Open Wireless Architecture – The Core to 4G Mobile Communications

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Abstract

Fourth Generation (4G) Mobile Communications is not focused only on the data-rate increase and new air interface. 4G Mobile converge the advanced wireless mobile communications and high-speed wireless access systems into an Open Wireless Architecture (OWA) platform which becomes the core of the emerging next generation mobile technology.

Asia is the most dynamic market of new generation mobile communications with an estimated business of over $100 billion in the next decades. The 4G mobile technology is convergence of wireless mobile and wireless access, will definitely drive this growth. Any single-architecture wireless system, including 3G, HSDPA, WiMax, etc., is a transitional solution only, and will be replaced by open wireless architecture system very soon where various different wireless standards can be integrated and converged on this open platform.

I. Introduction

In future wireless service provision will be characterized by global mobile access (terminal and personal mobility), high quality of services (full coverage, intelligible, no drop and no/lower call blocking and latency), and easy and simple access to multimedia services for voice, data, message, video, world-wide web, GPS, etc. via ONE user SINGLE terminal. This vision from the user perspective can be implemented by integration of these different evolving and emerging wireless access technologies in a common flexible and expandable platform to provide a multiplicity of possibilities for current and future services and applications to users in a single terminal. Systems of fourth generation mobile will mainly be characterized by a horizontal communication model, where different access technologies as cellular, cordless, WLAN type systems, short range wireless connectivity and wired systems will be combined on a common platform to complement each other in an optimum way for different service requirements and radio environments which is technically called "Converged Broadband Wireless Platform, or Open Wireless Architecture (OWA)".

OWA defines the open interfaces in wireless networks and systems, including base-band signal processing parts, RF parts, networking parts, and OS and application parts, so that the system can support different industrial standards and integrate the various wireless networks into an open broadband platform. For comparison, Software Defined Radio (SDR) is only a radio in which the operating parameters including inter alia frequency range, modulation type, and/or output power limitations can be set or altered by software. Therefore, SDR is just one of the implemental modules of the OWA system.

As stated in the newest OECD (Organization of Economy, Cooperation and Development) report in April 2005, "As too many wireless systems come out every day, the current closed architecture and proprietary systems do not bode well for its success", therefore open architecture platform will definitely drive the future wireless and mobile communications. Fourth Generation (4G) mobile communication will basically focus on the Open Wireless Architecture, and Cost-effective and

Spectrum-efficient High-speed wireless mobile transmission. The 3G system suffers tremendously worldwide because it did not fundamentally improve the wireless architecture, and making the architecture open is the final solution in the wireless industry.

II. Open Wireless Architecture

The 4G Mobile communications will be based on the Open Wireless Architecture (OWA) to ensure that a single terminal can seamlessly and automatically connect to the local high-speed wireless access systems when the users are in the offices, homes, airports or shopping centers where the wireless access networks (i.e. Wireless LAN, Broadband Wireless Access, Wireless Local Loop, HomeRF, Wireless ATM, etc) are available. When the users move to the mobile zone (i.e. Highway, Beach, Remote area, etc.), the same terminal can automatically switch to the wireless mobile networks (i.e. GPRS, W-CDMA, cdma2000, TD-SCDMA, etc.). This converged wireless communications can provide the following advantages:

- Greatly increase the spectrum efficiency
- Mostly ensure the highest data-rate to the wireless terminal
- Best share the network resources and channel utilization
- Optimally manage the service quality and multimedia Applications

III. Adaptive Modulation And Coding (amc)

The principle of AMC is to change the modulation and coding format (transport format) in accordance with instantaneous variations in the channel conditions, subject to system restrictions. AMC extends the system's ability to adapt to good channel conditions. Channel conditions should be estimated based on feedback from the receiver. For a system with AMC, users close to the cell site are typically assigned higher order modulation with higher code rates (e.g. 64 QAM with R=3/4 Turbo Codes). On the other hand, users close to the cell boundary, are assigned lower order modulation with lower code rates (e.g. QPSK with R=1/2 Turbo Codes). AMC allows different data rates to be assigned to different users depending on their channel conditions. Since the channel conditions vary over time, the receiver collects a set of channel statistics which are used both by the transmitter and receiver to optimize system parameters such as modulation and coding, signal bandwidth, signal power, training period, channel estimation filters, automatic gain control, etc.

IV. Adaptive Hybrid Arq

A successful broadband wireless system must have an efficient co-designed medium access control (MAC) layer for reliable link performance over the loose wireless channel. The corresponding MAC is designed so that the TCP/IP layers see a high quality link that it expects. This is achieved by an automatic retransmission and fragmentation mechanism (ARQ), wherein the transmitter breaks up packets received from higher layers into smaller sub-packets, which are transmitted sequentially. If a sub-packet is received incorrectly, the transmitter is requested to retransmit it. ARQ can be seen as a mechanism for introducing time-diversity into the system due to its capability to recover from noise, interference, and fades. Adaptive hybrid ARQ shows significant gains over link adaptation alone through e.g. Chase combining. Hybrid ARQ self-optimizes and adjusts automatically to channel conditions without requiring frequent or highly accurate C/I measurements:

- Adds redundancy only when needed.
- Receiver saves failed transmission attempts to help future decoding.
- Every transmission helps to increase the packet success probability.

V. Generic Mimo And Ofdm

Multi-standard BTS engine for the 4G OWA platformIncreasing demand for high performance 4G broadband wireless mobile calls for use of

multiple antennas at both base station and subscriber ends. Multiple antenna technologies enable high capacities suited for Internet and multimedia services and also dramatically increase range and reliability. This design is motivated by the growing demand for broadband wireless Internet access. The challenge for wireless broadband access lies in providing a comparable quality of service for similar cost as competing wire line technologies. The target frequency band for this system is 2 to 5 GHz due to favorable propagation characteristics and low radio-frequency (RF) equipment cost. The broadband channel is typically non-LOS channel and includes impairments such as time selective fading and frequency-selective fading. Multiple antennas at the transmitter and receiver provide diversity in a fading environment. OFDM is chosen over a single carrier solution due to lower complexity of equalizers for high delay spread channels or high data rates. A broadband signal is broken down into multiple narrowband carriers (tones), where each carrier is more robust to multipath. OFDM can be implemented efficiently by using FFT's at the transmitter and receiver. At the receiver, FFT reduces the channel response into a multiplicative constant on a tone-by-tone basis.

VI. Open Broadband Wireless Core

The open wireless platform requires:

- Area and power-efficient broadband signal processing for wideband wireless applications.
- Highest industry channel density (MOPS pooling) in flexible new BTS signal processing architectures.
- BTS solutions scalable to higher clock rates and higher network capacity.
- Waveform-specific processors provides new architecture for platform reuse in terminals for multiservice capability.
- Terminal solutions achieve highest computational efficiency for application with high flexibility.
- Powerful layered software architecture using virtual machine programming concept.

VII The key features of open BTS modem include (but not limited to):

VIII Multi-standard air-interfaces GSM, cdma-2000, WCDMA, HDR, TD-SCDMA,WLAN, OFDM, WIMAX proprietary standards

IX Highest channel-density 3GPP channels, cdma2000 channels OFDM channels ability to support multiple sectors on one chip grow from sectors-on-a-chip to BTS-on-a-chip or System in-Package

X Scalable data-rates support from 8 kbps to 384 kbps to 2 Mbps to 10 Mbps or higher

XI Configurable to mix voice and data programmable allocation of channels

XII IP-ready interfaces directly via BTS IP back-haul.

XIII Over-the-network programmable remotely configurable from network operations center

XIV The key features of open wireless terminal:

XV Multi-standard Air Interface GSM, cdma2000, WCDMA, W-LAN, Bluetooth, OFDM, WIMAX

XVI Power Efficient 100 MOPS/mW and more

XVII Scalable Architecture Breaks the 384 kbps, 2Mbps and 10Mbps plateau

XVIII High-level Modem VMI Simplifies programming for each standard Enhances reuse across standards

XIX Integrates across many platforms No DSP and minimal microprocessor dependent

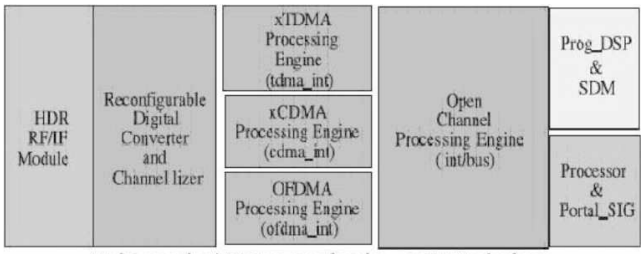
code

XX SIP Cores (Silicon Intellectual Property) Initial engine optimized for B3G/4G applications

VII. The Multi-standard BTS Engine for OWA Platform is shown in the following figure:

VIII HDR means Hardware Defined Radio

XIV SDM means Software Defined Module



Multi-standard BTS engine for the 4G OWA platform

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