MULTI-TIER MANET'S

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ABSTRACT:

While mobile ad-hoc networking (MANET) research has received a considerable attention in recent years, the majority of them have focused on single-tier (e.g., ground) and homogeneous (e.g., same radio for every node) MANET. Few have investigated the potential implications of multi-tier and heterogeneous natures of MANET on the design and performance of MANET protocols in a systematic manner. For example, one of the stark differences between single-tier and multi-tier MANET environments is that the multi-tier MANET naturally creates "coverage asymmetry " due to the much larger coverage area by airborne nodes compared to ground nodes. Consequently, the number of "neighbors " an airborne node sees can be potentially several orders of magnitude larger than that of a ground node. Treating this airborne node same as any ground node will adversely affect the performance of medium access control (MAC) and/or routing MANET protocols. In this paper, we present a detailed multi-tier MANET architecture, associated issues, and protocols developed. We present a new approach for routing in multi-tier heterogeneous wireless mobile ad hoc networks. This protocol, namely multi-virtual backbone protocol (MVP), naturally addresses key challenges arising from multi-tier wireless networks such as the coverage asymmetry and node heterogeneity. It also supports various QoS needs by constructing and maintaining QoS-specific virtual backbone infrastructure.

Keywords: Mobile ad hoc networks; Multi-tier MANET; virtual dynamic backbone; Airborne Communication Node**.**

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1. INTRODUCTION:

Mobile Ad-hoc networks (MANETs) are infrastructure-free wireless communication networks. MANETs are considered as ideal technology for instant communication networks in both military and civilian applications. Nowadays, tactical military networks are the main application area of MANETs. Tactical military networks, having critical operation environments, require very high security and performance together. Hostile environment of tactical military networks and infrastructureless-wireless characteristic of MANETs make these networks vulnerable to various attacks and compromises. A typical text on Mobile Ad hoc NETworks (MANETS) will describe such networks as simply being ”a collection of mobile nodes, communicating among themselves over wireless links and thereby forming a dynamic, arbitrary graph” – listing wireless characteristics and graph dynamics as the main challenges for designing protocols and applications for this network. While capturing important characteristics, this description does not make explicit how MANETs map into the Internet architecture – and does therefore not allow evaluation of existing IP protocols and their applicability on MANETs. Similarly, the lack of a clear architectural description within the context of the Internet has impeded the evaluation of the applicability of MANETs within the Internet.

This fact became explicit during the chartering of the IETF AUTOCONF working group in simple terms, the goal of the AUTOCONF working group is to provide automatic address configuration for MANET nodes. Most researchers and engineers familiar with MANETs shared the understanding that existing autoconfiguration approaches did not apply. Describing why and how was, absent a clear and agreed upon architectural model of MANETs, difficult – as was communication to experts outside the MANET community. The issue arose again within the context of routing and route optimisation within nested NEMO networks, where a clear architectural description of MANETs lead to a poor general understanding of how MANETs might be a candidate technology. The purpose of this memorandum is to document the MANET architecture within the general Internet and IP architecture.

MULTITIER MANET'S ARCHITECTURE:

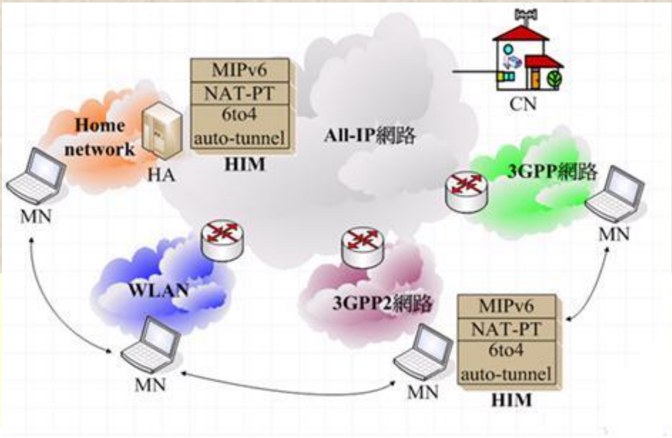

Figure:1)

- The two-tier heterogeneous MANET architecture
  - The low tier of the network consists of a set of mobile hosts each equipped with a IEEE 802.11 wireless LAN card.
  - To connect to the Internet, the high tier is comprised of a subset of the mobile hosts, called gateways, which can access to cellular/infrastructure networks.

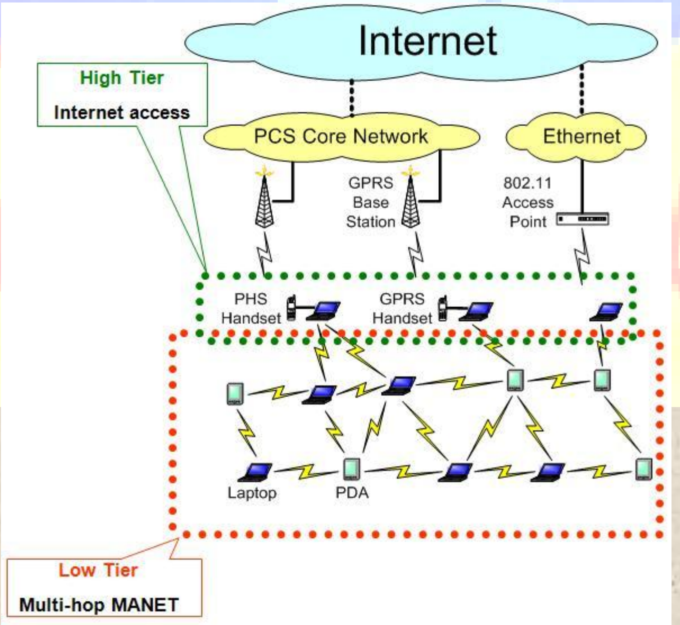

Figure 2)

VIRTUAL DYNAMIC BACKBONE FOR MANET'S:

An Internet backbone, in its simplest form, is built from routers and the long-haul circuits that interconnect them. With SwiftCOR virtual backbone routers, each physical router is logically subdivided into multiple virtual routers. Each virtual router acts like an independent router, but does so much more efficiently because it shares common resources. An ISP using a virtual backbone router service takes control over one virtual router in a backbone node creating a vPoP. The virtual routers are in turn interconnected either with dedicated circuits, or with MPLS label switched paths to create an entire virtual backbone service. SwiftCOR virtual backbone routers run a separate instance of the routing protocols and have dedicated I/0 ports, buffer memory, address space, route table and network management. Using this technology, a backbone service provider can create a virtual IP network service. This service, targeted at holesale customers, allows regional IP networks to be extended across the virtual backbone while maintaining full customer control over quality of service, security and and performance. Indeed, the virtual router-based backbone gives the wholesale customer the same management control and network performance as its own physical network.

It is important to stress that virtual routers comply with all applicable standards, operate using standard protocols and are managed by standard protocols. They peer with other routers just like physical routers and behave in all other respects just like physical routers.

Virtual wire allows for a virtual backbone to be dynamically maintained such that it is composed of reliable, relatively stable, and high-bandwidth links even under an environment with highly fluctuating wireless channels. The resulting structure, called Virtual Dynamic Backbone (VDB) which resembles a cellular-like infrastructure and is similar to spine [3] (but different in its construction and functionality) , serves as a common backbone for unicast and multicast routing. This cellular-like structure, combined with virtual wire and efficient link quality estimation algorithm, yields a number of attractive properties such as:

(i) simplified unicast and multicast routing,

(ii) fast recovery under link quality degradation,

(iii) bandwidth-efficient flooding, and (iv) easier QoS management.

THE AIRBORNE COMMUNICATION NODE DEMONSTRATOR:

The Airborne Communication Node (ACN) demonstrator has been designed and developed by EADS for the French MoD as a proof of concept with in mind to enhance telecommunications and network capabilities on the theatre of operations.

In a first approach, the Airborne Communication Node can be seen as a satellite-like system, but without some of the drawbacks of the satellite communication solution. It consists of an airborne high data rate communication payload – the node –, which serves mobile ground gateways (vehicles, ships, static) over a large coverage area as pictured on the figure 3.

Figure 3: Operational view of the Airborne Communication Node

The ACN has very ambitious operational characteristics: as a multi user communication system the radio capacity is very high compared to non satellite based current system with up to 40 Mbps per connected gateway. This data rate is achieved while keeping a top of the art robustness in an Electronic Warfare environment thanks to a WCDMA (Wideband Code Division Multiple Access) waveform. But most importantly the whole system is based on the IP (Internet Protocol) standard to allow a complete interoperability with existing networks and other IP based communication systems. The radio capacity is managed with dynamic radio and network resource allocation between the users to allow a global smart Quality of Service (QoS) management. The QoS is also made easier with a low latency comparable with DSL connections.

The whole system is moreover very quick and easy to deploy as there is no specific infrastructure constraints and as all the gateways are highly mobile across the coverage area. Through the mobility of the airborne platform, the coverage area can (as well) follow the ground operations. Despite in the sky, the node flies at a very high altitude (stratosphere) to ensure a limited vulnerability.

The Battlefield Airborne Communications Node (BACN) combined with Global Hawk, provides warfighters essential information to pursue and defeat the enemy.

BACN's Airborne Executive Processor (AEP) enables a persistent Gateway in the sky that receives, bridges, and distributes communication among all participants in a battle.

BACN BRIDGES THE GAP:

In theater operations, mountainous terrain inhibited line-of-sight communications; diverse weapon systems were unable to communicate with each other; each operating unit could see only a limited set of the complete picture. BACN bridges the gaps between those systems, enabling essential situational awareness from small ground units in contact up to the highest command levels. In response to a Joint Urgent Operational Need (JUON), Northrop Grumman accelerated integration of BACN onto manned aircraft and provided this indispensable capability to the war fighter in 9 months. The BD700 aircraft integrated with BACN were delivered in theater ahead of already aggressive schedules. Hawk optimizes BACN's powerful communications capabilities by exploiting the operational flexibility and economical endurance of that platform. Global Hawk makes BACN available to support the war fighter 24/7. Originally conceived as a technology demonstration, BACN rapidly proved at JEFX and other exercises that its capabilities were already mature enough to field. BACN's AEP provides translator and gateway interfaces among all supported communications systems, and forwards knowledge-based intelligence information to the Global Information Grid. By controlling the AEP via a ground station, BACN becomes:

1] Radio Agnostic

2] Platform Agnostic

CONCLUSION:

With intense, global-scale competition between large backbone operators, all market participants must be alert to new opportunities that can increase market share or grow revenues. Virtual backbone router technology provides just such an opportunity. By offering wholesale services based on virtual routing, a backbone owner can win a larger share of its available market, boost returns on installed fiber and strengthen the loyalty of its wholesale customers. Because virtual backbone routers offer users the power and flexibility to customize their service, they raise customer loyalty and increase retention. Early movers into this new technology will Gain a sustainable advantage, and those Tier 1 operators that move quickly to the starting line will be well placed to reap the greatest rewards.

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