WHITE PAPER

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Innovative DSP technology with RISC virtualization delivers high performance, flexible femtocell design

Introduction

Enterprises are increasingly exchanging wired connections for mobile phones, and smart phones are quickly becoming a primary means of Internet access. Together, these changes are accelerating the evolution toward wireless video and audio and creating an unprecedented increase in the volume and nature of wireless network traffic. The high data rates and bandwidths required to support these applications are a challenge for supporting today's networks.

Many network operators are looking to femtocells for a solution. Femtocells promise a cost-effective way to handle higher traffic volumes and improve data rates.

Femtocells are similar to wireless routers in that they are installed by users and take advantage of a broadband wired connection such as DSL or cable. These mini base stations extend the cellular service provider's network in an inexpensive fashion and provide improved indoor coverage and high data rates given their close proximity to the user. Operators believe that femtocell technology will play an important role in the network topology of 3G and 4G systems.

The TCI6489 DSP from Texas Instruments delivers a fresh approach to enterprise femtocell performance

In the enterprise femtocells are expected to have a range of 200 meters and serve as many as 32 users. For current WCDMA systems, enterprise femtocells can provide HSDPA throughput of up to 15 Mbps and HSUPA throughput of up to 5.7 Mbps.

Femtocell technology trials began in 2006, with product announcements from major operators around the world in 2008 and 2009. Market saturation is still low, however, and early concerns about the technology's viability remain because it has yet to be deployed at a large scale. Femtocells must integrate seamlessly into the existing infrastructure and not degrade the performance of existing macrocells through interference.

Because femtocells have no unique spectrum allocation, they could experience, or cause, previously unanticipated network interference. The sophisticated algorithms that have been developed to address the problem inevitably add to the computational load of the femtocell. Solutions for access control, security and network integration also raise the performance bar for the silicon that powers femtocells.

As always, cost is an important issue. Even though femtocells may be a less expensive and higher performance deployment option than conventional base stations, the anticipated profusion of femtocell suppliers is likely to create classic cost/performance competition. Assuring a predictable interaction with the existing wireless infrastructure is also an important issue, especially for network operators, who are well aware of the complexity and customization within their networks.

As result, network operators and third-party femtocell suppliers are looking for femtocell silicon that fits seamlessly into the existing cellular infrastructure, offers computational headroom, and keeps costs low. Ideally, they would also welcome a complete platform that includes software, digital baseband and analog RF solutions.

Femtocell silicon

Choosing femtocell silicon is a challenge in today's market, as the cost points drive some suppliers to develop hard solutions even though the technology has not yet matured through mass deployments.

The Texas Instruments (TI) TCI6489 DSP delivers a fresh approach to femtocell design, delivering a low-cost yet completely programmable device. It is a three-core device that delivers 2.55 GHz of raw performance. In addition to DSP capabilities, there are specific accelerators for the highest computational components of the HSPA network, allowing for a cost-effective overall solution.

The TCI6489 inherits a reputation for reliability in wireless applications based on TI's long standing incumbency in the wireless infrastructure space and large deployments of C64x+™ DSPs around the world.

RISC code on DSPs

Three cores offer plenty of computational headroom for the HSPA layer 1 signal processing applications. But the TCI6489 platform goes an important step further by integrating the higher layers as well. While most competing solutions use RISC processors, the TCI6489 substitutes an enhanced real-time virtualization capability created for TI C6000™ DSPs by VirtualLogix.

Both the TI DSP/BIOS™ software kernel foundation and Linux can run side by side on one of the TCI6489's three cores with negligible performance overhead. Implemented within a memory footprint of just 64 KB are the following features and functions:

- 2.6 Linux kernel
- Linux networking protocols
  - TCP/UDP, IPv4, IPv6, IPSec
  - IP multicast
  - IP forwarding and advanced routing
  - DHCP/BOOTP/RARP
  - IP tunneling
  - Fair packet scheduling (DiffServ, RSVP)
  - RTP/RTSP

The result is nothing less than full ISO Layer 1 to Layer 3 support on a single device.

The use of a single, homogenous processing system allows different customers to use different amounts of real-time processing and higher layer processing depending on their specific features. Figure 1 shows a conceptual model for RISC virtualization in the context of the chip's functional blocks.

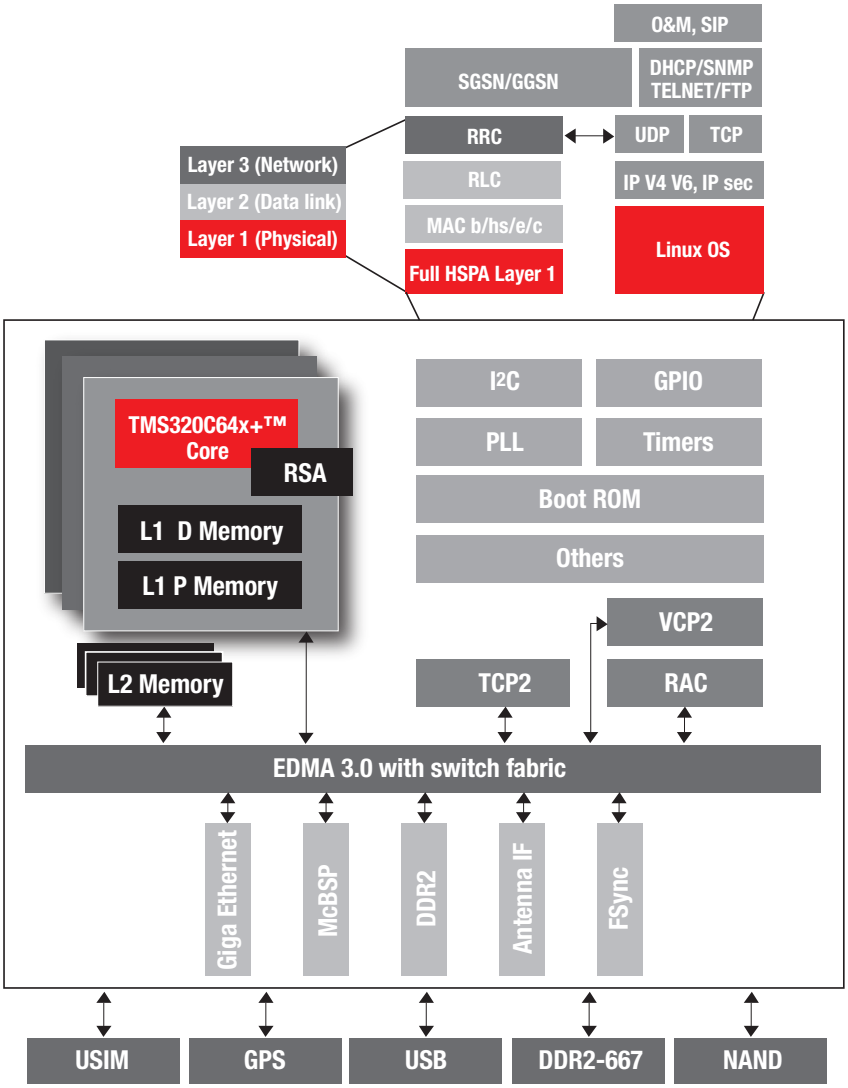

Figure 1. Virtualization allows single-chip support for ISO Layers 1 to 3.

Adding VirtualLogix's VLX onto the C64x+ DSP makes it possible to port legacy control code applications easily to TI DSPs such as the TCI6489. The functionality for wireless infrastructure applications include:

- The ability to run host processor functionality in parallel to data processing.
- Remote monitoring and control during integration, field trial and deployment.
- The addition of specialized agents such as network, file system and security.

Stack partitioning can be as straightforward as using two cores in the TCI6489 to handle the PHY layer and the third core for the rest, or designing a custom solution.

Hardware acceleration

Additional computing power is made available for the TCI6489 cores by integrating hardware accelerators specifically targeted at wireless functionality. The receive accelerator coprocessor (RAC) and rake search accelerator (RSA) assist the spreading and despreading functions in WCDMA, while the Viterbi coprocessor (VCP2) and Turbo coprocessor (TCP2) accelerate forward error correction computations. All of these components offload the basic yet computationally intensive processing, allowing the overall solution to be flexible yet inexpensive.

The RAC subsystem is a receive chip-rate accelerator developed for despreading the antenna data in WCDMA systems. The RAC accelerator can implement the following functions: finger despread (FD), path search (PS), preamble detection (PD) and stream power estimation (SPE). Its back-end interface (BEI) manages configuration and data output. A front-end interface (FEI) receives antenna data for processing and provides access to computational subsystems.

The transmit chip-rate processing is implemented by a DSP subsystem and the RSA accelerator. The DSP core generates both OVSF and PN codes and provides the multiplied result of these two codes as input to the RSA. The RSA applies the code values to the modulated symbols to achieve spreading and scrambling. It is also capable of carrying out the stream aggregation functionality.

Another prominent feature of the TCI6489 includes 3 MB of L2 SRAM cache (one per core) and four air interface (AIF) high-speed SERDES lanes. Each lane is configurable as either OBSAI or CPRI, with a maximum rate of 3.072 Gbps (OBSAI) and 2.4576 Gbps (CPRI).

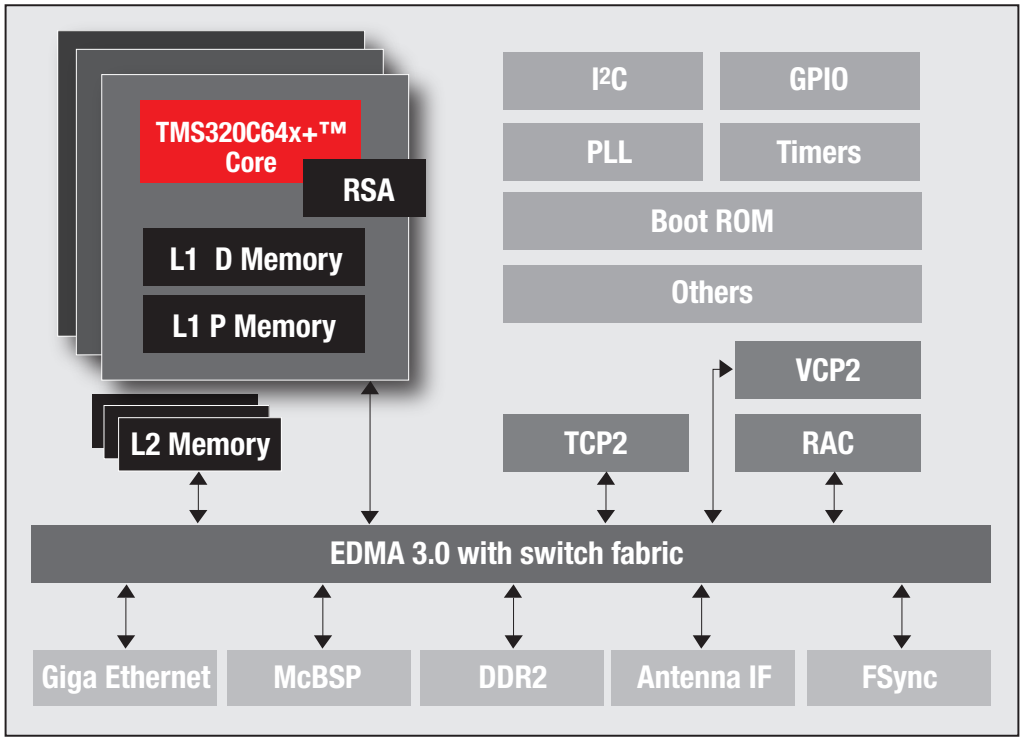

Figure 2. The TCI6489 block diagram with accelerators and peripherals.

Complete solution

TI and its third parties deliver a complete solution including software reference designs, evaluation hardware, and a proven reputation for success in wireless infrastructure applications.

In addition, the enterprise solution consists of an analog signal chain comprising DACs, ADCs, clock generators and modulators.

TI's three-core TCI6489 is compatible with all major 2G/3G and 4G systems including GSM, CDMA, WCDMA, TD-SCDMA, WiMAX and LTE. TI, along with third parties, reduces time to market by offering complete software solutions, tested on evaluation hardware and ready for customers to integrate into their designs.

Femtocell technology seems destined to enjoy wide acceptance by carriers and users as long as price points are met and the new technology integrates easily into the existing infrastructure. TI's complete solution is based on proven wireless infrastructure technology. It offers a low bill of materials cost by integrating all of the required software onto a single device, as well as providing a quick time to market thanks to the availability of software reference designs, hardware evaluation modules and a complete analog signal chain for the enterprise solution

For more information

www.ti.com/femtocell

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