

# Mobile Network Infrastructure as a Catalyst for Socio-Economic Growth in a Developing Economy

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## Abstract

Mobile Network world wide is of concern and has rapidly evolved to become a cornerstone for socioeconomic development in many parts of the world, especially in developing nations. This paper takes a critical look at the impact, issues and challenges of mobile Network in Nigeria, using mixed-methods approach, including data analysis, relevant informations from national dailies, journals and internet-based sources. The paper adopts a descriptive approach on the role of mobile Network in a developing society using Nigeria as a case study. Mobile Network issue in Nigeria has different dimension or component such as, Network availability, Network access and Network utilization. The challenges of Network are not limited to poverty but management, security, fraud, politics and technical indifferences. This paper presents a strategic framework for mobile Network security intervention in Nigeria. This strategy includes good governance, infrastructure, sustainable Networking, strengthening and improving both local and international linkages.

**Keywords:** *Mobile Network, Socioeconomic development, Mixed-method approach, Network Infrastructure, GSM, International linkages.*

## I. INTRODUCTION

Mobile (cellular) Network is a radio communication system that is distributed across land areas known as cells. Each cell is served by at least one fixed transceiver, commonly referred to as a base station or cell site. In a cellular Network, adjacent cells operate on different frequency bands to minimize interference and to ensure efficient use of the available band width within each cell.

When these cells are linked together, they create a seamless network that delivers radio coverage across a wide area. This setup makes it possible for many portable devices like mobile phones and pagers to communicate with each another and with fixed telecommunication systems through base stations. Even as users move from one cell to another during an ongoing call or data session, the Communication continues smoothly without interruption. (Miao et al., 2016).

Cellular Networks provide several clear benefits compared to other communication solutions, making them a reliable and flexible option for modern connectivity.

They are highly flexible and can support the features and functions of both public and private Networks.

Key benefits include increased network capacity, reduced power consumption, wide coverage areas, minimized interference from other signals.

Mobile technology, as the name suggests, refers to portable technologies that allow users to communicate and compute while on the move. Examples of mobile Information Technology devices include laptops and network computers, palmtop computers or personal digital assistants (PDAs), mobile and smart phones, Global positioning system (GPS) devices, and wireless debit or credit card payment terminals.

Mobile devices can operate using a variety of communication technologies. These include Wireless fidelity (W<sub>1</sub>-F<sub>1</sub>) which is a form of wireless local areas network technology, Bluetooth which enables short range wieless connections between devices, third generation (3G) networks and general packet radio services (GPRS) for mobile communication, dial-up data networking

services that use moderns and telephone lives, Virtual private networks (VPNs), which provide secure access to private networks.

As a result, mobile devices can be connected to home networks or the internet even while users are travelling.

Mobile computing also enhances the quality of services offered to customers. For example, during meetings, service providers can remotely access customer relationship management systems over the internet and update customer records in real time. In addition, wireless payment terminal allow customers to pay for goods or services without visiting a cash register, for instance, diners can conveniently settle their bills directly at their tables (Qiu & Gai, 2017).

More advanced mobile solutions make it possible to connect directly to office networks while working off-site, enabling secure access to databases, accounting systems, and other enterprise applications.

Through such connections, users can create new customer accounts, check product prices and stock availability, and Place orders online in real time.

This capability promotes greater flexibility in working arrangements, such as remote work from home or production while travelling. In addition, public spaces increasingly, provide networking hotspots that allow user to connect to the office network systems or the internet. The continue growth of cloud computing has further enhanced the use of mobile devices by delivering services over the internet, thereby supporting more flexible and efficient working practices.

The government in 1999, at the coming of a new democratic dispensation has unleashed such aggressive competition never before in the country. The competition opened up a sector that had before been reserved only for the elite in the land.

Since 2001, mobile network remains a cardinal dividend of democracy and looking at the evolution of growth and the dynamic nature of technology, the sector doesn't seem to be ready for any let off any time soon.

From one end of the country to another, from the remotest rural setting to the city center in Lagos or the seat of power in Abuja, mobile network is touching and improving the lives of ordinary Nigerians.

In recent engagements, industry regulators have expressed their commitment to opening up new avenues of competition and growth to meet Nigerians' strong and growing desire for modern communication tools.

According to vanguard of June 2, 2012, Nigeria's telecoms history over the last decade comes with making you think of achievement very well in recent times. From about 400,000 connected lines in 2001 to over 119.5 million lines at the moment and from a Tele-density of

0.44% to 70.8% within the same period. Investment also jumped from a paltry N80bn to over N2.8trn within a decade (Mathew et al., 2021). This revolution would not have been possible but for the confidence engendered by our new democratic dispensation. Recent reports have also revealed that Nigeria has achieved 45% internet penetration with a connection of 196 million subscribers and that figure also ranked Nigeria as number one among top ten internet connected countries in the continent. A brief review of the current strategic direction shows that the industry regulator, Nigerian Communication Commission (NCC) is presently focused on several key priority areas. These include, the consolidation and integration of mobile wireless services with particular emphasis on improving quality of service, the expansion of fixed line and broadband infrastructure to support national development, the promotion of a more competitive telecommunications market that offers greater choice to customers.

In addition, the NCC is committed to strong regulatory compliance through effective monitoring and enforcement, as well as to achieving nationwide connectivity as a catalyst for accelerated economic growth.

ICT and broadband network have become national infrastructure like transport, energy and water network but with an impact that promises to be even more powerful and far reaching. For Nigeria, broadband can stem

p rural urban migration, accelerate development in all facets of life, increase investment, enhance cashless economy and reduce over reliance on mobile telephony and mobile network. This contributed to increasing quality of service on the networks.

Amongst the various and widely published regulatory interventions, the NCC is currently pursuing, the open access model is one such initiative that provides a frame work for sophisticated infrastructure sharing, while government is making significant intervention to address sundry issues affecting the operators' business environment in a bid to mitigate any negative effect on their ability to provide quality services. The NCC has recently embarked on enforcement activities resulting in the shutting of some illegal operations and the arrest of some pre-registered SIM card vendors.

Mobile communication technology recently has emerged as a vital tool in bridging development gaps. In regions where traditional infrastructure is weak or absent, mobile networks provide an alternative means for people to connect, learn access services and conduct business. For developing Nations, this has meant a faster path to inclusion, innovation and progress. Mobile phones are no longer a luxury but a necessity, used for mobile banking, remote health care consultations, online learning and even citizen participation in governance.

The evolution from 2G to 5G has reshaped communication, business, education, healthcare, and

governance. Studies indicate that a 10% increase in mobile penetration can contribute up to 2.5% of GDP growth in developing nations (Aker & Mbiti, 2010). (World Bank, 2019) also attested to it. Despite significant advances in mobile technology, many developing nations still struggle with limited access, high deployment costs, poor network infrastructure and digital illiteracy. There is also lack of comprehensive understanding regarding how mobile communication can be strategically used to accelerate development across various sectors.

➤ *The study is Guided by the Following Objectives;*

- Assessment of the current level of mobile network penetration in developing nations.
- Examination of the impact of mobile communication on development sectors such as health care, education and finance
- Identification of the challenges limiting effective use of mobile networks.
- Recommendation of strategies for maximizing the developmental benefits of mobile communication.

➤ *The Research Questions are;*

- How widespread is mobile network access in developing nations?
- What specific roles does mobile communication play in improving development outcomes?
- What are the key limitations and barriers to mobile network usage in these Regions?
- What can governments and stakeholders do to enhance mobile network effectiveness?

The study provides insights for policymakers, development organizations, and telecom providers, enabling them to create targeted policies and investments. It also contributes to achieving global development goals such as the UN SDGs

The research focuses on developing nations with Nigeria as a case study, examining mobile communication's roles in health care, education, finance and governance. Limitations include data availability and the diversity of national policies across different countries.

Mobile Networks have evolved significantly since the introduction of first generation in 1979. In the early stages, voice and data networks were developed separately and operated independently. Mobile communication was still in its infancy, and the first commercially automated cellular network was launched in Japan by NTT in 1999, initially serving the metropolitan area of Tokyo.

During the 1980s, data networks primarily relied on packets-switching technologies such as X.25, while voice networks used circuit-switching systems supported by Private Automatic Branch Exchange (PABX). Managing these networks was complex and inefficient, as communication was largely asynchronous. At this time, internet usage was limited mainly to universities and research institutions.

By the late 1980s, the convergence of voice and data networks began to take shape. In the 1990s, digital transmission gradually replaced analogue circuit-switched technologies. Integrated Services Digital Network (ISDN) emerged as a leading circuit-switched solution for telephony, although it was costly and often used as a back up for leased lines. This period also saw intense competition among technologies aimed at supporting integrated services such as data, voice, video and other real-time applications. Since X.25 could not effectively support this convergence, Asynchronous Transfer Mode (ATM) was widely proposed as a viable alternative.

In 1991, the first modern-based data services on second generation (2G) digital cellular networks were introduced in Finland using the GSM standard. Towards the end of the 1990s, Cisco introduced Tag switching, which later evolved into Multiprotocol Label Switching (MPLS) after standardization. This innovation encourage service providers to migrate to MPLS-based network backbones, as MPLS-VPN technology allowed multiple customers to share a single Provider Edge (PE) router instead of requiring dedicated hardware for each client.

The launch of third-generation (3G) mobile networks in 2001 marked another major milestone, once again led by Japan through NTT DoCoMo using the WCDMA standard. 3G was the first mobile network standard to enable internet web browsing on mobile phones, providing users with access to multimedia content and richer online services (Mannweiler et al., 2020).

Although Asynchronous Transfer Mode (ATM) was originally designed to support integrated voice, video or data services, it was rarely used for these purposed in practice.

Nevertheless, ATM remained popular among service providers for some time. During this period, service providers typically operate two network layers; a Wide Area Network (WAN) backbone that supported customer access technologies such as ATM, Frame-Relay, or even X.25, alongside higher-speed links used to build emerging MPLS backbones.

Over time, it became clear that ATM performed better in theory than in the real-world developments. The technology began to encounter significant scalability challenges, particularly as large Local Area Network Extension (LANE) environment collapsed under heavy traffic loads due to limitations in handling broadcast and multicast replication. It soon became evident that ATM was not suitable for multi-gigabit networks. At the same time, voice over IP (VoIP) emerged as a more practical solution for network convergence. As a result ATM was gradually replaced by all-IP network using Packet Over SONET (POS) and increasing faster Ethernet technologies evolving from 10Mbps and 100mbps to 1Gbps, 10Gbps, and now 100Gbps links.

With the rapid growth in the number of connected users and the widespread adoption of smartphones,

enhanced mobility support became essential. This shift positioned internet protocol version 6 (IPv6) as a key enabler for next-generation of mobile networks.

Fourth-generation (4G) networks and Long-Term Evolution (LTE) rely heavily on IPv6 to provide a sufficient address space and to support seamless mobility. LTE is a 4G mobile specification designed for multimedia applications, offering multi-megabit data rates, improved spectral efficiency, reduced latency, and enhanced mobility. LTE targets peak data rates of up to 300Mbps in the down link and 75Mbps in the uplink, while also reducing overall network deployment costs.

At the core of LTE is native support for IPv6, particularly through proxy mobiles IPv6 (PMIPv6). In this architecture, a proxy mobility agent manages mobility signaling on behalf of a mobile device.

Two key network functions are defined within PMIPv6, the local mobility author (LMA) which acts as the home agent within a PMIPv6 domain and serves as the topological anchor point for the mobile node's address and the Mobile Access Gateway (MAG), which resides on the access router and is responsible for initiating mobility-related signaling on behalf of the connected mobile device.

The work is grounded in the Diffusion of Innovations Theory by Everett Rogers in (Lund, 2025), which explains how new technologies are adopted in society. Mobile technology's adoption is analyzed through the lens of its perceived benefits, compatibility with existing systems and ease of use. Mobile networks drive entrepreneurship, e-commerce, and mobile banking. Mobile money platforms, such as M-Pesa, reduce transaction costs and increase financial inclusion (GSMA, 2021).

Empirical Review's numerous studies highlight how mobile networks have revolutionized communication in

developing nations. For example, mobile Health (m-health) services in Kenya have improved rural access to medical advice. In India, mobile banking has empowered the unbanked population while mobile learning platforms have supported remote education in Nigeria.

The gaps in the Literature has research focused on mobile technology adoption, fewer studies analyze its cross-sectorial impact or provide a holistic development framework. This study fills the gap by integrating multiple sectorial perspectives.

## II. RESEARCH DESIGN

This study adopted a mixed-methods approach, integrating both quantitative and qualitative data.

### ➤ Population and Sample

The study draws data from mobile users, service providers and government stakeholders in selected countries such as Kenya, India and Nigeria.

### ➤ Data Collection Instruments

The instruments used for the data collection includes the following;

Questionnaires for users and stakeholders, Interviews with telecom experts and case studies from Africa, Asia and Latin America, Secondary data and reports from ITU, GSMA, UNDP, World Bank and national reports, and National telecommunications regulatory agencies.

### ➤ Data Analysis Techniques

Quantitative data were analyzed using descriptive statistical techniques, while qualitative data obtained from interviews were systematically examined to identify recurring patterns and meaningful insights.

## III. RESULT AND DISCUSSION

Table 1 Illustrates Mobile Penetration and GDP Growth Contribution in Selected Developing Countries.

Country	Mobile Penetration (%)	GDP Growth Contribution (%)
Kenya	89	2.4
Nigeria	76	1.8
India	84	2.1
Bangladesh	74	1.6

Mobile money in Kenya, has transformed informal markets. Improving financial inclusion by over 70% in rural areas. Telemedicine initiatives supported by mobile networks has reduced rural maternal and child mortality rates.

In Nigeria, mobile networks have expanded access to e-government services and online education platforms. Startups leveraging mobile connectivity have emerged, providing jobs for youth.

Mobile broadband expansion supports e-commerce, digital banking, and rural telemedicine in India. Mobile

applications provide farmers here with market and weather information. While in Bangladesh, mobile infrastructure enables agricultural market access, SMS weather alerts, mobile health systems and e-learning platforms in remote communities.

The work shows a growing mobile penetration rate in most developing countries, often surpassing 80% in urban areas but lagging in rural communities due to infrastructure gaps. Mobile network comprising of data and voice network has the following impact and roles in the society.

➤ *Job Creation;*

Mobile Networks generate both direct jobs such as technicians, engineers as well as indirect jobs such as agents, developers employment. While mobile money services improve access to banking in rural areas.

➤ *E- Education*

Fleet technologies Ltd, a leading ICT service provider has introduced a comprehensive online educational solution through a centralized portal known as ACADA. This platform delivers a wide range of administrative and academic services for educational institutions through a single access point.

ACADA is a suite of enterprise web application built on a portal-based architecture, designed to enhance the administration and operational efficiency of institutions at all levels of education, including tertiary, secondary, and primary schools. The system enables convenient interaction among students, parents or guardians, and teachers.

The ACADA suite comprises three main enterprise portal solutions; the fees portal, the school portal and the enterprise resources planning (ERP) portal. The fees portal simplifies school fee payments by allowing parents and guardians to make payments online. It also eliminates reconciliation challenges by routing all on line payments into a single designated bank account.

The school portal supports efficient admission management enabling prospective students to apply online. Application forms can be completed and submitted electronically, and the associated application fees can also be paid online. This approach removed the need for applicants or guardian to travel long distances to obtain and return physical application forms.

The Enterprise resources planning (ERP) portal is a secure and integrated platform that facilitates online payments for goods and services using debit card such as inter-switch or verve cards, thereby further enhancing operational efficiency and financial transparency.

On-line recruitment, registration, result check e t c. still follow suit. The exhibition of ICT products can motivate students and youths in computer appreciation, skill acquisition in computer use and enhancing e-learning. Student will have a field day going through the infrastructural facilities available not only for education but also for e-learning platforms, digital classrooms and teacher support tools.

➤ *E- Banking Start*

In modern banking management, the provision of robust, reliable, and efficient platform for online electronic banking services has become an essential and well established practice. This involves automating customer transaction processes to ensure timely, secure, and highly available service delivery across multiple banking channels. To support this objectives, banks have intensified awareness campaigns to educate customers and

the general public on the benefits, convenience, and security of alternative electronic and card-based payment solutions.

Electronic banking products and services have had significant impacts on everyday business transactions nationwide. The bank's debit card portfolio which includes cashplus debits card, SKS cashplus, and v-pay cards offers substantial benefits to users. These cards can be used for ATM cash withdrawals, payments at point-of-sale (POS) terminals, online transactions, and access to linked accounts such as children's accounts. Of particular note is the v-pay card, which, in addition to its use at ATMs and POS terminals, is a highly secure chip-based card that enhances transaction safety. Another key product in the bank's card offerings is the MasterCard. The premium MasterCard range provides customers with international credit card facilities, enabling round-the-clock access to cash and global transactions, while the standard MasterCard supports nationwide online payment.

For organizations seeking to automate payment processes such as staff salaries, contractor payments, and subscription fees the bank's automated payment systems provide a reliable and efficient solution.

Online shopping is increasingly becoming a common practice among the upwardly mobile youths and some corporate organizations, making electronic payment solutions essential for supporting business operations and meeting payment schedules.

The bank's web pay platform enables individuals and organization to make online payments using debit cards issued on the interswitch Network. Similarly, Merchant POS solutions support secure debit card payments, helping to reduce cash handling risks, theft, and revenue leakages.

For the collection of bills and other recurrent payments, the bank offers the PayDirect. Platform, which provides a secure online solution for payment collection. This system also allows organization to monitor collections effectively, with payments being made through any of the bank's branches.

The bank's electronic payment solutions extend to educational sector through the College pay platform, which enables schools to collect tuition fees and other levies electronically. Payments can be made through any branch, while school bursars can conveniently monitor all transactions remotely.

While Automated Teller Machines (ATM) are commonly used for cash withdraws, they offer a wide range of additional services. Customers can perform balance enquiries, generate mini statements, transfer funds, and pay utility bills. The bank has also leveraged telecommunication technologies through its BankConnect platform, which uses an Interactive Voice Response (IVR) system to allow customers to conduct transactions via mobile or fixed-line telephones. From the comfort of their homes, customers can check account balances, stop

cheques, change PINs, transfer funds, and request new cheque books.

With this extensive range of online and electronic banking platforms, customers remain at the center of the banking ecosystem. Through mobile banking, microcredit services, and digital payment systems, customers receive timely transaction alerts and enjoy enhanced convenience, transparency, and control over their financial activities.

#### ➤ *E-Health*

Electronic Health Records (EHRs) also known as electronic Medical Records (EMRs), Computer-based Patient Records (CPRs) or Electronic Patient Records (EPRs) have gained widespread attention due to their efficiency and ease of use. An EHR contains comprehensive information about a patient's healthcare history, regardless of how many times the patient has visited a healthcare facility or how many providers have been involved in their care. It consolidates all clinical informations related to a patient in one accessible system. If all hospitals and healthcare organizations maintained patient data using EHR systems, there would be significant improvements in the quality of patient care, along side substantial reductions in healthcare costs.

EHR systems are capable of storing, retrieving, distributing, and displaying medical images through picture archiving and communication systems (PACS). This enables healthcare professionals to quickly review both current and previous medical images directly from a patient's EHR. In addition, EHRs support the storage and management of electronic prescriptions, further enhancing clinical efficiency and patient safety.

Health care providers are increasingly encouraged to adopt Health Information Technology (HIT) initiative such as EHRs, often supported by government funding. Early adoption allows providers to benefit from available funding opportunities and avoid potential reduction in future healthcare reimbursements. Globally healthcare organizations are being urged to Implement HIT solutions to deliver improved care at lower costs. To achieve this, healthcare systems must invest in secure, scalable and cost effective IT infrastructures that support EHRs and other digital health technologies aimed at reducing the overall cost of care delivery (Kurose & Ross, 2020).

#### ➤ *E - Prescribing*

E-health initiatives extend beyond EHRs and include services such as SMS reminders for immunizations, mobile health consultations, outbreak alerts, and electronic prescribing (e-prescribing). E-prescribing allows physicians to use computerized order entry systems to generate and transmit prescriptions electronically while automatically checking a patient's medication history and known drug allergies from their EHR. Research by the RAND co-orporation, a non-profit research and policy analysis institution, suggests that widespread adoption of e-prescribing could eliminate approximately 200,000 adverse drug reactions annually and save up to \$1billion each year. The same research indicates that broad adoption

of HIT technologies could result in annual savings of up to \$80billions (UNDP, 2020), (Mulcahy et al., 2024) also attest to it.

Electronic health care records and e-prescriptions are critical HIT initiatives with regard to patient information.

#### ➤ *Telemedicine*

Telemedicine is another important HIT initiative that uses telecommunications technology to bridge the physical distance between the patients and healthcare providers. It improves access to medical services while reducing cost by enabling virtual consultations through video conferencing. Patients can also capture and transmit images or videos of their medical conditions to healthcare professionals for diagnosis and treatment at a later time. Telemedicine is particularly beneficial for home healthcare services and patients in remote or underserved areas.

#### ➤ *Health Monitoring*

Health Information Technology also supports health monitoring by empowering individuals to track and manage their own health. By reducing the need for expensive diagnostics tests, and repeated hospital visits and unnecessary prescriptions. Health monitoring technologies contribute to better health outcomes and lower healthcare costs. Monitoring can be conducted through home-based systems, mobile devices, or clinical Kiosks.

#### ➤ *E- Government*

In addition to healthcare, information and communication technologies play a vital role in public sector transformation. As part of efforts to extend the benefits of ICT to citizens in Nigeria, the Federal government has partnered with Microsoft to strengthen local digital capacity. This collaboration aims to improve governance by streamlining internal communication, enhancing transparency, reducing operational costs, and delivering more efficient public services. The initiative also supports broader social and economic development, stimulates private sector growth, and enhances Nigeria's global competitiveness.

Nigeria ICT initiative within the last ten years have benefited in science and technology education (STE) in the course of teaching, mentoring and research. The impact of the ICT initiative on teachers and teaching in STE from a survey carried out revealed, learning basic computer and internet skills, learning to use ICT technologies for teaching and research, Have open access to computers and internet, aids teachers search for study and teaching materials and enhanced the academic performances of teachers, improve the ICT capacities of teachers and quality of teaching.

The Nigeria's ICT initiatives implemented by the government, agencies of government, private sectors are broadband infrastructure computer laboratories, digitals libraries (MTN project), deregulation of the telecoms sector PTFD projects, classmate PCs etc.

## **CHALLENGES OF MOBILE NETWORK AND RECOMMENDATIONS**

The classmate PC is a compact, mobile learning assistant designed specifically as an educational solution for students in emerging markets. These rugged learning device are built to be durable and affordable, providing a collaborative learning environment for both students and their teachers. They feature built-in wireless connectivity and digital pen support, and can run on either the Microsoft windows or the Linux operating system.

Other basic services offered by the mobile network to the society include: High quality voice transmission, Messaging SMS replacing sending letters by post. Multimedia playing music, viewing videos, films, television, Internet access browsing, net-web surfing include pagers e-library, Video conference, Tele-presence, group game playing, M-commerce, Tracking of stolen vehicles/equipment using modern, and Bluetooth services etc.

E-government covers Civic engagement platforms, e-voting and public services announcements.

### **IV. CONCLUSION**

Mobile networks are engines of socio-economic development, driving digital finance, e-health, e-learning, smart governance, and agricultural information systems. Higher mobile penetration correlates with GDP growth, poverty reduction, and improved public services.

Network trend analyses revealed that, for many people around the world, mobile phones has become the primary means of accessing the internet and may soon become the only access point. According to findings by Ericson, users globally now regard internet access as a fundamental requirement for mobile broadband services, a trend that continues to drive the rapid growth in mobile data traffic.

With the mobile sector stabilizing and attention shifting to the broadband sector, there will be more investment, more revenue to government, more employment and social security and improvement in social-economic infrastructure that will be a strong foundation upon which a viable telecom service will be built for the future.

Future living environments are increasingly expected to rely on information resources delivered through interconnected communication networks. Emerging devices such as personal digital assistants, mobile phones and other handheld technologies continue to enhances information processing and access while supporting user mobility. In addition conventional household appliances and gadgets including digital cameras, washing machines, cooking ovens and refrigerators are now being equipped with computing capabilities, extending the concept toward a fully pervasive computing environment. Mobile computing environment are therefore shaped by recent advances in both computing and mobile technologies. Mobile networks serve as a unifying platform, connecting users within Nigeria and across the global community.

Managing a mobile network at a small and medium sized business can be challenging. Inadequate network infrastructure, changing technology, Regulatory and security issues, Low digital literacy, High cost of data and services with storage and obstacles to implementation are just a few of the challenges. However, there are several things that can be done to better face the challenges of mobile management.

With the widespread adoption of smart phones and tablets, we now live in an increasingly mobile-driven world. Third party mobile applications such as Apple's Siri, cloud services and platform like Yelp are growing rapidly and continue to enrich our daily lives. The mobile application eco-system is vibrant and highly supportive of open innovation, enabling phone and tablet manufacturers to continuously improve hardware and firmware.

At the foundation of this mobile world lies the cellular network. Unfortunately, the current state of cellular networks present a less encouraging picture. They are largely closed, proprietary systems are built on rigid, monolithic equipment. Innovation is limited to a very small group of equipment vendors and is not easily accessible to the wider research community. As a result, cellular networks are vulnerable to outages, dropped calls, performance issues and complex management challenges. The closed nature threatens to slow the mobile revolution or prevent it from reaching its full potential.

Mobile operators are also facing increasing pressure to protect their businesses. Although many successfully weathered the global financial slowdown, they now face a strong competition from internet giants such as Apple, Google and Microsoft, which are steadily capturing a growing share of consumers and business opportunities.

At the same time, users are by passing traditional cellular networks by relying on Wi-Fi to access services and content on their mobile devices.

When the global mobile community recently gathered in Barcelona, the major topic of discussion was how operators could generate additional revenue from the network into which they have invested heavily.

Recent United Nations figures indicate that over two billion people now use the internet, while data usage is at all-time high and continues to grow (UNDP, 2020). This growth, however, hides the reality that mobile operator's voice revenues have been declining for some time. Although data revenue are rising, there is still uncertainty about the most effective ways to monetize mobile data.

As mobile devices and services become more advanced, enormous volume of data are been generated, often without adequate management or oversight. This raises serious concerns, including the growing threat of viruses and security breaches. It is inevitable that

organizations will increasingly demand robust data management services and solutions before they become overwhelmed by unmanaged information. Furthermore, the need for a fully secure mobile data backbone-offering features such as data locking, remote wiping, and restoration in the event of device loss-has become critical. Safeguarding personal data and digital content such as ringtones, contacts, photos podcasts, games, videos and even full-length movies is therefore a top priority especially among young people and early adults.

Social media networks offer many benefits, but unfortunately, some individuals misuse these platforms for criminal activities. Several forms of crime are common on mobile and online networks. These include spying on people's emails, hacking into security systems, stealing sensitive data, impersonating organization or government bodies, uncovering competitors' strategic marketing plans, embezzlement of company funds and stealing credit card information for illegal sale.

Cybercrime has grown to such an extent that it has become essential to include it in academic curricula. Exposing students only to the harmful or unethical use of the internet creates a serious imbalance. With a stronger and more forward-looking educational system, students could be taught legitimate and ethical ways to use the computers and the internet, particularly in software development.

By teaching software creation as a recognized and productive skill, education systems can empower students to use technology as a lawful means of generating wealth and solving real-world problems, rather than engaging in criminal activities. This approach would not only reduce cybercrime but also promote innovation, entrepreneurship, and responsible digital citizenship

Fraud does not only result in direct financial losses for banks; It also undermines trust in the entire financial system as a reliable channel for conducting business. This makes it essential for banks and electronic payment service providers to increase investment in fraud management, particularly in strengthening people, processes, and technologies. In addition, greater effort is needed to raise cardholders' awareness of cybersecurity threats and privacy risks (ITU, 2022) as well as (UNESCO, 2020) attested to it.

There is little doubt that Health Information Technology (HIT) initiatives- such as electronic health record (EHR), e-prescribing, telemedicine, and remote health monitoring-have the potential to significantly improve the quality of healthcare while reducing costs for both providers and patients. However, these technologies are still largely in the implementation phase. Three key factors must be carefully considered when developing an HIT solution; security, scalability and cost.

Health care IT infrastructures enable the exchange of highly sensitive data among providers, insurers, and patients requiring networks that are robust enough to

transmit large files, such as MRI, scans, without performance degradation, while also remaining secure and compliant with the regulatory requirements. These regulations mandate strict privacy and security controls to prevent unauthorized access, use, or disclosure of patient data, particularly electronic health information (Beaver & Contos, 2018).

Despite advances in mobile networking technologies such as UMTS in Europe, truly high-speed mobile data connections remain limited. This constraint makes it difficult to support data-intensive applications such as mobile voice over IP (VoIP). Applications like Skype require broadband connections, significant processing power, and high energy consumption- capabilities that most mobile devices and networks still struggle to provide efficiently. Mobile phones, even smart mobile phones cannot yet handle large applications that convert traditional voice into VoIP data without rapidly draining battery life. As a result, VoIP solutions cannot simply be transferred from PCs to mobile devices. The challenge, therefore, lies in delivering of the benefits of VoIP to mobile users in a practical and energy-efficient way. They are trying to get all infrastructures working. It cost millions and millions for UMTS licenses in Europe to traffic high-speed data but no one is using it because it is very expensive and it's still not an Ethernet.

If you try port a VoIP call into a cell phone, you also need a lot of processor power so this is another thing. Mobile phone cannot handle a big application that has to transform the regular voice into VoIP data and send to a data channel. If you get an application to run on a mobile phone with a processor, it also drains down batteries very fast. So, you cannot just port VoIP as you do it from a PC or MAC to a mobile phone. The mobile phone is not a computer yet, even if you have a smartphone. The challenge is to find ways to provide VoIP benefits to your mobile phones.

Overall mobile networks, have demonstrated a transformative potential, particularly in enabling societies to leapfrog traditional development barriers. However, realizing their full potential requires strong collaboration among governments, the private sector, and international organizations. Given the challenges outlined, banks and payment service providers must enhance fraud management strategies, improve consumer education, and strengthen cooperation with law enforcement agencies.

Furthermore, innovation in mobile cellular networks is constrained by the limited access, academic researchers have to real-world network management tools and large-scale operational data. As a result, much wireless research is conducted using Wi-Fi rather than cellular networks.

Addressing this gap requires closer collaboration between network operators and academic researchers. By gaining insight into real operational challenges, researchers can propose future cellular network designs capable of meeting the evolving demands of the mobile world.

Governments now should invest in rural network expansion and digital education, Telecom providers should offer affordable data plans and devices, Development agencies should support mobile-based programs in healthcare and education, and Policies should address cyber-security, privacy, and digital inclusion.

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