4G WIRELESS NETWORKS: BENEFITS AND CHALLENGES

Pushpendra Kr. Verma*

Dr. Jayant Shekhar**

Abstract

The era of new wireless communications is upon us. Eventually it will penetrate into our daily life and change the way we live just like many technological innovations whose original research came from the military needs. In this paper, we investigate future wireless network especially in the hostile military environment. By combining two hottest wireless network topics, 4G (the fourth generation of cellular communication systems) and MANET (the Mobile Ad-hoc Network), we explore potentials as well as foreseeable challenges to the wireless communications in the future battlefield.

Mobility is one of the most invigorating features, having an enormous impact on how communication is evolving into the future. Mobility in 4G networks requires new level of mobility support as compared to traditional mobility. There is plenty of related research on mobility in next generation networks, which promises support for emerging ambient and ubiquitous communications. This paper aims to identify and explore the different issues and challenges related to mobility management in 4G heterogeneous networks. A review of the existing solutions and ongoing projects related to these mobility management issues is presented; which can help in discovering a unified approach to seamless mobility in future generation networks.

Index Terms—4G networks, Wireless Networks, Security and Privacy, Quality of Service, Architecture

* Research Scholar, Department of Computer Applications, NIMS University, Jaipur, Rajasthan, INDIA.

** Professor, Swami Vivekanand Subharti University, Meerut, Uttar Pradesh, INDIA.

INTRODUCTION

The existence of 4G Networks in today's technology-driven society is important indicators of advancement and change. 4G, or Fourth Generation networks, are designed to facilitate improved wireless capabilities, network speeds, and visual technologies. It is anticipated that as these networks continue to thrive, the demand for advanced related technologies will also grow, thereby creating new alternatives for savvy technology users to exceed their desired expectations. The following discussion will evaluate the current state of 3G Networks and will examine the future potential of these networks in expanding technology-based capabilities for consumers and industries alike.

In this paper we present an overall vision of the 4G networks starting by presenting some of the key features they will provide, and then discussing key challenges the researchers and vendors are attempting to resolve, and finally briefly describing some of the proposed solutions to these problems.

Benefits of 4G networks

The benefits of 4G networks will enable a greater range of services and use-cases. However, the business models and eco-systems required to drive adoption from a customer and service provider perspective have not yet been established. Next generation networks will lead to the emergence of a diverse range of eco-systems that better support the various players via new business models servicing a wide range of segments, customers and uses.

Digging a little deeper, all carriers cite a similar set of rationale for these technology upgrade announcements, namely; faster throughput, lower latency and lower costs per Mbps. As new services are launched, service providers and other players in the eco-system are poised for improvements in two areas: delivering existing services faster and better; delivering new services that create new revenue streams. The question to be more fully addressed is how will subscribers truly benefit from the technology upgrade and how can carriers best position themselves to monetize the gains? In the near term, it will be important to understand where 4G offers improvements over 3G and why that might matter to users.

1) Technology Performance Improvement: Delivers higher downlink and uplink throughput in addition to lower latency and network capabilities.

It is generally accepted that mobile data traffic will continue to grow significantly over the coming years. It is also true that regardless of the 4G technology selected (LTE or WiMAX), when compared to 3G, most core transport and throughput bottlenecks will certainly be addressed by the technology itself. 4G technologies offer at least 2x more efficient use of spectrum, higher max speeds, and improved support for real-time applications.

However there are additional network and capacity challenges such as signaling management and edge or gateway management that will need to be fully addressed to maximize benefits from the upgrade.

2) New Mobile Application Enablement: Enables new mobile applications (like Telepresence) and enhances existing ones (Streaming Music) Some 4G services will be enhanced by improved 4G bandwidth and latency such as smart home monitoring or digital storage. Other services will see no measurable gain from riding on a 4G network, such as MMS, digital picture frames and many near-field communication applications. Therefore, it's critical to take a very close look at those services and applications that are expected to become fully enabled by 4G improvements. We see services such as streaming video, MMOG/gaming and specialized applications such as interactive learning and connected cars to gain the most from the technology's deployment.

3) Addressable Device Expansion: Network capabilities and chipset scale could extend connectivity to many new types of devices. Handset technologies continue to evolve along a vast array of features enabling new value added services via smartphones and more specialized devices. The Terminal operating model has traditionally favored a carrier controlled service experience. Commercial operating systems such as RIM or Windows Mobile have reduced some control, in turn attracting heavy data users but in turn creating increased network congestion. Additionally, the increasingly open eco-systems, further enabled by 4G, present a challenging opportunity for operators as third parties develop applications and customization tools to meet user needs. Devices are becoming highly configurable through open standards and more specialized devices – netbooks, tablets, eReaders, etc. – are entering the market.

We believe vendors need to consider a micro-segmentation based device roadmap to meet smaller customer segment needs; new distribution channels are required to support adoption of Converged Mobile Devices and 4G applications

4) Differentiated Customer Experience: Managing the customer expectation and experience with new services and care.

In gaining a deeper understanding of how these services are fully enabled we consider the customers experience and how it blends into the fabric of how we live, the need or ability to deploy specialized or configured devices to support enablement, and lastly, how to make money and when to share the revenue from service delivery.

To date, understanding the 4G user experience has been insufficient and it is unclear how much the user experience will change as more and different 4G services come on line. We do know that consumer expectations around price points are resetting with mounting expectations to pay "a little for a little" which challenges the current pricing and monetization approaches. We also believe that customers are expecting more bundling of services into a "solution" that supports the way they live. So, successful adoption of 4G services will be highly dependent on determining the most likely Use Cases for 4G services.

5) Business Model Evolution: 4G will be key to enabling alternative partnership and monetization models.

The past two or so years have exposed the industry to the fallacy of all you can eat pricing models, or flat rate voice and data plans. This has encouraged behavior consistent with Pareto's rule for data usage where 4% of subscribers usually consume upwards of 70% of the available bandwidth. The resulting network bottlenecks constrain access in cities with a high count of smart devices. The bandwidth needs of many 4G use cases suggests this problem will only get worse if existing pricing approaches move forward. One option currently being contemplated by operators encourages moving toward tiered pricing based on typical factors such as speed, time and quality of service. Another potential service model is bandwidth on demand and the correlated pricing approach to charge premium pricing for these burst requests. This may prove beneficial to planned high bandwidth consuming events such as streaming video or mobile TV.

Given what we know today, 4G will require expansion of payment models to favor lower up-front costs (subscriptions, one time purchases, ad-based, fermium and per-use). However, open development platforms and collaborative solution development/deployment approaches may impact how multiple charging models might work. Clearly new 4G service use cases and eco-system arrangements lead to the important question of who will generate the bill for services and how will revenues be shared.

CHALLENGES

1. Security and Privacy

In the development of 4G Networks, security measures must be established that enable data transmission to be as safe as possible. Specifically, "The 4G core addresses mobility, security, and QoS through reuse of existing mechanisms while still trying to work on some mobility and handover issues" [3]. Therefore, it is necessary for the organization to develop an effective series of tools that support maximum 4G security measures as a means of protecting data that is transmitted across the network from hackers and other security violations. Because of the nature of the 4G network, there is an increased likelihood of security attacks, and therefore, multiple levels of security, including increased requirements for authentication, will be necessary to protect data and information that is transmitted across the network .

One of the main goals of G4 networks is to blanket very wide geographic area with seamless service. Obviously, smaller local area networks will run different operating systems. The heterogeneity of these wireless networks exchanging different types of data complicates the security and privacy issues. Furthermore, the encryption and decryption methods being used for 3G networks are not appropriate for 4G networks as new devices and services are introduced for the first time in 4G networks. To overcome these security and privacy issues, two approaches can be followed. The first is to modify the existing security and privacy methods so that they will be applicable to heterogeneous 4G networks. Another approach is to develop new dynamic reconfigurable, adaptive, and lightweight mechanisms whenever the currently utilized methods cannot be adapted to 4G networks .

2. Quality of Service

With respect to network quality, many telecommunications providers are promising that there will be enhanced connectivity, and the quality of data that is transmitted across the network will be of the highest possible quality, as in the case of Ericsson's 4G Network for TeliaSonera . The company promises that "The new 4G network will do for broadband what mobile telephony did for voice. With real-time performance, and about 10 times higher data rates compared to today's mobile broadband networks, consumers can always be connected, even on the move" . As a result, it is important for providers to develop an effective approach to the 4G Network that will enhance quality, provide effective security measures, and will ensure that all users are provided with extensive alternatives for downloading video, music, and picture files without delays.

The main challenge that 4G networks are facing is integrating non-IP-based and IP-based devices. It is known that devices that are not IP address based are generally used for services such as VoIP. On the other hand, devices that are IP address based are used for data delivery. 4G networks will serve both types of devices. Consequently, integrating the mechanisms of providing services to both non-IP-based as well as IP-based devices is one of key challenges 4G networks have to address.

1. Complex Architecture

Multimode End-User Terminals

To reduce operating costs, devices that operate on 4G networks should have the capability to operate in different networks. This will not only reduce the operating cost but will also simplify design problems and will reduce power consumption. However, accessing different mobile and wireless networks simultaneously is one of the major issues 4G networks have been addressing. One mechanism that has been proposed to handle this problem is termed "multi-mode devices". This mechanism can be achieved through a software radio that allows the end-user device to adapt itself to various wireless interfaces of the networks. Figure 2 shows an example of such solution.

System Discovery and Selection

Due to the heterogeneity of 4G networks, wireless devices have to process signals sent from different systems, discover available services, and connect to appropriate service providers. Various service providers have their own protocols which can be incompatible with each other as well as with the user's device. This issue may complicate the process of selecting the most

appropriate technology based on the time, place and service provided, and thus, may affect the Quality of service provided to the end user.

One solution to resolve this issue is called "System-initiated discoveries". This mechanism allows automatic download of software modules based on the wireless system the user is connected to Another approach to handle this problem is based overlay networks. In such case, the end-user device is connected to different networks through an overlay network.

Service and Billing

Managing user accounts and billing them has become much more complicated with 4G networks. This is mainly due to heterogeneity of 4G networks and the frequent interaction of service providers. The research community addressed this concern and proposed several frameworks to handle the customers' billing and user account information.

Conclusion

In our opinion, the real story around 4G services are the inherent business improvements. 4G will enable delivering new applications via new partnership models, supported by intelligent systems and controls that have cross-platform operability. We see a world where increasingly open networks, with a greater variety of applications across varied device types drive the uptake of 4G services. With that, the growth of 4G – enabled by new solutions and devices, will likely require a new approach to the traditional 3G eco-systems. Especially considering the breadth of target segments (consumer, prosumer, SMB, Governments), the existing and emerging devices (modems, embedded cards, smartphones, embedded CE devices, specialized enterprise devices, M2M devices), and the plethora of spectrum and transport services (fixed, nomadic, mobile, VoIP, OTT Video, etc.). These new eco-systems will need to consider how to monetize the additional services delivered to customers and how these services are woven into the fabric of potential user's lives

References

- 3GPP TS 23.107 v.5.9.0, "Quality of Service (QoS) Concept and Architecture," June 2003.
- Accenture, Accenture 4G accelerator solution. 2009.
- E. Buracchini, "The Software Radio Concept," IEEE Commun. Mag., vol. 38, no. 9, 2000, pp. 138–43.
- J. Chavis, What is a 4G network?, 2009
- H. Eguchi, M. Nakajima, and G. Wu, "Signaling Schemes over a Dedicated Wireless Signaling System in the Heterogeneous Network," Proc. IEEE VTC, Spring 2002, pp. 464–67.
- Ericsson, Ericsson to build commercial 4G network for TeliaSonera. 2009.
- J. Fleck, "A Distributed Near Real-time Billing Environment," Telecommun. Info. Net. Architecture, 1999, pp. 142–48.
- F. Ghys and A. Vaaraniemi, "Component-based Charging in a Next-generation Multimedia Network," IEEE Commun. Mag., vol. 41, no. 1, Jan. 2003, pp. 99–102.
- S. Higgenbotham, Countdown to 4G: who's doing what, when, 2008.
- R. Jackson, T-Mobile 4G network coming with help from Comcast, 2009.
- T. H. Le and A. H. Aghvami, "Performance of an Accessing and Allocation Scheme for the Download Channel in Software Radio," Proc. IEEE Wireless Commun. And Net. Conf., vol. 2, 2000, pp. 517–21.
- A. Lyle, Clear, first 4G network launched, 2009
- J. Al-Muhtadi, D. Mickunas, and R. Campbell, "A Lightweight Reconfigurable Security Mechanism for 3G/4G Mobile Devices," IEEE Wireless Commun., vol. 9, no. 2, Apr. 2002, pp. 60–65.
- N. Montavont and T. Noel, "Handover Management for Mobile Nodes in IPv6 Networks," IEEE Commun. Mag., vol. 40, no. 8, Aug. 2002, pp. 38–43.
- D. Perkins, 4G: challenges and opportunities, 2007.
- A. D. Stefano and C. Santoro, "NetChaser: Agent Support for Personal Mobility," IEEE Internet Comp., vol. 4, no. 2, Mar./Apr. 2000, pp. 74–79.
- P. Taylor, AT&T to roll out 4G network, 2009.
- B. Thai and A. Seneviratne, "IPMoA: Integrated Personal Mobility Architecture," Comp. and Commun., 2001, pp. 485–90.