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Performance Analysis of Location Based Ad Hoc Routing Protocols under Random Waypoint Mobility Model

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Abstract- Mobile ad hoc Network is a self- configuring infrastructure-less network of nodes connected through wireless link. Each node in the network can act as router as well as host to find paths to exchange information. For finding paths, location based routing protocols have been developed for mobile ad hoc networks. This paper presents performance analysis of location based routing protocols, Greedy Perimeter Stateless Routing (GPSR) and Zone Routing Protocol (ZRP), based on metrics such as throughput, end-to-end delay, packet delivery fraction, and routing overhead.

Keywords- MANET, ZRP, GPSR, location based routing protocols.

I. Introduction

A Mobile ad hoc Network (MANET) is an autonomous collection of mobile nodes. A typical MANET is also an infrastructure-less network as shown in figure1 and a node in the network receives its data from the source node. Mobile nodes in the network self-organize and self- configure as the network topology changes. Since MANET lacks infrastructure, each mobile node acts as a host as well as a router, to forward data from other nodes in the network. The desired target node may go outside the range of the source node transmitting the packets. For finding the path from the source to the target node, needs a routing process. MANET technology can be applied in two main areas. In the first area, wireless networks by adding new mobile nodes that use MANET technology at the edge of the network. For example, drivers in a city who can communicate with each other while obtaining traffic information, students on a university campus, company employees in a meeting room, and many other similar situations. In the second area, MANET technology can be applied in no infrastructure available, or the pre-existing infrastructure has been destroyed by a disaster or a war. For example, search and rescue operations, military deployment in a hostile environment, police departments, disaster recovery, and many others. Many routing protocols have been proposed in the literature and a variety of comparisons have been carried out on these protocols. Network performances are analyzed using the metrics like, throughput, packet delivery fraction, end-to-end delay, packet loss, routing overhead. Random Way Point (RWP) mobility model is employed to analyze the performance of ad hoc routing protocols.

This paper present a comparison of location based routing protocols (ZRP and GPSR) with the use of simulation. These protocols can help to find path to exchange information and also know the location of target node. The performances of location based routing protocol are analyzed using Random Way Point (RWP) mobility model with varying node density, node speed and traffic load.

Figure 1: Example of Ad Hoc Network

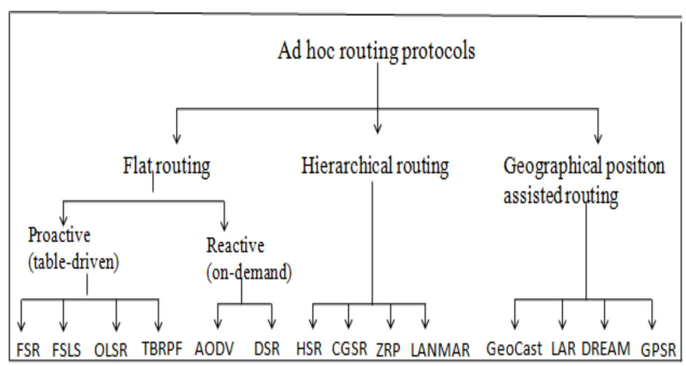
II. Related Work

Sree Raga Raju, et al. [11] compared the performance of DSR, AODV, and ZRP. They found that the performance of ZRP was not up to the task and it performed poorly throughout all the simulation sequences.

P. Manickan and T. P. Manickan and T. G. Baskar et al. [12] compared performance of three routing protocols, DSDV, AODV, DSR. They analyzed these routings with Network Simulator version 2 (NS-2). They concluded that DSR performance is better in compression of AODV and DSDV due to a smaller amount of routing overhead when nodes have high mobility, counting the metrics throughput, Average End to End Delay and Packet Delivery Ratio.

Ajay Prakash Rai and Rasvihari Sharma et al. [13] compared the performance of routing protocols (AODV and DSDV). They concluded that for large wireless network performance of AODV is much better than DSDV in terms of PDF, packet loss and delay.

III. Classification of Routing Protocols



Proactive routing protocols – Proactive protocol also called table-driven routing protocol and all the nodes maintain the list of information about the next node through it. The source node does not need route discovery to find a route to destination and needs required amount of data for maintenance when failure.
Reactive routing protocols - Reactive protocol also called as on-demand routing protocol is based upon query–reply dialog. Consuming more time to find routes and flooding of network obstruct can cause.
Hybrid routing protocols – Hybrid protocols take advantages of proactive and reactive routing and is based upon distance vector protocol but contain advantage of link state protocol. Hybrid protocol enhances interior gateway routing protocol.
Hierarchical routing protocols – Hierarchical routing starts with proactively prospected routes and serves demand for additional routes on reactive flooding.
Geographic routing protocols – Geographic routing is based on position of a location where source sends location message to destination rather than address of the network.

A. Zone Routing Protocol (ZRP)

Zone Routing Protocol (ZRP), a hybrid routing, is suitable for a wide variety of mobile ad-hoc networks. In ZRP, a zone for every node is defined with single configurable parameter n hops (zone radius) from it. The sequence number for message is used to discover loop free routes. ZRP uses three different route discovery protocols, Intrazone routing Protocol (IARP), Interzone Routing Protocol (IERP), and Bordercast Resolution Protocol (BRP).
Intrazone Routing Protocol (IARP) - The proactive Intrazone Routing Protocol (IARP) is used to maintain the local topology. The IARP is derived from globally proactive link state routing protocols that provide a complete view of network connectivity.
Interzone Routing Protocol (IERP) - Interzone Routing Protocol (IERP) is very similar to classical route discovery protocols. An IERP route discovery is initiated when no route is locally available to the destination of an outgoing data packet. The source generates a route query packet, which is uniquely identified by a combination of the source node's address and request number. The query is then relayed to a subset of neighbors as determined by the bordercast algorithm called Bordercast Resolution protocol. Bordercast, is used to reduce the number of redundant forwarding in route discovery of interzone routing protocol.

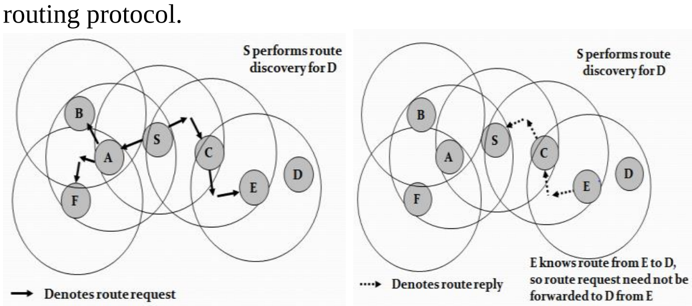


Figure 2: ZRP Path Discovery Process

In ZRP, peripheral nodes are nodes containing minimum distance from the node equal to the zone radius. IARP requires Neighbor Discovery Protocol. Link failures are identified by Hello messages and ensure that neighbors are present. IERP is invoked if IARP is unable to locate the destination.

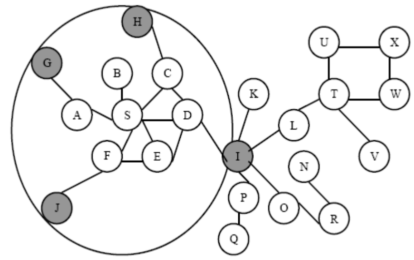


Figure 3: ZRP example

This example shows the node S which is the source sends packet to destination i.e. node X. This diagram has zone radius r=2. To check whether destination is within its zone checking by node uses the routing table offered by IARP because if not found then route request is issued by IERP. Request is broadcast to peripheral nodes represented gray in fig 3.

Route Maintenance

Each node proactively maintains routes within a local region. Knowledge of the routing zone topology is leveraged by the ZRP to improve the efficiency of a globally reactive route query/reply mechanism. The proactive maintenance of routing zones also helps in improving the quality of discovered routes, by making them more robust to changes in network topology.

B. Greedy Perimeter Stateless Routing (GPSR)

Greedy Perimeter Stateless Routing (GPSR) specifies only the geographic forwarding strategy, and GPSR's data forwarding algorithm embraces two components: greedy forwarding and perimeter routing.

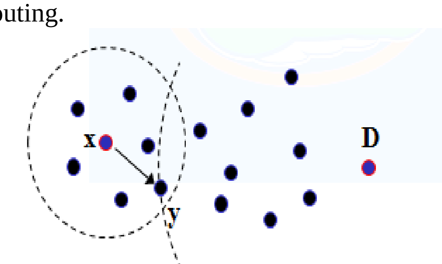


Figure 4: Greedy forwarding example, y is x's closest neighbor to D

Greedy Forwarding

In Greedy Forwarding, the source node knows the geographic locations of the destination node. The information of position will be integrated into the route request packet. A local table with the listed positions of the entire neighbor nodes in its range is maintained by each node. The node which have to treat the route request packet checks its local table for a nearest node with the destination and forwards the data packet to the corresponding node.

An example of Greedy forwarding is shown in figure 3. X receives a packet destined for D. x's radio range is represented by the dotted circle. The packet is forwarded from x to y, as the distance between y and D is less than that between D and any of

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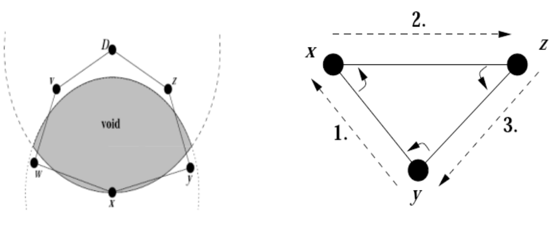
x's other neighbors. This Greedy forwarding process repeats, until the packet reaches D. When the packet cannot find a neighbor node closest to the destination, a recovery strategy called the perimeter forwarding is used.

Perimeter Routing

When a node is unable to find a neighbor node nearer to the destination, greedy mode will be changed into perimeter mode.



(a) (b)

Figure 5: (a) Node x's void with respect to destination D.
(b) The right-hand rule (interior of the triangle).

In figure 5 (a), x is closer to D than its neighbors w and y. The radius of D is equal to the distance between x and D. Although two paths (X→y→z→D) and (X→w→v→D), X will not choose to forward to w or y using greedy forwarding. X is local maximum in its proximity to D. The packet mode will be placed to perimeter mode and the second algorithm will be active.

In perimeter mode forwarding, the right hand rule is used for traversing the edges of a void (the shaded region without nodes). This algorithm finds out a possible path around a void to the destination node.

The right hand rule states that when arriving at node x from node y, the next edge traversed is the next one sequentially counterclockwise about x from edge (x, y). The right hand rule traverses the interior of a closed polygonal region in clockwise order. In figure 5 (b), edges are traversed in the order (y→X→ z→ y). The rule traverses an exterior region, in this case, the region outside the same triangle, in counterclockwise edge order.

IV. Simulation Environment

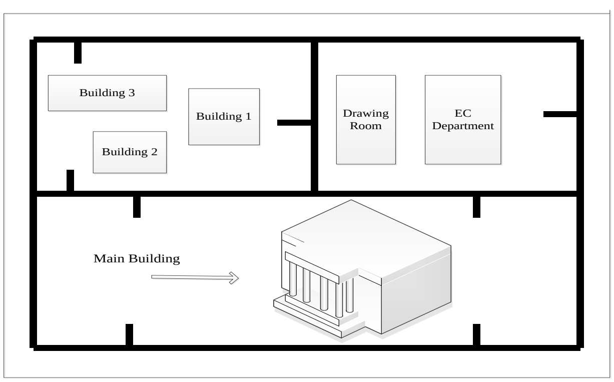


Figure 6: Simulation Network Area

NS-2.33 is used for the entire simulation. The TCL script is used to run NS-2 simulation for analyzing the performance of routing protocols in MANETs. These files are then used for the simulation and a trace file is generated as output. Prior to the simulation, the simulation parameters must be selected. The trace files can then be scanned and analyzed for the various performance metrics. After the output trace file have analyzed with awk script, these data are plotted on Microsoft Office Excel. And the trace files can also be used to visualize the simulation run with Network Animator (NAM).

For MANET simulation, performance metrics are used to analyze the protocols.

Throughput – Throughput is the total number of packets that have been successfully delivered from source node to destination node.

End-to-End Delay – End-to-end delay is the average time delay for data packets from the source node to the destination node.

Packet Delivery Fraction – Packet delivery fraction is the ratio of total number of packets received by destination over total number of packets sent by source.

Routing Overhead – Routing overhead is all packets sent or forwarded at network layer.

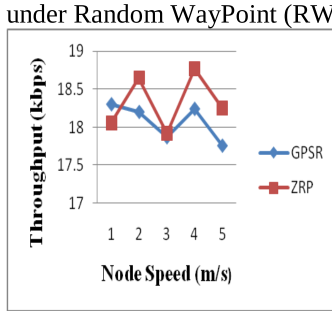
There are many simulation parameters that need to be varied in order to perform exhaustive simulations.

Table1. Simulation Parameters

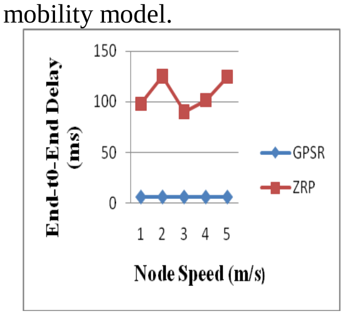
Parameters	Value
Routing Protocols	ZRP, GPSR
Mobility Models	Random Way Point
Propagation Model	Two Ray Ground
MAC Layer protocol	IEEE802.11
Antenna Model	Omni Antenna
Channel Type	Wireless Channel
Simulation Area	200m×200m
Simulation Time	100s
Number of nodes	10, 20,30,40, 50
Node Speed	1, 2, 3, 4, 5
UDP connections	20, 40,60, 80, 100
Packet size	512 bytes

V. Simulation Results and Analysis

Figure 1, 2 and 3 represent as the performance of location based routing protocols. The protocols are analyzed for throughput, end-to-end delay, packet delivery fraction and overhead at varying node density, node speed and traffic load under Random WayPoint (RWP) mobility model.



(a)



(b)

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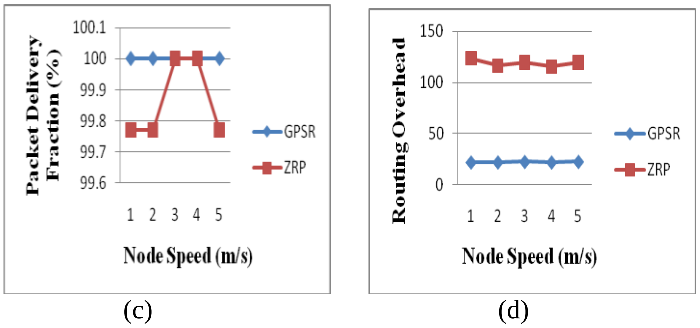

Figure 1: (a) Throughput, (b) End-to-End Delay, (c) Packet Delivery Fraction and (d) Routing Overhead for varying node speed

Figure 1(a) shows the throughput of the protocols. GPSR performs better than ZRP in low node speed. ZRP scales well when the speed of node in the network increases. ZRP has a lower throughput than GPSR which increases fluctuately.

Figure 1(b) shows the end-to-end delay of the protocols. GPSR has the lower end-to-end delay at low and high node speed as compare to ZRP. ZRP has a higher end-to-end delay than GPSR in all case, which increases when the speed of node increases. This is not desirable property of a protocol, as that end-to-end delay reveals that ZRP inefficiency to operate properly in a network.

Figure 1(c) illustrates the packet delivery fraction of the two protocols. GPSR has better performance than ZRP in term of PDF in all case. The PDF of GPSR are same with 100%. ZRP has a lower PDF in case of 1 and 2m/s, which increase significantly up to 100% at 3 and 4m/s. After 4 cases, ZRP performance drop significantly with 5m/s.

Figure 1(d) shows the routing overhead of location based routing protocols. GPSR has lower routing overhead whereas ZRP has a higher routing overhead in simulation results. ZRP presents small fluctuations in term of routing overhead. That high routing overhead degrades the performance of the protocols as it consumes more bandwidth.

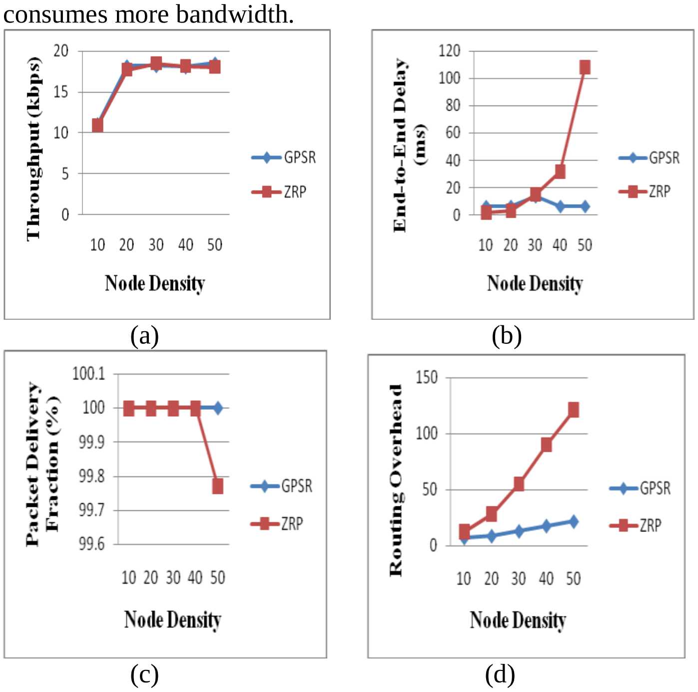

Figure 2: (a) Throughput, (b) End-to-End Delay, (c) Packet Delivery Fraction and (d) Routing Overhead for varying node density

Based on the results of simulation as indicated in figure 2(a) it is observed that both protocols have a similar performance at all nodes. GPSR has a smaller better than ZRP in term of throughput. The throughputs in the two protocols increase when the number of nodes increases.

GPSR has the lower end-to-end delay at low and high node density as compare to ZRP, as we see in figure 2(b). ZRP has a lower end-to-end delay than GPSR in case of 10 and 20 nodes, which increase exponentially with 50 nodes.

Figure 2(c) shows the PDF of the protocols. Both protocols have an identical performance except in case of 50 nodes, in which ZRP performance drop significantly with that node.

Figure 2(d) shows the routing overhead of ZRP and GPSR. GPSR has a lower routing overhead than ZRP, but the routing overhead of GPSR has slightly increase when the number of node increase. ZRP has the worst performance due to the high routing overhead with increasing nodes.

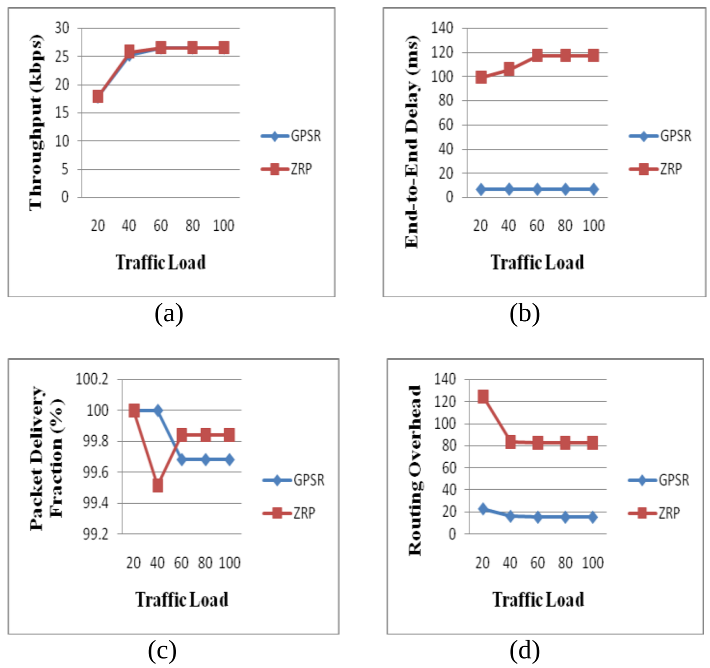

Figure 3: (a) Throughput, (b) End-to-End delay, (c) Packet Delivery Fracyion and (d) Routing Overhead for varying traffic load

Above the two protocols have a similar performance in term of throughput as seen in figure 3(a). Impoving the throughput is also well the performance of the protocols.

Figure 3(b) illustrates the end-to-end delay of both protocol. GPSR has a better performance than ZRP in all case. The performance of ZRP degrades with increasing network connections.

Figure 3(c) shows the PDF of ZRP and GPSR. Both protocols have an identical performance in term of PDF (100%) at 20 connections. At 40 connections, the PDF of GPSR continue stable whereas that of ZRP drop significantly with 99.5%. After that the PDF of both protocols, GPSR and ZRP stable with 99.68% and 99.84% respectively.

Figure 3(d) shows the routing overhead of ZRP and GPSR. GPSR has a lower routing overhead than ZRP under varying traffic load. The routing overhead of both protocols decrease when the number of connection increase.

VI. Conclusion

In this paper, performance analysis are carried out on the simulation results of two location based routing protocols, ZRP and GPSR. All the simulations are performed over mobile ad hoc network. From the investigation, GPSR out performed ZRP in terms of end-to-end delay, packet delivery fraction and routing overhead.The two protocols have similar high throughput in varying node density and traffic load. High node speeds in GPSR can break the links in the network. So the throughput of GPSR decreases when the speed of node increases. ZRP has high end-to-end delay and routing overhead whereas GPSR has low end-to-end delay and routing overhead. This is the main reason of performance degradation of the routing protocols in high end-to-end delay and routing overhead. From previous simulation, it has been observed that GPSR performs better than ZRP.

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References

[1] Sanku Sinha and Biswaraj Sen, Effect of Varying Node Density and Routing Zone Radius in ZRP: A Simulation Based Approach, Sikkim Manipal Institute of Technology, ISSN: 0975-3397, Vol.4 No. June 2012.

[2] Biswaraj Sen, *A Simulation Based Performance Analysis of AODV and DSDV Routing Protocols in MANETs*, Department of Computer Sc & Engineering, Sikkim Manipal Institute of Technology, India, Vol.2, Issue.4, July-Aug. 2012.

[3] http://www.eexploria.com/manet-mobile-ad-hoc-network-characteristics-and-features.

[4] Georgios Kioumourtzis, Performance evaluation of ad hoc routing protocols for military communications, Research Academic Computer Technology Institute and University of Patras, 26500 Rion, Greece, September 2011.

[5] Raed Saqour and Mohamad Shanudin, *A Prediction Scheme to Enhance the Routing Process in Geographical GPSR Ad hoc Protocol*, Universiti kebangsaan Malaysia Bangi, Selangor, 43600, MALAYSIA, {r_saqour2002@yahoo.com / msz@ftsm.ukm.my}.

[6] V.Kanakaris, D.Ndzi and D.Azzi., “Ad-hoc Networks Energy Consumption: A review of the Ad-Hoc Routing Protocols”, Journal of Engineering Science and Technology Review 3 (1) (July 2010).

[7] Brad Karp, *GPSR: Greedy Perimeter Stateless Routing for Wireless Networks*, Harvard University/ ACIRI, in Proc. Of the 6th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom 2000).

[8] R.Jain, A.Puri, and R.Sengupta, “Geographical routing using partial information for wireless ad hoc networks,” IEEE Personal Communications, pp.48–57, Feb.2001.

[9] Parma Nand, Comparative Study and Performance Analysis of FSR, ZRP and AODV Routing Protocols for MANET, Wireless Computing Lab. IIT Roorkee India (91), 2011.

[10] S.kannan, *An Investigation about Performance Comparison of Multi-Hop Wireless Ad-Hoc Network Routing Protocols in MANET*, SSNS College of Technology, Sathy Main Road, Coimbatore- 641035, Tamil Nandu, Issue 3, No 6, May 2010.

[11] Sree Ranga Raju, Kiran Runkana, Jitendranath Mungara, ” ZRP versus AODV and DSR: A comprehensive study on ZRP performance”, International Journal of Computer Applications (0975 – 8887) Volume 1– No12, 2010.

[12] P. Manickam and T. G. Baskar, “*PERFORMANCE COMPARISONS OF ROUTING PROTOCOLS IN MOBILE AD HOC N ETWORKS*,” vol. 3, no. 1, pp. 98–106, 2011.

[13] Ajay Prakash Rai and Rasvihari Sharma, " Performance Comparison of AODV & DSDV Ad-Hoc Network Routing Protocols On The Basis Of Variable Speed & Pause Time", Volume 2, Issue 10, April 2013.

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