APT REPORT

on

COST EFFECTIVE WIRELESS SYSTEMS IN UNDER -SERVED AREAS OF ASIA PACIFIC USING IMT-2000 AND OTHER TECHNOLOGIES FOR FWA

No. APT/AWF/REP-2
Edition: August 2007

ASIA PACIFIC TELECOMMUNITY
The APT Wireless Forum

Report
APT/AWF/REP-2
August 2007

Source:AWF-4/OUT-02(Rev.1)

APT REPORT ON COST EFFECTIVE WIRELESS SYSTEMS IN UNDER -SERVED AREAS OF ASIA PACIFIC USING IMT-2000 AND OTHER TECHNOLOGIES FOR FWA

1. BACKGROUND

Under the working scope framework of AWF, TG2 takes the liability to research the cost-effective systems and their applications in rural and under-served areas.

Therefore, TG-2 has assessed the use of wireless technologies for promoting telecommunication development and applications in the rural areas. Meanwhile as part of its tasks, the appropriate and suitable frequency bands for the systems application have been investigated.

The following characteristics of the developing countries need to be considered:

- Low level of income per inhabitant
- Large rural and sparsely populated areas
- Difficult geographical terrain

For most of developing countries, the demands of communications delivery are primarily presented as the following characteristics:

- Affordable pricing of communication services, minimal initial investment and total cost of the network
- Solutions that enable coverage of rural areas (with varied terrain characteristics) with large cells
- More importantly, the appropriate harmonized spectrum should be considered and identified worldwide to provide global roaming and economies of scale

The economical, well-proven, and quick-deployment technologies are required to fulfill the requirements.

.

2. CRITERIA OF THE WIRELESS TECHNOLOGIES TO BE ASSESSED

To assess the use of IMT-2000 and other emerging wireless technologies for promoting telecommunications development in rural areas, with the following criteria:

- capable of providing return to an operator/investor;
- large area coverage with minimal network components;
- no proprietary solution that only meet one need;
- be robust and proven technology.

And the technologies to be assessed are:

- IMT-2000 application in lower frequencies < 600 MHz bands;
- Other emerging wireless technologies, such as development of radio frequencies driven by IEEE community.

3. METHODOLOGY

The assessment is based on the following sources:

a. Questionnaires survey distributed by TG2 and feedback received from the APT members.

The Questionnaires related to the subjects consist of:

Q2. The usage of lower frequency band(s) (below 600 MHz) in the AP region (See ANNEX 1) and

Q3. Offer technologies that can be used for FWA applications (See ANNEX 2).

The Q1 which was conducted at the same time was intended to survey the Application of IMT-2000 technologies for Fixed Wireless Access application, which also is reported in AWF-3 meeting.

The responses that have been received are the followings:

No	Respondent	Reference	Remark
1	Indonesia	Doc AWF-2 /23 -rev	Q2 and Q3
2	Pakistan	Doc AWF-2/22	Q2 and Q3
3	Japan	Doc.AWF-2/19	Q2
4	Singapore	Doc. AWF-2/21	Q2
5	Huawei	Doc.AWF-2/24	Q2
6	Lucent	Doc.AWF-2/25	Q2
7	CDG	Doc.AWF-2/20	Q2
8	Siemens	Doc.AWF-2/26	Q2
		Doc.AWF-2/27	Q3

b. Presentation input during the AWF meeting.

No	Contributor	Reference
1	Huawei Co.Ltd	AWF-2/29
2	Xinwei Telecom Tech Inc	AWF-2/30
3	ZTE Corporation	AWF-2/50
4	Motorola	AWF-IM2 /39
5	S.R of Vietnam	AWF-3 / 35
6	ARIB Japan	AWF-3 / 15

c. AWF Report on IMT-2000 technologies for FWA applications

4. SYSTEMS USING FREQUENCY BANDS BELOW 600 MHZ

The frequency bands below 600MHz, especially between 400-600MHz are the choice for research and analysis, in consideration of the larger cell coverage compared with higher frequencies, less capital investment in radio network deployment, suitable for rural and under-served areas in developing countries. The bands below 600 MHz are presently used in different ways, mainly for broadcasting and for interactive voice communications services.

The migration from analogue to digital TV is on the way throughout the world. Digital transmission technology is enabling the available spectrum utilization to be more effective. According to ITU-R SG1, digital television is approximately four times more efficient than analogue television in the broadcasting service. With switching-off of analogue services, resources are released and the so-called “digital dividend” is obtained. In consequence, the converged technologies bordering between different market sectors would disappear and the services are finally targeting the same market.

As per ITU radio regulation, frequency bands of 470 – 806 can be allocated for Fixed, Mobile or Broadcasting. However, it has to be realized that migration from analogue to digital TV is not that easy in the developing countries, where it has to be resolved who burden the replacement of analogue TV set by digital TV set. Therefore, it need some time, could be about 10 years, before the analog broadcasting will be really cut-off. In the transitional period, digital TV broadcasting will be along side with the analogue TV broadcasting (simulcast).

In strategy, the frequency to be freed is the lower end, under 500 MHz. Therefore it is recommended that APT member countries speed up the broadcasting digitalization process to enable efficient used of the spectrum.

Through APG (APT Preparatory Group) meeting, several countries including Indonesia, Sri Lanka and Vietnam have endorsed the use of frequency bands 450–470MHz for cellular mobile.

Technologies in this category including:

4.1 Using IMT-2000 For Both Mobile And Fixed Wireless Access:

The advantage for IMT-2000 technology using lower frequency bands is broader coverage, which means less base stations are required for the network. Thus the cost of infrastructure development is much lower. For example, CDMA-450 coverage is 16 times than the deployment in 2.1GHz. BTS number is 1/16 of 2.1GHz and 1/12 of 1800MHz. For the operators, it brings on minimal initial investment and reduces total cost of the network. Not only it is commercially viable for the existing available network but also means the new chances to operators.

Frequency (MHz)	Cell radius (km)	Cell area (km^2)	Relative Cell Count
450	48.9	7521	1
850	29.4	2712	2.8
950	26.9	2269	3.3
1800	14.0	618	12.2
1900	13.3	553	13.6
2100	10.0	312	24.1

Source: Qualcomm ITU 8/F Submission, June 11, 2001, "COVERAGE COMPARISON OF IMT-2000 SYSTEMS AT VARIOUS FREQUENCY RANGES, INCLUDING 450 MHZ"

Table 1: Coverage comparison of IMT-2000 systems at various frequency ranges, including CDMA450

CDMA450:

CDMA450 is CDMA2000 using 450MHz frequency bands. It has the advantages such as:
Better Coverage

Low frequency UHF, 450MHz signals result in lower propagation loss and yield a broader coverage than higher frequencies in the other mobile communication system. For example, coverage for CDMA -2000 at 450 MHz is up to 50km, whereas in comparison W-CDMA in 2000MHz bands has a propagation range of only 2~10km. (See Table1 above). Moreover, 450MHz signals result in stronger non-line-of-sight transmission capacity and it is reflected more suitable to solve the coverage of rural areas in varied difficult geographical terrain with large cells.

Spectrum Efficiency

CDMA450 System is wireless technology platform based on CDMA2000 technology operating in the 450MHz frequency bands. CDMA450 can provide all CDMA2000 features, based on a family of CDMA2000 standards developed by 3GPP2 and published by the TIA and recognized by the ITU as an IMT-2000 system. The carrier bandwidth of a CDMA450 system is 1.25MHz. The spectrally efficient CDMA-450 technology provides large voice capacity and high user data throughput(s) that makes it ideal for providing mobile, broadband, and fixed services to rural, sub-urban, and sparsely populated areas, especially where the amount of spectrum is limited. CDMA-450 can support about 70 voice users per base station with one carrier in each sector of a 3-sectored cell. CDMA2000 1X can provide a peak data rate of up to 307.2 kbps (614.4 kbps using two simultaneous radio channels) on the downlink and up to 153.6 kbps on the uplink, per user. The estimation is based on a "full buffer" traffic model. The peak data rate provided by CDMA2000 1xEV-DO on the downlink is 3Mbps and on the uplink is 1.8Mbps (1xEV-DO Rev. A). Backward-compatible air interface enhancements currently being standardized will further increase the capacity, boosting 1xEV-DO multimedia data rates on both the forward and the reverse links.

Robust migration to next generation technologies (including IP)

A major benefit to operators using CDMA-450 is the ability to migrate the network to an all IP network, sometimes referred to as beyond 3G or a 4G system. The benefits of an IP core network include:

- Enhanced voice and data services
  - VoIP
  - High speed data transfer
  - Internet access
- Ease of service introduction
- Lower maintenance
- Standard protocols and services
- Cross technology roaming and inter-operability.

The operator can evolve existing network through the use of the MMD architecture[1]. The transition is seamless and robust with minimal disruption to existing services. A typical example of a CDMA-450 network utilizing the MMD architecture is sketched below:

Availability of Equipments

- Infrastructure equipment manufacturers: today, there are five manufacturers offering CDMA450 equipment: Huawei, Hyundai Syscomm, Lucent Technologies, Nortel Networks, and ZTE.
- Terminal (Devices) equipment manufacturers: today, there are ten manufacturers offering CDMA450 terminals: AnyDATA, Axesstel, Compal, Giga Telecom, GTRAN, Huawei, Hyundai Syscomm (Curitel), Synertek, Topex and ZTE.

EVN Telecom, a new fixed and mobile operator in Vietnam, uses CDMA-450 for the provision of basic telephony (fixed wireless) in rural areas that lack adequate (or any) wire line services. CDMA-450 is suited for such service because its broad reach provides wide area rural coverage at relatively low cost, while the CDMA air interface technology offers high spectrum efficiency for maximum capacity. Fixed wireless, as opposed to mobile service, can be structured in a way that keeps per-user cost quite low, making it affordable to a much broader cross-section of rural populations. Deployment of CDMA 450 base station is also faster and easier than deployment of copper and other fixed line solutions. CDMA-450 can also provide Internet access, through fixed wireless service. Fix wireless access service not only be provided to rural and mountainous areas but also in the cities where the demand is high but it is difficult to build fixed wire line.

1xEV-DO in 450 MHz (Wireless Broadband for Rural Communication):

There is new challenge of universal service where the universal service means not only voice service but also data service. On the other hand, the quickly popularization of broadband service leads to new digital gap between urban and rural areas.

To provide broadband services, Huawei proposes the 1xEV-DO in 450 MHz which can provide peak data rate: forward 2.4Mbps, reverse 153.6kbps (single user) with average data throughput up to 650kbps. This technology application is proven to be economical, quick to deploy, complying the international standard and holding a mature industry chain.

Robust migration to next generation technologies (including IP [1] for a complete description of the MMD architecture and functionality, refer to the appropriate TIA/EIA IS-CDMA2000 standards.

In rural areas, coverage is the key issue and the proposed technology can give 16 times coverage than other technologies deployed in 2.1 GHz. Furthermore, this technology can be deployed quickly since the outdoor macro and mini BTS' suit for various environment; does not need equipment rooms & air-conditioners, and has adaptability to other network (Satellite, Microwave, HDSL, IEEE 802.16, Optical etc). In addition, this 1xEV-DO in 450 MHz can support rich Data Services, such as: Telemedicine, E-Learning, Wireless cyber café, Leased Line, Internet, and Mobile business.

Up to February 1, 2005, there are 24 1xEV-DO commercial applications in Asia, America and Europe, where users have exceeded 10 million. There will be 18 new EV-DO deployments this year.

4.2. Using Other Technologies

Flash OFDM System at 400 – 500 MHz

The Flash OFDM system is for deployment in the 400-500 MHz range. The carrier bandwidth is 1.25 MHz, thus it fits the NMT bands which are licensed in this frequency range. It coexists with CDMA 2000 because it uses the same carrier bandwidth and similar filter masks.

Typical system characteristics are:

- Large cell sizes
- High data rates
  - Sector throughput per Carrier is on Down Link from 1 – 1.5 Mbit/s and on the Up Link from 0.5 – 0.6 Mbit/s
  - Low transmit delay
  - Average latency is 50 ms

The technology is therefore suitable for all FWA applications – from fixed to nomadic to basic mobile use. OFDM is generally supported from the Internet, which has the role of a backbone network
New product development suitable for FWA is based on radio technologies driven by international community within IEEE.

Flash OFDM deployment is in the 400 – 500 MHz band; the carrier bandwidth is 1.25 MHz and can be co-existence with CDMA450.

The orthogonal frequency division multiple access method is used to provide better spectral efficiency and much higher bit rates than existing radio technique with better quality of service.

5. SYSTEMS PROVIDING BROADBAND WIRELESS ACCESS IN A RANGE OF FREQUENCY BANDS

Apart from the ITU related developments on IMT-2000, there are other radio technologies driven forward by the international community within IEEE. They are IP based and go from local area applications (Public and Private WLAN) to wide area applications (Flash OFDM, WiMAX). It is estimated that globally around 80.000 to 100.000 Public WLAN hotspots are providing wireless local access to switched networks, preferably to the Internet. These hotspots are mainly in-building (airports, hotels, conference centres) and are therefore well suited for complementing IMT-2000.

The new developments like Flash OFDM and IEEE 802.16e or WiBro (Korea, is in the process of merging with IEEE 802.16e) could be in competition to or complimentary of IMT-2000.

Their cell ranges, traffic capacity and bit rates are in the same order as compared with the enhanced UMTS/WCDMA developments. For voice services, new Wi-Fi handsets are entering the marketplace. The main difference between IMT-2000 and such technologies is in the mobility: whereas UMTS/HSPA is developed as a full blown mobile radio access system with wide roaming support and automatic handover, such technologies generally offer nomadic-quasi stationary use with or without global roaming support.

The most common broadband WLAN currently deployed in many places is Wi-Fi (IEEE 802.11 standard). Wi-Fi is already widely deployed on the license exempt 2.4 GHz band in hotels, airports, cafes and homes; it is low cost (lower than hundred USD) and supports short range applications until 10 Mbps peak data rate.

For many countries in the Asia Pacific, rural expansion is critical. Industry is also looking at what more can be done to remove other barriers to guarantee more people in developing countries using mobile phones. The convergence of Internet and telephony networks has resulted in packet-switched networks. The Internet or IP-based services have such promises because of technical characteristics providing the potential to expand universal service: specifically, the ability to offer flat rate best-effort service, the ability to offer pricing without requiring an understanding of the underlying billing mechanisms.

New IP mobile technologies which are under development in the world can provide affordable solutions for connecting the rural population through internet and voice connectivity IP based broadband wireless technologies can potentially fulfill the goal of connecting the unconnected.

Seamless Mobility to enhance the growth of GDP and quality of life through societal applications including tele-education, tele-medicine, e-governance, entertainment as well as employment generation is driving the demand for flexible, quickly deployable wireless broadband access (BWA) technologies. With the flexibility that wireless broadband access affords, a service provider can offer premium “on demand” high-speed connectivity or mobile broadband services with millions of users not only in Metro areas but also in rural and remote areas. Quality of Service is also being designed to allow for services that require low latency, such as voice and video. Most importantly, the impact of this technology – assuming favorable regulatory conditions -- will be significant in developing nations where service providers haven’t deployed wired infrastructure or where there isn’t sufficient quality wiring to support a growing population. Especially for low population density areas (rural and remote) and associated “green field” deployments, wireless broadband access may be far easier, faster and cheaper to deploy than new wired infrastructure.

Several countries have decided on a broadband wireless access policy , and some countries have done the allocation and chosen the operators to implement it. IEEE 802.16e supports 10 km line of sight range application in the [3.5] GHz frequency range and up to 40 Mbps data rate; the policy decisions usually include issues relating to the frequency band on which broadband wireless access type systems will be licensed, bandwidth of each assignment, number of licensees, the selected assignment method, spectrum usage period of the licensee, roll-out obligation of licensee etc.

For harmonization and guidelines for countries in deciding their policy on broadband wireless access, ASEAN has done a survey on how its member countries allocate and plan for systems providing broadband wireless access..
AWF has also started to gather information from its members.

For systems providing broadband wireless access, the following frequency ranges are considered:

- 2.3 GHz (2300 – 2400 MHz)
  In several countries this frequency bands used for micro wave link by operators, and now the government is requesting the operators (most probably incumbent) to move from the previously license bands of 2.4 GHz.
- 2.4 GHz (2400-2483.5 MHz)
  Unlicensed bands in many countries, and have been used for hot spots in many locations of the countries.
- 2.5 GHz (2500 – 2690 MHz)
  In some countries overlapping with Satellites
- 3.3 Ghz (3300 – 3400 MHz)

- 3.5 GHz (3400 – 3600 MHz)
  Available worldwide, licensed, harmonized in CEPT1; however in several countries overlapping with satellite
- 5 GHz (5725 – 5850 MHz)
  License exempt in many countries.

For many countries in the Asia Pacific, 3.5GHz is also used for FSS (Fixed Satellite System). The sharing study between the BWA and FSS is on going within the Spectrum Sub Working Group-4
In India only 3.5 GHz band is recommended by TRAI.

BWA Combined with 3G:

ZTE shows that BWA is a powerful wireless technology that gives all telecoms carriers a good weapon to hold future broadband position. BWA system not only can be deployed as a single network, but it also can be combined with 3G, DSL and other systems.

There are several reasons of combining BWA with incumbent networks: minimize BWA deployment costs, protect operators' existing investment, provide unified and integrated services, and simplify network maintenance and management.

By combining BWA with incumbent networks, a number of goals can be achieved such as: unified AAA platform, unified user management, seamless inter-network implementation (Highest-level), new service development relying on existing network resources.

Examples of the internetworking scenarios between BWA, 3GPP and 3GPP2 networks were described.

Multi-carrier Wireless Internet Local Loop (McWiLL):

Xinwei illustrates that the trends in wireless communication are 3G and Broadband Wireless Access (BWA). The 3G mobile standards were based upon high speed voice frameworks with supplementary data services whereas BWA was based upon nomadic broadband data frameworks with supplementary IP voice services. As a consequence, the different target applications may end up with different networks. Xinwei proposed McWiLL (Multi-carrier Wireless internet Local Loop) which integrates narrow-band voice and nomadic broadband data into IP based core networks. It is running under regulated frequency spectrum, which makes users accountable and controllable.

McWiLL evolves from Synchronous Code Division Multiple Access (SCDMA) Wireless Local Loop. McWiLL has patented technologies including Smart antenna, Synchronous CDMA,

Software radio, Joint detection, Dynamic modulation and Dynamic channel allocation. McWiLL system could be inter-connected with any standard core network as well as with IMS/NGN to realize the intercommunications between fixed or mobile data services and voice services. The McWiLL commercial trial was launched in 2004. The cost per line is less than $300 including system equipment and terminal.

6. PERSONAL HANDY PHONE SYSTEM (PHS)

The Personal Handy phone System (PHS) was originally launched by Japan in 1995.
In the recent years we have seen PHS deployment in about 10 countries, such as China, Thailand, and Vietnam. The total subscribers, including Japan, amounted to 99 million and continue to show high growth rate, especially in China.

PHS is applied by taking advantage of the existing wired backbone network, featured with micro cell concept, large network capacity, ease of installation and low output power. PHS System is used for both data and speech communications. It was standardized in 1993, maintained by ARIB standard RCR.STD – 28 V4.0 and described in ITU-R Rec. M 1033 Appendix 6. The frequency band utilized is 1893.5 – 1919.6 MHz and then extended to 1884.5 – 1919.6 MHz, which is within 2.1 GHz IMT-2000 TDD frequency bands.

7. CONCLUSIONS AND RECOMMENDATIONS

For many countries in the Asia Pacific, the rural expansion is critical. Due to the characteristic of most rural area of the developing countries in the Asia Pacific, the need of cost-effective systems for telecommunication development & application in rural and under-served areas is paramount.

The cellular mobile IMT-2000 technologies, which can be offered both mobile and fixed combined with lower frequencies range (400–500MHz) will bring wide coverage, lower cost, spectral efficiency, readiness to migrate to IP based network.

Some countries have endorsed through APG meeting, 450–470MHz as first priorities to be realized for terrestrial fixed and mobile network.

It is recommended that APT member countries speed up the broadcasting digitalization process to enable efficient use of the spectrum.

Also, the new IP mobile technologies based on IEEE 802.11n, 802.16 and 802.16e technologies which are under development in the world can provide affordable solutions for connecting the rural population through internet and voice connectivity based on broadband wireless access can potentially fulfill the goal of connecting the unconnected.

The frequency bands considered are licensed bands such as 2.3 GHZ, 2.5 GHz, 3.3 GHz and 3.5GHz, and the unlicensed band such as 2.4 GHz and 5 MHz. The harmonization study by the Spectrum Working Group is highly welcome to fulfill the research tasks.

In addition, it is recommended that Spectrum Working Group takes further study to identify minimum guard bands required for the coexistence of PHS systems with other systems.

ANNEX 1

QUESTIONNAIRE 2

Usage of lower frequency band(s) (below 600 MHz) in the AP region

Introduction

Lower frequency bands are likely to provide greater coverage than higher frequencies and thus may be ideally suited for the provision of telecommunication services to underserved and hard to reach areas. In order to facilitate the further development of the telecommunication infrastructure in countries with large areas of low-population density, the following questions on advanced wireless services in the lower frequency bands are investigated by the following survey questions.

Survey Questions

1. How are the bands below 600 MHz presently used in your country, in terms of:

    1.1. Applications? (i.e.: voice, data, Internet, telemetry, broadcasting, mobile, FWA, etc.)
    1.2. Type of Systems? (i.e.: trunking–dispatch, cellular, data, backhaul, point to point, etc.)
    1.3. Type of user? (For example: Commercial, Private (including enterprise, industrial and commercial), Public Safety, Government, etc.)
    1.4. Technology? (For example: Analog, Digital, etc.)
    1.5. Extent of deployment? (For example: local, regional and national.)
    1.6. Geography? (For example: rural and urban.)

2. What are the advantages of using advanced wireless technologies, including IMT-2000 in the lower frequency bands, in terms of:

    2.1. Coverage Benefits?
    2.2. Spectrum Efficiency?
    2.3. Robust migration to next generation technologies (including IP)?
    2.4. Opportunity for fixed/mobile convergence and provision of voice and data services?

3. Does your Administration have plans to or see the need to introduce advanced wireless services / technologies / applications, including IMT-2000, in the bands below 600 MHz? If so, in what time frame?

    3.1. If your country already utilizes advanced wireless technologies in the lower frequency bands, please provide specific examples and/or case studies.

4. What could be the economic benefits for the Asia Pacific Region for having IMT-2000 technologies in the lower bands (For example: meeting the teledensity requirements, universal service obligations, ubiquitous access, attraction of investments, job creation, other benefits)

ANNEX 2

QUESTIONNAIRE 3

Survey of (other) technologies that can be used for FWA application

Introduction

Today many technologies have been used or considered for fixed wireless access (FWA) applications, in particular, technologies from cellular platforms (including 1st and 2nd generation as well the 3rd generation-IMT-2000) and specialized systems — like Subscriber Radio, LMDS, Wireless Local Loop and a number of propriety systems.
The application of FWA benefits both developing and developed countries. The former are deploying or planning to deploy FWA on the ground of the substantial saving in investment as compared with that of copper-based access facilities in order to vigorously enhance the very low teledensity of their fixed service. In the latter, teledensity of wire-line access systems as provided by the incumbent operator are more than adequate. However, it became apparent that FWA is becoming attractive for newly licensed fixed line operators to offer competition in local exchange service.
This survey explores particular technologies that may be used for present and future FWA application.

Survey Questions

1. Please discuss suitable technologies for FWA that is now being or planned to be used by administrations and provided by infrastructure manufactures. These may include technologies that are currently available or are in the development road-map of network vendors.

2. What are the benefits of deploying those FWA systems that use technologies as discussed in 1?

3. What are the frequency bands suitable for those FWA systems that use technologies as discussed in 1within the terrestrial fixed and mobile frequency allocations?

4. What are the frequency bands that might allow compatible operation between those FWA systems that use technologies as discussed in 1 and systems of existing radio services within the terrestrial fixed and mobile frequency allocations?

5. What are the interface requirements between those FWA systems that use technologies as discussed in 1 and the switched network (e.g., PSTN, ISDN)?

6. Any other comments or view regarding the subjects of the above questions?