Analysis of STAR and ZRP Routing Protocols for a Static Ad Hoc Network using Qualnet Network Simulator

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ABSTRACT
In this paper, performance analysis of adhoc routing protocol is done on the basis of certain parameters. These parameters for the analysis are throughput, number of bytes received. The routing protocols compared are STAR and ZRP. The comparison also stands between the FTP and FTP generic systems. The performance evaluation will be done on the Qualnet simulator platform.

Keywords
STAR, ZRP, Throughput, FTP, FTP Generic.

1. INTRODUCTION
A mobile adhoc network is an infrastructure less network of mobile devices connected without wire. It is a continuously self-configuring network. In this network each device is free to move independently in any direction by changing its links to other devices. Different types of adhoc routing protocols[1, 2, 3]:

- Table driven (proactive) routing.
- On-demand (reactive) routing.
- Hybrid (both proactive and reactive) routing.
- Hierarchical routing protocol.

- **Table 1. Comparison between the above routing protocols [4]**

S.No.	Table driven	On demand	Hybrid	Hierarchical
1.	Proactive	Reactive	Both proactive and reactive	
2.	Periodic update of destinations and their routes by updating routing tables.	finds a route on demand by flooding the network with Route Request packets	Combines the advantages of both proactive and reactive protocols Finds he routes proactively and then fulfill their demands of route by reactive method of flooding the route with route request packets.	Depends on the hierarchy of nodes which protocol can be used proactive or reactive.
3.	Examples OLSR DSDV	Examples AODV DSR	Examples ZRP IARP IERP	Examples CBRP FSR
4.	Advantages and Disadvantages • Maintenance complexity. • Difficult to restructuring and failure. • Low delay. • High bandwidth requirement.	Advantages and Disadvantages • High latency time. • clogging • Routes discovered when needed so high delay • small control overhead: no route updates • low scalability: no route updates	Advantages and disadvantages • Fast link establishment; • Less overhead as compared to table-driven and reactive protocols. • high storage and processing requirements as compared to reactive protocols	Advantages and Disadvantages • Advantage depends on depth of nesting and addressing scheme. • Reaction to traffic demand depends on meshing parameters

2. ADHOC ROUTING PROTOCOL
2.1 Star
It is a link state algorithm based on proactive routing protocol. It is a table driven routing protocol. It scale well in large networks. It has several advantages like reduced bandwidth consumption as well as time reducing latency by using predetermined routes. It saves bandwidth by allowing and forming of non-optimal paths. Based on this, STAR is divided into two types

- Optimum routing approach (ORA)
- Least overhead rooting approach (LORA)

Table 2. Simulation parameter for Physical and Mac layer

ORA	LORA
Chosen when the route updates are generated and update packets are broadcast	Generates routing update when it finds a new destination or destination becomes unreachable or when notices a possible routing loop
It has an advantage that it eliminated the periodic updating procedure present in the link state algorithm by making update dissemination conditional.	Reduced the amount of rating overhead disseminated into the network.

In this routing protocol each node discovers and maintains the information of the network and builds the shortest path tree (source tree). The mechanism of this protocol involves the detection or discovery of neighbors and exchange of topology information (update packets) among nodes. There are two alternate mechanisms to discover neighbors:

- When node receives hello message it dissolves a new neighbor.
- When node does not receives any hello message it has been determined that this neighbor is broken or out of its range

2.2 ZRP

Since there are certain disadvantages associated with the implementation of routing protocols for a MANET, when both proactive and purely reactive techniques are used. The Zone Routing Protocol, or ZRP, takes out the good of both the techniques and presents a new hybrid scheme, using the merit of pro-active discovery within the local neighborhood of the node, and using a reactive protocol for neighborhood communication [5].

- In a MANET, the most of the communication takes place between the neighborhood nodes. Therefore the changes in the topology in the vicinity of a node are significantly effective–rather than the addition or the removal of a node on the other side of the network, which has only limited impact on the local neighborhoods.
- The ZRP is a distinct critical protocol as it provides a plate form and framework for other protocols. The separation between the nodes of a global topology which lie in the neighborhood of each other gives the freedom to us for applying distinct approaches – and thus taking advantage of each technique's feature for a given situation.
- These local neighborhoods are called zones (hence the name); here each node needs to belong to various overlapping zones to put up effective communication within a MANET network and each zone may be of a different size. The "size" of a zone is not a geographical measurement, but is given by a radius of length x, where 'x' is the number of hops to the perimeter of the zone.

These zones characterization is similar to that in cellular mobile communication, but in that case these zones rely on the fixed nodes communication which is not possible in MANET. Fig 1 shows an example, routing zone with x=2.

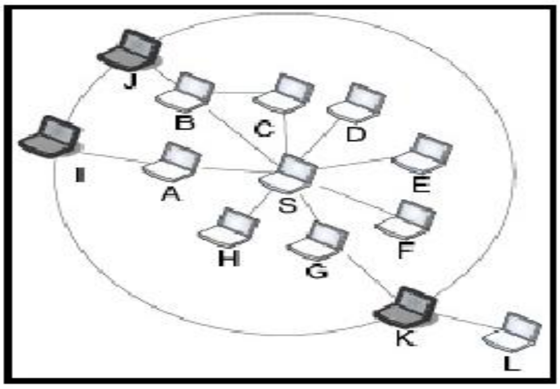

Fig 1: Routing Zone of node A With x=2

In the example above, node A has multiple routes to node F, including one that has a hop count of c>x. Node G is out of A's zone. The nodes on the perimeter of the zone (i.e. with a hop count hc=x) are referred to as peripheral nodes (marked gray), nodes with hc<x are interior nodes. Before a node actually constructs a routing table and starts communication with neighbors it must determine its peripheral nodes first. Media access protocols (MAC) are often used to know about the immediate neighbors [6].

Alternatively, a node may require a Neighbor Discovery Protocol (NDP). Such a Neighbor Discovery Protocol generates "hello" packets for all the neighboring nodes and if this node in turn receives a message as a response, then it is understood that it has direct point-to-point connection with this neighbor. The NDP is free to select nodes on various parameters, such as signal strength or frequency/delay of beacons etc. If the MAC layer of the nodes does not allow for such a NDP, the Intrazone Routing Protocol must initiate the direct node discovery process. The routes to the peripheral nodes are calculated by IARP protocol and are commonly a proactive protocol. The Intrazone Routing Protocol, or IARP, is described in more detail. Communication between the different zones is guarded by the Interzone Routing Protocol, or IERP. That is, if a node encounters a packet with a destination which does not belongs to its zone – i.e. it does not have a valid route for this packet – then the scenario of peripheral nodes comes into picture, which maintain routing information for the neighboring zones, so that they can make a decision of where to forward the packet to. Through the use of a bordercast algorithm rather than flooding all peripheral nodes, these queries become more efficient. The Interzone Routing Protocol and the Bordercast Resolution Protocol are presented in later discussions. The Zone Routing Protocol consists of several components which are presented in fig 2 [7].

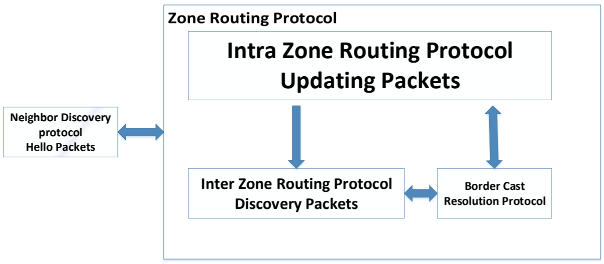

Fig 2: ZRP components

For example, AODV, which is a reactive protocol might be used as the IARP, while OLSR, a pro-reactive protocol might be used as IERP. It seems that being hybrid in nature ZRP seems to indicate that it is a hierarchical protocol, but actually ZRP is in fact a flat protocol [8, 9, 10].

2.2.1 Intrazone Routing Protocol (IARP)

It has been assumed that in ZRP, the very first step of node discovery is implemented on the link-layer and is executed by NDP, the first protocol to be part of ZRP is the Intrazone Routing Protocol, or IARP. This protocol communicates directly with the interior nodes within its zone and as such is limited by its peripheral nodes radius (the number of hops from the node to its peripheral nodes).

- Each node maintains the information of its neighborhood which lies within its routing zone proactively. DSDV protocol also applies the same strategy.
- Each node maintains the routing table of its routing zone so that the path to any node within its zone can be found out from this table.
- Each node periodically generates a hello packet called as zone notification message for communicating with nodes within its zone.

2.2.2 Interzone Routing Protocol (IERP)

- ZRP uses its reactive routing component, the Interzone Routing Protocol, or IERP, and uses its known information about local topology of node's zone and, using a reactive approach carries on its interaction with nodes in other zones.
- In IERP on demand route queries are entertained, only when a route request is made.
- Bordercasting do help in reducing the route discovery delay (in contrast to IARP, where the route is immediately available). It is an approach in which only peripheral nodes are queried about.
- A node does not send a query or reply back to the nodes the request came from, even if they are peripheral nodes.
- In order to convert an existing reactive routing protocol for use as the IERP in the ZRP, pro-active updates for local routes must be disabled, as IARP already provides this functionality.
- Furthermore, the IERP needs to be able to move sidewise with the IARP. It should also handle the information about the routes provided by IARP. The method of routing should also be efficiently marked. Instead of flooding, Bordercast Resolution Protocol (BRP) enhances the system by initiating route requests with peripheral nodes.

2.2.3 Bordercast Resolution Protocol (BRP)

- The Bordercast Resolution Protocol, or BRP, is used in the ZRP to direct the route requests initiated by the IERP to the peripheral nodes in its zone, thus removing redundant queries and maximizing efficiency.
- A bordercast tree is constructed utilizing the map provided by the IARP. Unlike IARP and IERP, is a packet delivery service, and not a routing protocol.
- The BRP keeps track of all the nodes to which the query has been sent to, so that it can prune the bordercast tree of nodes that have already received (and relayed) the query.
- When a node receives a query packet for a node that does not lie within its local routing zone, it constructs a bordercast tree so that it can forward the packet to its neighbors.
- These nodes, upon receiving the packet, reconstruct the bordercast tree so that they can determine whether or not it belongs to the tree of the sending node. If it does not, it continues to process the request and determines if the destination lies within its routing zone and taking the appropriate action, upon which the nodes within this zone are marked as covered.
- In the context of ZRP, the BRP can be seen as the glue which ties together the IARP and the IERP in order to take full advantage of the proactive and reactive components where they are best used

3. SIMULATION PARAMETERS

In this section, the effect of two on-demand routing protocols, namely Source Tree Adaptive Protocol (STAR) and Zone Routing Protocol (ZRP) are analyzed on static ad-hoc network. The analysis is made on the basis of throughput and data reception at FTP and FTP generic servers respectively. The Qualnet network simulator is used to simulate the network. The simulated network is shown in Fig 3 and Fig 4.

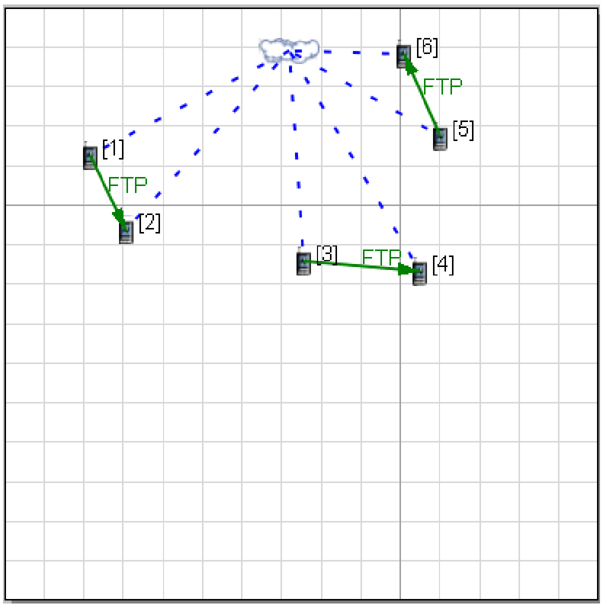

Fig 3: The simulated network for FTP applications

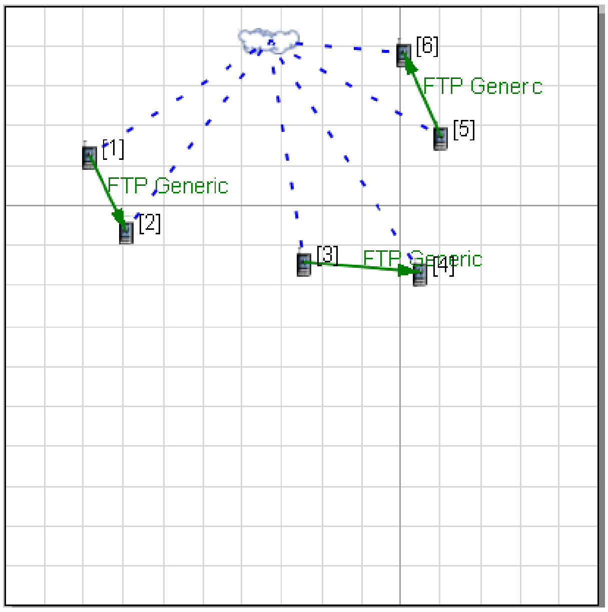

Fig 4: The simulated network for FTP generic applications

The simulation parameters for Physical and MAC layer is shown in Table 3

Table 3. Simulation parameter for Physical and Mac layer

S.No.	Layer	Parameter	Value
1.	Physical layer	Radio type	802.11b
2.	Physical layer	Packet reception model	PHY802.1B
3.	Physical layer	Antenna model	Omnidirectional
4.	MAC layer	MAC protocol	802.11

4. RESULT ANALYSIS

In this section, clustered column histogram is used to compare throughput, jitter and no. of bytes received by server end for both the protocols in terms of FTP and FTP generic applications

4.1 FTP Comparison

Fig 5 and Fig 6 shows the comparison of STAR and ZRP routing protocols using FTP application.

4.1.1 *Throughput:*

The average rate of successful message delivery over the simulated network, i.e. throughput is compared at the server nodes. It is clear from Fig 5, that the average throughput at server nodes in FTP application is better in case of ZRP routing protocol.

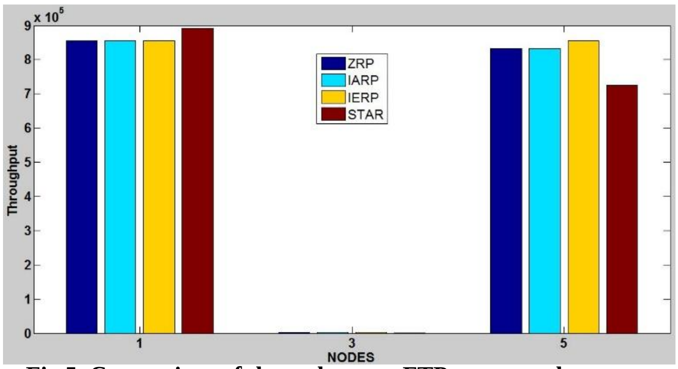

Fig.5. Comparison of throughput on FTP server nodes

4.1.2 *Data Received:*

Fig 6 shows the comparison of the number of bytes received at FTP server nodes for ZRP and STAR routing protocols, and it's clear from the figure that the number of bytes received by FTP server nodes is either same or higher in case of ZRP routing protocol. So, it's clear that data loss in case of the ZRP routing protocol is less, hence ZRP is better routing protocol.

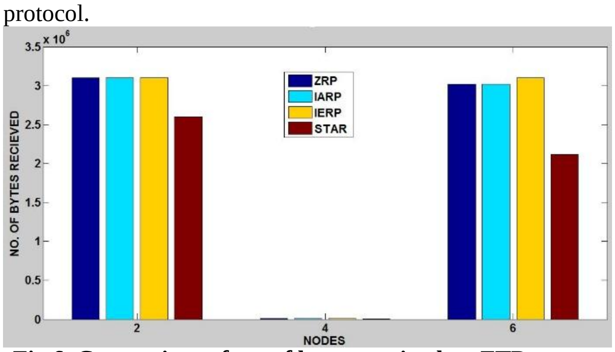

Fig 6. Comparison of no. of bytes received on FTP server nodes

4.2 FTP generic comparison

Fig 7 and Fig 8 shows the comparison of STAR and ZRP routing protocols using FTP generic application

4.2.1 *Throughput:*

The average rate of successful message delivery over the simulated network, i.e. throughput is compared at the server nodes. It is clear from Fig 7, that the average throughput at server nodes in FTP generic application is better in case of ZRP routing protocol.

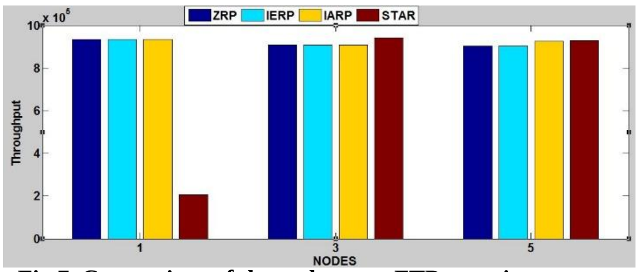

Fig 7. Comparison of throughput on FTP generic server nodes

4.2.2 *Data Received*

Fig 8 shows the comparison of the number of bytes received at FTP generic server nodes for STAR and ZRP routing protocols, and it's clear from the figure that the number of bytes received by FTP generic server nodes is either same or higher in case of ZRP routing protocol. So, it's clear that data loss in case of the ZRP routing protocol is less, hence ZRP is better routing protocol.

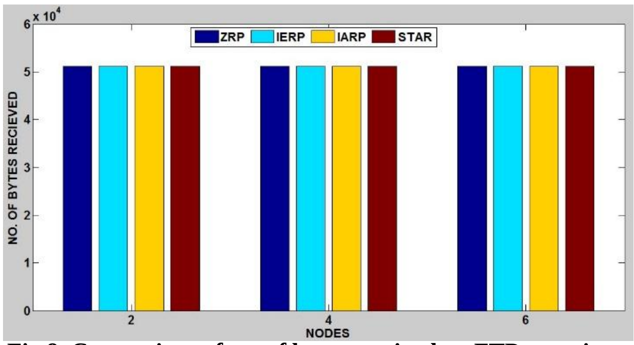

Fig 8. Comparison of no. of bytes received on FTP generic server nodes

5. CONCLUSION

This paper has compared the two routing protocols named STAR and ZRP for FTP and FTP generic applications. The throughput at server nodes in FTP and FTP generic application is better in case of ZRP routing protocol and the number of bytes received by FTP and FTP generic server nodes is either same or higher in case of ZRP routing protocol. So, it's clear that data loss in case of the ZRP routing protocol is less, hence ZRP is better routing protocol than STAR.

6. REFERENCES

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