

# LEVERAGING SOCIAL NETWORK TIES FOR TRUST-BASED COOPERATION IN WIRELESS COOPERATIVE NETWORKS

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**ABSTRACT :** Cooperative wireless communication provides a way to offload the main network using short distance communication techniques. But the whole idea depends upon how the nodes behave. In normal scenario if the nodes cooperates, it has to devote some of its resources for cooperation. So it is highly possible that the nodes may refrain from cooperation. So to gain advantages of communication, we have to establish a mechanism which can ensure that all nodes will cooperate when necessary, selfish nodes will become cooperative nodes and in worst scenario, if they do not then they will not be served by cooperative group nodes. In this paper, we have proposed a algorithm, which will assign cooperation factor (local and global) to nodes. Other nodes will check these parameters before cooperation. So by this cooperation is ensured from all nodes. The algorithm outperforms basic cooperative scenario.

**KEY WORDS :** Trust based cooperation, social networks, Wireless cooperative networks.

## 1. Introduction

Mobile devices use cellular services for accessing network. As the mobile devices are growing rapidly, it becomes quite difficult to serve all the users. The user demand for network access is also growing rapidly. The resources available to serve large number of users with very high data rate are very scarce. But if we analyze the data requirement then it can be observed that in many scenarios like sports event and other similar scenario people needs the same set of data. So it is possible that out of all users, some users download the data from network and share with the others nearby them using nomadic networks (i.e. wi-fi or bluetooth etc.).

The idea looks promising at first stage but it needs the user devices to cooperate for data sharing. When any device agrees for this, it has to donate some of its battery life and time slots for cooperation. So it can improve the network resource utilization but the node may lose its resources. So it is necessary that every time all nodes must agree for cooperation when requested. Otherwise some nodes will always cooperate and suffer, while others will use cooperation when they needed and become selfish and deny cooperation when required by others. (M. Sami et. al. 2016)

A mechanism is needed which will record and transmit the activity report of all nodes. So that all nodes will know the amount of cooperation is provided by every nodes surrounding it. So when

other nodes request for communication, they can take decision of whether to forward their data or not.

Social networks play a crucial role in cooperative wireless networking, enhancing communication efficiency and network performance. Social connections facilitate the sharing of network resources, such as bandwidth and energy, among users with established relationships. Users are more likely to cooperate with those in their social network, improving overall network reliability and security. Social ties influence content dissemination patterns, enabling more efficient and targeted data distribution. Social relationships can be leveraged to design effective incentive schemes for encouraging user participation in cooperative networking. Social information provides valuable context for optimizing network protocols and services. Social-aware routing algorithms can enhance packet delivery efficiency by exploiting user relationships and common interests. Social ties influence how users connect and form ad hoc networks, impacting overall network topology and performance. Cross-layer optimization: Social network information can be used to optimize various layers of the network stack, from physical to application layers. (Chen. X. et. al. 2015)

Incorporating social network analysis into cooperative wireless networking can lead to more efficient, reliable, and user-centric communication systems.

Trust-based cooperation in Device-to-Device (D2D) communication using social networks is an emerging area of research that combines elements of mobile networking, social network analysis, and trust management. This approach leverages social relationships and trust metrics to enhance the efficiency and security of D2D communications.

It utilizes social network data to assess trust levels between devices. It considers factors such as friendship strength, interaction frequency, and common interests. It develops trust models that incorporate both direct and indirect social connections. (E. Datsika et. al., 2016)

It prioritizes resource allocation (e.g., bandwidth, power) based on trust levels and optimizes network performance by favoring high-trust connections. (M. Asshad et. al. 2019)

It develops mechanisms for trust propagation across the social network and implements adaptive trust update algorithms based on D2D communication experiences.

It integrates trust metrics into various network layers (e.g., physical, MAC, network) and develops cross-layer protocols that leverage social trust for improved performance and also optimizes energy efficiency through trust-aware power control mechanisms.

For successful implementation we will need Incentive Mechanisms which will help in encouraging trustworthy behavior in D2D communications and implement reputation systems that reward cooperative nodes. (Y. Zhu et. al., 2017)

An adaptive trust model must be developed that adjust to changing network conditions. By incorporating these aspects, researchers and developers can create more robust and efficient D2D communication systems that leverage the power of social networks and trust-based cooperation.

In direct communication, the source transmits data to the destination without intermediary support. The MAC layer governs this process using CSMA/CA:

- Source senses the channel.
- If idle, it sends an RTS frame.
- Destination responds with a CTS frame.
- Source transmits data after receiving CTS.
- Destination acknowledges with an ACK frame.

This approach is efficient in high-quality channels but suffers from path loss and fading.

Cooperative communication introduces a relay node. The MAC layer is extended to incorporate relay coordination, typically via enhanced RTS/CTS handshakes:

- Source sends a RTS to destination (relay nodes also receive it).
- Destination responds with CTS.
- Relay overhears and if possible it sends CoopCTS.
- Source transmits data (overheard by relay).
- Relay forwards the overheard data to the destination.
- Destination combines signals and sends ACK.

This approach provides spatial diversity and better performance under poor channel conditions. (Korakis T. et. al. 2007). All advantages of Cooperative communication depends upon the relay's decision making. If even after overhearing the RTS/CTS and analyzing that its participation will improve the network performance, if the relay do not send cooperative CTS, then eventually after certain time all nodes will conclude that they are losing and so they will stop cooperating.

To ensure cooperation a mechanism must be developed. The mechanism should have certain parameters, one basis of that all nodes can decide that whether the node requesting for service is trustworthy or not.

In this paper, we have developed a mechanism, which ensures that every nodes are assigned local and global trust value (TV). A minimum threshold of TV is required to get the cooperation service. The TV will be updated based on cooperation participation or denial.

## **2. Trust based cooperation**

Incentive mechanisms in trust-based D2D communication using social networks aim to encourage cooperative behavior and enhance network performance. Key aspects of such mechanisms include:

**Trust-based rewards:** It allocates higher data rates or priority access to devices with higher trust scores. It provides increased network resources to nodes that consistently demonstrate trustworthy behavior

**Reputation systems :** It implements a reputation scoring system based on past interactions and social network data and allows devices to earn and lose reputation points based on their behavior in D2D communications. (J. Yan et. al. 2017)

Quality of Service (QoS) differentiation: It offers improved QoS parameters (e.g., lower latency, higher reliability) to devices with higher trust scores and implements trust-aware scheduling algorithms that prioritize high-trust connections

Energy efficiency incentives: It rewards energy-efficient behavior in D2D communications and provides incentives for devices that assist in relaying data for others, considering their trust levels

Dynamic pricing models : It develops trust-based pricing schemes for D2D services and adjusts service costs based on trust scores and network conditions

Trust-aware resource pooling : It encourages devices to form trusted clusters for sharing resources and provides incentives for participating in collaborative computing or storage tasks

Social network-based recommendations : It implements a system that recommends trusted D2D partners based on social network connections and rewards devices for successful D2D interactions resulting from these recommendations

These incentive mechanisms can be combined and tailored to specific D2D communication scenarios, considering factors such as network topology, user preferences, and application requirements.

### 3. System Model

In our model, we have defined three parameters i.e. PTV (Positive Trust Value), NTV (Negative Trust Value) and FTV (Final Trust Value).

In cooperative communication, the transmitting node may ask for help in its data transmission to a neighboring node. If the neighboring node replies positively then transmitting node will transmit the data. The neighboring node relays the data to the destination node or next intermediate node. When they receive the data successfully, they will send positive acknowledgement. The positive acknowledgement will increase the PTV value of the neighboring node.

In other scenario, a node request help in data transmission, but the neighboring node (even though it can help) denies the help then it will increase NTV value of that node.

The scenario is visible to the nearby nodes who are in transmission range of sender or receiver. The nodes are generally communicating their own group as well as other groups. So transmission of multiple parameters across networks for many nodes may

increase the overload. So a generalized parameter FTV (Final Trust Value) is developed.

For deriving final trust value, PTV and NTV of a node by the perspective of various nodes is considered. It may be possible that due to channel vulnerability there will be two or more than two different values of PTV and NTV for same node. In that case latest information will be considered. Normally nodes are transmitting their perception of other nodes parameters at periodic time and update their tables accordingly.

$$PTV = (PTV / (PTV + NTV)) * (1 - \mu) \dots\dots (1)$$

$\mu$  = uncertainty parameter

$$NTV = (NTV / (PTV + NTV)) * (1 - \mu) \dots\dots (2)$$

The final FTV value is derived by comparing PTV and NTV value of all nodes.

There will be two more values of PTV and NTV which will be received from the nodes which are in other group. It is denoted by  $PTV_{global}$  and  $NTV_{global}$ .

$$PTV_{final} = (PTV + PTV_{global}) / 2 \dots\dots (3)$$

$$NTV_{final} = (NTV + NTV_{global}) / 2 \dots\dots (4)$$

$$FTV_{final} = PTV_{final} + 0.5 * \mu \dots\dots (5)$$

### 4. Simulation and Results

We consider that multiple nodes are randomly distributed across 1000 square meter. Two nodes within a distance of 250 m are randomly matched into a source-destination D2D communication link.

We have simulated the distance threshold with average system throughput. It can be seen from figure 1 that cooperative communication is better than direct communication. But trust based cooperation outperforms the comparison. The reason is in cooperative scenario, there is a possibility that few nodes will deflect. But in case of trust based cooperation, those nodes cannot deflect because if they do so they will not be provided cooperation by other nodes.

We have simulated how number of nodes will impact the average system throughput. Here also the proposed algorithm outperforms both direct and cooperative communication. It give 80% more throughput compared to cooperative communication.

In last comparison we have done a standard practice of comparing all three by the perspective of

normalized energy efficiency. The performance is 33% more better than cooperative communication.

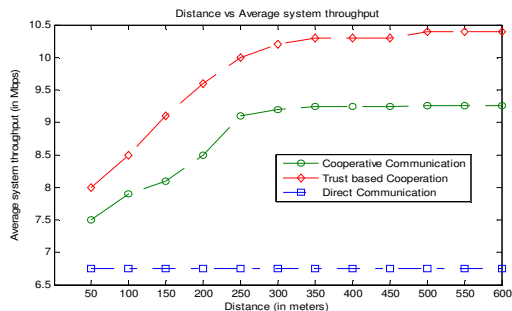


Fig 1 Distance vs average system throughput

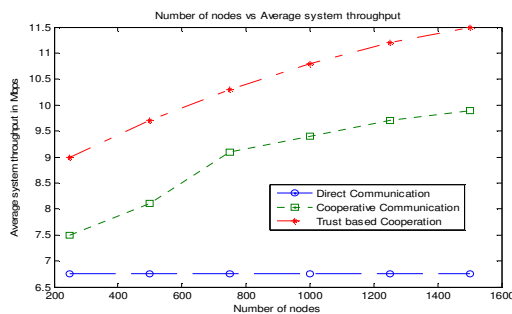


Fig 2 No of nodes vs average system throughput

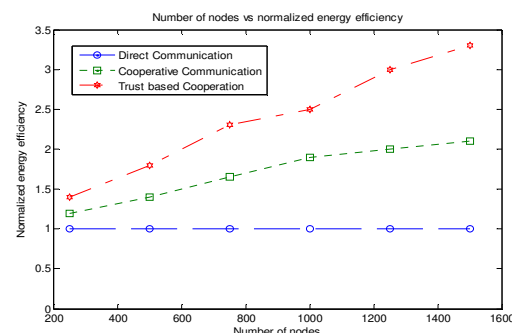


Fig 3 No of nodes vs normalized energy efficiency

## 5 Conclusion

In this paper, we proposed a new approach of trust based cooperation using social network ties. Social network provides multiple ways which motivates user to cooperate. The trust based cooperation forces the nodes to cooperate and it ensures that network throughput and energy efficiency improves significantly.

## 6 REFERENCES:

1. J. Yan, R. Wang, D. Wu, and S. Sanyal, "Trust-Oriented Partner Selection in D2D Cooperative Communications," *IEEE Access*, vol. 5, pp. 3444–3453, Jan. 2017,
2. Chen. X., Gong, X., Zhang, J., & Proulx, B. Exploiting Social Ties for Cooperative D2D

Communications: A Mobile Social Networking Case. *IEEE/ACM Transactions on Networking*, 23(5), 1471–1484. April 2015

3. Y. Zhu, B. Li, J. Jiang, and B. Li, "Rado: A Randomized Auction Approach for Data Offloading via D2D Communication," Oct. 2015, vol. 6, pp. 1–9.

4. Korakis, T., Erkip, E., Panwar, S., & Knox, M. (2009). Cooperative network implementation using open-source platforms. *IEEE Communications Magazine*, 47(2), 134–141.

5. M. Asshad, D. L. Msongaleli, A. Kavak, S. A. Khan, and K. Küçük, "Cooperative communications using relay nodes for next-generation wireless networks with optimal selection techniques: A review," *IEEE Transactions on Electrical and Electronic Engineering*, vol. 14, no. 5, pp. 658–669, Mar. 2019,

6. M. Sami, S. Subramaniam, M. Khabazian, F. Hashim, and N. K. Noordin, "A Survey and Taxonomy on Medium Access Control Strategies for Cooperative Communication in Wireless Networks: Research Issues and Challenges," *IEEE Communications Surveys & Tutorials*, vol. 18, no. 4, pp. 2493–2521, Jan. 2016,

7. E. Datsika, A. Antonopoulos, C. Verikoukis, and N. Zorba, "Green Cooperative Device-to-Device Communication: a Social-Aware Perspective," *IEEE Access*, vol. 4, pp. 3697–3707, Jan. 2016,