Poster: CIS: A Community-based Incentive Scheme for Socially-aware Networking

Feng Xia, Qiuyuan Yang, Li Liu, Tie Qiu, Zhikui Chen, Jie Li
School of Software, Dalian University of Technology, Dalian 116620, China
f.xia@acm.org

ABSTRACT

To address selfishness in socially-aware networking, we propose a Community-based Incentive Scheme (CIS). CIS utilizes community to stimulate cooperation among selfish nodes and allows all nodes to behave selfishly to imitate the realistic condition. The simulation results show that CIS effectively stimulates selfish nodes to cooperate, achieves higher delivery ratio while not increasing latency dramatically.

Categories and Subject Descriptors

C.2.2 [**Computer-Communication Networks**]: Network Protocols; H.1.2 [**Information Systems**]: User/Machine Systems—*human factors*

Keywords

Socially-aware networking; selfishness; incentive scheme; data forwarding

1. INTRODUCTION

Socially-Aware Networking (SAN) is a novel communication paradigm, which exploits social properties of mobile users to improve the performance of networking services. In SAN, due to resource constraints or privacy concerns, users are unwilling to relay data for others. Further, the presence of inherent selfishness degrades the performance dramatically. Especially, nodes with *individual selfishness* refuse to relay data for any others whereas nodes with *social selfishness* provide services for those with social relationship [1].

To tackle selfishness, several credit-based mechanisms [2, 3] utilize virtual credits to stimulate cooperation. However, they strive to encourage sharing from an individual perspective, and fail in taking full advantage of social characteristics (such as community) which are unarguably more stable than individual mobility. Additionally, they assign nodes with fixed selfish behavior (i.e. individual selfishness or social selfishness). This is unrealistic because a selfish node may behave cooperatively when its requirement of delivery is satisfied. Thus, it is essential to find an appropriate solution to imitate the realistic condition.

In this work, we propose a Community-based Incentive Scheme (CIS) for SAN. In CIS, nodes in a community have same abilities to represent the community. Therefore, we can concentrate on community to community communication instead of node to node. This is the major contribution of this poster. All nodes can behave selfishly to a community, which depends on whether they possess enough credits to the community for delivery. The number of message copies is positively correlated to credits, which helps stimulate nodes to cooperate for mutual benefit.

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2. DESIGN OF CIS

CIS consists of 6 components and its work process involves 8 steps as shown in Fig. 1 from node M's perspective. It works as follows: 1) *Credit management* allocates the values of credits for different communities. 2) *Message replication* assigns the number of message copies determined by credits. 3) Node M and Node N encounter and exchange a message list. 4) *Forwarding management* controls which messages can be added to the forwarding list. 5) *Selfishness management* decides a transmission list concerning the selfishness. 6) *Message priority* changes the transmission priorities of messages in order to obtain required credits effectively. 7) Transmission is initiated. 8) *Credit distribution* awards credits for cooperation. The other node (N) has the same flow.

2.1 Credit Management, Message Replication and Credit Distribution

These 3 modules are critical in administration of credits. In CIS, nodes are grouped into different communities according to their social ties, which can be friendship, interest similarity, etc. Each community maps a credit initialized by credit management at each node. Credit distribution awards credits to nodes for relaying messages. Message replication utilizes credits to forward node's own messages to corresponding community. The values of community credits are changed asynchronously as messages created and relayed.

To be specific, message replication determines the number of message copies to community i (CP_i) based on corresponding community credit (C_i) shown in (1). The consumption of credits by creating copies is computed by (2).

$$CP_i = \begin{cases} 0 & (C_i \leq minC_i) \\ maxCP \times C_i/sumC & (C_i > minC_i) \end{cases} \quad (1)$$

$$C_i = C_i - CP_i \times \alpha \quad (2)$$

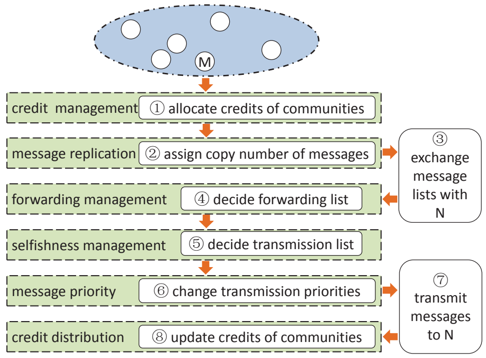

Figure 1: Workflow of CIS.

In (1), $minC_i$ is minimum credit value of community i, $maxCP$ is maximum limited copy number of a message, $sumC$ is sum number of C_i satisfying $C_i > minC_i$. In (2), α is unit credit each copy needs to pay.

Credit distribution increases the corresponding credit by β when a node relays a message for a community. The credit will be obtained if a message is delivered to its destination or removed due to TTL expiration or buffer limitation.

2.2 Selfishness Management

In this module, CIS maintains the balance between selfish behavior and delivery requirements. As long as a selfish node satisfies $C_i > minC_i$ and (3), CIS allows the node to take selfish action to community i. In (3), $initC_i$ is initial credit value of community i, β is unit credit gained for relaying a copy, RLN_i and CPN_i are sum of relayed copies and message copies for community i respectively.

$$RLN_i > (minC_i - initC_i + CPN_i \times \alpha)/\beta \tag{3}$$

2.3 Forwarding and Message Priority Management

Forwarding management extracts a forwarding list comprised of specific messages from a message list based on CP_i and delivery probability. Message priority management applies a compensatory strategy to replenish its low community credits by changing transmission priorities of messages. Considerations for social factors, intra-community messages are prior to the inter-community ones, and then followed by the ones with higher contact probabilities.

3. EVALUATION AND DISCUSSION

The preliminary simulations are carried out in the Opportunistic Network Environment simulator. We set up individual selfishness (IndividualS) and social selfishness (SocialS) situations to examine how CIS stimulates cooperation. Meanwhile, we introduce ideal situation (Ideal) in which all nodes cooperate in forwarding as a bound. The metrics are cooperation degree, delivery ratio and average latency. Particularly, cooperation degree is the ratio of relayed messages (delivered messages excluded) and delivered messages, representing the willingness of nodes to cooperate in relaying messages for others. The simulations are conducted with 60 mobile nodes divided into 6 communities. In CIS, we initialize 30 credits for each own community and 10 for each of the rest. α and β are both set to 1.

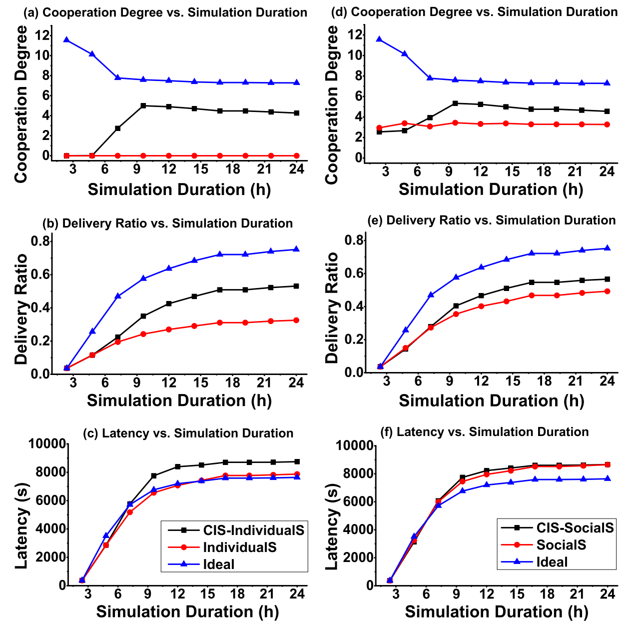

Figure 2: Performance with individual selfishness ((a)-(c)) and social selfishness ((d)-(f)).

Fig. 2 shows that generally CIS keeps the same trends with IndividualS, SocialS and Ideal. Furthermore, CIS effectively stimulates selfish nodes to cooperate (see Figs. 2(a) and 2(d)) and significantly increases the delivery ratio (see Figs. 2(b) and 2(e)). Nonetheless, CIS does not achieve better in average latency, this is caused by the fact that CIS involves more dynamic selfish nodes in delivery which can extend the latency. Though Fig. 2(c) shows CIS experiences the highest average, IndividualS delivers the least number of messages and we can treat the latency of unsuccessful ones as infinity. Fig. 2(f) shows an encouraging phenomenon that CIS stays stable whereas SocialS is rising slowly. We can say that CIS does not increase latency dramatically.

CIS effectively stimulates cooperation in selfish nodes and achieves higher performance in realistic condition. However, several issues are yet to be studied, e.g. 1) how to reduce average latency; 2) how the circumstances of combining individual and social selfishness affects performance.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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