

## Selecting the routing protocol for networking an adaptive mobile network with mesh topology

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**Abstract.** In this paper, we report about selecting the routing protocol for networking an adaptive mobile network with mesh topology. Routing protocols that operate over wireless mesh networks are described. An adaptive wireless mobile network model is built-up in ns2 network simulator. A problem of routing protocol multicriteria choice is solved using the hierarchy analysis method.

**Keywords:** wireless networks; routing protocols; hierarchy analysis method.

### 1. Introduction

The focus on the routing over the mesh networks is determined by the complicate topology, high mobility and other peculiarities of mesh topology networks that make searching and maintaining the shortest route to the destination the crucial mechanism for efficient network operation. The routing protocol should use multiple possible routes; it should have an intelligent selection mechanism for selecting the optimal route, be reliable and failsafe and at the same time scalable and compatible with various radio transmission technologies. Routing over mobile communication networks is considered to be an intricate task due to mobile service and subscriber heterogeneity which brings to the need of re-routing.

Nowadays there are a lot of algorithms that provide data transmission route searching over wireless networks. The most developed routing protocols are protocols concerned with network topology [1]. They can be divided into the following categories: proactive, reactive and hybrid (TABLE I) [2].

TABLE I. ROUTING PROTOCOL CLASSIFICATION FOR ADAPTIVE MOBILE MESH NETWORKS.

<i>Adaptive mobile network routing protocols</i>			
<i>With network topology binding</i>			<i>Geo-routing</i>
<i>Proactive:</i>	<i>Reactive:</i>	<i>Hybrid:</i>	
DSDV	AODV	ZPR	GPSR
RA-OLSR	RM-AODV	HWMP	LAR
TBRPF	DSR	LANMAR	MFR
OSPF	TORA	CEDAR	NFP
CGSR	LMR		DREAM
WRP	ABR		GLS
RIP	SSR		
FSR	RDMA		
TBRPF	SSA		

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The first protocol group provides routing by using the predetermined and periodically updated network-state tables, whereas reactive type protocols realize “on-demand routing” creating the route after the Request to Transmit. The hybrid protocols combine proactive and reactive routing schemes.

The optimal network route choice is made on the base of various criteria (metrics). The most common metrics is path length.

## 2. Selecting the routing protocol for networking an adaptive mobile network with mesh topology

### 2.1. Means for simulating the wireless networks Ns2

The network simulator ns2 [3] was used as a simulation means; it is a program product with an open code that combines the network simulator, various protocol implementation and visualization means, traffic model means, etc.

Ns2 is an object-oriented software and its core is implemented in C++ [4]. OTcl (Object oriented Tool Command Language) is used as a simulation scenario language. Ns2 supports entirely the C++ classes’ hierarchy and detailed OTcl classes’ hierarchy. Both hierarchies have the same structure, i.e., there is a single-valued correspondence between the same classes of the two hierarchies. The usage of two programming languages in ns2 is explained by the requirement to use a system language for the detailed protocol simulation and also by the ease of operating the higher abstraction level programming language to realize and modify various simulation models. Such an approach is a compromise between the ease of operation and velocity.

The using of ns2 makes it possible to describe the network topology, traffic sources and receivers configuration, connection parameters (the passband, the delay, the packet loss probability and many other simulated system parameters. In the course of simulation it is possible to control buffer parameters, to monitor received, transmitted and lost packets, to gather statistics and etc. The output trace-file generation provides information on the traffic dynamics, connections state and network object state as well as protocol operation.

The simulator uses an interpreter which is otclsh command shell add-on with the using of command and configuration interface in OTcl language (that is an object-oriented version for Tcl, Tool Command Language) In this case simulation is implemented by means of OTcl scenarios/scripts.

The authors have analyzed a series of routing peculiarities in wireless mesh networks having a mesh topology [5, 6]. The present paper compares DSDV, AODV and DSR protocols using the wireless mobile distributed network model. A wireless network model has been simulated that consisted of 50 subscribers’ stations. The network was deployed in the area of 670x670 meters. The stations were supposed to be mobile with random velocity values within the range 0 to 20 m/s. Each station had time periods of stationarity and move. In the stationary periods it was fixed, while in mobile periods it started moving with random velocity and direction. The mobile period started once terminated the stationary period. In the beginning of the movement, the station selected the destination point and started moving in its direction. Once reached the destination point, the station passed to the fixed mode. AODV, DSDV and DSR protocols have the same motion law and network node location. In the course of simulation, a constant bit rate graph (CBR) was used, the packet size was set to be equal to 1024 bytes, the number of packets was 1000.

For the radio wave propagation model, a two-ray signal model with reflecting one of the rays from the surface (TwoRayGround) is used. With the using of the said model, the input signal power  $P_r$  is defined from the following formula:

$$P_r = \frac{P_t G_t G_r h_t^2 h_r^2}{d^4} \quad (1)$$

where  $d$  is the distance between the receiver and the transmitter,  $P_t$  is transmit signal power,  $G_t$ ,  $G_r$  are gain factors and  $h_t$ ,  $h_r$  are the transmitting and receiving antennae elevation heights, respectively (Fig. 1, Fig. 2, Fig. 3, TABLE II).

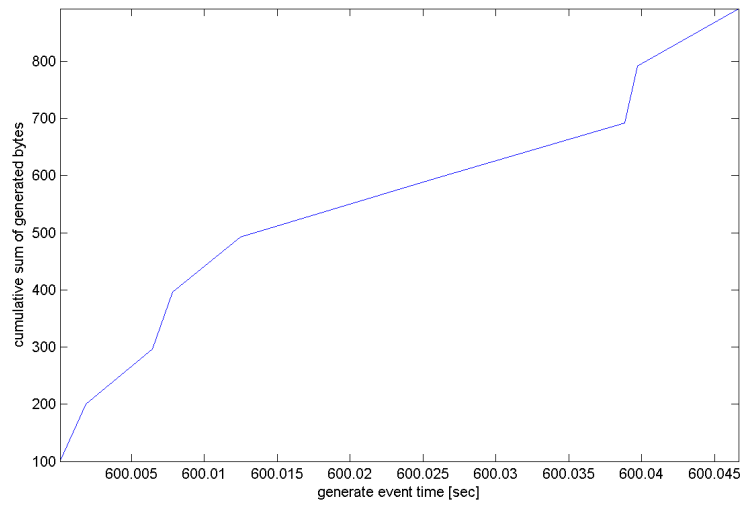


Fig. 1: Total AODV routing protocol overhead amount in function of time.

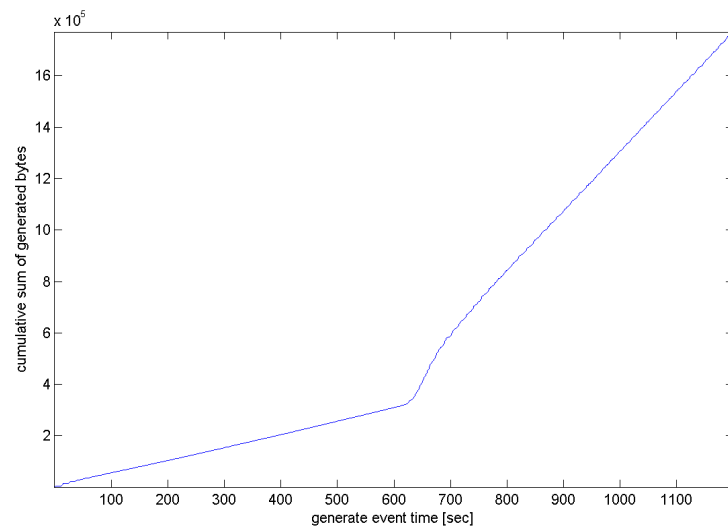


Fig. 2: Total DSDV routing protocol overhead amount in function of time.

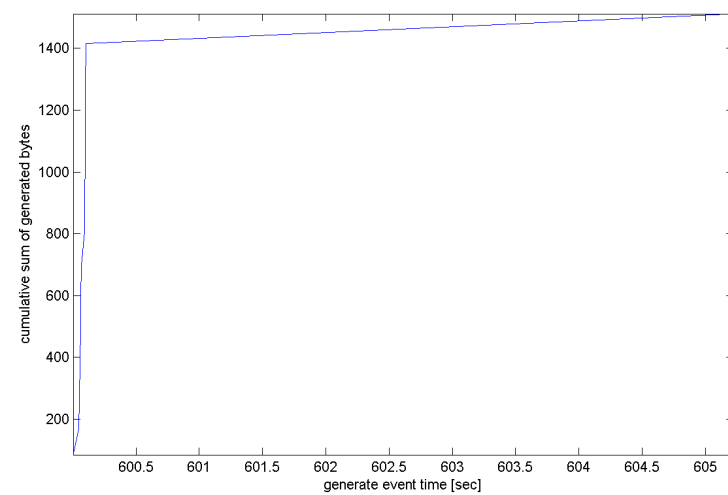


Fig. 3: Total DSR routing protocol overhead amount in function of time.

TABLE II. SIMULATION RESULTS.

AODV	Lost information amount, byte	0
	Retransmitted information amount, byte	1024000
	Transmission time, s	126.6944
DSDV	Lost information amount, byte	5256
	Retransmitted information amount, byte	36220
	Transmission time, s	129.8505
DSR	Lost information amount, byte	0
	Retransmitted information amount, byte	43702
	Transmission time, s	128.4865

Basing on the results acquired, we can come to the conclusion that AODV protocol allows to avoid losses and decrease the user information transmit time over the wireless mobile network. However, the lack of routing monitoring mechanism in the course of data transmission results in using non-optimal paths for data transmission. DSDV-protocol proactive mode of operation allows to react opportunely when the best routes from the source to the destination appears, but it could not prevent the information losses in the case of re-routing; and what is more, it results in an excessive network load due to the proper overhead. DSR provides the stable data interchange over the mobile network, reacts opportunely to the appearance of the shortest routes, nevertheless, the said protocol requires further improvement in order to increase the mean user-data rate.

## 2.2. Hierarchy analysis methodology

Hierarchy analysis methodology (HAM) makes it possible to find out the best of the alternative versions or to distribute the resources among the alternatives according to their priorities.

The general view for decision-making hierarchy will be as follows (Fig. 4), where  $K_i$  are selection particular criteria,  $A_j$  are possible alternatives.

- $A_1$  –AODV protocol
- $A_2$  –DSDV protocol
- $A_3$  –DSR protocol

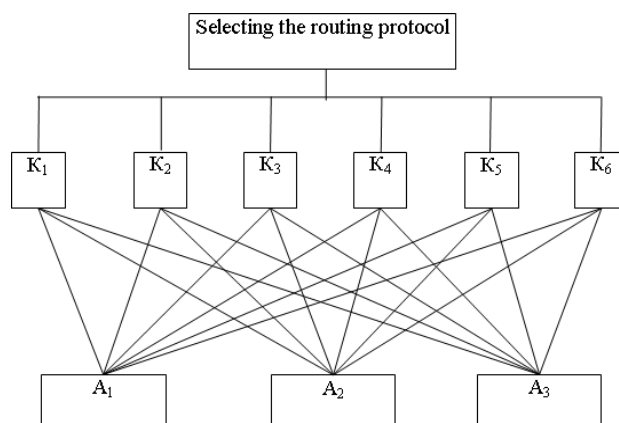


Fig. 4: Decision-making hierarchy general view.

TABLE III is a paired comparison matrix for the second-layer hierarchy containing criteria that impact the common objective, that is, routing protocol choice.

TABLE III. CRITERIA RELATIVE IMPORTANCE MATRIX.

Selection criteria	K <sub>1</sub>	K <sub>2</sub>	K <sub>3</sub>	K <sub>4</sub>	K <sub>5</sub>	K <sub>6</sub>	Priority vector
K <sub>1</sub>	1	3/1	7/1	3/1	5/1	5/1	0,4
K <sub>2</sub>	1/3	1	3/1	1/5	3/1	3/1	0,13
K <sub>3</sub>	1/7	1/3	1	1/7	1/3	1/3	0,04
K <sub>4</sub>	1/3	5/1	7/1	1	5/1	5/1	0,3
K <sub>5</sub>	1/5	1/3	3/1	1/5	1	5/1	0,09
K <sub>6</sub>	1/5	1/3	3/1	1/5	1/5	1	0,05

Main eigen value: 6,74

Conformity index: 0,15

Conformity ratio: 0,11

Global priorities calculation.

TABLE IV. GLOBAL ALTERNATIVE PRIORITIES A<sub>1</sub>, A<sub>2</sub> AND A<sub>3</sub>.

	K1	K2	K3	K4	K5	K6	Generalized or global priorities
A1	0,334	0,5	0,01	0,49	0,65	0,65	0,437
A2	0,332	0,01	0,5	0,2	0,07	0,07	0,22
A3	0,334	0,49	0,49	0,31	0,28	0,28	0,349

### 3. Conclusion

All the DSR-protocol operation mechanisms are build-up on the requests, which makes it possible to avoid the need of using periodical overhead sendings and to react only to the changes of the route currently in use. DSR protocol provides for each user the possibility to choose and control routes that he uses for packet routing, which can be used for load balancing via the individual nodes or for increasing the data transmission reliability.

DSDV protocol application periodically requires complete routing table updates, so this protocol does not seem to be the most efficient for the networks with high topology dynamics. Also, DSDV limits the number of nodes that can be connected to the network, and each time the changes take place in the network, the information interchange is unstable unless the packets with messages of updates are distributed among all the nodes.

AODV protocol application results in delays due to routing, however, it allows to reduce the general overhead amount as well as to reduce the user information losses. One more advantage of AODV protocol is its quick route recovery when the network topology is changed.

According to the calculation, routing protocols have the following utility ratios: DSR – 0,349; DSDV – 0,22; AODV – 0,437. The results that confirm AODV protocol preference are true only in the case of high node mobility over wireless mobile networks.

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