ISSN:0975-9646

K.V. Ashok et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 2 (5) , 2011, 2262 - 2266

Mobile Communications for E-Applications

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Abstract-The evolution and growth of digital communications technologies has spurred various instances where wireless communications are being tremendously utilized to a multitude of ends and more importantly provoking new paradigm shifts. Digital inclusion and connectivity availability on a global scale remains one critical concern and definitely fuels the motivation and initiative for innovative solutions and appropriate models to bring the digital divide to a close. Mobile Information and Communications Technologies (lCTs) are more than a suitable and powerful technology that will help provide connectivity and digital access in a much faster and cheaper way for underserved areas of the globe, and therefore are to be strategically investigated and assessed within their most vital, strategic and profitable functional or usage contexts

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I.INTRODUCTION

HARNESSING MOBILE ICTs FOR DEVELOPMENT

It has become something of a cliche to say that recent dramatic revolutions in the field of Information and Communications Technologies (lCTs) have transformed our lives, although in the case of developing or emerging countries, this is true in a most dramatic way. ICTs in fact, constitute one important sector that has been successfully utilized to generate value and achieve key global aspirations such as the UN's Millennium Development Goals (MDGs).

A. A case for Rural and Remote Areas

Of more than 3.5 billion inhabitants in the world's low income countries, approximately 72% live in rural areas [1]. Rural and remote areas have evidently characterized as ones that considerably display very low ICT penetration and presence due several factors pertaining to the availability of resources and low potential of adoption. ICTs through their inherent, synergistic and dynamic property of evolving and can be tremendously leveraged to remedy the problem of connectivity in rural and remote areas.

B. Moving towards the best alternatives

A better, more available and cheaper option to enable Rural and remote connectivity reveals itself to be mobile Technology. Mobile technology through its various Developments has recently spurred increased interest and have become a considerable alternative as they provide Adoption as it offers much deployment flexibility and Low-cost feasibility. Thus, wireless access technologies Increased speed, link distances and resistance to difficult Propagation conditions. Furthermore, it becomes much more essential and crucial to extensively and comprehensively explore and research further, when targeted scopes or contexts are strategically selected and are under much consideration and of increased interest.

II. THE MOBILITY PARADIGM

The concept of mobility is one that perfectly lends itself to the context of providing feasible and cheap connectivity solutions to rural and remote areas. Mobile technology has emerged as a niche for the underserved as it offers connectivity, or access which is the first step toward opportunity. Connectivity is only one component of ICT, which is considered that span the four Cs: computer (rather, devices), connectivity, content and (human) capacity. As shown in Fig. 1 mobile ICTs can enable a more obvious human development through efficiency, empowerment and opportunities. The capacity of these technologies to reduce many traditional obstacles, especially those of time and distance has the potential to benefit millions of people in all comers of the world.

Fig.1 The Value of Mobile Communications

III. TRIGGERING AND ACHIEVING DEVELOPMENT

The deployment of effective ICT e-applications aimed at sustainable growth and development using mobile technology leads us to a preliminary investigation of the environment which ought to be permissive enough to achieve the best results. Considering different scenarios and case instances, an e-application or more precisely or contextually "m-application" in its use is supposed to allow its users to pervasively or ubiquitously access and share information. Various enabling factors therefore come in scope.

A. Suitable Wireless Technologies/ Broadband Availability

Wireless communication has been proven to be a key and suitable element in making ICTs available and optimally effective in rural and remote areas. Several wireless technologies are currently available and other innovative ones being developed, these being capable of offering broadband connections and supporting different e-applications suited for a rural or remote area. Among these, we can specifically distinguish the ones that potentially represent the most appropriate ones meeting the local requirements for successful and optimal deployment of e-applications. These are the following:

Mobile Cellular Networks (GSM/GPRS/ CDMA/3G): They offer medium coverage, carrier-grade voice services and medium to high -speed data services. Initially and primarily conceived for voice services, these network services provide a relatively optimal Quality of Service

(QoS) depending upon several and various factors relevant to the scope and environment. The 3G mobile networks more particularly enables the deployment of high speed data for wireless mobility. Specified by International Mobile Telecommunications-2000 (lMT -2000), these systems are to seamlessly integrate one or several radio channels with fixed networks for delivering high-speed data/voice services of up to 2Mbps rates

Mobile Internet (WiFi, WiMax): WiFi (802.11) and WiMAX (802.16) standards will extend the potential of Wireless Local Area Networks (WLAN s) to better speed rates and to a far wider coverage range. More particularly, the WiMax technology will allow a large coverage area of up to 50km and speed rates of 144Mbps

Wireless Mesh/Sensor Networks (WMN): A WMN is dynamically self-organized and self configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves (creating, in effect, an ad hoc network). WMNs consist of mesh routers and mesh clients, with mesh routers wireless routers relaying each others' packets in a multi hop fashion. WMNs are a modular and suitable solution when it comes to rapidly deploying a dynamic and scalable network within defined boundaries. Wireless mesh networks have the potential to deliver Internet broadband access, wireless local area network coverage and network connectivity for stationary or mobile hosts at low costs both for network operators and customers. Adoption of these networks is rapidly growing along with advanced research being carried for higher functionality in wireless services.

Next-Generation Radio Technologies (4G, Wireless VoIP): Wireless technologies are aggressively developing and evolving towards a groundbreaking and vantage point where performance and capacity are significantly increased. Next Generation Mobile Networks is a distinct notation for the next generation of mobile wireless networks which will provide a tremendous technology evolution beyond today's 3rd generation mobile networks (3G). Within this new paradigm or concept we will see a strong convergence of disparate technologies into a more consistent and dynamic core capable of offering services at higher grades and levels along with a much better and richer experience. As a result, we have new stemming trends such as IP Multimedia Subsystem (IMS), Voice over IP (VoIP), and Unified Communications which can all hinge on the mobility advantage (4G) and be of vital service to underserved areas.

B. Devices and Platforms

Powerful and effective ICT e-applications are mostly designed and delivered on software platforms and devices for use. In relevancy to rural and remote areas capitalizing on the power of mobile communications, specific and appropriate mobile devices and platforms are to be rolled out, these allowing optimal functionality and performance along with a good user experience. These mains elements are identified as the following

- Mobile phones/Smartphones and Personal Digital Assistants (PDAs)
- Mobile Internet Devices (MIDs) and/or Ultra-Mobile PCs
- Laptops (wireless-enabled) and/or Net books

Devices and their platforms represent the nodal interface Between the individual (user) and the data or information thus playing a crucial role in the information service process. However estimable challenges and limiting factors still exist with regard to the availability, characteristics, properties and features of those devices in terms of offering or allowing the best or most optimal user connectivity experience. These constraints are mainly

- Cost/Price
- Usability and Functionality
- Performance and Computing (Processing
- power and Power supply):
- Operation environment and conditions

IV. DEVISING STRATEGIC ICTs APPLICATIONS

ICTs have changed the way business is conducted, facilitating learning, information flow and knowledge sharing, thus empowering citizens and communities to redefine governance. The resulting global information society has created significant wealth and economic growth. Bringing ICTs to rural or remote areas fundamentally implies a certain transformation that leads to a better exploitation and use of different resources, thus improving life in various aspects. Strategic domains or sectors are essentially considered in developing rural and remote areas. These are: health, commerce (business), government and environment

A. e-Health

Applications for e-Health can be implemented through mobile wireless technology to serve and benefit rural and remote areas with an improved efficiency and yet at a reduced cost. From the concept of e-Health stems the one of "m-Health" or mobile health, generally used to designate the implementation of e-health through the use of mobile ICTs [4]. Given the great potential mobile ICTs offer for rural and remote areas, a wide array of applications are being considered. Key targeted e-Health applications using mobiles are the following [8]:

• **Remote data collection and monitoring**: by making an effective and extensive use of smart phones, PDAs or mobile phones, critical and vital data can be remotely gathered from patient locations and stored in appropriate databases to be accessed and updated on a real-time basis. Also, remote monitoring can therefore be implemented wirelessly to help patients in improving their conditions.

• **Disease and epidemic outbreak tracking:** with a Successful and effective deployment of mobile devices, disease and epidemic outbreak can be made possible and optimized given the fact that these devices can capture, receive and send data on disease occurrence and also be designed to sense natural incidence of particular disease factors.

• **Diagnostic and treatment support**: the ability to timely diagnose a condition and accordingly provide treatment is an important element in health care and can be strongly supported and streamlined by mobility where a device can be used to assist a worker in his/her diagnosis process and also lead himlher to the best prescription.

• **Communication and training for health workers**: mobile technology comes as a crucial lever to empower health workers, bridge communication gaps and meet the requirement of consistently training health professionals and workers on the current trends and new practices.

• **Education and awareness:** short message services (SMS) being incrementally cost-effective and scalable can be leveraged to inform and educate the population, provide Alerts and interactive exchange between rural patients and healthcare workers.

B. e-Government

Mobile ICTs have great capability to effectively deliver public services to society and in this sense can be extensively harnessed to particularly improve government for populations living in rural and remote areas. By focusing on the scope of mobiles' potential for development, the idea of m-government comes forth and verily suggests the use of mobiles devices to conduct government-oriented activities. We identify the different mobile e-government or m-government applications as relevant to the following [9]:

• **Communication between government and remote citizens:** the communication process between governments and citizens living in remote areas can be improved and treamlined through the use of Short Message Services (SMS), which are already available on mobile and other handheld devices,

• **Payments and financial transactions:** on the top alternative for payments and financial transactions, other available mobile devices such as MIDs, Netbooks and Laptops can provide wireless data connectivity through prime access technologies (WiMax, WiFi, GPRS/EDGE) to securely help users conduct or perform their vital transactions.

• **Administration and decision-making inclusion**: rural and remote areas citizens would be no longer marginalized, when there are available means to include them in the decision-making process of the government and also help them respond and participate well into administration activities. For this, SMS and mobile internet applications are deemed suitable to remotely input and retrieve information.

C. e-Environment

Implementing e-Environment strategies should firstly be rendered in a synergetic effect of any ICT e-applications in a sense that they should be environmentally friendly as to help reduce the carbon footprint, secondly concretized in relevant ICT applications aimed at combating, monitoring and mitigating different climate or environmental disasters. Mobile e-environment or m-environment applications can be made available to allow rural and remote areas populations to protect themselves, their environment and actively participate in the climate change fight. Main applications are identified as
implementable for the following cases:

• **Observation and warning or alerts systems**: Satellite networks, Geographical Information Systems (GIS) databases can be linked wirelessly and made available to be accessed
from mobile platforms in order to analyze weather trends and other environment-critical information,

• **Emergency and Disaster Mitigation:** By using mobiles devices along with wireless localization technologies such as GPS, critical communications can be made effectively in a timely manner and allow responders in case of disaster to effectively manage situations and save lives

•**Awareness and Capacity Building**: mobile information systems such as SMS, e-mail, phone calls, social web feeds can allow remote populations to educate and inform themselves about maintaining low-carbon lifestyles, current climate trends, and any other potential disaster threats.

V. PRACTICAL IMPLICATIONS

A. Establishing an opportunistic, correlative and contextual matching model between technologies and applications

To be able to correctly define the different feasibility implications and successfully approach the implementation challenge, one requirement is to carefully consider the different available technologies and systematically compare and assess them against their application and usage domains. This meaning that given the fact each technology presents more or less constraints and other limiting aspects, there will be varying tradeoffs depicting how one solution lends itself better to a context than the other.

Considering the different characteristics and aspects of the e-Health e-Commerce, e-Government and e-Environment, we are faced with an important technical aspect that is relevant to how the most appropriate technology can be chosen in order to respond to the context's requirement and implications. The following table (Table I) therefore suggests a typical model that provides a mapping of the different application domains to their technical requirements and constraints.

TABLE I

CONTEXTUAL CATEGORIZATION AND MAPPING OF MOBILE TECHNOLOGIES AND APPLICATIONS WITH CONSTRAINTS AND OPTIONS

Domain of application	Implications and Requirements	Constraints	Technology Compatibility	Best Technology Options
e-Health	• Distributed Architecture • Robust and Secure Telemedicine Networks • Optimal bandwidth for reliable data links • Optimal availability	• Environment (Terrain, Geography, Location) • Implementation Cost • Deployment Cost • Operation Cost • Maintenance Cost • Performance • Reliability • Security • Availability • Capacity • Adoption and Usability	Wireless Data/Voice Networks (Cellular, 3G/4G) Mobile Web (WiFi, WiMax)	High-Performance Mobile Wireless: 4G, VoIP (voice over WiFi) WiMax
e-Commerce	• High-performance Client/Server integration • Highly secure data transfer • High-speed data links (increased bandwidth) • Banking and commerce web applications • Optimal availability and capacity		Cellular Wireless (3G/4G), Mobile WiMax, Mobile Satellite Internet	Reliable and Secure Data Transfers over: WiMax and VSATs
e-Government	• Mobile Web integration • Peer-to-Peer Integration • Centralized Architecture • Wireless Alerts and Monitoring System • Optimal Security for critical Information exchanges		Cellular Wireless (3G, 4G), WiFi, Wireless Mesh Networks (WMNs),	Optimal and reliable information transfer and sharing over: 3G, WiMax
e-Environment	• Mobile Web integration • Peer-to-Peer integration • e-Emergency services • Location-based services		Cellular Wireless (3G, 4G), WiFi, Wireless Mesh Networks (WMNs)	3G, WiMax, WiFi

B. Adopting an integrated and hybrid implementation approach for suitable implementations and deployments

Building and implementing mobile wireless networks for rural and remote area is deemed to be an extremely challenging task with more or less complexities and intricacies. However, the opportunity and advantage still lie in the fact that technological constraints can be dealt with and managed through the consideration of a wide range of available technologies and diverse implementations. Successfully rolling out mobile networks in remote and areas implies gradual procedures where technologies, features and capabilities can be incrementally built on top of each other through to fully enriched, capable and mature deployments.

The internet combined to its different variants, reveals itself as the core enabler and crucial fulcrum that would bridge and fuel all the different network constituents. Thus, IP-centric models and technologies will have predominance. Practically speaking, it is expedient to mention Wireless Community Networks (WCNs) which represent a new, community-based small locality oriented strategy for overcoming the lack of technology and related opportunities in underserved areas. They are a good example of development model suitable for remote and rural area. Building Wireless Community Networks is a suitable and appropriate alternative as the feasibility pertains to cost-efficiency and sustainability which we will make case of and address in the following section. Overall, what would be the most beneficial and convenient is the deployment of an hybrid/integrated set of networks that would eventually responds to various application needs. Fig. 2 [10] shows an example of such a full implementation within a typical environment.

V. ECONOMIC AND FINANCIAL SUSTAINABILITY

Any deployment aiming for sustainability must be cash flow positive. Considering rural and remote areas, key elements of a low-cost strategy should be acceptable quality within affordability.

A. Providing Low-Cost Solutions

Only low-cost solutions are the suitable ones for rural and remote area given their relatively low financial and purchasing power. The provided applications have to be cost-effective for basic needs and services in the concerned fields of health, government and environment. Technologies however can be incrementally costly as long as there are perceptible benefits leading to a better lifestyle. The concept of leapfrogging also implies a significant move toward reducing the cost of implementation and deployment. Wireless equipment and supplies turns out to be cheaper that wired infrastructure equipment. Moreover, there is great cost reducing potential in adopting and utilizing free and open source software tools and computing platforms. The Free and Open Source Software (FOSS) or the Free Software Foundation has been established to provide accessibility to such resources and help develop or implement through support.

B. Business Models Considerations

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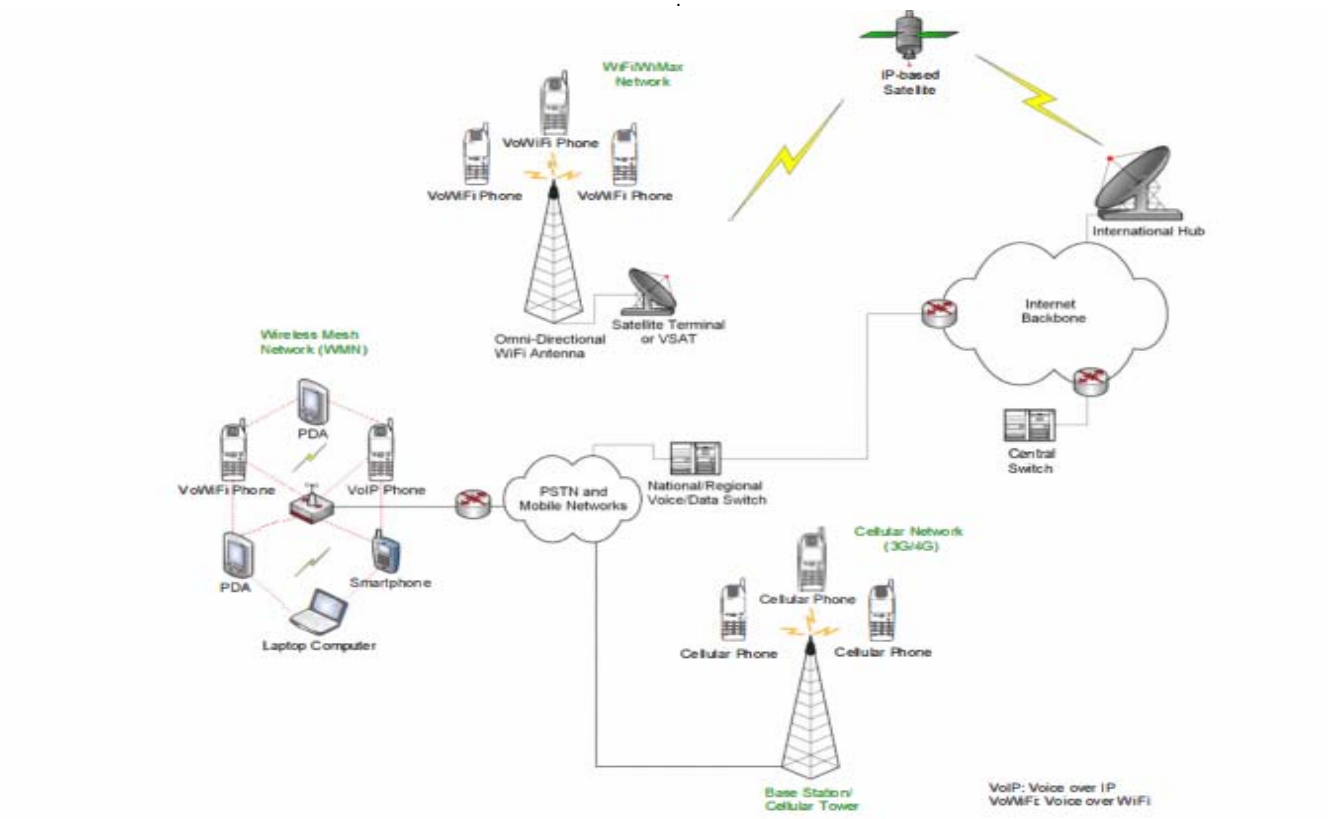

Fig. 2. Hybrid and integrated model network of mobile technologies for a rural/remote ecosystem

VI. CONCLUSION

Mobiles are definitely proven to be more than suitable and attractive to help achieve sustainable development in rural and remote areas, as they provide countless benefits and advantages in their integration. As an emerging technology, mobile communications in still in development and tremendous work and research in been carried out in order to devise more innovative solutions and alternatives that can especially benefit rural and remote areas. Nevertheless, it still worth pointing out the few drawbacks faced by such initiatives, which taken in consideration, will help improve and streamline solutions and projects to be implemented.

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