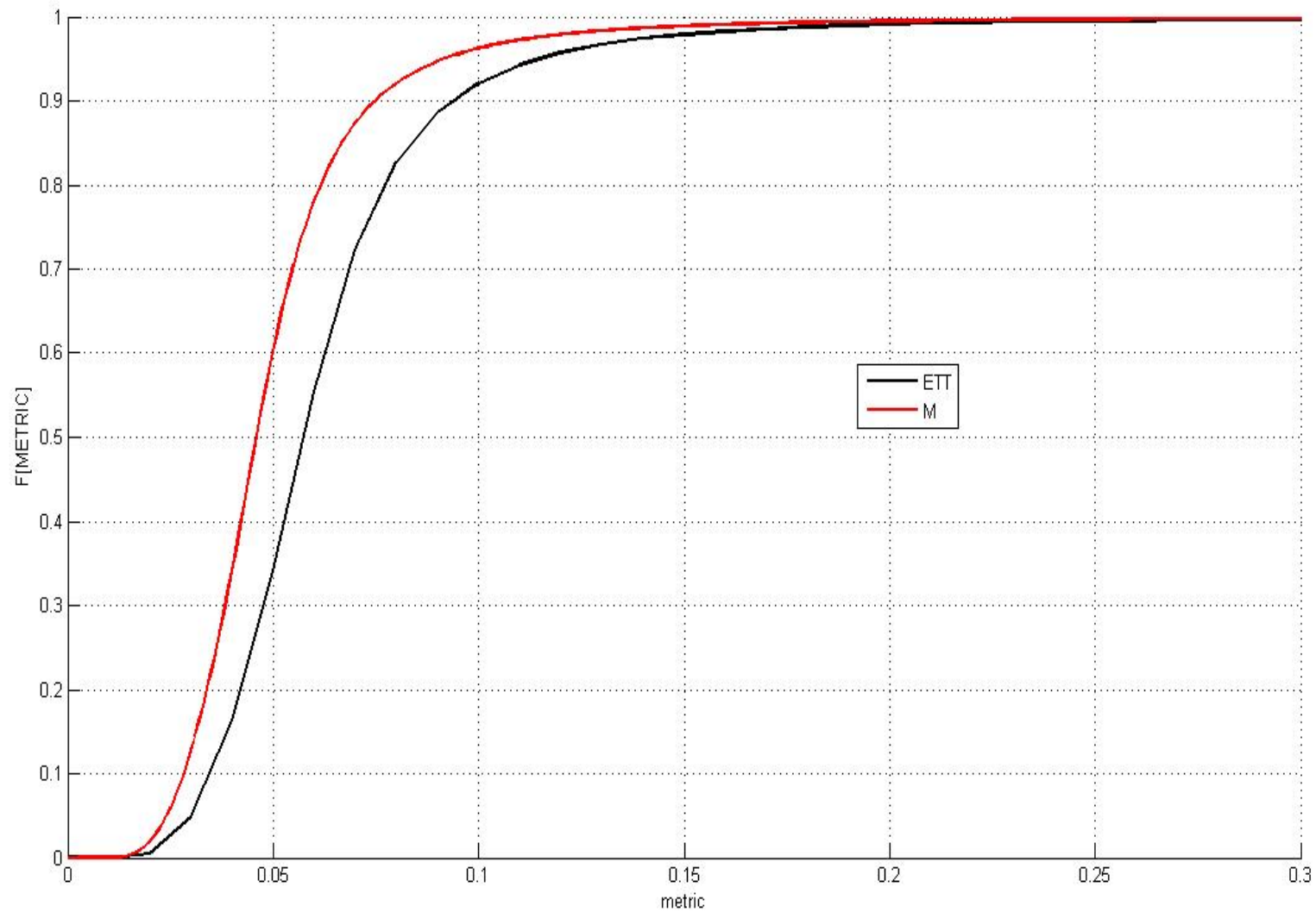


*Ref. Multidimensional Routing, a New Frontier for Wireless Global Optimization
17th International Conference on Software Telecommunications and Computer Networks
Split – Hvar-Korcula, September 24 – 26, 2009*

This approach emphasizes little variations in parameters (SNR, delay..)



The metric is more sensitive and can discern between multiple paths with more awareness



Bio-inspired routing algorithms (1)

ANT COLONY ROUTING ALGORITHMS OPTIMIZATION

Thanks to an indirect communication mechanism, named *stigmergy*, based on the release of *pheromones*, ants progressively choose the shorter path toward the food.



ROUTING PROBLEM SOLVING

Example → AntHoc for MANET

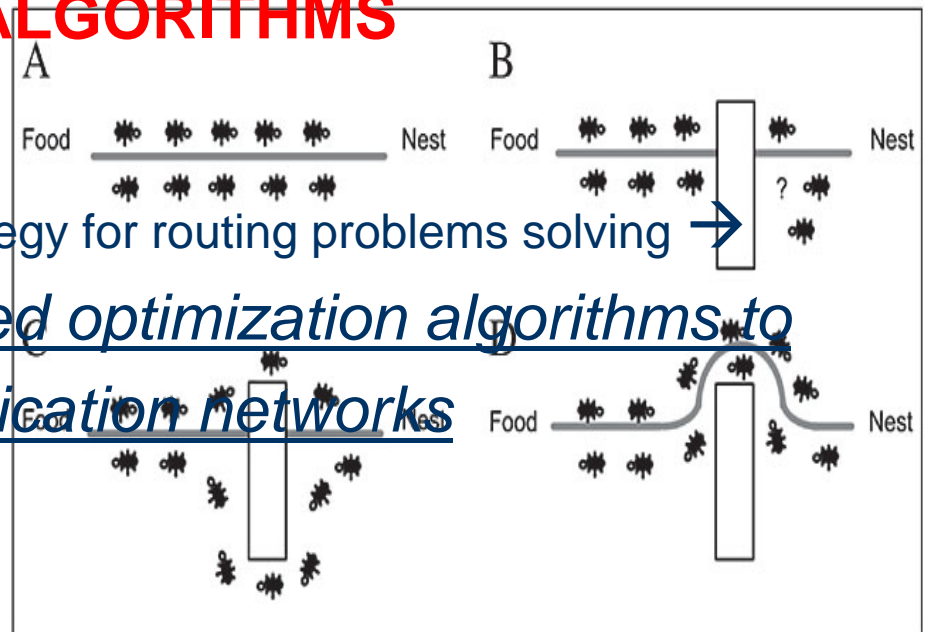


Figure 2. A. Ants in a pheromone trail between nest and food; B. an obstacle interrupts the trail; C. ants find two paths to go around the obstacle; D. a new pheromone trail is formed along the shorter path.

Application of Bio-inspired optimization algorithms to telecommunication networks

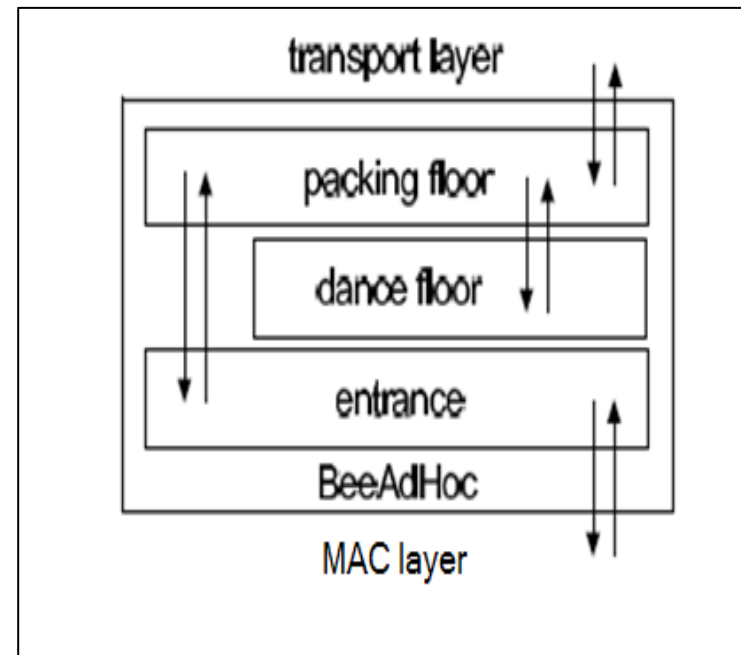
Bio-inspired routing algorithms (2)

BEE-INSPIRED ALGORITHM

BeeAdhoc Architecture →

Each **node** is compared to an **hive** and each **packet** is compared to a specific **bee** with its own role (*forager, packer, scout, beeswarm*) in the food search (route discovery toward destination).

They use a direct communication for signaling the path 'goodness' (*bee dance*)



Conclusions

- Ad-hoc and mesh networks are a very hot topic in telecommunication research
- Many different task groups are focusing on routing and channel access problems solving
- My research activity regards to routing metric definition → to use non linear function in order to emphasize the relationship between cross-layer parameters.
- Moreover we are focusing on bio-inspired algorithms both for routing and channel access problem solving

Next future goals

- ✓ Statistical analysis of non linear routing metrics, including topology consideration
- ✓ Definition of 'goodness' functions for ant/bee-inspired routing algorithms
- ✓ Performance evaluation of both non linear metrics, applied to existing protocols, and ant/bee-inspired algorithm by means of OMNet++ simulations
- ✓ Deep study of Particle Swarm and application to Channel Access



Thank you