Accelerate Embedded System Development with Linux and SUSE® Embedded Solutions

Key Considerations for Selecting a Commercial Linux Distribution for Embedded Solution Development and Management
Introduction

The embedded systems market is expected to grow 5.6% over the next six years.¹ To manage and keep pace with this growth, embedded system developers are under significant pressure to simplify their development process while bringing products to market faster and more securely.

Adapting to a Rapidly Changing Development Environment

Development of embedded systems is rapidly changing as new technology is introduced and connectivity of devices increases. Embedded developers are under mounting pressure to add more functionality into applications, which in turn increases the complexity of managing fixed-function devices, appliances, or other hardware over the entire product lifecycle. Furthermore, embedded software developers are challenged to bring products to market faster and more securely, while lowering overall costs.

“Software development is challenging. Embedded software development targeting the newest breed of devices is even more challenging.”²

This increased demand to bring products to market quickly can often result in mistakes, quality issues, unsecure products, and poor end-user experiences. Additionally, developers are at higher risk for burnout when put under time-to-market pressure.

Developer Jeremy Katz at DoneDone says, “Burnout is dangerous because it produces bad code. If a developer is overworked and apathetic, they’ll only put in the minimum amount of effort required for each task. Healthy and happy programmers, however, tend to write higher-quality bug-free code, which in turn keeps projects on schedule and on budget.”³

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² www.embedded.com/design/operating-systems/4008931/
³ https://arc.applause.com/2015/07/02/software-developer-burnout/
While tools and technology have significantly improved over recent years, embedded system developers still need to better manage development schedules, broaden and improve skills across their teams, and have access to stronger debugging tools. UBM recently surveyed embedded system developers about their greatest concerns in regard to design and their current work on embedded systems. Their key concerns are summarized in Figures 1 and 2, highlighted in more detail below.

If you could improve one thing about your embedded design activities, what would it be?

**Figure 1.** Developer Perception of how to Improve Embedded Design Activities
Debugging tools and the debugging process

Figures 1 and 2 illustrate that developers consider the debugging process and developer tools the two key areas that present current challenges and opportunities for improvement in the future. Developers need better tools and transparency into their systems to assist them with the debugging process.

“Tools promise great insight into system operation. Tools designed for embedded systems let you see, live while it happens, what your program is doing, what resources it’s using, and how it interacts with the external world. The insight they provide is truly powerful; you can often quickly spot problems, issues, or inefficiencies that would take days to discover by other means.”

![2015 UBM Electronics Embedded Markets Study](image)

Which of the following challenges are your own or your embedded design team’s greatest concerns regarding your current embedded systems development?

<table>
<thead>
<tr>
<th>Challenge</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>The debugging process</td>
<td>25%</td>
<td>29%</td>
</tr>
<tr>
<td>Meeting schedules</td>
<td>23%</td>
<td>26%</td>
</tr>
<tr>
<td>Meeting application performance standards</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>Power management/Energy efficiency</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>Testing/Systems integration</td>
<td>13%</td>
<td>16%</td>
</tr>
<tr>
<td>Increased lines of code and software complexity</td>
<td>12%</td>
<td>16%</td>
</tr>
<tr>
<td>Maintaining legacy code</td>
<td>8%</td>
<td>10%</td>
</tr>
<tr>
<td>Ensuring data security*</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Sticking to our cost budget</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>Keeping pace with embedded systems technology</td>
<td>9%</td>
<td>11%</td>
</tr>
<tr>
<td>Meeting safety &amp; development process standards</td>
<td>9%</td>
<td>8%</td>
</tr>
<tr>
<td>Software compatibility when porting to new devices</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Providing network connectivity*</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Selecting the right processors for the job</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Configuring/selecting scalable cloud services</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>Managing remote design team/multible locations</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Managing multiple operating environments</td>
<td>4%</td>
<td></td>
</tr>
</tbody>
</table>

“Tools promise great insight into system operation. Tools designed for embedded systems let you see, live while it happens, what your program is doing, what resources it’s using, and how it interacts with the external world. The insight they provide is truly powerful; you can often quickly spot problems, issues, or inefficiencies that would take days to discover by other means.”

Investing in the engineering team's skills

Figure 1 underscores embedded system developers' wish to have more time to invest in their skills. As embedded systems continue to change and grow, engineering teams need to adapt by acquiring new skillsets. Embedded system developers are continually challenged with finding time to invest in skills development, while balancing schedules and product lifecycle management. Enabling embedded developers to offload certain tasks and functions allows them to spend more time focusing on honing the skills they need to flourish in current and future development landscapes.

Meeting development schedules

Figures 1 and 2 highlight embedded developers' concerns and desire to effectively manage development schedules. Embedded system developers are now under even greater pressure to get applications to market faster. However, according to Embedded.com, “70% of development teams had a development cycle of 12 months or less on their last project, and only 38% of teams finished on or ahead of schedule.” One out of 3 developers was on schedule for their projects according to UBM.6

Testing and systems integration

When projects are behind schedule, testing time is often cut to bring in faster results. Testing embedded systems devices is too important of a job to short-change. Without effective testing, the chance for negative outcomes such as bugs, risks, higher development costs, and performance issues increases. As noted in Figure 2, embedded system developers rank procuring adequate time for testing as a top priority.

Ensuring data security

Network security is crucial for most organizations, and is another key concern for embedded system developers (see Figure 2). Meeting stringent security requirements demands an ongoing program of operating system maintenance and patching, which often includes dedicated development resources. Patches and updates without dedicated support can be difficult to deploy in hardware and devices already certified and in the field. Auth0 recently found that 85% of developers admitted that they had rushed applications to market despite having security concerns about the device. Read the full security white paper to learn how SUSE Embedded solutions address the top security concerns of embedded solution developers.8

Managing long product lifecycles

Once deployed, devices and/or hardware may remain in use for years—even decades—making in-house system management and maintenance an overwhelming feat for development teams (see Figure 2). Many organizations lack the resources or manpower to regularly monitor and update security, manage bug fixes, and patch the operating system throughout the product lifecycle.

Avoiding high development costs

The costs associated with developing and maintaining a custom proprietary operating system can be prohibitive, yet staying within scope of a defined budget remains a top priority (see Figure 2). Expensive and overly complex licensing and subscription models can drive up development costs, as well as costs to end-users, eroding profits or diminishing competitive advantage. Embedded developers need to manage costs carefully in order to remain competitive.

With all of these challenges, how can we facilitate the concept of Jeremy Katz's healthy and happy programmers in order to bring products to market quickly, securely, and cost-effectively? Embedded system developers are evaluating technology solutions that enable focus on value-added tasks.

Overcoming Embedded Development Challenges

Investing in the right technology solutions can help overcome many of the challenges developers and companies face when bringing embedded solutions to market. More and more embedded system developers are recognizing that embedded Linux operating systems will enable them to keep up with the ongoing pressure to innovate in a rapidly changing environment. As interconnected devices and systems continue to become more pervasive, VDC projects that the adoption of Linux in the embedded operating systems market will grow steadily at a CAGR of 16.7% for open Linux.9

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5 www.eetimes.com/author.asp?section_id=36&doc_id=1326878
6 www.embedded.com/electronics-blogs/say-what-/4439703/
Embedded-systems-survey-uncovers-trends---concerns-for-engineers
7 https://auth0.com/blog/surprised-turns-out-consumers-dont-trust-iot-security/
8 https://suse.lookbookhq.com/suse-embedded-must-reads/
embedded-security-white-paper
The selection of an embedded operating system is a complex process that requires consideration of multiple factors that impact every aspect of the project—from development time to licensing costs.

There are a number of commercial Linux vendors, so it’s important to evaluate embedded Linux vendors based on the following criteria and questions:

1. **Support**
   - What support and/or training is provided?
   - How long can a project be supported?

2. **Features**
   - What functionality and value-add features are available?
   - How do these features improve the productivity of a development team?

3. **Security**
   - What features are included to enable a more secure device?
   - What capabilities are available to manage security over the lifecycle of the device?

4. **Development Environment**
   - How easy is the system to use?
   - What tools are provided for the development environment?

5. **Documentation**
   - What resources are available to streamline and optimize development efforts?

6. **Pricing**
   - What is the pricing structure for embedded Linux?

   Embedded system developers recognize that Linux satisfies many of the questions above and the top operating system requirements identified in Figure 3 on the following page. The question for many embedded system developers becomes, ‘which version of Linux do I use?’ Commercial and technical support are pivotal reasons that more and more embedded system developers are turning to a commercial Linux operating system such as SUSE Embedded solutions for embedded system development, training and support.

   In addition to the questions above, embedded system developers need to evaluate key criteria when choosing an operating system. See Figure 3 for the results from a recent UBM study on the embedded development market.\(^\text{10}\)

   Unlike unsupported Linux solutions, Commercial Linux offerings such as SUSE Embedded solutions provide tech support, commercial support, training, interoperability with other systems, and customized pricing for the embedded development environment.

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10 [https://devzone.nordicsemi.com/attachment/a61052ff4978f8c42b4f6f4b11a1b0e0](https://devzone.nordicsemi.com/attachment/a61052ff4978f8c42b4f6f4b11a1b0e0)
What are the most important factors in choosing an operating system?

<table>
<thead>
<tr>
<th>Factor</th>
<th>2015 (N = 1062)</th>
<th>2014 (N = 1394)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of full source code</td>
<td>45%</td>
<td>33%</td>
</tr>
<tr>
<td>Availability of tech support</td>
<td>32%</td>
<td>30%</td>
</tr>
<tr>
<td>Real-time performance</td>
<td>29%</td>
<td>30%</td>
</tr>
<tr>
<td>No royalties</td>
<td>25%</td>
<td>28%</td>
</tr>
<tr>
<td>Compatibility w/ other software, systems</td>
<td>24%</td>
<td>23%</td>
</tr>
<tr>
<td>Freedom to customize or modify</td>
<td>28%</td>
<td>23%</td>
</tr>
<tr>
<td>Open-source availability</td>
<td>23%</td>
<td>21%</td>
</tr>
<tr>
<td>My familiarity with the operating system</td>
<td>20%</td>
<td>19%</td>
</tr>
<tr>
<td>Purchase price</td>
<td>17%</td>
<td>15%</td>
</tr>
<tr>
<td>The processors it supports</td>
<td>15%</td>
<td>16%</td>
</tr>
<tr>
<td>Software development tools available</td>
<td>14%</td>
<td>15%</td>
</tr>
<tr>
<td>Small memory footprint</td>
<td>13%</td>
<td>12%</td>
</tr>
<tr>
<td>Simplicity / ease of use</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td>Commercial support</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>Other software, middleware, drivers, code</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Popularity</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Successful prior use for similar apps</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Safety Certification</td>
<td>4%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Figure 3. What Are the Most Important Factors in Choosing an Operating System?
SUSE Embedded Solutions: The Linux of Choice for Embedded Systems

Not all commercial Linux companies are created equal. Founded in 1992, SUSE is the world’s first provider of an Enterprise Linux distribution. SUSE is committed to delivering reliable, best-in-class security and service to its customers, and to the Open Source community. SUSE believes that trust in Open Source Software security in general, and the user’s privacy in particular, is indispensable.

As referenced in the following table, SUSE Embedded solutions are uniquely positioned to help embedded developers overcome their key challenges:

<table>
<thead>
<tr>
<th>Embedded Developer Challenge</th>
<th>SUSE Embedded Solutions’ Capabilities</th>
</tr>
</thead>
</table>
| **Debugging Process**       | With SUSE Linux Enterprise you get a set of robust programming tools (compilers/debuggers) along with support and packages for deeper inspection/debugging including:  
  - Robust support and developer services to assist with debugging issues  
  - Supportconfig tool to capture a system’s current state and a Supportconfig Analysis (SCA) tool that prescriptively suggests remedies for known configuration issues found in the supportconfig output  
  - Transparency via a ChangeLog on what changed (compared to upstream or to the previous release, etc.)  
  - Access to the latest tools through Toolchain module  
  - Access to SDK (software development kit)  
| **Managing Schedules**      | SUSE Linux Enterprise helps fixed-function device and server manufacturers bring innovative solutions to market quickly, helping with:  
  - Proven and managed Linux OS distribution and reliance on industry-leading support services that can streamline development and certification of appliances, devices, and products, creating faster go-to-market times for the OEMs and organizations that require a lean, fixed-function OS footprint.  
  Learn more: [www.suse.com/embedded/](http://www.suse.com/embedded/) |
| **Security**                | Leverage industry security certifications and reduce the time and cost of maintaining security updates and patches including:  
  - Advance notification of security flaws and vulnerabilities that work with the Open Source community to fix those vulnerabilities before a system is threatened.  
  - A dedicated team of security experts  
| **Testing and Systems Integration** | SUSE Linux Enterprise Server is compatible with a wide range of industry-standard hardware and software, freeing engineering teams from building, testing, and debugging custom drivers and hardware interfaces. As a result, system builders can:  
  - Design and create solutions quickly and with confidence that their products will perform to their specs, requirements, and expectations.  
  - Have confidence that various system vendors are supported for on-going hardware and driver certification and compliance.  
  - Utilize the available SUSE test suites to assess supportability of the target hardware platform and virtualization scenarios.  
  Learn more: [www.suse.com/partners/ihv/yes/self-service-testing.html](http://www.suse.com/partners/ihv/yes/self-service-testing.html) |
| **Long Lifecycle Management** | Many manufacturers lack the resources to monitor and update security and bug fixes and patch the operating system on an ongoing basis for the life of a product. With SUSE Linux Embedded solutions, customers get up to 13 years of lifecycle management from proven Linux experts. Learn more: [www.suse.com/lifecycle/](http://www.suse.com/lifecycle/) |

continued on next page
### Embedded Developer Challenge

**Avoiding High Development Costs**

Organizations that rely on unmanaged Linux distributions often end up with a mix of proprietary and Open Source code, complicating licensing requirements. Expensive and overly complex licensing and subscription models can drive up development costs, as well as costs to end-users, eroding profits or diminishing competitive advantage. With SUSE Embedded solutions developers can:

- Utilize JeOS (down to X86-64) to develop feature-focused appliances and leverage platform flexibility to develop systems faster and stay focused on critical project requirements.
- Create powerful business solutions and build innovative hardware rather than spending time ineffectively “on the management, maintenance, and scalability of an unmanaged Linux system.
- Benefit from embedded-specific contract agreements built around streamlined OS usage and project requirements.

Learn more: [www.suse.com/partners/embedded/](http://www.suse.com/partners/embedded/)

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### Investing in the Engineering Team’s Skill

**SUSE Embedded Solutions’ Capabilities**

SUSE Linux Enterprise Server is widely recognized as a “developer-friendly” operating system that gives developers:

- Access to the tools and resources such as: JeOS, SDK, Kiwi required to maintain the system effectively, seamlessly consume updates, and ensure systems are stable and secure.
- Comprehensive developer training, access to advanced developer tools, and an ever-growing number of development resources to help engineering teams get up to speed faster and stay informed.
- A complete design environment with SUSE Studio™ that includes tools for compiling and debugging, as well as a robust build environment for both scheduled and triggered builds to streamline development and testing.

Learn more: [www.suse.com/support/policy.html](http://www.suse.com/support/policy.html) or [www.suse.com/services/training/](http://www.suse.com/services/training/)

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### SUSE Embedded Solutions Capabilities Against Buying System Criteria

<table>
<thead>
<tr>
<th>Buying Consideration Criteria</th>
<th>SUSE Embedded Solutions’ Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Support</strong></td>
<td>Reap the benefits of having access to the #1 Linux support in the industry(^\text{11}) backing your embedded applications and stay focused on innovation and business solutions that drive growth. Industry-leading support from SUSE helps organizations across a wide range of industries avoid delays in development and engineering to:</td>
</tr>
<tr>
<td></td>
<td>- Respond quickly to bug reports and technical issues so developers don't spend time troubleshooting or waiting for resolution from the broader Open Source community.</td>
</tr>
<tr>
<td></td>
<td>- Reduce verification cycle time, allowing new products to come to market more quickly.</td>
</tr>
<tr>
<td></td>
<td>- Work closely with partners’ internal engineering teams to anticipate and resolve technical challenges.</td>
</tr>
<tr>
<td></td>
<td>SUSE offers 10 years of standard major version product support plus three years of extended support. Minor releases also have the longest long-term support lifecycle of many industries.</td>
</tr>
<tr>
<td>Learn more:</td>
<td><a href="http://www.suse.com/support/">www.suse.com/support/</a></td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td>Powerful, real-time security with full transparency into code fixes, patches, and updates</td>
</tr>
<tr>
<td></td>
<td>Install only what is needed</td>
</tr>
<tr>
<td></td>
<td>Configure what is installed</td>
</tr>
<tr>
<td></td>
<td>Enable and protect what is configured</td>
</tr>
<tr>
<td></td>
<td>Securely run what is enabled</td>
</tr>
<tr>
<td>Learn more:</td>
<td><a href="http://www.suse.com/support/">www.suse.com/support/</a></td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>Stringent security requirements across industry platforms require a secure operating system that meets regulatory standards and Common Criteria, as well as efficient processes for deploying security updates and patches that support devices and other hardware.</td>
</tr>
</tbody>
</table>

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\(^{11}\) [https://suse.lookbookhq.com/suse-embedded-must-reads/top-ten-reasons-for-suse-support](https://suse.lookbookhq.com/suse-embedded-must-reads/top-ten-reasons-for-suse-support)

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[www.suse.com](http://www.suse.com)
A SUSE Embedded solution, based on the SUSE Linux Enterprise code base, offers a meaningful choice of components up and down the software stack to suit the needs of an embedded operating system. Including an enterprise-grade Linux kernel, plus a core of available user-space packages, SUSE Linux Enterprise also provides a significant ecosystem of modules, extensions, and developer tools.

SUSE Embedded solutions deliver secure, flexible, and scalable Linux software and support for organizations seeking an embedded operating system that can be built into fixed-function products. Ideal for manufacturers of devices, hardware, and appliances, SUSE Embedded solutions make it easy to develop, maintain, grow, and manage embedded Linux systems across a wide range of platforms and industries such as high-performance computing, financial services, industrial controls, security, healthcare, and retail.

Embedded system developers will benefit from an optimized system footprint running on SUSE Linux Enterprise Server that provides access to:

- Tools and training that make development and management simple
- Flexible, embedded-specific subscription models that keep costs down, lowering total cost of ownership
- Powerful, real-time security with full transparency into code fixes, patches, and updates
- World-class support from proven Linux experts throughout the product lifecycle
- A dedicated and experienced partner that can maximize the power and flexibility of Linux in order to help organizations succeed

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Buying Consideration Criteria | SUSE Embedded Solutions’ Capabilities
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Development Environment | SUSE Embedded solutions come with tools that enable flexibility such as Studio, KIWI, Open Build Service, and Just Enough Operating System (JeOS) images and build descriptions are available to kickstart embedded solution development creativity. With a SUSE Embedded solution, developers can focus on creating innovative products that are secure and add identifiable business value. SUSE Studio even allows you to build, update, configure, and manage your application images through its powerful web-based tool.
Learn more: [www.suse.com/partners/isv/developer_tools](http://www.suse.com/partners/isv/developer_tools)

Documentation | The SUSE Best Practices are a series of documents that provide reliable technical information not covered with the SUSE product documentation and based on real-life installation and implementation experiences from subject matter experts.
Learn more: [www.suse.com/documentation/](http://www.suse.com/documentation/)

Pricing and Contract Management | Embedded system developers will benefit from an optimized system footprint running on SUSE Linux Enterprise Server that provides flexible embedded-specific subscription models that keep costs down, lowering total cost of ownership.
Using SUSE Linux Enterprise as the foundation, SUSE Embedded solutions are often designed on the premise of JeOS. This means optimized systems can be designed to meet the requirements of a fixed function application or appliance, helping to streamline and target specific functionality with a minimal OS footprint.
Contact us today: [embedded@suse.com](mailto:embedded@suse.com)

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14 [https://susestudio.com](https://susestudio.com)
18 [www.suse.com/support/policy.html](http://www.suse.com/support/policy.html)
Conclusion
As previously stated, not all Linux solutions are created equal. Unpaid and unsupported embedded Linux do not provide developers with the tools, security, support, and documentation that are required to rapidly innovate, manage costs, and improve security.

More embedded system developers are choosing SUSE Embedded solutions to overcome their key development and design challenges. SUSE Embedded solutions are proven and trusted in the marketplace, and enable developers to simplify the development process and bring products to market faster and more securely.

Find out why embedded developers choose SUSE Embedded solutions:

- **Industry-leading support:** [www.suse.com/support/](http://www.suse.com/support/)
- **Flexibility:** [www.suse.com/partners/embedded/](http://www.suse.com/partners/embedded/)

Read the Teradata case study to learn about SUSE Embedded solutions in action at: [www.suse.com/success/stories/teradata.html](http://www.suse.com/success/stories/teradata.html)

Learn more about a SUSE Embedded solution by visiting us at [www.suse.com/embedded/](http://www.suse.com/embedded/) or contacting our technical team at: [embedded@suse.com](mailto:embedded@suse.com)