

# MANET-Satellite Network Interoperability Issues and Challenges: An Overview

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**Abstract:** A remarkable advancement in the research of Mobile Ad hoc Networks (MANETS) has been seen in the last two decades. The concept of MANET is based on the infrastructureless self-configurable wireless nodes which act as a router and host. This intrinsic characteristic of MANET renders it quite suitable for tactical and emergency communications scenarios. Since the satellite system has regional as well as global coverage, therefore integration of MANET with satellite network will provide considerable advantage in engineering communication during emergency scenarios which emerges due to natural disasters or military conflicts. This paper carries out an overview of existing work on MANET integration with satellite network and issues concerning integration of MANET with satellite system.

**Keywords:** MANET, Satellite, Integration, Node, Gateways, Networks

## I. INTRODUCTION

Mobile Ad hoc Network (MANET) comprises of group of self-configurable mobile nodes that is associated with each other through wireless medium. MANET is an infrastructureless wireless network where the topology of the network changes dynamically [1-4]. The technology offers wide application in potentially adverse scenarios which may result due to natural or manmade calamity or military conflicts. The life cycle of MANET has been categorized into three generations. The first generation dates back to 1970's with the advent of Packet Radio Network (PRNET) by Defense Research Project Agency (DARPA) [5]. In early 1980's PRNET gradually evolved into Survivable Adaptive Radio Network (SURAN). Subsequently, Globe Mobile Information System (GloMo) and Real Term Digital Radio (NTDR) projects, funded by US Department of State came into existence [2,4]. Internet Engineering Task Force (IETF), gave rise to actual functioning group of MANET which worked to standardized the routing protocols of MANET [2]. The present day Ad hoc networks are categorized as third generation. MANET is quite suitable for tactical networks, wireless sensor networks and device networks, however it experiences severe impairments, as nodes which acts as a router and host moves frequently and this causes break in network at times and leads to network partitioning [2,4]. The network partitioning also occurs due to scarce node density. In such scenarios Satellite communication may help in doing away with network break by setting up recovery links. This is achieved by selecting a MANET gateway node from partitioned network which will provide access to Satellite system. These gateways are special communicating device which enables integration process using suitable addressing scheme and routing strategies. The major issues associated with gateways are load balancing, hand-offs, multi-homing, load balancing, energy management and effective interoperability while adapting effectively with dynamic topology, choosing appropriate algorithm for selecting the best node as a gateway [1]. The concept of MANET-Satellite network will provide local and remote connectivity in highly dynamic and fluid environment but it also raises significant challenges in terms of optimum utilization of

network resources, link availability, Quality of Service (QoS), Quality of Experience (QoE) and economy of energy and cost.

## II. GATEWAYS ROLE IN MANET-SATELLITE INTEGRATION

Gateways plays vital role in integrating two or more networks with similar or different architecture. Gateway nodes acts as service providers in the network and provides access to other network. It facilitates routing within and outside network, provides security to MANET network by restricting outflow & inflow traffic and controlled access to external networks. The number of gateways in MANET-Satellite integration depends on the number of networks used in the integration process. In integrated scenarios routing of MANET and external networks are combined. Gateway nodes are one of the MANET nodes, therefore it is desirable that gateway discovery phase be integrated with path resolution phase of a MANET routing protocol. MANET routing methods requires modification to incorporate gateway discovery and selection strategies to forward packet from source node to destination node.

## III. MANET AND SATELLITE INTEROPERABILITY

MANET is characterized by self-organizing wireless nodes which create temporary topologies arbitrarily. The MANET's node being wireless suffers from several constraints, such as bandwidth, delay, latency, power and mobility issues [2,4]. These constraints raise difficulty in ensuring requisite QoS for desired applications. In addition to these constraints, the random movement of MANET nodes and it's arbitrarily self-configuration may be quick and unpredictable. These networks can work in standalone topology or may be connected to the backbone network. However, in the process of dynamic mobility of MANET nodes, the network splits into separate and unconnected groups. In such scenarios Satellite communications can be effectively used to bridge the unconnected networks. A cluster based technique is used to provide access to Satellite communication [6, 7]. In this technique, once partitioning is detected, the nodes choose a subset of terminals that provides Satellite communication access [6]. These cluster based techniques segregates network into manageable entity for routing maintenance and location management [6,7]. In clustering, network is divided into virtual groups of mobile nodes and cluster head is selected among mobile hosts which act as local coordinator. There are many clustering algorithms, however, the issue of cluster maintenance is pivotal for all available algorithms as it is required to cope with the dynamic node mobility and ensure the consistency of cluster structure. The other prime issue in this technique involves selecting of nodes in a distributed fashion without a centralized control [6,7].

## IV. OVERVIEW OF EXISTING WORK

In the last two decades remarkable work on MANET routing, security, medium access or self configuration has been carried out. In this section, projects focused on MANET integration with Satellites have been discussed with a point of view that this is one of the promising options to derive communication between two isolated MANET networks, usually the situation

which arises during disaster management and military conflicts. In fact achievement of such integration will enable larger reach to networks as satellites have global coverage [1].

### **A. P2PNET**

Peer-to-Peer Network (P2PNET) is a serverless peer-to-peer communication based on MANET. It supports temporary group communication and information networks. In [8] serverless peer-to-peer communication network based on MANET to support temporary group communication has been proposed. In P2PNET some nodes may have Satellite communication capability and acts as gateway to enable other nodes to access internet through it. P2PNET supports communication needs such as VoIP, Push-to-talk, instant messaging and mobile social network. P2PNET concept is suitable for areas affected by natural disaster, battle field scenarios and mobile learning environments as it is designed for temporary serverless, infrastructureless and internet-blocked environments. In the first phase of the project an ad hoc Walkie-Talkie-like communication was implemented. Additional, complex experiments including multi hop communications and addition of Satellite gateways in the system architecture are planned.

### **B. DUMBONET**

Digital Ubiquitous Mobile Broadband Optimized Link State Protocol Network [DUMBONET] project was developed by intERLab and its partner for search and rescue operations in disaster-struck scenarios [9]. DUMBONET is an emergency network platform in which Satellite links are utilized. DUMBONET uses Satellite communication links to tackle MANET partitioning. In the test bed experiment, two simulated disaster sites and a simulated remote site were interconnected via IPStar geostationary satellite. The Optimized Link State Protocol (OLSR), where all devices belonged to same private subnet was used to route the traffic among them. A successful transmission between the remote site and disaster site was achieved.

### **C. SAVION**

Savion project proposed a new "ad-hoc network" architecture based on dedicated protocol for allowing a full meshed configuration which was optimized for voice but also allowed data, images and communications through self-configured relay nodes to overcome the constraint of line-of-sight [10]. The concept was primarily built to integrate a satellite segment for emergency applications. In this project use of Savion MANET solution for communication between teams involved in emergency activities via Satellite gateway for interconnecting teams with high level managers not present in the area was proposed. The data packets among different teams were routed via satellite links when MANET network partitioned. In this project TCP/IP and non-TCP/IP connections were successfully set up and used for chatting and file exchanges.

### **D. MONET**

Mechanism for Optimization of Hybrid Ad hoc Networks (MONET) is a European collaborative project which started in January 2010, [11]. The project is focusing on end-to-end optimization of resource management in a hybrid network by considering its impact on both the MANET and Satellite segments. The issues such as re-organization of MANET to connect to Satellite access points, reorganization of Satellite access points, selection of which access point to use, utilization of Satellite as relay between two MANETs, the adjustment of routing in accordance with the current network situation and the exchange of cross layer information to improve resource

management are being investigated under this project. The project also proposes to develop solutions for the optimization of a hybrid MANET-Satellite network by implementing prototypes of the most promising algorithms and protocols and testing it using Commercially-off-the shelves equipments in laboratory as well as field scenarios. The successful accomplishment of MONET project will bring out noticeable value addition in broadband access technology for remote areas, on demand connectivity for Airports & aircrafts and augmentation of public safety communication during emergency scenarios.

### **CONCLUSION**

The evolution of MANET-Satellite interoperability concept emerged primarily to tackle the communication between two partitioned MANET networks to deal with a communication scenarios faced in emergency and fluid tactical situations. The initial projects on MANET-satellite integration primarily dealt with forwarding inbound and outbound data traffic to connect with external or backbone networks. However, the latest projects in this field such as MONETS are focusing on core issues of hybrid MANET-Satellite networks which includes optimization of network resources and link availability, ensuring requisite QoS and QoE and minimizing cost and energy. The successful accomplishment of project objectives will bring noteworthy value addition in core MANET applications and provide impetus to research in this field.

### **References**

- [1] G. Jisha et al, "Role of Gateways in MANET Integration Scenarios", Indian Journal of Science and Technology, vol. 9(3), Jan 2016.
- [2] Dr Nupur Soni, "Integration of mobile ad hoc networks in 4G networks", International Journal of Emerging Technology and Advanced Engineering, vol. 4, pp. 435-442, Jun 2014.
- [3] Cao Hunag, Xiaojun Guo and Zeguo Liu, "A wireless networking architecture using MANET for mobile communications of remote patrol areas in Tibet", proceedings of the 2<sup>nd</sup> International Conference on Computer Science and Electric Engineering (ICCSEE 2013), pp. 800-803, 2013.
- [4] Mohit Kumar et al, "An overview of MANET: History, challenges and applications", Indian Journal of Computer Science and Engineering (IJSCE), vol. 3, pp. 121-125, 2012.
- [5] A. Goldsmith, S.A Jafar, N Jindal and S Vishwanaths, "Capacity limits of MIMO channels," Selected Areas in Communications, IEEE Journal, vol. 21, issue 5, pp. 684-702, Jun 2003.
- [6] M. Hamdi and Laurent Frack, "Novel Cluster maintenance protocol for efficient Satellite integration in MANETs", 29<sup>th</sup> AIAAA International Communication Satellite Systems Conference, 2011.
- [7] M. Bheemalingaiah, M. M. Naidu and D. Sreenivasa Ra, "Energy aware clustered based multipath routing in mobile ad hoc networks", I. J. Communications, Network and System Sciences, pp. 123-130, 2009.
- [8] Y. N. Lien, H.C. Jang and T. C. Tsai, "A MANET based energy communication and information system for catotrophic natural disaster", 29<sup>th</sup> IEEE International Conference on Distributed Computing Systems Workshops (ICDS09), pp. 412-417, 2009.

- [9] K. Kanchanasut, A. Tunpan, M. A. Awal, D. K. Das, T. Wongsardsakul and Y. Tsuchimoto, "DUMBONET: A multimedia communication system for collaborative emergency response operations in disaster-affected areas", International Journal of Emergency Management, vol. 4, pp. 670-681, 2007.
- [10] M. Luglio, C. Monti, C. Roseti, A. Saitto and M. Segal, "Internetworking between MANET and Satellite systems for emergency applications", International Journal of Satellite Communications and Networking, vol. 25(5), pp. 551-558, 2007.
- [11] A. Olivera, Z. Sun, M. Monier, P. Boutry, D. Gimenez, A. Pietrabissa, and K. Banovec Juros, "On optimizing Hybrid Ad-hoc and Satellite Networks the MONET Approach", Future Network and Mobile Summit, pp. 1-8, IIMC, 2010.

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