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Brief Overview of Ad Hoc Routing Protocols

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Abstract:
Manets are self configuring networks. Why manets are self configuring networks? It's because they possess they dynamic toplogy. it is difficult to predict the topology of manets. There are numerous applicable protocols for ad hoc networks, but one confusing problem is the vast number of separate protocols. This research paper deals with a classification of ad hoc routing protocols and also presents some specified protocols according to that classification. Presented protocols are selected according to an entity formed by this paper The emphasis of this paper is not to present protocols in detail but to present main features of wide variety of different protocols and evaluate their suitability and tradeoffs.

1. Introduction
Ad hoc radio networks have various implementation areas. Some areas to be mentioned are military, emergency, conferencing and sensor applications. Each of these application areas has their specific requirements for routing protocols. For example in military applications low probability of detection and interception is a key factor such is routing efficiency during fading and disturbed radio channel conditions. At sensor applications low or minimum energy consumption is a precondition for an autonomous operation. In conference applications a guaranteed quality of service for multimedia services is a needed feature. All application areas have some features and requirements for protocols in common. The routing protocol overhead traffic is not allowed to drive the network to congestion nor is a local change in link not allowed to cause a massive control traffic storm throughout the network.

2. A Taxonomy for Routing Protocols
Traditional classification is to divide protocols to table-driven and to source-initiated on-demand driven protocols [1]. Table-driven routing protocols try to maintain consistent, up-to-date routing information from each node to every other node. Source-initiated on-demand protocols create routes only when these routes are needed. One very attractive taxonomy has been introduced by Feeney [3]
. - Communication model.
What is the wireless communication model?
Multi- or single channel? **-** Structure. Are all nodes treated uniformly?
How are distinguished nodes selected? Is the addressing hierarchical or flat?
- State Information. Is network-scale topology information obtained at each node? **-** Scheduling. Is route information continually maintained for each destination? This model does not take an account for if a protocol is unicast, multicast, geocast or broadcast. Also the taxonomy doesn't deal with the question how the link or node related costs are measured. The overall taxonomy and specially the unicast protocol classification can be seen in figure 1.

2.1. Communication Model
Protocols can be divided according to communications model to protocols that are designed for multi-channel or single-channel communications. Multi-channel protocols are routing protocols generally used in TDMA or CDMA-based networks. They combine channel assignment and routing functionality. That kind of protocol is e.g. Cluster head Gateway Switched Routing (CGSR) [4].

2.2. Structure
Structure of a network can be classified according to node uniformity. In uniform protocols there is no hierarchy in network, all nodes send and respond to routing control messages at the same manner. In non-uniform protocols there is an effort to reduce the control traffic burden by separating nodes in dealing with routing information.

2.3. State Information

Protocols may be described in terms of the state information obtained at each node and / or exchanged among nodes. Topology-based protocols use the principle that every node in a network maintains large scale topology information. This principle is just the same as link-state protocols use. Destination-based protocols do not maintain large-scale topology information. They only may maintain topology information needed to know the nearest neighbours. The best known such protocols are distance-vector protocols, which maintain a distance and a vector to a destination (hop count or other metric and next hop).

2.4. Scheduling

The way to obtain route information can be a continuous or a regular procedure or it can be trigged only by on demand. On that basis the protocols can be classified to proactive and on-demand protocols. Proactive protocols, which are also know as table-driven protocols, maintain all the time routing information for all known destinations at every source. In these protocols nodes exchange route information periodically and or in response to topology change. In on-demand i.e. in reactive protocols the route is only calculated on demand basis. That means that there is no unnecessary routing information maintained. In on-demand i.e. in reactive protocols the route is only calculated on demand basis. That means that there is no unnecessary routing information maintained.

2.5. Type of Cast

Protocols can be assumed to operate at unicast, multicast, geocast or broadcast situations. In unicast protocols one source transmits messages or data packets to one destination. Multicast routing protocols try to construct a desirable routing tree or a mesh from one source to several destinations. The purpose of geocast protocols is to deliver data packets for a group of nodes which are situated on at specified geographical area. Broadcast is a basic mode of operation in wireless medium. Broadcast utility is implemented in protocols as a supported feature. Protocol only to implement broadcast function is not a sensible solution.

2.6. Cost Function

Rough classification of protocols according to cost function can be based on hop count approach (no special cost function applied) and to bandwidth or energy based cost functions. Also quite a different approach to routing metrics is used by Associatively Based Routing (ABR) protocol, which uses degree of association stability for a metric to decide for a route. That means that presumably more permanent routes are preferred. [5].

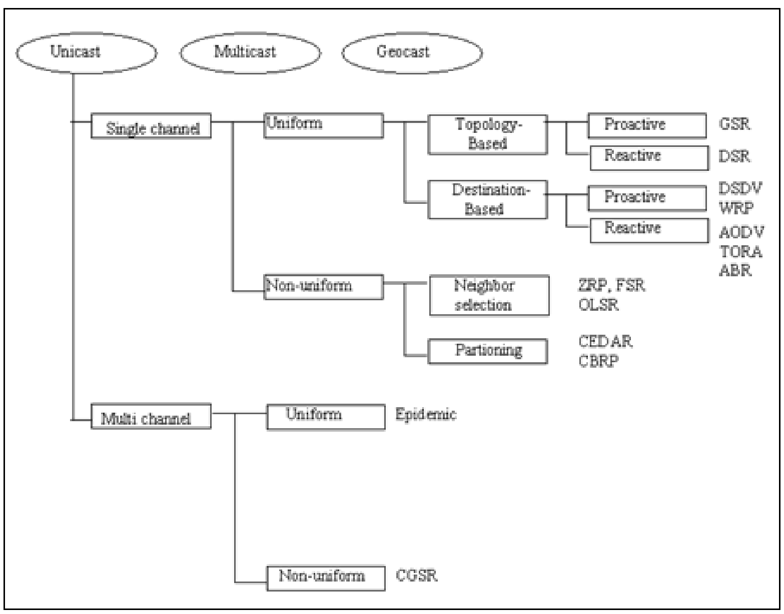

Figure 1: Taxonomy of Protocols. Classification of uncast protocols shown

3. Overview of Selected Protocols

There are unicast, single channel protocols, which are uniform or non-uniform. Uniform protocols are divided to topology-based protocols, in where nodes are aware of the topology information of all other nodes in the network or to destination-based protocols, in where nodes only know the preferred next hop to a destination. One protocol to belong to that topology-based class is GSR (Global State Routing) and the other is DSR (Destination Source Routing). One main difference between these protocols is the scheduling method. GSR is a proactive protocol, which will all the time have the information needed for routing. DSR is on its behalf reactive protocol, which will obtain needed information only on demand. To be classified to single channel, non-uniform protocols there are such protocols as ZRP, FSR, OLSR, CEDAR and CBRP. Form these protocols ZRP, FSR, and OLSR belong to neighbor selection protocols, which have a common feature to select network subsets by individual nodes themselves. In partitioning protocols there are some kind of clustering and cluster head selection mechanism. To partitioning protocols belongs e.g. CEDAR and CBRP.

3.1. Topology Based Protocols

3.1.1. GSR

Global State Routing (GSR) [6] is a uniform, topology oriented, proactive routing protocol. It is a variant of traditional link-state protocols, in which each node sends link-state information to every node in the network each time its connectivity changes. GSR reduces the cost of disseminating link-state information by relying on periodic exchange of sequenced data rather than flooding. In GSR, each node periodically broadcasts its entire
topology table to its immediate neighbours. The topology table includes the node's most recent assessment of its local connectivity and its current link-state information for the whole network topology. Based on the complete topology information in the topology table, any shortest-path algorithm can be used to compute a routing table containing the optimal next - hop information for each destination. GSR defines a variant of Dijkstra's algorithm for this purpose.

3.2. Destination Based Protocols

3.2.1. WRP

The Wireless Routing Protocol (WRP) [7] is a proactive, destination-based protocol. WRP belong to the class of path finding algorithms. In WRP there is a quite complicated table structure. Each node maintains four different tables as in many other table-driven protocols only two tables are needed. These four tables are: 1) distance table, 2) routing table, 3) linkcost(k): (pijk). The equivalent routing table contains the distance to the destination (Dij), the predecessor of the chosen shortest path to destination (pij), the successor (sij) of the chosen shortest path to destination and also a marker (tag ij) used to update routing table. The link-costtable of a node lists the cost of relaying information through each neighbour (lik). Each entry of MRL contains the sequence number of the update message, are transmission counter, an acknowledgement-required flag with one entry per neighbor and a list of updates sent in the update message. The MRL records which updates in an update message need to be retransmitted and which neighbors should acknowledge the retransmissions. Table and 4) message retransmission list (MRL) table. The distance table of a node (i) contains the distance of each destination node (j) via each neighbour (k): (Dijk) and the predecessor of destination(j) reported by neighbours

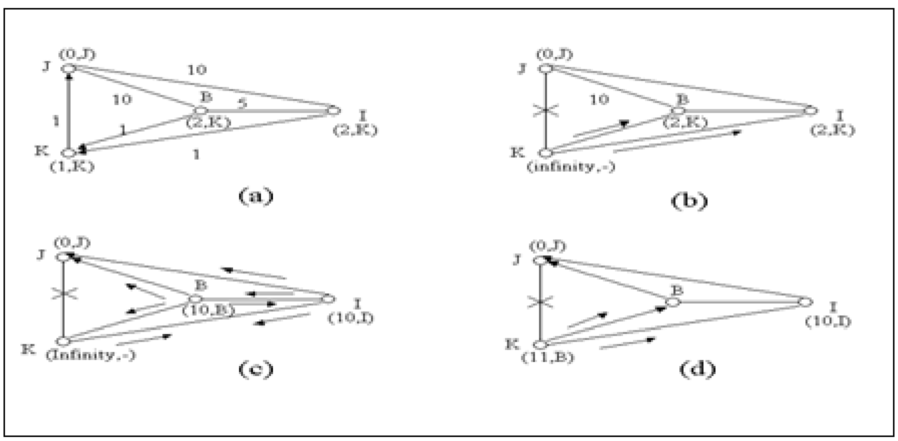

Figure 2: An example of WRP-routing protocol's operation [7]

3.3. Neighbor Selection Protocols

3.3.1. OLSR

Optimized Link State Routing (OLRS) [8] is a topology based, neighbour selection protocol, in which each node only maintains a subset of network topology information. OLRS is a proactive protocol, because it exchanges the topology information with other nodes regularly to maintain information required for routing. OLRS reduces the cost of distributing network-scale link-state information by two ways. First, it uses multipoint relays (MRP) [9] to reduce redundant rebroadcasting during flooding operation. That is the key concept of the protocol. MRPs are selected nodes, which forward broadcast messages during the flooding process. In figures 3 (a) and 3 (b) there is an illustrative example of what is the cost difference between broadcast by flooding and by multipoint relays.

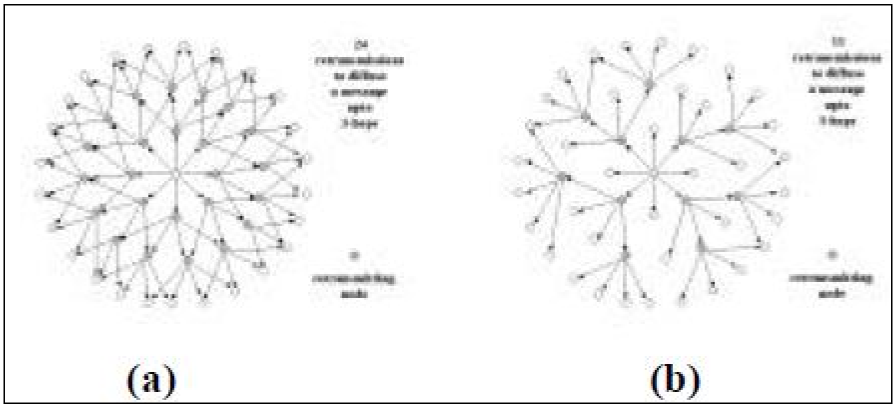

Figure 3: Diffusion of broadcast message using pure flooding (a) and multipoint relays (b) [9]

In the OLSR protocol, each node uses this flooding technique to distribute the link-state of its own MPR set. This is done periodically. The update period is in its minimum when there is detected a change and when the network is in its stabile state there is a updates only between refresh intervals. Each node uses the attained topology information to construct its routing tables.

Parameters	DVMRP	AODV	CAMP	ODMRP
Multicast delivery structure	Source-based tree	Core-based tree	Multicast mesh	Group-based
Use of centralized node	No	Yes (Multicast group leader	Yes (Core nodes)	No
Core node recovery	N/A	Yes	Yes	N/A
Routing scheme	Table-driven	On-demand	Table-driven	On-demand
Dependence on unicast routing protocol	No	No	Yes	No
Routing approach	Flat	Flat	Flat	Flat
Routing metric	Shortest path	Shortest path to another multicast member along the existing shared tree	Shortest path	Shortest path

Table 1: characteristics of various multicast mobile adhoc network multicast routuing protocals

4. Applicability of different Protocols

4.1. Evaluation Criteria

Different kind of ad hoc routing protocols are suitable for different kind of network structures and node behaviours. When evaluating protocols one needs some appropriate classification also for the features of performance metrics. The critical features for ad hoc networks can be classified according to Subbaro [19] to following quantitative and qualitative features. Quantitative features are:

- **Network settling time**, which is the time for a network to reach a stable state and be able to send its first message reliably.
- **Network join time**, which is the time for an entering node or group of nodes to become integrated into the ad hoc network.
- **Network depart time,** which is the time required for the ad hoc network to recognize the loss of one or more nodes, and reorganize itself to manage lacking links.
- **Network recovery time**, which is the time for a network to recover after a condition that dictates reorganization of the network.

- **Frequency of updates**, which is the number of control packets or overhead bytes inside packets to be sent in a given time to maintain proper network operation. This means also same as overhead.
- **Memory required**, which is the storage space required for routing tables and other management tables.
- **Network scalability number**, which is the number of nodes that a network can scale to and
- still preserve communications. According to RFC 2501 [20] quantitative metrics for
- network routing protocol performance are:
- **Route acquisition time** , which is a particular concern for on-demand protocols
- **Percentage out-of-order delivery**, which can affect how efficiently transport layer protocols can perform it's own task..
- **Efficiency**, which is an internal measure of protocols effectiveness. It deals with the protocol overhead questions. It could be said to be some kind of utilization ratio between routing effectiveness and overhead .Network recovery time is an important factor for fast changing dynamic networks. If the recovery time is too long, it causes the network to maintain a too long a time an unstable state. That causes routing errors to happen, which on its side causes lost packets and needs for retransmissions. Frequency of updates is also a meaningful parameter for bandwidth constrained radio networks. If the protocol needs too often or too large update packets to be sent, it will consume in dynamic networks too much available total capacity. Network scalability number has a meaning when there is a need for large scale networks to be constructed. large scale is not a clear term, but the number of nodes can surprisingly grow up, when ad hoc environments reach their success. In military environments scalability is an essence. The qualitative critical features are the following:
- **Knowledge of nodal locations**. Does the routing algorithm require local or global knowledge of the network?
- **Effect to topology changes**. Does the routing algorithm need complete restructuring or incremental updates?
- **Adaptation to radio communications environment**. Do nodes use estimation knowledge of fading, shadowing or multiuse interference on links in their routing decisions?
- **Power Consciousness**. Does the network employ routing mechanisms that consider the
- Remaining battery life of a node?
- **Single or multichannel**. Does the routing algorithm utilize a separate control channel?
- **Bidirectional or unidirectional links**. Does the routing algorithm perform efficiently on unidirectional links.
- **Preservation of network security**. Does the routing algorithm uphold the fidelity of the network, for example low probability of detection or interception and overall security features.
- **QoS routing and handling of priority messages**. Does the routing algorithm support
- Priority messaging and reduction of latency for delay sensitive real time traffic? Can the
- Network send priority messages even when it is overloaded with routine traffic levels.
- **Real-time voice and video services**. Can the network support simultaneously real-time Multicast voice and/ or video on-demand services while supporting other routine traffic services? The RFC 2501 also mention some qualitative properties. One feature not mentioned above is ability to usemultiple routes to avoid congestion One very important question is, if a protocol is able to use only bidirectional links. Decision not to use unidirectional links, may have noticeable effects to total network throughput. Quite many ad hoc protocols are only operating at bi-directional links, some to mention are e.g. DSDV and AODV. Unidirectional links in ad hoc environment are not exceptions, because of asymmetrical nature of radio channel caused by interference, jamming and different receiver or transmitter characteristics. Quality of services and support for real time services, including priority messages and data packets, is an acute problem to be solved. Applications to need these services will emerge most probably in all ad hoc network solutions, so the implemented routing method should support that need. Also scalability and congestion avoidance management will be a main feature for any routing protocol to be used in any real life implementations.

4.2. Small Scale Static Networks

When choosing a routing protocol for a small-scale static network there is not so many constrains to take into account. Because of small size and minor node movements, proactive protocols have no problems to keep up with their tables. Non-uniform protocols would surely be overkill. The question to be important may be closely associated to energy constrain issues, when dealing with e.g. sensor networks or with laptop computers. Also questions related to real time voice or video services may be relevant. Ability to use multiple routes could be an important issue. That is because of ever increasing interference phenomena, typical for license-free radio bands. A sudden appearing interference should not interrupt the ongoing voice transmission, but the routing protocol should be able to manage that situation seamlessly. From presented protocols GSR or WRP may be the right selection, but also one should consider to use some mesh based multicast protocols e.g. CAMP. The advantage for the mesh-based approach is the ability to maintain several routes, which is a robust method against interference as well as for managing the movement.

4.3. Summary of Applicability

It is possible to construct some kind of suitability chart to be used for protocol evaluation. Below there is one such chart, which is based only to intuitive assumption about earlier mentioned design principles.

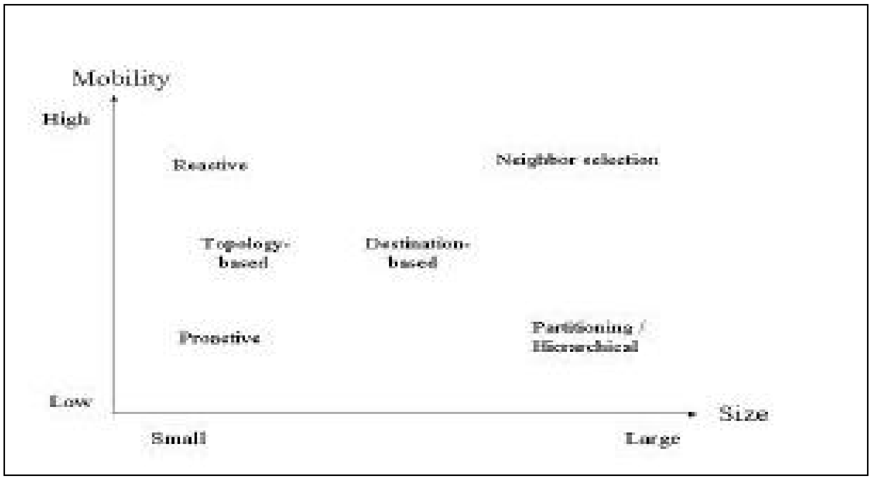

Figure 11: Suitability of Different kind of Ad hoc Routing Protocols

5. The Assumptions Made are the Following

- Proactive protocols have poorer performance: Characteristics with high mobility networks than reactive have. This is based on the fact that with high mobility it is not an easy task to manage consistent network information in all nodes.
- Topology-based protocols have the disadvantage to disseminate the topology information over the network. As the network size grows, it is a complicated task to transfer high amount of topology information especially over low bandwidth wireless links. Destination based protocols are assumed to scale a little bit better, because of smaller control traffic amounts.- With very large size some kind of differentiation is an essence. The differentiation can be based on hierarchical structures, but these are hard to maintain while the network isin high mobile state. So the neighbour selection protocols are preferred over partitioningprotocols when mobility increases.

6. Conclusion

The presented taxonomy of routing protocols is a meaningful attempt to clarify the vast field of ad hoc routing protocols. The taxonomy is a little bit complicated and itis not always an easy task to classify a protocol according to that taxonomy, but the meaning of classifying is try to get some rough basis for protocol's performance evaluation. When comparing the simulation result of presented protocols, there is a little difficult situation to reach a common understanding about the results. This is because of every simulation has been conducted according to different premises. One question arises if there should be
a common framework for tests and simulations. That definition could be a part of e.g. RFC 2501, which concentrates to routing performance issues and evaluation of protocols.

7. References

1. E.M. Royer, C-K. Toh, A Review of Current Routing Protocols for Ad-Hoc Mobile Wireless Networks, IEEE Personal Communications Magazine, April 1999, pp. 46-55. http://www.cs.ucsb.edu/.
2. N. Nikaein, H. Labiod, C. Bonnet, "DDRDistributed Dynamic Routing Algorithm for Mobile Ad-Hoc Networks", Proceedings of the First Annual Workshop on Mobile Ad HocNetwork&Computing, MobiHOC 2000, Boston,pages 19-27, August 2000. http://www.eurecom.fr/~nikaeinn/ddr.pdf
3. L.M. Feeney: Taxonomy for Routing Protocols in Mobile Ad Hoc Networks", SICS TechnicalReport T99/07, October 1999. http://www.sics.se/~lmfeeney/research.html
4. C.C. Chiang, H.K. Wu, W. Liu, M. Gerla, "Routingin Clustered Multihop Mobile Wireless Networks with Fading Channel", Proceeding of IEEE Singapore International Conference on Networks, SICON'97, pages 197-212, April 1997. http://www1.ics.uci.edu/~atm/adhoc/papercollection/gerla-routing-clustered-sicon97.pdf
5. C-K. Toh, "Associativity-Based Routing Protocol to Support Ad-Hoc Mobile Computing", Wireless Personal Communications Journal, Special Issue on Mobile Networking and Computing Systems, Vol.4, No. 2, pp.103-139, March 1997. http://citeseer.nj.nec.com/context/738649/0
6. T. Chen, M. Gerla, "Global State Routing: A new Routing Scheme for Ad-Hoc Wireless Networks", Proceedings of IEEE ICC'98, pages 171-175, August 1998. http://www1.ics.uci.edu/~atm/adhoc/papercollection/papers.html
7. S. Murphy, J.J. Garcia-Luna-Aceves, "An Efficient Routing Protocol for Wireless Networks", ACM Mobile Networks and Applications Journal, pages 183-197, Nov.1996. http://citeseer.nj.nec.com/10238.html
8. Philippe Jaquet, Paul Muhlethaler, Amir Qayyum, "Optimized Link State Routing Protocol", IETF Draft, 2001. http://www.ietf.org/internetdrafts/draft-ietf-manet-olsr-06.txt
9. A. Qayym, L. Viennot, A. Laouiti. Multipoint relaying: An efficien technique for flooding in mobile wireless networks. INRIA research report RR-3898, 2000. http://www.inria.fr/rrrt/rr-3898.html

10. A. Iwata, C.C. Chiang, G. Pei, M. Gerla, T.W. Chen, “Scalable Routing Strategies for Ad-Hoc Wireless Networks”, IEEE Journal on Selected Areas in Communications, pages 17(8): 1369-1379, August 1999. http://www.cise.ufl.edu/~tld/research/resources.html
11. M Gerla, X. Hong, G. Pei. Fisheye State Routing Protocol (FSR) for Ad Hoc Networks, IETF Draft, 2001. http://www.ietf.org/internet-drafts/draft-ietfmanet-fsr-02.txt
12. R. Sivakumar, P. Sinha, V. Bharghavan. CEDAR: a Core-Extraction Distributed Ad hoc Routing algorithm. IEEE Journal on Selected Areas in Communications, Vol 17, No 8, August 1999. http://www.cs.cornell.edu/People/egs/615/sivakumar99cedar.pdf
13. A. Vahdat, B. Becker: Epidemic Routing for Partially-Connected Ad Hoc Networks. http://www.cs.duke.edu/~vahdat/ps/epidemic.pdf
14. E.L. Madruga, J.J. Garcia -Luna-Aceves. Scalable Multicasting: The Core-Assisted Mesh Protocol. 1999. http://www.ee.surrey.ac.uk/Personal/G.Aggelou/PAPERS/madruga.monet99.pdf
15. C-K Toh. Ad Hoc Mobile Wireless Networks,Protocols and systems. Prentice Hall PTR. 2002. ISBN 0-13-007817-4