A SEAMLESS CITY:
THE CASE STUDY OF TAIPEI'S WIFI PROJECT

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Summary

Many municipalities, such as Grand Haven of Michigan, Cumberland of Maryland, and the newly case, Philadelphia, all recognize the merit to promote public access to wireless broadband, and make efforts to achieve the goal of being the digital city. Taipei is no exception on the right track, but in a different way. It seems that the "M-Taipei Initiative" makes Taipei the largest WiFi hot zone covered in the world. This paper explores the features of the M-Taipei Initiative and analyzes its uniqueness from the perspective of transaction cost economics. Unlike other municipal projects, Taipei's employs the build-and-transfer method to invite the private sector's investment. In so doing, could the tender firm be allowed the most autonomy and flexibility in response to market dynamics and generates higher economic efficiency. It also applies the concept of the eco-system to analyze the three factors symbiotic to engender network effects. This case study expectedly provides other countries with some guidelines to develop the WiFi network and its services.

1. Introduction

Nowadays mobile phones have become a mixture of consumer electronics, fashion, and banking. We do not make calls over this mobile handset but also retrieve emails, download MP3 music, play games, pay the parking meters with the same device. The term wireless broadband is then widely cited for the next-generation of human lives, or at least, to be a critical component of human communication and behaviors. It's the vision that science fictions portray about all the time and will be realized someday. However, the market of wireless broadband seems far from maturity even if the topic is the chic chat.

The third-generation (3G) mobile communication licenses were first auctioned at the skyrocketed prices in the Britain and Germany in 2000, but the subsequent deployment of such the network, to the enterprise wide, was far more than disappointing. Japan is perhaps the most successful region of utilizing wireless services that over 70 percent of its Internet users access to the web wirelessly, nevertheless, the technology offering the wireless Internet access is the upgrade from PHS. Some medium-range wireless communications technology such as wireless fidelity (i.e., WiFi) is then used as the "hot-spot" type to provide wireless broadband at a fixed location, such as airports, hotels, or coffee shops. It's estimated that, by the end of 2005, there are more than 150,000 WiFi hot spots around the world and, the worldwide users are up to a total of 30 million in 2004 (the Gartner Group).

The Taipei City Government of Taiwan recognized this wireless phenomenon and made a thoughtful judgment from the public perspective. Early last year, it announced the "M-Taipei Initiative" to make the whole Taipei city (about 240 square kilometer) a wireless city by 2006. It then called for a "build and operate" (BO) tender project to invite the private sector's participation in construction and subsequent operation. The City Government formed a public-private partnership with Q-ware Co., which outweighed other competitors through a fierce beauty contest, in September, 2004. On the date of writing, roughly 2,500 access points are installed in the city and citizens can access wirelessly to the Internet at all 68 subway stations. It is so far the largest WiFi coverage ever in the world.

This paper explores the features of the M-Taipei Initiative that distinguishes itself from other similar projects. It identifies the major issues in construction and operation: partnership vs. contracting-out, technical difficulties, accumulation of the installed base, assessment of profit making, the payment mechanism, and so on. Some economic

literature such as the transaction cost theory and network effects are applied to the analysis of these issues. With this case study, the paper is able to sketch a framework of developing the WiFi network for other cities in so doing.

II. Highlights of the "M-Taipei Initiative"

1. Purpose and Objectives

Right after Taipei City Mayor Ma Ying-Jeou took the office in 1999, he vowed to make the Taipei City Government a digital city. During his first term (1999-2002), the Taipei City Government launched the "Cyber City" program, and continues the "Cyber City: Phase II" project since the Mayor's second term (2003-2006). After the six-year efforts, Taipei endures a high growth of electronic (or paperless) public administration and an expansion of school computer facilities. Currently, 86.2 percent city households have personal computers installed at home, and among which 69 percent set up fixed-lined broadband access to the Internet.

As voice, data, and video services converge due to technological evolution, there is a great demand for the broadband service, which gradually replaces the dial-up one. In this sense, the Taipei City strives to build a wireless broadband network and make all citizens connected anywhere at anytime. Consequently, the City Government included wireless broadband as one of the six primary agenda in "Cyber City: Phase II" and announced the "M-Taipei Initiative" on February, 2004 and signed a tender contract with Q-ware Co., a subsidiary of the Uni Group that owns the largest chain of convenience stores in Taiwan, to construct and operate WLAN after a 4-month bidding period on September 2004.

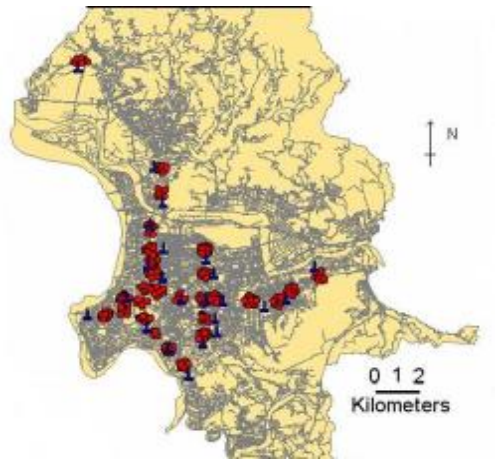
The M-Taipei Initiative adopts the WiFi (wireless fidelity) technology as the default standard to build the network. Considering the problem of strand assets due to technological renovation and substitution, this plan calls for a build-and-operate (BO) tender that grants the private partner the nine-year franchise of construction and operation while without transferring networking facilities. In this BO tender, the City Government does not allocate budget to the built-up, instead permitting Q-ware Co. the access right to install access points (APs) on all the city-owned public facilities, including bridges, underground tunnels, street lamps, traffic lights, school buildings and so on. Q-ware must, in the public interest of bridging digital divide, contribute three percent of

its revenue to the Wireless Taipei Fund every year since its operation.

2. Coverage

The built-up comprises of three stages. The Phase I covers 30 subway stations, 5 underground shopping streets, and 150 kilometer outside the station (shown as red dots in Figure 1). The construction started from September 7, 2004, the day the City Government signed a tender contract with Q-ware Co., and was complete in January 5, 2005.

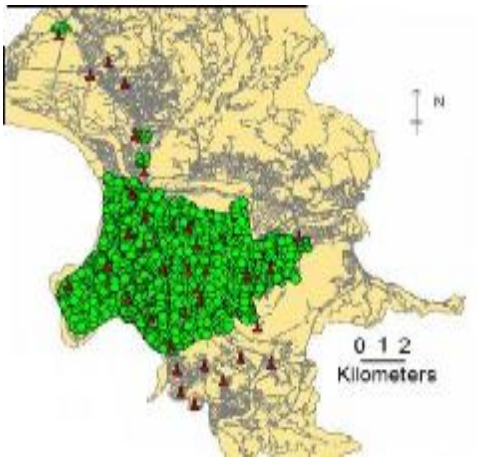
Figure 1. The First-Phase of M-Taipei Installation



522 access points were installed during this period, and there is roughly twenty percent of Taipei population (e.g., 520,000 people) accessible to the Internet by the WiFly connection. Currently, Q-ware Co. offers trial services for free. More than 33,000 people have registered as the WiFly members since this February, and in average 400 users login in the WiFly service every day.

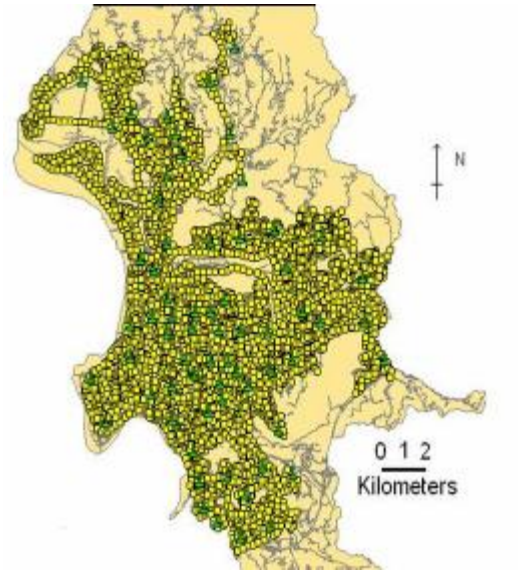
The second phase began on February 1, 2005 and is expected to due 180 calendar days later, which is July 31, 2005. The AP installation extends to the remaining 36 subway stations and the downtown area (about 28.2 km^2, equally one-tenth of city geography). Figure 2 shows the coverage in green shaded area. This wireless coverage allows for the accumulative fifty percent of Taipei population (e.g., 1.3 million people) having outdoor access to the Internet. It is estimated that 2,700 access points be installed in the downtown area since mesh networking technology Q-ware Co. takes on can significantly reduce the AP quantity in need by its two-layer architecture.

Figure 2. The Second Phase of M-Taipei Installation



The third-phase construction is 180 calendar days long as well, beginning when the second-phase is finished. As shown in Figure 3, the wireless coverage will extend to the enlarged downtown area represented by the yellow shaded area. This area is about 134 km^2, where ninety percent population resides. The total number of APs used in three stages expectedly amounts to 10,000; namely, 74.62 APs will in average be installed per square kilometer. The M-Taipei plan allows Taipei to become the largest and densest wireless city in the world.

Figure 3. The Third Phase of M-Taipei Installation



3. Oversight

In order to facilitate this BO project, the "Taipei Wireless Broadband Task Force" was formed within the Government to call for collaboration among the department and agencies. The staffs are organized into five sub-working groups according to their departmental functions and jurisdiction: Finance & Law Team, Construction Team, Administration Team, Application Service Team, and Marketing Team. The Chairperson of Research, Development, and Evaluation Commission (RDEC) is taking in charge of the Task Force and reports the progress to the Mayor once a month.

In addition, the Wireless Broadband Oversight Committee was set up on the behalf of Taipei citizens to supervise Q-ware's operation and management. The Commission comprises of city government officials, scholars, and professionals that keep its decisions independent from political influence. Its mission includes (1) ratifying the tariffs of wireless services; (2) hearing the consumer complaints or contract disputes; (3) reviewing the operator's annual financial reports and business plans; (4) approving the proposal by the operator as how the Wireless Taipei Fund be allocated, and (5) and arbitrating among firms regarding the uses of city resources, and etc.

III. Public-Private Partnership

Wireless local area network (WLAN) has apparently become the cutting-age technology to be deployed in many cities around the world. It is estimated that the number of worldwide users is up to a total of 30 million in 2004 (the Gartner Group). Some cities like City of Westminster (UK), Corpus Christi (Texas) and Cumberland (Maryland), to name a few, began to recognize the importance of public information access so that they initiated the municipal WLAN projects.[1] In their model, the government contracts out the WLAN built-up to a firm with government funding so the public can have access to the Internet in underserved areas and minority groups at low costs.

The Taipei city, seeing the market of WLAN surging, is in contrast taking a different approach in developing wireless broadband network around the city. Indeed, wifi hot spots are increasingly deployed by the private sector at fixed locations, such as

[1] Other examples are as follows: San Francisco constructing a free WiFi hot zone beginning in 2005; Rio Rancho, San Sebastian, and Cebu going unwired; Anaheim and Log Angeles pondering citywide WiFi; and Frederiction expanding its free city wireless network.

airports, café, or fast food restaurants, to provide Internet users with a speedier access. The growing number of commercial hot spots suggests that there is a demand for mobile Internet access, whereas the concern lies in how and when for businesses to make profits. Due to the fact that WLAN is run as the hot spot, many application services requiring full-scale coverage, such as VoIP, can hardly be launched, which in turn restricts the WLAN profitability. Consequently, the WLAN operators more or less take a minimalist approach of network construction to avoid stranded investment. The firms however acknowledge that, due to its use of unlicensed (or free) band, WLAN could be the ultimate substitute for 3G if the former can be deployed at a much larger scale, like the hot zone. The Taipei City Government thus decided to cooperate with the private sector to build wireless hot zone in Taipei.

1. Market Hazards and Policy Insurance

Institutional economists contend that, provided with costless transaction, individuals need respond only to market and no rules or norms are necessary during their trade (Coase, 1956). Unfortunately, the transaction in the real world does incur costs. And their very presence calls for the necessity to search non-market alternatives such as organization or lawmaking to mitigate the costs. The term transaction costs is then created to refer to a general class of information, negotiation, or enforcement problems that affect market outcomes (Frant, 1991:116). More specifically, bounded rationality of human beings causes them to be unable to process information needed for decision-making or to simply make idiosyncratic decisions (Simon, 1961:24). Imperfect (or asymmetric) information, that is, an inability to obtain needed information for decision making, results in agents' incorrect response to market dynamics. Uncertainty further undermines the agents' abilities to make complete contracts for market exchange (Ostrom *et al*, 1993:47-8). In this sense, institutions are created to mitigate transaction costs for the agents. They are therefore more willing to undertake market exchange.

Since WLAN was originally developed to bypass the "last mile" (that is thought as the bottleneck in telecommunication) at certain locations rather than formed as the network of long-range transmission, there is vast uncertainty concerned with its business model. The business risk undoubtedly lessens firms' willingness to invest in this technology and defers them from entering the market. Following the transaction cost theory, some non-market alternatives should be brought to abate the risk so that firms can undertake telecommunications investment. Instead of itself building the network, government shall provide the firms with enough policy insurance against market

uncertainty to increase their willingness to deploy and operate WLAN. As government suffers from incomplete information to respond to market dynamics, its own making of wifi products will entail another set of transaction costs, which eventually results in market inefficiency. The municipal WLAN projects directed by city governments world-wide inevitably deprive the firms from business opportunities while without taking both public and private incentives into consideration.

Contrary to the global municipal WLAN start-ups, the Taipei City Government takes a cooperative approach with businesses in hopes of casting a higher economic efficiency during the WLAN deployment. First of all, the Office evaluated the business risk by analyzing Taipei's demographics and IT statistics. Nowadays, 80 percent of Taipei citizens reside in the central downtown area with 10-kilometer wide and 13-kilometer long, which in turn engenders the population density of 9,559 head per square kilometer. Beside Taiwan ranked as the top one country of the mobile phone penetration rate, the 95 percent citizens frequently use cellular phones and one-third have the extra portable communication devices (either PDA or notebook). Taipei citizens apparently enjoy IT literacy as the 89.2 percent households have installed personal computers (PCs) at home and among those 69 percent already switched to the fixed-line broadband access. The high urban density, a paramount mobile device penetration rate, and convenient broadband access all together indicate that Taipei is best situated to develop WLAN. As Taipei people have been nurtured technology savvy, Taipei is surely a potential market for WLAN and the risk there is comparatively lower than other cities.

The City Government determined to pool the risks for Q-ware by granting it a nine-year exclusive franchise of building and operating the network. Although not allocating the budget to or financially subsidizing the project, the Office allows Q-ware the right of way to install APs at all city-owned facilities, that is, school and public buildings, bridges, tunnels, free ways, street lamps, traffic lights and so on. Due to the drawback of WiFi short-range transmission, enormous APs must be installed to avoid signal evaporation and excessive negotiation costs are borne to Q-ware when too many parties are involved in leasing their facilities. This exclusive right of way significantly reduces Q-ware's *ex ante* negotiation costs and *ex post* coordinative efforts since it does not have to bargain with private entities one by one.[2] RDEC also utilizes the Task Force as the venue to mandate the "open access" policy over the departments and

[2] When Q-ware picked up school buildings as the installation points, some school teachers and parents were somehow dubious about the safety of electromagnetic wave APs carry on, which even aroused their opposition. In this case, the Task Force ordered Education Department to explain the safety issue to the teachers and parents. Until the City Hall helped to relinquish their concern Q-ware could not begin the work at schools.

agencies so that the negotiation costs within the City Hall are greatly saved.

Another problem that demands the Office's efforts is power. It was never posted as a threat before when WLAN was supplementary for the last mile at indoor locations such as home or offices. As far as the outdoor built-up is concerned, the optimization point to install APs may not have power supply. For example, the street lamp is a more suitable point of installation because of its height, whereas its power is fed only at night. Since the business power generation and transmission is still considered as a natural monopoly and run by stated-owned enterprise Taiwan Power Co., it is usually more time-and-effort saving for public agencies (including public companies) to negotiate with each other than Q-ware doing so.

The third problem lies in backhaul transmission. Even if the M-Taipei Initiative takes on the Mesh technology that congregates six APs under a backhaul AP, there is still a great demand for wired DSL/Cable lines to guarantee transmission stability and service quality over a large coverage. Taipei's plan in this sense will cost in average 2 million US dollars per month regarding the backhaul transmission provided 10,000 APs be deployed on the city landscape. The Office has no choice but cooperate with Q-ware to search for backhaul solutions. It on the one hand helped Q-ware to bargain a wholesale price of renting ADSL lines from Chunghua Telecom, the state-owned fixed-line incumbent. It on the other hand supports WiMax trials over the Network as WiMax holds the strong candidate status to solve the backhaul transmission problem. All three cases demonstrate that government's administrative coordination better ensures the firm business certainty and then increases its willingness to invest in the WLAN business.

2. Incentive Schemes and Market Evolution

Comparing the municipal WLAN projects with Taipei's, both apparently involve government in building the network. They do however differ from each other in terms of the extent to which government shall participate. The former emphasizes on public-financed construction, that is, the contracting-out approach in which government plays a major role in planning and allocating resources. While the latter embraces the public-private partnership (i.e., the build and operate approach) that upholds market mechanism and government only provides businesses with policy safeguards in their undertakings. These two approaches respectively honor two distinctive models that agents embark on exchange: market and government (hierarchy).

Oliver Williamson treats market and hierarchy as different governance structures in which the integrity of transaction costs are decided (1996:378-9). Market in his saying refers to the arena in which autonomous parties spontaneously engage in trade, and it is vulnerable to opportunism under uncertainty and asset specificity. As the market allows the agents to reliably appropriate benefits associated with their efforts, defined as *incentive intensity* or *high powered* incentives, it encourages the parties to engage in efficient activities even if provoking opportunism under asset specificity and uncertainty. In contrast, hierarchy provides the parties with *low powered* incentives since it does no measure the degree to which the benefits they expect are proportional to their efforts (Williamson, 1996:378). The low powered incentives are more capable of preventing opportunism but generate inefficient allocation of resources.

Which governance structure is more appropriate for city-wide WLAN deployment? The answer depends on what group of users it aims to serve. As hierarchy renders low powered incentive that does not measure agents' benefits to their efforts, it better serves non-marketed users such as government or non-profit organizations. The customers with high-powered incentives such as consumers and business groups will better be served by the market mechanism. Most of the municipal WiFi projects around the globe are designed as a complementary venue of providing public services such as police patrol and surveillance, traffic monitoring, parking management, permits and licensing, procurement, and so on. Although citizens can access to the Internet via the WiFi network, the contracted firm is not aggregating the commercial services delivered to them. On the contrary, the M-Taipei Initiative provides services to government as well as citizens. The City Government and its partner Q-ware have division of labor in providing services: the Government is responsible to produce its own services like G2G and G2C; while Q-ware develops and delivers B2B services to general customers.

Why did Taipei, compared with other cities, instead take consumer services so seriously? The RDEC argues that delivering consumer services is the more viable and durable way of developing WLAN since all service provision derives from market innovation. As market rewards the agent to the degree to which he/she made efforts, it certainly encourages firms' innovation (such as design, sales, marketing, advertisement, and public relations) that can meet consumers' expectation and earn returns. Even electronication of public service requires business efforts to tailor both government and citizens' preferences. Most countries do recognize that massive production and administration costs are borne to their governmental agencies if the agencies develop public services themselves. Can market efficiency only be achieved when government contracts out public service production to the private sector. In addition, WLAN will

leave too much idle capacity due to its excessive bandwidth if the government continues to be the sole user. Therefore, the operation and management of the WiFi network in the long term should be handed back to the industry to fully utilize the bandwidth.

As a result, the M-Taipei initiative takes a one-step resolution to unlock the potential market for the telecommunication enterprises. Figure 4 depicts Taipei's initiative as the upward triangular symbiotic relationship in which Q-ware with the efforts of administrative coordination made by the City Government provides the services that match customers' penchant. The market governance structure the Government employs allows the tender company autonomy and flexibility in response to industrial dynamics and generates the most economic efficiency.

[Figure 4 inserted here]

IV. The Business Model

Although we have developed a triangular-relationship model to analyze Taipei's WLAN initiative, it is imperative for us to define the factors driving augmentation of the network because the project is foremost and has the largest WiFi coverage in the world. In plain language, what is the business model for the WiFi hot zone citywide? Reminding us network economics, the view of network effects obviously serves the starting point for our inquiry.

Network effects, or network externalities, refer to interdependence of one's utilities with another person's decision-making on network services. Network effects are indeed inherent in information and communication goods and services. In this sense, one's utility is affected by another person's choice of certain information or communication services. Valuation of a communication service thus depends on the number of persons subscribing it. A larger network base casts higher valuation as one can reach more people or more likely be reached; therefore one has high interests in joining such the network (Sharpio & Varian, 1998:126-30).

Network externalities of communication services are normally associated with positive feedback. For firms, the service network will not exist until its installed base exceeds the minimal level, that is, the critical mass point (Economides & Himmelberg, 1995:47). Once the critical mass point is reached, the network launches itself and

continues to expand until prevailing. Positive networks externalities lead to an extreme outcome in the market that the big get bigger while the small get smaller. The telecommunication market usually results in the dominance by a single firm with the largest installed base (i.e., the *winner-take-all* market).[3] For consumers, they have switching costs to shift between different services (Shy, 2001:78-113). In this sense, the new service cannot be consolidated if consumers' switching costs are extreme. Positive network effects together with collective switching costs cause the telecommunication entrants with a smaller installed base hardly to compete with the dominant one and leave them no choice but to follow the latter's technologies and standards. Recent telecommunications regulations promulgate interconnection among network operators to deter the dominant one from engaging in anticompetitive behaviors based on their positive network effects.

Due to the dissimilar technological standards, WiFi is not interoperable with the 2G and 3G mobile systems and seemingly fails to share the latter's network effects. That is, mandated interconnection alone cannot constitute the WLAN's installed base. There are few more steps must be taken into action to ensure the formation of the WiFi network. Indeed, the concept network effects is not applicable to only the analysis of competition between two (or more) networks but also the one of bundling heterogeneous yet compatible services (Shy, 2001:137). In other words, Taipei's WiFi initiative must be able to ally (interconnect) with other networked goods/services, not necessarily information/telecommunications ones, so that the interconnection generates heterogeneous network effects larger enough to compensate consumers' switching costs to draw their subscription of wireless access services.

As each product/service has an installed base, bundling different products/services together can expand each other's market. The more products/services a firm's could be bundled, the larger installed base it could entail and the higher profits the firm is expected to earn. Taipei's strategy is then to make its WiFi network more compatible with the products and services in its downstream market or in other industries. Its downstream products include end-user handheld devices and content services, and the potential heterogeneous alliance includes the fixed-line telecommunication network, the public transportation system, the payment scheme, and the convenience-store chain. Figure 5 portrays another triangular relationship of the M-Taipei initiative. Some observers call this triangle as the "eco-system" of WiFi to capture the symbiotic essence in between. It is very unlikely that the WiFi network can grow alone without the

[3] Network externalities might entail negative feedback when the network is overloaded. For example, past a certain size, Internet traffic may get crowded so that it reduces everyone's utilities to log in the Internet. The network is burdened by its oversize (Katz & Sharpio, 1994:94).

development of ancillary handsets and content services.

[Figure 5 inserted here]

1. Infrastructure

Since a few firms have already provided the wireless access service over Taipei, Q-ware could generate higher network effects of its own network by roaming with these private hot spots. Additionally, WiFi was originally served as the hot point at the end-user side for the fixed-line telecommunication enterprises. WiFly could hence enlarge its installed base by allowing customers roaming via their fixed-line accounts. As far as the payment schemes are concerned, WiFly can better be compatible and connected with the users' banking accounts or credit-card accounts so that they do not have to reload their credit history but feel easy and convenient to switch to the service. As mentioned previously, Q-ware's mother company owns the 577 Seven-Eleven stores and 46 Starbucks in Taipei. The convenience stores and coffee shops themselves on the one hand offer Q-ware extra installation points to increase the WiFi coverage; while on the other hand serve as the brick-and-mortar channel to sell the service and to bundle heterogeneous goods (coffee + the WiFi access). With its brick-and-mortar niches, Q-ware is advantageously positioned in competing with other emerging operators.

2. Handheld Devices

Since WiFi signals transmit over the unlicensed spectrum, various receiving equipments are made in this wonderland without standard specification. It is imperative to have both manufactures and the network operator cooperate with each other to design compatible handheld devices for WiFly. At present, the most commonly-used and often standardized WiFi devices are notebooks and personal digital assistants (PDAs). Nevertheless, the notebook is too heavy to carry outdoors and the PDA's limited functions fail to satisfy the customers' multiple needs. Surely, a device easy to carry and with the communication function is the killer one for wireless broadband, that is, the WiFi phone. Since the voice over Internet protocols (VoIP) is a perfect substitute to the traditional phone service, WiFly should be able to appeal to a herd of consumers once the WiFi phone is available to them.

Several prototypes of the WiFi phone are in production, but they are priced

expensively (compared to the popular 2G handsets) due to its smaller scale of economies and the higher production costs. Therefore, an alternative module, the "dual-mode" handset (GSM + WiFi), is developed during the transition. Another alternative is to have the WiFi phone embedded with extra functions so as to increase the utility of possessing it. For example, Intelligence Card Co., whose Easy Card is used as the payment scheme for Taipei's subway system, is experimenting to incorporate the Easy-Card chip into phone handsets. That is, commuters can pay with their handsets embedded with the Easy Card chips when they take subway. The purchase of WiFi handsets is expected to rise greatly once the integration with the Easy Card is done.

3. Content

The WiFi network can provide a variety of application services due to its ample capacity. More valuable services the operator offers, the higher bundling effects it entails and the larger number of consumers it is able to draw. The question lies in that what service is worth of provision? VoIP is assuredly the killer application for WiFly.[4] Industrial analysts besides VoIP often cite "3G" to name the three most profitable broadband services: game, girl (pornography), and gambling. Of course, the stream video service, ring-bell downloads, and messaging each casts quite a lot ballots, too.

For the City Government, it can raise the WiFi users by providing the *exclusive* public services over the network. The Government started to build the "Wireless Campus" in all municipal elementary and high schools since this year (2005). The wireless sign-in system traces students' presence at the campus via the RFID sensor and simultaneously sends an automated message to alert the parents if their children are missing. The Department of Traffic updates the latest traffic, parking, and bus information by real-time image transmission over the WiFi network. People can also use the wireless devices to check 30 routes of the city buses and pay for parking meters. By the same token, police surveillance and distance treatment/nursing (m-medicine) are made possible.

V. Conclusion

[4] The Luxembourg-based Skype Group, founded by Niklas Zennström and Janus Friis (also founders of KaZaA) in 2002, is a global P2P telephony company that offers users VoIP communications via their free software downloads. As of today, there are more than 150 million downloads worldwide, and 4 million alone in Taiwan. Many see the popularity of Skype as a sign of the potential VoIP market.

Even if many cities are deploying the WiFi network citywide, Taipei ahead them has completed the largest WiFi built-up around the world. This lead does not come from nowhere; Taipei has paid off for this prestige. First of all, the mesh solution to enhance the WiFi transmission has not been implemented elsewhere before Taipei's undertaking. Q-ware has encountered so many unknown factors during this built-up, such as power, tree shades, and the uneasiness of renting private buildings that cause the project postponed.

Secondly, the public-private partnership is said to save Q-ware's transaction costs and to mitigate the firm's business risk, it nevertheless generates political risk for the Government. Since the M-Taipei vision is one of Mayor Ma's primary achievements, he and the City Government suffer from the political risk of the project breakdown. The political risk surprisingly turns to the regulatory rent for Q-ware (Friedman, 1984:267). Since the City Government cannot afford to have the project failed, it will devote as much resource as possible to keep Q-ware in the "game." Q-ware in this sense could gain favorable treatments from the Government, such as tax exemption or direct subsidies, in order to stay alive, and the Government misallocates the resource to Q-ware. This paper recorded and analyzed Taipei's experience of building the wireless network in hopes of providing a model for other cities in their deployment.

VI. References

[1] Economides, N., and Himmelberg, C. (1995) "Critical Mass and Network Size with Application to the US Fax Market" Discussion Paper No. EC-95-11, Stern School of Business, NYU.

[2] Coase, Ronald (1960) "The Problem of Social Cost" *Journal of Law & Economics*, vol 3. pp.1-44.

[3] Frant, Howard (1991) "The New Institutional Economics: Implications for Policy Analysis" in *Policy Analysis and Economics: Development, Tensions, Prospects* edited by David Weimer Boston: Kulmer Academic. pp.111-27.

[4] Frieden, Rob (2001) "Privatization and Globalization in Telecommunications", *Managing Internet-Driven Change in International Telecommunications*, Artech House, Boston,

U.S.

[5] Friedman, Lee S. (1984) "Uncertainty and Public Policy", *Microeconomic Policy Analysis*, McGraw-Hill, Inc., U.S.

[6] OECD e-Government Studies (2003) "The e-Government Imperative," http://www.oecd.org

[7] Ostrom, Elinor, Larry Schroeder and Susan Wynne (1993) *Institutional Incentives and Sustainable Development: Infrastructure Policies in Perspective* Boulder: Westview.

[8] Sharpio, Carl and Val R. Varian (1998) *Information Rules: A Strategic Guide to the Network Economy*. Boston: Harvard Business School Press.

[9] Shy, Oz (2001) *Economics of Network Industry*. Boston: MIT Press.

[10] Simon, Herbert (1961) *Administrative Behavior,* New York: MacMillan.

[11] The Economist, Men's Best Friend, P5-7, March 31, 2005

[12] The Gartner, Inc, Enterprises Must Implement a Wireless Strategy, press release, 2004

[13] The website of Q-ware Co. "WIFLY," www.wifly.com.tw, 2005

[14] The website of Research Development and Evaluation Commission Taipei City Government, www.rdec.taipei.gov.tw, 2005

[15] the website of Taipei City Government, www.taipei.gov.tw, 2005

[16] William Lehra, Lee W.McKnight (2003) "Wireless Internert access:3G vs WiFi？" *Telecommunications Policy* 27, pp.351-370.

[17] Williamson, Oliver E. (1996) *The Mechanisms of Governance* Oxford: Oxford Univ. Press

[18] Wireless Broadband Access Task Force, Connected On the Go: Broadband Goes Wireless, FCC report, 2005.

Figure 4: M-Taipei's Upward Triangular Relationship

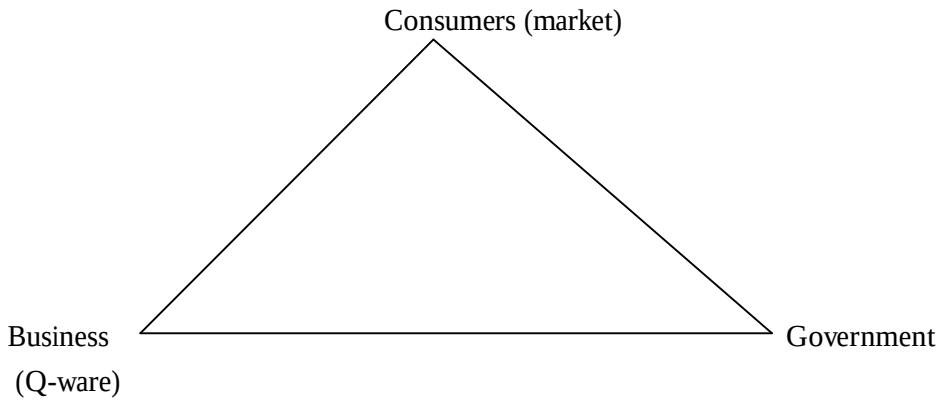


Figure 5: The Downward Triangular Relationship of M-Taipei

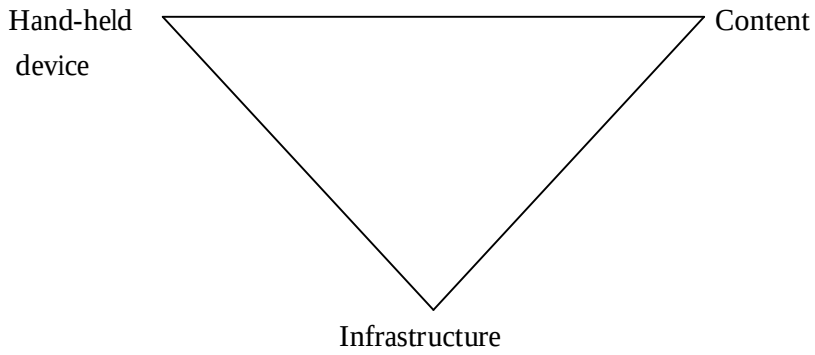


Figure 6: the Two-fold Tri-symbiotic Relationship of M-Taipei