A COMPARISON OF EMBEDDED COMPUTING PLATFORMS: SBCs vs CoMs

Keywords

SBC
x86
ARM®
CoM
Off-the-shelf
Time-to-market
Modularity
Standard
Scalability

Introduction

Any company that intends to produce an IoT-powered product or enable a pre-existing product with smart functionalities faces the problem of choosing the right tool for the job. The market, indeed, offers a wide range of solutions but different scenarios pose different issues and require specific tools to be addressed properly. Most **computing platforms** appear to be equally capable of delivering to the inexperienced, yet **each one of them presents its own set of advantages and trade-offs, knowledge of which is critical to achieve the set market objectives as efficiently as possible.**

Nowadays there are two major categories of embedded computing solutions available to designers and engineers: **SBCs and CoMs**. Both present distinctive features that make one a better choice in a certain context and worse in other ones. Even if **both are available at different levels of energy-efficiency and computing power, they differ in flexibility and cost per unit**. In addition, the diversity between the two categories greatly impacts on the marketing time as well as influencing other business choices and considerations.

Usual applications for SBCs and CoMs are kiosks, vending machines, industrial automation, medical devices, Passenger Information Systems and all the new IoT-driven applications.

Of course, boards based on microcontrollers may well constitute a third category. In concept, they are the least sophisticated counterparts of Systems on a Chip. Unlike SoCs, in fact, microcontrollers present negligible processing power and lack many important features. In practical terms they allow a discrete, real-time, predictable response to events and *stimuli* from the real-world.
Due to this ability, they are ubiquitous in industrial systems. While a prudent combination of microcontrollers can be employed to perform a wide variety of tasks, they are excluded from this white paper because of their limited capabilities.
Ultimately, microcontrollers are used for custom board designs and an off-the-shelf boards market doesn't exist. Moreover, they are complementary, not alternatives to SBCs and CoMs, and thus are more of a given than a debatable implementation.

This white paper will identify the pros and cons of SBCs and CoMs, exploring the technical differences and unique features of both and will also examine the implications of choosing one platform over another from a business perspective.

SBCs

SBCs, short for **single-board computers**, are general-purpose computers that nowadays may **also be used for rapid prototyping (maker boards)**. They have been available for decades, in fact since the invention of PCs they represented for many the very first introduction to computing electronics. Their popularity decreased during the end of the 90s with the mass adoption of laptops although in the last ten years there has been a steady, rapid growth due to the emergence of the Maker Movement, DIY electronics and open source software and hardware tools.

STAND-ALONE SOLUTIONS

Single-board computers are **computers built on a single circuit board**. They are designed as **stand-alone solutions** in the sense that **they provide all the tools required for rapid prototyping**, including memory, one or more data storage peripherals, processing power and input/output interfaces (so-called "I/Os"), **without the need for the user to retrieve additional modules**. Nevertheless, compatible modules may **expand even further the functionalities of a single-board computer and offer new options to developers**. If equipped with special connectors they can be combined to form clusters, reaching an even higher processing power and versatility.

OFF-THE SHELF SOLUTIONS

In addition to the previous point, single-board computers are **off-the-shelf solutions**. The manufacturer's intent is to produce a general-purpose machine that offers a wide range of out-of-the-box tools though this impacts negatively on customization. Plug and play, fixed solutions such as SBCs, allow **quick set-ups and implementation**. Designed for a gentle learning curve, **off-the-shelf SBCs are often easier to use than COMs development kits** and allow **to move on directly to the product development** and testing phases without the need to previously assess all the technical requirements for the project. As a result, **SBCs allow developers to explore the problem and experiment with greater freedom than with CoMs**.

MANY FORMATS

There is no one-size-fits-all form factor in relation to SBCs. While on ARM architecture dominates the proprietary form factors, on x86 architecture there are some standard form factors, such as **embedded NUC™** (**Picture 1**) and **Pico-ITX** (**Picture 2),** to name but a few. This implies that for each final application the right compromise in form factor can be found (**Pictures 3, 4**).

FEATURE-RICH

Given their all-inclusive nature, single-board computers tend to present an overabundance of features. This is because SBCs are conceived as prototyping toolboxes and are therefore especially suitable for a target audience that does not know what specific tools it needs for its purpose. Typically, not all the features on board will be exploited. The board will often appear to be overpopulated, while Industrial-oriented features may also be absent.

ARM/x86

Two macro groups of SBCs can be identified, **depending on the underlying architecture: x86 and ARM**. The first is characterised by a more powerful CPU, medium- to high-power consumption and more flexibility as far as operating systems are concerned. Conversely, ARM architectures are designed for low-power applications, where energy-efficiency is a greater concern than CPU performance.

Being the backbones of personal computers, x86 architectures excel in terms of flexibility and are compatible with the overwhelming majority of OS available for the PC domain, to such an extent that essentially all personal computers on the market are x86-based.

On the other hand, mobile devices such as smartphones, tablets and wearables have traditionally been under the rule of ARM. However, improvements to these two architectures by manufacturers and software designers, such as Intel® and ARM Holdings, are currently in the pipeline and may change the panorama.

Thanks to all these characteristics, an **SBC empowers developers to concentrate their efforts on system integration rather than electronics design**, in fact with SBC the company does not have to allocate resources to a new task, being able to continue on its path. This allows the company to stay completely focused on what is most relevant to the business, particularly important for start-ups and SMEs, which often only have a small amount of capital to invest.

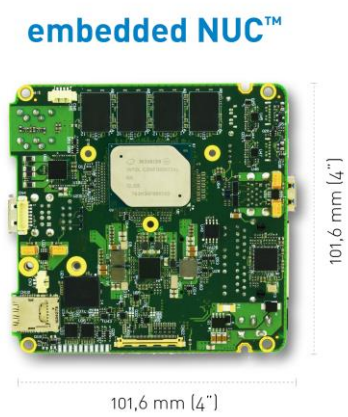
The Product Life Cycle represents another critical difference between SBCs and CoMs. Although not entirely consumer-oriented, many SBCs (typically miniITX) are indeed closer to consumer devices than CoMs and may move through an average innovation cycle of six to twelve months as they may mount CPUs that are available only for consumer products. In order to have a long-term available SBC, companies have to deal with the CPU's long-term availability in advance. In fact, **there is no perfect replacement** for SBCs**, apart from choosing the same form factor, implying the need for a new design.**

SBCs are particularly suitable for the start-up phase when the project specifications are not yet defined and there is a need to evaluate various solutions. These off-the-shelf solutions allow both to skip additional design phases and to launch quickly the product on the market.

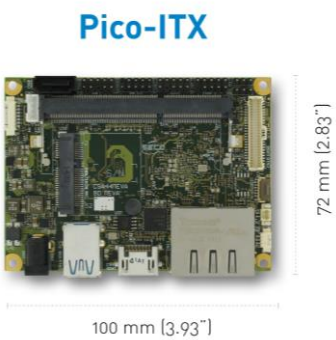
In actual fact, **SBCs are best suited to low volumes**. Due to the low cost per unit, it is quite possible to rapidly move from concept design to an initial prototype in a short space of time, making **SBCs ideal platforms for small-to-medium projects as well as for start-ups at the prototyping stage**.

More importantly, these aspects imply a considerably **faster time to market**. A single-board computer offers whatever is necessary to reach the market as quickly as possible. While on a small scale, this is a **preferable solution for kiosks, vending machines and digital signage, as well as for enabling interactive environments such as AR, VR, and projection mapping**.

Finally, unlike CoMs, where a customer is faced with carrier board design, **the Life Cycle Management of the complete computing system** of single-board computers **is entirely taken care of by the manufacturer.**



Picture 1.
SBC-B68-eNUC



Picture 2.
SBC-A44-pITX

Picture 3.
SBC-A62-J

Picture 4.
SBC-B08

CoMs

A CoM, short for **Computer on Module**, is an embedded computer that, rather than mounting all the components on the circuit board as in SBCs, **must be mounted on a carrier board**, which exposes the bus through standard peripheral connectors. CoMs have existed since 2003 and today are the ideal platform when pursuing a modular approach.

MODULARITY

The selling point of CoMs is the modular approach: a COM is in fact a computer on a module that needs to be stacked on a carrier board to work (together the module and carrier board are called "**system**").

From a design perspective, a COM features a microprocessor, I/O controllers, RAM and whatever else is necessary for the COM to work as a computer. Unlike single-board computers, they don't expose standard connectors for peripherals because they are placed on the carrier board where I/O signals are driven, through the CoMs standard connectors.

STANDARD FORM FACTORS

CoMs are based on **consolidated, globally accepted standard form factors**, i.e. **Qseven®**, founded by SECO and by other partners in 2008, **SMARC** and **COM Express™ (Pictures 5-9)**. If on the one hand single-board computers are available in various forms and offer a wide assortment of features, on the other hand CoMs have been standardised over time in order to make the modularity approach an actual possibility. CoMs in fact also standardise the footprints and the interface on the carrier boards.

MULTIVENDOR SOLUTIONS

CoMs are multivendor solutions: a CoM (based on a standard form factor) may be designed with the same processor family by several companies, with a very high "switching" compatibility, which makes room for competition in terms of price and ensures long term availability for the customer.

On the contrary, once chosen a single-board computer, it could be difficult to find a compatible solution, even if based on the same processor family.

Whether or not based on a proprietary design, single-board computers are perceived by the market as flagship devices of their manufacturers.

SCALABILITY

Thanks to these standards, CoMs are the foundation of any custom solution deployed on a mass scale. Indeed, **CoMs involve no design limitations and no compromise in terms of scalability**.

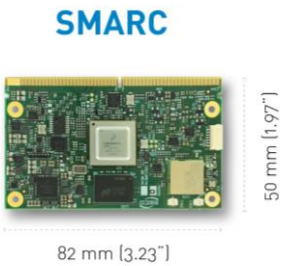
The approach is extremely different in comparison to SBCs: rather than an overpopulated board that addresses all the aspects, the designs of CoM systems are focused on fulfilling all (and only) the set of features necessary for the end product: from the mechanical dimensions to the set of standard connectors for I/Os to special connectors dedicated to the product's field of application.
Furthermore, it is easier to scale the performance of the final product using different modules on the same carrier board, spanning from ARM to x86.

CROSS PLATFORM

As far as architectures are concerned, CoMs once more offer greater freedom than SBCs. Indeed, **CoMs usually support cross-compatibility between x86 and ARM architectures**.

Picture 5.
Q7-B03

Picture 6.
µQ7-A75-J



Picture 7.
SM-C12

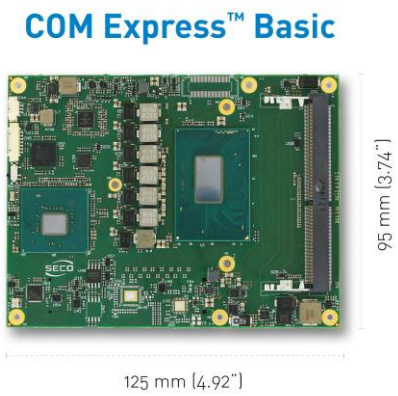
Of course, all these advantages come at the expense of time to market as a COM-based system will always mean that the **carrier board design** will be part of product development.

However, there is a great deal of freedom for the engineer: the footprint for example may be of any shape and size. While an SBC would have imposed restrictions in this respect, a CoM-based system allows maximum flexibility.
This is crucial in certain markets where the form factor is relevant, such as for portable devices.

Functionalities of decoupling between the carrier board and the COM scores another major point on SBCs: upgradability. As a matter of fact, **CoMs are easily upgradable**. If, for instance, a COM reaches the end of its life-span, the engineer will have to replace it but will not have to redesign the carrier board.

In economic terms **computer on modules are suitable for mid- to high volume projects**. A single COM-based system is not as cheap as an SBC (there are NRE costs for the carrier board), but when dealing with thousands of units, single-board computers can't compete with computer on modules in terms of trade-off between costs and advantages.
Given this consideration, a company that is building a new product will have to thoroughly estimate the breakeven point beforehand. This is even more important given that CoMs benefit from **an easier upgrade of the Product Life Cycle than SBCs (keeping the same carrier board with newer CoMs).**

Finally, concerning **Life Cycle Management**, the CoM remains under the vendor's responsibility.



Picture 8.
COMe-C08-BT6

Picture 9.
COMe-B75-CT6

SBCs vs CoMs: drawing conclusions

In conclusion, CoMs and SBCs share a few similarities and differ on many points (**Table 1**).

In summary, single-board computers are stand-alone, off-the-shelf solutions designed for low volumes, while CoMs are multivendor, standardized, high-volume solutions to address the embedded market on a mass scale.
It is therefore and ultimately a business decision.

With regard to companies operating in the kiosk market, for example, a single-board computer, which is the target for this market, is the quickest and cheapest solution. Broadly speaking, **single-board computers tend to be the best solutions for Small-Medium Projects, for which a company** does not generally have the resources, time and money-wise, to design a carrier board.

Conversely, for medium-to-large projects, if companies have time and know-how, single-board computers do not effectively represent an alternative to CoMs and full-custom SBC solutions because they are not scalable and as such will place limits on the expansion of the business.

Instead, for certain projects or for start-ups, SBCs constitute a fundamental tool to be used at a different phase of product development – in fact at the beginning of product development. Indeed, SBCs offer invaluable help as far as rapid prototyping is concerned because they allow the creation of a minimum viable product as quickly as possible. This minimum viable product could be used for prototyping and pre-series to study the market as well as the target audience, from which the company will be able to gather crucial feedback and then turn it into a better COM-based product.

SINGLE BOARD COMPUTERS		CoMs (Qseven®, SMARC, COM Express™)
Stand-alone solution	VS	Modular Solution
Off-the-shelf solutions	VS	Multi-vendor solution
Many formats (only a few standards: i.e. Pico-ITX, embedded NUC™,…)	VS	Consolidated Standard Form Factors
Typically not 100% needs-focused: Often over populated or missing features	VS	Little or no compromise of design requirements and scalability
Different Architecture (ARM/x86), different SBCs	VS	ARM & x86 cross compatibility
Engineering effort mainly in system integration	VS	Effort on carrier board design
No perfect replacement with EOL (apart standard form factor, i.e. embedded NUC™, Pico-ITX, etc..)	VS	Easily Upgradable (no mechanical redesign needed)
Best price for low volumes	VS	Best price for mid- to high volumes
Faster time-to-market	VS	Longer product life-cycle (same carrier board)
Life Cycle Management: 100% SECO	VS	Life Cycle Management: Customer only for carrier board, if designed. Otherwise, 100% SECO

Table 1.

About SECO

SECO is a world-leader in electronic embedded solutions. With over 40 years of experience, SECO has shown the ability to adapt its know-how to new and challenging customer needs and to provide cutting edge solutions to its partners. On the strength of its know-how and in contrast with recent outsourcing trends, SECO has always run the entire production cycle in-house, from the development stage to mass distribution. Thanks to new, innovative solutions and superior research and design activities together with the partnership of major scientific Universities and world-leading companies, SECO has expanded on the international scene becoming a global market-leader, while providing solutions to modern challenges. www.seco.com

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