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Ad-hoc and Infrastructured Networks Interconnection

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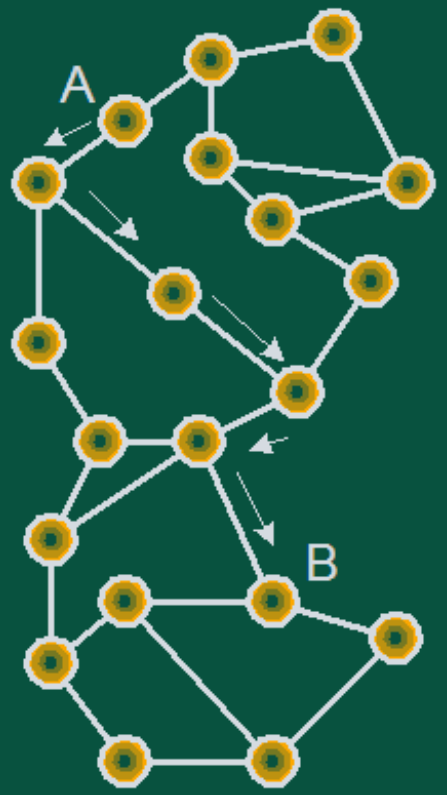
Mobile Ad-hoc Networks (MANET)

- Temporary and spontaneous
- Dynamic topology
- No centralized administration
- Every terminal is a router
- Resources (energy, BW) are limited
  - Efficient routing required



- Hot Research topics related to ad-hoc networks:
  - QoS, security, charging, routing and mobility

Ad-hoc Routing Protocol Characteristics

- Distributed Operation
  - All nodes participate on route discovery and maintenance
- Routes to individual terminals and not to networks
  - Not possible to aggregate routes
- Overhead efficiency: BW and energy
- Security: prevent selfish or malicious behaviours
- Operation approaches
  - Demand-based operation (e.g. AODV)
    - Adapt to traffic patterns on a demand basis; save energy and bandwidth
  - Proactive operation (e.g. OLSR)
    - Forwarding table has always an entry per node; small route discovery delay

AODV (RFC3561) - Ad-hoc On Demand Distance Vector

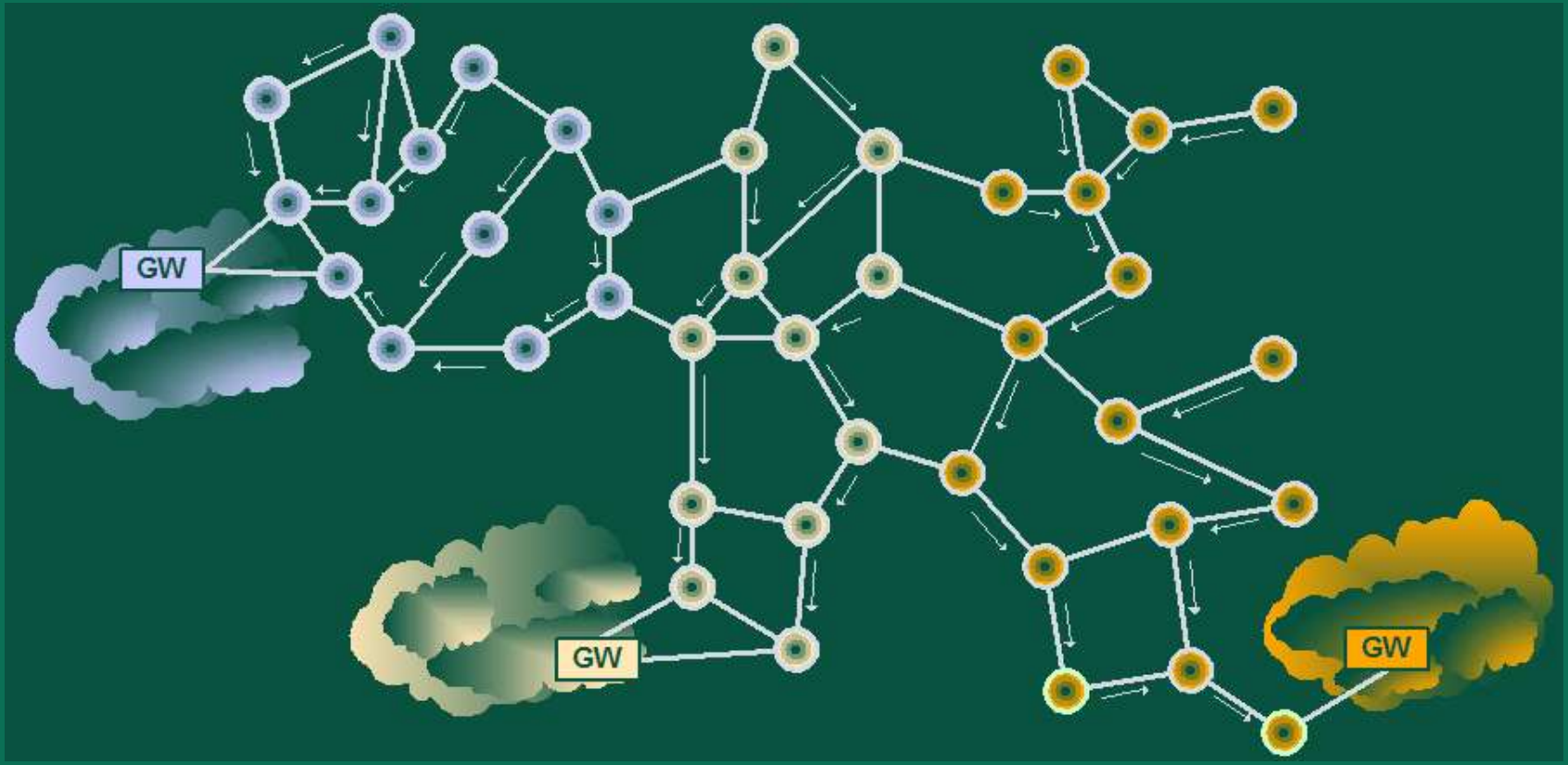
- Before sending a packet to a new destination
  - A RREQ message is disseminated
- Each node in the path caches a route back to originator
- RREP is unicast to the originator
  - From the destination or an intermediate node
- RERR sent to notify nodes when link loss occurs
- Every node in the path knows the route
  - To the destination and to the originator

Ad-hoc and Infrastructure Integration

- Extend the provider network to shadow areas
- Routing and mobility issues
  - Find the gateway to the Internet
  - Configure global IPv6 address (in the visited network)
  - Support multiple gateways
  - Distinguish ad-hoc from non ad-hoc destinations
  - Handover between gateways
- Our solution → GW_INFO
  - Based on draft-jelger-manet-gateway-autoconf-v6-02.txt
  - Many changes
  - User space daemon running on Access Routers and Mobile Terminals

GW INFO - Find the Gateway to the Infrastructured Network

- The Gateway is located in the Access Router
- Gateway periodically spreads a GW_INFO message
  - Gateway address (and prefix); distance to gateway
  - List of adjacent ad-hoc gateways (address, prefix)
- Each node selects an Upstream Neighbour (UN)
  - The next hop in the best path to the gateway
- Nodes forward GW_INFO msg received only from its UN
- Special propagation technique to avoid network flooding
- *Prefix Continuity* concept
  - Ensures every node in the best path to gateway uses same prefix


GW
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GW

GW INFO - Configure Global IPv6 Address

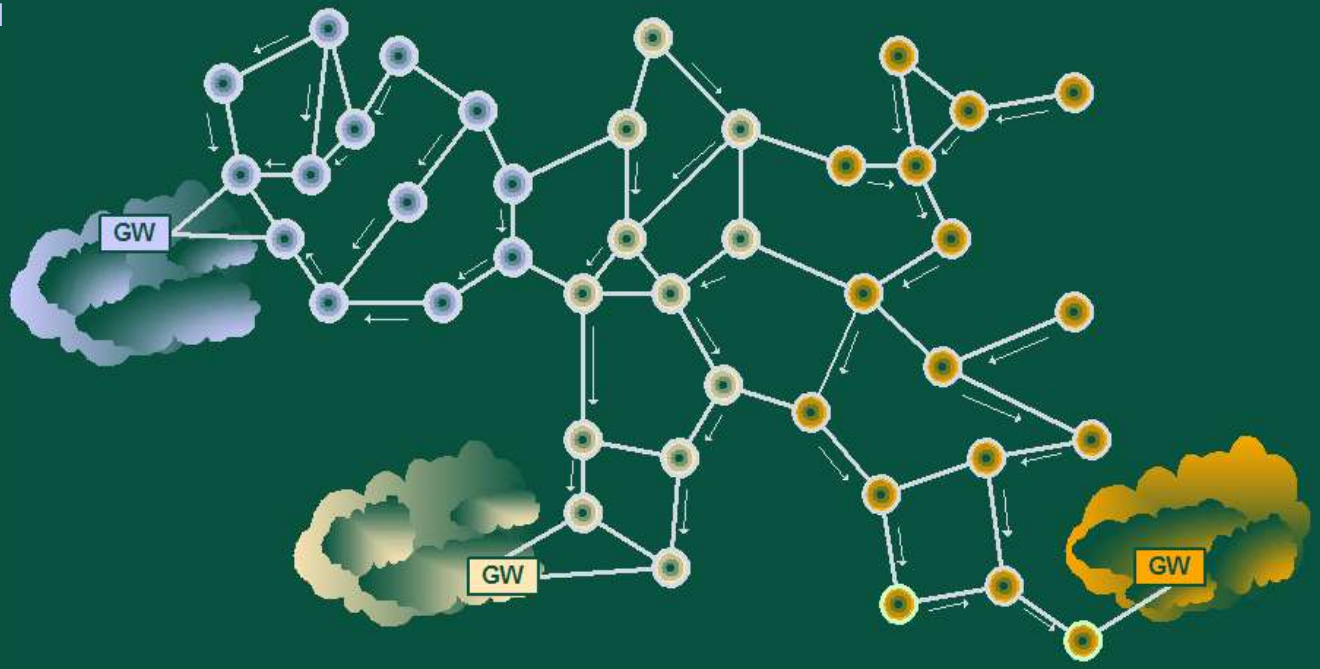
- Without MIPv6
  - Each node auto-configures a global address
  - Prefix obtained by GW_INFO message
  - IPv6 addr = Prefix (64 bits) + Interface ID (64 bits)
- With MIPv6
  - Avoid changes to MIPv6 implementation
  - Create an internal false router advertisement (r_adv)
  - MIPv6 implementation receives the r_adv
  - MIPv6 configures the address, as usual
    - Gateway prefix + EUI or CGA; Performs Binding Updates

GW INFO - Distinguish Ad-hoc from non Ad-hoc Destinations

- Interface with CARD module at the ad-hoc GW / AR
- Obtain list of adjacent ARs supporting ad-hoc
- GW_INFO msg spread in MANET carries this list
- Each node is aware of adjacent MANET prefixes
- AODV used to get routes to adjacent MANETs
- Other destinations use the path to gateway
  - Through the Upstream Neighbor

GW INFO - Handover Between Ad-hoc Networks

- MANET attached to a single GW
  - Only MANETs attached to infrastructure considered
  - Different GW ➔ Different MANET ➔ Different prefix
- Prefix / gateway selection policies
  - Min distance (hop count); max stability (maintain GW as long as possi



The Problems - Summary

- To find the best gateway and to create a global IPv6 address
  - Lower costs; Shorter path (hops); Best QoS;
  - Stability: avoid to change gateway (minimize the nº of handovers)
  - Interface with MIPv6: change CoA, necessary to BU to HA and CN
- To distinguish ad-hoc and non ad-hoc destinations
  - Optimize routes between ad-hoc nodes with different prefixes
  - Non ad-hoc destined packets are delivered to the gateway
    - Minimize overhead avoiding routing headers (tunneling)
- Handover
  - Switch between ad-hoc networks
    - Different gateway » Different prefix » Different ad-hoc network
  - Switch between ad-hoc and infra-structured operation modes

Work Carried out as a PhD Work – Expected Original Contributions

- Gateway Selection
  - Algorithm to select the best gateway
    - Considering the operation of multiple gateways simultaneously (multihoming)
- Handover
  - Efficient protocol to execute ad-hoc handover
    - Between ad-hoc networks
    - Between ad-hoc and infrastructured networks
- Interface with MIPv6
  - Method to interact with MIPv6 dealing with CoA creation
  - Optimization of the MIPv6 operation in ad-hoc networks
- Optimization of routing between ad-hoc clouds

Expected Results

- Software module
  - provide internet access to ad-hoc nodes
- Key features
  - Efficiently find and select a gateway or gateways
  - Configure global IP address considering MIPv6
  - Routing protocol independent
  - Ad-hoc handover
  - MIPv6 signaling overhead optimization