耐延遲網路下結合社會網絡之資料傳播技術

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Content

This project considers the delay- or disruption-tolerant networking (DTN) technologies that are characterized by high node mobility, uncertainty of node existence, and intermittent connectivity. Data dissemination in DTNs resorts to new routing paradigms instead of traditional end-to-end routing paradigms in mobile ad hoc networks (MANET).

The second-year research follows the previous results, and proceeds to exploit the network-coding methodology for message multicasting in delay tolerant networks. We now obtain two additional efforts: (A) message multicasting with network coding-based routing in DTNs, and (B) a new buffer management and scheduling policy for replication based message multicasting in DTNs.

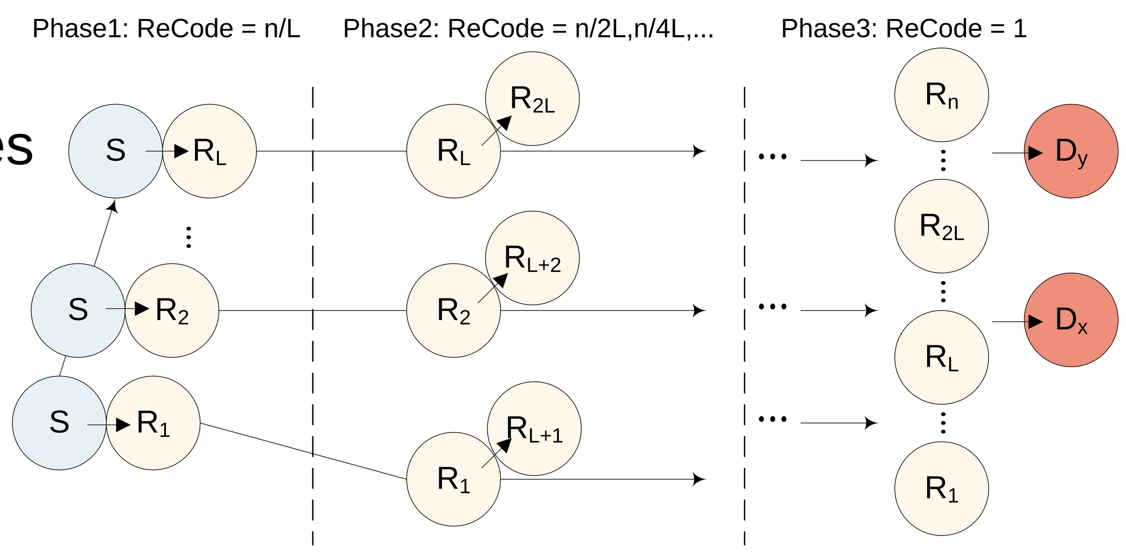
Part A

A1. Introduction

This study exploits the basic functionality of network-coding paradigms and designs a network coding multicast mechanism for efficient data dissemination in DTNs. Intermediate nodes in a network can perform a specific remix qualification method capable of alleviating the critical problem of data dependency among coded blocks as restoring original messages by destination nodes. By simulations, the proposed mechanism outperforms, cost-effectively, the naive network-coding and replication-based delivery mechanisms for message multicasting in DTNs.

A2. Mechanism Design

Proposed scheme includes following three phases：
(1) Generation
(2) Distribution
(3) Restoration



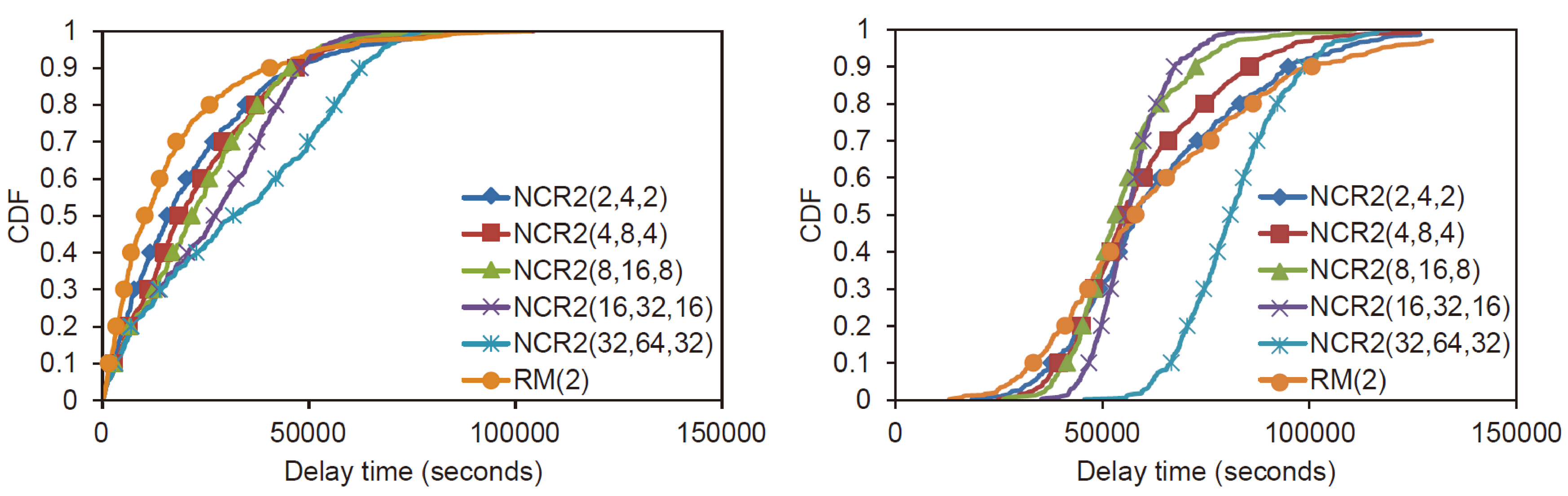
Remix Qualification

To avoid remixing dependent coded blocks into useless coded blocks in Phase 2. Suppose that all these coded blocks bring an original identifier, e.g., RootID, to represent their linear combination relationship with the original source node. Furthermore, a coded block can be coupled with an extended RootIDSet structure to indicate concurrent dependency with multiple relay nodes which ever encoded this coded block for transmission in a network

- **Strict method**: a coded block is not to be remixed as it has been remixed k -1 times, since this coded block is already characterized by all independent terms from the original message that was initially divided into k independent coded blocks.
- **Loose method**: a coded block is not to be remixed as the size of RootIDSet of this coded block is equal to k.

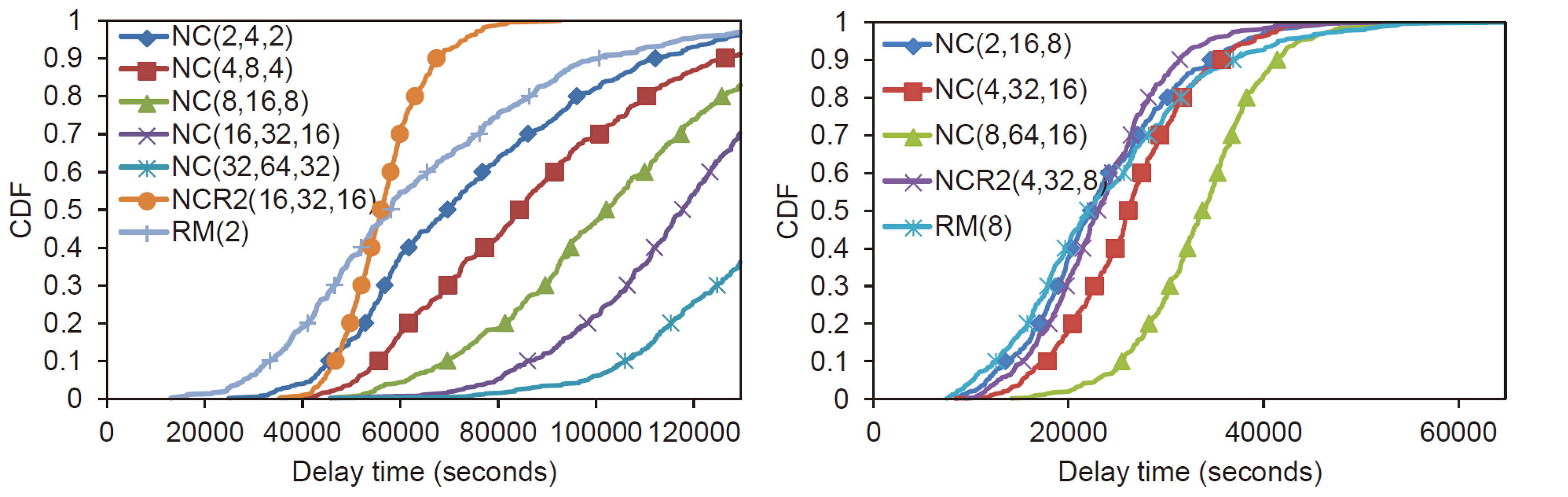
A3. Simulation result

- CDF of delivery delay time under different numbers of destination nodes (N)



(a) $N = 1$ (b) $N = 16$

- Delay time distribution of NC without remix and NC with remix qualification (NCR2) under different values of replication factor



(a) $r = 2$ (b) $r = 8$

Part B

B1. Introduction

This study proposes a new buffer management and scheduling policy to facilitate message multicasting in DTNs. The design of this policy elegantly extends an optimal knowledge-based scheduling and drop policy, and derives a new utility function to prioritize messages in buffer to maximize the successful delivery rate in a network. Performance results show that the proposed scheme outperforms not only the original policy but also several buffer management policies under message multicasting in DTNs. In addition, there are many new observations and insights into the effects by different node and networking conditions, providing significant information for developing new schemes in support of multicasting in DTNs.

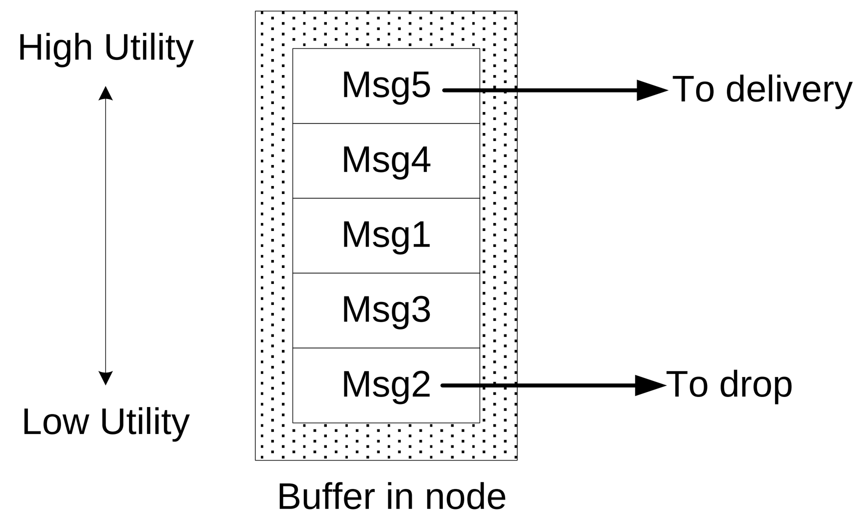
B2. Proposed E-GBSD Policy

Prioritizing the delivery and dropping schedules among messages in a buffer according to utility function.

Symbol	Meaning
L	Number of nodes in the network
$K(t)$	Number of distinct messages in the network at time t
R_i	Remaining Time To Live for message i
N_i	Number of destinations for message i
$n_i(T_i)$	Number of copies of message i in the network after elapsed time T_i
$m_i(T_i)$	Number of nodes that have seen message i since its creation until elapsed time T_i
λ	Meeting rate between two nodes

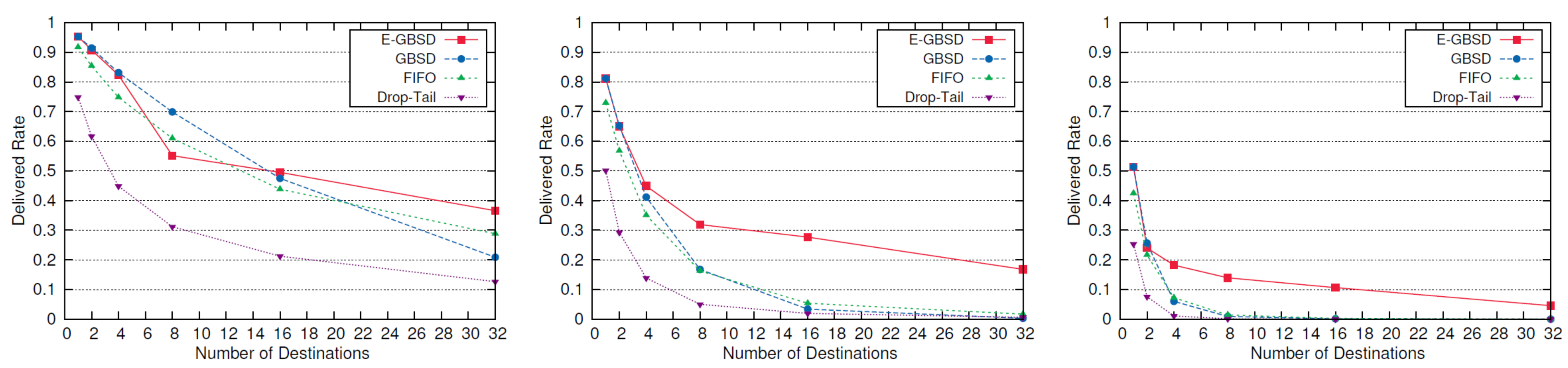
Utility function for delivery rate in multicasting

$$U_i(MDR) = N_i \lambda R_i e^{-\lambda n_i(T_i) R_i} \times \left(1-\frac{m_i(T_i)}{L-1}\right) \times \left(\left(1-\frac{m_i(T_i)}{L-1}\right) \times (1-e^{-\lambda n_i(T_i) R_i}) + \frac{m_i(T_i)}{L-1}\right)^{N_i-1}$$



B3. Simulation result

Delivery rate under different numbers of destinations (70 nodes)



(a) 10 sources (b) 20 sources (c) 50 sources

Summary

Therefore, the second-year research result achieves two contributions capable of cost-effective and reliable performance improvement for messaging multicasting mechanisms in DTNs. Their effects are manifested under both analytical and performance investigations. Our research actions are going to design and investigate various heuristics to upgrade delay-tolerant routing functionalities by various features of social relationship among nodes in delay-tolerant network environments.