Challenges and issues in 4G – Networks Mobility Management

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Abstract - ***Wireless broadband technology is now in motion to provide higher data rate, wider coverage and improved mobility. Towards this the 4G - network is an integration of various wireless technologies and expected to provide seamless mobility. Moreover 4G-networks will be entirely packet switched systems based on IP protocol. One of the research challenges for 4G-Network is the design of intelligent mobility management techniques that take advantage of IP-based technologies to achieve global roaming among various access technologies. Hence Mobile IPv6 is considered to be one of the key technologies for integration of heterogeneous networks. However the original Mobile IPv6 does not support fast handover, which is essential function for mobile networks. Number of research groups working towards this to develop a common protocol to enable seamless mobility. In this paper we identify and explore the different issues and challenges related to mobility management in 4G - networks.***

Keywords: 4G-Networks, Mobility management, Handoff, Location management, etc.

I. INTRODUCTION

Wireless access has seen exponential growth in past decade, and different wireless technologies have been emerging. Recent trends indicate that future network infrastructures will consist of heterogeneous wired and wireless networks. In a fourth generation (4G) environment, a mobile node is equipped with multiple interfaces and it will be able to handover seamlessly between heterogeneous networks to guarantee the continuity of an ongoing application session. In order to make seamless handover possible, future network devices should be capable to roam freely across various access technologies such as wireless local area networks (WLANs), WiMAX networks, cellular systems, etc [18].

The 4G has been developing with the aim of providing transmission rates up to 20 Mbps while simultaneously accommodating Quality of Service (QoS) features [2]. The goal of 4G will be to replace the entire core of cellular networks with a single worldwide cellular network completely standardized based on the IP for video, packet data utilizing Voice over IP (VoIP) and multimedia services [2]. The newly standardized networks would provide uniform video, voice, and data services to the cellular handset or handheld Internet appliance, based entirely on IP. 4G systems will be deployed with software defined radios, allowing the equipment to be upgraded to new protocols and services via software upgrades. It is not a system designed from scratch nor it offers completely new technical solutions. 4G is more a concept whose major goals are integration and convergence. The integration should offer seamless interoperability of different types of wireless networks with the wireline backbone.

II. CHALLENGES AND ISSUES

In the 4G - Networks, different types of wireless networks are interconnected to support handoff from one technology to another. These wireless systems were designed independently and targeting different service types, data rates, and users, and thus require an intelligent interworking approach. Effective, secure and efficient operations and management are the major challenge for the development of 4G. In such environment, both the mobile user and the interconnected wireless networks together play an important role in determining how service continuity and service quality can be served in a handover and helps in providing best service to the user [2]. There are number of research challenges which need to be solved in order to achieve 4G network goals. These challenges are listed below [5] [6]:

A.Network Discovery: 4G – Network devices will be multi-mode, multi-access and reconfigurable. Which means each terminal can be using more than one type of network and possibly can access multiple networks simultaneously for different applications. In such an environment, a terminal must be able to discover what networks are available for use. As a solution to this issue currently a technique namely Software defined radio is proposed. In this technique components that have been implemented in hardware are instead implemented using software on a personal computer or other embedded computing devices.

B.Access technologies: 4G- network is a heterogeneous wireless environment consist of number of radio technologies and may have overlapped radio coverage. A mobile user needs to switch between access networks to maintain service continuity and optimise service quality. Dealing with heterogeneous access technologies is a challenge to the design of 4G – Network. More over selecting the network that will satisfy the QoS

requirements of the current service and that will be the most economical.

C. Network architectures: 4G is an integration of heterogeneous wireless networks. Moreover these networks rely on different network architectures and protocols for transport, routing, mobility management and so forth. The interconnection of these networks in an integral manner to facilitate the cooperation between them is another research challenge.

D. Network conditions: Network conditions such as bandwidth, delay, jitter and so forth may vary across wireless networks, and result in different service quality to be provided. How does a mobile user deal with the variation in network conditions, and maintain service quality when crossing heterogeneous wireless networks is needs to be addressed.

E.Charging and Billing: In the 4G network environment multiple service providers will be involved during a session, if the users roam from one service provider network to one or more other service provider networks. Thus, a single session may consist of number of charges. Moreover, different charging schemes maybe used for different types of services. One challenge is to keep track of charges per use per segment of a session that used their network, service or content. There will need to be more charging agreements between the service providers in order to allow roaming during a session in order to get a continued service as far as a customer is concerned.

F. Large number of operators: A large number of network operators are expected to co-exist and collaborate in the 4G - Networks. In such circumstances, mobile users who are responsible for handover decision will require increased levels of control over how services can be secured in handover. This will be complicated by versatile trust relationships between network operators.

G. Security: The level of security provided in different networks is different. More interconnectivity and inter-working will make the vulnerability even greater. Monitoring, detecting, analysing and preventing worms and viruses on wired networks is very difficult but the same tasks on wired, wireless, and mobile networks combined would be even more difficult and challenging.

H.Congestion Control: Congestion control is another critical issue in 4G - networks. Avoidance or prevention of the congestion and detection and recovery after congestion are two basic approaches taken towards the congestion control. The avoidance scheme will require the network to suitably implement the admission control and scheduling techniques. The detection and recovery would require flow control and feedback traffic management.

III. Mobility Management in 4G

Mobility management is a very crucial in 4G-Networks as it is heterogeneous network which is more complex to handle. It can take place in different layers of the OSI model including network layer (L3), link layer (L2) and cross-layer (L3 + L2) [17]. The layer-2 (L2) mobility refers to the case where the Mobile Node (MN) roams among different access nodes while the point of attachment to IP network remains the same. The layer-3 (L3) mobility involves the change of IP addresses. For efficient delivery of services to the mobile users, the 4G - networks require new mechanisms of mobility management where the location of every user is proactively determined before the service is delivered. Moreover, for designing an adaptive communication protocol, various existing mobility management schemes are to be seamlessly integrated.

4G systems support both horizontal handoff and vertical handoff. Horizontal handoff handles the intra-system handoff when an MN moves between two different cells or access points within the same wireless communication system, while vertical handoff deals with the inter-system handoff when an MN moves from one wireless communication system to another different wireless system. It is difficult to realize the vertical handoff among different wireless communication systems while meeting the various Quality of Service (QoS) requirements. If handoff latency is too long, packets may get lost or disconnections may occur during the handoff. Therefore, fast and seamless handover is a big challenge for 4G heterogeneous networks that are supposed to support real-time high speed multimedia applications that require small handoff delay and high data-rate transmission.

In order to support real-time high speed multimedia applications 4G requires small handoff delay and high data-rate transmission [6]. The design of handoff management techniques in 4G - networks must address the following issues:

- Signalling overhead and power requirement for processing handoff messages should be minimized,
- QoS guarantees must be made,
- Network resources should be efficiently used,
- The handoff mechanism should be scalable, reliable and robust.

There are numerous methods for performing handoff in 4G – Networks. The decision-making process of handoff may be centralized or decentralized. From the decision process point of view, there are three different kinds of handoff decisions: Network-Controlled Handoff, Mobile-Assisted Handoff, and Mobile - Controlled Handoff [18].

In a network-controlled handoff protocol, the network makes a handoff decision based on the measurements of the Mobile Nodes at a number of Base Stations. Where as

in case of mobile-assisted handoff process, the MS makes measurements and the network makes the decision. In mobile-controlled handoff, each MS is completely in control of the handoff process.

IV. Requirements and Solutions for Mobility Management for 4G

Besides the basic functions that implement the goal of mobility management, there are many other requirements on performance and scalability that should be carefully taken into account when trying to design or select a mobility management scheme [5][6]. These includes following:

A. *Seamless handoff:* the handoff operations should be quick enough so that handoff latency is very less in order to reduce the packet drop as much as possible.

B. *Signalling traffic overhead*: the number of signalling packets or the number of accesses to the related databases should be minimized to avoid the load on the network.

C. *Routing efficiency:* the routing paths between the communication nodes to the mobile nodes should be optimized to exclude redundant transfer or bypass path.

D. *Quality of Service (QoS):* the mobility management scheme should support the establishment of new QoS reservation in order to deliver a variety of traffic, while minimizing the disruptive effect during the establishment.

E. *Fast security:* the mobility scheme should support different levels of security requirements such as data encryption and user authentication, while limiting the traffic and time of security process e.g. key exchange.

F. *Bandwidth:* Higher offered bandwidth ensures lower call dropping and call blocking probabilities. Hence bandwidth handling should be an integral part of the handoff technique.

G. *Handoff Latency*: Handoff Latencies affect the service quality of many applications of mobile users. Therefore a good handoff decision model should consider Handoff latency factor and the handoff latency should be minimized.

H. *Power Consumption:* In 4G networks, we need to find ways to improve energy efficiency. During handoff, frequent interface activation can cause considerable battery drainage. The issue of power saving also arises in network discovery because unnecessary interface activation can increase power consumption. It is also important to incorporate power consumption factor during handoff decision.

I. *Network Cost:* A multi criteria algorithm for handoff should also consider the network cost factor. The cost is to be minimized during VHO in wireless networks.

J. *User Preferences:* The user preferences could be preferred networks, user application requirements (real time, non-real time), service types (Voice, data, video), Quality of service (It is a set of technologies for managing network traffic in a cost effective manner to enhance user experiences for wireless environments) etc.

K. *Network Load Balancing:* Network load is to be considered during effective handoff. It is important to balance the network load to avoid deterioration in quality of services.

V. Advantages And Disadvantages

1) Advantages of 4G

a. Pure Data Network: 4G-network is a "All-IP" based data network. A completely data based network will allow for more bandwidth which means more data can be passed through the network.

b. More Devices and Applications: 4G network devices can take advantage of the higher bandwidth and speeds to deliver more robust and data applications.

c. Speed: Theoretical speed of 4g has been suggested that data rates up to 100 Mbps for high mobility and 1Gbps for low mobility should be the target value.

d. Hand Off: The improved 4G network standards will allow for smooth hand off from one coverage area to another without interruption to any ongoing data transfers. This will result in smooth streaming data for the user.

e. Faster response time: One benefit of 4G technology is faster response time or lower latency. 4G technology reduces latency to 1/100th of a second (about 10ms).

2) Disadvantages

In spite of all the above mentioned advantages, there are still limitations that must be addressed. One major limitation is operating area. Rural areas and many buildings in metropolitan areas are not being served well by existing wireless networks. This limitation of today's networks will carry over into future generations of wireless systems. Moreover new frequencies means new components in cell towers are required. Some other limitations are such as battery usage is more, it is hard to implement, and it need complicated hardware. Another disadvantage is consumer is forced to buy a new device to support the 4G since it is impossible to make current equipment compatible with the 4G network.

VI. CONCLUSION

As the wireless communications technologies evolve dramatically, the recent research focus has shifted to the development of fourth-generation (4G) mobile systems. Instead of developing a new uniform standard for all wireless communications systems, 4G communication networks strive to seamlessly integrate various existing wireless communication technologies. Due to increased popularity of the mobile devices, mobility management became an important issue in 4G – Network. One of the major challenges for mobility management is the criterion of a mobility management protocol including vertical handoff support which enables the users to move between different types of networks. The trend in telecommunication market is to provide Mobile Nodes with multiple network interfaces, such as Ethernet, IEEE 802.11a/b/g Wi-Fi, WiMAX and UMTS. Along with the increasing population of advance Mobile Node (MN), there is a requirement for efficient mechanisms for seamless handover among heterogeneous networks. The mechanisms should guarantee the Quality of Service (QoS), i.e., no disruption in service which can be recognized by users. Traditional operations for handoff detection policies, decision metrics, and radio link transfer are not able to adapt to dynamic handoff criteria or react to user inputs and changing network availabilities. Nor are they able to deliver context-aware services or ensure network interoperability. Thus, new techniques are needed to manage user mobility between different types of networks.

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