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Detection of Selfish Node in Manet using a Collaborative Watchdog

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Abstract

MOBILE ad hoc networks (MANETs) have attracted a lot of attention due to the popularity of mobile devices and the advances in wireless communication technologies. A MANET is a peer-to-peer multihop mobile wireless network that has neither a fixed infrastructure nor a central server. Each node in a MANET acts as a router, and communicates with each other. The resource and mobility constraints of mobile nodes may lead to network partitioning or performance degradation. Several data replication techniques have been proposed to minimize performance degradation. Most of them assume that all mobile nodes collaborate fully in terms of sharing their memory space. In reality, however, some nodes may selfishly decide only to cooperate partially, or not at all, with other nodes. These selfish nodes could then reduce the overall data accessibility in the network. Due to such problem the overall process of MANET got affected. In this work, first examine the impact of selfish nodes in a mobile ad hoc network from the perspective of replica allocation. This is known as selfish replica allocation.The selfish replica allocation could lead to overall poor data accessibility in a MANET. The proposed selfish node detection method and novel replica allocation techniques to handle the selfish replica allocation appropriately. The proposed strategies are inspired by the real-world observations in economics in terms of credit risk and in human friendship management in terms of choosing one's friends completely at one's own discretion,and applied the notion of credit risk from economics to detect selfish nodes. Every node in a MANET calculates credit risk information on other connected nodes individually to measure the degree of selfishness.

Keywords: Mobile ad hoc networks, degree of selfishness, selfish replica allocation.

Introduction

In MANET Network partitions can occur frequently, since nodes move freely in a MANET, causing some data to be often inaccessible to some of the nodes. Hence, data accessibility is often an important performance metric in a MANET. Data are usually replicated at nodes, other than the original owners, to increase data accessibility to cope with frequent network partitions. A considerable amount of research has recently been proposed for replica allocation in a MANET. In general, replication can simultaneously improve data accessibility and reduce query delay, i.e., query response time, if the mobile nodes in a MANET together have sufficient memory space to hold both all the replicas and the original data. For example, the response time of a query can be substantially reduced, if the query accesses a data item that has a locally stored replica. However, there is often a trade-off between data accessibility and query delay, since most nodes in a MANET have only limited memory space. For example, a node may hold a part of the frequently accessed data items locally to reduce its own query delay. However, if there is only limited memory space and many of the nodes hold the same replica locally, then some data items would be replaced and missing. Thus, the overall data accessibility would be decreased. Hence, to maximize data accessibility, a node should not hold the same replica that is also held by many other nodes. However, this will increase its own query delay. A node may act selfishly, i.e., using its limited resource only for its own benefit, since each node in a MANET has resource constraints, such as battery and storage limitations. A node would like to enjoy the benefits provided by there sources of other nodes, but it may not make its own resource available to help others. Such selfish behavior can potentially lead to a wide range of problems for a MANET. Existing research on selfish behaviors in a MANET mostly focus on network issues alone.

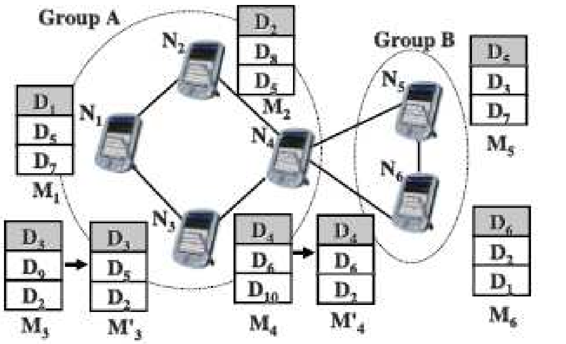

Fig. 1. Example of selfish replica allocation

Let us consider the case where N3 behaves “selfishly” by maintaining M3’, instead of M3, to prefer the locally frequently accessed data for low query delay. In the original case, D3,D9,and D2 were allocated to N3. However, due to the selfish behavior, D3,D5, and D2, the top three most locally frequently accessed items, are instead maintained in local storage. Thus, other nodes in the same group, i.e., N1,N2, and N4, are no longer able to access D9. This show cases degraded data accessibility, since N1, N2, and N4 cannot fully leverage N3’s memory space as intended in cooperative replica sharing

We believe that the partially selfish nodes (e.g., N4 in Fig. 1) should also be taken into account, in addition to the fully selfish nodes (e.g., N3 in Fig. 1), to properly handle the selfish replica allocation problem. We therefore need to measure the “degree of selfishness” to appropriately handle the partially selfish nodes. Motivated by this concept of “partial selfishness,” we borrow the notion of credit risk (CR) from economics to detect selfish nodes. Since the credit risk is calculated from several selfishness features in this paper, it can measure the degree of selfishness elaborately.In our scheme, a node can measure the degree of selfishness of another node, to which it is connected by one or multiple hops in a MANET.

The proposed selfish node detection method and novel replica allocation techniques to handle the selfish replica allocation appropriately. The proposed strategies are inspired by the real-world observations in economics in terms of credit risk and in human friendship management in terms of choosing one’s friends completely at one’s own discretion. We applied the notion of credit risk from economics to detect selfish nodes. Every node in a MANET calculates credit risk information on other connected nodes individually to measure the degree of selfishness. Since traditional replica allocation techniques failed to consider selfish nodes, we also proposed novel replica allocation techniques.

First we detect the selfish node by self replica allocation. Use those replica we devise novel replica allocation techniques with the developed selfish node detection method. They are based on the concept of a self-centered friendship tree (SCF-tree) and its variation to achieve high data accessibility with low communication cost in the presence of selfish nodes. The SCF-tree is inspired by our human friendship management in the real world. In the real world, a friendship, which is a form of social bond, is made individually. For example, although A and B are friends, the friends of A are not always the same as the friends of B. With the help of SCFtree, we aim to reduce the communication cost, while still achieving good data accessibility. The technical contributions of this paper can be summarized as follows.

- Recognizing the selfish replica allocation problem: We view a selfish node in a MANET from the perspective of data replication, and recognize that selfish replica allocation can lead to degraded data accessibility in a MANET.
- Detecting the fully or the partially selfish nodes effectively: We devise a selfish node detection method that can measure the degree of selfishness.
- Allocating replica effectively: We propose a set of replica allocation techniques that use the self-centered friendship tree to reduce communication cost, while achieving good data accessibility.
- Verifying the proposed strategy: The simulation results verify the efficacy of our proposed strategy.

After building the SCF-tree, a node allocates replica at every relocation period. Each node asks non selfish nodes within its SCF-tree to hold replica when it cannot hold replica in its local memory space. Since the SCF-tree based replica allocation is performed in a fully distributed manner, each node determines replica allocation individually without any communication with other nodes.

Node Behavioral Model

Three types of behavioural states for nodes summarized as follows:

- Type-1 node: The nodes are non selfish nodes. The nodes hold replicas allocated by other nodes within the limits of their memory space.
- Type-2 node: The nodes are fully selfish nodes. The nodes do not hold replicas allocated by other nodes,but allocate replicas to other nodes for their accessibility.
- Type-3 node: The nodes are partially selfish nodes. The nodes use their memory space partially for allocated replicas by other nodes. Their memory space may be divided into two parts: selfish and public area.

The detection of the type-3 nodes is complex, because they are not always selfish. In some cases,a type-3 node might be considered as non selfish since the node shares part of its memory space.

Detecting Selfish Node

The network is modeled as a set of N wireless mobile nodes with C collaborative nodes and S selfish nodes (N = C +S). At a specific period, or relocation period, each node executes the following procedures:

- Each node detects the selfish nodes based on credit risk scores (CR).
- Each node makes its own (partial) topology graph and builds its own SCF-tree by excluding selfish nodes.
- Based on SCF-tree, each node allocates replica in a fully distributed manner.

The CR score is updated accordingly during the query processing phase to effectively measure the "degree of selfishness".

$$\text{Credit Risk} = \frac{expected\ risk}{expected\ value}.$$

A node wants to know if another node is believable, in the sense that a replica can be paid back, or served upon request to share a memory space in a MANET. With the measured degree of selfishness, a novel tree that represents relationships among nodes in a MANET is proposed for replica allocation termed the SCF-tree. The key strength of the SCF-tree-based replica allocion techniques is that it can minimize the communication cost, while achieving high data accessibility. This is because each node detects selfishness and makes replica allocation at its own discretion, without forming any group or engaging in lengthy negotiations.

At each relocation period, node Ni detects selfish nodes based on nCRki. Each node may have its own initial value of Pki as a system parameter. Interestingly, the initial value of Pki can represent the basic attitude toward strangers. For instance, if the initial value equals zero, node Ni always treats a new node as a nonselfish node. Therefore, Ni can cooperate with strangers easily for cooperative replica sharing. Replicas of data items are allocated by allocation techniques. After replica allocation, Ni sets NDki and SSki accordingly. Recall that both NDki and SSki are estimated values, not accurate ones.

Building SCF Tree

The SCF-tree based replica allocation techniques are inspired by human friendship management in the real world,where each person makes his/her own friends forming a web and manages friendship by himself/herself.He/she does not have to discuss these with others to maintain the friendship.The decision is solely at his/her discretion.

Prior to building the SCF tree each node makes it own partial topology graph Gi=(INi,ILi)which is a component of the graph G,Gi consists of finite set of the nodes connected to Ni and a finite set of the links,the SCF tree consists of only non selfish node s,we need measure the degree of selfishness to apply real world friendship management to replica allocation in a MANET.

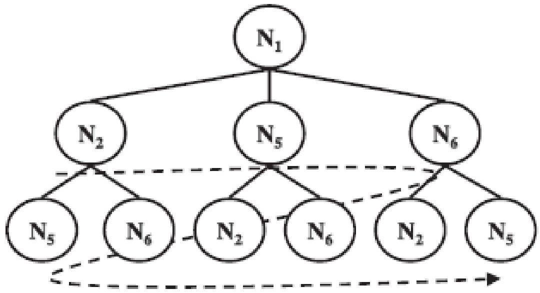

Fig 2 SCF tree of N1

Allocating Replica

After building the SCF-tree, a node allocates replica at every relocation period. Each node asks nonselfish nodes within its SCF-tree to hold replica when it cannot hold replica in its local memory space. Since the SCF-tree based replica allocation is performed in a fully distributed manner, each node determines replica allocation individually without any communication with other nodes.

The objective of the SCF tree based replica allocation technique is to achieve good data accessibility with low communication cost in the presence of selfish nodes, each node processes the following procedures:

- Each node allocates replica at its discretion
- When each node receives a request for replica allocation from Nk during a relocation period,it determines whether to accept the request.
- If the request is accepted ,each node maintains its Mp based on nCRik.

A. Identifying Selfish Contact

The detection time of selfish nodes have to be reduced based on contact dissemination. If one node has previously detected a selfish node using its watchdog it can spread this information to other nodes when a contact occurs. We say that a node has a positive if it knows the selfish node. The watchdog is overhearing the packets of the neighborhood. Thus, when it starts receiving packets from a new node it is assumed to be a new contact. Then, the node transmits one message including all known positives it knows to this new contacted node. The number of messages needed for this task is the overhead of the collaborative watchdog.

The collaborative nodes have no information about the selfish nodes. A collaborative node can have a positive when a contact occurs in the system. In the model one of the nodes is the selfish node. Then, the collaborative node can detect it using its watchdog and have a positive about this selfish node. Nevertheless, a contact does not always simply detection. To model this fact, we introduce a probability of detection (pd).This probability depends on the effectiveness of the watchdog and the type of contact (for example if the contact time is very low, the watchdog does not have enough information to evaluate if the node is selfish or not).

A node has 2 states: NOINFO, when the node has no information about the selfish node, and POSITIVE when the node knows who the selfish node. All nodes have an initial state of NOINFO and they can change their initial state when a contact occurs. Using a contact rate λ we can model the network using a Continuous Time Markov Chain (CTMC) with states si=(c), where c represents the number of collaborative nodes in the POSITIVE state. At the beginning, all nodes are in NOINFO state. Then, when a contact occurs, c can increase by one.

B. IMPLEMENTATION OF COLLABORATIVE CONTACT

Assume both nodes are collaborative. Then, if one of them has one or more positives, it can transmit this information to the other node; so, from that moment, both nodes have these positives. We model this with the probability of collaboration (pc). The degree of collaboration is a global parameter of the network to be evaluated. This value is used to reflect that either a message with the information about the selfish nodes is lost or that a node temporally does not collaborate.

C. PSEUDO CODE

Step1: Detecting selfish nodes,

1. Find the Credit risk for each Node for allocating replica
2. Finds the node behavior partial or full selfish.

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3. Find the query processing time.
4. Determine the expected node responds to the requested node or unexpected node responds to the requested node.

Step 2: Building the SCF-tree

1. Each node has a parameter and the depth of SCF-tree.
2. When Particular Node builds its own SCF-tree, it first appends the nodes that are connected to appropriate node by one hop to its child nodes.
3. Then, appropriate node checks recursively the child nodes of the appended nodes, until the depth of the SCF-tree is equal to parameter.

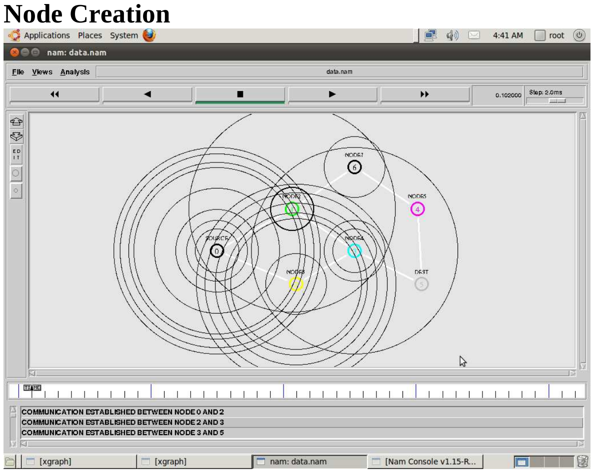
Step 3: Allocating replica based on SCF-tree

1. SCF-tree-based replica allocation
2. SCF-tree based replica allocation with degree of
3. Selfishness
4. SCF-tree based replica allocation with closer node
5. Extended SCF-tree based replica allocation

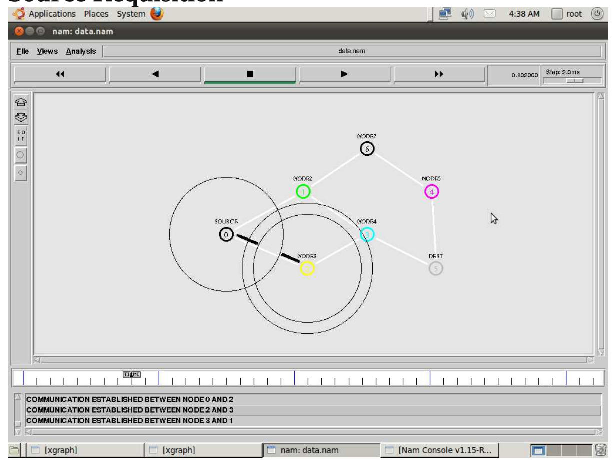
Step 4: Evaluate the performance of proposed method.

Simulation Study and Results

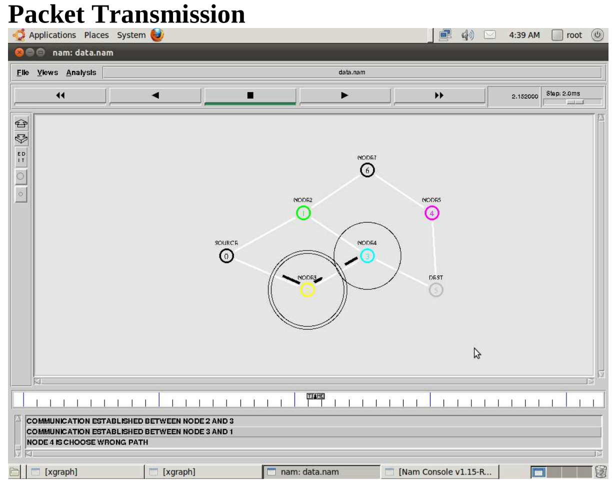
Node Creation



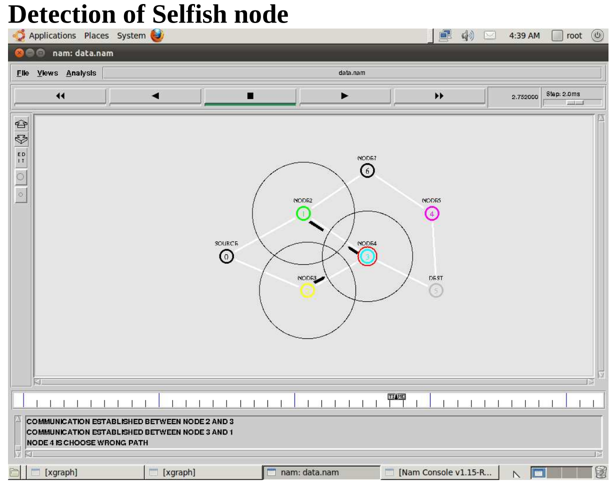
Source Requisition



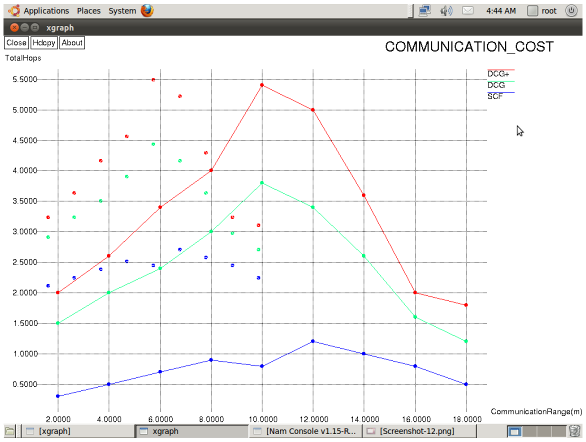
Packet Transmission



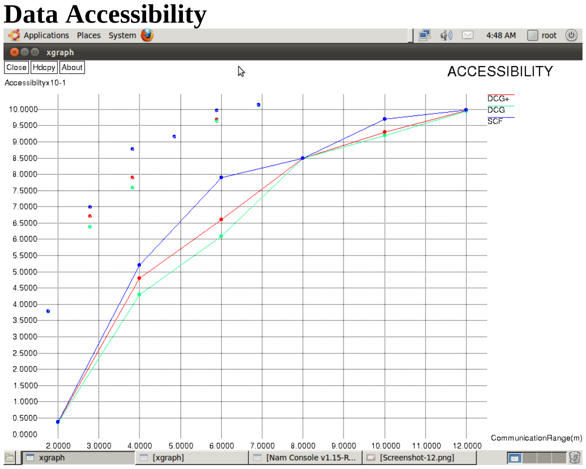
Detection of Selfish node



Communication Cost



Data Accessibility



Conclusion

Selfish replica allocation leads to overall poor data accessibility in a MANET. The proposed selfish node detection method and novel replica allocation techniques handle the selfish replica allocation appropriately. Every node in a MANET calculates credit risk information on other connected nodes individually to measure the degree of selfishness. The proposed collaborative watchdog approach reduces the overall detection time with a reduced cost in term of message overhead. This reduction is very significant when the watchdog detection effectiveness is low. Furthermore this reduction can be obtained even with a moderate degree of collaboration. Extensive simulation shows that the proposed strategies outperform existing representative cooperative replica allocation techniques in terms of data accessibility, communication cost and query delay.

References

[1] Handling Selfishness in Replica Allocation over a Mobile Ad Hoc Networks, Jae ho choi,kyu-sun shim,saangkeun lee and kun lung wu,fellow,IEEE Transactions on mobile computing,vol.11,No.2,February 2012.
[2] A Pure Nash Equilibrium-Based Game Theoretical Method for Data Replication across Multiple Servers,S.U.Khan and Ahmad,IEEE Trans.Knowledge and Data Eng,.vol.21,no.4,pp.537-553,Apr.2009.
[3] Consistency Management Strategies for Data Replication in Mobile Ad Hoc Networks, T.Hara, and S.K.Madria,IEEE.Trans.Mobile Computing,vol.8,no.7,pp.950-967,July 2009.
[4] From Selfish Nodes to Cooperative Networks – Emergent Link-based incentives in Peer-to-Peer Networks, David Hales,Proc.IEEE Int'l Conf.Peer to Peer Computing,pp.151-158,2004.
[5] Ad hoc-VCG: A Truthful and Cost-Efficient Routing Protocol for Mobile Ad hoc Networks with Selfish Agents, Luzi Anderegg, Stephan Eidenbenz,Proc.ACM Mobicom,pp.245-259,2003.
[6] Selfish Caching in Distributed Systems: A Game Theoretic Analysis, B.G.Chun, K. Chaudhuri,H.Wee, M.Barreno, C.H. Papadimitriouy, J.Kubiatowicz,Proc.ACM Symp.Principles of Distributed Computing,pp.21-30,2004.
[7] Cooperative Cache- Based Data Access in Ad Hoc Networks,G.Gao, L.Yin,C.R. Das,Computer,vol.37,no.2,pp.32-39,Feb.2004.
[8] Managing and Sharing Servents Reputations in P2P Systems, E.Damiani,S.D.C di Vimercati,S.Paraboschi and P.Samarati,IEEE Trans.Knowledge and

Data Eng.,vol.15,no.4,pp.840-854,July/Aug.2003.

[9] TWOACK: Preventing Selfishness in Mobile Ad Hoc Networks,K.Balakrishnan,J.Deng and P.K.Varshney,Proc.IEEE Wireless Comm.and Networking,pp.2137-2142,2005.

[10] Efficient Peer-to-Peer Information Sharing over Mobile Ad Hoc Networks,M.Li, W.C.Lee and Sivasubramaniam,Proc.World Wide Web(WWW)Workshop Emerging Applications for Wireless and Mobile Access,pp.2-6,2004.