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5G- The Future of Mobile Network

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***Abstract*-- Since the 4G concepts have already moved to the standardization phase, we must begin to work on the building blocks of the following generation (which we refer to as 5G) wireless networks. These networks will facilitate the provision of ubiquitous and affordable broadband (very high speed) wireless connectivity. This paper aims at highlighting some of the concepts and technologies which will facilitate the affordable provision of very high data rates with virtually ubiquitous coverage in 5G wireless networks. We refer to this goal as enabling the 4A paradigm: "any rate, anytime, anywhere, affordable". In particular, the paper will focus on the coherent integration of advanced radio resource management (RRM) techniques with certain advanced physical layer (PHY) operations in the presence of advanced radio access network (RAN) architectures; we refer to this design principle as the "integrated cross-layer cross-network design".**

5G technologies will change the way most high-bandwidth users access their phones. With 5G pushed over a VOIP-enabled device, people will experience a level of call volume and data transmission never experienced before. 5G technology will offer the services in Product Engineering, Documentation, supporting electronic transactions (e-Payments, e-transactions) etc. Today you will hardly witness a cell phone without an mp3 player with huge storage memory and a camera. You can even use the new 5G cell technologies to hook your phone to your laptop for broadband Internet access. The modern day cell phone resembles a hand held computer more than it does a phone, as most of them contain cameras, video players, MP3 recording, and much more.

Keywords—4G Cellular networks, RRM , VOIP ,WIMAX.

I. INTRODUCTION

We are living in era of convergence. Convergence is merging of technologies, domain and discrete IT systems. Basic of convergence lies in Digitization. The digitization of everything is creating a more natural communications experience. Boundaries separating various technologies, engineering practices, functions etc. are dissolving. So tomorrow, our car, our mobile phone, our home security system, our office, all the systems that surround us, will communicate with each other automatically to fill our environment with our preferences and our need to feel connected anywhere, anytime and with anyone, across the world. This is called Ubiquitous Computing paradigm.

Wireless technologies are going to take taking new dimension in our lives. The wireless broadband will soon become readily available to everybody while, being at home, driving the car, sitting in the park, and even on a pleasure boat in the middle of a lake.

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And because of this, our need to have information at any time and to be connected at all places, all the time, will be satisfied. The world of universal, uninterrupted access to information, entertainment and communication will open new dimension to our lives and change our life style significantly.

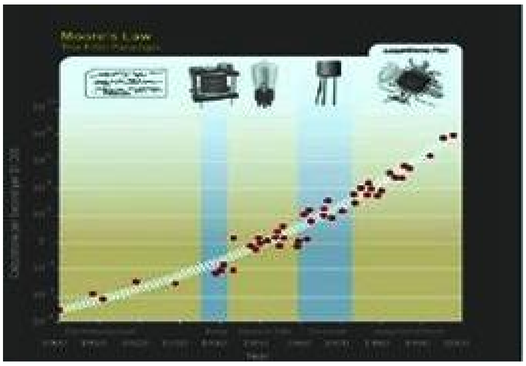

Figure 1. Representation of Moore's Law.

II. THE NEED FOR 5G

The 4G mobile system is an all IP-based network system. The features of 4G may be summarized with one word—integration. The 4G systems are about seamlessly integrating different technologies and networks to satisfy increasing user demands. 4G technologies shall combine different current existing and future wireless network technologies (e.g. IPv6, OFDM, MC-CDMA, LAS-CDMA and Network-LMDS) to ensure freedom of movement and seamless roam from one technology to another. These will provide multimedia applications to a mobile user by different technologies through a continuous and always best connection possible. 4G networks are integrated with one core network and several radio access networks. A core interface is used for communication with the core network and radio access networks, and a collection of radio interfaces is used for communication with the radio access networks and mobile users. This kind of integration combines multiple radio access interfaces into a single network to provide seamless roaming/ handoff and the best connected services.

The main distinguishing factor between 3G and 4G is the data rates. 4G can support at least 100Mbps peak rates in full-mobility wide area coverage and 1Gbps in low-mobility local area coverage. The speeds of 3G can be up to 2Mbps, which is much lower than the speeds of 4G. However, 4G standard will base on broadband IP-based entirely applying packet switching method of transmission with seamlessly access convergence. It means that 4G integrated all access technologies, services and applications can unlimitedly be run through wireless backbone over wire-line backbone using IP address. **But 5G will bring us perfect real world wireless or called "WWWW: World Wide Wireless Web".**

The idea of WWWW, World Wide Wireless Web, is started from 4G technologies. The following evolution will be based on 4G and its idea to form a real wireless world. **Thus, 5G should make an important difference and add more services and benefit to the world over 4G. 5G should be more intelligent technology that interconnects the entire world without limits. Therefore, in this paper, we propose a multi-bandwidth data path scheme for 5G real wireless world, completed WWWW.**

TABLE I. COMPARISON OF 3G & 4G

Items	3G	4G
Speed	Up to 2 Mbps	Full mobility: up to 100 Mbps; Low mobility: up to 1 Gbps
Services	Difficult Global Roaming	Smooth Global Roaming
Core network	WAN & Packet Switching	Broadband IP-based packet switching
Technologies	WCDM, CDMA2000, TDSCDMA	OFDM, MC-CDMA, LAS-CDMA, Network-LMPS

III. WHAT CAN BE 5G?

An old man's phone detects that it hasn't moved for more than 2 hours during the man's regular waking hours. It issues an audible alarm, but no response! So it emits a signal that triggers a RFID chip implanted inside his body. The RFID chip responds by verifying the identity of the man and also a brief burst of telemetry that indicates that he is experiencing heart beat irregularities and his blood pressure is dangerously low. The phone quickly sends an automated text message to a medical alarm system, including not only the identity and the health data of the owner but also the fact that the man is not in his own apartment but in a reading room of a library. This is what I think of a "Fifth Generation" world, also sometimes referred as the 5G world.

The development of the mobile phone device as a ubiquitous part of daily work and personal life presents the opportunity to examine how technology drivers are pushing for the integration of real life with mobile technology in future. A few years ago, this kind of scenario would have sounded mindless, but right now it just looks like the next advance in present mobile technology. Our perception about what new technology is to come has changed from being called "science fiction" to just being addressed as "not yet invented". At the data transfer rates of the earliest cellular phones on the so-called 1G network, our "e-Bible" could be downloaded in about 1.75 hours, although no mobile device at that time could display or even store that amount of data. On a present day 3G mobile network, the download time drops to approximately 6 seconds. On a 4G network, that time drops to 0.06 seconds. What could be the data rates and download speeds that we can expect for a 5G technology which is still in the phase of conceptualization?

Gene Roddenberry's Star Trek writers hit upon a very valid fact that as technology complexity increases, the ability to automate instructions also increases. Star Trek gadgets reflect the actual path of interaction between humans and technology. Just as we saw in the *Old man's story*, with the flip of a dial or the push of a single button or just plain automation, an entire complex automation may be invoked. And this is what I expect from my "Fifth Generation" world – A Star Trek.

IV. IMPULSE

The high-level goal of this paper is to explore the technologies which will facilitate the affordable provision of very high data rates with virtually ubiquitous coverage in beyond-4G (which we refer to as 5G) wireless networks. **We refer to this goal as enabling the 4A paradigm: "any rate, anytime, anywhere, affordable"**. At the technical level, the paper focuses on the coherent integration of advanced radio resource management (RRM) techniques with certain advanced physical layer (PHY) operations in the presence of advanced radio access network (RAN) architectures; we refer to this design principle as the integrated cross layer cross network design.

We will put aside, for the time being, the varying levels of reliability and delay sensitivity associated with different traffic types, and focus only on the rate aspect. Now, let us consider a 3-dimensional plot representing the traffic demand in a region where the x- and y-axes show the space (geography) and the z-axis the rate demand at a particular time instant. Next, let us also consider the time evolution of this 3D plot. (As mentioned above, the dynamic range of this plot is expected to be very high, as such, a logarithmic z-axis will be more appropriate). **The fundamental question we are facing is, how can this highly varying traffic demand in the given region be served in the most efficient way?**

The fulfillment of the "any rate, anytime, anywhere, affordable" paradigm is arguably the most important challenge towards the 5G cellular networks. The next obvious question is to identify the key enabling technical concepts for 5G.

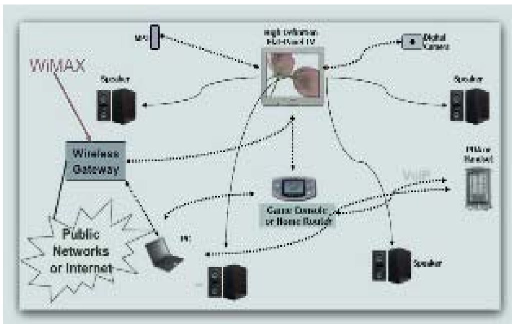

Figure 2. Wireless communication towards consumer networks.

V. TECHNICAL ASPECTS

Many countries have established projects for the development of 4G systems. However, the first start to this project is the Defense Advanced Research Projects Agency (DARPA), which is the same organization that developed the wired internet. Since the distributed architecture has been so successful in the wired internet, they chose the same distributed architecture for the wireless mobile internet for 4G standards. 4G is still developing in laboratories, experts and policymakers have yet to agree on all the aspects of 4G wireless networks. Most people have the same understanding of 4G which integrate with IPv6, OFDM, MC-CDMA, LASCDMA, UWB and Network- LMDS.

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IPv6 is basic protocol for address issue in 4G networks. OFDM stands for orthogonal frequency Division Multiplexing, which transmitting large amounts of digital data over a radio wave. OFDM works by splitting the radio signal into multiple smaller sub signals that are then transmitted simultaneously at different frequencies to the receiver. LAS-CDMA stands for Large Area Synchronized Code Division Multiple Access, which enables high-speed data and increases voice capacity. It is designed for global area. MS-CDMA stands for Multi-Carrier Code Division Multiple Access, which is designed for running on wide area, called macro cell. The Network-LMDS, Local Multipoint Distribution System, is the broadband wireless technology used to carry voice, data, internet and video services in 25GHz and higher spectrum. It is designed for micro cell.

A. CONVERGENCE ARCHITECTURE

CDMA development group (CDG) has issued convergence architecture for 4G, which combined Pico cell, Micro cell, Macro cell and global area (shown in Figure 3). This architecture clearly shows that in Pico-cell area, there are four wireless network covered, in micro cell area, there are three wireless network covered, in macro cell area, there are two wireless network covered at least. The problem is that for any users at a certain place and time, it is one network supply wireless services for them, the others keep wireless network resources waste. 5G is real wireless world, it is completed wireless communication. We design mix-bandwidth data path for 5G so that all wireless network resource can be used efficiently.

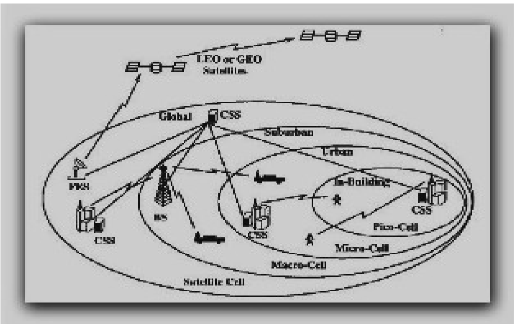

Figure 3. Convergence architecture.

B. MIXED BANDWIDTH DATA PATH MODEL DESIGN

In order to design mix-bandwidth data path, we propose a new data model as shown in Figure4. This model based on any two networks overlay area. When a mobile node comes into the overlay area, both of the two networks can supply services for the mobile node simultaneously. Data request can be sent from any one network, and reply can be from any other network.

In this model, the MN request can go through the first connection (MN → BS → PDSN → CN) and the resulting reply can come from the second connection (CN → PDSN → AP → MN). Thus, two networks supply services for the mobile node simultaneously. Following this model, we propose mix-bandwidth data path shown in Figure 4, which contains four components. They are bandwidth management, bandwidth selection, packet receiver and bandwidth monitor.

The function of bandwidth management is to install and delete bandwidth monitor components dynamically, when it receives indication messages from the mobile IP protocol. The bandwidth management is located at both ends of the sender and the receiver. On each path, there is one bandwidth monitor installed. The function of bandwidth monitor is to monitor the available bandwidth and calculate the proper transmission rates on the corresponding path. The current existing path is informed by the bandwidth management after installing/deleting each bandwidth monitor. The bandwidth monitor will provide the rates information when it receives the current existing path information from bandwidth management. The function of the bandwidth selection is to calculate and report encoding rates to encoder, and then IPv6 applications will be encoded to appropriate paths. The packets receiver accepts incoming packets from the bandwidth monitor, filters and reorders them before sending them to the decoder. A detailed description on each of these four modules is given in the following sub-sections:

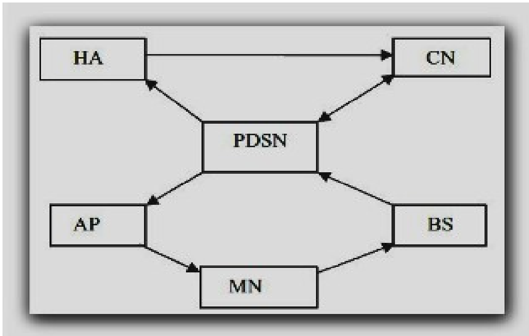

Figure 4. Mixed Bandwidth Data Path Model.

1) BANDWIDTH MANAGEMENT

We assume that these any two networks are WLAN and CDMA2000. WLAN network is used to cover small area, and CDMA2000 is used to cover wide area. Both of them have different bandwidth, data rates and cost. Therefore, bandwidth management component is needed for implementing bandwidth selection in the mix-bandwidth data path architecture. During the bandwidth selection, the bandwidth management will perform the following two operations: Firstly, the bandwidth management installs bandwidth monitor for the new bandwidth path, and then it sends a RATE_READY message to the local sender/receiver to indicate the existence of new bandwidth when mobile IP reports a new location with PATH_ADD message. The bandwidth management will delete the bandwidth monitor and send a RATE_DEL message to the local sender/ receiver to indicate that an existing bandwidth is lost when the mobile IP reports a loss of new location with PATH_LOSS message. Both types of bandwidth indication messages contain a unique PATH_ID to identify the bandwidth to a mobile node. To allow a sender to be able to maintain two bandwidths simultaneously, mobile IP simultaneous binding and route optimization options are used.

2) BANDWIDTH SELECTION

Bandwidth selection is located at the sender side only. Since WLAN has integrated into CDMA2000 networks, the message exchange is between both networks i.e., from the sender to the receiver. In this case, the bandwidth selection will calculate and report the encoding rates to the encoder so that it can adapt its encoding rates accordingly after the bandwidth selection receive the bandwidth existence information from the bandwidth management and the rate information from the bandwidth monitor. The bandwidth selection is also responsible for assigning bandwidth encoded IPv6 application.

3) BANDWIDTH MONITOR

We have earlier stated that the function of bandwidth monitor is to calculate the proper transmission rates and monitor packet flows on the corresponding path. The bandwidth monitor is located at both the sender and the receiver on each bandwidth path which is installed by the bandwidth management. The data transmission rate is calculated by certain algorithm. From the theoretical point, a lot of rate control algorithm can be used in this proposed architecture to calculate data rates. However, we has selected TCP friendly rate control (TFRC) algorithm for the bandwidth monitor. During data rates calculation, bandwidth monitor at the sender periodically exchanges TFRC rate control information with the corresponding bandwidth monitor at the receiver. Both the sender and the receiver reports are exchanged between the sender and the receiver. In this case, the sender generates a report to update the rate control information and the receiver generates a report too for the controlled path in order to observe congestion status to the sender. The rate control information of the report includes the path ID so that it can be directed to the corresponding bandwidth monitor which is inherited from the TFRC definition.

4) PACKETS RECEIVER

Packets receiver is located at the receiver side only. The function of packets receiver is to buffer and reorder all the packets received from both bandwidth monitor. It is further to filter out the redundant packets before delivering them to the target application.

5) SYSTEMS IMPLEMENTATION

System implementation can be divided into two sections as follows:

i. Message exchanges for establishing new data path; and

ii. Data transmission on the established new path.

In the first case, when a mobile node comes into WLAN overlapping region from a CDMA2000 coverage area, it sends requests for better services from WLAN. In our simulation system, the values of “calls attempted” and “calls accepted” are assigned “1”, which shows that there is one mix-bandwidth data path established between WLAN and CDMA2000 networks for the mobile node.

In the second case, we connect the values of total packets which sent from both of MN request and CN reply. The value of MN requests is much less than the values of CN replies.

6) THROUGHPUT AND AVAILABLE BANDWIDTH

Throughput is very important aspect that can determine the quality of service of wireless network for our proposed new scheme. The simulation result shown in Figure4 in which TCP/IP is working on both CDMAWLAN integrated network with our proposed mix bandwidth data path and CDMA2000 network. From Figure5, the throughput is increased when TCP/IP working on integrated network because available bandwidth is much higher than TCP/IP working on CDMA2000 network alone. Furthermore, TCP/IP working on the integrated network can increase data rates more promptly then it working on CDMA2000 network since available bandwidth in WLAN network higher than in CDMA2000 network.

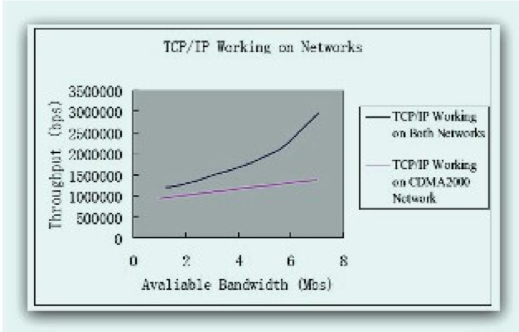

Figure 5. Throughput vs. Available Bandwidth.

7) DATA TRANSMISSION EFFICIENCY

Figure 6 shows the relationship between available bandwidth and bandwidth waste. This relationship indicates data transmission efficiency in our proposed new mix-bandwidth data path scheme. Bandwidth is the main cost paid to achieve a higher performance in our proposed new protocol, as it is able to obtain higher data rates and efficiently utilize both network resources. To evaluate this cost, we have measured data transmission efficiency. Data transmission efficiency is defined as the ratio of the number of unique application packets received to the total number of packets transmitted. From Figure 6, it is clearly seen that the bandwidth waste increase when available bandwidth increase. This is because of the available bandwidth between 11 Mbps to 54 Mbps, but throughput is between 2.5 Mbps to 4 Mbps. Therefore, throughput and data rats increase as available bandwidth increase, but the data transmission efficiency is depending on many factors.

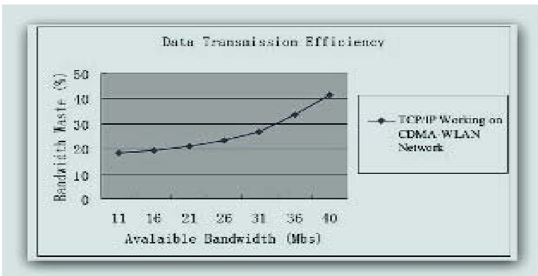

Figure 6. Data Transmission Efficiency.

C. *ADVANCED RADIO ACCESS NETWORK, RAN*

The transmission rate can be increased by increasing the MIMO gain and/or the bandwidth and/ or the spectral efficiency. Although increasing the rate through the MIMO architecture looks very attractive, it is not feasible to deploy a high number of antennas, especially at the UT, due to a number of practical limitations. Increasing the transmit power to achieve a higher is not very profitable due to the logarithmic relation between SNR and , in addition to many other prohibitive factors associated with high transmit power levels, once again, especially at the UT. Finally, bandwidth is scarce, and the licensed portion of it is very expensive. Besides, increasing the transmission bandwidth results in a linear decrease in SNR; therefore, even if the available bandwidth happens to be very high, the received power will also have to be very high to guarantee a sufficient SNR. This, in turn, means that high path-losses cannot be tolerated; as such, UT and BS cannot be too far apart. It is clear that the data rate, the dynamics of which are governed by the above equation, is not unbounded in practical scenarios. If higher and higher rates are required in a given area, deploying a dense network of BSs with a very dense channel reuse scheme becomes inevitable.

VI. CONCLUSION

Data requests will be controlled by PCF (Packets Control Function) in CDMA2000 network and data reply will be controlled by PDIF (Packet Data Interworking Function) in WLAN network. Data traffic is routed through PDSN from CDMA2000 network to WLAN network. The mix-bandwidth data path scheme has been defined to do bandwidth reselection for rerouting so that all network resources can be used efficiently. The new mix bandwidth data path scheme does not consider issues such as congestion relief, re-negotiated Quality of Service, or the movement pattern of the mobile node. In future, there is a need to develop a new detection algorithm that can support the broad level of network integration promised by the 5G wireless system.

REFERENCES

[I].Ganchev, M.O'Droma, H.Chaouchi, I.Armuellus, M.Siebert, N.Houssos "Requirements for an Integrated System and Service 4G Architecture" IEEE 2004.

[2]. Jatinder Pal Singh, Tansu Alpcan, Xiaoqing Zhu, "Towards Heterogeneous Network Convergence: Policies and Middleware Architecture for Efficient Flow Assignment, Rate Allocation and Rate Control for Multimedia Applications", MNCNA '07, Port Beach- CA, USA, November 26, 2007.

[3]. 3GPP2, "CDMA2000 WLAN Interworking", S.R0087-Av1.0, Mar. 2006.

[4]. Jun-Zhao Sun, Jaakko Sauvola, and Douglas Howie "Features in Future: 4G Vision from a Technical 5Perspective", IEEE 2001.

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