

# Social-based forwarding in delay-tolerant networks

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# Introduction

- Delay-tolerant networks(DTNs)
  - Intermittently disconnected networks
  - Aim at make users able to exchange data even in such a disconnected environment, by opportunistically exploiting any nearby device to move messages closer to the final destination
  - Due to users' movements and wireless links instability
- Existing MANET routing protocols is not applicable in DTNs
  - Because, the main assumption of the MANET environments is that a sender and a destination are connected to the network at the same time

# Introduction(cont.)

- Necessity to adopt social perspectives to routing protocol in DTNs
  - Within the physical communication range, mobile devices can communicate with each others
  - Mobile devices are moved by users
  - The number of communication chances of mobile devices is determined by encounter chances of the users

# Related works

	Bubble Rap	SimBet	HiBOp
Objectives	1. To make an efficient message delivery in opportunistic networks 2. How to select the next forwarder(s) which have more probability to deliver the message to the destination		
Utility value	Based on community and centrality(ranking) of the node	Based on tie strength betweenness centrality of the node and similarity from comparing destination node	Based on similarity of between node (destination) contexts(IT) and node(forwarder candidate) contexts(IT,CC,HT)
Contexts	Node contacts duration and frequency	Node contacts matrix that a given node has encountered	Identity table(users itself, physical neighbors) History table(attributes in the IT of encountered node)
Metrics	Delivery success ratio, Total cost(total number of messages)	Delay time, Delivery loss,, Amount of traffic, Average number of hops per msg	Delay time, Delivery loss, Amount of traffic, Buffer occupation,

# Characteristics of social networks

Properties	Details
The small world effect	Most parts of vertices in most networks seem to be connected by a short path through the network
Transitivity (or clustering)	A heightened number of triangles in the network-sets of three vertices are connected to each of the others
Degree distributions	Each vertex has a different number of edges
Network resilience	If some vertices are removed from a network, the typical length of paths between vertices will increase and vertex pairs will become disconnected
Mixing patterns	Vertices pair up with others
Degree correlations	A special case of assortative mixing according to a scalar vertex property is mixing according to vertex degree
Community structure	Groups of vertices that have a high density of edges within them, with a lower density of edges between groups
Betweenness centrality	The betweenness centrality of vertex $l$ is the number of geodesic paths between other vertices that run through $l$

# Routing protocol with adopting social network characteristics

Protocols	Social metrics	Social network characteristics
SimBet	Centrality Community Tie Strength	Community structure, Degree distribution Short average path length, Transitivity
Bubble Rap	Centrality Community	Community structure, Degree distribution Short average path length, Transitivity
HiBOP	Community Tie Strength	Community structure, Degree distribution Short average path length, Transitivity Degree correlation

# Limitations of existing works

- Even if each node selects the next forwarding nodes having high delivery probability with social characteristics, it is far from optimal
- When resources like buffer are limited, the performance is decreased

# Limitations of existing works(cont.)

SimBet (Infinite buffer)	[Message Info] Source Node: 1, Destination Node: 22, Sent Time: 26306		
No.	Intermediate Node	Encountered Time(s)	Difference of Utility Value
1	34	27298	0.48
2	37	79203	0.04
3	28	79559	0.06
4	40	81589	0.09
	22	81596	
Elapsed Time from source node to destination node: 55290			

# Limitations of existing works(cont.)

Optimal	[Message Info] Source Node: 1, Destination Node: 22, Sent Time: 26306		
No.	Intermediate Node	Encountered Time(s)	Difference of Utility Value
1	41	26600	-
2	8	26789	-
3	38	26872	-
	22	29538	
Elapsed Time from source node to destination node: 3232			

# Limitations of existing works(cont.)

Contacts	Node 1	Node 2	Encountered Time(s)
1	41	1	26600
2	34	1	26636
3	8	1	26758
4	38	1	26872
5	34	1	27298

# Limitations of existing works(cont.)

Buffer management	Delivered Messages	Overheads	Delay Time(s)
Drop Tail	21332	6.46	24273
Drop Front	22424	6.15	19806
Drop Weight	22998	6.1	21263
Infinite	38880	4.63	26557

# Issues and approaches

- How to select next forwarding nodes that more closes to optimal path
  - use some social characteristics to select next forwarding nodes within optimal path
- When dropping, how to select a message to be dropped
  - escape buffer overflow
  - drop a message based on importance factor in network

# Issues and approaches(cont.)

- How to select messages in buffer, when the total number of messages being forwarded are limited
  - Based on QoS of messages

# Proposed Architecture

