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Mesh Networks, Communications Emergency Response

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ABSTRACT

Maintain communications in emergency situations greatly facilitates decision making at critical times, the situations are not limited to natural disasters are also included terrorist attacks and the crowds of people, these situations require resources and access to information immediately and efficiently, excessive traffic, the number of users are collapsing systems (if they exist in the place), as an integrated solution of communication have developed wireless mesh networks (WMN-English acronym), which also provide redundancy, interoperability and access to services over IP, network capacity to generate a portable MAN momentarily, while conducting search and rescue activities, population censuses and others. Becoming an efficient solution within the limits of ad hoc networks and wireless networks.

Keywords: *Mesh Network, services, redundancy, emergency.*

I. INTRODUCTION

Mesh networks appear in the world of wireless networks based on the concept of ad hoc networks, known as mesh networks [3] have a decentralized infrastructure and mesh, allowing the flow of packets (data, voice, video) to along the network, on a tour of this article shows the evolution and development to generate efficient solutions made from these networks, dynamic, redundant, scalable, self configurable and capable of providing QoS.
Based on the concept of Manet, (Mobile Ad Hoc Network), supplemented by the presence of WiFi networks, there is the emergence of mesh networks, with military origins, aimed at generating message transmission chains of information between members of the brigades, acting as mobile nodes, then the evolution of wireless networks with protocols 802.11.x (wireless networks), 802.16.x (Wimax) and the protocol 802.15.5 (Bluetooth), it away from the military camp and conceived a more accurate mesh network with similar functions but with different destinations. Mesh networks like ad hoc networks [11], provide robustness, ease of deployment, low cost, dynamic configuration and redundancy vital for emergency communications and the integration of ad hoc networks, LAN or WAN infrastructure within and topology.

II. GENERAL MESH NETWORKS

The development of mesh networks as well as other communications systems have undergone changes as technology advances, these networks have had a development in which three stages are evident [1] development:

a) First generation: The nodes transmit in a single direction, cannot receive and transmit simultaneously, the information sending node to node.

b) Second Generation: uses two ranges, one dedicated to services and another dedicated to the interconnection of nodes, a disadvantage occurs when the number of users grows and traffic increases, this results in increased congestion and shipping packages Data slowed.

c) Third Generation: Has a two-way communication that is transmitted and received at the same time, using various channels to maintain connectivity.

As a result of this transition and the development of mesh networks identifies three types of key infrastructure for its formation, the Mesh Routers, Mesh Clients and Hybrid. [2], with simulations of its performance under the standards of IEEE 802.11 as evidenced in [15] with the following types of nodes:

a) Type Mesh Router: Besides the conventional functions of a router, this node has additional capabilities for controlling multi-hop transfer of packets, is the mobility support of other members of the Network and is responsible for the Mesh interaction with customers and other networks. Is a fixed node

b) Type Client Mesh: This type of nodes do not have capabilities to be gateways or bridges but have the ability to form a mesh network with point to point links, hardware and software is less robust than a Mesh router but higher than the used by nodes in ad hoc networks. It is a mobile node.

c) Hybrid type: type made up of nodes Mesh router and client, where customers can communicate with other mesh through Mesh routers and mesh clients or between access to other networks such as Internet. As shown in [12] and [22] architecture is one of the parameters to be considered to provide better guarantees and better uses of resources for members of the mesh network, allowing customers access via the conventional protocol Ethernet and Mesh Clients through proactive or reactive protocols chosen. The Mesh network architecture depends on the type of nodes, how to maintain routing tables, traffic management and especially the maintenance of the roads. In [2] propose the following architecture with a Master Mesh which controls Mesh routers and connectivity with other networks.

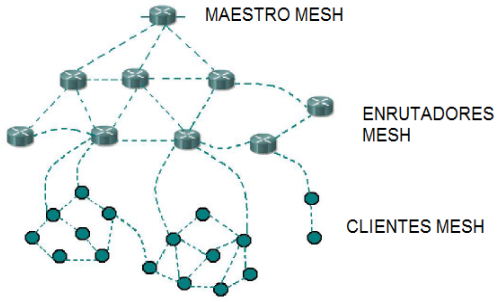


Fig. No 1. Mixed in Mesh Architecture

The management of spectrum resources, channels of transmission and reception, the routes of packets and network behavior is directed and controlled by the routing protocol chosen for the establishment, maintenance and network connectivity, especially the following protocols:

a) OLSR (Optimized Link State Routing Protocol): [4]

This protocol is proactive type is periodic messages sent between nodes, creating an information dissemination network (broadcast), to identify the members of the same and scope, maintaining updated routing table, but generating additional traffic to the Web has been used frequently in mesh networks due to sending periodic Hello message type used to know the status of neighboring nodes and messages Topology Control (TC) used for dissemination of proprietary information with neighbors and include checklists with multipoint transmissions stored in lists MPR calls. (Multipoint Relay).

b) AODV (Ad-Hoc On Demand Distance Vector) [4]

This protocol is reactive, ie acts on demand, according to requests from members of the network sends request messages RREQ and RREP waits for a response to generate the routing tables, if no answer or a fact is wrong in the table is generated to the requesting node error and restarts the route search.

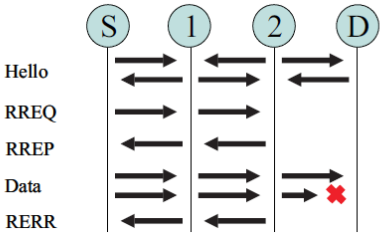


Figure N°2. AODV Protocol.[5]

c) Hybrid Protocols: These protocols are highly efficient because it does not depend either on demand or constant updates of the routes and locations of the nodes, as shown in [5], with the protocol HTSMA (Allocation Hybrid Multichannel Spatial Temporal) which is looking for both broadcast and have stored the location of neighboring nodes, this protocol has two parts, the first channel used for shipments with jumps greater than 1, and another for neighboring nodes, ie equal to 1 hop . Just as this routing scheme in mesh networks, there are several models that seek to improve performance, traffic management, control and manage energy consumption more suitable routes for transmission from end to end. As is the case MeshHASeDiP protocol, which is based on the discovery of a route in two modes reagent (MRD) and another Proactive (MPD) according to the characteristics of the mesh network according to [6], generating discovery zones reactive and proactive.

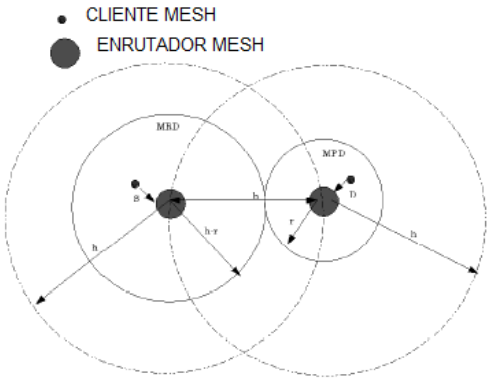


Figure N° 3 Hybrid Discovery.[6]

The protocols mentioned above, meet the needs of ad hoc networks and mesh networks, which is why they have

been modified to improve yields or generate a new type of protocols known as hybrids which possess useful reactive and proactive features to maintain and manage the network.

III. EMERGENCY COMMUNICATIONS

The natural disaster recovery and public safety, require coordinated actions of specific resources and needs minimal communication between the entities involved, members of the same and the community, which is why there are so-called ETS [8] (Emergency Telecomunication Services), regulated by the recommendations of the ITU, ITU - R. E106 "International Plan of preferences for emergency disaster relief operations" applied to basic telephony services (PSTN), Integrated Services Digital Network (ISDN) and public mobile networks (LMN). ETS can be used in national contexts embedded in international contexts, allowing recovery from major events such as earthquakes, hurricanes, tsunamis or terrorist attacks.

Maintain communications in times of crisis, with specific characteristics such as authenticating users quick ETS, security and traffic, preferential access to telecommunications facilities, establishing preferential communication, exclusive use of resources allowable degradation of the quality the ETS traffic service are vital elements to ensure coordination of the entities involved and proper access to communication resources.

This recommendation allows the appropriation of the concept of ETS and proper management of communications resources, identifying the minimum basic needs in emergency communication.

Many government agencies have devoted much effort and research for obtaining real communication systems as is the case of Federal Emergency Management Agency (FEMA) of the U.S., who have faced major disasters and have determined the characteristics of the emergency communication systems such as:

a) Rapid Deployment*:* reduce installation time and deployment, performing procedures that are not complex and do not require specialized personnel for its formation and implementation.

b) Scalability and Robustness: Must be able to withstand the constant changes in operating conditions and network functionality, the environment or infrastructure. Be flexible for different types of users and needs them.

c) Portability: You must respond to short times in both installation and operation using minimal resources and infrastructure to facilitate the operation of the groups responsible.

d) Security: The data managed by different respondents, be they government agencies, local and international agencies, armed forces etc, must have appropriate security to prevent misuse and leakage or loss of information generated in the care of the emergency.

e) Cost: Networks must respond to installed generating and maintaining reasonable prices, these variables are vital to the viability of the network.

Given these characteristics, the technical parameters such as bit-rats are determined by the needs of the task forces or first responders, creates a new concept of networking as seen in [7] which has recommended three levels of networks, primary networks - which respond to the initial impact of the emergency and basic needs of functionality includes point to point links and limited duration, secondary networks, operating with a continuous duration (24 hours) and the possibility of linking mobile nodes within network and tertiary networks-these consist of a PAN network integration, sensors, networks and network Lan Ad - Hoc.

An important element of emergency communications is to identify "a taxonomy 'or classification of emergency communications by the standards and capabilities of networks, an interesting and comprehensive investigation is presented in [9] with the concept of networks and specialized ad hoc systems (SAHNS), by designing two types of networks the spontaneous and opportunistic, categorized into three levels: high, medium and low, according to their abilities and characterized by the design (application-specific), adaptation (context) or and hybrid networks (design and adaptation).

Additional features have interoperability, heterogeneity of software, persistent connectivity and the addition of resources or the network members.

Within this classification mesh networks have the following characteristics:

Rapid deployment and incremental, not limited by minimum requirements, self-organization, capable of internet access, does not require a centralized structure, does not need additional resources, such as routers structures differ Mesh, Mesh clients, customers, conventional, nodes may be heterogeneous in hardware but in software, can be wired or wireless, works under mobility schemes is redundant but it depends on the bandwidths of the nodes, a limited radio communication

hardware nodes is interoperable , has arbitrary topology and coverage can be from PAN to MAN. Similarly presents a case for monitoring and network planning for emergency services as evidenced in [10]

IV. MESH NETWORKS IN EMERGENCY COMMUNICATIONS

The development of mesh networks has been extensive and have not been limited solely to be implemented in simulated environments, so below several significant experiences both simulated and implemented in the development of such networks that reveal all the features previously listed and fully complying with the requirements established for emergency communications.

The first case discussed is in the province of Tucuman, Argentina [13]. Where were located nine buildings with 400.000m^2 coverage in this application we used the protocol OLSR (Optimized Link State Routing) using Mesh router node type in the main buildings of the municipality and provided a range of services around this network of which are: Public Safety: using video cameras, communication: IP server was implemented between the buildings of the municipality; Roaming: The network users have access within range of the WMN, Internet access and email address.

In rural settings have been successfully implemented several mesh networks, as referred to in the first case, we have proposed several improvements turn which is evidenced in [16], using protocols where reagents are tested two types of ring topologies (fixed nodes), and other mobile mobility schemes, using the reactive protocol AODV (Ad-Hoc on demand distance vector) and is simulated for use in the event of an earthquake, so the use of these two topologies, for This development software is used NS2 with simulation times of 150 seconds, under frequency of 914 MHz with different antenna gains, for a coverage area of 900 to 700 m^2. Taking into account various factors affecting operating results and network behavior, such as is the delay and the transport protocol used for network maintenance and sending packets using UDP and TCP protocols, show a higher yield with the UDP protocol and topology ring, both handling collisions as in the control of network traffic, however show a packet loss when using these combinations of topology and transport protocols.

Many government agencies have developed these networks and have invested resources for proper implementation and use as evidence SAFECOM [17], a program of the Department of Homeland Security, which includes communications digital two-way radio (TETRA) systems, mobile and satellite, this will have for a research group called MITOC, which have been implemented with proprietary systems software and hardware mesh, various types of heterogeneous networks, this system has an infrastructure using different mesh service, comprising the following elements, satellite terminal equipment, radio base, IP services, Internet access through a "bubble" providing access to wireless users in the group MITOC. The mesh network is designed to share resources among all members in an emergency, it is notable that these networks are operated in a state of emergency due to the rapid deployment and providing communications to all members of the emergency team and the incident commander.

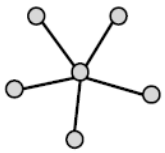
Many projects have mesh networking satisfactory yields by adopting the IEEE 802.11, for that reason in [22], proposes a partnership scheme, which allows scaling and maintaining the quality of network service under all times, generating a series Head called cluster groups, which have a common metric for maintaining connectivity of the network as is the case of the transmission power level, generating gain in the network coverage.

It is therefore proposed in [20] a rural application where all nodes including those awaiting work together to update tables and sending the packets, the cooperative system allows for greater coverage and increased information flow with energy consumption efficient and therefore presents improvements compared to the common scheme Mesh type multi hop. In the simulations showed a better performance in terms of prejudice to interference, fading and noise.

The study of mesh networks, also seeks to improve the time of creation and maintenance of the network, to find ways more efficient to use, given the characteristics of robustness and dynamics of its formation. So the protocol is implemented [19] FACE (Fast exploration approximate center) an algorithm that seeks the appointment of a gateway quickly and efficiently without increasing network latency significantly, for that this algorithm uses two types of trees expansion to form the network and manage traffic in the same, starting with the primary tree expansion, which seeks the maximum node centrality in the network, to expand the network through it, after a period of continuous approximation centrality, which seeks to calculate which is the central node, with sample values for the election of the central node, finally makes a notification distance which compares the distances of all nodes and choose the central node for managing network.

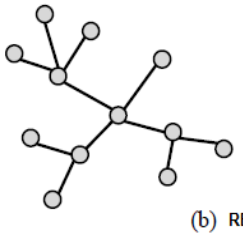
A similar development occurs with the proposal given in [21], which seeks to model a mesh network from block diagrams and the calculation of the network topology by either star or mesh, in this paper all evidence based development graph theory to the management and network dimensioning. This development RELIABILITY

evaluates the network by using diagrams and rules established for its formation, using them either in series or parallel adding nodes and edges in the graph parallel to increase network reliability.



$$R_{star}(t) = \left(R_{\sigma}(t)\right)^{5} \times \left(R_{\epsilon}(t)\right)^{4}$$

(a) RED ESTRELLA



$$R_{tree}(t) = \left(R_{\sigma}(t)\right)^{12} \times \left(R_{\epsilon}(t)\right)^{11}$$

(b) RED ÁRBOL

Figure N° 4. Types of networks using block diagrams. [21]

V. CONCLUSIONS

- As evidenced emergency communications are an innate need of daily actions, as well as an emergency can not be determined accurately, a redundant communications system that provides all the communication parameters are extremely necessary, to coordinate post-event actions and be able to generate logistical levels [14] appropriate.

- As is evident throughout this article and in [18] mesh networks combine a number of characteristics that make an efficient and inexpensive to maintain communications in Emergency and in complex environments such as some rural areas.

- Mesh networks include protocols (OLSR, AODV) and advanced metrics such as diagrams, graphs to calculate the reliability and network management efficiently, enabling you to model a network and mobility patterns as shown in various applications mentioned in this Article, positioning mesh networks as a variation of ad hoc networks and wireless networks.

- The extreme ease of implementation and simulation of such networks, to visualize the operation and behavior of the network, offering variety of services and a new way to control a network, traffic flow, the number of users, dynamically and self-organizable.

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