MULTI-MODE BASE STATION/COMMON PLATFORM/SOFTWARE DEFINED RADIO: WHAT'S IN A NAME?

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ABSTRACT

It is commonly known that Software Defined Radio (SDR) technology is rapidly maturing and coming to fruition in the military through programs like the Joint Tactical Radio System (JTRS). This coincides with the trend in commercial wireless infrastructure towards "multi-mode base stations" and "common platforms" driving the concept of base stations (BTSes) that can support more than one air interface protocol and be upgraded after deployment to add new applications or services. The advantage for operators is the ability to significantly reduce capital expenditures (CAPEX) and operating expenditures (OPEX) by remote upgrades through software. Infrastructure vendors also benefit from reduced costs due to lower development costs, economies of scale, and a greatly simplified supply chain. Ironically, SDR technology is enabling this evolution in commercial platforms, despite its strongly held affiliation with military applications. This paper will examine the trends in commercial wireless and the impact of SDR technology for infrastructure applications.

1. INTRODUCTION

SDR is perhaps best known and most commonly associated as the enabling technology behind the US Department of Defense (DoD) JTRS program targeted at replacing all US military tactical radios, from airborne to shipborne to handsets, with a family of reprogrammable and reconfigurable radios. However, SDR is actually an enabling technology that is applicable to many markets, including MILCOM, cellular infrastructure, cellular handsets, public safety, and even automotive telematics. Whether or not a market adopts SDR technology, and the rate at which it does so, is primarily a function of the economic trade-off between the increased bill of material (BOM) cost for flexible hardware versus the increased revenue from software upgrades and reduction in development costs and risk. Given that the commercial wireless infrastructure industry is moving towards multi-mode BTSes and common platforms, we give pause to ponder what's in a name. Are these terms really distinct?

2. MEGA TRENDS IN COMMERCIAL WIRELESS: THE NEW REALITY

Certain mega trends in commercial wireless have and will have far reaching implications for the industry and the business models required for success. They are disruptive and affect the wireless value chain from the operators all the way to the component vendors. For example, the commoditization of hardware combined with differentiation through application software and services is changing fundamental business models in ways that favor SDR as a common platform for delivering multiple modes and/or applications to both subscribers and operators.

With regard to hardware, BTSes are being increasingly commoditized (i.e., year over year cost reductions of 10-15 percent expected), as are mobile phones, resulting in cost pressure on downstream hardware vendors, including subsystem and component vendors. Typically, this is characterized as a reduced cost per card or per function. At the same time, value continues to pool in application software and services, as illustrated in the value chain in Figure 1.

From a value chain perspective, this means that subscribers place substantial value upon the available applications and services for their mobile phones. The phones themselves are just the delivery platforms, while the network is the infrastructure needed to support them. In turn, this drives a change in the business models of operators, who are now looking to monetize these applications and services. In order to maximize this potential revenue stream, it requires a flexible infrastructure that can evolve to support new applications and services, as well as upgrades to the air interfaces. New applications and services will increase average revenue per user. (ARPU), while the air interface upgrades will provide the increased bandwidth to support them.

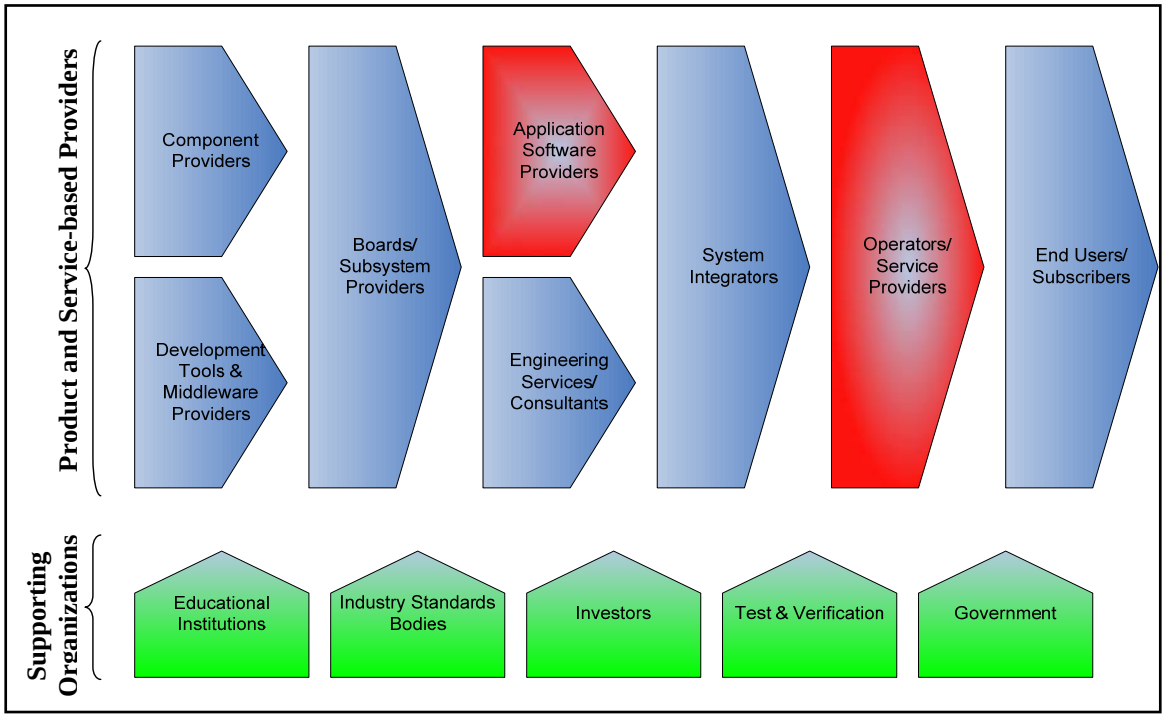

Figure 1: The Wireless Value Chain depicting value pools (red) of increased profitability in application software and services [1].

In this new paradigm, the most successful telecommunications equipment manufacturers (TEMs) will be those offering flexible networks through SDR (software-defined radio) technology, enabling them to increase their revenue through software downloads to upgrade their infrastructure even after deployment. It is expected that TEMs supporting WiMAX and LTE, for example, will derive 50 percent of their revenue from software and services, as opposed to the 20 percent or less seen today for W-CDMA.

Interestingly enough, while the MILCOM market has embraced the term "SDR" ever since Joe Mitola first coined it in 1991, SDR has not received widespread acceptance in the commercial wireless industry for perhaps that very reason. Instead, the commercial wireless industry has generally adopted the terms "multi-mode" and "common platform" to essentially describe SDR technology in BTSes. When looking at the usage of the terms in more depth, multi-mode seems to be a marketing term positioning the benefits of SDR, whereas common platform has an orientation around providing an SDR-enabled means to reducing both development costs and risk.

4. MULTI-MODE AS A MARKETING FEATURE

The term multi-mode generally refers to the feature whereby a BTS can be reprogrammed or reconfigured to support multiple air interfaces, upgraded as air interfaces evolve, and updated with downloads of new applications and services as required by operators. Hence, it is essentially a marketing term used to differentiate SDR BTSes from traditional non-programmable BTSes, as well as to justify revenue streams associated with software upgrades even after the infrastructure has been deployed. Nevertheless, it is clear that SDR technology is the critical enabler for multi-mode BTSes.

5. COMMON PLATFORM AS A MEANS TO REDUCE COST & RISK

Common platform, on the other hand, is an engineering term used by TEMs when referring to an SDR platform strategy for reducing their development costs and risk. These are often the primary concerns of project and product managers. The use of a common platform to support multiple air interfaces can reduce development costs by having fewer hardware platforms to develop, debug, build and test. Fewer

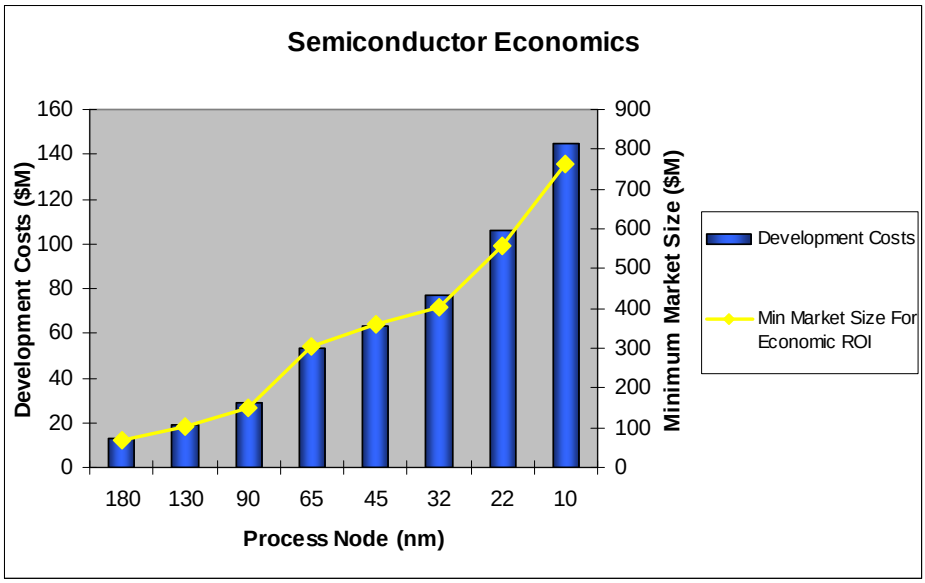

Figure 2: Substantial increases in development costs at successive process nodes are requiring significantly larger market sizes to justify development [2].

hardware platforms can also greatly simplify logistics and reduce supply chain costs by having to negotiate with fewer component vendors and stock fewer components. It also allows for better component pricing through economies of scale.

At the same time, risk is substantially reduced with common platforms because they can support more than one air interface and be upgraded during development or after deployment, allowing TEMs to capture revenue through software upgrades. Risk is also reduced from a time-to-market perspective. When new air interfaces are introduced, there is a long standardization period, during which ASSPs are typically not available and ASICs are too risky. Subsequently, most TEMs develop platforms with FPGA and DSP-based architectures. By combining a common platform approach with FPGA architectures, it is possible that a new platform for a new air interface would not even be necessary. Rather, the TEM could use an existing common hardware platform and focus on development of the software. Once again, SDR technology emerges as the frontrunner in enabling a common platform strategy.

6. SDR PROCESSING COMPONENTS & SEMICONDUCTOR ECONOMICS

Regardless of the preferred term (multi-mode, common platform or SDR), the fundamental underlying technology is reprogrammable or reconfigurable hardware, such as FPGAs and DSPs. This points to an interesting convergence of mega trends, in which the economics of the semiconductor industry, like the commercial wireless infrastructure industry, are trending towards reprogrammable and reconfigurable processing devices due to the marked increase in development costs at each successive process node. This is clearly illustrated in Figure 2.

The wireless infrastructure industry is predicted to grow at a CAGR of 2.4 percent from 2007 to 2012 according to iSuppli. At the same time, the development cost of an ASSP or ASIC will have increased by 45 to 170 percent, depending on the exact process nodes used. Most FPGAs and DSPs today are at the 65 or 90-nanometer (nm) process node, and are expected to be at 32-nm node in 2012. Given the extreme disparity in market growth vs. increased development costs, it is unlikely that there will be any ASSPs or ASICs developed for wireless infrastructure at the 32-nm process node, and certainly not at the 22-nm process node. Additionally, the consolidation in wireless TEMs — 91 percent of the market is served by just 5 manufacturers — combined with shorter production cycles further increases the risks of ASSP development to the extent that if an ASSP fails to be adopted by two or three of the major players, it is unlikely to ever recover development costs. (Note that mobile phones will continue to drive sufficient volume to justify ASSPs and ASICs, although even SDR-enabled handsets are starting to become available now.)

Given the issues with moving to next generation process nodes, why move at all? Why not just stay at an older process node? There are certainly markets and opportunities for which this may be a legitimate option. However, for signal processing applications such as a wireless BTS, "general purpose" FPGAs and DSPs will continue to be developed at successive process nodes since the cost of those devices can be amortized over several markets, unlike ASSPs which are dedicated to a single application in a given market. Furthermore, an ASSP device at an older process node will not be able to compete on important factors such as unit cost, size and possibly even power consumption.

7. CONCLUSION

So, once again, we ask what's in a name? The terms "multi-mode", "common platform" and "software-defined radio" are more or less synonymous. SDR is generally used in a technology context to describe reprogrammable or reconfigurable radios, whereas multi-mode is expressed as a marketing feature of a BTS, and common platform is a means to reduce development costs and risk. Despite the differences in how these terms have been used to date, the underlying technologies are the same: reprogrammable and reconfigurable hardware like FPGAs and DSPs. In addition, the disruptive dynamics of the commercial wireless industry and the economics of the semiconductor industry are converging on business models that heavily favor the development and deployment of SDR BTSes. It is clear that commercial wireless infrastructure is following the MILCOM lead of reprogrammable and reconfigurable radios, regardless of the terminology.

[1] Modified from SDR Forum 2006 Yearbook.
[2] Source: Xilinx and Venture Capital Insights.