

REVIEW APPROACH: PROEP PROTOCOL FOR MESSAGE PASSING IN OPPORTUNISTIC NETWORKS

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ABSTRACT

This paper reviews the ProEp Protocol, an innovative hybrid approach designed for message routing in opportunistic networks. By combining the Epidemic Routing and Probabilistic Routing methods, ProEp aims to enhance message delivery reliability while minimizing resource consumption. Opportunistic networks, characterized by intermittent connectivity and the absence of fixed infrastructure, face unique challenges such as high delays, frequent disconnections, and limited resources. This review discusses the motivation, design, evaluation, and potential improvements of the ProEp Protocol.

1. INTRODUCTION

Opportunistic networks, also known as delay-tolerant networks (DTNs), are networks where connectivity is sporadic and unpredictable. These networks rely on the mobility of nodes to store and carry messages until a suitable forwarding opportunity arises. Unlike traditional networks that depend on consistent infrastructure, opportunistic networks operate in environments with sparse or no network coverage, such as remote areas, disaster zones, and urban settings with intermittent connectivity.

The primary challenges in these networks include ensuring reliable message delivery, managing resource constraints, and addressing security concerns. Conventional infrastructure wireless networks often fall short in providing continuous, high-bandwidth, and cost-effective service in these scenarios, making opportunistic networks a valuable alternative for specific applications.

2. MOTIVATION AND CHALLENGES

The challenges in opportunistic networks are multifaceted. Firstly, ensuring reliable message delivery in the face of frequent disconnections and varying delays is a significant hurdle. Traditional routing methods may not be effective in such dynamic environments. Secondly, resource consumption is a critical issue. The broadcast nature of message dissemination can lead to excessive bandwidth usage and rapid battery depletion. Lastly, security concerns such as data privacy, integrity, and trustworthiness of participating nodes need to be addressed to ensure the network's reliability and usability.

The ProEp Protocol is motivated by the need to address these challenges effectively. By integrating Epidemic and Probabilistic Routing strategies, ProEp aims to achieve a balance between reliable message delivery and efficient resource utilization.

3. RESEARCH OBJECTIVE

The primary objective of this research is to develop a routing protocol that enhances message delivery reliability and reduces the broadcast storm problem in opportunistic networks. The ProEp Protocol employs a probability-based forwarding mechanism that selects nodes with the highest likelihood of successful message delivery, thereby minimizing unnecessary transmissions and conserving resources.

PROBLEM STATEMENT AND SCOPE

The ProEp Protocol is designed to ensure efficient message passing in environments where traditional network infrastructure is unavailable or unreliable. By leveraging node encounter histories to calculate transmission probabilities, the protocol selects the most suitable nodes for forwarding messages. This approach reduces resource consumption and improves delivery rates, making it particularly useful in scenarios like disaster recovery, military operations, and rural connectivity.

4. LITERATURE REVIEW

- **Burgess, J., Gallagher, B., Jensen, D., & Levine, B. N. (2006).** "MaxProp: Routing for Vehicle-Based Disruption-Tolerant Networks" - This paper introduces MaxProp, a routing protocol designed for vehicle-based disruption-tolerant networks (DTNs). It prioritizes the scheduling and forwarding of messages based on the likelihood of delivery, thereby improving the overall efficiency of message passing in DTNs. The study's insights on message prioritization and scheduling are fundamental to understanding protocols like ProEp.
- **Lindgren, A., Doria, A., & Schelén, O. (2003).** "Probabilistic Routing in Intermittently Connected Networks" - This paper discusses probabilistic routing techniques in intermittently connected networks, where the probability of

successful message delivery is a key metric. The proposed protocols leverage historical encounter information to make informed forwarding decisions, which is relevant for the design of opportunistic protocols like ProEp.

- **Vahdat, A., & Becker, D. (2000).** "Epidemic Routing for Partially-Connected Ad Hoc Networks" - This foundational paper presents the concept of epidemic routing, where messages are spread through the network in a manner similar to the spread of a virus. The relevance to ProEp lies in the dissemination strategy and the analysis of message propagation in opportunistic environments.
- **Spyropoulos, T., Psounis, K., & Raghavendra, C. S. (2008).** "Efficient Routing in Intermittently Connected Mobile Networks: The Multiple-copy Case" - This work explores efficient routing strategies using multiple message copies to enhance delivery probability. The methods proposed for resource allocation and message replication provide a deeper understanding of the mechanisms that can be employed in ProEp.
- **Pelusi, L., Passarella, A., & Conti, M. (2006).** "Opportunistic Networking: Data Forwarding in Disconnected Mobile Ad Hoc Networks" - This survey paper provides an extensive review of various data forwarding techniques in opportunistic networks. It highlights the challenges and solutions, offering a comprehensive background against which the ProEp protocol can be evaluated.
- **Zhang, Z., & Li, B. (2006).** "MOON: A General Methodology for Designing Overlay Networks" - This paper presents MOON, a methodology for designing overlay networks that can adapt to various application requirements. The relevance to ProEp is found in the overlay network concepts and adaptive strategies that can be applied to message passing in opportunistic networks.
- **Wang, Y., Wu, S. F., & Yguel, M. (2009).** "On the Performance of Hybrid Routing Protocols in Delay Tolerant Networks" - This paper evaluates the performance of hybrid routing protocols, combining proactive and reactive strategies to improve message delivery in delay-tolerant networks. The performance analysis provided here is essential for assessing the potential benefits and limitations of ProEp.
- **Grossglauser, M., & Tse, D. N. C. (2002).** "Mobility Increases the Capacity of Ad Hoc Wireless Networks" - This seminal paper discusses how node mobility can enhance the capacity of ad hoc wireless networks. The insights on mobility patterns and their impact on network performance are directly applicable to the development of protocols like ProEp.
- **Zhang, X., Neglia, G., Kurose, J., & Towsley, D. (2007).** "Performance Modeling of Epidemic Routing" - This paper provides a detailed performance model for epidemic routing, analyzing key metrics such as delivery delay and resource consumption.

The modeling techniques used here can be instrumental in evaluating the performance of the ProEp protocol.

- **Conti, M., Giordano, S., & Passarella, A. (2014).** "From Opportunistic Networks to Opportunistic Computing" - This paper extends the concept of opportunistic networking to opportunistic computing, where the focus is on leveraging opportunistic contacts for computational tasks.

The discussions on resource utilization and opportunistic interactions provide a broader context for the applications of the ProEp protocol.

5. PROEP PROTOCOL DESIGN

The ProEp Protocol merges the advantages of PROPHET and Epidemic Routing algorithms. It limits the number of nodes involved in message forwarding to the two with the highest transmission probabilities. This strategy not only curtails unnecessary message replication but also enhances delivery rates. The protocol's design is tailored to scenarios where rapid and reliable communication is crucial, such as emergency response and ad-hoc military networks.

PERFORMANCE EVALUATION

The performance of the ProEp Protocol is evaluated based on several parameters, including communication delay, buffer size, and hop count. The results, illustrated through graphs and data analysis, indicate that the ProEp Protocol outperforms existing routing techniques in terms of message delivery success and resource optimization. Key findings include:

- Reduced Communication Delay: ProEp achieves lower average delays compared to Epidemic and Randomized Routing due to its probabilistic selection of optimal forwarding nodes.
- Efficient Buffer Usage: By limiting the number of message copies, ProEp reduces buffer occupancy, preventing overflow and ensuring more efficient use of memory resources.
- Optimal Hop Count: The protocol maintains a lower average hop count, ensuring messages are delivered through fewer intermediaries, which enhances delivery speed and reduces resource strain.

6. CONCLUSION

The ProEp Protocol offers a robust solution for routing in opportunistic networks by balancing message delivery reliability with resource efficiency. Its hybrid approach, combining the strengths of Epidemic and Probabilistic Routing, addresses the key challenges of opportunistic networking environments. Future research could focus on real-world implementations and further optimizations to enhance the protocol's effectiveness across diverse scenarios.

7. KEY CONTRIBUTIONS

1. Enhanced Message Delivery: The ProEp Protocol significantly improves the reliability of message delivery in opportunistic networks.
2. Resource Efficiency: The protocol reduces resource consumption by limiting unnecessary message forwarding and employing a probability-based selection mechanism.
3. Hybrid Routing Approach: By integrating Epidemic and Probabilistic Routing techniques, ProEp provides a balanced solution that leverages the advantages of both methods.
4. Security and Trust: The protocol enhances security by increasing trustworthiness and protecting data privacy through probabilistic methods.

8. FUTURE DIRECTIONS

Future research should explore the deployment and testing of the ProEp Protocol in various real-world environments, such as urban areas, disaster zones, and remote regions. Additionally, further enhancements to the probabilistic model and integration of advanced security mechanisms could improve the protocol's performance and robustness. Investigating the impact of different mobility patterns and node densities on the protocol's effectiveness would also provide valuable insights for optimizing its deployment.

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