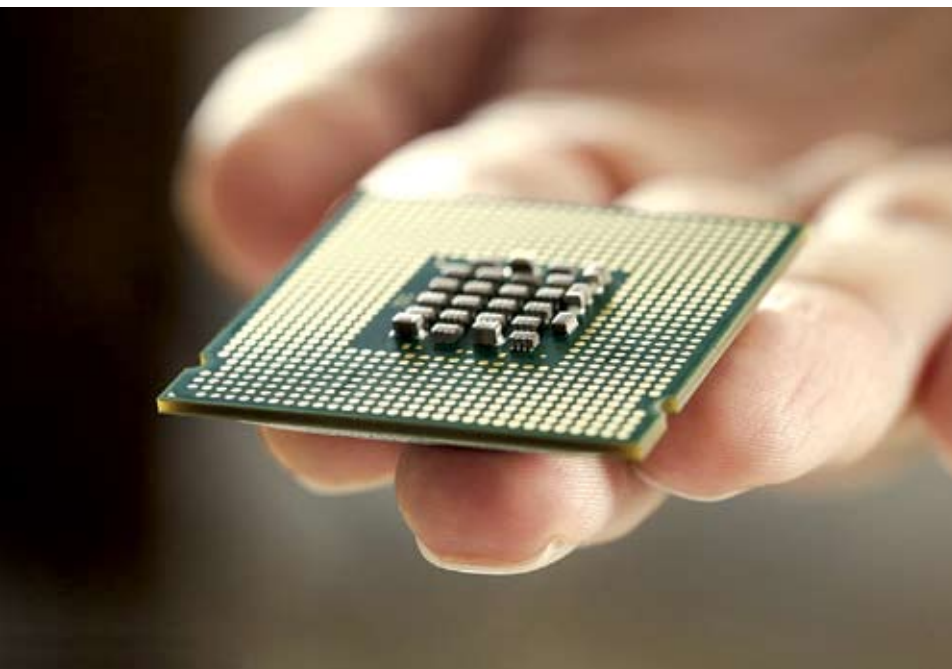


# EMBEDDED SYSTEMS

## Can India Move from Implementing to Initiating Products?

**Currently, as most users are outside India, they decide what is needed next. In future, though, India can migrate from the role of product implementer to product initiator by focusing on the growing domestic market**



### ■ UMA BANSAL

**C**onsumer electronics and telecom companies are starting to recognise the importance of localisation of their products, with India emerging as a big market for these products. Given this, the Indian embedded solution providers are in a unique position where they can add value not only in the development process but also in the

conceptualisation of new and unique products.

Currently, most of our embedded activities pertain to products developed for foreign markets. And most Indian embedded system houses are engaged in sub-system architecture, hardware and software implementation, testing and integration stages of the value chain. India can move up the value chain by conceiving and specifying products (as against service), system architecting, system validation

and making it production-ready in all respects for commercial success.

### The embedded ecosystem

The players in the embedded space include system integrators, IC design houses, electronic design automation vendors, board design houses, test houses, software tool providers, and embedded software and application software providers.

Most of the semiconductor manufacturers are involved in VLSI chip design and embedded software development. Indian companies are developing embedded products in consumer, industrial, telecom, automotive, computing and medical space for local as well as export markets.

Transnational global companies like Cisco, Juniper, Honeywell, GE, Bosch, Delphi, Visteon, Continental and many more have set up their embedded development centres in India. In addition, design services companies of India like Wipro, HCL, Satyam, Mindtree, L&T, TCS, Tata Elxsi, KPIT Cummins and many more are doing embedded software and hardware product development in India for global accounts.

### India's forte: embedded software

The show stealer so far has, of course, been embedded software development. "Embedded software develop-

## “Embedded software development companies in India have created a strategic advantage for themselves.”

—Ganesh Guruswamy, vice president and country manager, Freescale Semiconductor



ment companies in India have created a strategic advantage for themselves. The success stories of large Indian software services companies like Wipro Technologies, Tata Consultancy Services, HCL Technologies and Mindtree in working with the global design ecosystem underscore our country’s strengths in the embedded software space. These companies are now at a stage where they can both conceive and develop products for the global and Indian market,” says Ganesh Guruswamy, vice president and country manager, Freescale Semiconductor.

The total embedded software market was worth \$5.9 billion in 2008 and employed 125,600 technical people. Embedded software contributed approximately 81 per cent to the overall revenues and 82 per cent to the overall workforce of the Indian semiconductor industry.

The embedded software sector can be classified into captive and non-captive units. The captive embedded software companies include semiconductor companies that follow the IDM or fabless model and develop the software required for chips and reference boards. OEMs also develop software for their own products. The non-captive companies are third-party embedded software developers, hardware/board designers or the third-party VLSI design companies that provide embedded software solutions as part of their service offerings. There are also a few EMS and ODM companies that provide embedded software development services specific to the products

that they design and manufacture for clients.

The embedded software market is fragmented, with several players operating in India. Embedded software is required by varied industries in the non-traditional areas of discrete manufacturing and industrial process control as well as common industries like automotive electronics, computing products and consumer electronics.

### Moving up the value chain

Vivek Sharma, vice president-emerging markets region and director-India Design Center, STMicroelectronics, says that if we talk about our place in the value chain for an embedded system, Indian companies today are more of system solution/product implementers. As most of the users aren’t in India, outside teams define what is needed next. In future, though, we can move up the value chain, by migrating from the role of product implementer to product initiator. As the local market grows in coming years, this will create a big opportunity in the local context. Engineers here can become product initiators (deciding what product is to be done), which will give further boost to innovations. And when we innovate, someone has to conceive the ideas. Universities can play a big role here.

The shift has already started: The embedded systems industry in India is undergoing a gradual change from a software-driven outsourcing model to one increasingly focused on growth and development of the domestic market. Indian companies are migrating

from being centres of resource augmentation to product innovation and design centres.

“The last few years have seen a huge growth in the number of small and innovative companies doing complete design of innovative embedded products. A similar trend exists in the captive design centres of multinationals and Indian service companies. They are becoming accountable for more and more of complete product design/delivery/ownership,” informs Praveen K. Ganapathy, director-DSP business development, Texas Instruments India.

Access to local customers driven by domestic consumption will enhance product knowledge and further catalyse maturation of the Indian companies to be able to do complete product development, drive product strategies and roadmaps, and do high-end consulting.

The embedded software market will expand as non-captive companies move up the value chain to offer more high-value activities around middleware and develop applications for them.

### Market size and forecasts

According to an ISA-Frost & Sullivan report published earlier, the semiconductor and embedded design industry (including chip design, hardware board design and embedded software) in In-

### Impact of recession

We cannot ignore the fact that the industry is right now in the midst of a slowdown. Customers are not yet canceling contracts, but they are taking longer to decide and discretionary spends have slowed. Globally, the total number of design starts is dropping. This has led to a drop in the outsourcing opportunities. In turn, this means there is a cost pressure on the outsourcing.

However, there is a positive side too: Once the market starts bouncing back, companies will first look at outsourcing and then increasing their own headcount. It could mean an opportunity for the Indian design service companies.

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dia generated revenues of \$3.25 billion in 2005, and could reach \$14.42 billion by 2010, and further to \$43 billion by 2015, growing at a compounded annual growth rate (CAGR) of 30 per cent during the forecast period.

However, “given the prevailing slowdown, the ISA has revised the estimated growth rate for the calendar year 2009 to 13 per cent, which is roughly half of the growth rate exhibited before. In year 2006, the semiconductor industry in India had grown 25-30 per cent. And it had been growing annually at this rate for the last few years. So we clearly see the impact of recession on the local semiconductor market,” informs Sharma.

Qualitatively, let’s look at the local market from two perspectives. What we consume in India has two components:

1. Total market (TM) for semiconductors. All the semiconductors that we use in India irrespective of whether we are manufacturing them here or bring them from abroad
2. Total available market (TAM) for semiconductors. Semiconductors which are being used inside electronic items made in India, i.e., local semiconductor consumption

The data for year 2008 as per ISA report was \$6 billion for TM and \$2.5 billion for TAM in India. Whatever we are using in India, e.g., mobile phones, the semiconductor content that goes inside it is TM. If the mobile phones are manufactured here in India, the semiconductor content inside them is TAM.

Companies like LG are producing

designs in India not only for the local market but also for the world market. Most of the design centres aren’t hiring any more, so surely there is impact on design centres which are designing for foreign markets.

The vast majority of the embedded processor market remains microcontroller units (MCUs), which are low-cost autonomous embedded processing units used in embedded applications having low-end processing requirements.

Embedded CPUs, DSPs and FPGAs all typically provide higher levels of processing performance than MCUs and command higher average selling prices, but exist in smaller unit quantities, making MCUs also the largest dollar-volume segment of the four embedded processing technologies.

**Growth drivers**

Demand-pull in the embedded space stems mainly from:

1. Consumer electronics
2. Security and surveillance including biometrics
3. Communication
4. Defense and avionics
5. Medical electronics, particularly portable monitoring devices

In consumer electronics, digital entertainment will be a high-growth area. Security and surveillance will see strong growth with increase in government spending. In medical electronics, developers are working on the latest ultrasound, MRI and diagnostic devices, for both local and overseas markets.

Other areas that will see growth

include automobiles (where we are seeing innovative products at breakthrough price points such as the Tata Nano), energy saving appliances and alternative energy devices like inverters and solar cells.

An ISA-IDC report observes that the power sector reforms in the Indian industry will help the embedded systems business with overall infrastructure upgrade and introduction of sophisticated electronics equipment for the industry.

**Emerging trends**

Consumer electronics applications are digital TV sets, digital camcorders, DVD players, set-top boxes, digital video recorders/home video servers, PDA cameras, network cameras, video-phones, digital still cameras and smart phones.

In this area, we are seeing migration in technology from:

1. Fixed-function to multi-function devices
2. Analogue to digital media
3. Proprietary to commercial software
4. 8- and 16-bit to 32+ bit processors
5. Limited, fixed-line bandwidth to high-bandwidth wired/wireless lines

Processing needs range from high-performance multi-core processors for applications like base stations and medical image processing to energy-harvesting, embedded processors for implantable medical devices.

Another growing trend is the move towards small form-factor designs which can be upgraded with minimal application efforts. ‘Small’ and ‘low power’ are the buzzwords. The embedded solution providers are constantly innovating to match these requirements. For instance, the MSP430 platform of ultra-low-power 16-bit RISC mixed-signal processors from Texas Instruments (TI) is good for battery-powered measurement applications, while its OMAP platform delivers a variety of high-performance application processors with extremely

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low power consumption.

At system-level trend could be towards “More than Moore” (integration of diverse and unrelated technologies like silicon VLSI, biosensors, high-power components and MEMS in a single system-in-package) rather than “More of Moore” (integration of more and more transistors on a single silicon system-on-chip and operating at higher frequency).

Digital security and surveillance is one of the hottest applications in the embedded arena benefiting from the multicore phenomena. Old surveillance systems requiring human monitoring are rapidly being replaced with intelligent surveillance systems. Also, the latest security and surveillance solutions need to be able to capture and process security video in real time.

“New applications would be e-passports, smartcard-based rural banking and micro-finance, live-stock identification and identification-based vehicle security,” says Dr N.S. Murthy, director, new business initiatives, NXP Semiconductors.

### High-end designs churned out of India

Poornima Shenoy, president of India Semiconductor Association (ISA), says that most (if not all) of the companies are responsible for some design blocks. And, these blocks will need to, more often than not, be used in more

than one design of that company, at the global level. This means that in addition to just developing a block, the local design team should make it a fully packaged, independently usable block, *a.k.a.*, intellectual property (IP). Also, as complete products are increasingly being developed in India, they are also responsible for their ‘IP packaging.’

Some of the technologies (IP) championed from India include:

1. OMAP from TI
2. Sharkfin from ADI
3. Wireless IPs from Ittiam and Wipro
4. Communication interfaces, like Bluetooth, from MindTree

TI’s scalable OMAP35x portfolio of devices is available for manufacturers wanting to redefine the standard for advanced user interfaces, Web browsing, productivity and multimedia experience, making it easier than ever to access information and media.

Target applications of OMAP devices include portable navigation devices, point-of-sale systems, patient monitoring and other medical applications, software-defined radio, IP-based communications, smart home media controllers, edutainment (eDictionaries) and portable consumer entertainment devices like portable media players and portable TV sets.

Freescale India design centre has completed many designs in the domains of wireless, networking and

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microcontrollers. The MCF5225x, Freescale's latest MCU, was created by the India team in a record time. This MCU is well-suited for a broad range of industrial networking, building/lighting control and medical applications that require high performance and connectivity options (Ethernet and USB).

eInfochips did the product design (for a US customer) of a transcode device used for video streaming application. It involved 16-layer board design with around 4000 components including more than eight high-speed processors.

### What advantages does India offer?

Nirav Shah, director of marketing, eInfochips, says that for embedded systems players, India offers the advantages of large domestic market size, low product development cost, embedded expertise including IP solutions, and established working models locally and globally.

Large Indian companies are moving towards higher-end activities in the embedded value chain with increased expertise in specific domains. They are metamorphosing from labour cost arbitrage to being true contributors to product innovation. A growing phenomenon is that of companies either investing in new design operations in India or significantly expanding their existing facilities. This will contribute to the further expansion of the talent pool and maturation of skill sets in Indian design companies, which will be a true differentiator in the long run.

At the same time, as the pressure mounts on foreign companies to reduce costs of product development, they are increasingly looking for off-shore partners who can provide cost-effective services.

### But this is not without challenges

The challenge and opportunity lie in the complexity that is involved in em-

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bedded design. There is an exponential increase in software complexity. In some areas, the code size is doubling every nine months. More than 70 per cent of the development cost for complex systems such as automotive electronics and communication systems is due to software development and test.

In order to exploit the opportunities, we need to make sure that we have the right resource and skill set levels within the embedded space—such as digital/analogue chip design, embedded software and board design.

There is also the question of how much the local ecosystem has evolved over the years to develop embedded products end-to-end. Indian companies need to provide start-to-finish services. We need to match or exceed the pace of developments that are happening in other countries such as China and Taiwan. High investment costs for R&D need to come down. Inadequate support from government for the capital-intensive semiconductor industry is affecting feeder segments like chip design.

**Talent crunch.** The fact that large MNCs are setting up manufacturing here is a testament to the fact that the domestic opportunity in India is growing and there will be a huge need for talent in the areas of embedded systems design, development and productisation.

Currently, the embedded space is witnessing a gap between the skill set required and the skill set available. No doubt, India is equipped with the required talent at design implementa-

tion and test levels, but the issue is the number of readily employable engineers, rather than the number of engineers. Institutes have been churning out engineers but they lack industry exposure and are not 'design-aware.' Hence there is a need for training and real-life design exposure before they can become productive.

The industry requires expertise in digital, analogue, software and board design. There has to be a talent transformation from traditional PC applications to embedded designs.

And if we wish to move up the value chain, we don't have the required talent at product specification, architecture and productisation levels as yet.

The Indian embedded system community needs to change its mindset from project focus to product focus. Though this is happening, it is too slow and too little. Additional focus is needed.

### Solution to talent crunch

The solution to talent crunch lies in industry and academia collaborations—engineering colleges providing students with hands-on experience. Many engineering colleges are not equipped with tool-kits that the students need to be trained on for joining the industry.

An engineering student in India would require a fair amount of training to reach the level of expertise that his counterpart in the West would reach with six months' training. This is because the engineering course structure is many a time not in line with industry

needs. A curriculum that has more of a practical orientation in addition to having theoretical perspective is required. There should be more stress on teaching the fundamentals and concepts. And it is necessary to arrange for guest lectures from industry veterans, so that the students could learn some of the best practices.

This is something which is also being recognised by the industry. Several companies have already taken proactive steps to increase the number of VLSI/embedded-trained engineers. Now we do see companies tying up with universities or setting up institutes to equip engineering graduates with the requisite skills.

eInfochips' university programme, *Impetus*, is designed to assist students by building their experience with embedded products, architecture and training materials. Students from engineering colleges are imparted training for four to six weeks.

TI India supports the academia through its University Programme. Termed as the *UniTI*, it stands for 'Universities and TI.' UniTI is the forum in which TI India interacts with universities and interested technical institutions in the role of a facilitator.

An ISA study on the status of semiconductor related research in Indian universities reveals that:

1. The role of government funding is 85-90 per cent of the funding available to university lab research
2. The top seven institutes account for 70 to 75 per cent of the total

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—Nirav Shah, director of marketing, elnfochips



research being undertaken in the academic institutes of the country. These institutes have the faculty and dedicated VLSI labs to support high-quality semiconductor-related research

3. These institutes account for around 61 per cent of research papers published in the field of semiconductors

The study recommends:

1. A public-private partnership (PPP) model involving the government, the industry and the academia to encourage applied semiconductor research

2. Setting up of technology business incubators (TBI). TBIs provide a robust platform for active industry-academia interactions, and help convert potential research ideas into their commercial success

3. Steps to enhance research infrastructure by developing dedicated research centres, enhancing the standard of semiconductor laboratories to match with industry standards and setting up semiconductor-related research centres in special economic zones

4. Performance-based incentives to faculty and research scholars, facilitating involvement of industry executives in academics and creating awareness about job avenues among PhD holders

5. Participation of the industry beyond just providing tools

### Road to success

The growth in the next four years for the embedded service industry will be higher in companies offering focused solutions on industry segments like automotive, industrial, portable/wireless and consumer electronics.

The future of embedded software looks bright given the exceeding pressure on the US companies for time-to-market and cost. Indian companies are investing in infrastructure and building domain expertise. IP creation will lead to royalty-based models as well as high-end expertise in specific domains in the embedded software value chain.

Having a local manufacturing ecosystem will also boost this industry with end-to-end product development and rollout happening from India. Companies that have been providing embedded design services will move up the value chain by building reusable components and undertaking complete system development, i.e., all levels of software development. There will be a strong focus on increasing margins and adopting business models which are not linearly dependent on the manpower. ●

The author is a deputy editor at EFY

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