



Personality Filter in Mobile Networks with Communication Constraints

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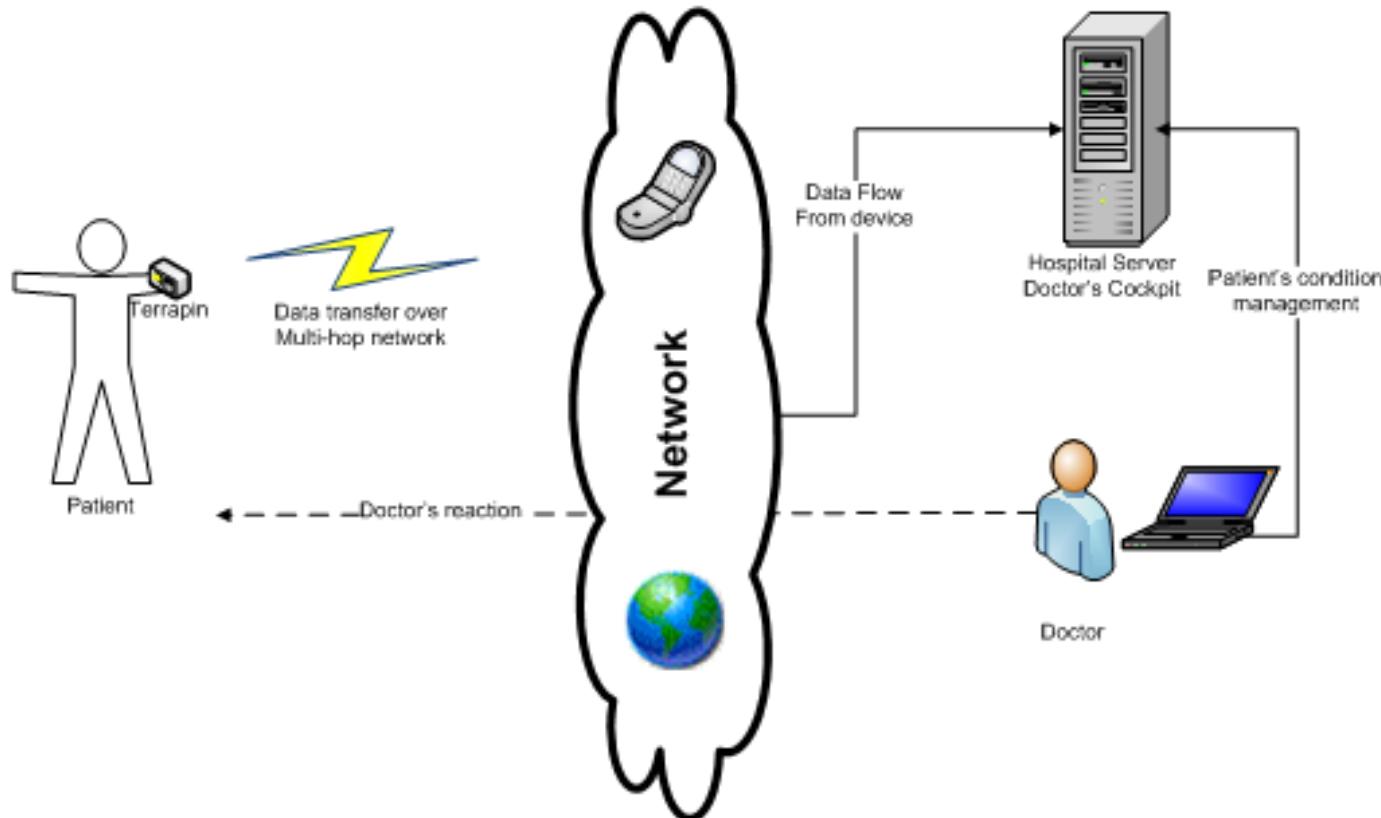
Contents

- Introduction
 - Dealing with selfish node behavior
- Generosity model for resource allocation in MANETs
 - Personality theory account
- Example Scenario: Emergency in the Mountain
- Implementation
 - fuzzy system framework
- Conclusions and future work

Problem statement

- To propose optimization algorithm for packet transmission in mobile ad-hoc networks (MANETs) via multi-hop communication
- Efficient packet transmission in MANETs has to deal with specific communication constraints:
 - device resources (power, bandwidth, CPU)
 - user resources – subscription plan, network coverage, *personal contacts*

Importance of multi-hop communication in rescue and emergency situations



Developed mainly for situations of destroyed or non-functional communication infrastructure

Problems of multi-hop communication

- Routing – finding optimal path from source to target
- Reducing interference among nodes
- Dealing with redundant messaging
- Reducing false alarm rate within the network - /closely linked with the trust issue/
- Dealing with situations of *selfish* node behavior

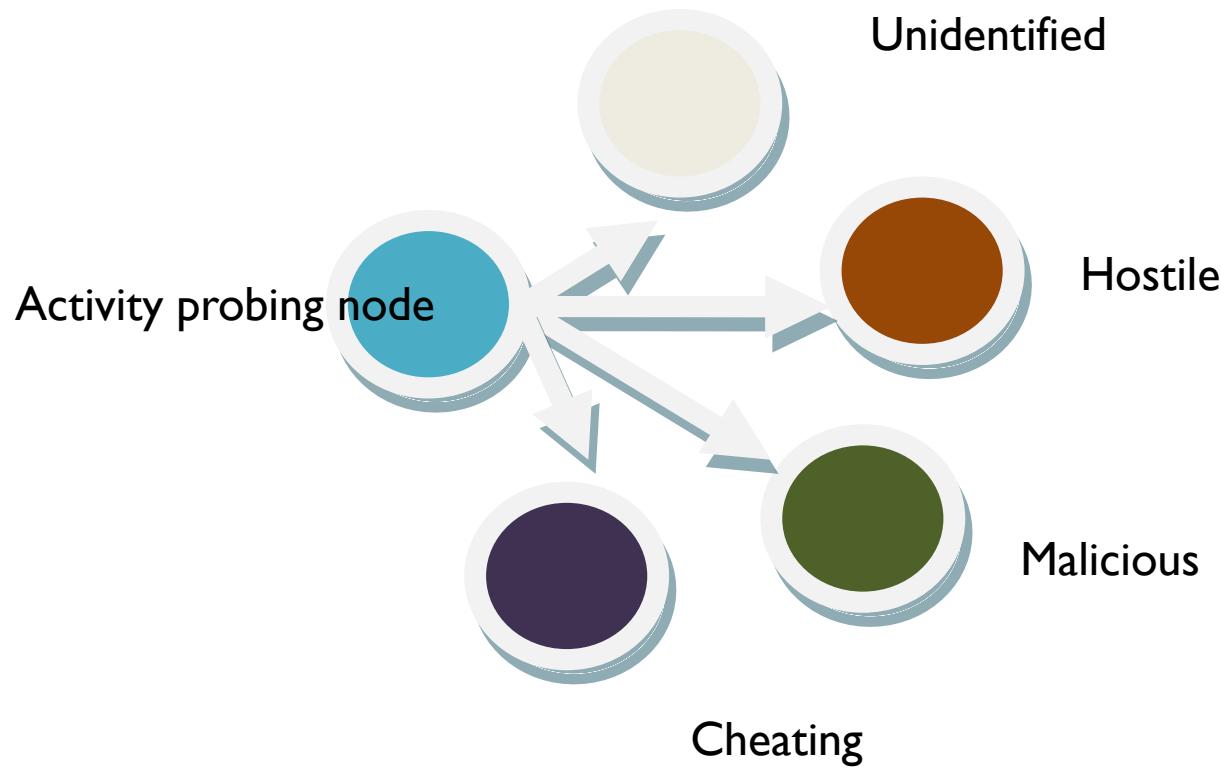
Node selfishness in MANETs

- One of the obstacles to the design of reliable MANETs is the issue of dealing with the particular behavior of the so-called selfish nodes
- – i.e. “selfish nodes refuse to help other nodes in forwarding packets due to the *anxiety* of having resource degradation such as exhausted battery power and limited processor capacity” [Razak et al., p.440]

Detrimental factors for network efficient performance are:

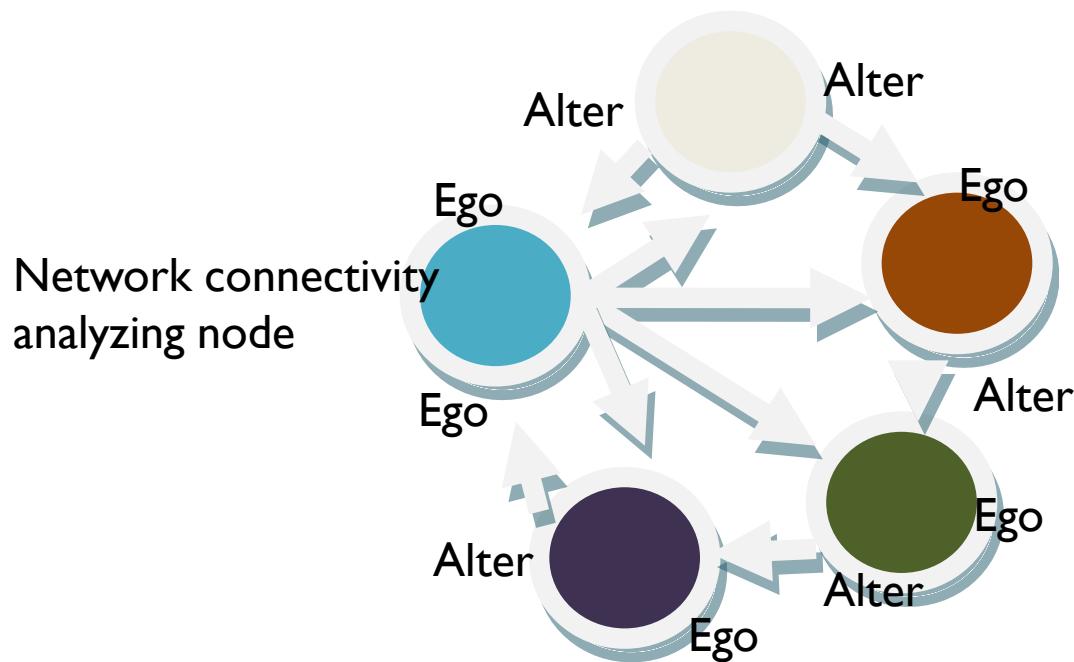
- Number of *selfish* nodes in a network which, if greater than 20%, lead to drastic drop in the network performance
- Node *hostility* which refers to node dropping packets without forwarding them
- - Node *maliciousness* which is a node making another arbitrary node look selfish
- - Node *cheating* that is a node “pretending” to be active while probed for selfishness until end of probe and becoming hostile after that

Ad hoc optimization



- Inefficient and resource wasteful

Social-network theory based optimization

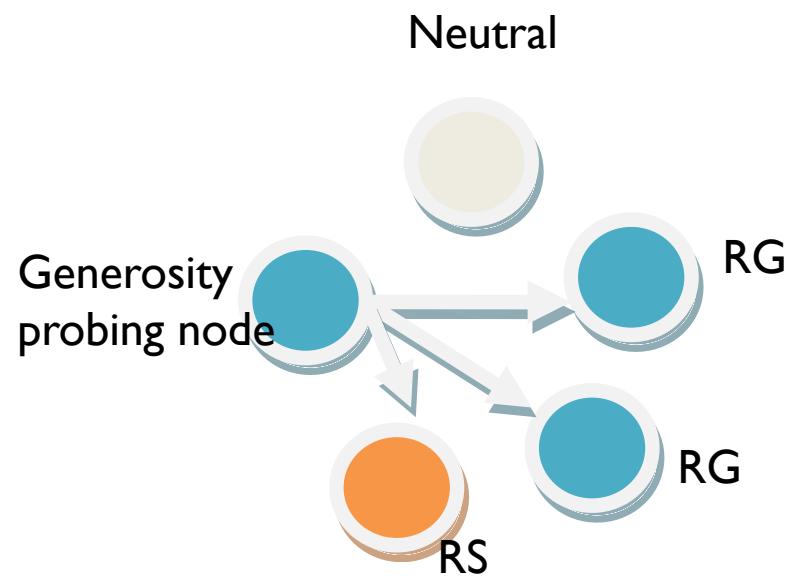
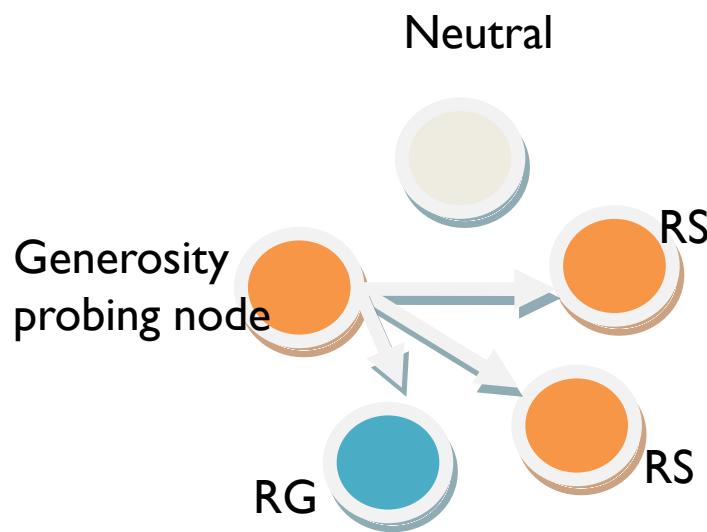


- Requires full connectivity data
- Circularity problem

Inspiration for the proposed framework:

- Imagine a group of teenagers in the park - the way they use their mobile phones to call friends is resource sparing
- Mobile phone technology is shared communication resource for the group rather than an individual accessory
- In everyday situations resources are shared on the basis of friendships, whereas in emergency – depending on the individual *will* to provide personal resource to someone in need.. i.e. thanks to their generosity

Personality-filter optimization



RG Reasonably generous

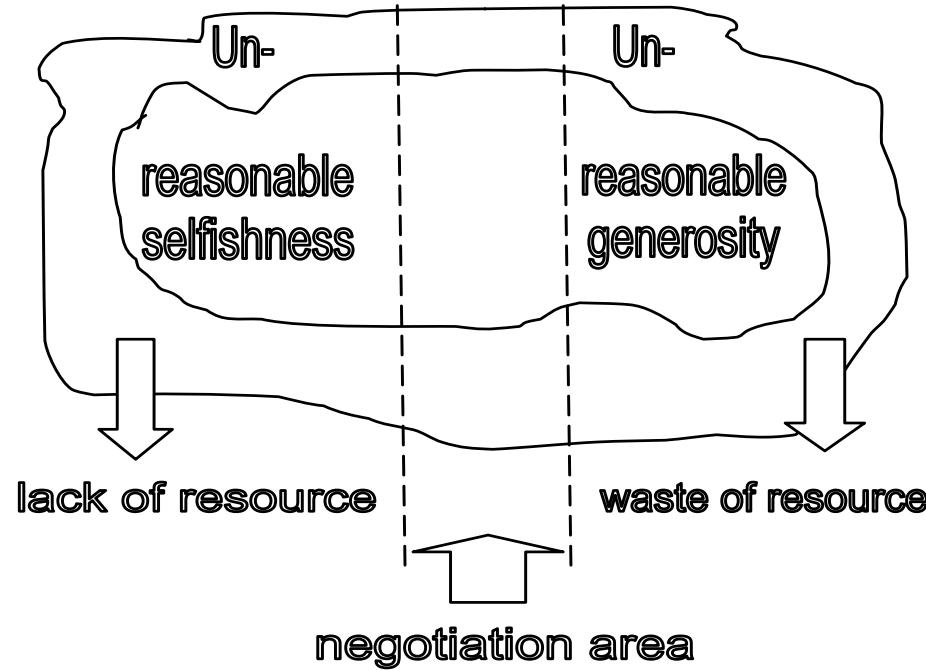
RS Reasonably selfish

- Needs to assess the amount of resource of a node **relative** only to the neighboring nodes
- Allows incremental probing without the negative connotations

Specificity of the approach

- Introduces the notion of situation demand
- Introduces negotiation area
- Defines 4 types of nodes among 4 main node types - Generous R node; Generous U node; Selfish R node; Selfish U node and 4 respective negotiation strategies.
- The modeled *situation demands* are of 2 kinds – urgent packet forwarding of small size vs. large packet forwarding.
- Fast negotiation strategies are preferred within the negotiation area of figure I, whereas outside it – these have to be more elaborate according to personality and situation demand.

Generosity model for resource allocation in MANETs



- Node selfishness is the opposite of node generosity along of a single dimension
- Within a population of nodes, some exhibit *selfish* behavior and some tend to be generous towards other nodes

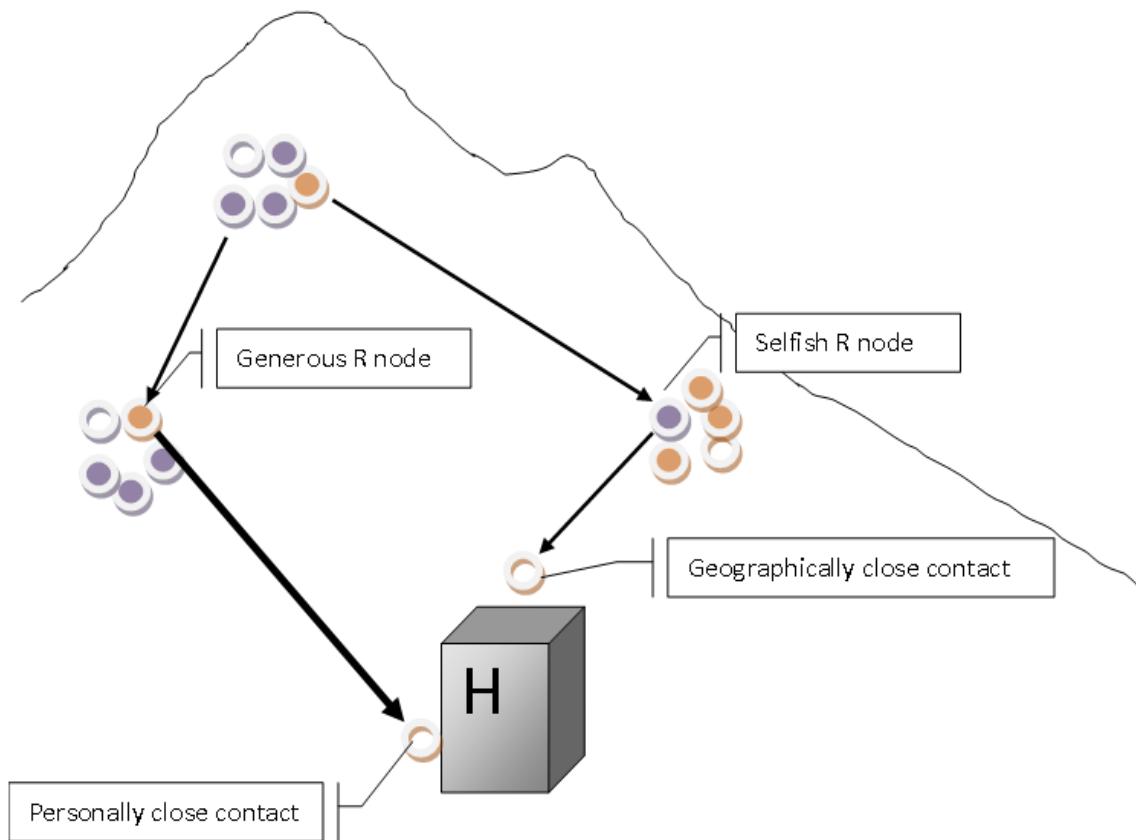
Reasonable selfishness/generosity

- The reasonable degrees of being selfish or generous conform to the situation demand
- In cases when someone is accustomed to receiving/possessing modest portions of resource, the owner of the resource becomes reasonably selfish and tends to refuse some of the requests for sharing resource
- Alternatively, in cases when someone is accustomed to receiving/possessing extra resource, the owner of resource becomes reasonably generous and tends to offer sharing some of their resource
- Thus, by *reading the relative input of resource* to a node within a cluster of nodes, it can be determined whether a node would act comparatively selfishly or generously in standard everyday situations
- Within the reasonable range of selfishness/generosity, the important factor is that there is always spared some resource which can be shared in emergency situations, provided the relevant negotiation strategy is applied

Negotiation strategies for unreasonable selfishness/generosity

- US - Cautious people often turn into unreservedly generous if it is pointed out to them the importance of their involvement in a good cause
- UG - It is necessary to distinguish geographical vs. personal node distance - the personally closest contacts are not evident by simple observation of behavior of the generous nodes
- MN - The general personality theory based assumption is that within a *socially significant context* – if node behavior resembles one of the negotiable cases – it will assess the situation demand and will respond appropriately

Scenario: Emergency in the Mountain



- In case one a **generous node** is contacted (left path) and message forwarding is requested to a **personally close node** near the hospital.
- In case two a **selfish node** is contacted (right path) and message forwarding is requested to a **geographically close node** near the hospital

Negotiation strategy for large packet forwarding

- Generous nodes are requested to forward large packets to personally indifferent contacts
- Selfish nodes can be convinced that the sacrifice is of *high social value* and is better forwarded via personally close nodes, sharing this way the receiver's gratitude
- The framework is consistent with the “small world theory” in that a limited number of nodes can always be found in order to link the source and target in communicating *socially significant* information

Implementation

- A framework is being developed for evolving fuzzy clustering in MANETs with constrained resources and limited capacity to keep previous information or perform complex validity-index computation [Lekova, 2010]
- The main advantage of the proposed model is in assisting methodologies for MANETs with constrained resources, low density and *a priori* unknown network connectivity structure

Conclusions and future work

- A novel personality account of user behavior is proposed in order to help determine the feasible path of packet transmission from source to target and to predict the availability of the communication resources in MANETs
- The framework is based on dynamically determining degree of node generosity along the selfishness/generosity personality dimension in fuzzy system representation
- Future work includes implementation and tests in GloMoSim/OPNET
- Other personality dimensions useful for MANETs implementing light-weight online unsupervised learning will be included