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Is Free Bluetooth Really Free?

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EMF is the premier market intelligence and advisory firm in the embedded technology industry. Embedded technology refers to the ubiquitous class of products which use some type of processor as a controller. These products include guided missiles, radars, and avionics as well as robots, automobiles, telecom gear, and medical electronics.

EMF has been conducting research into the embedded market for more than a decade. EMF survey work is recognized as the most comprehensive and statistically accurate set of measures in the embedded market space by LSA, IBM, Microsoft and a number of other firms. Using research discipline from medical inquiry, EMF has developed a series of survey questions for developers which provide insight into the following areas:

- Trends in Integrated Development Environments (IDEs) and Real Time Operating Systems (RTOS)
- Trends in host processors (both standard microprocessors and Digital Signal Processors (DSPs)
- Trends in Interfaces and Trends in Bus and Board Standards
- Trends in Systems Engineering and Systems Architecture
- Trends in Software Languages
- Trends in simulation
- Trends in testing
- Trends in product life cycle management
- Trends in product development performance, practices and management

Embedded Market Forecasters (EMF) is the market research division of American Technology International, Inc. EMF clients range from startups to Global 100 companies worldwide. Founded by Dr. Jerry Krasner, a recognized authority on electronics markets, product development and channel distribution; EMF is headquartered in Ashland, Massachusetts.

About the author:

Jerry Krasner, Ph.D., MBA is Vice President of Embedded Market Forecasters and its parent company, American Technology International. A recognized authority with over 30 years of embedded industry experience, Dr. Krasner was formerly Chairman of Biomedical Engineering at Boston University, and Chairman of Electrical and Computer Engineering at Wentworth Institute o f Technology and Bunker Hill Community College. In addition to his academic appointments, Dr. Krasner served as President of Biocybernetics, Inc. and CLINCO, Inc., Executive Vice President of Plasmedics, Inc. and Clinical Development Corporation, and Director of Medical Sciences for the Carnegie-Mellon Institute of Research. Earlier, he was Senior Engineer at the MIT Instrumentation Laboratory. Dr. Krasner earned BSEE and MSEE degrees from Washington University, a Ph.D. in Medical Physiology / Biophysics from Boston University and an MBA from Nichols College. He is a visiting professor at the Universidad de Las Palmas (Spain) where he was recognized for his work in neurosciences and computer technology.

Regarding the Data in this report

The data that is referred to in this report is *statistically accurate* and *authentic* and is based on:

- A statistically generated comprehensive and detailed survey of embedded developers and managers who reported on their design results (number of developers per project, vertical market of their design, time to market, percent of designs completed behind schedule or cancelled, closeness of final design outcomes to pre-design expectations, testing outcomes, etc.), the tools they used (development, modeling, Java, Eclipse, and other development tools), their choice of OS, IDE, communication middleware, processors used as well as where they go to learn about new products, tools and concepts.

- An EMF Dashboard – a unique tool that allows the user to simultaneously compare similar products (vendors can do competitive comparative analysis); that marketing executives can use for sales promo and strategic planning; that allows developers beginning a project to compare the experiences of hundreds of fellow developers that undertook similar projects to gain insights before making a commitment; and that allows CFOs and senior managers to look at what tools and processes resulted in the greatest cost savings.

For the interested reader, the following link demonstrates the power of the Dashboard and how we used it in developing the data that is presented herein:

http://www.embeddedforecast.com/EMF_DashboardIntro/EMF_DashboardIntro.html

For some reason people take their cues from price action rather than from values. Price is what you pay. Value is what you get.

Warren Buffet

Let's get right to the point.

As a veteran of the embedded wars going back to when "embedded" became something more than the market dominance of Microsoft and Intel ("Win-Tel"), I continue to be fascinated by the idea of a free lunch. Depending on which pocket you choose to pay for software, hardware or tools, the idea of free remains part of the FUD legacy.

If you pay nothing for software (say Bluetooth already embedded on chips or RTOSes) but it costs you 50% more in development costs and perhaps significant time in opportunity costs associated with delayed time-to-market, is Free Bluetooth really free? It depends on who is counting. Short of having definitive data to either support or to deny the claims of Linux, open source software or free Bluetooth, developers, their managers and CFOs can be mislead into undertaking development efforts that can prove to be more costly that using commercially available software.

Let's look to the issues surrounding wireless protocols in general and Bluetooth in particular.

Let's look at embedded wireless usage:

Wireless Technologies Used in Embedded Designs

Bluetooth	36.4%
802.11g	23.9%
Zigbee	22.4%
802.11b	18.4%
Proprietary	17.9%
802.11n	16.8%
GSM	16.1%
HTTP	15.5%
RFID	12.9%

If we had added up all of the usages of the WiFi protocols we would have a larger number of embedded usages than Bluetooth. However developers that use one WiFi protocol are inclined to use a lot of different protocols.

So we have established that Bluetooth is an important protocol for embedded and IoT applications. Let's look at the comparisons between Bluetooth user data (free and not free) and WiFi and "other" wireless protocol users. This data is based on 1058 respondents to the 2015 EMF Survey of Embedded Developers.

	Bluetooth Users	Free Bluetooth Users	WiFi Users	Other Wireless Users
SW Developers/Project	6.5	6.4	7.5	9.0
Time to market/months	12.1	12.0	12.7	12.8
Behind Schedule completions	32.6%	37.0%	36.2%	35.1%

Table I: Comparative Wireless Data

From Table I we can observe that when comparing free and commercial Bluetooth user data along with WiFi and other wireless protocols, Bluetooth in general offers a lower cost of development. The comparative development time between free and commercial Bluetooth appears to be the same. However three is a significant difference between behind schedule completions. This is an important finding.

Let's look at "Design Outcomes" as a further comparison between the free and non free versions of Bluetooth.

As part of the extensive survey, embedded developers were asked the question "How close was your final design outcome to your pre-design expectation". Developers were offered:

Within: 10%, 20%, 30%, 40%, 50% and "not within 50%". EMF believes that within 10% is an exceptional design outcome and within 20% is a very good design outcome. Developers were asked to answer the question for "Performance" and for "Systems Functionality". The results are presented in Table II.

	Bluetooth Users	Free Bluetooth Users	WiFi Users	Other Wireless Users
Performance				
Within 10% of pre-design expectation	52.3%	34.1%	55.6%	51.7%
Within 20% of pre-design expectation	17.4%	21.2%	17.7%	16.9%
Total developments within 20%	69.7%	55.3%	73.3%	68.6%
Systems Functionality				
Within 10% of pre-design expectation	56.0%	34.1%	56.5%	52.3%
Within 20% of pre-design expectation	15.6%	22.4%	16.9%	16.0%
Total developments within 20%	71.6%	56.5%	73.4%	68.3%

Table II: Comparative Wireless Data for Design Outcomes

When we compare the developments that use the free and non-free Bluetooth protocols for on-time completions (100% - behind schedule completions) and for design outcomes it

becomes abundantly clear that the free Bluetooth protocols have a cost burden that is imposed on developers and their developments.

This should come as no surprise. Chip vendors that offer free Bluetooth do so to enhance their chip sales – Freescale, for example, offers the MQX RTOS free with their chips. This is quite strange since the vast majority of developers use VxWorks with Freescale processors. Apparently there is a marketing disconnect between marketing and sales at Freescale.

What do Developers get when they BUY a Bluetooth Protocol Stack and not use a free one?

Maintenance is a continuous issue and when a free stack is used the user must either have their own staff to deal with issues or rely solely on the open source community. This is fine some of the time but there are other occasions where more control over the commercial product is required. When a stack is purchased on the other hand maintenance, update and support can be obtained from a team expert in the technology and their implementation of the protocol stack. This level of service means that dedicated staff are not required for this area. Instead these staff can be available for the many other aspects of product maintenance.

There are advantages in development too as commercial stacks will often offer an ecosystem rather than stacks alone, this may include design environments and debug tools and evaluation hardware. Such an ecosystem contributes greatly to on time and on budget projects.

Finally qualification is a complex, costly and time consuming task with some open source stacks. This task is greatly simplified by a commercial stack that comes as a qualified component and is backed up by the people experienced with the testing and qualification process.

Why taking the Bluetooth stack provided by chip manufacturers may not always be the best option

- It creates dependencies that are best avoided; if a product is to be in the field for many years end Of Life (EOL) issues must be dealt with. Choosing software that is provided with a chip then means that the software will also need to be changed when the hardware come EOL. This is double trouble. Much better to pick a Bluetooth stack that has an abstraction layer so that the same upper layer software will run despite changes in hardware. Increase quality and performance by choosing an independent stack.
- Other than the dependency on the hardware vendor there is the issue of meeting requirements. What if the required RTOS is not supported? What if the required functionality is not supported? What if the required quality is not provided? Let's face it. Chip vendors are in the numbers game and as such they must cater for the mainstream. But what if you want to create functionality that is beyond mainstream? The choice in these situations is to pick a stack vendor that is independent; specializes in

Bluetooth technology and takes the time to provide for new innovative functionality.