

Control-Based Mobile Ad-hoc Networks

GAME-THEORETIC APPROACH:

Dynamic Multi-Rooted Fault Tolerant Sensor Network Architecture

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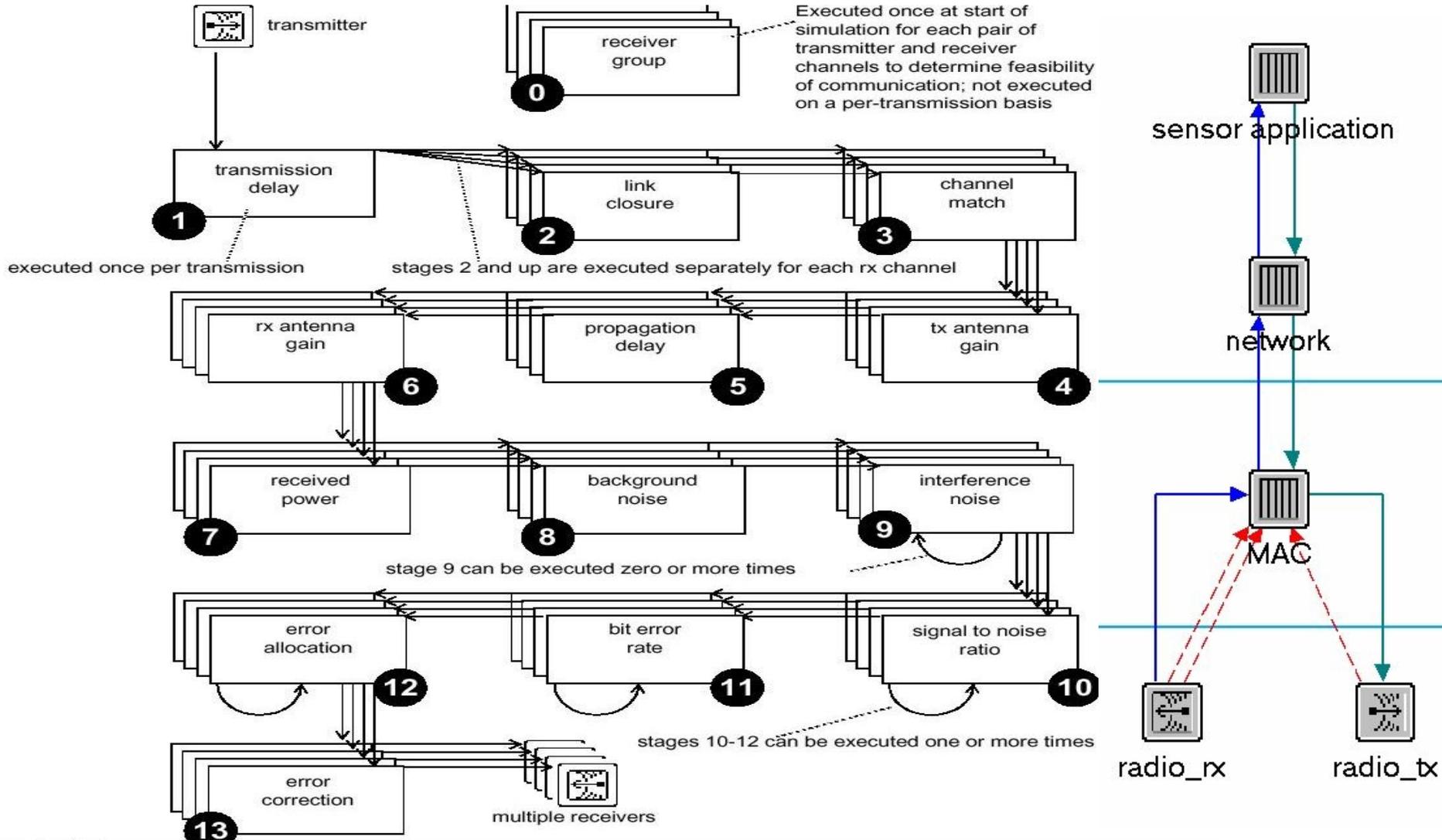


CBMANET has Three Interdependent Parts

- Model – Well-Defined (Game Rules)
 - Physical attributes (device/protocols/power/bandwidth)
 - Two types: Gateway/Mobile Nodes
 - Dynamic multi-rooted tree representation
 - *Actionable awareness*
- Search Algorithm – Adaptive (Players)
 - Each node is an adaptive player
 - Uses shared info, convergence starts from gateway
 - Propagates accumulated cost of sharing
 - *Temporal awareness*
- Evaluation Function – User-Defined (Goals)
 - Objectives/Costs
 - Risk
 - Probability
 - Criticality
 - *Utility Awareness*

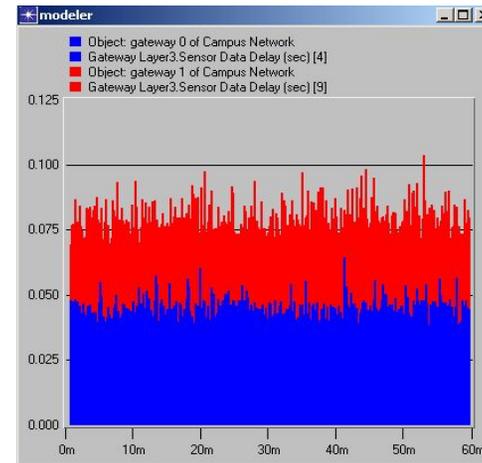
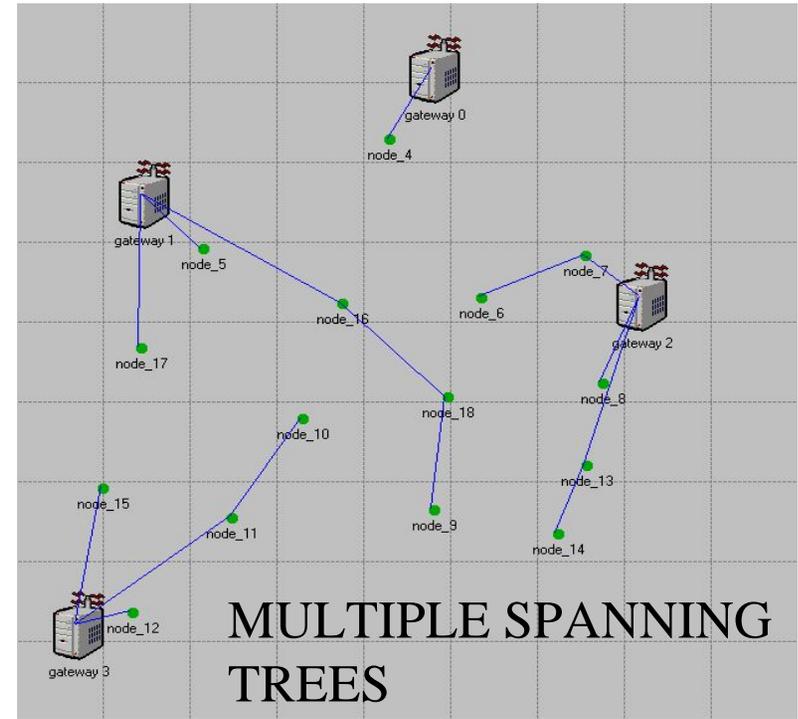
Model:

Opnet Wireless Physical Layer/Sensor Module



Search: Spans from Gateways to Mobile Nodes

- Automated topology construction
- Reduced convergence time
- Reduced MAC access delay
- Reduced end-to-end delay
- Fault-tolerant



Evaluation Function (Accumulated Cost)

$$R_i = W_1 * F_j + W_2 * P_{ij} + W_3 * H_i + \dots$$

F_j --- Fitness of node i as a parent to node j

R_i --- Fitness value of Node i

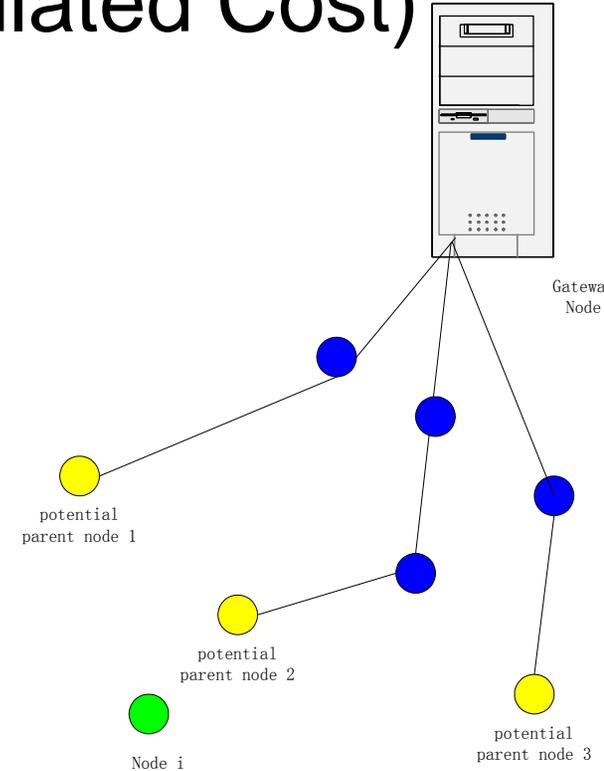
W_1 --- weight for F_i

P_{ij} --- received signal strength indicator (RSSI) for link from node j to node i

W_2 --- weight for P_{ij}

H_j --- number of hops to a gateway node

W_3 --- weight for H_j



- Connectivity converges to a multi-rooted tree where each gateway node is a root
- The distributed adaptive control mechanism propagates from gateway as accumulated cost
- Nodes recalibrate themselves based on all parent node inputs

Summary

- Transmission is only one hop to all children nodes and all parent nodes (this minimizes echoing of traffic patterns)
- Retransmission only occurs when a received packet from a child node is addressed to another child node at the receiving parent
- System is fault-tolerant to a changing environment and evaluation function
- Latency and energy are already considered (future version needs to consider capacity, fairness and priority, simply done by changing evaluation function)
- Feedback from all incoming parent nodes adaptively chooses the parent node with the least accumulated cost

Demo