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Resource Allocation for Performance Enhancement in Non-Uniform Mobility Model in MANETs

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ABSTRACT

The low-cost and easy-deployable mobile ad hoc networks (MANETs) have great potential to serve as the underlay network architecture for implementing lots of critical applications. In order to support different demands in such applications, understanding the fundamental performance of the MANETs and exploring their performance enhancement are of great importance. To this end, this paper, for the first time, investigates the performance enhancement of the MANETs by appropriately allocating the network resource. Specifically, we consider both the transmission resource and storage resource of a network node and use a two-tuple to depict a general resource allocation configuration. First, for a MANET with any given resource allocation configuration, we establish an analytical framework to model the network dynamics as queuing processes. With the help of the network modelling, we then derive the expressions of fundamental performance metrics, including per node throughput, expected an end-to-end delay, and throughput capacity. Based on these results, we further develop optimal resource allocation algorithms to determine the optimal setting of resource allocation, for enhancing network performance. Finally, we provide extensive simulation and numerical results to verify the efficiency of our theoretical modelling and illustrate the effects of resource allocation on network performance.

I. INTRODUCTION

The rapid evolution of communication and network technologies has spawned the emergence of mobile ad hoc networks (MANETs). MANETs, composed of mobile nodes communicating with each other via wireless links without infrastructure and centralized administration, represent a kind of self-autonomous network architecture [1]. Due to the advantages of low-cost and easy-deployable, MANETs have great potential to serve as the underlay network architecture for implementing a wide range of promising applications, such as environmental monitoring, emergency rescue, smart homes, e-health, and so on [2], [3]. In order to support different demands in such applications, understanding the fundamental performance of MANETs (i.e., throughput, delay, capacity, etc.) is of great importance [4], [5].

Since the pioneering work of Grossglauser and Tse [6], extensive research efforts have been devoted to the modelling and performance evaluation of MANETs under various network scenarios. Specifically, Grossglauser and Tse studied the scaling law of per node throughput (i.e., the asymptotic behaviour of per node throughput as the number of network nodes tends to infinity), and verified that a 2(1) per node throughput can be achieved in MANET with the two-hop relay (2HR) routing scheme and independent and identically distributed (i.i.d) mobility model. Later, Neely and Modiano [7] derived the exact throughput capacity of MANETs and demonstrated that the lower bound of achievable delay-to-throughput ratio is O(n) (n is the number of network nodes). Following this line, El Gamal et al. [8] and Sharma et al. [9] then explored the throughput-delay tradeoff in MANETs under symmetric random walk mobility model and unified mobility model, respectively. Wang et al. further studied the throughput of MANETs with multicast traffic in [10], [11], and conducted performance comparison between the unicast and multicast MANETs in [12]. More recently, taking into account the fact that the resource (especially the storage resource) of a node in a MANET is limited, the modeling and performance evaluation for buffer-limited MANETs was conducted in [13]–[15].

While the above works represent significant progress in the performance study of MANETs, they only focused on the performance analysis under given network scenarios, but failed to address the problem that how to enhance the network performance under these scenarios. It is worth noting that the resource of a node in a general MANET is limited, thus the way of utilizing the resource will greatly affect the network performance. Allocating appropriately the resource in a MANET is very promising for its performance enhancement, which is beneficial to implementing a wide range of practical applications more efficiently. However, the research with this consideration is largely uninvestigated.

II. CONTRIBUTIONS

• We, for the first time, explore the performance enhancement of a MANET by allocating its storage and transmission resource. For a general resource allocation configuration (η, κ), we establish an analytical framework to model the network dynamics as queuing processes. With the help of the network modeling, we derive the exact expressions of fundamental performance metrics, including per node throughput, expected end-to-end (E2E) delay and throughput capacity.

• Based on the results under the general resource allocation configuration, we analyze the properties of network performance expressions, and further develop efficient algorithms to determine the optimal setting of (η, κ), for maximizing per node throughput, throughput capacity, and minimizing expected E2E delay, respectively

• Finally, we conduct simulations to demonstrate the validity of our theoretical modeling and performance evaluation. Also, we provide extensive numerical results to illustrate how resource allocation affects network performance, which can serve as important guidelines for the configuration and operation of practical MANETs.

III. LITERATURE SURVEY

S. Haykin, “Cognitive radio: brain-empowered wireless communications,” IEEE J. Sel. Areas Commun., vol. 23, no. 2, pp. 201–220, 2005

In this paper, we focus on three on-line cognitive tasks:

1) Radio-scene analysis, which encompasses the following estimation of interference temperature of the radio environment detection of spectrum holes.

2) Channel identification, which encompasses the following estimation of channel-state information (CSI) prediction of channel capacity for use by the transmitter

3) Transmit-power control and dynamic spectrum management.

A. Ghasemi and E. S. Sousa, “Fundamental limits of spectrum-sharing in fading environments,” IEEE Trans. Wireless Commun., vol. 6, no. 2, pp. 649–658, Feb. 2007.

This paper addresses the spectrum-sharing for wireless communication where a cognitive or secondary user shares a spectrum with an existing primary user (and interferes with it).

We propose two lower bounds, for the primary user mean rate, depending on the channel state information available for the secondary-user power control and on the type of constraint for spectrum access.

L. B. Le and E. Hossain, “Resource allocation for spectrum underlay in cognitive radio networks,” IEEE Trans. Wireless Commun., vol. 7, no. 12, pp. 5306–5315, Dec. 2008.

We propose admission control algorithms to be used during high network load conditions which are performed jointly with power control so that QoS requirements of all admitted secondary users are satisfied while keeping the interference to primary users below the tolerable limit.

IV. EXISTING SYSTEM

The Existing system in this paper, for the first time, investigates the performance enhancement of the MANETs by appropriately allocating the network resource. Specifically, consider both the transmission resource and storage resource of a network node and use a two-tuple to depict a general resource allocation configuration.

First, for a MANET with any given resource allocation configuration, establish an analytical framework to model the network dynamics as queuing processes. With the help of the network modeling, derive the expressions of fundamental performance metrics, including per node throughput, expected an end-to-end delay, and throughput capacity.

In all these aforementioned work, every SU uses the same type of spectrum access methods, be it overlay, underlay or hybrid.

In reality, it is natural for SUs at different locations to use different spectrum access methods. For example, SUs close to or inside the primary system cannot share the channels with PUs and hence should use overlay spectrum access, while SUs located far from the PU system may use underlay spectrum access in addition to overlay, or even sensing free spectrum access proposed in. In fact, space opportunity, which can enhance the spectrum and energy efficiency, was not considered in most of the existing work.

V. PROPOSED SYSTEM

Proposed approach optimizes channel and power allocation in a multi-channel environment. The given algorithm maximizes the overall utility of a CR network and ensures sufficient protection of licensed users from unacceptable interference, which also supports diverse quality-of-service requirements and enables a distributed implementation in multi-user networks. Both analytical and simulation results demonstrate the effectiveness of this approach as well as its advantage over conventional approaches that rely upon the hard decisions on channel availability.

SYSTEM MODELS

5.1 NETWORK MODEL

We consider a time-slotted cell-partitioned network model which is widely used in previous studies [7]–[10], [12]–[15], where a torus network area is evenly partitioned into c nonoverlapping cells and n (n ≥ 3) mobile nodes randomly move in the network area following a ‘‘uniform type’’ mobility model [6]. Let Xi(t) denote the location of i-th node at time slot t, then with the ‘‘uniform type’’ mobility model, the stochastic process {Xi(·)} is stationary and ergodic with stationary distribution uniform on the network area, and the trajectories of different nodes are independent and identically distributed. It is worth noting that the ‘‘uniform type’’ mobility model is very general since it covers many typical mobility models as special cases, such as the i.i.d. mobility model [7], the random walk model [8], the random way-point model [28], and so on.

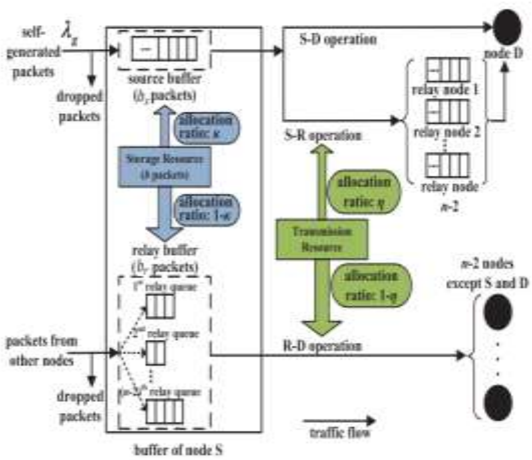

Fig 1: Illustration of resource allocation.

5.2 ALGORITHM USED

Algorithm 1 Optimal Transmission Resource Allocation Algorithm for Maximizing Throughput

Input: Network parameters $(n, c, b, \kappa, \lambda_g)$;
Output: Optimal transmission resource allocation ratio η^*;

```
Initialization: set the convergence tolerance ε > 0, the maximum number of iterations v_max, the iteration index v = 0, Z_l = 0, Z_u = 1, x_1(v) = 0.382 and x_2(v) = 0.618 ;
repeat
    y_1 = T|_{η=x_1(v)};
    y_2 = T|_{η=x_2(v)};
    if y_1 < y_2 then
        Z_l = x_1(v), Z_u = Z_u;
        x_1(v+1) = x_2(v);
        x_2(v+1) = Z_l + 0.618(Z_u − Z_l);
    else
        Z_l = Z_l, Z_u = x_2(v);
        x_2(v+1) = x_1(v);
        x_1(v+1) = Z_l + 0.382(Z_u − Z_l);
    v = v + 1;
until |x_1(v) − x_2(v)| < ε or v > v_max;
η* = x_1(v);
return η*;
```

Algorithm 2 Optimal Storage Resource Allocation Algorithm for Maximizing Throughput

Input: Network parameters $(n, c, b, \eta, \lambda_g)$;
Output: Optimal source buffer size b_s^*;

```
Initialization: set Z_l = 1, Z_u = b − 1, t = Z_l + ⌊(Z_u − Z_l)/2⌋;
repeat
    y_1 = T|_{b_s=t};
    y_2 = T|_{b_s=t+1};
    if y_1 < y_2 then
        Z_l = t, Z_u = Z_u;
    else
        Z_l = Z_l, Z_u = t + 1;
    t = Z_l + ⌊(Z_u − Z_l)/2⌋;
until Z_u − Z_l ≤ 2;
U(i) = T|_{b_s=t+i}, i = 0, 1, 2;
b_s* = t + arg max_i {U(i)} ;
return b_s*;
```

Algorithm 3 Optimal Resource Allocation Algorithm for Throughput Maximization

Input: Network parameters (n, c, b, λ_g);
Output: Optimal resource allocation configuration (η^*, b_s^*) and optimal throughput T^*;

```
Initialization: set the convergence tolerance ξ > 0, the maximum number of iterations w_max, the iteration index w = 0, and initialize the resource allocation configuration (η(w), b_s(w)), ;
repeat
    Given b_s(w), update η(w+1) according to Algorithm 1 (Optimal Transmission Resource Allocation Algorithm);
    Given η(w+1), update b_s(w+1) according to Algorithm 2 (Optimal Storage Resource Allocation Algorithm);
    w = w + 1;
    Update T(w) according to formula (21);
until T(w) − T(w − 1) < ξ or w > w_max;
η* = η(w), b_s* = b_s(w), T* = T(w);
return (η*, b_s*) and T*;
```

5.3 ROUTING SCHEME

To support the efficient operation of a MANET, we consider the popular two-hop relay routing (2HR) scheme [6], [7], [13]–[15]. Without loss of generality, we focus on a cell containing at least two nodes in a time slot, and the 2HR scheme is executed as follow. 1) If there exist source-destination pairs within the cell, equally likely choose such a pair to execute the sourceto-destination (S-D) operation. • S-D operation: If the source contains packets intended for that destination, it transmits the earliest generated packet; else, it remains idle. 2) If there is no source-destination pair in the cell, equally likely designate a node within the cell as the transmitter, independently choose another node as the receiver uniformly over the remaining nodes. This transmitterreceiver pair executes the Source-to-Relay (S-R) or Relayto-Destination (R-D) operation. • S-R operation: If the transmitter has self-generated packets, it relays the earliest generated packet to the designated receiver; else it remains idle. • R-D operation: If the transmitter has packets destined for the designated receiver, it forwards the oldest packet to the receiver; else it remains idle. It is worth noting that with the help of node mobility, the 2HR relay scheme can guarantee the end-to-end packet delivery from a source to its destination.

VI. SIMULATION

In this section, we first conduct simulations to verify the efficiency of our analytical framework and performance evaluation. Then we provide numerical results to illustrate the effects of resource allocation on network performance.

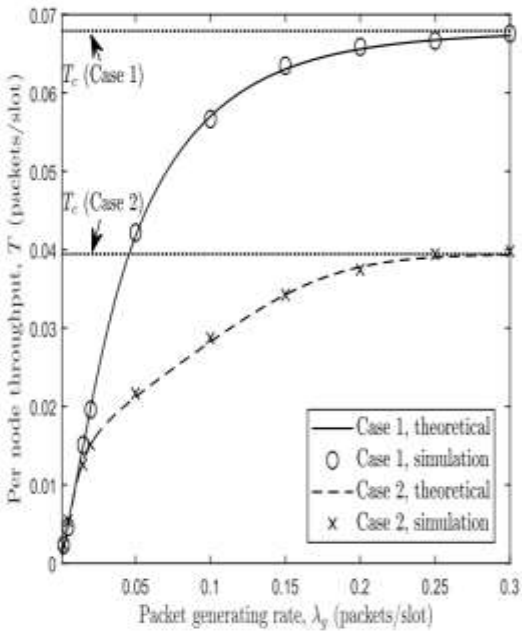

Fig:2 Validation for the per node throughput modelling.

Case 1: (n = 30, c = 15, b = 10, κ = 0.35, η = 0.3).

Case 2: (n = 50, c = 20, b = 15, κ = 0.5, η = 0.6).

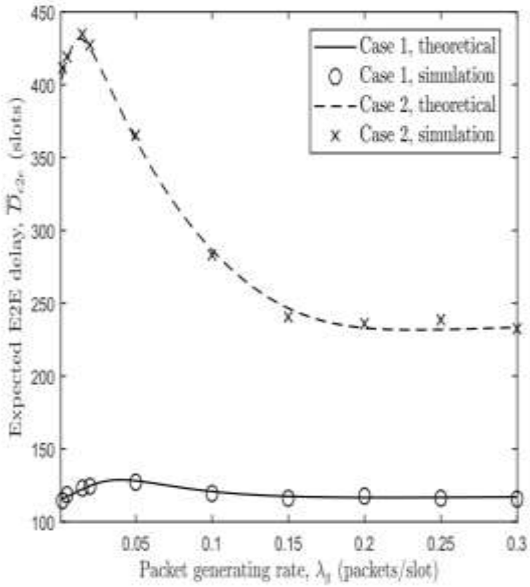

Fig:3 Validation for the expected E2E delays modelling.

Case 1: (n = 30, c = 15, b = 10, κ = 0.35, η = 0.3).

Case 2: (n = 50, c = 20, b = 15, κ = 0.5, η = 0.6).

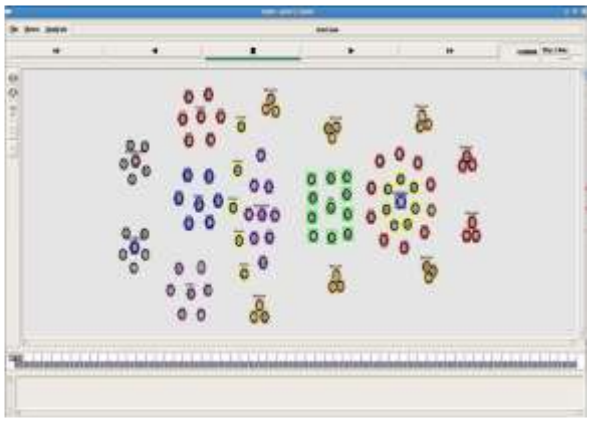

Fig:4 Simulation Environment

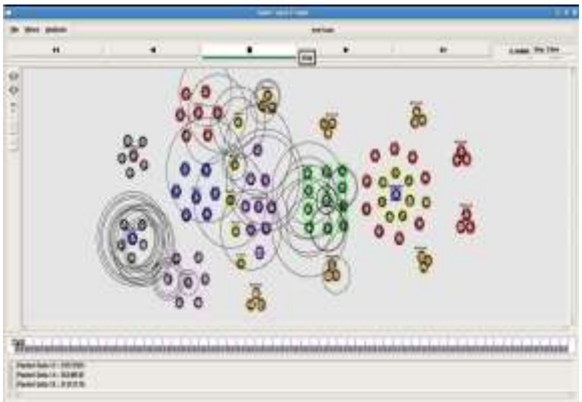

Fig:5 Simulation Started

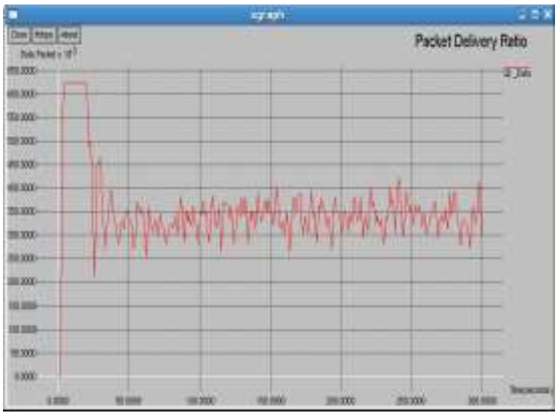

Fig:9 Packet Delivery Ratio

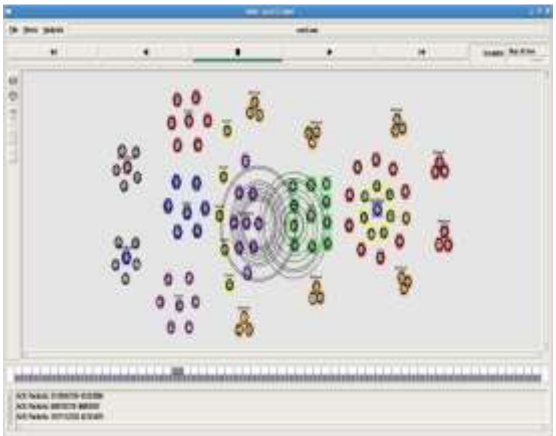

Fig:6 Transferring packets node to node

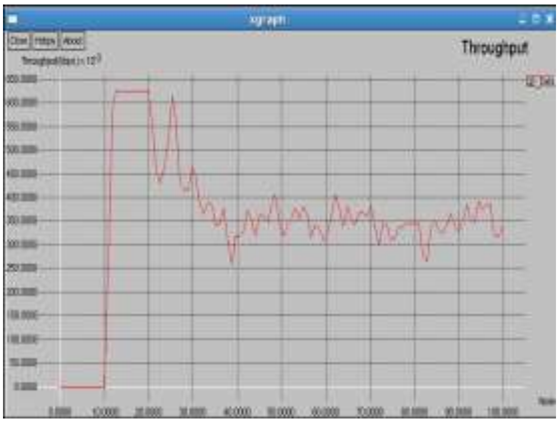

Fig:11 Throughput

Fig:8 Packet Dropping Ratio

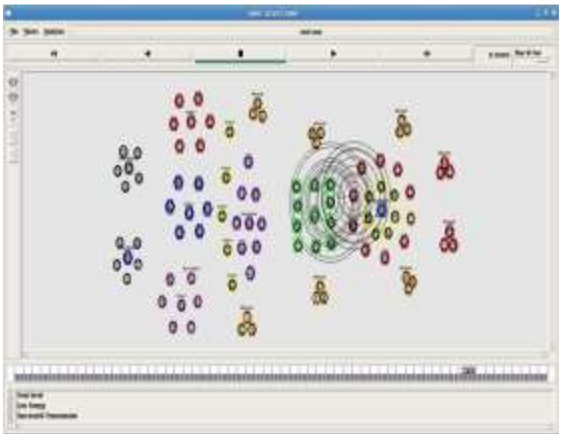

Fig:7 Packets delivered to Destination

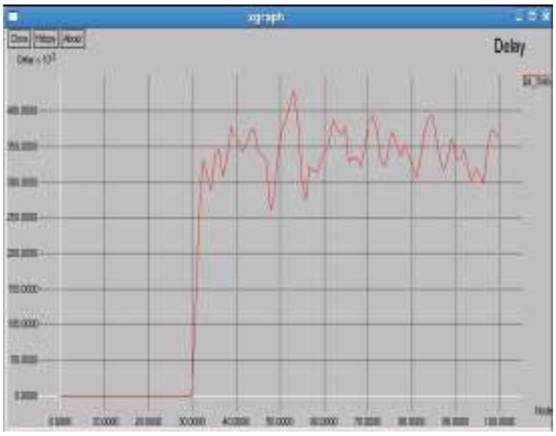

Fig10 Delay

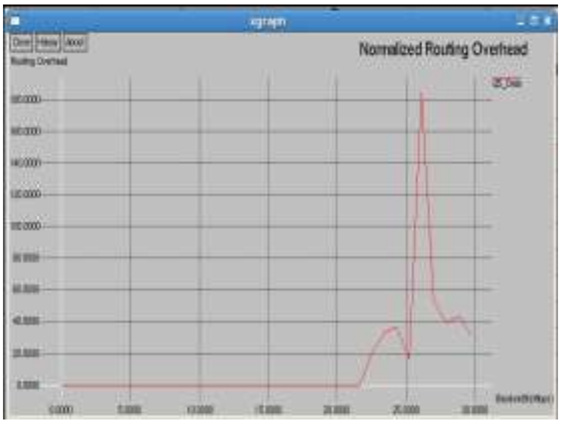

Fig:12 Normalized Routing Overhead

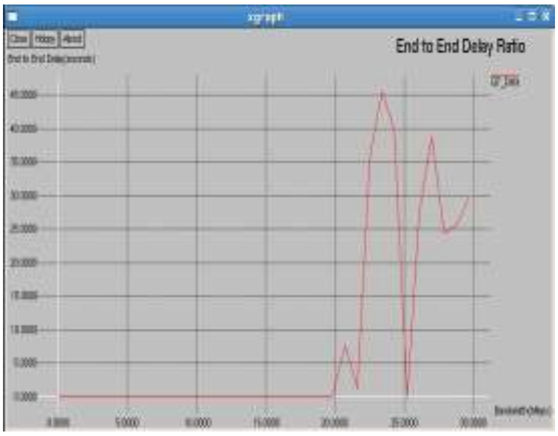

Fig:13 End to End Delay Ratio

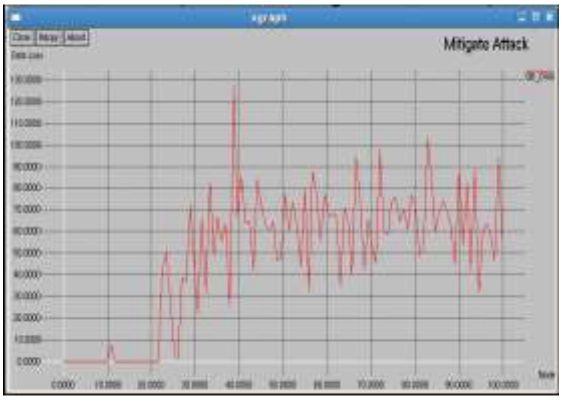

Fig:14 Mitigate Attack

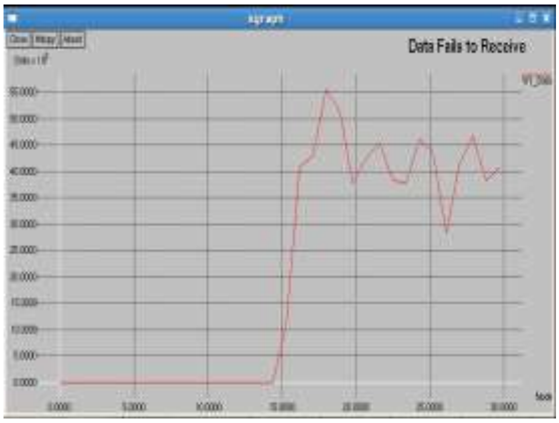

Fig:15 Data Fails to Receive

6.1 VALIDATION

First, we summarize in Fig. 2 the theoretical and simulation results of per node throughput T versus packet generating rate λg under the two cases. We can see from Fig. 2 that both simulation results can match the corresponding theoretical curves very nicely, indicating that our analytical framework is highly efficient for modeling the throughput performance of MANETs under a general resource allocation configuration. In addition, as indicated in Lemma 2, we can observe that the per node throughput T increases monotonically as the packet generating rate λg increases, and finally tends to a constant which is the throughput capacity Tc.

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6.2 ADVANTAGES

- This scheme intelligently utilizes frequency and space opportunities
- It offers better spectrum utilization and efficiency.
- It improves link reliability.
- It is lower in cost.
- It uses advanced network topologies.
- It has simple network architecture.
- It is easy in configuration and easy to upgrade.
- It is less in complexity.

6.3 APPLICATIONS

- Transmission control protocol (TCP) connection can be put to a wait state until the spectrum handoff is over.
- TCP parameters will change after a spectrum handoff.
- It is used to reduce the spectrum switching time significantly.

VII. CONCLUSION

conclusions can be drawn from this study: i) Appropriate resource allocation can bring the benefit of performance enhancement for MANETs; ii) The optimal resource allocation configuration is different for different performance objectives; iii) Usually, in order to achieve good network performance, a network node needs to be selfless to allocate more storage resource and more transmission resource for storing and forwarding packets of other nodes; iv) As the network size becomes large, in order to gain performance enhancement, each network node needs to allocate more resource for forwarding packets of other nodes. These findings can serve as useful guidelines for the practical configurations and operations of MANETs.

REFERENCES

[1] R. Ramanathan and J. Redi, ‘‘A brief overview of ad hoc networks: Challenges and directions,’’ IEEE Commun. Mag., vol. 40, no. 5, pp. 20–22, May 2002.

[2] M. N. Tehrani, M. Uysal, and H. Yanikomeroglu, ‘‘Device-to-device communication in 5G cellular networks: Challenges, solutions, and future directions,’’ IEEE Commun. Mag., vol. 52, no. 5, pp. 86–92, May 2014.

[3] H. Shariatmadari, R. Ratasuk, S. Iraji, A. Laya, T. Taleb, R. Jäntti, and A. Ghosh, ‘‘Machine-type communications: Current status and future perspectives toward 5G systems,’’ IEEE Commun. Mag., vol. 53, no. 9, pp. 10–17, Sep. 2015.

[4] J. Andrews, S. Shakkottai, R. Heath, N. Jindal, M. Haenggi, R. Berry, D. Guo, M. Neely, S. Weber, S. Jafar, and A. Yener, ‘‘Rethinking information theory for mobile ad hoc networks,’’ IEEE Commun. Mag., vol. 46, no. 12, pp. 94–101, Dec. 2008.

[5] A. Goldsmith, M. Effros, R. Koetter, M. Medard, A. Ozdaglar, and L. Zheng, ‘‘Beyond Shannon: The quest for fundamental performance limits of wireless ad hoc networks,’’ IEEE Commun. Mag., vol. 49, no. 5, pp. 195–205, May 2011.

[6] M. Grossglauser and D. N. C. Tse, ''Mobility increases the capacity of ad hoc wireless networks,'' IEEE/ACM Trans. Netw., vol. 10, no. 4, pp. 477–486, Aug. 2002.

[7] M. J. Neely and E. Modiano, ''Capacity and delay tradeoffs for ad hoc mobile networks,'' IEEE Trans. Inf. Theory, vol. 51, no. 6, pp. 1917–1937, Jun. 2005.

[8] A. El Gamal, J. Mammen, B. Prabhakar, and D. Shah, ''Optimal throughput-delay scaling in wireless networks—Part I: The fluid model,'' IEEE Trans. Inf. Theory, vol. 52, no. 6, pp. 2568–2592, Jun. 2006.

[9] G. Sharma, R. Mazumdar, and N. B. Shroff, ''Delay and capacity tradeoffs in mobile ad hoc networks: A global perspective,'' IEEE/ACM Trans. Netw., vol. 15, no. 5, pp. 981–992, Oct. 2007.

[10] X. Wang, W. Huang, S. Wang, J. Zhang, and C. Hu, ''Delay and capacity tradeoff analysis for motioncast,'' IEEE/ACM Trans. Netw., vol. 19, no. 5, pp. 1354–1367, Oct. 2011.

[11] Y. Wang, X. Chu, X. Wang, and Y. Cheng, ''Optimal multicast capacity and delay tradeoffs in MANETs: A global perspective,'' in Proc. IEEE INFOCOM, Apr. 2011, pp. 640–648.

[12] Y. Qin, X. Tian, W. Wu, and X. Wang, ''Mobility weakens the distinction between multicast and unicast,'' IEEE/ACM Trans. Netw., vol. 24, no. 3, pp. 1350–1363, Jun. 2016.

[13] J. Liu, M. Sheng, Y. Xu, J. Li, and X. Jiang, ''End-to-end delay modeling in buffer-limited MANETs: A general theoretical framework,'' IEEE Trans. Wireless Commun., vol. 15, no. 1, pp. 498–511, Jan. 2016.

[14] J. Liu, Y. Xu, Y. Shen, X. Jiang, and T. Taleb, ''On performance modeling for MANETs under general limited buffer constraint,'' IEEE Trans. Veh. Technol., vol. 66, no. 10, pp. 9483–9497, Oct. 2017.

[15] Y. Fang, Y. Zhou, X. Jiang, and Y. Zhang, ''Practical performance of MANETs under limited buffer and packet lifetime,'' IEEE Syst. J., vol. 11, no. 2, pp. 995–1005, Jun. 2017.

[16] K. Lee, Y. Yi, J. Jeong, H. Won, I. Rhee, and S. Chong, ''Max-contribution: On optimal resource allocation in delay tolerant networks,'' in Proc. IEEE INFOCOM, Mar. 2010, pp. 1–9.

[17] X. Sun and S. Wang, ''Resource allocation scheme for energy saving in heterogeneous networks,'' IEEE Trans. Wireless Commun., vol. 14, no. 8, pp. 4407–4416, Aug. 2015.

[18] Q. Wu, M. Tao, D. W. K. Ng, W. Chen, and R. Schober, ''Energy-efficient resource allocation for wireless powered communication networks,'' IEEE Trans. Wireless Commun., vol. 15, no. 3, pp. 2312–2327, Mar. 2016.

[19] C. Wang, C. Liang, F. R. Yu, Q. Chen, and L. Tang, ''Computation offloading and resource allocation in wireless cellular networks with mobile edge computing,'' IEEE Trans. Wireless Commun., vol. 16, no. 8, pp. 4924–4938, Aug. 2017.

[20] L. Liang, G. Y. Li, and W. Xu, ''Resource allocation for D2D-enabled vehicular communications,'' IEEE Trans. Commun., vol. 65, no. 7, pp. 3186–3197, Jul. 2017. doi: 10.1109/TCOMM.2017.2699194.

[21] A. Ahmad, S. Ahmad, M. H. Rehmani, and N. Ul Hassan, ''A survey on radio resource allocation in cognitive radio sensor networks,'' IEEE Commun.

Surveys Tuts., vol. 17, no. 2, pp. 888–917, 2nd Quart., 2015.

[22] M. E. Tanab and W. Hamouda, ‘‘Resource allocation for underlay cognitive radio networks: A survey,’’ IEEE Commun. Surveys Tuts., vol. 19, no. 2, pp. 1249–1276, 2nd Quart., 2017.

[23] S. Giannecchini, M. Caccamo, and C.-S. Shih, ‘‘Collaborative resource allocation in wireless sensor networks,’’ in Proc. 16th Euromicro Conf. Real-Time Syst., Catania, Italy, Jul. 2004, pp. 35–44.

[24] J. Yuan and W. Yu, ‘‘Joint source coding, routing and power allocation in wireless sensor networks,’’ IEEE Trans. Commun., vol. 56, no. 6, pp. 886–896, Jun. 2008.

[25] X. Wang, D. Wang, H. Zhuang, and S. D. Morgera, ‘‘Fair energy-efficient resource allocation in wireless sensor networks over fading TDMA channels,’’ IEEE J. Sel. Areas Commun., vol. 28, no. 7, pp. 1063–1072, Sep. 2010.

[26] J. Liu, K. Xiong, P. Fan, and Z. Zhong, ‘‘Resource allocation in wireless powered sensor networks with circuit energy consumption constraints,’’ IEEE Access, vol. 5, pp. 22775–22782, 2017.