Aviacomm

Software-Defined Radios: Mobile Architectures Come Full Circle

Introduction

Wireless communications systems have developed from simple amplitude modulation to sophisticated digital systems implementing spreading techniques and, more recently, OFDM. Having already evolved from devices which operated on a single frequency with a fixed channelization to multi-mode quad band phones, wireless systems continue to have more demands placed on them each and every year. And there is no end in sight: as consumers integrate wireless connectivity into their lives, they will only require more out of these life critical products.

The trend for the past 20 years has been to develop sophisticated ASICs, and add in the newly required functionality-- WiFi, GPS, Bluetooth and even FM -- into the silicon. This approach served two of the key requirements for wireless components: a smaller footprint and low power. The alternative has been to develop “soft-core” approaches wherein the mode and protocol support is performed in DSP. Unfortunately, this latter approach had limitations in terms of size and power consumption -- exactly the two dimensions the ASIC approach solved so well.

Going forward, however, the fundamentals of the market, coupled with improvements in technology, are causing the industry to re-think the ASIC vs soft-core approach. Today, new protocols, such as updates to the 802.11 standard and the new requirements and functionality of the latest 3GPP release, are being introduced on almost a yearly basis. As a result, companies will often release devices with “pre-release” support in order to get a jump on the competition. Thus, in an environment where new, complex PHY layer features are being rapidly introduced, flexibility in the baseband starts to become a much more important dimension to these products.

When the inevitable tweaks and fixes required for these complex designs are factored in, the soft core approach becomes much more attractive as updates are new firmware uploads as opposed to a re-spin of a chip. With so much at risk to getting the ASIC exactly right, re-spins can mean up to a year in production delays, incredible effort is expended in simulations and validations pushing ASIC development cycles into multiple years.

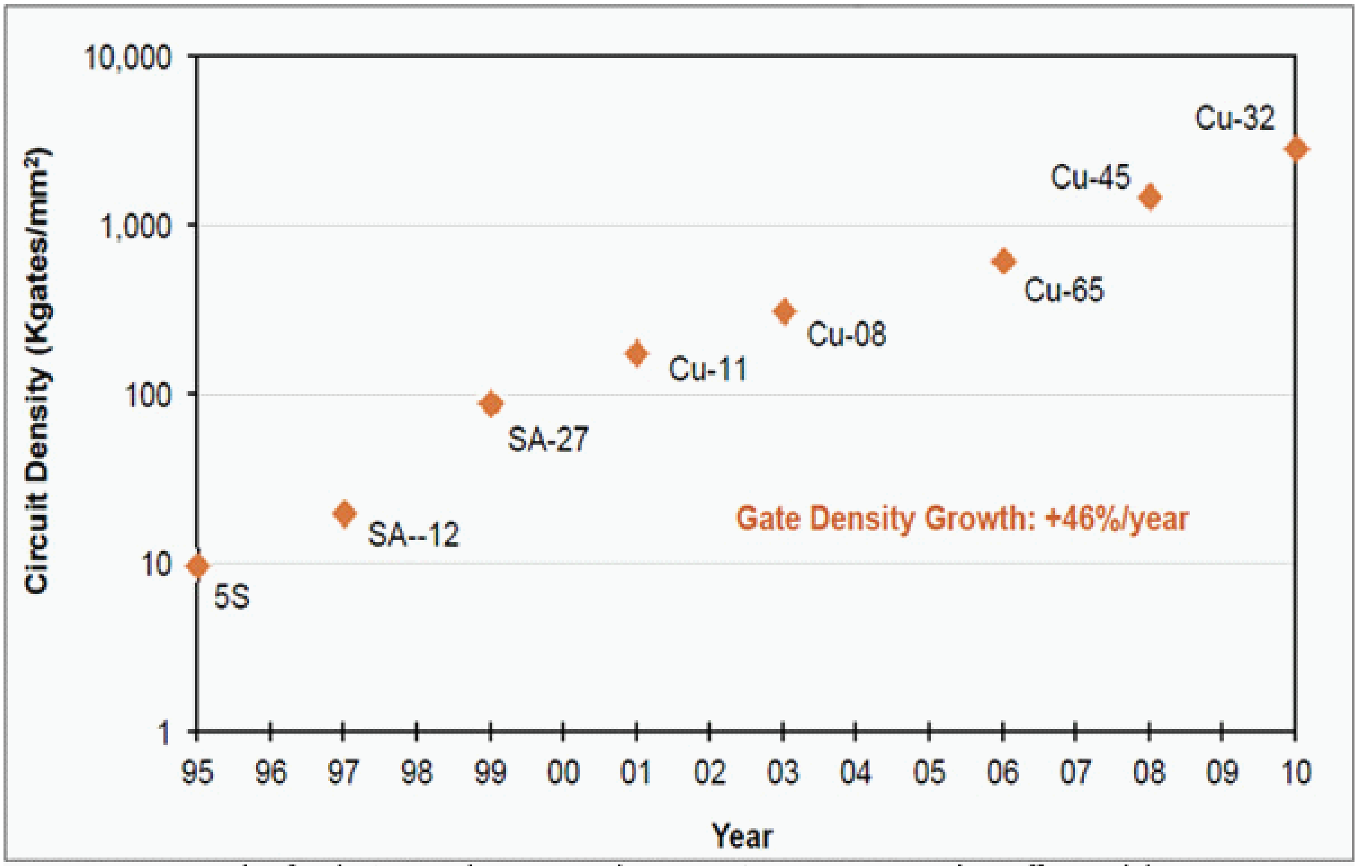

Fig 1. As an example of today's ASIC design complexity, IBM's Cu-32 ASIC product offering delivers 2.9K raw gates per square millimeter. Such advanced process nodes enable SoC design teams to integrate and implement extremely powerful and complex systems, and designers are taking advantage of these available gates. (Source: The McLean Report 2011)

As the industry shifts towards the soft-modem approach, it is imperative that the rest of the PHY also be flexible and programmable. A dynamic, flexible RF Front End (RFFE) is a critical complement to the soft modem to deliver truly adaptive devices. As new standards are released and adopted, the software-based system can be easily updated and its features easily expanded. A flexible RFFE also means that, as new bands are released by regulators; existing devices in the consumer's hands can be updated to support the new frequencies.

However, an RFFE that can dynamically change frequencies from 400MHz to 3GHz, switch channelizations from 0.5MHz to 20MHz, and meet the stringent performance requirements up and down that frequency range has not yet existed. Until today, that is. Aviacomm, with its Smart Analog Solutions Portfolio -- specifically, its ARF series of RFICs -- has met and conquered this challenge. As the emerging class of soft modems are introduced to the market, the resultant PHY layers in the system are ushering in a new era of communications devices: the general purpose, adaptive hardware platform that can be updated in the field with a software download.

Soft Modems – A Historical Perspective

When mobile communications systems were first introduced in the 1990's, the functionality, technology IP and ability of the ASICS of the day made them an impractical approach for the mobile phone. In addition, the standards themselves-- 3GPP and 3GPP2 -- were rapidly evolving, such that the preferred modem was based on DSPs, despite the power consumption penalty .

For basic voice communications, the DSPs of the time were more than powerful enough for the simple tasks they were asked to do. As the system began to add data communications functionality, the networks, devices and PHY layer technologies became increasingly complex. With the introduction of CDMA and 3G, not to mention additional protocol support at the time, such as GPS and WiFi, the soft approach could no longer support the PHY layer voice and data demands in a form factor that met size and power consumption needs.

Soft Modems in the Future

Today a typical smart phone supports up to seven wireless standards and at least six frequency bands. The challenge of building an ASIC that performs all these functions drives development cycles into years, all the while the protocols themselves continually evolve, with new releases every 12 months. Clearly, this environment calls for a more flexible, programmable approach, one that the soft-modem community is starting to deliver. Applications processors (APs) are increasingly more powerful, with 1.5GHz quad core processors being introduced today. These APs take on much of the MAC layer processing that used to reside in the modem, allowing the modem to be more of a PHY layer component. With focused functionality, more powerful processing, and lower power consumption, the soft-core modem is perfectly positioned in an environment with rapidly changing requirements and protocols.

A device with a soft modem will have a much quicker time to market. When a device has the ability, with new releases, to address bugs and new features, development cycles can be much shorter, and new standards can be introduced in months as opposed to years. If we now extend the functionality of these devices to switch protocols and, even more importantly, frequencies, the industry will have taken a huge step towards the ultimate wireless communications device: the cognitive radio.

The reality today is these systems are much closer to being available than one might assume. It is possible, with the ARF series of RFICs, to build a device today that can operate in 700MHz, TVWS, 3G bands or any of the 45 LTE bands and change between them in a seamless manner.

In addition to the flexible, wide-band RFIC, the rest of the component ecosystem is also moving towards cognitive radios with new, improved wide-band support. Today's smart phone may have as many as seven PAs, one for each frequency band. Tomorrow, advances in this field will bring to market wide-band PAs to match the flexibility of the soft modem and the Aviacomm RFIC.

Summary

In the early years of mobile communications, the soft-core modem was the preferred design technique. As protocols and data rates increased demands on the modem, a hard-coded ASIC approach was required to support these demands and do it in a size and power consumption required by consumers and heir mobile devices. The ideal hardware platform for the future is one which can be updated to meet new standards, new frequencies and new regulatory requirements. As the soft modem industry reclaims its position in the mobile ecosystem, flexible wideband RFFEs, led by Aviacomm's ARF series of transceivers, will be critical to the software design devices of today and cognitive radios of tomorrow.