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Factors affecting 5G mobile networks rollout in Pakistan

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Abstract: Pakistan holds a huge mobile telecommunication market base, consisting of nearly 185 million cellular customers as of August 2021 out of which 103 million are 3G & 4G users. Having a population of 220 million the demand for better and faster services is always there to be digested by the data ravening customers. At the moment broadband data users penetration is only 47.7% and it has a lot of viable potential for the mobile network operators to vie in more users from every part of the country.After acquiring 4G licenses by three mobile operators Mobilink, Telenor and Zong in Pakistan during the period 2014 to 2016, these companies launched their services. It became immensely clear that Government of Pakistan's regulatory policies towards digitalization of economy will greatly effects the rollout of mobile networks and the same will be true in the case of 5G technology deployment. The main factors that need to be considered are well-timed allocation of spectrum and an encouraging regulatory framework for mobile network operators, right of way, small cell deployment challenges. The pace of 5G network roll out by mobile network operators in Pakistan will be mainly based on these factors. Henceforth, the main purpose here is to search the comprehensive time-based underlying forces affecting the rollout of 5G mobile networks and the causes effecting its implementation in Pakistan.

Keywords: 4G, 5G, Mobile network, Infrastructure, Coverage, Regulatory.

1. Introduction

With the arrival of 3G and 4G services in Pakistan from 2016, the 3G and 4G users have increased at a tremendous pace nearing almost 64 million 3G users and 39 million 4G users (August 2021) [16].` The utilization of bandwidth for data users has sky rocketed from 100's of mega-bits to 100's of giga-bits. This incredible data usage has put extreme pressure on the mobile operator's network and quality of service been provided to their customers. The migration to 4G networks has brought a new level of expectations to wireless communications users. The higher speeds and packet delivery of 4G networks has made high quality multimedia available everywhere. With the advent of 5G mobile services becoming a reality, many users are anxiously waiting for its implementation.

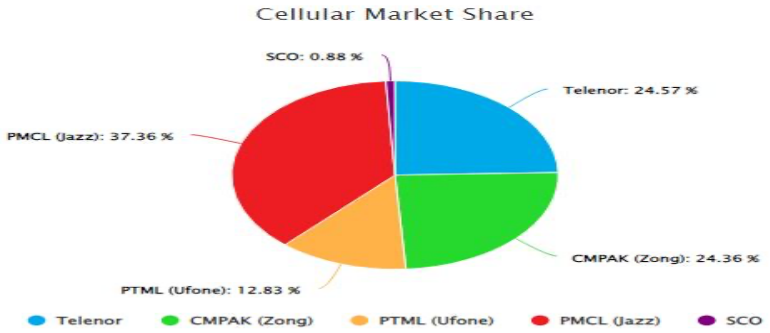

Figure 1. Cellular Market Share in Pakistan [1] (Jan-2023)

On 14 April 2014, Pakistan's auction of its first spectrum for 3G and 4G mobile telecom was held by PTA. Four companies Zong, Ufone, Telenor and Mobilink entered their bids, while Warid Telecom absented from the bidding. 3G auction earned Government of Pakistan $903 million and 4G auction earned $210 million. Pakistan's first 4G license was won by Zong (ChinaMobile) in 1800 MHz frequency band. Second license for 4G services could not be auctioned since no mobile operator participated in this auction. Mobilink alongwith Zong won 2x10 MHz in the 3G license category, while Telenor and Ufone won 2x5 MHz license category for 3Gservices. [1]

In June 2016 PTA again offered for auction 4G license in 850MHz spectrum. In this auction Telenor was the only bidder, hence it was awarded 10MHz block at a price of $395 million. In late October 2021 UFone acquired 4G license from PTA.

Table 1. Showing operational status of mobile companies in Pakistan [1].

Name	Start of Service	Technologies adopted	Operational Status
Paktel	1992	AMPS, GSM	Not Operational
PakCom	1992	AMPS, GSM	Not Operational
Mobilink	1998	AMPS, D-AMPS, GSM, DMA,LTE	2G, 3G & 4G services Operational
Ufone	2001	AMPS, CDMA	2G, 3G & G services Operational
Telenor	2005	AMPS, D-AMPS, GSM, CDMA,LTE	2G, 3G & 4G services Operational

Now 5G has been tested in many countries and is expected to become fully operational by 2020. 5G compromises of high intractability for cellular users having enormous bi-directional bandwidth. 5G technology comprises of subscriber management tools for fast remedial measures. Superior facilities of 5G technology are based on error avoidance Policy. 5G services can deliver huge broadcasting of data in Gigabits.

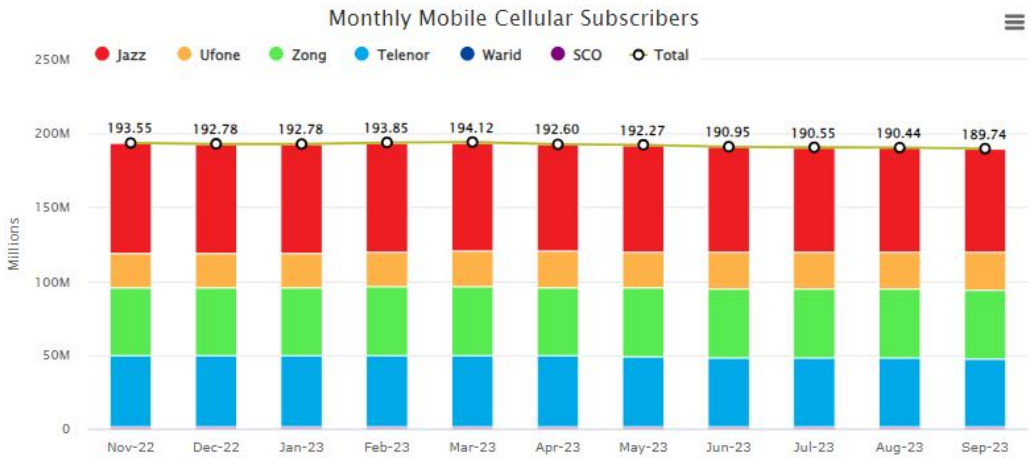

Figure 2. Monthly cellular subscribers [1] Jan-2022

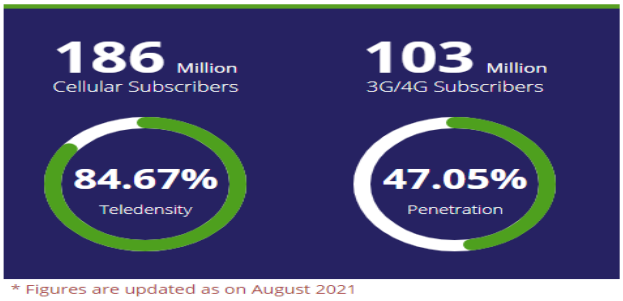

Figure 3. Teledensity and 3G & 4G users in Pakistan [1]

Pakistan being a developing country is lagging behind in 5G rollout in comparison to many other counties of this region. Main barriers in Pakistan for roll out of 5G network by mobile operators are Government policies, regulators guidelines, enhancement of existing infrastructure and investment incentives required for operators for early 5G rollout. The 5G wireless technology offers its users lot of enticing possibilities. The main question is what needs to be done to launch 5G services? There are several queries that need to be answered before launching 5G networks in Pakistan. The mobile telecom operators face many mutual and a few exclusive challenges in this regard. In July 2019, Pakistan Telecommunication Authority advertised for 5G network trails by the existing operators. It is expected that PTA will issue 5G spectrum license's by end of 2021, which will pave the way for launching of 5G wireless mobile services in Pakistan.

Pakistan has been included in a research paper by Goldman-Sachs in the N-11 list. This N-11 lists comprises of 11 countries that are estimated to hold huge potential for fiscal development and are economies to lookout for in near future.

2. Literature Review

The 5G services have two views, it is evolutionary & revolutionary. For 5G evolutionary view it will have the capability of supporting World Wide Wireless Web (WWWW) permitting vastly flexible network dimensions such as "Dynamic Adhoc Wireless Network (DAWN)". The network will consist of innovative technologies including smart antennas and flexible modulation for optimized wireless network. For revolutionary view, the new 5G network will be a highly intelligent network having smart technologies capable enough to interconnect the whole world without any limitations. [5].

Expectations from 5G networks are very high with the users expecting it to deliver a transformation into the Promised Land having exceptional end user experience coupled with new applications having advanced business models, highly fast new service with gigabit speeds. The society will be propelled into a new age of smart cities with fast technologies. Use of several 5G network potential cases have been identified by stakeholders from the industry and ITU-R has highlighted three most important classes.

The first is Enhanced Mobile Broardband (eMBB) having enhanced indoor-outdoor bandwidth augmented with virtual reality. The second is Massive Machine Type Communication consisting (mMTC) of IoT, tracking of assets, smart cities, smart homes, energy monitoring and remote monitoring. The third is Ultra reliable and low latency communications (URLLC) consisting of real time monitoring of smart grids, remote patient monitoring, autonomous vehicles control, tele-health/operations and industrial automation.

Table 2. 5G Technical use classes

Enhanced Mobile Broadband (eMBB)	**Massive Machine Type Communications (mMTC)**	**Ultra Reliable & Low Latency Communications (URLLC)**
Applications: Streaming, Web, Browsing, Video, Conference, VR etc. -High Throughput -Limited Movements of the user	Applications: Sensors, Smart city, -High number of devices, -Low cost -Enhanced Coverage -Long battery life -IOT based	Applications: Mission critical, Industrial automation, -Drone control, -Self-driving cars etc -Short delays -Extreme reliability

Despite these benefits, 5G systems adaption is still not fully mature and cautions are being sounded regarding its viable commercial case. Very high level of investment is needed for deploying 5G mobile networks. It has been estimated that the cost of 5G deployment ranges from $6.8 million to $35.5 million for a small to a mega cities. At the start of deployment, investment cases are prepared for urban cities with dense population, which are commercially viable for the network operators. It will be highly challenging commercial case for the mobile operators for deploying 5G services in rural areas and less populated cities where the population is sparsely located. This will result in increase of digital divide between the urban and rural areas.

The ITU-2018 report identifies some key issues for makers of 5G policy to consider before formulating new strategies for encouraging investment in the 5G network deployment. These issues signify powerful means for calibrating an approach for embarking on a prudently enabled faster transition to 5G policies and deployment.

The below displayed extracts of ITU report highlights some key issues and their proposed remedial responses for the government policy makers to formu¬late their strategies for the stimulation of investment in 5G mobile network by the operators. Through this approach the policy makers can signify potent means of regulating an overall methodology across main aspects of mitigation for fast-tracked changeover to 5G network deployment.

Table 3. 5G Key Issues Identified (ITU-2018 report)

No.	Summary	Consideration
1	Investment case	Policy-makers may consider undertaking their own independent economic assessment of the commercial viability of deploying 5G networks
2	4G network strategy	Until the case for 5G networks can be clearly made, policy makers may consider enhancing the availability of and boosting the quality of 4G networks
3	Harmonize spectrum	NRAs may consider allocating/assigning globally harmonized 5G spectrum bands
4	Spectrum roadmap	NRAs may consider adopting a spectrum roadmap and a predictable renewal process
5	Spectrum sharing	NRAs may consider allowing sharing to maximize efficient use of available spectrum, particularly to benefit rural areas
6	Spectrum pricing	NRAs may consider selecting spectrum award procedures that favor investment
7	Wireless backhaul	Operators may consider utilizing a portfolio of any type of wireless technologies for 5G backhaul in addition to fiber cable
8	Access/sharing of passive infrastructure	Policy-makers may consider allowing access to government-owned infrastructure such as utility poles etc to give wireless operator right to deploy small cells on them
9	Access costs	Policy-makers /NRAs may consider ensuring reasonable fees are charged to operators for deployment

2.1 5G Standardization

5G mobile network is expected to be greatly faster having speeds of sub-milli-second latency for transporting huge amount of data. For 4G networks the maximum speed or data transmission is up to 1 Gbps, whereas with 5G networks this data transmission speed will move to 10 Gpbs, much closer to wire-line services. Past three to four years the spectral efficiency has been greatly enhanced meaning increasing signal reliability for the users and providing excellent quality of service.

5G wireless network requires a huge amount of new consistent spectrum. Therefore, the regulators should defragment and clear all the main bands of required 5G spectrum for its deployment. All the 5G operators will require 80 to 100 MHz spectrum in mid-bands and high bands. 5G networks require wider frequency bands for supporting greater speeds for transporting large data traffic.

Table 4. 4G & 5G speed and latency comparison

	4G	**5G**
Approximate Deployment Date	2010	2020
Theoretical download speed	1 Gbit/s	10Gbits/s
Latency	60-98ms	<1ms

It has been forecasted by experts, that 5G profitable services rollout will suffer if sizeable spectrum is held back from allocation. This causes risks of limiting spectrum investment and operators have to overpay at the auctions which limits investments. If spectrum lots sizes are mismatched it means that the operators are not able to acquire the desired spectrum.

2.2 5G Regulatory Challenges

Predictable and fair rules are most vital for licensing spectrum alongwith affable tax regime. The auction of 5G spectrum can unlock massive growth potential for Pakistan with social and commercial benefits if the auction is handled with extreme thoughtfulness. If the mobile operators do not have access to adequate spectrum alongwith affordable price and tax regime, they might opt not to participate in the auction process and stay away. This will be a severe setback for the government for its anticipated earning of millions of dollars through spectrum auction as well as loss of high speed wireless mobile services for the users in Pakistan.[6]

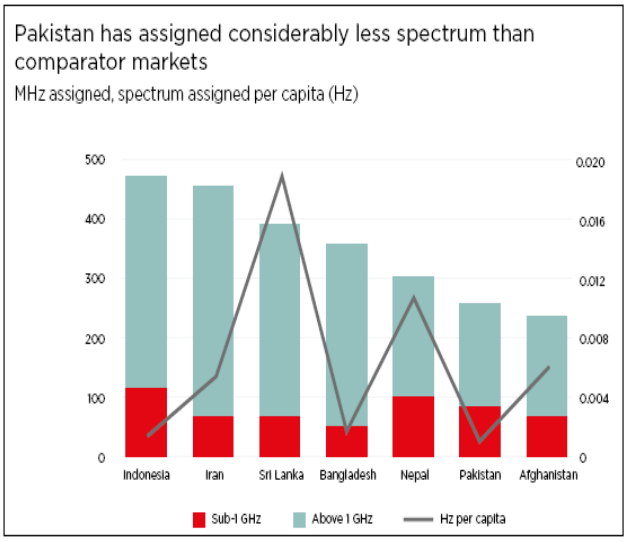

Figure 4. 5G allocated spectrum in Pakistan (Source PTA)

Pakistan as compared to other regional Asian countries has allocated less 5G spectrum for auction to mobile operators. With tremendous increase in wireless broadband users there is an exponential increase in data traffic. With introduction of growing number of IoT's, e-health applications, on-line gaming demands for additional bandwidth higher data speeds and better signal quality needs greater volume of spectrum. The base price bench mark set for existing spectrum and license fees for auction in September 2021 by PTA jeopardies sale of offered spectrum and the operators will not show interest in acquiring the

same from PTA at this price, which is fixed as $271 as its base price. This delay will make Pakistan fall behind regional countries in implementing rollout of 5G technologies. The Government of Pakistan and PTA should essentially ensure that right policy decisions should be made to attract potential buyers for the 5G spectrum.

PTA ought to avoid bloating spectrum prices, since this will risk limiting spectrum investment and will make the cost of services excessively expansive for the users. This will be due to huge base spectrum price and annual fees / taxes. Excessive spectrum base price will result in expensive and slower mobile broadband services with poor coverage. High spectrum prices are typically a policy decision, which tends to prioritize short term revenue target above long ranging social and economic benefits of the nation.
To evade this, government of Pakistan alongwith its regulator PTA should:

- Keep the spectrum base price, annual fees, and taxes to reasonable low or modest level instead of very huge amount. In some European countries e.g the base price for 5G spectrum is set at minimum possible level with the conditions for the acquiring operator to roll out their services geographically in whole of the country within 1 to 3 years with predefined quality and coverage, otherwise they will be penalized.
- Increase the spectrum bandwidth to avoid scarcity which can lead to decent bidding offers.
- Develop a concise roadmap for 5G spectrum by getting mobile operators feedback for future planning for rapidly changing technology demands.
- The 5G futuristic roadmap essentially linking spectrum availability and its acquiring conditions can repudiate operator's risks and will encourage them to make investment decisions by making a positive business case for acquisition of 5G offered spectrum.

Summing up it can be easily deducted that price and intricacy of procuring and using 5G spectrum decreases insecurity by allowing mobile operators to control the long-term cost of their investments in new 5G infrastructure and will help them more accurately assess the offered spectrum lots at the PTA auction. Otherwise, mobile operators will lose interest in acquiring 5G spectrums and Pakistan will lose not only appreciable revenue from auction payments, but also the investment that was to be brought in for upgrading the operator's infrastructure alongwith sale of 5G mobile phone markets. [7]

2.3 Cumbersome process for Right of Way

For Mobile operators in Pakistan to roll out 5G services, they require deployment of a very large number of small cells connected through optical fiber cables, since a very large amount of bandwidths will be required at the cell sites for transportation of huge internet data. For 5G to provide a good quality of service, increase in capacity will come from radical rethinking in the mobile network structure by involving use of large quantity of small sized cells to increase capacity of network and signal strength. This will reduce the pressure on existing network structures. These cells will merge into existing heterogeneous networks, supporting a wide range of air interfaces and spectrum bands. All the mobile operators will be pressed for manifold increase in cell sites in next couple of years to cover large portion of geographical areas. At the moment a large quantity of existing cell sites are connected through air-waves having digital radio systems and many of these sites will have to be switched over to optical fiber connectivity in addition to new sites to provide large bandwidths between the antennas and main backend core-systems. This shifting over from radio links to physical cables requires a nationwide comprehensive mechanism for right of way, which should be quick, efficient and cost effective for operators as well as for the concerned civic agencies to follow. At the moment no solitary mechanism exits especially for urban cities, where there are multiple agencies which give RoW approvals such as Cantonment Boards, district governments, different city development authorities, Pakistan railways, highway departments etc.

Leasing RoW is a very worthwhile way of making huge sums of additional income for these agencies from the mobile operators. But if a friendly, cost effective and universally implementable policy is approved as per Telecom Policy by PTA, it can help the operators to deploy the fiber in an efficient and effective way. At the moment this policy is not available in Pakistan, therefore, mobile operators face a lot of difficulties in obtaining No-Objection for RoW from these agencies, since each has a different procedure and cost.

2.4 Challenges of Medium and Small Cell deployment

In many countries regulations and policies slow down the deployment of medium to small cell sites due to extensive administrative rules and high cost of installation fees. This is especially true for Pakistan

where the "No objection process for installation of cell site" is very slow and costly in most of the urban areas, where majority of the 5G customers are residing. Getting permission, procuring site, deep-rooted lethargic regulations and disproportionate local agencies fees prevent quick and easy deployment of the cells. Sometimes it takes 12-18 months for the local approving agency to approve a planned site resulting in unnecessary delays. The small cells will ultimately be installed on street light poles, traffic signal poles, building tops and inside buildings. The mobile service providers will have to face many such challenges for network planning to ensure good quality of service to the users. It has to be ensured by the mobile network operators that they provide best possible performance coupled with optimal cost of network roll out to achieve key business goals for their business case to remain in positive. Now a day's nearly 60% of mobile traffic is generated by the users from inside the buildings and only 40% is from open areas. This means that operators should have an efficient and reliable signal transmission solution for the users inside the buildings. [UK journal].

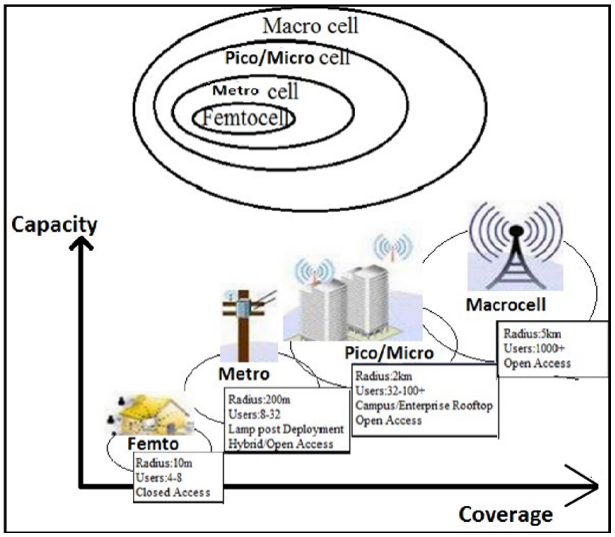

Figure 5. Showing different type of cells with coverage radius and number of users that can be accommodated [18].

2.5 Concerns of Electromagnetic fields exposure to Humans

Electromagnetic field exposure limits are different in many countries, but still it has not been experimentally proven that excessive radiofrequency Electromagnetic fields can harm human beings. If these radiofrequencies are within the ITU recommend limits, than it will not be of any harm to the public. In this regard the frequencies of electromagnetic fields should follow International Commission on Non-Ionizing Radiation Protection limits. 5G Femto & Pico antennas will be visible everywhere that is outsides on the streets, on top of buildings as well as insides the buildings, which will be a major factor of public concern. All regulatory steps should be implemented to keep the public safety top priority during the antenna deployment phase.

3. Conclusion

This paper has reviewed the road ahead for the commercial deployment of 5G mobile systems in Pakistan identifying many critical challenges being faced by mobile operators for an early roll out of the services. Some of the challenges are extremely important for the government timelines regarding vision of "Digital Pakistan-2030" to be met. If these hurdles are not adequately tackled by enforcing a virtuous business friendly policies and regulations, than the race against time may be lost. [9] The most critical role in shaping 5G roll out is of the regulatory authority, in this case Pakistan Telecommunication Authority and Frequency Allocation Board. [10]

Both PTA & FAB should introduce spectrum management in such a way that it should be economically viable for the mobile operators to prepare a business case for further infrastructure investment while acquiring 5G spectrum at an affordable price. Attention should be paid to the spectrum scarcity by offering further 5G bandwidth in 700-800 MHz and in 3.5 to 3.7 GHz to attract the operators. The spectrum

allocation methods should encourage the operators to efficiently use it, while also permitting the regulatory authority and GoP to collect reasonably good revenues from spectrum auctions.

Realistic revenue and beneficial license price expectations will be of vital importance to the introduction of 5G services in Pakistan. Many of the expected benefits from 5G depend on larger bandwidths than are used today. In our mobile market, effective release of new spectrum will require significantly lower spectrum prices per MHz to induce companies to invest in deployment of this service. Initially the business case for 5G will not support acquisition of large bandwidths by mobile operators if spectrum reserve prices are too high or due to onerous conditions for roll-out of services.[11] The mobile companies are having extreme doubts and are very skeptical about high investment requirements. The government, regulatory and local authorities need to overhaul their approach and policies to make them business friendly for mobile companies to invest in 5G services in Pakistan. This includes lowering the spectrum bandwidth price to mid-levels from the existing high base price at the moment, affordable and easy rules for right-of-way to deployment of small scale antennas at public assets. This will enormously strengthen the commercial case for investment in deployment of small cells like Femto & Pico cells for 5G access. ..[12]

With the implementation of above recommendations, 5G is foreseen to perform a significant role in development of digital economy by improving commercial growth, improving the citizens' life experience by creating new business prospects and opportunities, enabling IT & communication technologies to grow at an appreciably fast pace bringing prosperity to the people of Pakistan.

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