Performance Comparison of Ad Hoc Routing Protocols Based on Energy Consumption

Laurent Ouakil, Sidi-Mohammed Senouci, Guy Pujolle
Laboratoire LIP6
Université de Paris VI
8, rue du Capitaine Scott
75015 Paris – France
Laurent.Ouakil@lip6.fr
Sidi-Mohammed.Senouci@lip6.fr
Guy.Pujolle@lip6.fr

ABSTRACT
In this paper, we describe a major issue of ad-hoc networks. It concerns energy consumption since nodes are usually mobile and battery-operated. We present the results of a detailed simulation comparing, with respect to energy consumption, four ad hoc routing protocols that cover a range of design choices: DSR, AODV, DSDV and a new protocol OLSR [3]. A set of experiments was carried out to evaluate how the different approaches and algorithms affect the energy usage in mobile devices.

Keywords
Ad hoc routing, energy efficiency, performance evaluation.

INTRODUCTION
A "mobile ad hoc network" (MANET) is an autonomous and cooperative system, with a collection of wireless mobile nodes dynamically forming a temporary network without centralized control or established communication infrastructure. The nodes are free to move and organize themselves arbitrarily. When a receiving node is out of the direct range of the sending node, other nodes maintain network connectivity by routing packets for each other. Ad hoc routing protocols can be broadly classified as proactive routing protocols and reactive routing protocols [5].

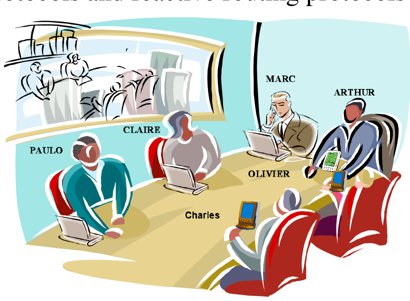

Figure 1. An ad hoc network in a meeting room.

Such infrastructureless networks are usually needed in battlefields, disaster areas, and meetings (cf. figure 1), because of their capability of handling node failures and fast topology changes. Those networks provide mobile users with *ubiquitous* communication capability and information access regardless of location.

One important aspect of ad-hoc networks is energy-efficiency since only a simple battery provides nodes autonomy. Every computation performed within the ad hoc node, and every packet (sent/received/forwarded) drains this finite resource. Thus, minimizing energy consumption is a major challenge in these networks where terminals have in addition a routing function. The type of routing protocol affects the energy dynamics in two ways – first, the routing overhead affects the amount of energy used for sending and receiving the routing packets, and second, the chosen routes affects which nodes will have a faster decrease in energy.

In this paper, we are concerned with ad hoc networks where nodes are battery-powered. We do not implement any energy-efficiency algorithms, but instead, we want to compare two proactive protocols (DSDV and OLSR) and two reactive protocols (DSR and AODV).

SYSTEM MODEL
To compare these protocols, we simulate an ad hoc network using the network simulator NS-2[1]. Energy consumption is mainly used by transmission and reception of data packets, including naturally forwarding packets and updating broadcasts.

EXPERIMENTAL RESULTS
A set of simulations was carried out, including different parameters: node speed, node number, area size, and traffic pattern.

Node speed varying
The effect of node speed is shown in figure 2. This experiment indicates that reactive protocols such as DSR and AODV use less energy than proactive protocols. Reactive protocols do not do any routing when there is no

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[1] Developed by the VINT research group at California university at Berkeley.

traffic in the network, whereas proactive protocols are constantly consuming energy by computing routes even when no data will be sent.

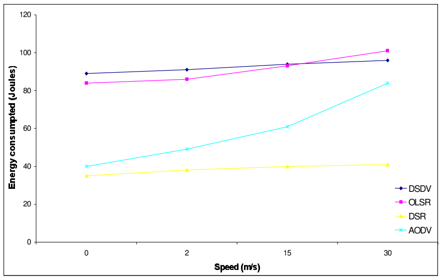

Figure 2. Energy consumption as a function of node speed.

Node number varying

We can see in figure 3, that reactive protocols outperform again proactive protocols when the node number grows. As the number of nodes grows, as proactive protocols suffer from their constant updates. Thus, proactive protocols have a scalability problem.

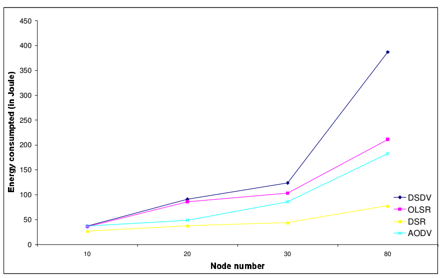

Figure 3. Energy consumption as a function of node number.

Area size varying

In figure 4, the distinction between proactive and reactive protocols disappears. Even if DSR has always a regular behavior, AODV consumes more than the two other proactive protocols. In large spaces, nodes are more spaced, and thus have more routing functions to assume.

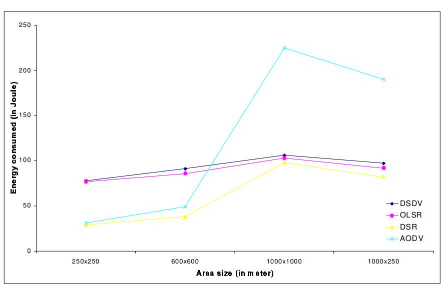

Figure 4. Energy consumption as a function of area size

Traffic and source number varying

Finally, figure 5 and 6 show a similar behavior of the routing protocols since the varying parameters concern the traffic. DSDV and OLSR outperform AODV in this approach.

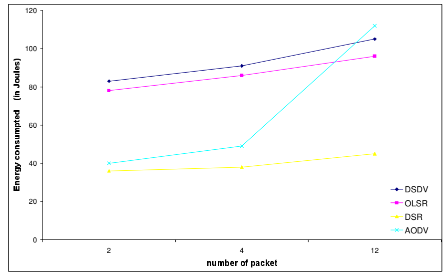

Figure 5. Energy consumption as a function of packet rate.

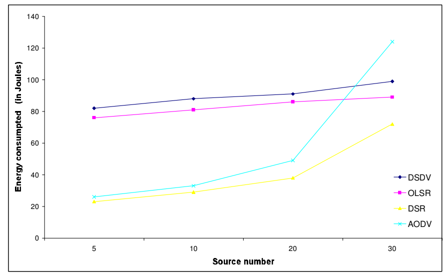

Figure 6. Energy consumption as a function of source number.

CONCLUSION

In this paper, we have seen that routing protocols affect clearly energy consumption. We have also seen that the choice of a routing protocol is linked to different parameters in the network (mobility, traffic type, number of nodes). The experiments show that:

- DSDV is efficient in a predictable scenario but inefficient in a mobile scenario;
- OLSR is efficient as a good compromise because it has never the worst results (but never the best);
- DSR is efficient with a mobility scenario but source routing increase the overhead;
- AODV is efficient with mobility and eliminates source routing overhead but discovery route requires more overhead and actually is more expensive than DSR.

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