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A SURVEY ON COGNITIVE HANDOVER BETWEEN THE TERRESTRIAL AND SATELLITE SEGMENTS

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Abstract – Handover is a mechanism that transfers information from one network terminal to another as a user moves through the coverage area in a cellular system. Here the network is selected in that particular cellular network environment using handover decision process. This handover decision will be either mobile or network initiated. Terrestrial area is poor in its network coverage. So here the terrestrial network is sensed and efficient mobile service with handover is made possible. This paper deals about how cognitive handover takes place efficiently between the terrestrial and satellite segments. The critical issues related to hybrid satellite/terrestrial architectures will be identified and analyzed all along this paper and the efficient handover over the terrestrial network is made possible.
Keywords– Handover, IEEE802.16g Protocol, Cognitive Radio, Terrestrial Networks, Hybrid Satellite, Casting, Load Balancing

I. INTRODUCTION

The choice of a satellite telecommunications system rather than a terrestrial one is usually driven by its intrinsic capabilities, for instance very large coverage areas, speed of implementation and inherent multicasting and broadcasting capabilities. Nevertheless, satellite systems suffer from many drawbacks such as technological complexity, high costs, and deep fading at high frequencies. Most successful satellite systems such as television broadcast and back-hauling of data in remote areas have up to now extensively exploited theses advantages in a competitive way with respect to classical terrestrial networks[1].

Other satellite systems providing for instance mobile telephony or aircraft telecommunications services have suffered from severe concurrence or insufficient market and have not enjoyed the expected success. Despite the recent enhancements at different layers increasing the efficiency and competitiveness of telecommunication satellite systems, they still have to face a harsh concurrence from terrestrial networks and do not succeed in asserting on the market of telecommunication services, except the ones traditionally provided over satellite, i.e. TV-broadcast and specific portable, nomadic telecommunications services. One reason for this is the way satellite and terrestrial telecommunication systems currently coexist: in a competitive manner. Therefore, the idea of jointly benefiting from the advantages and capabilities of both terrestrial and satellite telecommunication systems was developed [2].

This has been strongly acknowledged by the institutions, since greater level of integration between satellite and terrestrial telecommunication systems has been described as necessary for the future of satellite systems [3].

Cognitive Approach is followed were when the primary users are not using their space of channel and it is available as free chambers, these free chambers can be allotted for the secondary users in order to use these unused spaces. This mechanism is called as handover mechanism [4]. It happens dynamically and referred as Cognitive Handover.

The Scope of this paper is to provide effective handover in terrestrial networks using Hybrid satellites.

The rest of the study is organized as follows. In Section III, the overview of hybrid terrestrial network is explained in detail with the services provided. In Section IV Network Capability of Hybrid Terrestrial Satellite System is discussed were four major sections are discussed in detail to provide efficient handover effectively. In Section V an discussion is made about the study of hybrid satellite, how it works and how it is used in terrestrial

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networks, to provide efficient handover by load balancing and to maintain the QoS of the system effectively.

II. OVERVIEW OF HYBRID TERRESTRIAL SATELLITE SYSTEM

Telecommunication networks are making its progress and showing lights on systems that will work on different technologies, such as WiFi, WiMAX, 2G/3G, LTE, and satellite. In order to proficiently synchronize the working of the different technologies [5][6], the idea of hybrid networks [7] is being sincerely taken into account. Hybrid networks have the ability to efficiently provide cost - effective solution to employ satellite communications for not only broadcast and multicast services but also for mobile services. The principal driving factor is to facilitate and then utilize different wireless communication systems to provide varied range of services to users in most efficient and seamless way, by considering signal quality (coverage), handover, traffic congestion conditions, and cost issues. The fundamental capabilities of satellite networks, for instance very large coverage areas, speed of implementation and inherent multicasting and broadcasting capabilities make them the prime choice to serve niche areas like coverage in planes, navy ships, hostile environments etc. Despite all this, satellite systems suffer from many drawbacks such as technological complexity, high costs, and deep fading at high frequencies [8]. Therefore, the idea of jointly benefiting from the advantages and capabilities of both terrestrial and satellite telecommunication systems are gaining much impetus.

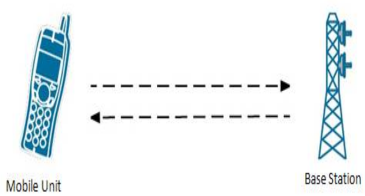

Fig 1: Traditional Cellular Communication

In the fig 1 the mobile unit seeks for connection from the nearest base station. If the channels are free the communication takes place effectively through the gateway. Thus seamless communication is provided by the base station to the mobile unit endlessly and effectively.

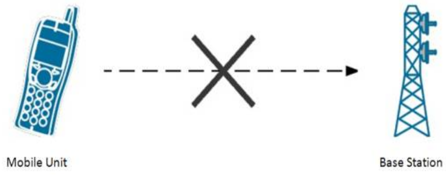

Fig 2 : No Network Coverage

In the fig 2 the mobile unit searches for network connection to the nearest base station. When no networks are available in the nearest areas the signal sent by the mobile unit terminates automatically. When this condition arises at the terrestrial networks hybrid satellites are used for effective communication.

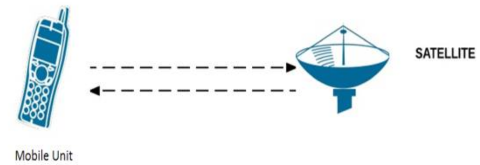

Fig 3: Hybrid Satellite Communication in terrestrial networks

This is illustrated in the fig 3, here the mobile unit seeks for the network terminal to ensure connectivity, when the connection is not available hybrid satellite is used for establishing seamless communication [9].

2.1Types of services

2.1.1Broadcasting Services

One of the main, traditional roles of the satellite systems is broadcasting or multicasting of the same content to the users over a wide geographical area. In this case, requirement is to combine a satellite and a terrestrial component to broadcast media content including TV programs and radio, to vehicular or even handheld devices [10]. Broadcast services generally provide unidirectional satellite link between the network components and the satellite segments, mainly because of the higher bandwidth consumption in such an implementation is on the downlink (i.e. from network to user equipment) whereas the bandwidth requirement on the uplink is very less and hence, can be managed by the terrestrial component of the hybrid architecture [11][12].

The fig 4 explains the satellite broadcasting communication. Here the satellite broadcasts its signals and information to the antennas. The satellite gains information from the base station that has to be distributed to the end-users. The antennas pass its signals to its nearest base station.

The base station provides a Wi-MAX transmission over that particular cellular network. Then the signal is passed as radio signals or for TV broadcast or for the purpose of Mobile communication.

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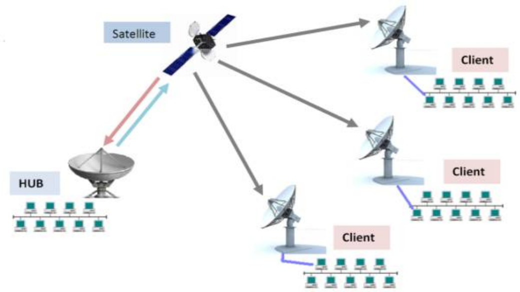

Fig 4: Broadcasting signals from one terminal to other

2.1.2 Multicast Services

In computing network, multicast (one-to-many or many-to-many distribution) is a group communication where information is addressed to a group of destination users simultaneously. Group communication may either be as *application layer multicast* or *network assisted multicast*, where the latter makes it possible for the source to efficiently transfer to the group in one transmission. Copies are automatically generated in other network elements such as routers, switches and cellular network base stations, but it is only limited to the network segments that currently contain the members of the group.

Network assisted multicast may be used at the Internet layer using IP multicast, which is often employed in Internet Protocol (IP) applications of streaming media, such as television, Internet, telecommunications scheduled content (but not media-on-demand) and multipoint videoconferencing, but also for ghost distribution of backup disk images to multiple computers simultaneously [13].

In IP multicast the implementation of the multicast concept occurs at the IP routing level, where routers create optimal distribution paths for datagram's forwarded to a multicast destination address. Implementation of the Network assisted multicast may also be done at the Data Link Layer using one-to-many addressing and switching such as Ethernet multicast addressing, Asynchronous Transfer Mode (ATM) point-to-multipoint virtual circuits (P2MP) or Infiniband multicast. In the below given figure5 multicasting is done were the data is sent to a group from source to destination.

IP multicast

IP multicast is one of the techniques for one-to-many communication over an IP infrastructure in a computing network. The destination nodes leave messages, for example in the case of Internet television when the user changes from one Television channel to another. IP multicast scales to a larger receiver population by not requiring the predictable knowledge of whom or how many receivers are available. Multicast uses network infrastructure efficiently by seeking the source to send a packet at an instance, even if it needs to be delivered to a large number of receivers. The node in the network takes care of multiplication of the packet to reach multiple receivers only when it is necessary.

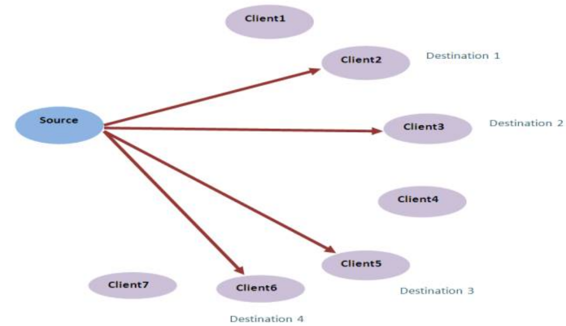

Fig 5 – Multicasting of the information from source to destination

Application layer multicast

Application layer multicast-over-unicast overlay services for application level group communication are widely used. Noticeably the Internet Relay Chat (IRC), which is busier and scales better for large numbers of small groups. IRC implements a single spanning tree between its overlay networks for all conference groups. However, this leads to suboptimal routing for some of the conference groups. Additionally, IRC keeps a large amount of distributed states that limit growth of an IRC network, leading to fractioning into many distributed non-interconnected networks. The lesser known PSYC technology uses custom multicast strategies for every conference. Also some peer-to-peer technologies include the multicast concept while distributing contents to multiple recipients, known as peer-casting.

Multicast over wireless networks and cable-TV

Wireless communications as well as cable TV bus networks are widely broadcasting media, i.e. multipoint channels, especially if the antennas are omnidirectional and radio/TV transmitters covering a region from a broadcasting network that sends the same content. However, the communication service provided may be unicast, multicast as well as broadcast, depending whether the data that has to be sent to some specific address or a specific group or to all receivers in that specific network.

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III. COGNITIVE HANDOVER

Cognitive radio (CR) is a formation of wireless communication in which a transceiver can intelligently detect Primary and secondary [14] communication channels are in use and which are not, and instantaneously move into available channels while avoiding unavailable ones. This optimizes the use of accessible radio-frequency (RF) spectrum while minimizing nosiness to other users. There are two control models [14] for opportunistic spectrum access or flexible spectrum usage namely the centralized control model and the distributed control model.

For each of the control scenarios, spectrum sensing is a critical aspect of the control of cognitive radios and policy-based adaptive radios which employ software [15] defined radio technology. In the below given figure6 load balancing concept is explained with the help of Cognitive handover.

3.1 Centralized System

The centralized control model is one in which the management of spectrum opportunities are controlled by a single entity or a node which has been inferred to as the spectrum broker [16]. The spectrum broker opportunities can be reutilized and by which radios in a network. A central broker may use sensors from the distributed nodes or may use other means for sensing the network and spectrum awareness [17]. Centralized control is real-time spectrum markets is one of the application.

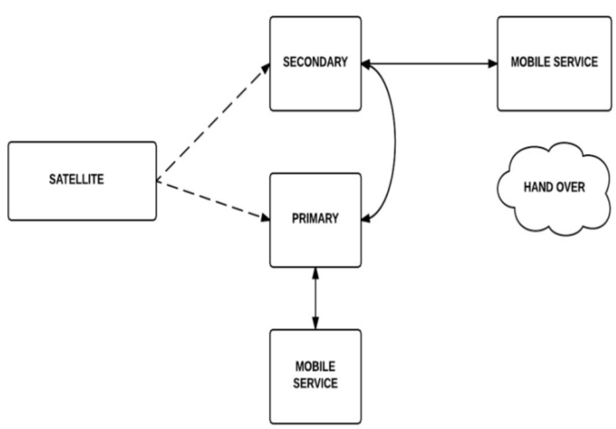

Fig 6: Working of Cognitive radio

3.2 Distributed System

The second exploited spectrum access or flexible spectrum usage control model is the distributed control model. For some real time scenarios, the distributed control may be between co-operative radio access networks. In this model the interaction that takes place is “peer-to-peer” [9]. In other words the cognitive radio or policy-based adaptive radio nodes in the network are collectively responsible for identifying and negotiating use of underutilized spectrum.

IV. NETWORK CAPABILITY OF HYBRID TERRESTRIAL SATELLITE SYSTEM

The Network Capability of Hybrid Satellite System is explained clearly with the four factors given below:

4.1 Handovers between the terrestrial and satellite segments

In hybrid systems, handover of services from terrestrial segment to satellite segment of the network is a complex task and becomes much more complicated. In traditional cellular wireless systems handover between two different adjacent cells is performed taking into account SNIR measurements, terminal location and congestion statistics [3]. In hybrid satellite architectures also, inter-system handover shall be performed but soft handovers and seamless communication may be hard to be achieved. Also, handover initiation might depend upon load balancing concept or even more complex factors like different cost functions, network state and specific connection admission control procedures with enforced handover. Since, in the case of hybrid architecture, the handover has to take place between different radio access technologies, this fits the case of vertical handovers or MIH (Media Independent Handovers), specified in IEEE 802.21 which enables handover of sessions from one layer 2 access technology to another. However, as per ITU M.1850 specification, the implementation of handovers in hybrid networks is still left to the operator as per his requirements [18]. This is made possible using IEEE802.16g protocol due to its vibrant features.

4.2 Protocol convergence between terrestrial and satellite segments

In the previous versions of protocols Data Link layer and the physical Layer were used as the management protocol. But in the IEEE802.16g protocol Network Layer, Data Link Layer and the Physical Layer are used as the management Layer [12]. The network Layer that is been used is the main key feature of this protocol that enables the use of IP address by the network layer. With the use of this network layer ,IP address is used for finding the mobile unit that needs seamless communication[5]. The report identifies the Satellite Dependent and Satellite Independent layers and enables interworking between them via an interface called Satellite Independent -Service Access Point (SI-SAP).

4.3 Load balancing

In hybrid satellite/terrestrial telecommunication systems, generally more than one path is available along which the traffic can be routed. The path selection in such cases is done according to different genre such as cost, QoS, application type, etc., used as input parameters in a specific cost function [6]. In hybrid systems, mainly three different possibilities for load balancing have been forecasted: per packet, which guarantees equal load per link but which suffers from the need for packet reordering at the reception side, per destination, which suffers from unequal traffic distribution among the different available links and from the handling of a lot of independent destinations, and finally, per flow which uses higher layer information (e.g. TCP layer in addition to the IP address) to determine the network that shall be used to carry each independent traffic flow [14].

Since per flow technique employs hashing algorithms, it suffers from the evolution of dynamic and static hashing techniques. Also, the complexity of this hashing algorithm acts as a limiting factor for this technique .

4.4 Quality of Service (QoS)

Quality of Service of terrestrial/satellite segments can be determined by its efficiency of handover performance mechanism and also the providence of seamless communication throughout the termination of that particular network. The inter-working of QoS mechanisms of terrestrial segments and satellite segments is a critical issue in hybrid terrestrial systems so that end-to-end QoS support can be effectively provided. ETSI has released a standard based on DiffServ mode to facilitate the QoS requirements in hybrid technology.

This standard distinguishes Satellite Dependent (SD) from Satellite-Independent (SI) layers, linked together by a standardized, SD layers agnostic interface called the Satellite Independent Service Access Point (SI-SAP). This standard relies upon the management and maintenance of abstract queues called Queue IDentifiers (QID). Each QID is associated with a given standard of quality of service. IP datagrams saved in these queues shall be processed according to their QoS class by the SD layers, responsible for the assignment of the satellite capacity which is of a particular forwarding behavior. Quasi-static QID allocation can be supported, even if more sophisticated services with dynamic resource reservation can be forecasted and foreseen, introducing a complex resource control problem for the SD manager.

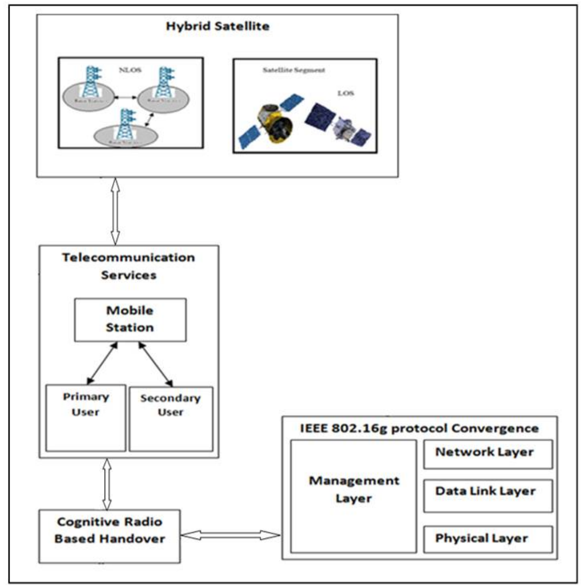

Fig 7: System Architecture of Hybrid Terrestrial Networks

This fig 7 explains how hybrid satellite is used efficiently in both LOS and NLOS ranges using the concept of cognitive radio to implement that in remote sensing. Cognitive radio checks for the number of free chambers in that particular network and this helps in dynamically allocating the spaces for any requesting user. This is made efficiently done using IEEE802.16g protocol which uses all the three OSI layers that establishes seamless mobile communication at terrestrial networks.

V. DISCUSSION

Here, in hybrid terrestrial/Satellite networks, the network coverage to terrestrial areas is made efficient with low cost of implementation using hybrid satellite technology. Mobile Communication is made possible through IEEE802.16g protocol that acts as a management protocol for mobile services. With this protocol, handover is also enhanced to a greater extent that specifies the network efficiency. Future work of implementation of ACO(Ant Colony Optimization) algorithm with the help of load balancing in order to achieve handover efficiently is under process.

VI. CONCLUSION

Initially envisaged to support handover between different wireless 802.x network technologies. The IEEE 802.16g also appears as the good candidate for handover management in future integrated satellite / terrestrial systems. In particular, the satellite network can provide the best and most comprehensive coverage for low - density populations, while the terrestrial network or the ground component can provide the highest bandwidth and lowest cost coverage for high-density populations in urban environment. Through this system efficient handover to terrestrial network is made possible.

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