International Journal of Information, Control and Computer Sciences
ISSN: 2517-9942
Vol:8, No:9, 2014

An Approach for the Integration of the Existing Wireless Networks

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***Abstract*—**The demand of high quality services has fueled dimensional research and development in wireless communications and networking. As a result, different wireless technologies like Wireless LAN, CDMA, GSM, UMTS, MANET, Bluetooth and satellite networks etc. have emerged in the last two decades. Future networks capable of carrying multimedia traffic need IP convergence, portability, seamless roaming and scalability among the existing networking technologies without changing the core part of the existing communications networks. To fulfill these goals, the present networking systems are required to work in cooperation to ensure technological independence, seamless roaming, high security and authentication, guaranteed Quality of Services (QoS). In this paper, a conceptual framework for a cooperative network (CN) is proposed for integration of heterogeneous existing networks to meet out the requirements of the next generation wireless networks.

***Keywords*—**Cooperative Network, Wireless Network, Integration.

I. Introduction

FUTURE wireless networks traffic will be dominated by the multimedia services. Wireless networks service providers striving to incorporate the high-speed access to real time as well as non-real time multimedia data services for the users from anywhere and at anytime in the next-generation wireless networks. Real time multimedia services have different service requirements in terms of communication delay (latency), data rate (bandwidth), jitter, fairness, seamless hand-off and data error rate. The inefficiencies of current IP technologies, in particular the energy consumption, throughput limitations of IP routers, mobility management, seamless roaming and security etc., is becoming serious issues for the future wireless networks [25]. Harnessing the full power of light to resolve these problems and to expedite the creation of future audio/video traffic dominated networks will also remain in focus for future wireless networks design. Extension of optical layer technologies and integration with existing protocols will be critical. In other words, the network paradigm is shifting toward Next Generations Wireless Networks (NGWN) that aims to be fully IPv6 compliance using Mobile IP (MIPv6) protocol without sacrificing the divergence in architectures and technologies [27]. Next Generation Wireless Networks required looking beyond the point-to-point or point-to-multipoint classical design of wireless networks [32]. They should be capable of complex interactions, where the involved nodes will cooperate with one another (within the same network or in the other networks) in order to improve the performance of their own communications and that of the global networks [25]. The demand for future wireless networks has inspired the idea of research on cooperative communications during the last two decades [1]. It has been observed from the literature that the concept of cooperative communications have emerged as a promising approach to increase network coverage, bandwidth and energy efficiency to reduce fading effects and data loss probability [2], [3]. Furthermore, most of the cooperative networks developed are based on the coordination of different spatially distributed nodes within the single wireless network, such as WSN, MANET etc [6]. In this paper, a conceptual framework of cooperative network (CN) is proposed for coordination among different wireless networks to achieve flawless overall network performance with anytime anywhere connectivity. Several network designs and technologies are available in the wireless domain these days. Each one of these technologies and designs came up to fulfill specific technological needs and service requirements - such as UTMS for wide area, WLL and WLAN for local area, Cellular for a region, Bluetooth for a room and satellites for global coverage area [18]-[20]. Due to the technological differences, the QoS and bandwidth requirements, cost of commissioning, bit rate, jitters etc. also differs widely among these networks. The effective design of a cooperative network (CN) may ensure efficient coordination among these diverse network technologies and can provide the best features of the individual network to fulfill the service requirements of the end users. For example, in CN a user may avail the global coverage (seamless roaming) of satellite network, low cost and high data rate of Wireless LAN and speed of UTMS [21]. This is the need of the future wireless networks and the vision of the CN. All these features in future wireless network can be incorporated by designing a whole new network from the scratch. However, that will be costly, time taking and will have lots of legal as well as social hurdles. CN aims to achieve the same objectives of the future wireless network by effectively integrating multiple existing heterogeneous wireless networks through the methods of efficient coordination among them to serve the users with the best available technology and optimum quality of services. It will reduce the weaknesses of the individual networks. For example, the low bit-rate of cdma2000 network can be overcome if WLAN coverage is made available by hand-off of the user to the WLAN [20]. If the user goes out of a UTMS coverage area, seamless roaming of the user can be ensured by vertical hand-off to the satellite network in the upper layer. The proposed conceptual CN should be capable of the following:

1. Take care of the technological differences among different networks – like handling of radio interfaces, signal format conversion, synchronization etc.
2. Traffic management, resources management, congestion control.
3. Auto-configuration and Energy-conservation.
4. Location management, hand-off management among different networks to support seamless roaming.
5. Ensure inter-network Authentication, Authorization, Accounting, Security and prevention of attacks.
6. Mechanism to decide the right network at right time to provide seamless hand-off and optimum QoS to the users.
7. Technology Independence and Scalability to interconnect any network reliably, efficiently and independently.

The conceptual design of Cooperative Network (CN) for NGWN is proposed here. CN will inter-connect heterogeneous wireless networks by adding an upper layer, called Network Coordinator (NC), covering all the heterogeneous wireless networks under it. It will achieve transparency to the heterogeneity of individual wireless network by using Internet Protocol (IPv6) as the inter-connection protocol [28]. The challenges for implementing the various functions (as stated above) are discussed conceptually. We are working on the efficient algorithm design and detail implementations of these issues.

II. Previous Work

The concept of cooperative communication was first introduced by Cover and El Gamal in their work on the properties of relay channel [1] of a three-node network. Since then, the idea has evolved and is being applied for efficient management of network resources. Laneman et al. developed cooperative protocols "decode-and-forward" and "amplify-and-forward" [2], [3] and achieved spatial diversity by transmitting signals to the destination via two different channels. A two-user code division multiple access (CDMA) cooperative diversity system was implemented by Sendonaris et al. in their work [4] to avoid multiple access interference. A scalable, energy-efficient and error-resilient cooperative routing protocol for WSN is proposed in [5]. Cooperative performance gains, signal propagation, receiving, and network overheads are estimated in [6]. Hunter et al. [7] introduced the concept of cooperation to perform error-control in wireless networks. Boyer et al. [8] applied cooperative concept in multi-hop transmissions in Adhoc networks.

The challenges of cooperation in the communications protocol stack are studied in [9] whereas a cooperative relay framework for the physical layers, medium access control (MAC) and network layers in wireless Adhoc networks is discussed in [10]. The power requirement to participate in a cooperative communications is discussed in [11]. A cooperation strategy is worked out for mobile users in CDMA network in [4]. The authors in [7] proposed distributed cooperative protocols to form cooperative network through selection of willing networks. A cooperative MAC protocol for IEEE 802.11 wireless networks is presented in [12] and it has been shown that performance enhancement can be achieved by exploiting the broadcast nature of the wireless channel.

The concept of forming a virtual antenna array in wireless networks, in which a node with single antenna cooperates with other nodes to transmit information to destination, has been developed in [13], [14]. The cooperating nodes, in such arrangement, play the important role of relay channels for the source node [15].

All the above works applied cooperative concept within a single network technology. Efforts have also been made to develop inter-network cooperative systems by introducing suitable network device/layer for handshaking between the interfacing networks [16]. The device/layer takes care of the issues (synchronization, packet format, authentication etc.) rose from such interfacing using the idea of a bridge inter-connecting two different LANs [17]. A gateway has been introduced to integrate GSM with IS-41 and DECT (Digital Enhanced Cordless Telephone) in [18] and satellite and terrestrial networks in [19]. The researchers in [20] have designed a new inter-working system for cooperative communications between WLAN and 3G technologies. Inter-public land mobile network (PLMN) backbone and GPRS Roaming Exchange (GRX) are introduced by The GSM Association in [21] to integrate any GPRS networks operated by any service providers who may not always have SLA among them.

All the above works inter-connect a pair of networks. They do not integrate any network implementing any technology. Therefore, these works does not support scalability.

The pioneer SMART project [22] developed a new framework integrating heterogeneous wireless networks with the help of two sub-networks, namely common core network for data traffic and basic access network for signaling. The framework is capable of integrating multiple heterogeneous networks. It needs the implementation and commissioning of the two sub-networks. Agent based integration of heterogeneous networks is proposed in [23], [24]. Mobile IP is used in [23] for inter-network cooperation whereas Session Initiation Protocol (SIP) is used in [24]. Though this agent based systems work well to provide connectives among heterogeneous networks, they do not guarantee inter-networks seamless hand-off [25] and best available QoS among the networks covering the end user.

To the best of our knowledge, none of the above works fulfill the characteristics, listed above, of the proposed conceptual cooperative network (CN). This boosts the moral for developing a CN framework for NGWN.

III. The Proposed conceptual Framework

NGWN demands technology independent, operator independent and agreement independent services; network independent coverage, seamless roaming and best available QoS among all the networks. Users of any existing wireless network (irrespective of the technology and service agreement used) desire to continue their ongoing services while moving from one location to another or one network to another. The network, in which the users belongs to, may be technologically different (CDMA, UTMS, LTE) from the network they roam into and possibly these heterogeneous networks will not belong to the same network operator. Therefore, CN must be designed to support flawless movement of users among heterogeneous networks belonging to different network operators with or without any service Level agreement (SLA) between any pair of these operators [38]. As the technological diversities among networks and number of network operators around the world are very large, it is not practically possible to have SLA between each pair of operators. Here, CN will play the vital role of coordination for inter-communications among the heterogeneous networks of the NGWN and all operators will have service agreements with only the single agent CN.

The purpose of the proposed conceptual framework is to provide a network overview that is capable of 1) integrating all types of wireless networks irrespective of their radio interfaces used, 2) providing inter-network seamless hand-off 3) offering the best available QoS to the users through the best technology covering the mobile user. The various functions, that the conceptual Cooperative Network (CN) is desired to take care of, are described below:

A. IPv6-Based Interconnection

The integration of heterogeneous networks will be required to take care of the following:

1. Integration of different Radio Access technologies like GPRS, cdma2000, UMTS, WLAN, etc.
2. Protocols for information exchange, routing, mobility management, QoS, auto-configuration, security, authentication, authorization, best network selection etc.

These services require a robust technological framework capable of inter-connecting the technologically diverse networks in an optimum but convenient way. IPv6 is the next generation Internet Protocol (IP) address standard intended to supplement and eventually to replace IPv4, the protocol that most Internet services are using today [26]. Every computer, mobile phone and any other device (cell phones, PDAs, appliances, cars, etc.) connected to the Internet needs a numerical IP address in order to communicate with other devices [28]. The original IP address scheme, called IPv4, has already exhausted for billions of new users and devices. So, instead of assigning unique IPv4 addresses to most new hosts, presently IPv4 addresses are shared using the methods like NAT, PPP, etc. [25], [26]. But new types of applications and services need unique addresses. IPv4 won’t work for large numbers of devices like IP phones, limits deployment of new services, compromises the performance, robustness, security, and manageability of the Internet [25]. To move forward and to continue adding new devices and services to the Internet, IPv6 (which has already been deployed globally by the ISPs on June 6, 2012) must be implemented. It was designed with the needs of a global commercial Internet in mind, and deploying it is the only way to move forward with an open and innovative Internet with “always-on” access technologies for cable, ethernet-to-the-home, etc. [28]. IPv6 provides following benefits:

The design of Mobile IP support in IPv6 (Mobile IPv6) benefits both from the experiences gained from the development of Mobile IP support in IPv4 (Mobile IPv4) [34]-[36], and from the opportunities provided by IPv6. Mobile IPv6 thus shares many features with Mobile IPv4 [34], but is integrated into IPv6 and offers many other improvements [27]. This section summarizes the major differences between Mobile IPv4 and Mobile IPv6:

- There is no need to deploy special routers as "foreign agents", as in Mobile IPv4. Mobile IPv6 operates in any location without any special support required from the local router [33].
- Support for route optimization is a fundamental part of the IPv6 protocol, rather than a nonstandard set of extensions.
- Mobile IPv6 route optimization can operate securely even without pre-arranged security associations. It is expected that route optimization can be deployed on a global scale between all mobile nodes and correspondent nodes.
- Support is also integrated into Mobile IPv6 for allowing route optimization to coexist efficiently with routers that perform "ingress filtering" [26].
- The IPv6 Neighbor Unreachability Detection assures symmetric reachability between the mobile node and its default router in the current location.
- Most packets sent to a mobile node while away from home in Mobile IPv6 are sent using an IPv6 routing header rather than IP encapsulation, reducing the amount of resulting overhead compared to Mobile IPv4.
- Mobile IPv6 is decoupled from any particular link layer, as it uses IPv6 Neighbor Discovery [12] instead of ARP. This also improves the robustness of the protocol.
- The use of IPv6 encapsulation (and the routing header) removes the need in Mobile IPv6 to manage "tunnel soft state" [35].
- The dynamic home agent address discovery mechanism in Mobile IPv6 returns a single reply to the mobile node. The directed broadcast approach used in IPv4 returns separate replies from each home agent.

In addition to the above, IPv6 also have the following properties:

1. Expanded addressing capabilities
2. Easy address auto-configuration (“plug-n-play”) and reconfiguration
3. Easier address management/delegation
4. Room for more levels of hierarchy and route aggregation
5. Ability to do end-to-end IPsec (because NATs not needed)
6. Chance to upgrade functionality, e.g., multicast, anycast, QoS, mobility
7. Chance to include new enabling features, e.g., binding updates
8. More efficient and robust mobility mechanisms
9. Strong IP-layer encryption and authentication
10. Streamlined header format and flow identification

Since IPv6 [29], [30] provides a globally successful technology for supporting applications in a scalable and cost effective way, it is expected to become the core backbone network of NGWN. IPv6 capable of making the movement of mobile users seamless among different wireless networks [31] and transparent to different radio technologies [32] in the same direction as the efficiency of Mobile IPv4 has been proved in [13]. IPv6 will enable the mobile devices with multiple radio interfaces to switch from one network interface to another without using Foreign Agent as proposed in [14]. IPv6-based interconnection hides the differences in the lower-layer technologies from that of higher layers without any modifications in the radio technologies of the existing networks [25], [33] and hence, capable of making the CN Framework scalable to any extend.

B. Cooperative Network (CN) Structure

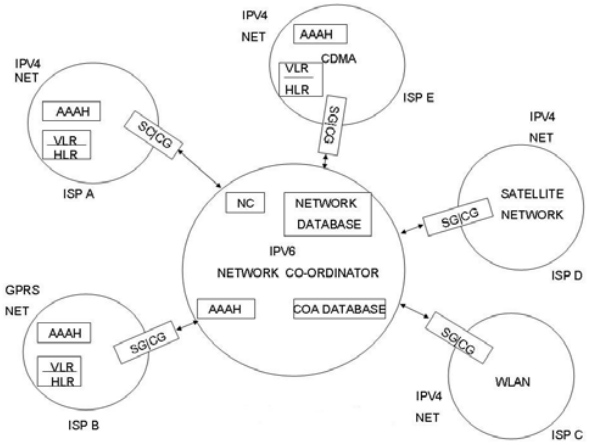

Fig. 1 Co-operative Network Framework

The proposed conceptual CN framework (Fig. 1) interconnects different heterogeneous networks like UTMS, CDMA, GPRS, satellite network, and WLAN under the control of different service providers A, B, C, D and E respectively. Usually, these networks are connected to the Internet through system gateways (SG): e.g., cdma2000 is connected to the Internet via a packet data serving node (PDSN), GPRS through a gateway GPRS support node (GGSN), the satellite network through a gateway station (GS), and the WLAN through an Access Router (AR). CN should be capable of integrating any number of networks of different service providers.

To form the cooperative framework, an umbrella layer, two functional components are introduced, namely - Network Coordinator (NC) and Coordinating Gateway (CG). The NC is the highest functional layer coordinating with all other networks through CG and CG resides between a particular network and NC. To reduce the workload in CG and to make it easily manageable, it is suggested that an independent CG be implemented in each network through which individual networks (e.g., PDSN, GGSN, GS, AP, GPRS, satellite and WLAN) [18]-[21], will be connected to the Internet as shown in Fig. 1. To participate in the cooperative network, each individual network [31], [32] has to register itself as a member of the CN before requesting any service from NC. At the time of registration, SLA [38] between the operator and CN is performed. A mapping of the existing IPv4 to IPv6 takes place at the time of registration. This eliminates the need of Foreign Agent (FA) when a mobile user communicates via a foreign network during roaming and NC records the Care-of-Address (CoA) [33]. NC is the single point and supreme controlling authority to allow inter-network communications to those networks that have registered themselves with NC. It abolishes the concept of SLA between each pair of networks willing to communicate each other. NC should be capable of looking after the existing AAA (authentication, authorization, accounting) services of networks [23] along with the issues of mobility management, location management, energy conservation, selection of best network to serve a mobile user with predefined service requirements [33]. AAAH stands for the authentication, authorization and accounting server of the home network, VLR/HLR stands for the Visitor/Home location register

C. Detailed Descriptions of the NC and CG

The components of the NC are shown in Fig. 2.

1) The authentication, authorization and accounting (AAA) unit is used billing and to authenticate and authorize the users moving between two networks belonging to two different service providers.
2) The ISP database unit stores and manages information about the network entities of the registered ISPs and networks to the NC.
3) The mobility management component determines if the inter-network hand-off request be granted. It performs speed control and location management. The mobility management unit assigns the Foreign Network Access Care-of-Address (CoA; i.e. an IPv6 address) after receiving the hand-off request and checking the authenticity of the mobile host (MH), networks (HN & FN) with the NC. CG actually connects or disconnects an MH to the appropriate network execute the seamless hand-off. During this process, mobility management component also performs Neighbor discovery, route optimization, selects the best available network for providing optimum QoS.

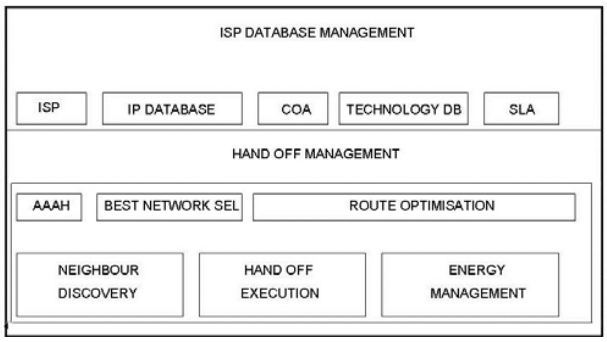

Fig. 2 Functional Units of Network Co-ordinator (NC)

4) CG is suggested to have the following components (Fig. 3) as described below.

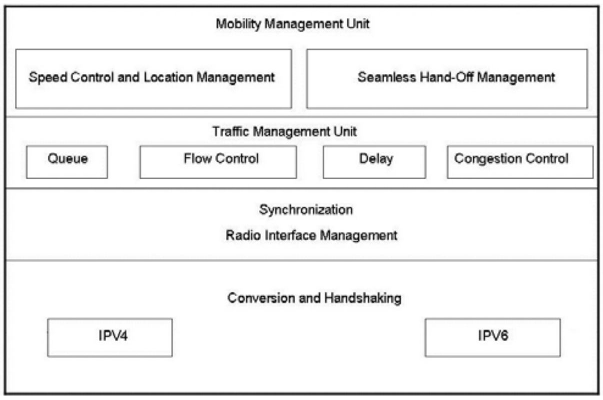

Fig. 3 Functional Units of Co-operative Gateway (CG)

5) The mobility management unit implements Mobile IP [25] (MIP) functionality using the concept of MIPv6. In case of wireless networks (e.g., CDMA, WLAN) not implemented Mobile IP, CG performs these functionality for that network. The mobility management unit will implement mobility management protocols for seamless inter-network hand-off.
6) The traffic management unit of CG performs network traffic management functions like congestion control, priority, flow control, delay control etc.
7) The IP conversion unit performs IPv4 to IPv6 or the reverse conversion, format checking and handshaking. It also manages the heterogeneous radio interfaces and their synchronization for the roaming users.

IV. Security in CN

In CN, authentication, authorization and Accounting mechanisms can be be performed as stated below.

A. Authentication and Authorization

IPsec is specified as the means of securing signaling messages between the Mobile Host and Home Network for Mobile IPv6 (MIPv6). MIPv6 signaling messages that are secured include the Binding Updates and Acknowledgment messages used for managing the bindings between a Mobile Host and its Home Network. An alternate method for securing MIPv6 signaling messages between Mobile Hosts and Home Networks is proposed in IPv6. This alternate method consists of a MIPv6-specific mobility message authentication option that can be added to MIPv6 signaling messages.

The base Mobile IPv6 specification [37] specifies the signaling messages, Binding Update (BU) and Binding Acknowledgment (BA), between the Mobile Host (MH) and Home Network (HN) to be secured by the IPsec Security Associations (IPSec SAs) that are established between these two entities.

This protocol proposes a solution for securing the Binding Update and Binding Acknowledgment messages between the Mobile Host and Home Network using a mobility message authentication option that is included in these messages. Such a mechanism enables IPv6 mobility in a host without having to establish an IPsec SA with its Home Network. A Mobile Node can implement Mobile IPv6 without having to integrate it with the IPsec module, in which case the Binding Update and Binding Acknowledgment messages (between MH-HN) are secured with the mobility message authentication option [34] (Figs. 4 (a) & (b)).

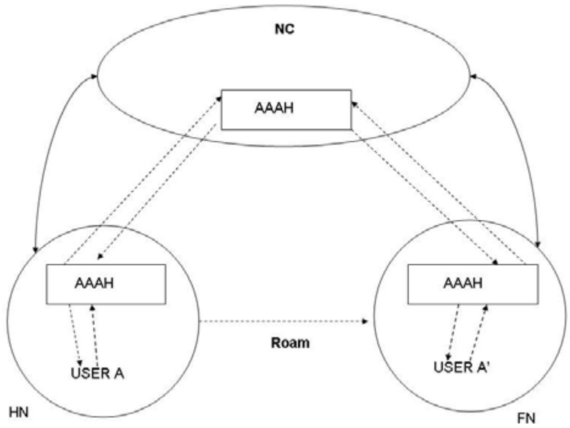

Fig. 4 (a) Authentication and Authorization during inter-network inter-operator Hand-off

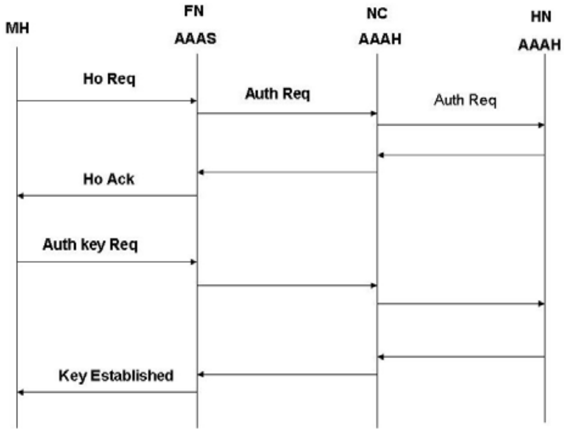

Fig. 4 (b) Authentication signalling process in Co-operative Network

The mechanism to authenticate the Mobile Node at the Home Network or at the Authentication, Authorization, and Accounting (AAA) server in Home network (AAAH) based on a shared-key-based mobility security association between the Mobile Node and the respective authenticating entity. The detail of this protocol is taken as future work.

B. Accounting

Once the MH is authenticated and authorized by the CN, the accounting unit of the CG keeps billing records for every MH based on the service conditions of the FN service provider and transfers this information to the AAA server of the CN. The AAA server forwards this consolidated accounting information for the MH as call detail records (CDRs) to the accounting unit of the CN. The NC is capable of interpreting and converting the CDRs if the format is different for HN and

FN. The converted CDRs are forwarded to AAA server of HN for billing purposes. NC is responsible for the inter-operation of different billing schemes supported by different network providers.

V. Mobility Management

Seamless roaming, best QoS with multimedia traffic and all-time connectivity are the driving forces behind the future wireless networks. Therefore, mobility management and selection of the best network are the two major issues to achieve these service goals.

A mobile host is always expected to be addressable at its home address, whether it is currently attached to its home network or is away from home [28]. The "home address" is an IP address assigned to the mobile host within its home subnet prefix on its home network. While a mobile host is at home, packets addressed to its home address are routed to the mobile host's home network, using conventional Internet routing mechanisms.

While a mobile host is attached to some foreign network away from home, it is also addressable at one or more care-of addresses. A care-of-address is an IP address associated with a mobile host that has the subnet prefix of a particular foreign network. The mobile host can acquire its care-of address through conventional IPv6 mechanisms, such as stateless or stateful auto-configuration [28]. As long as the mobile host stays in this location, packets addressed to this care-of-address will be routed to the mobile host. The mobile host may also accept packets from several care-of addresses, such as when it is moving but still reachable at the previous network.

The association between a mobile host's home address and care-of-address is known as a "binding" for the mobile host. While away from home, a mobile host registers its primary care-of address with a router on its home network, requesting this router to function as the "home agent" for the mobile host. The mobile host performs this binding registration by sending a "Binding Update" message to the home network. The home agent replies to the mobile host by returning a "Binding Acknowledgement" message. The integration of heterogeneous wireless networks in CN will have to handle two types of hand-off scenarios: Intra-network hand-off and Inter-network hand-off.

A. Intra-Network Hand-Off

In intra-network hand-off, two situations may arise:

1. MH will move from one AP to another AP of the same service provider within the same CG (Horizontal hand-off).
2. MH will move from one AP to another AP of the same service provider in different CG (Vertical hand-off).

The first case can be handled by using the standard mobility management protocols for horizontal hand-off of the network in which the MH is currently visiting. No change of address will takes place whereas in the second case, the change of address will occur. It requires the involvement of CN for smooth handling of the vertical inter-network hand-off as discussed latter.

B. Inter-Network Hand-Off

Here also, two types of hand-off may occur:

1. Hand-off from a lower-layer (micro) network to a higher-layer (macro) network.
2. Hand-off from a higher-layer (macro) network to a lower-layer (micro) network.

Both the above cases require vertical hand-off to take place to ensure seamless roaming service. This can be achieved by reducing the hand-off latency within the tolerable limits to ensure uninterrupted services with minimum QoS degradation. Several issues need to be addressed during vertical hand-off. In the presence of multiple heterogeneous wireless networks, in NGWN an MH will always be under the coverage of multiple networks and can be accessible through different overlapping networks. Decision on hand-off will be based upon the service needs of a MH and the selection of the best communication network to provide the desired QoS. Once the decision is taken, the hand-off initiation time is determined to ensure successful and seamless inter-network roaming. Based on the RSS, the MH sends *Binding update* to the HN as well as to FN. On receiving the *update*, the HN will learn that MH is receiving weak signal from it and about to move into another AP (FN) away from it. Then HN and FN forward the *update* message to the NC through their CGs. During this process, IPv4 is mapped into IPv6. NC then checks the authenticity of the MH. The authentication, authorization, and accounting procedures are carried out by NC before the MIP registration of MH [23]. If valid user is found, *Binding Acknowledgement* is sent to the MH. In case of binding failure, *Binding Error* message is send to all active entities (i.e. HN, FN, CG etc.). However, to avoid any chance of link failure or *ping-pong* effect, dual binding may be maintained during the initial duration of hand-off (vertical as well as horizontal). After successful registration with the higher-layer (macro) network, the MH uses both the lower layer as well as higher-layer networks for incoming traffic, but uses only the lower-layer network for outgoing traffic as long as it is within the coverage area of the lower-layer network to take advantage of the higher data rate of the lower-layer network. With an existing connection with the higher-layer network, the ongoing communications of the MH can be immediately handed over to the higher-layer network when it moves out of the lower-layer network. This ensures a seamless hand-off.

VI. The Best Network Selection

The NC helps each MH to receive best QoS by selecting the best available network for the desired QoS. The selection of the best network for the desired QoS depends on several factors. These factors can be network congestion, energy requirements, Mobility pattern of MH, data rate, signal strength and overall network load. It may also happen that MH hand-off to the second best network as the best network is congested or fully loaded. For optimum solution of this situation, a combined selection protocol can be designed that will be MH assisted and network controlled. In such a scheme, the MHs collect dynamic network conditions at regular interval and send to the NC. Then, the NC determines the best network for hand-off depending on the total network conditions for an optimized selection and load balancing for the whole cooperative network (Figs. 5 (a) & (b)).

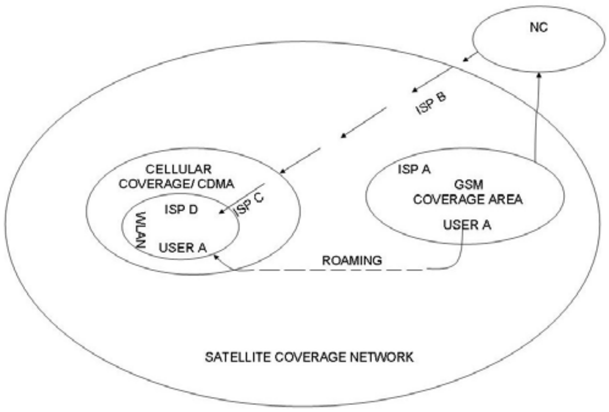

Fig. 5 (a) Best Network Selection in CN

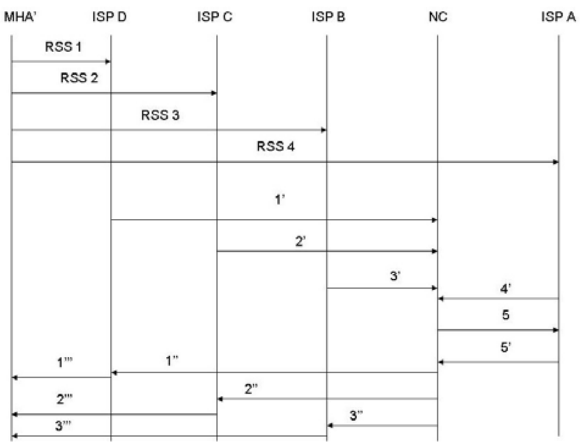

Fig. 5 (b) Best Network Selection Signalling Process

The hand-off management unit of the NC implements this protocol. The goal of the proposed protocol is to ensure seamless hand-off, optimum QoS for the MH as well as the whole system.

VII. Characteristics of Cooperative Network (CN)

The proposed conceptual framework for cooperative network (CN) should achieve the following design goals.

A. Scalable

CN should be able to integrate any number of wireless networks of different network operators irrespective of the SLA status among them with the help of the supervising layer encapsulating NC and CG. Therefore, it will be scalable. Integration of heterogeneous wireless networks globally can be achieved using bottom-up modular implementation of CN. In this modular approach, wireless networks of various operators are integrated at the local level (city, town, village) form the lowest (L1) module CNs. These L1 CNs of a regions or province are then integrated to form the second higher level (L2) module CNs. The L2 CNs are further integrated to form the third higher level (L3) module CNs and so on till global integration is realized. The determination of the exact number of modules depends on various factors and is implementation specific. Integration and coordination among the Modular CNs are very important and must be ensured through the SLA among the operators of the CNs globally.

B. Transparency to Heterogeneous Radio Access Technologies

By using IPv6 as the inter-connection protocol in CN, mobile users may roam seamlessly among multiple wireless networks in a manner that is completely independent of and transparent to different radio technologies.

C. Security

CN is capable of adopting the state-of-the-art security mechanisms as discussed in the authentication section in this article as well as the security and privacy techniques of existing wireless networks.

D. Seamless Mobility Support

CN is capable of supporting seamless intra- and inter-network mobility using Mobile IPv6 (MIPv6) as the mobility management protocol.

E. Cost effectiveness:

CN suggests using the access and core network infrastructure of the existing wireless networks. It does not require any change to the infrastructure of the existing networks. CN achieves integration of heterogeneous networks by adding only one new entity, the Network Coordinator (NC) and one new entity, Coordinating Gateway (CG), to each individual networks. Hence, it is cost efficient.

VIII. Future Work and Conclusion

The proposed conceptual framework will be tested to demonstrate the performance and efficiency for the following network tasks:

A. Resource Management in Integrated Wireless Networks

Managing resources among multiple wireless networks in an efficient way is important for achieving network reliability, robustness and efficiency. Without a coordinated approach, each network will manage its resources individually and reacts to network congestion independently that may cause network malfunctioning. Research would be initiated for efficient sharing of the network resources among multiple networks.

B. QoS

Providing desired QoS in heterogeneous wireless networks introduces new mobility management problems. Both the hand-off management unit in the NC and the mobility management unit in the CG could be involved to achieve the desired QoS.

C. Congestion Control

It is an important area of research for effective functioning, desired QoS and seamless hand-off. If the total network load is not properly monitored and coordinated, some of the individual wireless networks may get overloaded and some may be under-utilized. In such case, overall network performance, QoS, resource utilization will be poor. Users of the overloaded part of the network will be denied service in spite of available resources in the other part of the integrated network. Future research should address the efficient sharing of the individual network resources among multiple networks for global network congestion control.

D.Conclusion

In this paper, a conceptual framework is proposed for integration of existing heterogeneous wireless networks to form a global wireless network. The proposed framework is expected to be capable of providing operator independent, technology independent service with seamless roaming as well as the best available QoS within the coverage area of the mobile user presently located in. The working principles of the various functional units of the proposed framework are discussed. Some of the research issues in the framework are also mentioned. We are working on these issues for the implementation of a functional framework.

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