WHAT DOES MAINSTREAM TELECOM NEED TO EMBRACE 'TRUE SDR'?

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1. DEFINITIONS

Let's start with the title of this paper. By mainstream we mean the original equipment manufacturers (OEMs) of wireless data and telecommunications equipment for markets beyond government use (e.g. military, aerospace, public safety). In other words, commercial telecom network equipment and terminal OEMs – such as cellular base transceiver station (BTS), femtocell, and terminal manufacturers.

By 'True SDR' we mean radios where the application (waveform) functionality in software is abstracted from the hardware radio platform to provide reconfigurability through: modularity, flexibility, the use of 3rd party intellectual property (IP), and the reuse of in-house and/or 3rd party IP. We contrast this with 'firmware radio[1]' where limited reconfigurability is achieved by modifying low-level, proprietary firmware that is platform-specific and vendor-specific.

2. INTRODUCTION

In 'True SDR' terms, the last decade has primarily been about technical proof-of-concept. But we are coming to the end of this phase. Production of tactical radios for the US DoD's JTRS program is in full swing[2] and in commercial wireless infrastructure the 'True SDR' concept has been proven by the deployment of BTS products like Vanu's Anywave©[3].

Furthermore, reconfigurability is now being strongly promoted by the leading commercial BTS vendors as a significant competitive differentiator[4] - even if they can only deliver limited and low-level firmware modifications for their own platform-specific implementations.

Thirdly, standardization activities for SDR are now into their third generation (with the ETSI's Reconfigurable Radio Systems and the IEEE's SCC41 following on from the US DoD's SCA and the OMG's Software Radio Spec) and have grown out from their military origins into industry-wide and commercially-supported initiatives[5].

However even though great progress has been made in SDR technology and its commercialization, 'True SDR' has yet to be embraced by the mainstream OEMs, for commercial applications like BTSs, femtocells, and terminals. It is apparent that there is a chasm between where these market players are today and where 'True SDR' proponents would like them to be.

So why is there a chasm, when:

- The technological risk is bounded
- BTS vendor marketing departments are heavily promoting the features 'True SDR' enables
- Standardization initiatives are underway - which should create a healthy eco-system of COTS vendors and thus further lower risk and costs?

This paper explores some of the barriers still holding back the widespread commercial adoption of 'True SDR' and speculates on when these barriers are likely to fall.

2. IS IT REALLY PROVEN?

Well, yes! The 'True SDR' concept of abstracting the application (waveform) functionality from the hardware platform to provide modularity and flexibility via reconfigurable system architectures is proven in multiple products in production today[2,3]. Furthermore, being able to design applications in a hardware-agnostic manner and then auto-generate the source code for different multi-processing radio platforms (i.e. a mix of GPP, DSP and FPGA processors) is currently supported by a number of commercial off-the-shelf (COTS) vendors. FCC-approved[6] BTS solutions like Vanu's Anywave© also prove that any system-level and regulatory issues can be solved without compromising the modularity and flexibility of the radio system. So 'True SDR' as a technology works. The evolution of the technology now primarily concerns two questions:

Q1/ When will it be viable to perform A/D and D/A conversion for SDR at the antenna interface (excluding any receive or transmit signal amplification) and thus process the entire frequency band of interest in software?

Q2/ Can 'True SDR' be implemented to cost-effectively support the size, weight and power (SW&P) requirements of my form-factor?

In answering Q1: today it appears generally accepted that 'True SDR' can be applied to the protocol stack, baseband processing, intermediate frequency processing, and even some RF processing. The latest estimates are that it will be viable to perform A/D and D/A conversion at the antenna interface and process the entire frequency band of interest in software from 2012 onwards[6].

For Q2: multi-mode, wideband, handheld 'True SDRs' are already deployed by the US military. They currently don't have the form-factor of a 3G cell phone, but over the last five years the overhead of 'True SDR' has fallen dramatically and further significant reductions are expected. SW&P will remain a concern for battery-powered, small form-factor handhelds over the next five years, but expected advances in power sources (e.g. micro fuel cells) and hardware (lower power processors) and software technologies (lower footprint platforms) should see the issue largely resolved in the medium term.

3. OK, SO IT'S TECHNICALLY PROVEN, BUT DO I NEED IT?

"An interesting technology still looking for a business case": a description often heard applied to 'True SDR' in the past. It's still a valid question since many mainstream wireless infrastructure vendors have yet to adopt 'True SDR'. But the desirability of the functionality that it enables seems to be widely accepted today. There is a broad consensus that the following attributes will become mandatory features in the foreseeable future – especially if you are a BTS vendor seeking to remain competitive:

- Reconfigurable system architecture
- Modularity (enabling multi-mode, multi-band in one device)
- Flexibility (factory-gate configuration and field upgrades)
- Lower integration costs (for new hardware, new software and software reuse)
- Lower 'through life capability' costs
- Shorter time-to-market
- Longer operational life of devices
- Superior product support and customer service
- Fewer platform variants (product line rationalization)
- Leverage 3rd party IP and vendor independence
- Prepared for future advances (e.g. cognitive radio applications)
- Air interface independence (support all the potential winners: 3.5G + 4G + WiFi + WiMAX and ability to support future wireless standards with a minimum of rework)

So it works and I need it, but what about the cost?

4. OK, I NEED IT, BUT CAN I AFFORD IT?

There is no doubt that for the commercial market, 'True SDR' (i.e. with software abstracted from a specific hardware platform) is still seen as a relatively immature and potentially very disruptive technology. There is also no doubt that platform-specific radio implementations can be individually cheaper today. Finally, there is clear doubt that the dominant OEMs are enthusiastic about the impact of hardware-agnostic (i.e. portable) applications on their business models. So it is not surprising that these players are concerned about the impact of adopting 'True SDR' on: their cost base, their people, their processes, their culture, their control, and their value-chain partners.

Let's consider each of these in turn.

Cost Base: Like any new technology, 'True SDR' does not yet have the economies-of-scale driven by mass take-up. So COTS SDR tools and software platforms are still relatively expensive for low volumes. OEMs are thus concerned about the cost impact of having to buy and/or build new software platforms and tools. Prices will drop as volumes increase, but in a very price-sensitive market wireless OEMs are naturally reluctant to add new software products and development to their traditional bill of materials.

With respect to hardware; there is also concern that moving to 'True SDR' will lead to increased platform costs (e.g. DSP/FPGA versus ASIC), however history tells us (largely courtesy of Moore's law) that newer semiconductors always eventually offer superior price/performance. We see no evidence of this trend changing anytime soon with more efficient processors (GPP, DSP & FPGA) soon delivering the required performance to host 'True SDR' software platforms at acceptable cost.

Capex and Opex savings will also accrue in due course as the benefits of 'True SDR' flow into the product development, deployment and support lifecycle, but adopting 'True SDR' does have an up-front R&D cost. However, at some point in the (not too distant) future OEMs will feel the functionality/cost balance tip towards 'True SDR' architectures and adoption will take-off. It's very much a case of when, not if, OEMs will adopt 'True SDR'.

People: The impact of adopting a disruptive technology like 'True SDR' is naturally concerning for staff members who are greatly experienced in hardware radio and/or have little or no software expertise. 'True SDR' is a software technology. As product functionality and cost content move from hardware to software (even today over 50% of the content cost of a non-SDR BTS is software-related[7]), hardware companies become progressively more like software companies. This is not an easy transition. People have to change, processes have to change (integrating and testing software components isn't the same as testing boards), and organization culture has to change.

Culture and Control: Part of the culture change relates to control issues. With a new business model that relies on more 3rd party software components, there are obviously concerns about quality, integration, and system-level performance. It may take some time for an open market in 'True SDR' software components to achieve the level of trust enjoyed today by hardware components, however industry architecture standards and the latest software COTS products (e.g. model-driven engineering tools, operating environments, and waveforms) will go a long way to establishing an open and competitive market for 'True SDR' software.

Value-chain: Finally, the impact of 'True SDR' on the value chain and vendor relationships is equally disruptive. Hardware vendors, and in particular market share leaders, may have an interest in maintaining the status quo or at least controlling the rate of change. If so they will certainly create fear, uncertainty and doubt (FUD) around the perceived risks of adopting 'True SDR'.

Yes, 'True SDR' is a disruptive technology; where some will see a threat, whereas others will see an opportunity.

5. CAN I AFFORD NOT TO ADOPT SDR?

So, 'True SDR' offers great potential and potentially great disruption. Will the potential justify the disruption? The beauty of the free market is that open competition, rather than government regulation or monopolistic practices, will ultimately decide both the value of the technology and the rate of adoption.

Our view is that market drivers will make 'True SDR' the inevitable choice and therefore lead to it being widely adopted – the functional advantages (modularity, flexibility, through life capability cost, etc.) will simply be too compelling.

And as soon as one influential OEM successfully adopts 'True SDR', their product competitive advantage (in terms of product features and benefits) will quickly create a business disadvantage for any technological laggards.

So, within the foreseeable future, we expect that competitive pressures and threats will see the wireless equipment vendors transitioning to open, reconfigurable architectures, even if only to protect their market share.

6. SO IF IT'S WHEN, NOT IF, WHEN IS WHEN?

We must not underestimate the inertial impact of the barriers identified in paragraph four. The timing of broad-based 'True SDR' take-up will be largely driven by how quickly these barriers fall. Some of the barriers will be removed simply by competitive pressures - change or die - but others will require new 'True SDR' developments before they are fully overcome.

Software development tools and platforms

Everyone used to build their own RTOSes, but now COTS vendors like LynuxWorks, Symbian and WindRiver provide superior functionality at lower life-cycle cost. Similarly COTS 'True SDR' operating environments are coming to market to challenge the 'build, not buy' mentality. Furthermore, these COTS products are often compliant with maturing industry standards and will thus facilitate a more open market in tools and platforms. It is obvious that standards-based, affordable COTS SDR tools and platforms will help address the cost issue of 'True SDR' adoption. We anticipate it will be hard for OEMs to justify internal investment in building 'True SDR' platforms and tools when there are proven COTS alternatives on the market.

Standards

An open market in tools, platforms and software components can only be possible based on industry-standard software architectures. Whether these standards are proprietary and de facto (like processor architectures and MS Windows) or de jure (like VMEbus or OBSAI interfaces), is not as important as the fact that there is a widely adopted standard. Ideally organizations like the OMG (SWRadio specification) and ETSI (Reconfigurable Radio Systems Technical Body) will provide open 'True SDR' standards that will become widely adopted, but what the industry must have to minimize costs is a dominant software architecture that is supported by an eco-system of vendors. This is the only way to fully leverage economies-of-scale and drive down prices though free market competition.

Management

The industry is fast approaching a technological discontinuity. BTS content by value is already more software-related than hardware-related[7]. Wireless OEMs are thus becoming more driven by software design, development, integration and test, than by hardware design, procurement and assembly. How long before major BTS OEMs consider themselves software application companies rather than equipment manufacturers? How long before a software company (maybe partnered with a low-cost manufacturer) challenges the traditional OEM leaders. There is no doubt that brave leadership and cultural change will be required to remain competitive. Leaders, rather than managers of the status quo, will be required at the top and will have to drive the cultural change as their business success depends more and more on software and services.

System testing tools

A BTS built on a 'True SDR' architecture from software components (to provide modularity, flexibility and the lowest lifecycle capability cost) will still need to be system tested and certified – perhaps to even higher standards than hardware BTSs. Thus a new requirement for system-level testing tools for 'True SDRs' is emerging. The best way to address any quality concerns over software is to provide excellent testing capabilities to ensure robustness, correctness and compliance. These 'True SDR' testing tools are starting to emerge, but OEMs will be wary of using 3rd party software components from unknown vendors until the tools exist to eliminate most of the system-level risk.

The Vendor Issue

How to exploit the benefits of 'True SDR' if your current suppliers refuse to support your transition? Market leaders always like the status quo…that's why good ones are paranoid about technological discontinuities and do their best to anticipate or sometimes hinder them. Perhaps we can't expect hardware vendors to be pleased about the switch of cost content from hardware to software, but if they're smart they'll offer more software API support in their programmable products (e.g. IP cores) to turn a threat into an opportunity. As GPPs, DSPs, and FPGA become more powerful, lower power, smaller and cheaper (c.f. Moore's law) then more and more functionality goes into software. This is not necessarily bad news for chip vendors (Intel did pretty well from the evolution of Windows) but they have to understand that software development starts to drive hardware selection, rather than vice versa.

All the above considered, it is our view that 'True SDR' will move out of the lab at major commercial wireless OEMs (and start to replace firmware radio) in the 2009-2010 timeframe and be fully established down to consumer handset form-factors by 2015. If these predictions are true and you're a BTS vendor and you don't have a 'True SDR' architecture strategy in place by 2010 you'll need to follow your competitors very quickly and make up a lot of lost ground.

7. OPPORTUNITIES

All the issues mentioned above in section six are not just threats or timing factors. Read with an entrepreneurial attitude they are also business opportunities. Technologies and techniques that are required to support an industry evolution give birth to investments in products and services to meet those needs. After all, necessity is the mother of invention. So whether you are a supplier of 'True SDR' development tools, software platforms, software applications, standards-based consulting, management consulting, testing tools, or generic professional services there is a business opportunity to be grasped. Any disruptive technology like 'True SDR' creates the opportunity for new winners and losers. Which side do you want to be on?

8. CONCLUSION

So, if between today and 2015, 'True SDR' is going to create a whole new way of designing, building, configuring, deploying, maintaining and reusing wireless technologies, then we'd all better get familiar and comfortable with the coming changes. Opportunities will present themselves and those prepared to grasp them could be very successful. 'True SDR' will transition, as a deployable technology, from higher-cost military systems to low-cost consumer product in well under a decade. So unless you're only a few years from retirement you'd better sit up and take notice of how to manage the impact of 'True SDR' on your career, business or investments.

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