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ABSTRACT

With the growing need for ubiquitous connectivity, it is essential to develop business models which better fit noncommercial wireless communications services, particularly Wireless Community Networks (WCNs). Developing these business models for WCNs is challenging due to their public-private hybrid nature, lack of strong commercial incentives, high uncertainty, and the high complexity of the relationships among key business partners. The purpose of this paper is to propose a framework for developing public-private hybrid business model for WCNs and test it using several case studies. The framework addresses several elements such as product innovation, customer relationships, infrastructure management, and financial aspects of this emerging business. This framework would serve as a guide for WCNs to achieve digital, social, and economic inclusion for particular groups such as rural residents, underserved communities, and the mobile workforce. In addition, it should have a positive impact on addressing the pressing issue of the digital divide.

Keywords

E-business models, digital divide, wireless community networks, WiFi hotspots.

INTRODUCTION

The rapid proliferation of Information and Communication Technologies (ICTs) and their numerous commercial, social, governmental, and personal applications necessitates developing new business models to make these benefits available to all individuals. A broad range of new business models have evolved, particularly in the domain of digital economics, and many existing models have been enhanced taking advantage of emerging ICTs. ICTs help businesses to expand the geographical boundaries of their traditional markets, conquest new markets, reduce transaction and delivery costs, and create new products and services. ICTs have the capabilities to improve business partnerships, offer shared value propositions, create multi-owned distribution channels, and increase profit from shared and diversified revenue streams (Osterwalder and Pigneur 2004). However, around 85% of the world's population does not have access to the Internet. The average Internet usage rate is 2.5% in Africa, 9.6% in the Middle East, 36% in Europe, and 68% in North America (Internet World Stats 2005). In addition, almost 53% of the world's population lives in rural and remote areas where necessary communication infrastructure is not available. This is due to their low population density, inadequate income, and remote location, which do not provide strong business incentives to Internet Service Providers (ISPs) to deploy infrastructure. Such a harsh business environment increases the complexity, risk, and uncertainty with respect to different aspects of the associated business models. Therefore, providing ubiquitous and affordable wireless connectivity, particularly to rural and underserved communities, has grown to be a pressing issue and a public concern. The term "digital divide" describes the fact that people, in certain communities, can be divided into two groups according to whether they have affordable access to ICTs (Abdelaal and Ali 2005; Kruger 2004; Norris 2000).

International organizations have expressed a growing concern that the uneven diffusion of the Internet may leave many nations lagging behind and broaden the growing gap between developed and developing societies (Norris 2000). Information poverty and lack of technical skills prevent rural communities from developing their natural resources. Specifically, the lack of Internet access affects the ability of children to improve their learning skills, workers to improve their job opportunities, and low income families to benefit from the wide range of social, commercial, medical, personal, and civic services provided by the Internet (Abdelaal and Ali 2005). The pervasiveness of wireless communication improves time saving, productivity, flexibility, and quality of work. For instance, a study by Sage Research (2001) has found that wireless communication saves around $150 per week per user.

Previous discussion indicates the necessity for developing business models to provide affordable wireless communications to rural and underserved communities, and this is a challenging task. These business models should have new insights about product innovation, revenue models, cost models, service pricing, and infrastructure management. For instance, SkyFrames, Inc. deploys ISP facilities via satellites within schools in remote areas throughout the U.S. (eSat 2005). SkyFrames does not charge schools for Internet access in return for hosting the facilities, but it charges the local community for this service. The New Orleans WiFi network has been established with $1 million donated equipment after the hurricane disaster to help the economic recovery in the area. OzoneParis, Paris, offers free Internet access to individuals who make their rooftop available to host the network facilities. NYCWireless uses a distributed ownership and a centralized management model for the infrastructure to provide specific neighborhoods with free WiFi access. Google is planning to provide free WiFi access in San Francisco in return for sending advertising on the screens of the mobile devices. Therefore, the business model should reflect the characteristics of the designated community and take advantage of available resources.

Wireless Community Networks illustrate a collaborative business model through which the communities design, build, and run a wireless (or mesh) network to provide local communities with affordable (or free) Internet access for the purpose of bridging the digital divide. These networks could be implemented via deploying clusters of wireless networks either by pure wireless technologies (i.e. WiFi, WiMax, satellites) or by a combination of wireless and fixed networks (Abdelaal and Ali 2005; Akyildiz, Wang, and Wang 2005; Shamp 2005; Bahl 2004). However, there is a need for particular business models that better illustrate the business process of providing digital connectivity to rural and disadvantaged areas in order to bridge the digital divide. This business model should address innovative and flexible scenarios for strategic partnership, service pricing, product innovation, distribution channels, and financial aspects that better adapt to fit this adverse business environment and the associated segment of customers.

PREVIOUS WORK

A business model is an abstract which demonstrates how a firm generates revenue and specifies its position in the value chain (Rappa 2006; Osterwalder and Pigneur 2004). It outlines the contribution of the firm's business partners in creating, marketing and distributing a specific value to a particular segment of customers in order to generate sustainable revenue streams. The proliferation of the Internet and its numerous applications has created a new segment of electronic business (e-Business) models which include Affiliate, Subscription, Community, Brokerage, Information Collection, Advertising, Merchant, and Revenue Sharing. Osterwalder and Pigneur (2004) have developed a detailed ontology of e-business models whose pillars are product innovation, customer relationship, key business partners, infrastructure management, and financial aspects.

The exponential increase of WiFi hotspots at public venues (i.e. cafes, restaurants, business districts, airports) has evolved new business models. Shubar and Lechner (2004) have classified these business models into 14 categories based on ownership type and contribution in the value chain. However, this classification ignored community ownership as a growing business model for WCNs. Camponovo, Heitmann, Stanoevska, and Pigneur (2003) have explored different business models for private, community, wide area, and WiFi hotspots in the Swiss market. Their classification for WLANs business is based on whether the provided service is for commercial purposes or not and how extensive the service is. Their work is based on the ontology of e-Business models developed by Osterwalder and Pigneur (2004). The authors did not identify the differences between commercial and noncommercial WiFi hotspots. Jamaluddin, Doherty, Edwards and Coulton (2004) have proposed a hybrid operating model for public hotspots that can be used for advertising. The authors suggested offering free WiFi access to the public in return for sending localized advertisements to their wireless devices. The online community business model depends on user loyalty and voluntary contributions. In return, community members may obtain subscriptions, adverting, and self publishing (Rappa 2006). This model is not suitable for WCNs due to their high risk and up-front investment.

It is important to note that some aspects of WCNs require the government intervention and regulation due to their similarities with public goods. Meinrath (2005) has called WCNs "open infrastructures" and proposed a research agenda and plan of action for the ubiquity of this emerging business. The author suggested progressive reforms for spectrum usages and regulations, and emphasized the need to identify technical, business, and legal issues of WCNs. In addition, the author suggested conducting an in-depth assessment of the social and economic impacts of this emerging model, particularly with respect to the digital divide. Abdelaal and Ali (2005) have proposed different technical implementation scenarios to provide digital connectivity to rural areas via collaborative efforts led by local academic institutions. More importantly, wireless communications have several characteristics of public goods because they have economic externalities, no exclusivity and free-rider property (Ikeda and Ye 2003). Theoretically, the market fails when there are negative or positive network externalities. In case of positive externalities, the value of the service will increase when the usage increases and vice versa. Obviously, all market partners are subject to either taxes or bounties for negative externalities and positive externalities respectively. Therefore, government intervention is highly recommended to achieve efficient resource allocation. For

instance, it is recommended to provide incentives (i.e. free access, low rate) to new customers to subscribe to the service. If the wireless signal is not encrypted, network managers cannot exclude anybody from intercepting it (non-excludable). In addition, several users can use the signal without reducing the chance of others to use it (non-rival), particularly in ad hoc communications. Simply, this is because all individuals have the right to use the unlicensed frequencies. Usually, WCNs cannot afford licensed frequency bands. For cost reduction, Clement, Holbrook, and Staman (2005) have suggested involving local government organizations in deploying WCNs. Best and Maclay (2002) have discussed the immediate issues with respect to providing Internet access to rural and disadvantaged areas.

PROPOSED FRAMEWORK

This paper proposes a framework for developing a collaborative public-private hybrid business model which better fits WCNs and neighborhood networks for the purpose of digital inclusion. Developing such business models is a challenging task for the following reasons:

1. Their public-private hybrid nature
2. The lack of strong commercial incentives
3. Their high risk and uncertainty
4. Their high complexity

The *public-private hybrid* nature of WCNs, due to their similarities with public goods, imposes specific characteristics of business models. For instance, the vision of value creation, business partners, and service pricing in such models is different from traditional business models due to including public benefits (i.e. positive externalities) from this particular service. In addition, it requires different success factors such as using a makeup of community and public resources via collaborative efforts and volunteer work. Therefore, WCNs have customized revenue model which may have the goal of only recovering the associated costs.

Unlike commercial WiFi hotspots, WCNs have *a lack of strong commercial incentives* for ISPs due to the low population density, remote location, and low income of such communities. In addition, wireless LANs require a significant up-front investment to deploy the necessary infrastructure such as the Internet backbone (i.e. fiber cable, satellite system, T-1 line), gateways, antennas, routers, towers, and other equipment. The lack of commercial incentives and the high up-front investment prevent ISPs from entering the market, thereby creating a monopoly model. This will affect other aspects of the business model such as customer relationship, affiliation, and service pricing. This is basically because customer loyalty is guaranteed in such a model. Unlike cellular systems, WiFi and WiMax technologies usually use unlicensed frequency bands 2.4GHz and 2-11GHz respectively. VoIP via WiMax is expected to replace switched telephony for its high bandwidth (70Mbps), wide coverage, high mobility support, and built-in QoS. WiMax could be used to aggregate WiFi hotspots which facilitate roaming and settlement agreements due its wide coverage. This minimizes market entry requirements for small ISPs such as neighborhood networks and ad hoc communications. Consequently, WCNs may act as service aggregators, particularly using WiMax, since they are the only gateways to the Internet.

WCNs have *high risk and uncertain environment* because they usually depend on volunteers to build and manage the facilities, and on community resources and public grants to fund the facilities. This is one of the major reasons for the opposition against involving cities in such business. In addition, WCNs may not have stable revenue streams since the service may be provided free of charge or at low cost. In this case, the choices and resources are limited and this adds more uncertainty to the business model. For instance, Marietta, Georgia failed and sold its municipal network, at a substantial loss of $23 million, due to poor financial records.

Designing business models in such harsh business environments has *very high complexity* due to the diversity of associated business partners who have different business objectives and, probably, conflict of interest. For the many reasons discussed above, these partners could include federal/state organizations, non-profit organizations, academic institutions, businesses, and community members. The diversity of these business partners (including subscribers) is expected to affect all aspects of the business model and increase its complexity. For instance, the pricing policy should be able to differentiate among different users based on traffic load, target customer, content, security requirements, connection duration, or time of connection. Specifically, the basic service (Internet access) could be free of charge; however, users may have to pay for the content and upgraded services such as higher bandwidth, VoIP, gaming, advertising, and domain hosting.

Elements of the Proposed Business Model

This proposed framework for WCNs business models further explores the management tools and e-Business opportunities that better fit public-private hybrid business environments. Our work is based on the ontology of e-Business models developed by Osterwalder et al. (2004). Following are the components of the proposed business model:

- *Product Innovation***:** The novel service that WCNs provide is bridging the *digital divide*, improving the business environment, and enhancing municipal services via providing affordable or free Internet access to rural and underserved communities. This is to accelerate human development and improve the living standard for these communities. Providing connectivity to rural communities facilitates many consumer-to-consumer (C2C), business-to-consumer (B2C), and government-to-consumer (G2C) transactions. In other words, WCNs create a wide range of commercial, governmental, social, medical, and learning value generation channels. For instance, WCNs may affiliate with local businesses to better facilitate e-Commerce services via advertising, portals, location-based services, and e-billing. This inclusion process of rural communities in the e-marketplace decreases the transaction cost, thereby decreasing the prices of final products. Further, WCNs can collect information on the subscribers and their buying habits and sell it to other firms (Infomediary business model). Providing free WiFi access to schools in St. Cloud, Florida, saves around $100,000 a year. The crime and the murder rates have increased 300% and 84% respectively in New Orleans after the Hurricane Katrina. After the city deployed IP-based surveillance cameras in high crime neighborhoods using its WiFi network, the murder and the auto theft rates decreased 57% and 30% respectively. Therefore, they have a substantial impact on rural communities as shown in Table1.

Field	Value Generation Channels
Human development	Digital, social, and political inclusion
Telemedicine	Augmenting electronic public health services
e-Commerce	Advertising, portals, location-based services, e-billing, cost reduction
e-Government	Access to government resources, e-democracy, public safety
Community services	Mailing lists, bulletin boards, self publishing, virtual communities, accessing neighbors' knowledge and resources
e-Learning	Online tutorials, distance learning, digital classrooms

Table 1. Value Generation Channels for WCNs

- *Customers' Relationships:* The primary target customers of WCNs are resident of rural and disadvantaged areas. WCNs also may lease bandwidth and provide paid Internet access to other local ISPs, government organizations, and businesses for the purpose of cost recovery. The main concern is that the network operators may not work on improving service quality because of the guaranteed customer loyalty due to the lack of competition. The community characteristics (i.e. size, average income, location, degree of awareness, legal environment) have a significant impact on the elements of the designated business models. These characteristics impact the target customers, pricing policy, available resources, possible partnership, and type of ownership for the infrastructure.
- *Infrastructure Management:* The initial investment may be obtained from grants or donations such as in New Orleans, OmahaWiFi, and the Tribal Digital Village. However, one of the main challenges facing WCNs is providing long-term management structure. Usually, WCNs cannot afford full-time administration staff. They may collaborate with volunteers, use part-time staff, or affiliate with academic institutions in the locality to host, design, build, and run the facilities like in the SkyFrame, Inc model. Key business partners are subject to the business mission and the primary objectives of each partner from providing ubiquitous wireless connectivity to these communities.

  WCNs should collaborate with different community members, federal/state organizations, businesses, and academic institutions to enforce the success of this business model for the betterment of these communities. For instance, partnership with cities and counties is essential to reduce costs and utilize usable assets like towers, high buildings, public venues and any other assets and resources that might assist the building of these networks. Partnership with academic institutions is essential to take advantage of their resources such as manpower, facilities, location, equipment, and technical skills which may guarantee a long-term management team. In return, WCNs advance knowledge, and obtain free expertise, training facilities, and a better learning environment. Examples of WCNs which have partnerships with academic institutions are Sparknet, OutlawNet, AllCoNet, and OmahaWiFi. Recycling programs such as Dell, IBM, HP, and the National Recycling Coalition could participate and provide free equipment. Table 2 summarizes potential contributions and benefits of different business partners in WCNs. The main driving forces for this business model are public resources, business contributions and affiliations, resources of academic institutions, and community resources.

Business Partner	Potential Contributions	Potential Benefits
Volunteers	Time, equipment, experience, donations	Experience, recognition, connectivity, tax exemption
Federal/ state organizations	Funding, tax exemption, frequency licenses, access to public venues	Boosting municipal services, human development, e-Government
Businesses	Fund, equipment, experience, affiliation	Adverting, cost reduction, access to buyers and sellers, domain hosting, improving the business environment
Academic institutions	Hosting the facilities, operation, equipment, workforce	Obtaining a better learning and research environment, expertise, donations, and grants

Table 2. Possible Contributions and Benefits of Business Partners

- *Financial aspects:* Due to their public-private hybrid nature, the financial goal of WCNs may only be concentrating on recovering implementation and operation costs which they may obtain from different sources. For instance, several US federal organizations such as the Department of Agriculture (DOA), Federal Communications Commission (FCC), and organizations serve minorities that are working on providing Internet access to rural areas. Readers are referred to Kruger (2004) for detailed information about the regulations and funding opportunities provided by U.S. federal organizations for the purpose of bridging the digital divide in rural areas. Following are possible revenue streams for WCNs as proposed by our framework (Table 2).

    1. Grants from federal, state, and nonprofit organizations
    2. Corporate and individual contributions and donations
    3. Fees and revenues from business partners and affiliations such as e-auctions, portals, advertising
    4. Fees of community services such as self-publishing, upgrade services, and domain hosting

CASE STUDIES

Following are several examples of WCNs that illustrate the proposed framework:

AllCoNet Project

AllCoNet is a typical WCN in Allegany County, Maryland. It has utilized a collaborative partnership with federal/state organizations, non-profit entities, businesses, and the local community to build and run the WCN facilities. This network provides Internet access to approximately 95% of all business locations, 85% of all residential areas, and 100% of government facilities as well as 100% of all industrial parks at very affordable costs (www.**AllCoNet**.org).

- *Product Innovation:* The primary purpose of AllCoNet was to provide high-speed Internet access to local schools to improve the learning environment. However, the project has expanded its objectives to include bridging the digital divide and improving business opportunities in the locality via providing affordable wireless connectivity to public schools, libraries, government buildings, businesses, and local community organizations in the mountains of western Maryland. Another goal of the project is to emphasize the geographical advantages (i.e. business opportunities, tourism, and research) of the area. In addition, the project has saved about $840,000 a year for local businesses by facilitating e-Commerce transactions. Further, the project enhances the skills of the workforce and human development in the area. AllCoNet handles 850,000 circulation-desk operations per year for the public libraries and provides connectivity to 35 schools.
- *Infrastructure Management:* The project does not use full-time staff for management. Instead, it uses the workforce of volunteers and students of Frostburg State University to deploy and management the network. AllCoNet business partners include the City County, local businesses, the Rural Telecommunications Congress, and other public and private groups whose concern is to improve the quality of life in rural areas. The State of Maryland, the Appalachian Regional Commission (ARC), and the Board for Education are examples of main funding organizations (around 50% of the fund). This collaborative public-private hybrid business model provides faster, reliable, and inexpensive wireless connectivity to all community members and local businesses. It represents the demand aggregation concept in economic theory where it aggregates traffic from local ISPs, ad hoc communications, and mesh networks. It was easier for the project to obtain an FCC license to use wireless communications than to obtain the right-of-way for fiber optic cables.

- *Financial Aspects:* Most of the funds have been obtained from grants and leasing bandwidth to local entities. Initial costs were $4.7 million, 50% of which has come from the state and e-grants. The rest comes from the federal government and from issuing a local bond. AllCoNet leases bandwidth to other local ISPs such as TWR.

Other Case Studies

The British Columbia Wireless Network (B.C. Wireless) is a non-profit organization dedicated to provide affordable high-speed Internet access throughout the province of British Columbia, Canada, for the purpose of bridging the digital divide. It provides the technical infrastructure that provides connectivity and an information infrastructure that provides services to community members (i.e. web sites, community event postings). Further, the project is built on the notion of aggregating mesh and ad hoc networks where individuals participate by providing their own node (router or access point) to form a cluster of wireless networking. Mesh networks create an intelligent wireless network that can dynamically discover and route to other nodes without infrastructure (i.e. access points, routers). The project usually uses donated equipment and open-source software such as Linux for cost reduction. B.C. Wireless collaborates with volunteers, other hotspot providers, and public entities such as the Vancouver Public Library. It helps in recycling IT equipment and hosts training workshops sponsored by volunteers (http://www.bcwireless.net/).

The Tribal Digital Village project started in 2001 with a $5 million grant from HP through its e-inclusion initiative as there was no feasible commercial solution to deploy infrastructure in these reservations. The infrastructure has been designed, built, and managed by trained tribal members and high school students. The project has successfully promoted social, educational, cultural, telemedicine, community, and economic growth in these tribal reservations. It has created new business opportunities such as the Southern California Tribal Technologies Company (http://www.sctdv.net/).

There were no viable incentives for ISPs to deploy telecommunication infrastructure in Ore, Oregon, due to its small community and remote location. Ore's high school has leased a T-1 line and purchased the necessary equipment to build its own ISP facilities, which called OutlawNet (www.outlawnet.com). This project provides free Internet service to students and faculty members. It charges local residents and businesses for the Internet access in order to recover costs. In addition, they obtain public grants and community support to help in this regard. The project depends on volunteer students to run the facilities. In return, students gain free Internet access, better learning and research facilities, and expertise. Further, the project provides free technical training and refurbished equipment for needy individuals.

The Community Access Program (CAP) in Canada connects 5 million Canadian citizens through 2,000 projects via participating with 50% of the fund. The program helps communities to deploy and run wireless infrastructures using a "build it and get out" strategy (http://www.tc.ca/).

SUGGESTED SUCCESS TIPS

Previous case studies show that the success of this emerging business model requires collaboration with federal/local organizations, businesses, academic institutions, individuals, and technology partners. Such local and community-driven solutions for the digital divide problem are strongly recommended to take advantage of the available resources in the society and the particular characteristics of these communities. These partners should team up in a win-win strategy for a common investment and a shared vision in this arena for the betterment of the community. Academic institutions can obtain free high-speed Internet access, expertise, and learning facilities just for hosting the ISPs system. Individuals and businesses who contribute (i.e. donations, recycled equipment, volunteer work) should obtain some incentives from government, academic institutions, businesses, or WCNs. These incentives may include especial tax treatments, scholarships, internships, or upgraded services such as domain hosting and higher bandwidth. It is highly recommended that military satellites be configured for dual-usage to be used as a free Internet backbone for WCNs.

The main challenges for this emerging business model are its legal issues, quasi nomadic management structure, lack of competition, and unstable revenue stream. These legal issues are mainly due to its public-private hybrid nature where non-profit and private organizations are involved. Politicians' support is crucial to overcome these challenges particularly obtaining the right-of-way for the infrastructure and public funding. The instability of the management structure, due to its volunteer nature, could be solved by partnership with local academic institutions to guarantee a long-term management and operation structure. However, the lack of competition may affect the service quality.

CONCLUSION

This paper has proposed an abstracted framework for public-private hybrid business models to better fit WCNs in order to achieve ubiquitous connectivity for rural communities. Developing such business models is a challenging task due to the lack of commercial incentive, high uncertainty, and complexity of partners' relationship. This framework is supported by an

exploratory study of these emerging business models in order to identify the product innovation, customer interface, infrastructure management, and financial aspects of this emerging business. The driving forces for WCNs are public funds, community resources, partnership with academic institutions, and businesses' contributions and affiliations. These collaborative efforts achieve digital, social, and economic inclusion for underserved and rural communities. The individuals and organizations who participate with time, effort, equipment, and expertise into WCNs should receive special incentives to guarantee their loyalty and long-term partnerships. These upgraded services could include domain hosting, portal affiliation, advertising, or higher bandwidth. The unlicensed frequency band should be well regulated and expanded for more benefits for the public, as WCNs cannot afford licensed frequencies. Academic institutions are encouraged to deploy and run WCN facilities to obtain expertise, free Internet access, and better research and learning environments. In this case, a long-term maintenance and management structure for the facilities is guaranteed by the academic institution. Lack of competition, unstable revenue streams, and the quasi-nomadic management structure will remain as major challenges that require innovative solutions. Future work will further investigate the impact of using the capabilities of WCNs to send commercial advertising and location-based services to generate new revenue streams.

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