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Simulation of the Enhanced Associativity Based Routing Protocol for Mobile Ad Hoc Networks (MANET)

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Abstract: The simulations results showed that the overall EABR enhancement, when compared with ABR, in terms of communication overhead was ranging from 36% to 56%. While the overall EABR enhancement in terms of number of operation required to reconstructing the route was ranging from 36% to 55%. These enhancements were contributed to the novel way in route reconstructing introduced by EABR.

Keywords: ad-hoc mobile Network, ABR, EABR, Associativity, Simulation

INTRODUCTION

In [2] a new method for route reconstruction for the ABR[1] was proposed. The routing table was amended with a Serial No field to enhance the optimization while reconstruction of the route. Three MH movements were covered, namely SRC, IN and DEST.

The route re-construction process makes use of the advantage of locality of neighbouring Mobile Hosts (MHs) to quickly construct alternate and even shorter routes, i.e. route optimization through using the Here I am packets.

In the original ABR the DEST role in route reconstruction was passive in the case of DEST movement, while in EABR the DEST has an active role in route reconstruction. Beside that, ABR route invalidation was always performed toward the DEST in the case of IN movement, while an optimization was achieved in EABR to invalidate the shortest partial route from the IN toward either the DEST or the SRC.

In [3] the communication and operation complexity analysis for two protocols namely the ABR and the EABR was presented. The operation complexity and communication complexity as defined in[1] were compared for both the ABR and the EABR, where the values represent the worst–case analysis.

The EABR proofed to be better in route reconstruction, which is attributed to the novel way in which the EABR reconstruct the route after movement of any node and the active role of the moved node in route reconstruction phase [3].

MATERIALS AND METHODS

Study of Communication Overhead:
Network = 30 - 50 Nodes – Route = 30 nodes

In this scenario the number of nodes, which constitute the route, are 30 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 1, 2, & 3.

The simulation results showed that the EABR enhancement in route reconstruction ranges from 36% to 41% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement ranges from 60% to 70% under the different topologies, while enhancement reached 11% when the reconstruction is done in the second half of the route. The communication statistics are summarized in Table 1.

Table 1: Communication Statistics – Route = 30 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Communication	41%	38%	36%
EABR Enhancement in Communication in case the reconstruction point fail in the 1st half of the route	70%	66%	60%
EABR Enhancement in Communication in case the reconstruction point fail in the 2nd half of the route	11%	11%	11%

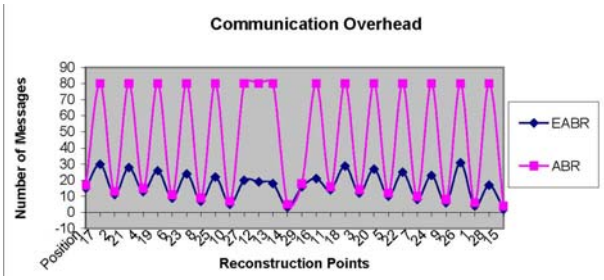

Fig. 1: Communication Overhead: Network = 50, Route Length = 30

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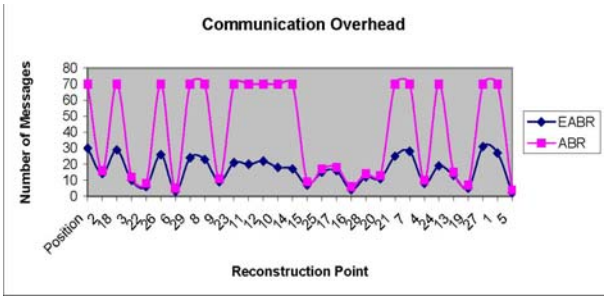

Fig. 2: Communication Overhead: Network = 40, Route Length = 30

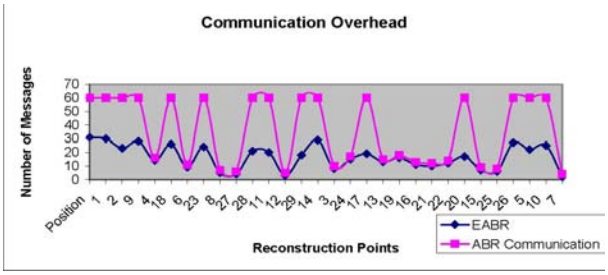

Fig. 3: Communication Overhead: Network = 30, Route Length = 30

Network = 30 - 50 Nodes – Route = 25 nodes: In this scenario the number of nodes, which constitute the route, are 25 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figures 4, 5 & 6.

The simulation results showed that the EABR enhancement in route reconstruction ranges from 34% to 38% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement ranges from 62% to 72% under the different topologies, while enhancement reached 12% when the reconstruction is done in the second half of the route. The communication statistics are summarized in Table 2.

Table 2: Communication Statistics – Route = 25 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Communication	38%	36%	34%
EABR Enhancement in Communication in case the reconstruction point fail in the 1st half of the route	72%	68%	62%
EABR Enhancement in Communication in case the reconstruction point fail in the 2nd half of the route	12%	12%	12%

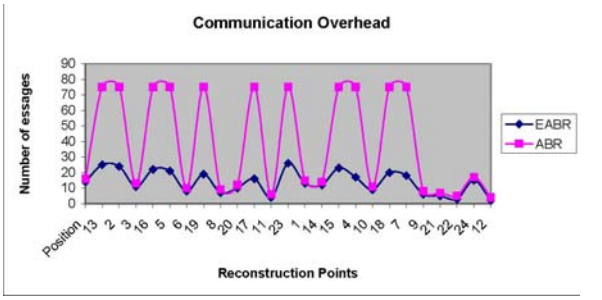

Fig. 4: Communication Overhead: Network = 50, Route Length = 25

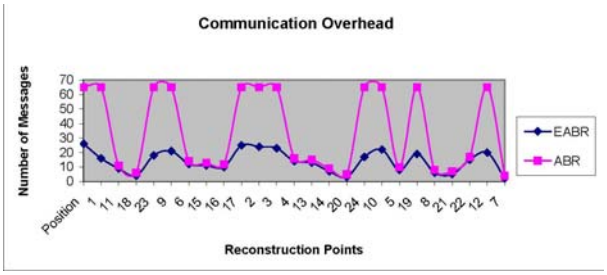

Fig. 5: Communication Overhead: Network = 40, Route Length = 25

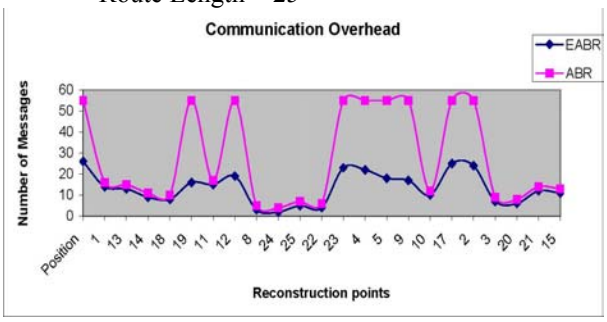

Fig. 6: Communication Overhead: Network = 30, Route Length = 25

Network = 30 - 50 Nodes – Route = 20 nodes: In this scenario the number of nodes, which constitute the route, are 20 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 7, 8 & 9.

The simulation results showed that the EABR enhancement in route reconstruction ranges from 38% to 42% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement ranges from 66% to 76% under the different topologies, while enhancement reached 14% when the reconstruction is done in the second half of the route. The communication statistics are summarized in Table 3.

Table 3: Communication Statistics – Route = 20 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Communication	42%	40%	38%
EABR Enhancement in Communication in case the reconstruction point fail in the 1st half of the route	76%	72%	66%
EABR Enhancement in Communication in case the reconstruction point fail in the 2nd half of the route	14%	14%	14%

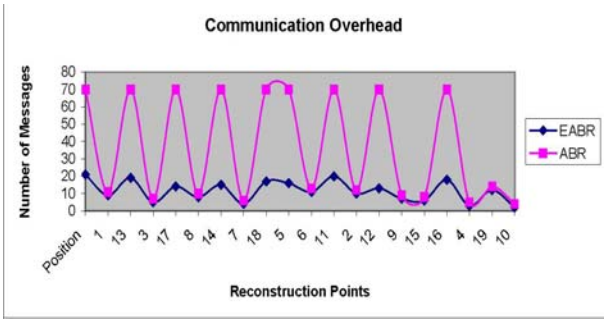

Fig. 7: Communication Overhead: Network = 50, Route Length = 20

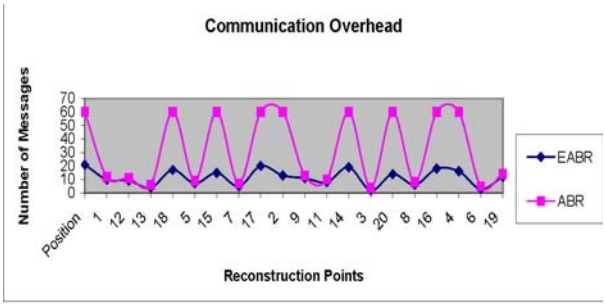

Fig. 8: Communication Overhead: Network = 40, Route Length = 20

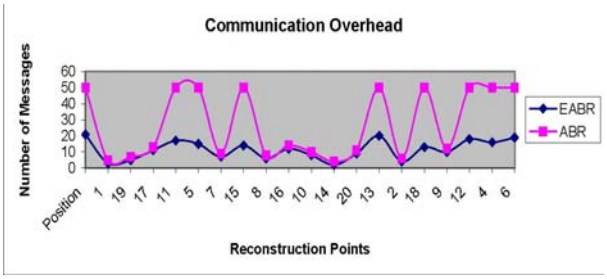

Fig. 9: Communication Overhead: Network = 30, Route Length = 20

Network = 30 - 50 Nodes – Route = 15 nodes: In this scenario the number of nodes, which constitute the route, are 15 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 10, 11 & 12.

The simulation results showed that the EABR enhancement in route reconstruction ranges from 38% to 47% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement ranges from 66% to 80% under the different topologies, while enhancement reached 14% when the reconstruction is done in the second half of the route. The communication statistics are summarized in Table 4.

Table 4: Communication Statistics – Route = 15 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Communication	47%	45%	43%
EABR Enhancement in Communication in case the reconstruction point fail in the 1st half of the route	80%	76%	71%
EABR Enhancement in Communication in case the reconstruction point fail in the 2nd half of the route	18%	18%	19%

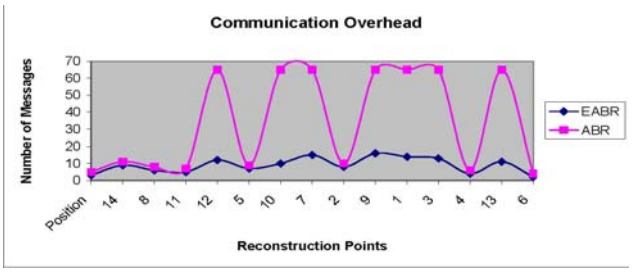

Fig. 10: Communication Overhead: Network = 50, Route Length = 15

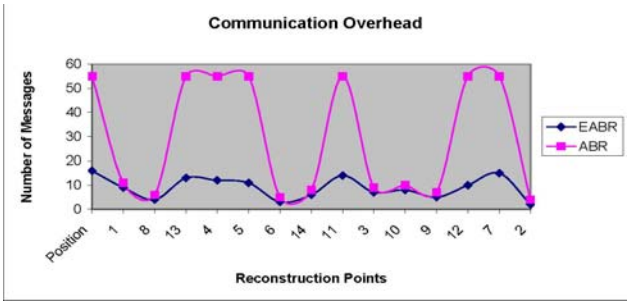

Fig. 11: Communication Overhead: Network = 40, Route Length = 15

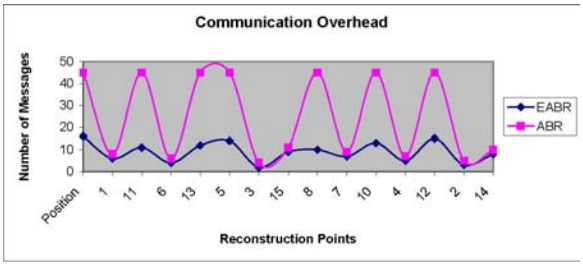

Fig. 12: Communication Overhead: Network = 30, Route Length = 15

Network = 30 - 50 Nodes – Route = 10 nodes: In this scenario the number of nodes, which constitute the route, are 10 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 13, 14 & 15.

The simulation results showed that the EABR enhancement in route reconstruction ranges from 44% to 47% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement ranges from 76% to 84% under the different topologies, while enhancement reached 22% when the reconstruction is done in the second half of the route. The communication statistics are summarized in Table 5.

Table 5: Communication Statistics – Route = 10 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Communication	47%	46%	44%
EABR Enhancement in Communication in case the reconstruction point fail in the 1st half of the route	84%	81%	76%
EABR Enhancement in Communication in case the reconstruction point fail in the 2nd half of the route	22%	22%	22%

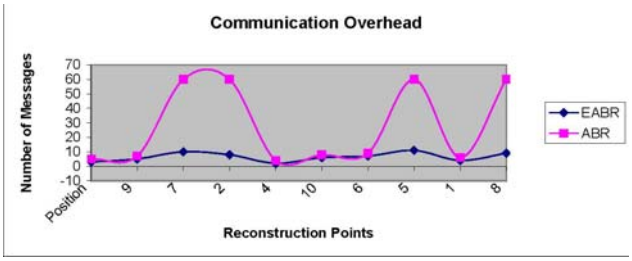

Fig. 13: Communication Overhead: Network = 50, Route Length = 10

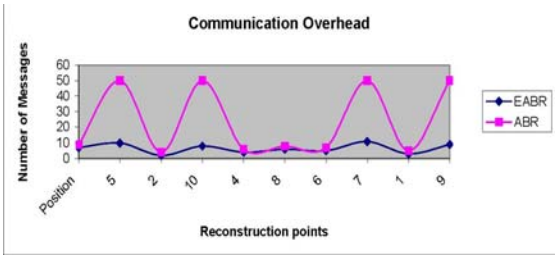

Fig. 14: Communication Overhead: Network = 40, Route Length = 10

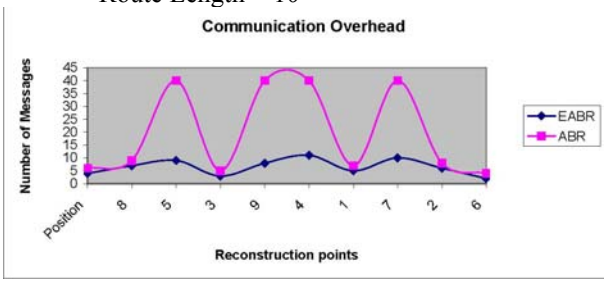

Fig. 15: Communication Overhead: Network = 30, Route Length = 10

Network = 30 - 50 Nodes – Route = 5 nodes: In this scenario the number of nodes, which constitute the route, are 5 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 16, 17 & 18.

The simulation results showed that the EABR enhancement in route reconstruction ranges from 54% to 56% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement ranges from 84% to 90% under the different topologies, while enhancement reached 33% when the reconstruction is done in the second half of the route. The communication statistics are summarized in Table 6.

Table 6: Communication Statistics – Route = 5 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Communication	56%	55%	54%
EABR Enhancement in Communication in case the reconstruction point fail in the 1st half of the route	90%	88%	84%
EABR Enhancement in Communication in case the reconstruction point fail in the 2nd half of the route	33%	33%	33%

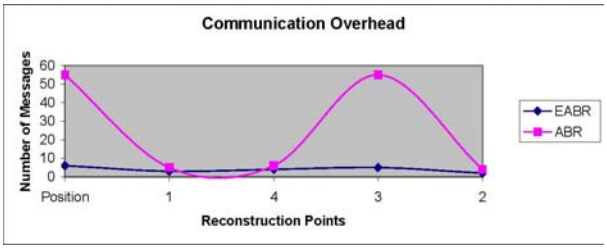

Fig.16: Communication Overhead: Network = 50, Route Length = 5

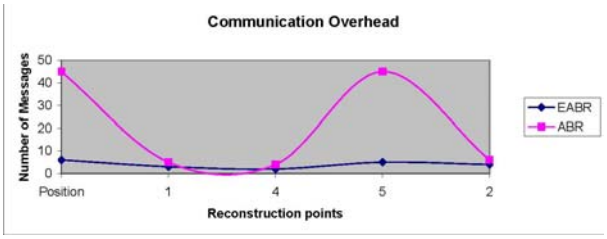

Fig. 17: Communication Overhead: Network = 40, Route Length = 5

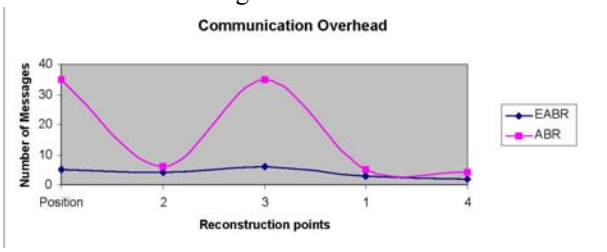

Fig. 18: Communication Overhead: Network = 30, Route Length = 5

Study of Operation Overhead

Network = 30 - 50 Nodes – Route = 30 nodes: In this scenario the number of nodes, which constitute the route, are 30 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 19, 20 & 21.

The simulation results showed that the EABR enhancement in route reconstruction reached 36% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement reached 66% under the different topologies, while enhancement reached 11% when the reconstruction is done in the second half of the route. The operation statistics are summarized in Table

Table 7: Operation Statistics – Route = 30 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Operation	36%	36%	36%
EABR Enhancement in Operation in case the reconstruction point fail in the 1st half of the route	66%	66%	66%
EABR Enhancement in Operation in case the reconstruction point fail in the 2nd half of the route	11%	11%	11%

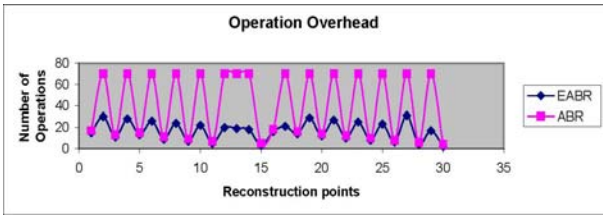

Fig. 19: Operation Overhead: Network = 50, Route Length = 30

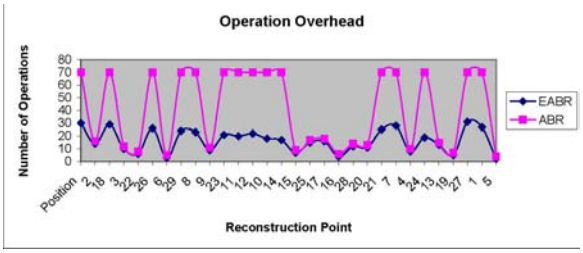

Fig. 20: Operation Overhead: Network = 40, Route Length = 30

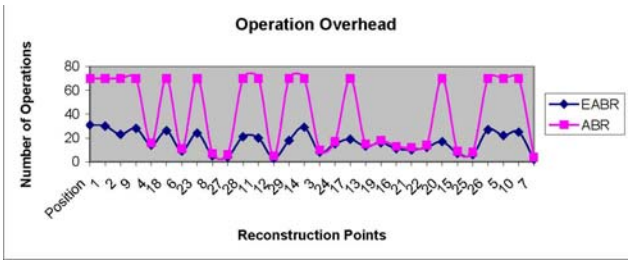

Fig. 21: Operation Overhead: Network = 30, Route Length = 30

Network = 30 - 50 Nodes – Route = 25 nodes: In this scenario the number of nodes, which constitute the route, are 25 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 22, 23 & 24.

The simulation results showed that the EABR enhancement in route reconstruction reached 38% under different topologies. In cases when the

reconstruction is done in the first half of the route the enhancement reached 68% under the different topologies, while enhancement reached 12% when the reconstruction is done in the second half of the route. The operation statistics are summarized in Table 8.

Table 8: Operation Statistics – Route = 25 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Operation	38%	38%	38%
EABR Enhancement in Operation in case the reconstruction point fail in the 1st half of the route	68%	68%	68%
EABR Enhancement in Operation in case the reconstruction point fail in the 2nd half of the route	12%	12%	12%

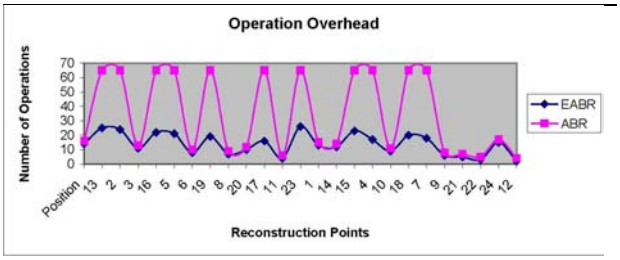

Fig. 22: Operation Overhead: Network = 50, Route Length = 25

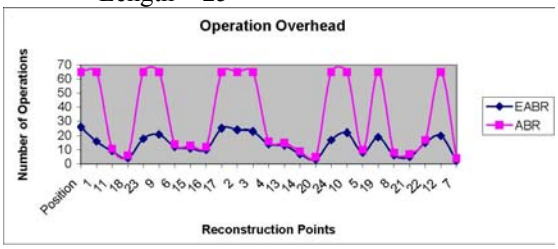

Fig. 23: Operation Overhead: Network = 40, Route Length = 25

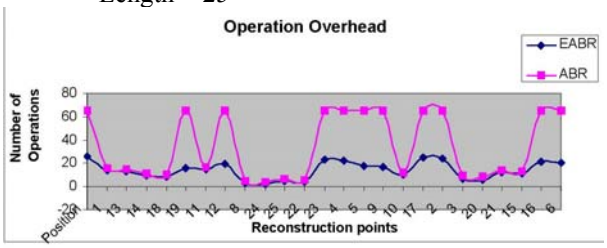

Fig. 24: Operation Overhead: Network = 30, Route Length = 25

Network = 30 - 50 Nodes – Route = 20 nodes: In this scenario the number of nodes, which constitute the route, are 20 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 25, 26 & 27.

The simulation results showed that the EABR enhancement in route reconstruction reached 40% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement reached 72% under the different topologies, while enhancement reached 14% when the reconstruction is done in the second half of the route. The Operation statistics are summarized in Table 9.

Table 9: Operation Statistics – Route = 20 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Operation	40%	40%	40%
EABR Enhancement in Operation in case the reconstruction point fail in the 1st half of the route	72%	72%	72%
EABR Enhancement in Operation in case the reconstruction point fail in the 2nd half of the route	14%	14%	14%

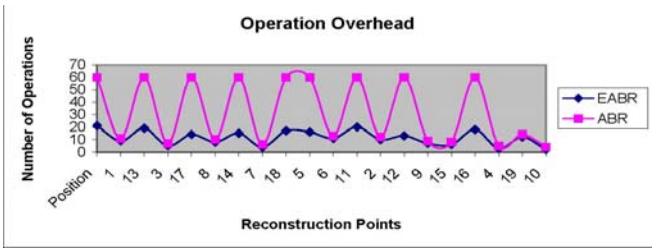

Fig. 25: Operation Overhead: Network = 50, Route Length = 20

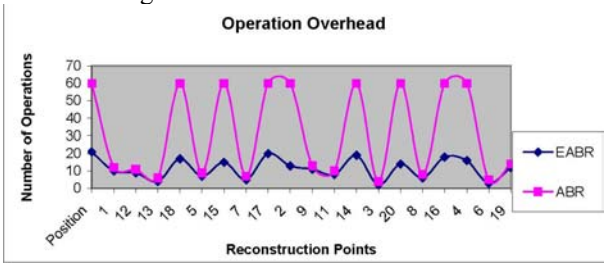

Fig. 26: Operation Overhead: Network = 40, Route Length = 20

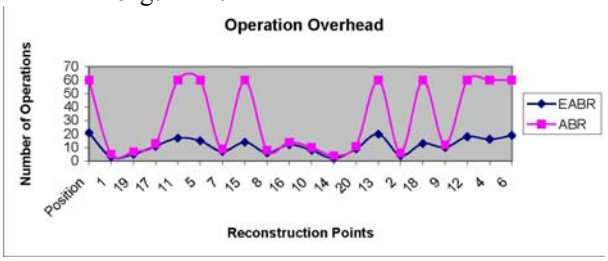

Fig. 27: Operation Overhead: Network = 30, Route Length = 20

Network = 30 - 50 Nodes – Route = 15 nodes: In this scenario the number of nodes, which constitute the route, are 15 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 28, 29 & 30.

The simulation results showed that the EABR enhancement in route reconstruction reached 45% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement reached 76% under the different topologies, while enhancement reached 18% when the reconstruction is done in the second half of the route. The Operation statistics are summarized in Table 10.

Table 10: Operation Statistics – Route = 15 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Operation	45%	45%	45%
EABR Enhancement in Operation in case the reconstruction point fail in the 1st half of the route	76%	76%	76%
EABR Enhancement in Operation in case the reconstruction point fail in the 2nd half of the route	18%	18%	18%

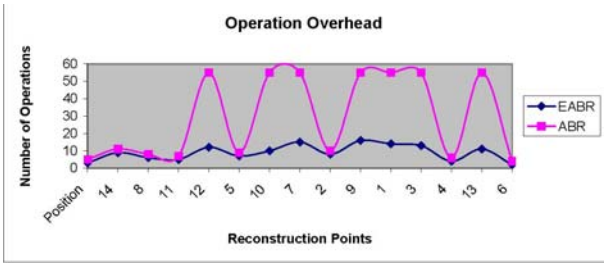

Fig. 28: Operation Overhead: Network = 50, Route Length = 15

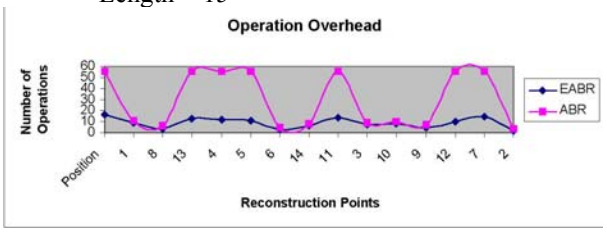

Fig. 29: Operation Overhead: Network = 40, Route Length = 15

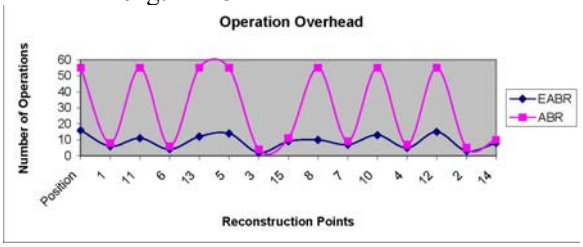

Fig. 30: Operation Overhead: Network = 30, Route Length = 15

Network = 30 - 50 Nodes – Route = 10 nodes*:* In this scenario the number of nodes, which constitute the route, are 10 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 31, 32 & 33.

The simulation results showed that the EABR enhancement in route reconstruction reached 46% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement reached 81% under the different topologies, while enhancement reached 22% when the reconstruction is done in the second half of the route. The Operation statistics are summarized in Table 11.

Table 11: Operation Statistics – Route = 10 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Operation	46%	46%	46%
EABR Enhancement in Operation in case the reconstruction point fail in the 1st half of the route	81%	81%	81%
EABR Enhancement in Operation in case the reconstruction point fail in the 2nd half of the route	22%	22%	22%

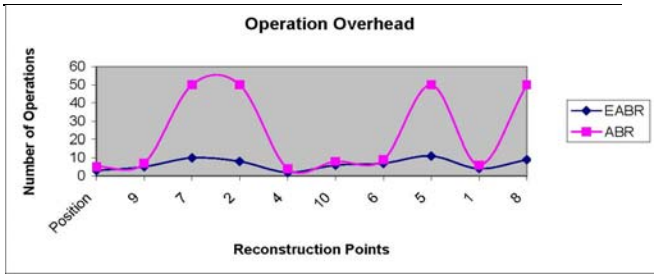

Fig. 31: Operation Overhead: Network = 50, Route Length = 10

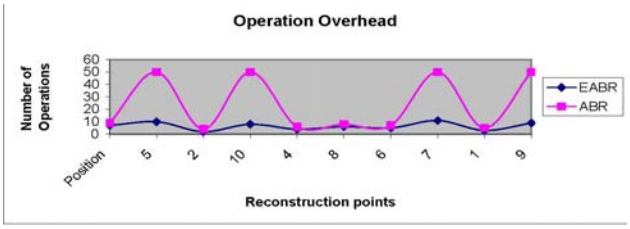

Fig. 32: Operation Overhead: Network = 40, Route Length = 10

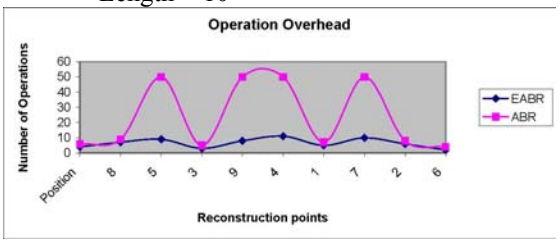

Fig. 33: Operation Overhead: Network = 30, Route Length = 10

Network = 30 - 50 Nodes – Route = 5 nodes: In this scenario the number of nodes, which constitute the route, are 5 while the number of nodes constitute the entire network are varying from 30 to 50. Different results were observed as shown in Figs. 34, 35 & 36.

The simulation results showed that the EABR enhancement in route reconstruction reached 55% under different topologies. In cases when the reconstruction is done in the first half of the route the enhancement reached 88% under the different topologies, while enhancement reached 33% when the reconstruction is done in the second half of the route. The Operation statistics are summarized in Table 12.

Table 12: Operation Statistics – Route = 5 nodes under different topologies

Number of Nodes in Network	50	40	30
EABR Enhancement in Operation	55%	55%	55%
EABR Enhancement in Operation in case the reconstruction point fail in the 1st half of the route	88%	88%	88%
EABR Enhancement in Operation in case the reconstruction point fail in the 2nd half of the route	33%	33%	33%

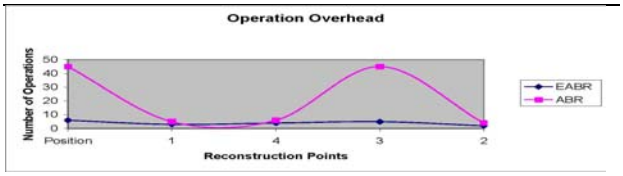

Fig. 34: Operation Overhead: Network = 50, Route Length = 5

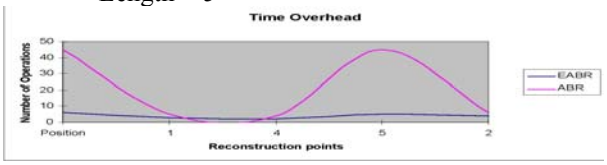

Fig. 35: Operation Overhead: Network = 40, Route Length = 5

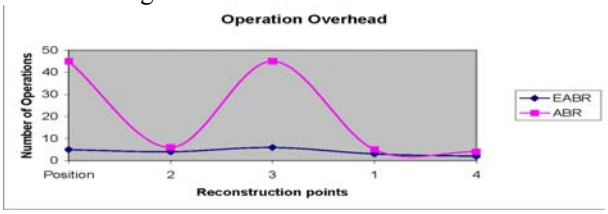

Figure 36: Operation Overhead: Network = 30, Route Length = 5

RESULTS AND DISCUSSION

The simulation study aimed to study the performance the EABR and original the ABR protocols in route reconstruction phase. The two factors used to conduct the simulation analysis between the protocols are: Operation Complexity and Communication Complexity as defined in [1].

The study was restricted by the following assumptions in order to study the performance in route reconstruction phase only, no other cases were included in the study as it fails beyond the scope of our interest.

1. Operation complexity and Communication Complexity as defined in [1]
2. Ideal environment i.e. no interference or noise signals
3. A conference-sized network ranging from 30 to 50 nodes
4. 2 nodes can communicate/ respond with each other if they are in the transmission range
5. Nodes move in random manner
6. The route is already established

The simulation strategy was based on measuring the communication overhead in terms of number of messages exchanged to perform a routing operation, and the Operation overhead in terms of the number of operations required to perform a protocol operation as defined in [1].

Different topologies ranging from 30 to 50 nodes were used; also different route lengths ranging from 5 to 30 nodes were used in this simulation study.

CONCLUSION

1. The overall EABR enhancement in terms of communication overhead is ranging from 36% to 56%.
2. The overall EABR enhancement in terms of number of operation required to reconstruct the route is ranging from 36% to 55%.
3. The EABR communication enhancement in case the reconstruction point fail in the 1st half of the route is ranging from 60% to 90%.
4. The EABR communication enhancement in case the reconstruction point fail in the 2nd half of the route is ranging from 11% to 33%.
5. The EABR Operation enhancement in case the reconstruction point fail in the 1st half of the route is ranging from 66% to 88%.
6. The EABR Operation enhancement in case the reconstruction point fail in the 2nd half of the route is ranging from 11% to 33%.
7. In the backtracking process of the ABR, the process stops after reaching the node, which represent half of the hop count, which can be optimized more as there is a big possibility to have the destination to settle near to the upper part of the route.
8. When the network consists of relatively a large number of nodes and the established route consists of relatively small number of routes, the ABR is not efficient in route reconstruction, while the EABR is better in such topologies if compared to the ABR.

REFERENCES

1. C.-K. Toh, 2002. Ad Hoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR, Prentice Hall, Inc. PP 79-116
2. Ayman, M., Said A. 2006. Enhanced Routing Re-Construction Method for the Associativity Based Routing Protocol for Mobile AD Hoc Network (MANET)", American Journal of Applied Sciences. PP 859-869
3. Ayman, M., Said A. 2006. Analysis of Enhanced Associativity Based Routing Protocol", American Journal of Applied Sciences. PP 853-858