IP-Based WCDMA Solution for the Provision of Advanced Wireless Services

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Abstract: Most operators will aggressively deploy Third Generation networks (3G) on their markets focusing on Wireless Multimedia and Mobile Internet. This will result from regulatory demands or from being in a very competitive market where quick 3G rollout is seen as the right strategy. This paper describes an all-IP, end-to-end quality of service (QoS) supported, WCDMA solution that provides high and variable bandwidth for emerging multimedia set of applications over various end devices.

Key-Words: 3G, all-IP WCDMA, UMTS, RAN, QoS, OSS, Wireless Multimedia, Mobile Internet

1 Introduction

The future of the Internet is increasingly wireless and includes devices that go beyond today’s PCs. These include personal digital assistants (PDAs), browser-equipped mobile telephones and devices yet to be imagined. Progressive operators are planning to deploy IP-based 3G networks that enable the delivery of wireless multimedia applications. This is significantly expanding the potential for new and incremental revenues to help offset the current decrease in ARPU (Average Revenue Per User) most providers are experiencing. These new voice, data and multimedia services will provide increased opportunities for differentiation, help expand subscriber loyalty and reduce the costly cycle of churn [1-13].

In addition to the improvements of data throughput and interworking, 3G will provide an additional spectrum for the operators. The increase in 3G spectrum efficiency will also provide the operator with more throughput over limited resources. The transition from the existing 2G networks to 3G capabilities will evolve over time. Dualmode terminals will attempt to provide seamless handover and roaming capabilities.

Business logic is quickly changing, accelerated by the shrinking costs of technology. The role of today’s telecommunication operators is also changing — wireless portals, pipes, brokers. The main challenge for service providers is the creation of seamless services for the end user. This means offering services to end users without concern with the access mechanism choice. For the end user the application simply works, every time, every where. Ultimately, this type of service implies a migration to horizontal layered all-IP networks, where all share the same backbone network (the Internet) and only the access technologies differ (Figure 1).

The evolution towards 3G all-IP networks leads to a new, more open ‘horizontal’ architecture for services, the network and end-user devices.
Horizontal architecture based on IP requires new revenue generation models for access and services charging [14]. It also requires network management systems and deployment strategies to handle both the legacy revenue generating network and the new 3G all-IP network.

2 WCDMA Overview

UMTS (Universal Mobile Telecommunications Service) represents the Third Generation of mobile telecommunications and is intended to form part of the International Mobile Telecommunications 2000 (IMT-2000) family of global 3G mobile/cellular standards, which will enable networks that offer true global roaming and support a wide range of voice, data and multimedia services [15]. UMTS uses WCDMA (Wideband Code Division Multiple Access) as the air-interface access technology (UMTS Terrestrial Radio Access — UTRA).

UMTS network supports the following QoS classes [16]:
- Conversational class (voice, video telephony, video gaming);
- Streaming class (multimedia, video on demand, webcast);
- Interactive class (web browsing, network gaming, database access);
- Background class (email, SMS, downloading).

There are two major paths for the evolution towards 3G: First, the migration from GSM via GPRS to UMTS/EDGE and, secondly, the evolution for IS-95 systems towards the CDMA2000 family [17]. A look at the evolutionary path from 2G to 3G (Figure 2) shows the likely migration path for service providers of each major format [18]. The WCDMA system looks like it will receive the most subscribers as operation is started in the IMT-2000 band.

WCDMA supports both packet and circuit-switched communications and it makes very efficient use of the available radio spectrum [19]. No frequency planning is needed, since one cell re-use is applied. Using techniques such as adaptive antenna arrays, hierarchical cell structures, and coherent demodulation, network capacity can be increased. In addition, circuit and packet-switched services can be combined on the same channel, allowing true multimedia services with multiple packet or circuit connections on a single terminal. WCDMA capacity is approximately double that of narrowband CDMA. The wider bandwidth and the use of both coherent demodulation and fast power control in the uplinks and the downlinks allow a lower receiver threshold [20]. WCDMA uses a network protocol structure (signalling) similar to that of GSM; therefore, it will be able to use the existing GSM network as the core network infrastructure.

WCDMA provides simultaneous support for a wide range of services with different characteristics (mobile/portable voice, images, data, and video communications) on a common 5 MHz carrier. The first release of the WCDMA specifications, release 99, includes support for data rates of up to 2 Mb/s in indoor or small-cell outdoor environments, wide-area coverage at rates of up to 384 Kb/s, and support for high-rate packet-data and circuit-switched services [21]. With the introduction of release 5 of the specifications in the spring of 2002, WCDMA packet data support is further enhanced — peak data rates in the order of 10Mb/s together with lowered roundtrip delays and increased capacity provide a further boost for wireless data access. In order to provide these high data rates, as well as to improve the system capacity, WCDMA release 5 employs three fundamental principles, relying on rapid adaptation of the transmission parameters to the rapidly varying radio conditions: fast link adaptation, fast hybrid ARQ (Automatic Retransmission reQuest), and fast scheduling of a shared channel [22-23].

WCDMA is based on the Direct Spread CDMA technology (DS-CDMA), known as WCDMA-FDD, where many users transmit over the same wideband frequency, each transmitter is assigned a distinct code and the intended receiver is able to utilize that code and de-scramble the information from the other conversations which just appear as noise to the receiver [24]. The Frequency Division Duplex (FDD) mode is used for symmetrical applications, i.e., those requiring the same amount of radio resources in the uplink as in the downlink.
3 Objective
Network infrastructure components capable of providing common capabilities related to security, subscriber identity, quality of service and accounting should be deployed in the network. These networking components should expose capabilities through standard and well-documented interfaces such as RADIUS, CORBA and XML. Architecting a future-proof services infrastructure that enables carrier to deploy single or multiple enhanced data, voice or converged applications was the service provider’s primary objective [25]. The network must rapidly enable the creation, integration and provisioning of new services quickly and easily through the support of open, Internet-based protocols. The result would be a more efficient and open service creation environment giving mobile service provider the ability to prototype, test and deploy applications in a very short cycle time.

3 Requirements
Wireless carrier needed to build 3G network that would support the following services:
- Mobile Internet and Intranet/Extranet access;
- Multimedia messaging service;
- Synchronization of mobile appliances with personal management software such as Microsoft Outlook, Lotus Organizer or Symantec ACT!
- Location-based services (route guidance, traffic data, navigation, mobile yellow pages);
- High-quality multimedia (video streaming and video conferencing);
- M-Commerce (Pay cinema and museum tickets, interactive shopping);
- Customized Infotainment (ring tone, screensaver, desk top);
- Online Gaming;
- Rich call with image and data stream, IP telephony, B2B ordering and logistics;
- Global roaming.

To meet these demands, mobile operator has turned toward all-IP WCDMA network that could deliver higher data rates based on QoS-enabled packet transmission and new modulation format.

5 All-IP WCDMA Solution
Architected from the ground up using an IP platform, an all-IP WCDMA solution employed the following 3G products:
- Lucent’s Flexent OneBTS base station — a flexible radio access platform delivering cost-effective long-term performance and scope for growth. The same Flexent OneBTS unit can support both GSM and UMTS [26].
- Cisco 10720 Aggregation Router supports services to the metro and advanced QoS [27].
- Lucent’s Flexent Radio Network Controller (RNC) is adaptable, high capacity WCDMA network element for call handling, operation and maintenance of multiple Flexent OneBTSs. Flexent RNCs provide QoS and, along with Flexent OneBTSs, form the WCDMA RAN (Radio Access Network) [28].
- Lucent’s Navis iOperations — an operations support system (OSS) package comprising the following software modules [29]:
  - Navis iEngineer (including the Navis Element Management Systems — EMS) helps configure, build and maintain networks; accommodate new technology and introduce new services.
  - Navis iProvision (including the Navis workflow, resource management and services activation software) accelerates operator’s revenues and reduces customer service costs.
  - Navis iAssure (including the VitalNet Network Performance Management software system) combines performance and fault management in the same tool to monitor, survey and manage networks for peak operations with top QoS.
- Lucent’s SpringTide 7000 Wireless IP Service Switch Router offers business-quality IP services such as mobile VPNs, enhanced security, location-based and multimedia services [30]. The switch provides QoS and performs the function of Packet Data Serving Node/Foreign Agent (PDSN/FA). SpringTide 7000 also features the policy driven stateful firewall while supporting intrusion detection and denial of service protection.

The solution depicted in Figure 3 supports open and standardized interfaces to control and expose its capabilities to a third-party development community. Third-party application and service developers provide the pool of creativity required to develop new and exciting applications. The key components for incorporating new applications into the network are the ability of the network to support revenue-sharing business models, per-flow accounting mechanisms, subscriber policy-based steering and the establishment of a development community (APIs — Application Programming Interfaces) for the applications.
The use of IP as a backhaul transport technology brought flexibility to an operator in choosing a Layer 1/2 backhaul technology: Metro Ethernet, Frame Relay, ATM, dedicated T1/E1s or wireless [31]. Wireless operator can even use multiple services simultaneously. Using IP transport for backhaul enabled one central office to support Base Stations spread out over a large geographic area, which eliminated the need for multiple central offices and duplicate network equipment.

Figure 3. All-IP WCDMA Solution
Continuous monitoring from an end-to-end perspective allows wireless carrier to address and troubleshoot quality issues on a proactive basis and will allow him to reduce the amount of churn that he experiences, increase the amount of billable time his subscribers incur and differentiate his services in the marketplace based on quality and not only on price.

6 Conclusion
Deployed solution is able to incorporate new best-of-breed services from operator’s strategic partners and content developers. Those third-party applications will be a driving force for the creation of new revenue. All-IP WCDMA network offered mobile service provider a solution that allowed him to deliver high revenue services, attract and retain customers, and reduce its operations, capital equipment and bandwidth leasing costs.

The wireless industry is at the beginning of the network evolution. This evolution will bring to market new and exciting applications that have the potential to change the way people communicate. Wireless operators wanting to capitalize on this opportunity will need to build a network capable of enabling these services quickly and easily. Operators who are successful at architecting a network capable of providing services will be able to create competitive advantages and drive new revenues for many years to come.

References:
Internet Protocol Technology in WCDMA GSM Core Network. Ericsson provides complete solutions and products to support deployment of new IP-based services and transport networks. Moreover, Ericsson's flexible core network architecture allows operators to address these drivers in an independent way. The main parts of this article describe how the requirements for the two main drivers for IP technology are met in the mobile core network. Paying special attention to support for the IP multimedia application, the authors describe how support for IP applications is implemented. They then describe how IP transport technology can be supported, including site IP-Based WCDMA Solution for the Provision of Advanced Wireless Services. S Milanovic, NE Mastorakis. 2nd WSEAS International Conference on Automation and Information (ICAI 2002 â€¢), 2002. 6. 2002. Cost-Effective Migration to All-IP Third Generation Wireless Communications Infrastructure. S Milanovic, NE Mastorakis. 2nd WSEAS International Conference on Automation and Information (ICAI 2002 â€¢), 2002. Advances in wireless communications have resulted into emergence of a wide range of applications. With the provisioning of statistical QoS requirements in buffer-aided relay communication systems. Using the concept of EC, a trade-off of statistical delay between two concatenated queues has been discussed. This framework was also used to investigate the enabling technologies such as W-WCDMA and MC CDMA for the fourth generation wireless networks. Various quality constraints for voice calls with EC as the performance metric have been investigated in [36], [38]. 2) VoIP Applications: With the advancement in Internet protocol (IP)-based networking, voice over Internet protocol (VoIP) applications have gained a lot of attention.