Fifth Generation of Mobile Technology: A Survey, Research Challenges and Issues

Rajiv Iyer
Assistant Professor
KCCEMSR
Thane(E)
extc.kccoe@gmail.com

Abstract - In this paper, the various aspects related to fifth generation of mobile technology (5G) is surveyed. It ranges from defining 5G, various technological barriers to be overcome and work done in various countries. The vision for the year 2020 that is presented in the studies for 5G is one of "everything everywhere and always connected". It assumes devices can operate on frequencies from a few hundred megahertz to (in some cases) eighty gigahertz. Indoor cell sizes may be as small as a single room. It employs pico- and femto-cells to maximize frequency reuse at RF. ITU's definition of 4G has an expectation of 1 Gbps single-user data rate. The goal for 5G is not necessarily to increase this, but to have a high-capacity network capable of delivering this rate to a much bigger user community; in other words to provider higher aggregate capacity for more simultaneous users. None of the studies have specific details of the core network that joins everything together, but they assume the seamless connectivity will be given. Some studies also focus on the advances in battery technology needed to support new mobile devices, ranging from simple sensors with a battery life of years, to multi-day time between charges for always connected smartphones and tablets.

Keywords

5G,survey, network planning, year2020.

1. INTRODUCTION

From generation 1G to 2.5G and from 3G to 5G this world of telecommunication has seen a number of improvements along with improved performance with every passing day. This fast revolution in mobile computing changes our day to day life that is way we work, interact, learn etc. A general understanding is that 5G should provide affordable wireless connectivity at a very high speed than the previous generation of mobile technology. 5G should be able to connect to various wireless technologies simultaneously and be able to switch between them.

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II.NETWORK PLANNING

For a long time network operators have been using Erlang's formulae as the basis for network planning. The central idea was predicting the number of simultaneous users a landline telecommunications network would have to support. As long as the networks were used mainly for voice calls, the same broad principles applied to mobile networks, with the added flexibility of using a smaller cell size in geographic "hot spots" where more users could be expected and cell capacity could be exceeded.

Today, as the provisioning and take-up of data services, and the types of connected devices, on both fixed-line and mobile networks continues to rocket, the rules of network provisioning need to be re-written. Data services are by their nature discontinuous. Moving to packet- rather than circuit-based service delivery allows more users to share the same resource even though the overhead associated with directing the data becomes more complex. As fixed-line network infrastructures have moved from copper to the virtually-limitless capacity of fiber, this packet delivery overhead is not an issue.

For individual subscribers, three main delivery mechanisms for general use have emerged: Data Over Cable Service Infrastructure Specifications (DOCSIS) modems using existing cable TV infrastructure, Asynchronous Digital Subscriber Line (ADSL) modems using the fixed-line telephone network, and third and fourth generation cellular networks with higher cell capacities (aka "mobile broadband").

Successive advances in mobile network technology and system specifications have provided higher cell capacity and consequent improvements in single-user data rate. The increases in data rate have come courtesy of increased computing power, and increased modulation density made possible by better components, particularly in the area of digital receivers. Along with the latest mobile network specifications, there is a concurrent move to the Evolved Packet Core (EPC) – the simplified all-packet network architecture designed specifically to improve data throughput and latency, and to better match the air interface part of the mobile network to the architecture of the network's backhaul and of fixed-line networks. In fixed-line networks, higher speeds for data-intensive services come via the extension of fiber optic cable into local distribution. Copper has become the "last yards", rather than "last mile" medium, as fiber-to-the-curb (sometimes "fiber-to-the-cabinet") and even fiber-to-the-home networks provide the high-speed broadband connectivity that is required for high-definition video streaming and like services.

These improvements have produced a "chicken and egg" conundrum for mobile network operators: the more data capacity they make available, the more complex and data-hungry equipment the device manufacturers offer, and the more sophisticated the demands of end-users become. The latest of these demands is “seamless connectivity” – the ability to move an application amongst devices: for instance, tablet to smartphone to home entertainment center – without interruption of the content. To provide this capability requires access to, and control of, the content over multiple networks: WiFi hotspot, cellular and landline. It is not just a technical challenge –associated billing needs a plethora of roaming agreements as well. The added complexity linked to managing multiple technologies and bands will herald new network planning techniques for 5G technology. Advancements in data analytics, geolocation technology, SON and CEM systems will lead to a more detailed view of user behaviour - not just at a network level, but also at a subscriber level. The placement of base stations and small cells will not be determined by network-centric analysis, but by the customer lifetime value of the users impacted by dropped calls, data buffering or poor download speeds in any given area.

This enhanced view will have a profound impact on an operator's ability to maximize profitability by taking a business view of network performance and customer experience. Such a detailed perspective will tempt operator marketing executives to consider either monetizing this generalized view to third parties, or pick up the mantle themselves and deliver innovative new offers and services to drive increased revenues and longer-term retention. The mobile industry is well on the way to achieving this reality, with much of this capability and functionality possible today.

III.LIMITED SPECTRUM

We should understand that wireless spectrum is limited. In the long run, this must mean only those connections which must be mobile should be wireless. As much service delivery as possible must be routed through fixed (fiber) networks to as close as possible to the point of consumption. We are already seeing the rise of television and radio services delivered over the internet, with more choice of material and timing than terrestrial or satellite broadcast can match. And in mobile networks, today’s WiFi offload becomes the starting point for the norm of tomorrow, freeing up cellular system capacity to give mobile users the best possible service.

In the mobile world, capacity gains come essentially from three variables: more spectrum, better efficiency and better frequency re-use through progressively smaller cell size. The fourth generation networks currently being built use more frequency bands than previous generations and can use broader channel bandwidths. We recognize, and seek to limit, the packet delivery overhead in wireless networks, since signalling absorbs finite network capacity. However, with mobile data consumption currently forecast to almost double year-on-year for the next five years, the network operators maintain they will struggle to meet long-term demand without even more spectrum. Freeing up frequency bands currently used for other systems will become a major priority.

At present, operators must typically support seven bands globally for GSM, UMTS, HSPA, LTE and LTE-A (450, 700, 900, 1800, 1900, 2100, 2200). In some regions LTE and LTE-A add three or four different bands (2.5 GHz, 2.6GHz, 3GHz and 3.5GHz). Device manufacturers must also contend supporting additional bands for Bluetooth and Wi-Fi (2.4GHz and 2.6GHz). 5G technology will add many more bands. Then there are the additional technologies like CDMA and EV-DO that sit outside of 3GPP that still require supporting in several significant global regions.

The reality is that at least one RAN technology is likely to be switched off before 5G is introduced. We have already seen operators re-farm 3G spectrum to better support LTE deployment. This migration is likely to continue as LTE can offer better spectral efficiency as well as faster and richer mobile services. It therefore seems likely that the arrival of 5G will signal the death of 3G in many global territories.

From a technical perspective it is possible to deliver up to eight bands simultaneously. However, simple network economics means that operators and OEMs are unable to support more than six different bands to deliver cost effective services. The early standards that 5G will be based on centre around the enablement of carrier aggregation - the ability to combine multiple disparate bands for new levels of spectral efficiency and to unlock extra capacity. This will be compromised if operators intend to juggle myriad spectrum bands.

Even disregarding carrier aggregation, the sheer cost of having to manage five network technologies and systems concurrently will have most operators worried. The respective handovers between these multiple bands will all need to be optimized for best possible quality of service and experience. This involves a great deal of technical complexity, especially when also addressing the signalling overheads that these multiple radio access technologies will present.

IV.DATA RATE

Last year, for the first time, smartphone shipments outnumbered PC shipments; also people bought three times as many tablets as the year before.

Users of these mobile devices download a billion apps each month. Apps for music and movies. Apps for searching, buying, selling and trading. Apps for home security and energy efficiency. You name it, there is an app for that.

Simply put, there is a lot of data flying through the air at any given moment. The challenge is making sure it all gets where it needs to be without delay. Picture this: multiple users on the same busy street corner all accessing different data streams at the same time. The wireless spectrum that carries all the data is limited, so the overall delivery rate will slow to a crawl, and some users may find it hard to connect at all. This is why service providers have been making huge investments: adding base stations with more and more antennas, adding many small cells and upgrading to new technologies to improve the speed and quality of their wireless networks. Meanwhile, demand just keeps growing.

As with LTE, higher data rates will not provide enough of a pull to encourage 5G take up alone. Subscribers will migrate to 5G if it offers a better mobile data experience in more places thanks to better coverage. This includes the provision of seamless offload to other technologies (including WiFi and shared public small cells) and better access to data thanks to cloud servers working in conjunction with mobile and WiFi channels. The mobile industry must also actively invest in developing antenna technology. The ability to automatically tilt an antenna is crucial to making 5G (and indeed LTE-A) a viable technology. Less than half of the world's antennas are even RET tiltable, less than ten per cent are RAS steerable and there are very few MIMO systems in operation. This will need to change if operators are to realize the instant, real-time configuration enhancements that user-centric 5G networks will need to become a reality.

V.WORK DONE IN VARIOUS COUNTRIES

A. European Union(EU)

Under “A Digital Agenda for Europe” the EU has already launched eight projects to begin exploring the technological options available leading to the future generation of "wired" (optical) and "wireless" communications, adding up to over €50m for research on 5G technologies deployable by 2020. Overall EU investments from 2007 to 2013 amount to more than €600m in research on future networks, half of which is allocated to wireless technologies contributing to development of 4G and beyond.

Their expectation is that next-generation communication systems will be the first instance of a truly converged network where "wired" and "wireless" communications will use the same infrastructure. This future ubiquitous, ultra-high bandwidth communication infrastructure, will drive the future networked society.

EU funding for this initiative is coordinated under the auspices of the Seventh Framework Programme for research and development (FP7).

B. Germany (Technical University of Dresden)

TU-Dresden previously pioneered 3G systems research in association with the Vodafone Chair Mobile Communications Systems, which is dedicated to cutting-edge research in wireless communication technology. Their vision for a next-generation system is user-centric, with required system attributes based on perceived future usage models: “The Internet of Things”. Their vision for 5G is to provide a new unified air interface to cover cellular, short-range and sensor technology that can deliver 10 Gbps, 1 ms latency and simple
sensors with 10-year battery life.

C. United kingdom

The project began in 2013, and is expected to cost around £35 million ($56 million USD), where about £11.6 million will come from the UK government and the other £24 million will be provided by a group of tech companies, including Samsung, Huawei, Fukitsu Laboratories Europe, Telefonica Europe, and AIRCOM International. An expansion of the program is also being sought with further proposals going to the UK government. It is claimed that the new network will be spectrum-efficient and energy-efficient. It will also be faster, with cell speeds bumped up to a capacity of 10Gbps.

D. China

China’s Ministry of Industry and Information Technology has established a working group called “IMT-2020 (5G) Promotion Group” for 5G research in February 2012. China is seeking participation with Taiwan in the program.

E. Japan (Tokyo Institute of Technology and DOCOMO)

Tokyo Institute of Technology in a joint outdoor experiment conducted recently with NTT DOCOMO, INC. succeeded in a packet transmission uplink rate of approximately 10 Gbps. In the experiment, a 400 MHz bandwidth in the 11 GHz spectrum was transmitted from a mobile station moving at approximately 9 km/h. Multiple-input multiple-output (MIMO) technology was used to spatially multiplex different data streams using eight transmitting antennas and 16 receiving antennas on the same frequency.

F. South Korea

South Korea is planning to 'invest £900m in 5G development. South Korea's science ministry is reportedly investing 1.6 trillion won (around £900m) in the development of 5G. Smartphone users in South Korea will be able to download a feature film in less than a second with the introduction of the 5G network. South Korea holds a 30 per cent stake in the global mobile market, where more than 78 per cent of its 50 million population use smartphones.

VI. CONCLUSION

5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers.
As data traffic has tremendous growth potential, under 4G existing voice centric telecom hierarchies will be

moving flat IP architecture where, base stations will be directly connected to media gateways. 5G will promote concept of Super Core, where all the network operators will be connected one single core and have one single infrastructure, regardless of their access technologies. 5G will bring evaluation of active infra sharing and managed services and eventually all existing network operators will be MVNOs (Mobile virtual network operators) .

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