

WHITE  
PAPER

# Modern “Software Factory” for Embedded Systems

—  
Launch new products  
x3 times faster\*

\*Average observed from 150+ successful cutting-edge projects

# THE PARADOX OF EMBEDDED PRODUCT DEVELOPMENT

Our lives intersect daily with systems containing an average of 200 to 400 integrated circuits, whether in our smartphones, our elevators or washing machines.

Powerful processors and small microcontrollers alike are ubiquitous and punctuate the lives of today's increasingly demanding consumers.

The Fortune 100 consumer electronics companies immediately spring to mind, but there also exist a variety of companies of all sizes that rely on electronic systems to differentiate their products and increase their performance and overall usability.

**However, product development can be very arduous due to the extreme sophistication of embedded systems.**

Indeed, in the ever-fragmented embedded market we have assessed:

- **10,000 different microprocessors and/or microcontrollers** to choose from
- About **+20 different Real-Time Operating Systems (RTOS)** along with about **+100 software modules** (connectivity, communication, graphics, etc.) and **+10 different compilers**, etc.

**This means that between the different microprocessors, microcontrollers, RTOS and compilers available on the market, almost two hundred million permutations are possible.**

**This is referred to as the “Matrix of Pain”.**

▶ *Most manufacturers are exposed to an incredible pressure to release their product faster on the market due to cut-throat competition.*

*Yet, the embedded complexity makes product development highly complex, and is often linked to delays and cost overruns.*



# '80s TRADITIONAL METHODS DESPERATELY NEED AN UPGRADE

## Marketing is being held hostage by inadequate tools and methods

To keep their competitive edge, marketing professionals need to imagine new products and services in order to either extend existing lines or create new ones.

This process typically requires the R&D or engineering divisions to develop one or several prototypes. And this is where things get tricky.

**Indeed, while marketing directors demand applications or services with high added value, they must first rely on the know-how of their research and development teams to design the early prototypes of said systems.**

Even when high quality design documentation is available, R&D teams often cannot cope with the plethora of possibilities at their disposal.

**In fact, many software modules and tools available on the market today are often incomplete, with (very) limited interoperability. They often comes as “coding samples”, providing little or no guarantee of reliability or reuse potential. This means that ready-made solutions often need enormous amount of re-engineering to meet operational reality.**



TRADITIONAL METHODS ARE DOOMED TO FAIL

## Craftsmanship and ad-hoc techniques may have worked in the past but are not adapted to rapid and constant design iterations

Even the most talented R&D teams are ill-equipped to deal rapidly with the complexity of the task at hand (the infamous Matrix Of Pain). And so, they consider a “boutique development” approach, and eventually come up with a solution, albeit one that may not be reasonable in terms of costs, time and resources. Moreover, it is an open secret in the electronics industry that solutions found by traditional methods are usually neither portable nor sustainable, and rarely economical.

**Antiquated homegrown systems and software development techniques make it near impossible to either industrialize the process of rapid prototyping or ensure brand consistency across heterogenous products.**

Bottlenecks at the R&D stage results primarily from the extraordinary length of time required to design, program, test, and implement a software than can only be used on a specific hardware. **A gain in productivity would imply more time for R&D to collaborate with other teams at the early stages of the prototyping process to avoid costly mistakes.**



These development paradigms are time-consuming and error-prone, and yet time is more precious than ever before and there is little (if any!) room for error.

▶ *Legacy development methods are simply too slow for today's competitive embedded market. Companies need to modernize their processes to create more value and generate systemic business wins.*

# MICROEJ DRASTICALLY SIMPLIFIES YOUR EMBEDDED SOFTWARE DEVELOPMENT

The programming environment can quickly become a nightmare for some of the stakeholders, given the difficulties of software development due to:

- ⬡ The complexity and fragmentation of the hardware and software modules offering,
- ⬡ The notorious lack of flexibility and interoperability in most programming environments,
- ⬡ The inability to port applications from one device or system to another,
- ⬡ The uncertainty of being able to ensure the maintainability of said systems,
- ⬡ Unnecessary code transformation between a simulated prototype and a finished product,
- ⬡ The lack of software modularity with poor evolution capabilities or adaption to different configurations.

**MICROEJ Virtual Execution Environment (VEE) is a standard, flexible and mature on-device platform that enables the marketing and development teams to maximize creativity in tandem while avoiding costly impasses.**



## Secret to success: down-scaled virtualization

**MicroEJ VEE uses the same virtualization principle as that has been used on computers and servers for over 20 years, but on a drastically lower footprint.** Thanks to virtualization, **MicroEJ solves the “Matrix of Pain” and its infamous 2 hundred million combinations**, while leveraging the existing software layer IP (typically in C language) which often carries a significant portion of the system’s added-value.



**MICROEJ** VEE

▶ *MICROEJ VEE radically simplifies how a device software is built, from prototyping to hardware choice, by integrating simulation, systematic software reuse, modularity, agility, continuous integration, automated testing and partial software updates in the development process.*



MICROEJ DRASTICALLY SIMPLIFIES YOUR EMBEDDED SOFTWARE DEVELOPMENT

## Facilitated product concept validation

**Simulation enables prototyping on Virtual Devices (virtual twins of real products), which decouples hardware and software development (aka separation of concerns).**

Virtual Devices enable the testing of the very same code that will run on the physical device, including the device front panel with keys, displays and sensors to test various configurations such as UI/UX schemes, IoT edge to Cloud robustness. Indeed, true code simulation enables the testing and troubleshooting of several IoT connections with ultimate flexibility and ease.

**Thanks to the versatility of MicroEJ's Virtual Execution Environment, it is possible to develop not just one, but five or more prototypes simultaneously and choose the best one.**

Since the software running on the Virtual Devices is, by essence, identical to the code that will run on the physical device, manufacturers take advantage of an accelerated proof-of-product which, once accepted, can be used "as is" to carry on the product development.

**It means that 100% of the software built during the prototyping phase can be used for production with no further adaptations.**



## Predictable Bill of Materials

There is only so much hardware that you can design and test, so through evaluation of the best compromise between performance and cost quickly hits a limit in time and resources.

**Thanks to Virtual Devices development, teams no longer have to make a guess on the final hardware to start prototyping, which enable them to analyze early on, the best trade-off for the best quality/cost ratio of any given technical solution.**

Examples of such evaluations can be, for instance, the IoT communication bandwidth which correlates with RAM sizes, or for the UI, the displays color range, refresh rate, or graphical effects needed to build a high-quality user interface on an optimal memory footprint, all while staying in control of the electronic components budget.



MICROEJ<sup>®</sup>VEE

- ▶ *Since simulated software can be executed out of the box on any MicroEJ-ready electronics such as processor evaluation boards, different hardware configurations can be tested within days, greatly facilitating marketing and development teams coordination for a cost-efficient and appealing final product.*

MICROEJ DRASTICALLY SIMPLIFIES YOUR EMBEDDED SOFTWARE DEVELOPMENT

## Sustainable and flexible software development process

Software architecture is about making the right structural choices which are costly to change once implemented. Given the unpredictability of product requirements changes, hard-coded and monolithic solutions can destroy your business.

**Good quality code and processes allows code to be changed faster, enabling manufacturers to quickly pivot when necessary.**

Object Oriented Programming (OOP), simulation and automated testing are three powerful techniques for a sustainable and flexible software development. OOP introduces a modular architecture approach, which means a large software

## Re-usable software applications

**With MicroEJ, it is possible to create plug & play software modules that implement application functionality and microservices. Modules can then be stored, shared and safely distributed on a large fleet of products built on very different hardware through an application store.**

It enables manufacturers to capitalize on these software modules and manage them as “assets” portable from one device to another without further development.

or system is divided into smaller, separated chunks of code that can be developed by different teams.

As a result, team members can simultaneously test, refactor, integrate and deliver their work more frequently, which translates in a fast, iterative process with each software module being seen as a separate entity, editable and testable at any moment, both on Virtual Device and real device.

**The entire software production line, from the build to the testing, becomes automatized and adjustable, allowing for changes, incremental additions and facilitates an Agile process implementation.**

**This flexibility results in obvious facilitated maintenance and faster evolutions and adaptations, resulting in huge time and costs savings.**

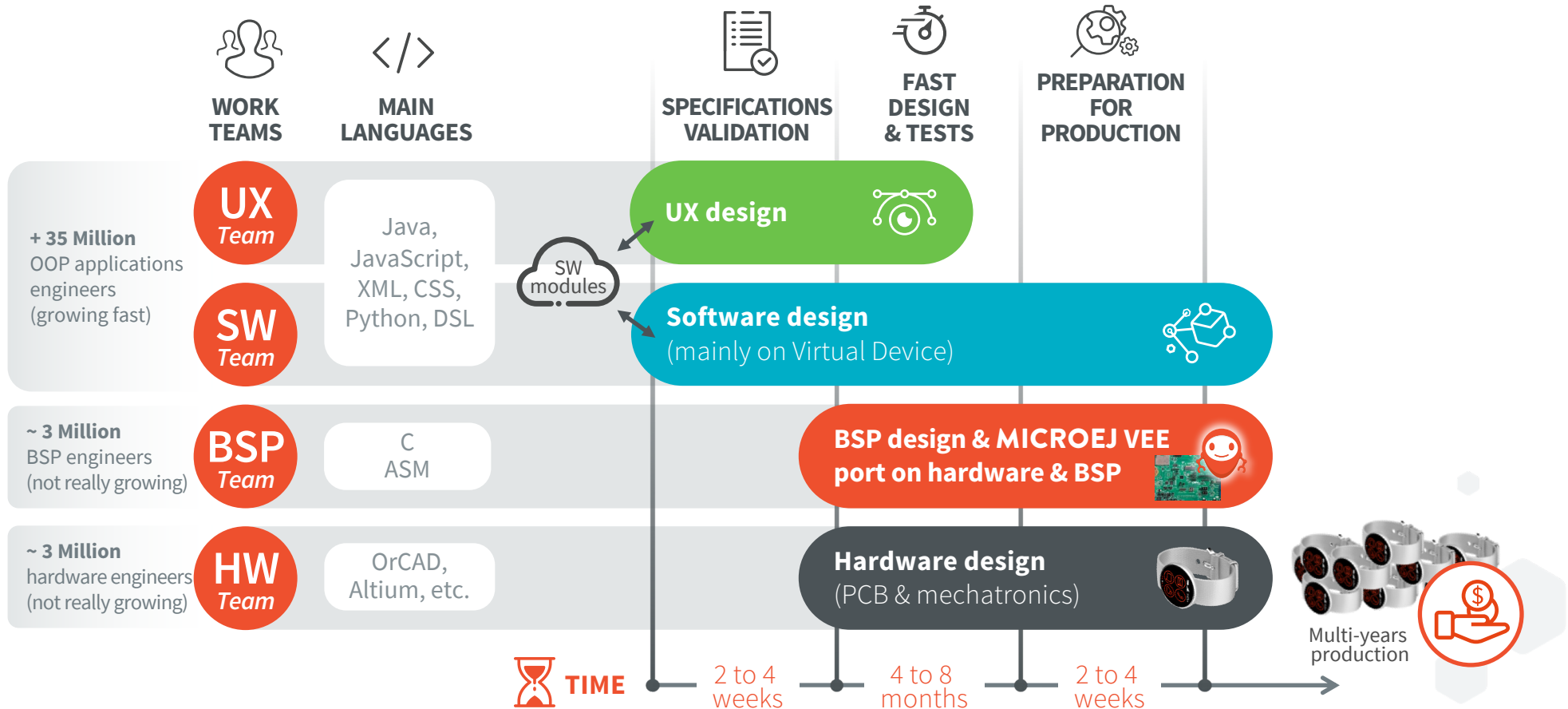
**It also brings tangible benefits to marketing teams that wish to reuse graphical user interface modules for a consistent brand identity.**



MICROEJ<sup>®</sup>VEE

# DESIGN VELOCITY x3 THROUGH SEPARATION OF CONCERNS

ACCELERATE TIME-TO-PRODUCTION AND LOWER RISKS BY ENABLING PARALLEL SPRINTS





# MAKE OR BUY

There are mainly two possible paths when it comes to your design cycles: the boutique or homegrown traditional methods, where one risks spending countless cycles trying to reinvent the wheel, or a streamlined, automated development environment with MicroEJ facilitating the early validation and rapid prototyping phases.

**Today, making a choice between using homegrown tools or buying off-the-shelf - COTS solutions (Make or Buy) has never been easier: anyone who wants to save time and money will choose mature off-the-shelf solutions such as MicroEJ (Buy) for its ease-of-use and speed in delivering a state-of-the-art product within time and budget.**

Many customers have already seen a drastic reduction in development time:

- **Smartwatch manufacturers report an average development cycle of just 4-5 months with MicroEJ, compared to a whole year using traditional tools and methods.**
- **Medical device manufacturers report shaving +60% off the costs associated with the simulation & execution of their software.**
- **Factory automation market customers reveal that they are now able to cope with hundreds of actuator references without increasing engineering resources.**

The list goes on and amounts to several tens of millions of dollars in cumulated new revenues, thanks to the use of a readily available, safer and well-maintained development environment, enabling a much faster pace of new products introductions

▶ *These hard financial metrics are also complemented by the fact that MicroEJ is a strong advocate for brand value. The portability of the applications help maintain the look-and-feel across several product lines, graphical interface, ergonomics and user experience, business logic and most importantly, the core IP of the brand.*



## CASE STUDY 1

# Works with Leroy Merlin Enki and MicroEJ scale up ecosystem integration a smarter home experience

### BACKGROUND

Enki by Leroy Merlin is a brand of ADEO Group, third largest DIY retailer in the world. Enki provides a smart home automation solution aimed at controlling all kinds of smart home connected devices (smart thermostats, lightning, energy monitors, etc.) through a unified smartphone application to deliver final users a simplified smart home experience.

# WORKS WITH LEROY MERLIN: CASE STUDY 1

ENKI AND MICROEJ SCALE UP ECOSYSTEM INTEGRATION FOR A SMARTER HOME EXPERIENCE

## Challenges

- A typical smart home environment is made of heterogeneous devices using different technologies that are able to talk to each other.
- Creating and rapidly scaling relevant and attractive smart homes ecosystems is extremely arduous due to complex technical challenges.

## Solutions

- **Enki (by Leroy Merlin) launched a pivotal solution in order to unify diverse Smart Home devices.** Enki's offer consists of a universal smartphone application, a Cloud platform and an Enki box, which integrates Wi-Fi, Bluetooth, Zigbee, EnOcean, LoRa, DIO and RF 433MHz protocols for seamless connectivity and interoperability.
- **MicroEJ was chosen as a strategic partner to enable faster ecosystem integration thanks to a universal edge-to-cloud connector dedicated to standalone Wi-Fi devices made available to any partners willing to connect their device to Enki's cloud.**



# WORKS WITH LEROY MERLIN: CASE STUDY 1

ENKI AND MICROEJ SCALE UP ECOSYSTEM INTEGRATION FOR A SMARTER HOME EXPERIENCE

## Benefits

- Smart Home manufacturers are able to quickly integrate Enki's wide ecosystem through tools provided via the "Works with Enki" portal, including the universal edge-to-cloud connector made available by MicroEJ.

Behind "Works with Enki", manufacturers will find MicroEJ software development kit, which enables them to take advantage of the off-the-shelf edge-to-cloud connector without any modifications (no recompilation, no revalidation, no requalification) for easy integration.
- A ready-made edge-to-cloud connector easily integrated in any kind of electronic product **avoids unnecessary product support, accelerates ecosystem integration, and ensures future-proof connectivity.**
- As a result, the end consumer enjoys an extensive range of "Enki friendly" Smart Home Wi-Fi devices that may now all be controlled from one single application.



## An accelerated path to ecosystem integration

Enki supports over 400 products from 25 different brands, many of them running on different technical environments. This number of different products and technologies put a great strain on support and development as device connectivity was at times difficult to manage and maintain. Indeed, teaching manufacturers on how to connect their device to the Enki's Cloud was extremely time consuming and not a viable solution on the long run.

Consequently, Enki started looking for a faster way to integrate new Wi-Fi devices to their ecosystem and empower manufacturers with ready-to-use software modules to accelerate integration.

**MicroEJ was chosen as Enki's partner, as its virtualization technology enables an application mindset: once designed, software modules (including edge-to-cloud connectors) can be run as-is to different electronics with literally no adaptations, fulfilling the promise of software modules reuse on any hardware.**

## MicroEJ Virtual Execution Environment (VEE) offers major benefits to Enki and its ecosystem of Smart Home partners

### ► ACCELERATED SOFTWARE DEVELOPMENT

**Virtualization combined with Object Oriented Programming technologies (OOP) makes it possible to build software modules portable across different electronic chips and operating systems.** As a result, developers can take advantage of ready-to-use software modules, which greatly reduces device development time, testing efforts, and risks.

### ► SIMPLIFIED ECOSYSTEM MANAGEMENT WITH ENKI SDK

Enki built a specific Software Development Kit (SDK) bundling support of specific electronics such as Wi-Fi processors and cloud protocol stacks (data communication, device on-boarding, etc.).





Thanks to the Enki SDK, **Enki can address many partners in parallel to create new products with limited support resources.**

Partner development teams just need to customize the software platform to their electronics specificities, with the help of reference design examples and ready-made software applications available in the SDK.

**Enki partners can create a Virtual Device (aka a simulator) to prototype their connected device and test its connectivity to Enki's cloud within hours. Since Virtual Devices acts exactly as a real device, software can run to the actual hardware with high confidence.**

#### ► SECURITY AND CONFIDENTIALITY

**In addition to supporting approved security standards such as secure boot, data encryption and authentication with certificates, MicroEJ brings security at software execution using the combination of virtualization, sandboxing and right management access.**

### KEY TAKEAWAYS

Acceleration of device integration in Enki's ecosystem of 3 months on average.

The solution is future proof, since the cloud connector can be updated at any time, even if the device is already deployed on the field.





## CASE STUDY 2

# MicroEJ brings a faster path to innovation to home appliances manufacturers

### BACKGROUND

One of the leading manufacturing provider worldwide, recognized for its electronic design, manufacturing and supply chain services in markets such as automotive, appliances, wearables and connected homes, launched electronic reference designs to provide home appliance manufacturers with an accelerated path to innovation.

# BOOSTING INNOVATION: CASE STUDY 2

MICROEJ BRING A FASTER PATH TO INNOVATION TO HOME APPLIANCES MANUFACTURERS

## Challenges

- The rapid pace of innovation in the appliances industry generates an increasing pressure to release high volume products faster in order to reach the market before the competition.
- The extreme complexity of the segmented embedded industry as well as inefficient development processes result in extended deadlines and extra costs.
- Product specifications are constantly adjusted due to OEM specific requirements.

## Solutions

- **The company introduced off-the-shelf and adjustable electronic references to match a wide array of home appliances with minimum adaptations.** However, front panel display development was still a costly and time-consuming process for most device manufacturers.
- MicroEJ was chosen as a partner to **complete this hardware platform concept with a matching, scalable software on-device platform.** Its modular software technology allows software modules to be developed, integrated and tested independently, **opening the door to fast evolutions and adaptations.**

## Benefits

- Dedicated appliance reference designs and ready-made software modules enable manufacturers to benefit from a **packaged, simple to use solution for a faster time-to-market.**
- Manufacturers benefit from **cost optimized, reusable software modules, ready to be used on flexible hardware reference platforms** adapted to their customer needs.
- **MicroEJ VEE extremely low-footprint virtualization technology enables fast, attractive user interfaces, reliable edge-to-cloud and edge-to-edge connectivity through low power, low cost hardware, translating into huge margin gains.**
- **Over 20 million C/Java/Javascript developers can now easily build apps for heterogeneous home appliances** as easy as they would for Android smartphones or tablets, with no retraining required.



## Teaming up to boost innovation in the home appliances industry

By taking advantage of off-the-shelf front panel electronic configurations, leading home appliance OEMs are able to produce new products faster with minimum adaptations. The software part, however, was still a challenging and costly process as front panel displays had to be created from scratch.

**MicroEJ solved that issue by enabling an agile development that enables Continuous Integration (CI) across different teams (hardware, software, marketing, etc.).**

**As software modules are engineered, integrated and tested separately, it is much easier to change specifications (add or remove functionalities for instance) to match with manufacturers distinct requirements.**

## MicroEJ VEE (Virtual Execution Environment) offers major benefits to original equipment manufacturers:

### ► FASTER GO TO PRODUCTION PROCESS

A classic product development process typically involves building a physical prototype and test it. Most of the time, testing will reveal design flaws that requires a re-design or re-configuration, which can stretch the development schedule indefinitely. On the other hand, virtual prototyping enables software development on virtual devices (virtual twins of real devices), which separates hardware and software development.

**Virtual testing and design adjustments can be executed more easily, cutting both time and costs of development as a result.**

### ► LEVERAGED DESIGN INVESTMENT

**With MicroEJ, software modules can be stored, shared and safely distributed across different hardware configurations.**

This process is especially valuable in the case of IoT communication and user interfaces: **reused graphical widgets ensure a consistent brand image across different lines of products, which creates a familiar user experience for home appliance consumers love and recognize.**



## CASE STUDY 2: MICROEJ BRING A FASTER PATH TO INNOVATION TO HOME APPLIANCES MANUFACTURERS

**► RELIABLY BY DESIGN: FUTURE-PROOF PRODUCTS**

Smart home appliances often have the reputation of coming with an expiration limit: since the device software is hard to update, connectivity protocols can become obsolete, security breaches can happen, and more generally, the lack of added functionalities can result in a decreased demand in the product.

**With MicroEJ, manufacturers can easily and securely update their device applications over-the-air and manage their life cycle remotely** (start, stop, install, uninstall of apps). It makes it simple to add recipes in a smart cooker, update an IoT protocol, add a new interesting feature.

**MicroEJ software solutions, combined with cutting-edge manufacturing services, deliver a smarter development process and a faster access to market**

**By offering hardware+software packaged platforms, MicroEJ and its manufacturing partner greatly relieves home appliances manufacturers from the complexity of the embedded world** (fragmented technologies, multiple hardware, RTOS/OS, middleware, etc.).

**Ready-made electronic configurations and virtual devices enable product development industrialization:** manufacturers can try and choose between different, ready-to-use modules, prototype, test and launch on a controlled timeframe and budget, resulting in an accelerated path from design to manufacturing.

**KEY TAKEAWAYS**

OEMs take advantage of versatile hardware+software platforms that truly adapts to their requirements for UI/UX, Cloud connectivity and Edge computing.

On average, over +10 smart home or smart appliances projects, the launch of new products was x3 times faster than without virtualization.



# A MULTI-LEVEL VALUE PROPOSITION FOR ECONOMIC SUCCESS

## Turn your software into your most powerful asset, enabling x3 faster products launches

- **Run several market-ready design prototypes to validate early and often**, assuring the alignment of the business plan with market reality (instead of relying on market research only).
- **Easily adjust Bill of Material costs by choosing only the right and relevant functionalities** to achieve a perfect product marketing mix in line with market requirements.
- **Greatly reduce the maintenance costs** associated with the remanufacturing of old or obsolete designs.
- **Considerably reduce costs by managing development risks** and subsequently market timing issues, with early simulation, validation and rapid prototyping to facilitate market launch on time and budget.
- **Improve overall return over investment** by spending a lot less capital and operational funds in the design cycles and product derivative development.
- **Reuse user interface software modules** to protect brand value and market recognition.
- **Quickly and easily rejuvenate older products with modern add-ons** while maintaining the strength of existing applications and user experiences across different legacy hardware environments.
- **Take advantage of a large C/Java/Javascript developer community** versus the limited “C-only” community currently available worldwide (20 million vs 1 million).

Up to  
-15%  
**BoM COSTS**

Up to  
-40%  
**R&D COSTS**

Up to  
-70%  
**TIME TO MARKET**

Up to  
-80%  
**EMBEDDED SOFTWARE COMPLEXITY**

## Leverage your assets and know-how

Although MicroEJ fits perfectly into the high-volume and cost-constrained electronic devices markets, it is also suitable for products with small and medium production runs. There are a large number of quality designs that fulfill their requirements perfectly, but do not have the connectivity, fancy smartphone-type touchscreens or automated over-the-air Maintenance Alert notification.

MicroEJ allows for the rejuvenation of these machines by complementing their existing IP, to make them more relevant in our interactive connected world, and possibly create new revenue streams with additional services in the Internet of Things (IoT) marketplace.

**There is no need to spend large amounts of resources or suffer significant delays in developing a robust and updated solution.**

**MicroEJ allows for quick design add-ons, while leveraging and protecting your assets and know-how.**



## Take advantage of a large ecosystem of third-party power players

In response to market fragmentation, MicroEJ brings together a rich ecosystem of major players in the electronics and embedded marketplace, offering a unique and strong value proposition.

The list of partners includes tools vendors, semiconductor manufacturers, board vendors, software stacks and libraries suppliers (graphics, operating systems, communication protocol...), and RTOS vendors.

Some of these players include leading worldwide companies in their respective sectors such as NXP, STMicroelectronics, Renesas, Microchip, Realtek, Espressif, Murata, ARM/Keil, IAR, WolfSSL, Segger, Google, Sony... to name a few.



MULTI-LEVEL VALUE PROPOSITION FOR ECONOMIC SUCCESS

**MICROEJ®** is a software vendor of cost-driven solutions for embedded and IoT devices. We are focused on providing device manufacturers with secure products in markets where software applications require high performance, compact size, energy efficiency, and cost-effective development.

Today hundreds of companies in the world with over 40 million products sold, have already chosen MicroEJ to design electronic product applications in a large variety of industries, including smart home, wearables, healthcare, industrial automation, retail, telecommunications, smart city, building automation, transportation, etc.

MicroEJ combines more than 15 years of experience and counts among its customers large Fortune 100 companies such as Landis+Gyr, Zebra Technologies, Atlantic, Thales, EDF, Delta Dore, ECA, Stago, Groupe SEB, Enki by Leroy Merlin, Hager, Hillrom, Iridium, etc.



SEE ALL

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