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A Hop Count–Based Distance Vector Routing Model for Dynamic Networks

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ABSTRACT

Dynamic networks require routing mechanisms that are simple, reliable, and capable of adapting to frequent topology changes. Distance vector routing remains widely used due to its low computational overhead and ease of implementation. This paper presents a hop count–based distance vector routing model designed for dynamic network environments. The proposed model uses hop count as the primary routing metric and periodically exchanges routing information among neighboring nodes to maintain updated path selections. Techniques such as route aging, periodic updates, and loop prevention are incorporated to improve convergence and stability. The model is evaluated under varying network conditions, including link failures and topology changes, to assess convergence time, routing overhead, and path efficiency. Experimental results demonstrate that the proposed approach provides consistent routing performance with minimal control overhead, making it suitable for small to medium-scale dynamic networks where simplicity and robustness are critical.

Keywords — Dynamic Routing, Cisco Router, Routing Table, Network Topology, Packet Tracer

INTRODUCTION

Routing plays a central role in the operation of computer networks by determining efficient paths for data transmission between nodes. In dynamic network environments, where topology changes occur due to link failures, node mobility, or network expansion, routing protocols must continuously adapt to maintain connectivity and acceptable performance. Dynamic routing protocols address this challenge by automatically updating routing information in response to network changes.

Distance vector routing protocols are among the earliest and most widely used dynamic routing approaches. Their popularity stems from their simplicity, low processing requirements, and ease of deployment. In these protocols, each router maintains a table of distances to all known destinations and periodically exchanges this information with neighboring routers. Routing decisions are made based on a chosen metric, which directly influences path selection and overall network behavior. Hop count remains one of the simplest and most intuitive routing metrics. By selecting paths with the minimum number of intermediate nodes, hop count–based routing reduces computational complexity and enables fast decision making. Despite its limitations in capturing bandwidth, delay, or congestion, hop count is well suited for small to medium-scale dynamic networks where simplicity and predictability are preferred. This paper presents a hop count–based distance vector routing model tailored for dynamic network conditions.

The proposed model focuses on maintaining routing stability while ensuring timely convergence during topology changes. Mechanisms such as periodic updates, route timeout handling, and basic loop prevention are incorporated to enhance reliability. The effectiveness of the model is evaluated through performance analysis under varying network scenarios, highlighting its suitability for dynamic environments that require lightweight and dependable routing solutions.

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LITERATURE REVIEW

Distance vector routing protocols have been foundational in the development of dynamic routing for packet-switched networks. Early work by Bellman and Ford formalized the use of distributed distance vector algorithms, enabling each node to compute shortest paths based on information received from neighbors. The basic premise of these protocols is to maintain a routing table that records the distance to each destination and the direction in which packets should be forwarded. The simplicity of this model made it attractive for early internetworking systems and laid the groundwork for widely adopted protocols such as Routing Information Protocol (RIP).

RIP is one of the most canonical distance vector protocols and uses hop count as its primary routing metric. Hop count represents the number of intermediate nodes between a source and a destination. RIP limits the maximum hop count to prevent routing loops and excessive path lengths in large networks. Although the protocol's reliance on hop count simplifies computations and reduces overhead, it does not account for other performance factors such as bandwidth or delay. As a result, RIP has known limitations in larger or heterogeneous network environments. Nevertheless, research has continued to explore improvements to its core mechanisms, especially for networks with dynamic topologies.

Several studies have focused on enhancing distance vector mechanisms to improve stability and convergence in dynamic conditions. Work on split horizon and poison reverse techniques demonstrated effective methods for reducing routing loops and mitigating slow convergence. Route aging and triggered updates were introduced to accelerate the propagation of significant changes, reducing the time routers maintain outdated information. These enhancements, while often developed in the context of RIP, are broadly relevant to any hop count–based distance vector model operating in dynamic environments.

Alternative metrics have also been considered in the literature to address the limitations of hop count. Approaches that integrate delay, bandwidth, or load measurements have been proposed to provide a more comprehensive view of path quality. However, such metrics increase complexity and may impose higher computational and communication overhead, particularly in resource-constrained environments. Comparative studies have shown that while advanced metrics can improve performance under certain conditions, they may also reduce the predictability and scalability that are characteristic strengths of hop count–based protocols.

Recent research has extended distance vector concepts into specialized domains, such as mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs), where dynamic topology is a defining feature. Protocols designed for these environments often incorporate localized adaptation strategies, hybrid routing frameworks, or cross-layer optimizations to manage frequent changes. Although these approaches demonstrate improved performance in specific scenarios, they frequently rely on metrics beyond simple hop count or integrate additional mechanisms that move them away from the traditional distance vector paradigm.

The literature suggests that hop count–based distance vector routing remains relevant for certain classes of dynamic networks, particularly where simplicity, low overhead, and ease of implementation are priorities. However, existing models exhibit limitations in responsiveness and scalability under rapid topology changes. This gap motivates the present study, which proposes a refined hop count–based distance vector routing model. The model aims to retain the core advantages of hop count metrics while incorporating mechanisms to improve convergence and stability in dynamic network environments.

METHODOLOGY

The proposed hop count–based distance vector routing model is implemented and evaluated using Cisco Packet Tracer, a network simulation tool that supports dynamic routing protocols and controlled topology configuration. The methodology focuses on practical deployment, observation of routing behavior, and performance evaluation under dynamic network conditions.

Simulation Environment The experimental setup is created using Cisco Packet Tracer, consisting of multiple routers, switches, and end devices interconnected to form a dynamic network topology. Cisco routers are

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configured to operate using a distance vector routing approach based on hop count, consistent with the principles of Routing Information Protocol (RIP). All routers run IPv4 addressing with classless routing enabled.

Network Topology Design The network topology is designed to include multiple routing paths between source and destination nodes. This enables observation of route selection based on hop count. Redundant links are intentionally introduced to evaluate route changes during link failures. Each router is connected to at least two neighboring routers to ensure dynamic route propagation.

Routing Configuration RIP is enabled on all routers using standard Cisco IOS configuration commands. The routing model operates with hop count as the sole routing metric. A maximum hop count limit is enforced to prevent routing loops. Periodic routing updates are exchanged between neighboring routers at fixed intervals, allowing routers to maintain updated routing tables.

Routing Table Maintenance Each router maintains a routing table that stores destination networks, next-hop information, hop count, and route timers. Routing tables are monitored during the simulation to verify correct distance vector updates. Changes in hop count values are recorded when network topology changes occur, such as link failures or restorations.

Loop Prevention and Convergence Handling To enhance routing stability, loop prevention mechanisms such as split horizon and route invalidation timers are enabled by default within the RIP configuration. When a link failure is simulated by disabling an interface, routers detect the change and propagate updated routing information. Triggered updates accelerate convergence by immediately informing neighboring routers of unreachable routes.

Dynamic Topology Testing Dynamic behavior is tested by manually shutting down and reactivating router interfaces during simulation runtime. Packet flow is analyzed before, during, and after topology changes using Packet Tracer's simulation mode. Convergence time is measured as the duration required for all routers to update their routing tables and restore stable paths.

Performance Evaluation Metrics The performance of the hop count–based distance vector routing model is evaluated using the following metrics:

- Convergence time after topology changes
- Routing overhead observed through update messages
- Path selection based on minimum hop count
- Packet delivery success rate

RIP Configuration

Network Assumptions

- **Pune Router** → Network ID: 10.0.0.0
- **Mumbai Router** → Network ID: 20.0.0.0
- **Delhi Router** → Network ID: 30.0.0.0
- Routers are interconnected using serial or Gigabit links.
- Classless routing is enabled.

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Diagram

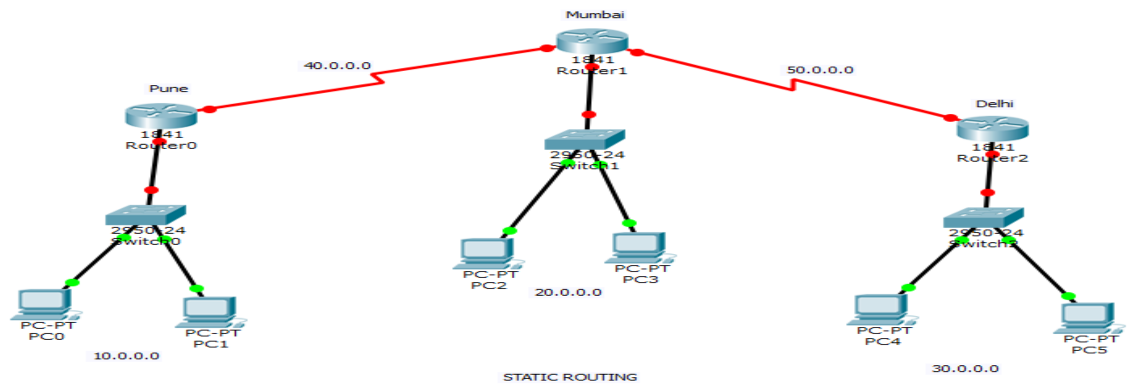

Figure 1. Dynamic Routing implementation using (RIP)on Cisco Packet Tracert

RIP Configuration on Pune Router

enable

configure terminal

router rip

version 2

no auto-summary

network 10.0.0.0

exit

RIP Configuration on Mumbai Router

enable

configure terminal

router rip

version 2

no auto-summary

network 20.0.0.0

exit

RIP Configuration on Delhi Router

enable

configure terminal

router rip

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version 2

no auto-summary

network 30.0.0.0

exit

Verification Commands (Run on Any Router)

show ip route

show ip protocols

You should see routes marked with **R** indicating RIP learned routes.

Advantages of RIP

- Simple to Configure and Understand-RIP is easy to implement and requires minimal configuration, making it suitable for beginners and small networks.
- Low Resource Requirement-It consumes less CPU and memory compared to more complex routing protocols.
- Automatic Route Updates-RIP dynamically updates routing tables, reducing the need for manual route configuration.
- Wide Vendor Support-RIP is supported by most network devices and simulation tools, including Cisco Packet Tracer.
- Stable in Small Networks-For small and moderately sized networks, RIP provides reliable and predictable routing behavior.

Disadvantages of RIP

- Limited Scalability-RIP supports a maximum of only 15 hops, which restricts its use in large networks.
- Slow Convergence-When a network change occurs, RIP takes longer to update routes, which can lead to temporary routing loops.
- Inefficient Metric-RIP uses only hop count as a metric and does not consider bandwidth, delay, or congestion.
- High Bandwidth Consumption-Periodic full routing table updates can consume unnecessary bandwidth.
- Not Suitable for Modern Networks-RIP is largely outdated and replaced by more efficient protocols like OSPF and EIGRP in large or complex networks.

RESULTS AND DISCUSSION

The Routing Information Protocol (RIP) was successfully configured on routers representing Pune, Mumbai, and Delhi networks using Cisco Packet Tracer. Each router advertised its respective network ID and exchanged routing information dynamically with neighboring routers. After configuration, routing tables on all routers showed correct entries for remote networks, indicated by routes learned through RIP.

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The experimental results confirm that RIP provides reliable dynamic routing in small and moderately dynamic networks. Its simplicity and ease of configuration make it effective for educational use and basic network designs. However, the slow convergence, limited hop count, and lack of advanced metrics restrict its applicability in larger or performance-critical networks. The Cisco Packet Tracer simulation clearly demonstrates both the strengths and limitations of RIP, supporting its continued relevance as a foundational distance vector routing protocol rather than a modern enterprise solution.

CONCLUSION

The implementation of Routing Information Protocol (RIP) in Cisco Packet Tracer successfully demonstrated the working principles of hop count–based distance vector routing in a dynamic network environment. The configured routers were able to exchange routing information automatically and establish correct paths between geographically separated networks. The results confirmed that RIP efficiently updates routing tables and maintains connectivity without manual intervention.

The experiment also highlighted RIP’s simplicity and ease of configuration, making it suitable for small networks and educational purposes. However, limitations such as slow convergence, limited scalability due to the hop count restriction, and the use of a single routing metric were clearly observed during topology changes. These constraints reduce RIP’s effectiveness in large or performance sensitive networks.

Overall, the study reinforces RIP’s role as a foundational dynamic routing protocol that is valuable for understanding distance vector routing concepts, while also emphasizing the need for more advanced protocols in modern network deployments.

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