An interview with Ivo Bolsens, SVP and CTO of Xilinx, November 8, 2012, Anaheim, California

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Ivo Bolsens is senior vice president (SVP) and chief technology officer (CTO) at Xilinx, a leading supplier of field-programmable gate arrays (FPGAs). At Xilinx, he is responsible for advanced technology development, as well as the company’s research laboratories and university program. Design & Test’s Erik Jan Marinissen met with Dr. Bolsens in November 2012 during the IEEE International Test Conference [1] in Anaheim, CA, USA, where Bolsens was the opening keynote speaker at the co-located 3D-TEST Workshop [2]. Shortly prior to his keynote talk, this interview took place during lunch at a Disneyland restaurant, covering Bolsens’ career from IMEC to Xilinx, current and future FPGAs, the differences between research and company environments, and Xilinx’ recent 3D-FPGA product.

Ivo Bolsens grew up in Belgium and started his career in that country at IMEC, right at the start of this renowned research institute in 1984.
Bolsens: “At that time, I was actually a PhD student with Prof. Hugo De Man at the electrical engineering department of the Katholieke Universiteit Leuven (KU Leuven). We had a big fire in the basement of the department that destroyed a large part of our manufacturing lab. After the fire, Prof. Roger Van Overstraeten worked with the Flemish government to pull together enough resources to create a new lab.” (Laughing) “This is what has become IMEC, although the original working title was “SuperLab.” Nobody could have envisioned back then the scale of IMEC today, but in hindsight, the name “SuperLab” wasn’t that far off . . .”

Among existing staff and students of the KU Leuven, there was a call for participation for the new start-up IMEC, and with his supervisor Hugo De Man, Bolsens joined IMEC, while continuing his PhD research for KU Leuven.

Bolsens: “I still remember how we moved into the first IMEC building. The building was not completely finished, as there were no outside doors yet. It was in the winter and we were posting our desks around the central computer room, so we would get the heat from the computers to warm up. And we were wearing gloves with the fingers cut out to use our keyboards.”

D&T: “What topics did you work on at IMEC?”

Bolsens: “I was working on design methodologies. The biggest project I worked on was the famous “Cathedral” project, which was a silicon compiler avant la lettre. The technology was picked up by Philips; they industrialized it under the name “Piramid.” Subsequently it got commercialized by Mentor Graphics as “DSP Station.” Cathedral was combining several interesting things: compiler technology, processor architecture, digital architectures in general, and digital signal processing (DSP). That technology was pretty advanced; ahead of its time, I would say.”

D&T: “You can also be too early with technology . . .”

Bolsens: “Yes, as some say: ‘It is always the second mouse that gets the cheese!’”

Bolsens completed his PhD studies and continued to work at IMEC for 17 years on topics as knowledge-based verification for VLSI circuits, design of DSP applications, wireless communication terminals, hardware/software co-design, and system-on-chip design. In the meantime, he had climbed up within IMEC to the position of Vice President of Information and Communication Systems. In 2001, he moved to Xilinx in the Bay Area of California.

Bolsens: “From within IMEC, we had founded CoWare, a start-up on hardware/software co-design. Belgium-born Wim Roelandts, CEO of Xilinx, was serving on the board of CoWare, and that is how I got to know him better. On a certain day, Roelandts calls me up and says: ‘Are you interested in joining Xilinx? We are looking at somebody to take over the role of our CTO.’ I remember that I told him: ‘Wim, I don’t know too much about FPGAs, so this does not seem the right thing to do.’ He replied: ‘If I need to know something about FPGAs, I have 2,000 people I can ask. I am not looking for yet another FPGA expert. I need someone who can bring in some new insights and new technologies and that is what I expect you to do.’ I appreciated Wim on the board of CoWare and I had learned a lot from interacting with him. And so, I decided to take the step. I always wanted to one day go to Silicon Valley, as that is the place where it all happens. If you look at it from outside, you might think that there is a lot going on there, but it is even more so when you are actually located there. It is definitely a very dynamic environment: everybody knows everybody, a very tight network in terms of picking up information. It is still by far the place to be. And not just in semiconductors alone. Silicon Valley has reinvented itself a couple of times now and they keep on doing it, creating the next wave of technology. Now, it is all about the Facebooks and Googles.”

D&T: “Xilinx and IMEC are of the same age. Both were founded in 1984.”

Bolsens (surprised): “Yes, you are right, that is true. Xilinx was the world’s first FPGA company. The company was based on an important patent, the well-known Ross Freeman patent. Ross Freeman was one of the founders of Xilinx and he had the first patent on programmable logic. Unfortunately, Freeman passed away in 1989, only a few years after launching Xilinx as a successful company and, in fact, creating a whole new industry. A few years ago, he was inducted in the National Inventors Hall of Fame. Xilinx was also the first semiconductor company that was using the fabless model, which is now successfully applied by many other companies. In those early days, Xilinx was manufacturing its chips with Seiko Semiconductor in Japan. The reason for choosing Seiko was that one of the founders of
Xilinx had a personal relationship with one of the managers at Seiko, who had been working with RCA when Seiko was manufacturing chips for RCA. You could say that Seiko served as our foundry before the term even got invented. Of course, all those things happened way before I joined Xilinx; I have most of my stories from Bill Carter, Xilinx employee from the very start and the outgoing CTO, when I joined Xilinx.

**D&T**: “To what extend is design of an FPGA still full-custom design?”

**Bolsens**: “In the beginning, FPGAs were all custom design, similar to memory design. However, this has evolved over time. An FPGA has become much more than just a programmable logic array. Today, an FPGA is an SOC (system-on-chip) that combines all programmable technologies: a programmable CPU, a programmable DSP, and programmable logic. The latter is still custom design, but the others are designed with standard cells.”

**D&T**: “Which markets are served by FPGAs?”

**Bolsens**: “Our biggest market is the telecommunications infrastructure. Every wireless base-station has Xilinx FPGAs in it. One reason is that the volumes in telecom infrastructure do not merit application-specific ICs (ASICs). A second reason is that FPGAs can be updated for new standards and algorithms.”

**D&T**: “I understand that the volumes of wireless handsets are a lot larger than those of wireless base-stations, but it still seems a pretty sizeable market to me.”

**Bolsens**: “You are right about market size. But do not forget that a state-of-the-art ASIC design easily takes up 40 to 50 million dollar. With a volume of one million products, that is $50 per product, which you do not need to spend for an FPGA. Plus, another problem you have with an ASIC: from design start to product takes two years or so. In the fast-evolving world of internet and wireless, two years is becoming a bottleneck. And with FPGAs you benefit from the latest technology; our latest products are in
28 nm and we are designing now for 20 nm, while most ASICs are in either 65 nm or even 90 nm technology. Some companies have to risk their entire future on a single ASIC design project. FPGAs offer a cheap and reliable path to get your product out. If that product is then really successful in terms of volumes, you can still consider changing over to an ASIC.

**Bolsens** (continuing): “The automotive market provides big opportunities for FPGAs in driver’s assistance and multimedia. Real-time stitching of images for surround view of the car is very compute-intensive and perfectly suited for FPGAs. There is another big opportunity in data centers. Traditionally, the networking in data centers was standard; now more intelligence is built in, also for security reasons. As a consequence, there is more attention required for real-time manipulation of the pay-load data, not just sorting based on the header. The hype term in that field is “software-defined networks.” For data centers, there is also a shift in focus from computing to network capability and latency. When you click on a Facebook page, the data center assembles that page on the fly from all different places. And you do not want to wait for that. There is not much computing going on, but it requires a lot of low-latency networking. FPGAs are very good at that, as they can implement extremely parallel architectures. I can program an 800-bit wide data path in an FPGA like that (EJM: snaps his fingers), while on a microprocessor with a 64-bit data path, you have to start sequencing the computing in time. Moreover, data centers are big-iron infrastructure, with a similar cost structure to base-stations.”

**D&T**: “Are there things you cannot do with an FPGA? Analog, RF . . .?”

**Bolsens**: “Well, we have standard analog-to-digital convertors in our FPGAs. But analog is where more work is needed in the future. If you look at SOCs, they have, of course, a big chunk of digital, but many of them have analog interfaces to the real world. And that is where FPGAs still need to make more progress. We have now gigabit transceivers, Serdes, which are analog functions, as a first step.”

**D&T**: “It probably all depends on finding the common denominator that is of benefit to multiple customers.”

**Bolsens**: “Yes, that is true. But if it is more tailored, that is where 3D integration kicks in. A company might couple their hardware with functionality that they are really good in to our FPGA in a way that is transparent to the customer. This is definitely going to happen, but there are a lot of practical business issues in the way still.”

**D&T**: “Programming an FPGA is still considered as an activity for hardware engineers. Shouldn’t this move over to the software domain?”

**Bolsens**: “Absolutely. That is why Xilinx acquired AutoESL, which allows you to compile normal C code to an FPGA. Today, that works pretty well in the DSP world. We are working hard to generalize that. The ultimate goal is that you look at an FPGA as a heterogeneous multicore processor. You write C code, and seamless to you as designer, some of that C code is compiled to run on one of our two embedded ARM cores and other C code is compiled into the FPGA fabric. No need to talk in terms of clocks, flip-flops, or registers, but behavior. One of the challenges is if the C code does not run fast enough; how do you tell that to a software guy, and how do you remedy that?”

**D&T**: “So, then the C code needs to be extended with pragmas to steer it into a different mapping?”

**Bolsens**: “Indeed, that is what you do. So, then you still need to have a bit of hardware knowledge. In a constrained application environment, like video processing, that already works pretty well.”

**D&T**: “What was different at the company Xilinx, as opposed to the research institute IMEC?”

**Bolsens**: “One of the things I learned, is that innovation is a result of two things: creativity, being smart, is one thing, but you also need to get buy-in within the company for what you are doing. An important aspect of doing research in a company is that you have to be able to communicate the benefits of your new technology and the value of what you are doing. That is different when you are working in a research environment, where the focus is on progressing the technology and its fundamental understanding as such; on some figure of merit you are better than somebody else and you can write papers about that. In a company, you spend a lot of time in getting everybody aligned about a certain technology, getting people excited, and making sure that all pieces of the puzzle are in place.”

**Bolsens**: “3D is a good example of that. We had a 3D-FPGA demonstrator that we could program in 2006, while the first product came in 2011. The technology was not changed a lot, but there was a
lot of effort spent in picking up the loose ends and getting the supply chain aligned."

**D&T**: "How is Xilinx organized? Is there a central technology organization?"

**Bolsens**: "We have a central product development organization, next to a central advanced development organization which I am heading. And then you have the different vertical market segments which define the product requirements from a marketing perspective. In product development, it is very important that you adhere to your schedule and risk is very carefully monitored. So, what we do in advanced development is to de-risk the technology, such that if it is used by the product development groups for an actual product, they know pretty much what to expect. For example, our 3D technology sat for a long time in advanced development, because a lot of it was path-finding, exploring how you would do things. Once we had figured that out, the product group picked it up with a much better understanding of what the choices were and could come up with a product development schedule that was adhering to a certain timeline and resource plan."

**D&T**: "In 3D, one needs a lot of new technologies on the manufacturing side. How does that work out for a fabless company?"

**Bolsens**: "There was a lot of interaction that happened within the supply chain. Initially, it was mainly with some start-ups here and there, to try out things. The next step was to pull in the foundries and OSATs. These discussions were with our peers, CTO groups. All of them were dabbling around with 3D. A few of them, including TSMC and Amkor, were able to step up to the plate and get it inside their company accepted as part of the roadmap. We worked with them to figure out whether or not we could use existing equipment or had to develop new equipment. After that phase, it moved over into the hands of the product development guys. They have the big budgets that can buy the new equipment and make things move forward."

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**D&T**: "One of the main drivers of your 2.5D-FPGA is to get the yield up."

**Bolsens**: "Well, that is how it has started. Actually, the first product idea was not that, but later we decided that 2.5D was the first product step we were going to do to use that technology. FPGA vendors roll out a new product family with every technology node. We are very aggressive in adopting new technologies. In a new technology node, we typically first develop the lower-end products, simply because the yields are not yet there to cost-effectively build the very large dies required for the high-end products. By doing the stacked die, we were able to provide an FPGA at a complexity that you could never build monolithically in that technology, two-three years before the competition could do it. So, that is the reason why we took that as a first product step. But in the meanwhile, we have moved forward. We have now heterogeneous products with mixed-signal Serdes in a die separate from the FPGA die."

**D&T**: "Was the heterogeneous product the original idea behind Xilinx’ 3D work?"

**Bolsens** (mysteriously smiling): "Without disclosing too much, let me say this: the original idea still has to happen; and it will! Originally, we were mainly driven by the excitement of the possibilities of the 3D technology and we still have the ultimate goal in mind when doing things. But in a company, you have to find a good compromise between the risk and the return-on-investment. Xilinx being the first to bring a 3D product to the market has created a lot of brownie points for us. After the facts, it all looks an obvious thing to do, but at the time it certainly was not."

**Bolsens**: "FPGAs are actually the perfect vehicle to introduce a new technology like 3D. First of all, FPGAs being used in infrastructure, we are not as cost-sensitive as chips in a cell phone. If a new technology comes with a bit of extra cost in the beginning, that is something FPGAs can cope with. And then there is the nature of an FPGA: a very regular architecture with tremendous programmability, allowing the ability to build in a lot of safety in our products to cope with potential challenges. It is not by coincidence that we were the first to come out with the 3D-FPGA. So, we are little less vulnerable for some issues in the interposer; if something does not work, you can program the interconnect around it and take another wire. In general, we have a tradition of working with foundries. They like FPGAs to develop their advanced technologies. FPGAs are regular and programmable, where you can connect to every single logic gate for diagnosis. In that sense, we always have been an R&D partner for foundries. We are not the kind of people that wait until the final PDK (physical design kit) is there..."
D&T: “By the way, are you calling the technology 2.5D or 3D? Some people don’t like the term 2.5D…”

Bolsens: “From a marketing perspective, Xilinx calls it 3D. But sometimes I have the need to differentiate between the two concepts and then I use the terms 2.5D and 3D. I will be doing that in my keynote address at the 3D-TEST Workshop [2] later today.”

D&T: “I think originally people saw the 2.5D interposer-based die stacking only as a stepping stone for true 3D stacking. That is no longer the case anymore.”

Bolsens: “Absolutely. 2.5D is here to stay. True 3D will happen of course, but it is just one extra level of challenges.”

D&T: “You are also in charge of the Xilinx University Program. Can you tell us more about it?”

Bolsens: “Sure. It is the widest-spread university program in the industry; over 12,000 university groups world-wide participate in it. We provide a development board and ‘clip art’ teaching material for professors: ready-made examples, lab exercises, etc. They can be used to teach a versatile range of topics including digital design, microprocessor design, digital signal processing, and video and image processing. I notice that in Asia, a lot of the projects are actually driven by the students themselves. With our Zynq platform, we provide a platform with all sensors you find in a car: camera, motion sensors, gyroscope, etc. With this, you can build your own car or robot. Another example is MIT (Massachusetts Institute of Technology). They give all their undergraduate students in engineering a “Nerd Kit,” a personal FPGA development board which stays with the student during his/her entire university career. If they teach a DSP course, the lab exercises are on the board. Next semester, a course on real-time operation systems; the corresponding exercises are on that board. We have a special group at Xilinx that develops and distributes the boards and exercises. Some of that material, we donate, but we request in return commitment to actually use it.”

Bolsens: “Furthermore, on the high end, we work with a select group of leading academics for internships and research projects. We want those universities to take our technology and use it in unusual places and markets where we typically do not sell our products today. In a company, the marketing organization talks to existing customers about new features in our next products; but they never talk to customers we do not have. And that is where the universities come in. These guys do things with FPGAs where you think ‘Wow, that is kind of cool,’ and so they create the customer opportunities of the future. This is also how we got into data centers.”

D&T: “Thank you for an interesting interview.”

Bolsens: “You are welcome.”

References