WIRELESS BASEBAND EVOLUTION – MULTIPLE DESIGN APPROACHES FOR 4G MODEMS

The evolution of 4G wireless baseband indicates there are two evolving technologies that are currently competing for the leading position; namely LTE and WiMAX. WiMAX has emerged as the technology of choice for computing devices and M2M, as well as for fixed wireless connections in underdeveloped areas. It is promoted by the WiMAX forum, led by Intel and other companies. LTE is evolving as the "GSM" direction towards cellular broadband and is promoted by the 3rd Generation Partnership Project (3GPP) and adopted by baseband OEMs and operators including Qualcomm, ST-Ericsson, Verizon, Vodafone and others. It is unclear which standard will eventually prevail, and it is highly possible that both standards will coexist and serve different use-cases in different geographies. To ensure that both of these standards are supported in 4G modems, a flexible solution that would allow for specific implementations under both technology roadmaps is required.

The evolution of mobile modems is not solely restricted to the increase in complexity of wireless standards. Today's Smartphones already must support multiple wireless air interfaces. 4G mobile devices will need to support, alongside WiMAX and/or LTE, a large number of wireless air interfaces including GSM, GPRS, EDGE, W-CMDA, HSPA and recently also HSPA+.

As it is impossible to foresee the future of the wireless baseband market, chip vendors are facing tough conditions. The cost of development and the multiple changing standards increase the risks involved in a traditional, hardware-based design approach for the terminal modem, where it is conceivable that the vendor can develop their chip targeting the wrong standard and ending up with an obsolete solution before even being launched. More importantly, hardwired designs struggle to provide the flexibility needed to support all the standards without having to duplicate large amounts of silicon, making them much more costly, bulky and power-hungry. This naturally leads to a demand for a programmable solution that can offer the required flexibility and reduce the development cycle needed for supporting multiple standards.

Different Approaches for Mobile Broadband Modem Design

There are three main approaches that can be explored in the context of designing a new mobile baseband chip:

- Traditional (hardwired) approach – implementing the entire modem in hardware. This basically offers fast time-to-market for the first chip. Also, hardening the design for specific standards usually assures the lowest level of power consumption. However, such an approach has no flexibility and roadmap for next generations, as discussed in the previous section.

- Hybrid approach – mixing hardwired design with a programmable processor. The modem areas that require flexibility are mapped to a programmable DSP core to allow flexibility using software implementation. The remaining computation-intensive and less flexible modem parts such as FFT are implemented in hardware, as in the traditional hardwired approach.

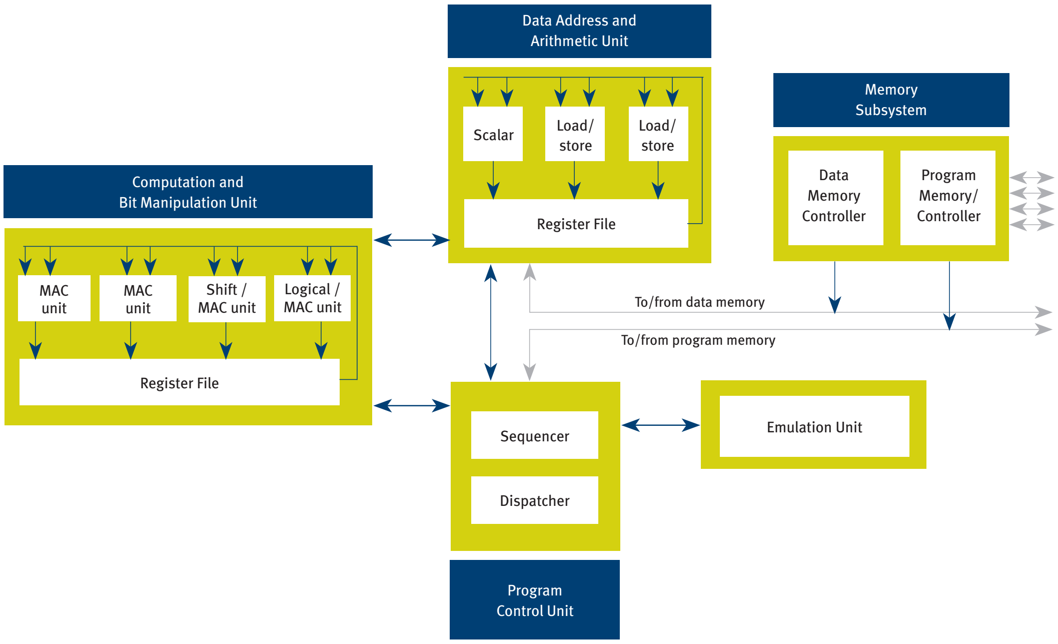
- SDR approach – a complete "Soft-Modem" implementation, supporting multiple wireless standards concurrently on the same chip, in software. This approach offers full flexibility using a fully programmable solution and can address multiple standards, both existing and future, without the need to reissue new products. However, the main concerns involved with such an approach are the more complex design effort and higher power consumption compared to the hardwired approach, which is specifically optimized for the supported standards.

Since the usage of the traditional approach involves a high risk of missing the market requirements which are currently unforeseeable, it is highly unlikely that any vendor would opt for such an architecture. We will focus on the latter two programmable approaches.

Hybrid mobile modem approach using CEVA-X1641

CEVA-X™ is a family of high performance multi-purpose DSP cores, widely used in mobile and wireless applications and shipping in large volumes by multiple market leaders.

The CEVA-X architecture has a unique mix of Very Long Instruction Word (VLIW) and Single Instruction Multiple Data (SIMD) architectures. The VLIW architecture allows a high level of concurrent instructions processing thus providing extended parallelism, as well as low power consumption. CEVA-X architecture enables efficient programming in high level C-language that significantly reduces development cost and time-to-market.



CEVA-X1641 Block Diagram

CEVA-X1641 is a quad-MAC member of the CEVA-X DSP family consisting of 16-bit data width and four MAC units. CEVA-X1641 can run at high frequency over 700 MHz @ 65nm worst case conditions.

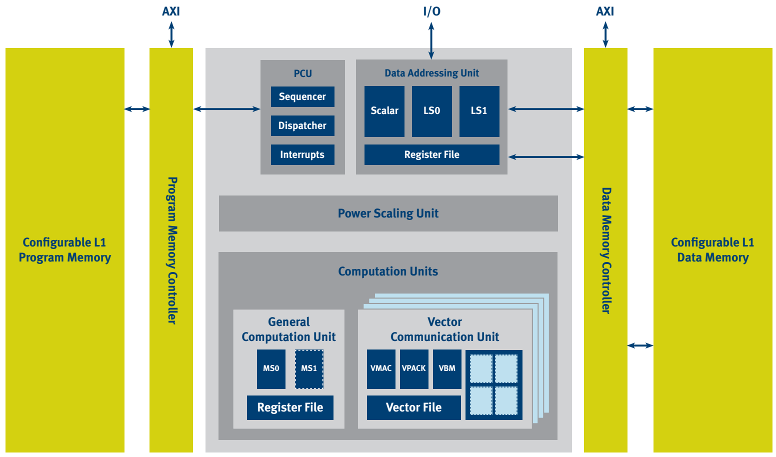
This high-performance and easy-to-use DSP offers multiple different software-hardware partitioning for mobile modem SoCs. Different baseband customers are using different implementations and partitioning, ranging from single core to multi-core in their modem design, assisted by different HW accelerators to complete the modem functionality. The selection of an extremely powerful market-standard DSP architecture such as the CEVA-X1641 protects software investment and ensures a clear roadmap for future product generations. Multiple CEVA customers are currently building 4G modems based on the CEVA-X1641 as their DSP of choice.

Soft-Modem SDR approach using CEVA-XC

CEVA-XC™ is an extremely powerful communications processor designed and optimized for advanced wireless communications. CEVA-XC builds on the CEVA-X and is capable of supporting multiple air interfaces in software, including the most demanding 4G mobile standards; LTE cat. 5 and WiMAX II (IEEE 802.16m), alongside 3G and 3.5G. This innovative processor enables true soft modem implementation by supporting multiple air interfaces concurrently on the same architecture.

Using a software programmable architecture to deliver a single engine for all wireless processing, CEVA-XC eliminates the need for multiple baseband co-processors. Thus, it reduces power consumption and die size related to additional memories, data buffers and overall data traffic common to such distributed architectures.

The CEVA-XC architecture builds upon 1, 2 or 4 Vector Communications Units integrated into a CEVA-X processor. Each vector unit is a 256-bit SIMD engine, using 3-way VLIW and a large array of 16 MAC, arithmetic, logic and shift units. CEVA-XC instruction set handles the requirements of 4G wireless modems, including matrix processing, MIMO detectors, complex filtering, data permutations and bit stream processing.



CEVA-XC – Block Diagram

Conclusion

As we move towards 4G, the development cost and the multiple changing standards increase the risk involved in a traditional, hardware-based design approach. It is essential to design a flexible solution that can be quickly adapted to changing standards and reused across multiple product generations. A programmable solution based on either the hybrid approach or full soft-modem enables the required reusability and ensures fast time-to-market.

The trend of moving towards programmable solutions has long been accepted by the wireless baseband leaders. It is now being standardized around DSP architectures such the two CEVA DSP cores presented here, which offer licensees the freedom of choice depending on their system architecture and level of flexibility required. And with recent advancements in power saving techniques and lower geometries, these programmable approaches are becoming the preferred method for implementing 4G standards in a wide variety of applications.

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