19th Meeting of the Wireless World Research Forum, Indian Institute of Technology - Madras, November 2007

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OVERVIEW

This report presents a summary of the comments and observations with respect to the 19th Meeting of the Wireless World Research Forum (WWRF) held in Chennai, India. The Forum took place in Le Meridien Hotel from November 5 - 7, 2007. The conference was jointly organized by the WWRF[1], Midas[2], and the Indian Institute of Technology - Madras[3]. The forum provided an outstanding opportunity for researchers, scholars, operators, original-equipment-manufacturers and policy makers working in the area of wireless communications to present and discuss the trends of the various technologies, latest research/developments, and services/applications in the field. The forum offered several Plenary Sessions, Working Groups (WG), and Special Interest Groups (SIG), which focused on disciplines within the global wireless communications community.

Note: a glossary of terms can be found at the end of the document.

In general the theme was to shape the global wireless future by develop a common vision for the year 2020. Moreover, the forum focused on influencing the decision makers' views of the wireless world, enable powerful R&D collaborations, and advance wireless frontiers to serve the global customers. A main aspect of all the speakers was on the need to optimize the Kilo Bytes per second per Hertz per Cell (KB/Sec/Hz/Cell) in order to achieve very high spectrum efficiencies. The routes to the wireless future are WiMax (802.16) for the IT community and 3GPP/LTE for the Telecommunication community. In terms of commercial roll out, technologies such as cognitive radio are beyond the 2020. The overall impression exemplified by the experts is that wireless broadband such as WiMax could not replace the kind of capacity and services that are offered by wired broadband such as DSL in the present day of the game. In all cases the backhaul problem cannot be neglected.

Overall forum was quite intriguing especially to see the actual progress of cutting edge wireless technologies such as WiMax, LTE, etc that are paving the way for the communication industries to take them to the next level. Most importantly the researchers laid out the truth about the

1 Website -- http://www.wireless-world-research.org/
2 Website -- http://midasindia.com/
3 Website -- http://www.iitm.ac.in/

shortcomings and the realistic potential of the innovative technologies which seem to defy theoretical frameworks. If not had been exposed to this forum the knowledge and awareness of the current state of affairs in the wireless world would have been oblivious and backwards.

Two papers submitted by authors from LIRNEasia were accepted for presentation in 2 different working groups and publication in forum proceedings. The first paper titled "Challenges of Optimizing Common Alerting Protocol for SMS based GSM Devices"[4] was an output of the "Evaluating Last-Mile Hazrd Information Dissemination Project" (or HazInfo Project) research findings, which was presented in the WG1: Human Perspectives and Service Concepts. The second paper titled "Wireless Mesh Networking – as a means of connecting rural communities[5] was based on the design considerations of implementing the mesh network at Mahavilachchiya, Sri Lanka. Both papers were based on practical field level experiences. As a result they were well received by the audience and were inquisitive of the practical issues that sometimes defy the theoretical frameworks.

KEYNOTES

India's Quest for Next Generation Wireless, Prof. Jhunjhunwala, Telecom and Networks Group (ashok@tenet.res.in)

Liberalization of Telecom initiated a competition between GSM and CDMA wireless/cellular technologies as local loops with low CapEx, fast rollout, and low maintenance cost. As a result, in present day, India is growing at 100 million lines per year (largest telecom market in the world) compared to 1 million lines per year in 1994 (total of 10 million lines installed).

The high incline in growth happened with mobile infrastructure at less than Euro 70 per line with handset cost being as low as Euro 20, services available at Euro 0.02 per minute, and ARPU at Euro 4 per month. Similar to the number of TVs increasing from 10 million to 100 million in India with average cost per set dropping as low Euro 40 and tariffs set below Euro 2.0.

India is amongst the leaders in Telecom consumers, operators, design-houses, and product-houses. The quest is to become a Telecom MVNO and Technology Leader before 2013. Move on MVNO is stagnant because there is no heavy usage on SMS or Data yet.

There is still unfinished business with respect to making all villages having mobile coverage by 2010, operators bringing the ARPU down to 3 per month, and providing all urban homes with broad band (need 100 mil broadband connections by 2015). India aims at a capacity target of 5Mbps per user by year 2010.

Broadband access options for India are – Fiber, Ethernet, DSL, Wireless, 2-way cable of which all of them have issues such as slow build up of FTTx in fiber, QoS / Non-robust / Non-scalable in Ethernet, Copper infrastructure only with incumbent (BSNL/MTNL) in DSL, wireless still not upto par, existing infrastructure too poor to handle upstream data in 2-way cable.

Question is can wireless do it again for broadband as it did it for telephony? Hype of 3G, which nearly destroyed Telecom operators in Europe; can WiMax / EVDO / HSPA give what we need; i.e. can they compete with DSL, which provides low end 512 Kbps and high end 2Mbps at Euro 5 – 10 per month?

Need to understand the business case – In urban (Pune) and dense-urban (Mumbai) areas in India assuming 70% of population are inhabitant in a 400 - 600 square km area would give 3700 – 1500

4 Authors – Nuwan Waidyanatha (LIRNEasia), Dileeka Dias (University of Moratuwa), and Harsha Purasinghe (Microimage)
5 Authors – Chanuka Wattegama et al (LIRNEasia)

households (5 per household); assuming 50 – 60% are subscribers and 5 competitive operators in each area would imply 500 – 600 subscriber/operator/cell (cell radius 1 km). Overall market segmentation and user density prescribes that wireless technology needs to support 500 to 800 broadband subscribers/operator/cell. India would need closer to 10 bits/sec/Hz/cell. Operators are unlikely to get more than 10 MHz.

WiMax / EVDO / HSPA struggle to provide 2-3 bits/sec/Hz/cell may provide higher data rates with 3G but will that be adequate to supply for the demand but will still not be able to compete with low end DSL. In 2009 with 802.16M, LTE, and UMB at 4 – 6 bits/sec/Hz/cell will the price be affordable.

Fixed wireless may be a temporary answer where the throughput is enhanced by 4 folds compared to mobile wireless at rates of 6 – 8 bits/sec/Hz/cell. Broadband technologies such as codeDECT at 256/512 Kbps per connection in fixed environments (ideal for small towns / rural broadband). 802.11d/e does the same but at a much higher price.

India has does not face the 'range' problem as it is a highly dense country; where base stations are approximately 500 meters apart opposed to the case study of a wireless mesh network in Sri Lanka presented by Chanuka Wattegam where a single village had two towers placed 4km apart. India every village has a fiber optic ring running within a 5km range; hence, satellite technology will not play a key roll.

Next generation wireless needs to enhance spectral efficiency from 2-3 bits/sec/Hz/cell to at least 10 bits/sec/Hz/cell with spatial multiplexing being the catalyst. 4G wireless options – IEEE802.16m, LTE, and 3GPP UMP all based on OFDMS are to be available by 2010 at affordable prices.

TeNet current research focus is on Multi-cell performance evaluation, enhancing Physical and MAC layer algorithms based on MIMO techniques, Multi-user dynamic resource allocation, and Multi-user Cell co-operation. Future research is on studies of system wide impact of emerging standards such as WiMax, UL problems in OFDMA, pragmatic cross layer optimization, and P2P CPE relaying.

Driving Innovation in a Wireless Word – Vodafone's Vision of the year 2020, Prof. Michael Walker, Director, Vodafone Group R&D (mike.walker@vodaphone.com)

Turmoil in wireless/internet is a result of reshaping in worldwide industry, accelerating changes in processes, and increasing mobile business. These factors require new drivers for hardware, new application, and open innovation. The enablers are open new markets: financial transactions, smart homes, new content, telemetric, and health industry applications; where mobility remains the main driving force. "Everything is sitting in a boiling pot with many things surfacing."

Statistics from major European market today show average traffic per subscriber of 80% data and 20% voice for fixed lines at 80Kbps/subscriber and 2% data and 98% voice for mobile lines at 0.25Kbps/subscriper (average broadband traffic per subscriber is 99.7% for fixed and 0.3% for mobile). Data traffic per subscriber is growing at 11% per year and even at ½ that rate (i.e. 5.5%) traffic per subscriber will double by 2020. DSL penetration, like mobile, will reach 100% households at, which is double that of today. Total fixed and mobile traffic by 2020 could be 200 times by that of today. A very small shift of traffic from fixed to mobile will drastically increase the load on mobile traffic.

Break through for mobile services are due to open innovation/open source (OPEN Innovation, BeteVine, Open Source Consortium), Mobile web technologies (Ajax, Mobile web server), Social Communities (flickr, facebook, YouTube, wikinomics), Network centricity (Wikipedia, Google,

MySpace), and Telematics (eSafety, eCall). Terminal capabilities are raising the stakes with increase in multimedia functionality, www capability web 2.0, dependency on wireless broadband).

In mobile broadband today HSDPA is in all 3G markets with line speeds of 3.6Mbps. Since 2007 the 3G evolution: HSUPA, HSPA + (MIMO, QAM …) 7.2 Mbps and will increase to 14.4 by 2010 and to 40 Mbps in the future. GSM began in 1991 but EGDE is still developing.

With DSL setting user expectations and countries such as Korea, Japan, and UK setting the demand trends of 45-65% household broadband penetration can mobile catch up?

There are 2 routes to the wireless future – 1) IT community with 802.16 for computers with communication 2) Telecom community with 3GPP/LTE for smart phones.

With HSPA simplistic DL set at an upper bound 7 – 10 bite/sec/Hz/cell for 3 sector cells. Next generation mobile networks have set targets of 'essential' requirement being 3 – 5 times HSPA/EVDO and a 'preferred' requirement of 6 – 8 times HSPA/EVDO. Baseline for HSDPA today is 1.7 bits/sec/Hz/cell. The best estimates for WiMax or LTE DL spectral efficiency is 5 bits/sec/Hz/cell with UL facility typically being half the down link capacity. Still HSPA is not up to par and not yet clear. HSPA will keep improving until WiMax or LTE eventually take over. However, there is little scope for WiMax and LTE with a new modulation and coding scheme. Base-station cooperation can increase UL capacity. Increase data rates implying more cells per spectrum and smaller cells will that deliver more capacity per unit area. Distributed MIMO is a promising way of increasing UL capacity but the gain comes at a higher cost in backhaul traffic. Also with the increase number of cells per area the challenge is in building smaller (lamppost size) antennas opposed to the large antennas that sit on building roofs in present day.

European appeal of 4G is weak at present but the standards bodies are considering the next steps of LTE+, 802.11m, and UMT-Advanced; where players such as Verizon-wireless and China Mobile are likely to move faster towards the common solution with Vodafone following. Ultimatum is convergence towards one Physical Layer across TDD/FDD and a common architecture. Industry balance is tipping in LTE's favor with Vodafone, Ericsson, and Verizon-wireless as key stakeholders; WiMax with stakeholders such as Sprint and Intel are trying to force the balance in the other direction. However, China Mobile is sitting right in the middle of the LTE WiMax balance; where China's technology choice for broadband will make a critical impact on the technology choice for the world, between LTE and WiMax, in the world.

PLENARY SESSIONS

India Wireless Broadband Market Requirements: BWCI Vision, Mr. Raja Srinivas, Vice-President, Tata Teleservices ()

Broadband Wireless Consortium of India (BWCI) comprising Aircel, Airtel, CEWit, IITM, Idea Cellular, MTNL, Reliance, Tata Teleservices, Vodafone Essar, and VSNL have a unified view to increase spectral utilization in India. The operator environment is a dense subscriber base of 600 to 900 subscribers per cell, depending on the market segment and has a thick mix of morphologies leading to cellular radius varying between 100m to 20km. Spectrum limitations, higher competition, need for mobility, mix of applications, higher data rates, and demand on price points are setting the requirement bounds for the stakeholders.

Broadband services will be driven by internet access (browsing/email, VPS), Consumer/Retail (entertainment, gaming, mobile TV), Mobility (world on the move), Niche application (eGov, eCommerce, Tele-education, Telemedicine, VoIP).

Throughput and performance requirements are set by DSL standards at a lower bound of 256kbps, an upper bound of 2Mbps, and an average of 512Kbps. Wireless should be able to provide sustained throughput (low SNR, high interference, & varied terrains conditions), low power (human safety, less interference, & longer battery life), improve spectral efficiency (maximize customers/spectrum), cheaper/deeper coverage, scale transmission power (on demand addressing of market segments), and handovers (seamless mobility across multiple standards).

Feature requirements are based on – standards based products leading to interoperability, critical QoS on enterprise applications, multiple services on single access point, lawful interrupts for public security, high quality voice support, backward compatibility while evolving in to new standards, and self installation (plug-n-play).

Usage and Capacity assumptions are that 33% of the subscribers are connected of which 33% will be actively sending and receiving packets meaning 10% of the subscribers are actively connected at any given time. In the context of India the 600-900 subscribers/cell 10 simultaneous active connections at the rate of 512 Kbps results in 30Mbps/cell.

TDD frames of all operators must be synchronized (e.g via GPS) to avoid receiver saturation when bands of two operators are adjacent. TDD UL and DL frames must be of same length and also synchronized; should apply even if operator uses different TDD technology. UL DL ration can be 1:1 or 1:4. TDD system technology upgrade should allow an operator licensed in a certain band to be able to evolve in to a different technology within the same band with flexible frame duration, same or lower out-of-band emission spectral density in the new standard, and same or lower in-band EIRP in the new standard.

In FDD systems when specifying bands in new standards for common applications and ease of deployment the UL DL directions must be harmonized. System technology upgrade should allow an operator licensed in a particular bandwidth should be enabled to evolve in to another technology in the same bandwidth.

OTHER PRESENTATIONS

The presentations above have some significant facts that are of interest. The remaining presentations focused on discussing various standards for technologies as well as theoretical and practical research in developing architectures and algorithms for higher gains.

GLOSSORY OF TERMS

3GPP – 3rd Generation Partnership Project
802.11m – IEEE wireless networking standard for mobile devices
ARPU – Average Revenue Per User
CapEx – Capitol expenses
Cell – Cellular covering, usually 1 – 3 Km
CDMA – Code Division Multiple Access
CPE – Common Platform Enumeration

DL – Downlink
DSL – Digital Subscriber Line
EIRP – Equivalent Isotropic Radiated Power
EVDO – Evolution, Data Only
FDD – Frequency Division Duplex
GSM – Global System for Mobile
HSDPA – High Speed Downlink Packet Access
HSPA – High Speed Packet Access
HSUPA – High Speed Uplink Packet Access
HZ – Hertz
KB – Kilo Bytes
Kbps – Kilo bytes per second
LTE – Long Term Evolution
OFDM – Orthogonal Frequency Division Multiplexing
OFDMS – Orthogonal Frequency Division Multiple Access
Mbps – Megabytes per second
MIMO – Multiple Input Multiple Output
MVNO – Mobile Virtual Network Operator
P2P – Peer 2 Peer
QAM – Quadrature Amplitude Modulation
QoS – Quality of Service
Sec – Seconds
SNR – Signal to Noise Ratio
TDD – Time Division Duplex
UL – Uplink
UMB – Universal (Ultra) Mobile Broadband
UMTS – Universal Mobile Telecommunication Service