WNDRVR

REALIZING THE DEVOPS VISION IN EMBEDDED SYSTEMS

ABSTRACT

DevOps and other modern CI/CD practices are being quickly adopted in enterprise software development and are making their way into the embedded world.

Market demands for ever more complex systems and faster development cycles mean that the adoption of more efficient development methodologies is rapidly turning into an absolute imperative for embedded systems companies. Even if you had infinite budget, there aren't enough qualified engineers to get the work done. Using traditional embedded development methods wouldn't allow the sort of gains that you would see by adopting more efficient methodologies.

Wind River® has risen to meet this trend by developing a portfolio of tools that enable the implementation of new DevOps processes. Wind River Linux, VxWorks®, Wind River Helix™ Virtualization Platform, and Wind River Studio all include critical features in their core architectures that facilitate the DevOps and CI/CD workflow, while Wind River Simics® provides the needed system simulation to avoid getting bogged down with test hardware.

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INTRODUCTION

Markets demand ever more complex systems and faster development cycles. Meanwhile, there is a shortage of qualified embedded engineers and developers. Even if infinite budget were available, there simply aren't enough people resources to get the work done when relying on traditional development methods.

This is driving the urgent need for embedded development teams to adopt the agile methodologies that have revolutionized data center development efforts.

The software and tools in the Wind River portfolio enable the implementation of DevOps and CI/CD methods and is made for the specialized needs of embedded systems.

WHAT IS DEVOPS, REALLY?

You've surely heard about DevOps. To keep everyone on the same page, though, it's worth taking a moment to review the definition and discuss what it means for makers of embedded systems. DevOps is the combining of software **dev**elopment, IT **op**erations, and quality assurance (QA), three previously separate workflows and IT groups.

Traditional Methods

Traditionally, software developers wrote code. When they were finished, and the application had been through QA, it would be deployed into production by IT Ops, who arranged for the servers, storage, and other needs to make the code perform as expected in the data center. In embedded systems, the "Ops" half of the equation refers to the people who put the software onto the embedded system and oversee the production of whatever device the software powers.

This model worked well for the "waterfall" method of software development, wherein developers spent relatively long periods of time perfecting the embedded system software before turning it over to Ops. There's nothing wrong with this approach. It's just a little slow.

Traditional development methods are simply too slow for today's competitive embedded market.

Agile Methods

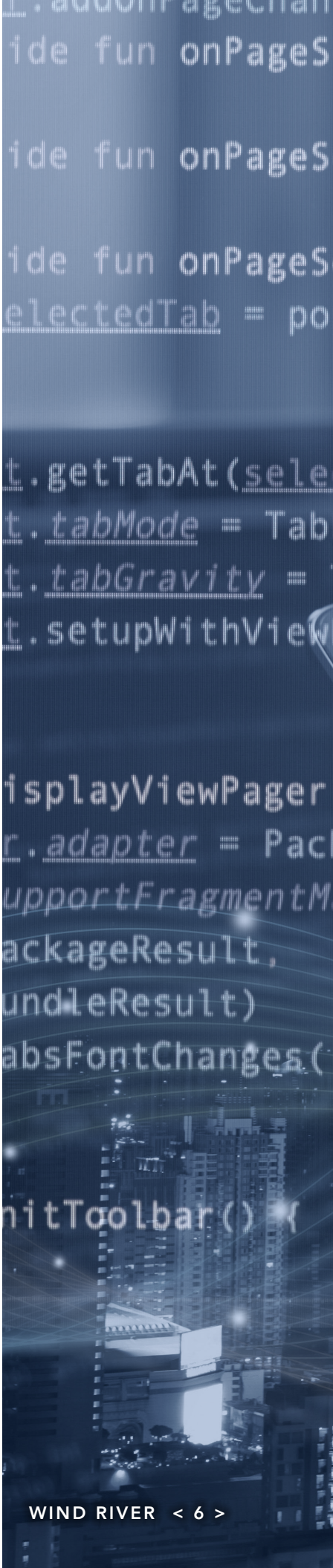
Agile methodologies introduced a new approach to software development. With agile, dev teams work in “scrums” and push out releases at a faster clip than is usual in the waterfall model. What became quickly apparent was that agile teams were creating code so rapidly that it was better to integrate the Ops and QA teams into the development process. They all started to work together under the DevOps banner.

Continuous Integration/Continuous Deployment

Another consequence of DevOps relates to the mechanics of integrating and distributing the new code itself. The pace of code releasing grew so quickly that only automated software could handle it. Plus, many of the code releases were just small updates to existing applications. It made little sense to do a big uninstall/reinstall routine every day (or even every few hours) as new code came out of DevOps teams. To solve this problem, we now have continuous integration (CI) and continuous deployment (CD) of code. CI/CD tools take code and place it right into a production application without stopping any functions from running. This is like the old “change the tire while the car is moving” concept. But here, it works.

Integrated DevSecOps

As DevOps teams got busier, new issues began to emerge. One involved security. Releasing new code every week or even every day creates risk exposure. Developers started to get asked to include security practices in their work. The result is a workflow known as DevSecOps.



DevOps and CI/CD: A Workflow Comprising Separate but Interdependent Toolsets

Turning DevOps and CI/CD theories into practice requires toolsets that, although technically separate, are interdependent to complete CI/CD processes. Figure 1 shows a simplified version of the most common DevOps-to-cloud-CI/CD workflow. Each step in the workflow is supported by a specific type of tool.

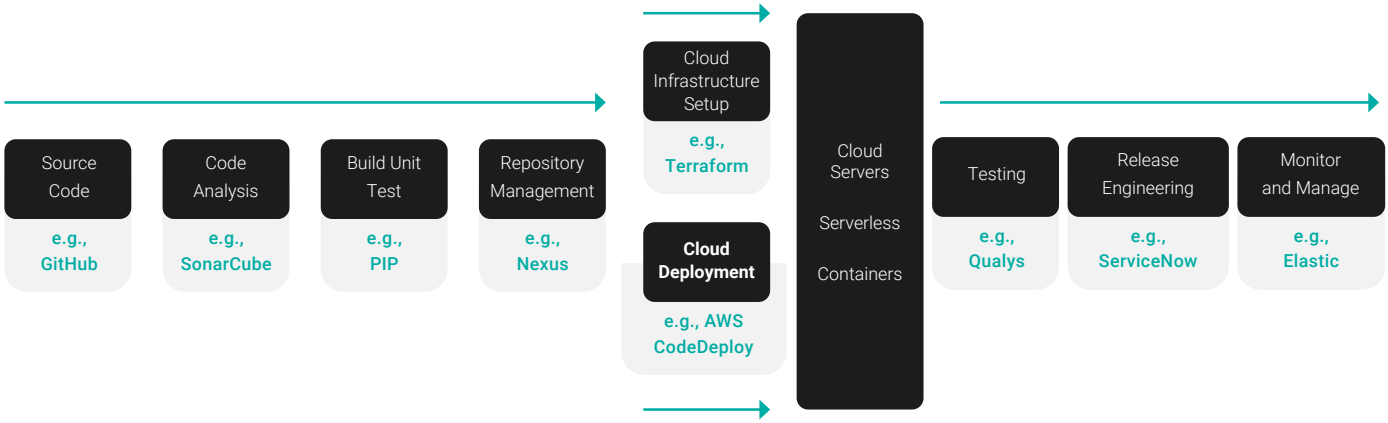


Figure 1. DevOps and CI/CD as a workflow that relies on numerous separate but interdependent toolsets

For DevOps and CI/CD to be successful, developers, testers, security people, and operations teams must be able to collaborate in real time as code moves through this workflow. Their software development tools and cloud platforms must support the tools and workflow in order to make the entire process work. (The examples shown here should not be viewed as authoritative. They merely represent a small sampling from a large pool of DevOps and CI/CD technologies.)

Organizations need ways to effectively integrate portions of the embedded development process to produce better software faster.

THE "CARROTS AND STICKS" PUSHING DEVOPS INTO THE EMBEDDED SYSTEMS WORLD

DevOps is becoming popular with embedded systems makers for a combination of positive and negative reasons — carrots and sticks, if you will. The carrots include the ability to move better products to market faster. Done right, DevOps makes the once sequential Dev, QA, Security, and Ops schedules overlap to some extent — essentially becoming DevSecOps. There are fewer iterations in every cycle, so everything advances more rapidly.

DevSecOps also has the positive effect of enabling high-performance teams. This is not an automatic outcome, but in general, improved communication and collaboration raises team productivity and morale. The end product will typically be of higher quality. This is not guaranteed, but in our experience, when developers, QA, security people, and operations staff work together, they create better products.

CI/CD methods speed up time-to-market, improve collaboration, and produce better products …

but organizations face challenges when trying to implement these new methodologies.

The sticks, factors that are forcing companies to embrace DevOps, are largely related to personnel limitations. Developers who can write good code and who understand embedded systems are hard to find. Many design teams are facing a shortage of developers who understand embedded systems and their role in specific industries, such as aerospace or automotive.

This basic shortage of people is exacerbated by the requirement for developers to have security clearances. DevOps is critical in this context because it enables a small, limited talent pool to produce more software than ever before.

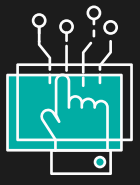
BARRIERS TO THE DEVSECOPS VISION

The primary barriers to the adoption of CI/CD and DevSecOps are:

CULTURE

SECURITY

TOOLSETS



HARDWARE

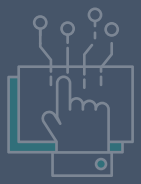
CULTURE

Not every embedded systems company has an easy time making the move to DevOps, even when there is a strong intent to get it going. One issue that comes up is a lack of coordination between groups. Simply declaring that DevOps will be the mode of software development and release is inadequate to get teams to integrate their processes.

Adopting DevOps must be a revolutionary change in management processes. Team members need to be trained on the new methodologies and tools. They need the chance to ask questions and determine how these novel methods will work at their specific organization. DevOps and CI/CD are cultural shifts as much as they are technical and procedural.

Wind River has more experience in agile development in the embedded systems world than any other organization. We pioneered the process for the development of our own products. Our Professional Services team can help your organization make the leap to DevSecOps with best practices for making the most effective use of our cutting-edge development tools.

Effective CI/CD implementation requires a shift in management processes and company culture.



SECURITY

Security can also impede the progress of DevOps. Application security can be challenging, and speeding up the development process doesn't automatically mitigate risk. If anything, it opens up a bigger attack surface area. You need to ensure security throughout the entire embedded development process.

Wind River Professional Services puts security first. We offer an innovative approach by combining extensive security expertise with industry-leading software and solutions. We start with a comprehensive security assessment to determine how to ensure security across the development process.

Our Professional Services team uses the assessment to identify how to assist you with:

- **Design:** Determine and identify potential issues before any code is written.
- **Implementation:** Review and optimize software configurations and settings before testing.
- **Testing:** Make improvement recommendations after the code has been written but before it is deployed in the field.
- **Post-deployment:** Identify continuous improvement opportunities that don't require platform changes once devices are deployed. Some security enhancements can be completed through organizational measures and corresponding controls.

The Wind River Professional Services team brings decades of experience in hardening the security around embedded devices to protect them from cybersecurity threats.

TOOLSETS

Although many data center toolsets already come with DevOps- and CI/CD-friendly functionality, in the embedded world most development is still being done in the traditional waterfall manner. Wind River is leading the way by providing robust agile functionality in every product release and roadmap.

Wind River products now support both the tools and the workflow required for effective DevOps and CI/CD.

We Now Use DevOps and CI/CD for Our Own Releases

Wind River products now enable the full DevOps-CI/CD workflow. To make this successful for our customers, we started with our own dev-test-release processes. (We certainly felt it would be right to use a process we advocated for others.) Today, products such as Wind River Linux, VxWorks, and Helix Platform are produced using our own DevOps environment. We have learned a great deal about the unique needs of these methodologies in the embedded systems context. Our insights into the process have led to an effective DevOps-CI/CD stack, as depicted in Figure 2.

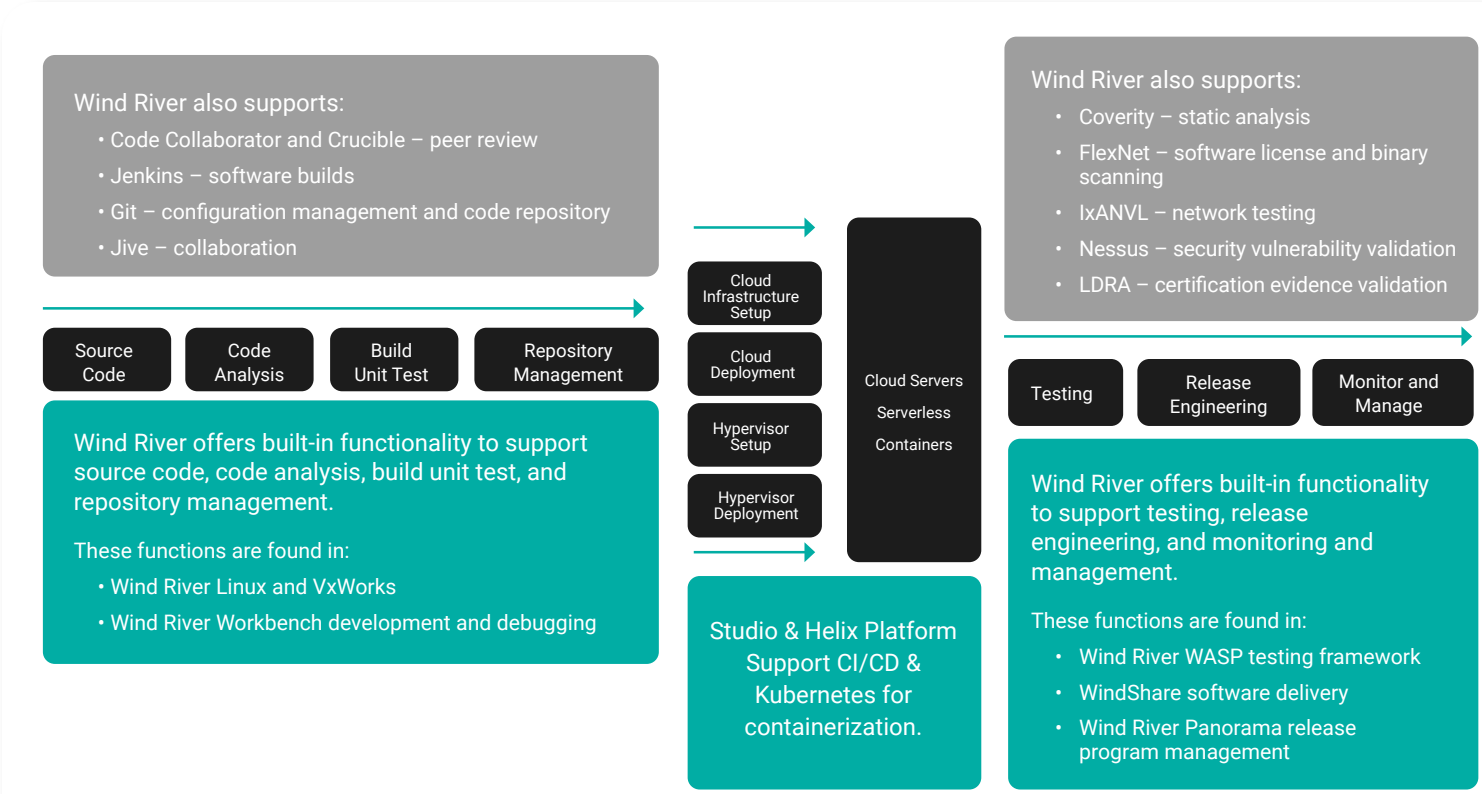


Figure 2. Wind River products either directly offer DevOps and CI/CD functionality or support a range of industry-standard toolsets in each functionality area of the workflow

How Wind River Products Enable DevOps and CI/CD in Embedded Systems

The process of forming the DevOps and CI/CD environment shown in Figure 2 has led Wind River products to provide the DevOps and CI/CD functionality required for the workflow. In addition, the Wind River portfolio supports many of the industry-standard tools for each function.

Wind River Linux and VxWorks

The Wind River commercially supported Linux operating system and accompanying dev-test toolsets enable quick embedded development from prototype to production. VxWorks, the industry's leading real-time operating system (RTOS), offers comparable functionality. They both support the standard functions in the development stage of the DevOps workflow. These include source code creation, code analysis, build and unit test, and repository management. If our customers have their own preferred tools, Linux and VxWorks support such tools as Jive, Git, and Jenkins to allow for additional functionality.

Wind River Linux also supports CI/CD pipeline tools such as OSTree, an upgrade system for Linux-based operating systems, which facilitates deployed capability updates. It performs the kind of atomic upgrades of complete file system trees that are needed to perform CI/CD, i.e., change the tire while the car is moving.

At runtime, both Wind River Linux and VxWorks embody qualities that make them ideal for DevOps and CI/CD in the embedded space. This includes the capability to work with container technology to enable rapid application and microservices development and deployment via embedded systems DevOps.

Abstraction of App Code from the OS

Abstraction of application code from the underlying operating system and hardware stack is an essential factor in making DevOps-CI/CD work. Changes to application code are frequent in DevOps-CI/CD. If there are issues with a new build, it can quickly be rotated out of production and fixed. The OS layer is not so forgiving, especially when changes are occurring in a live production environment. For this reason, VxWorks supports industry-standard abstraction frameworks. This is particularly important in embedded systems that must conform to tightly controlled industry standards. Without this support, it would be nearly impossible to do DevOps for real-time embedded systems. VxWorks support includes:

- **Robot Operating System (ROS2):** Software libraries and tools for creating robotic applications

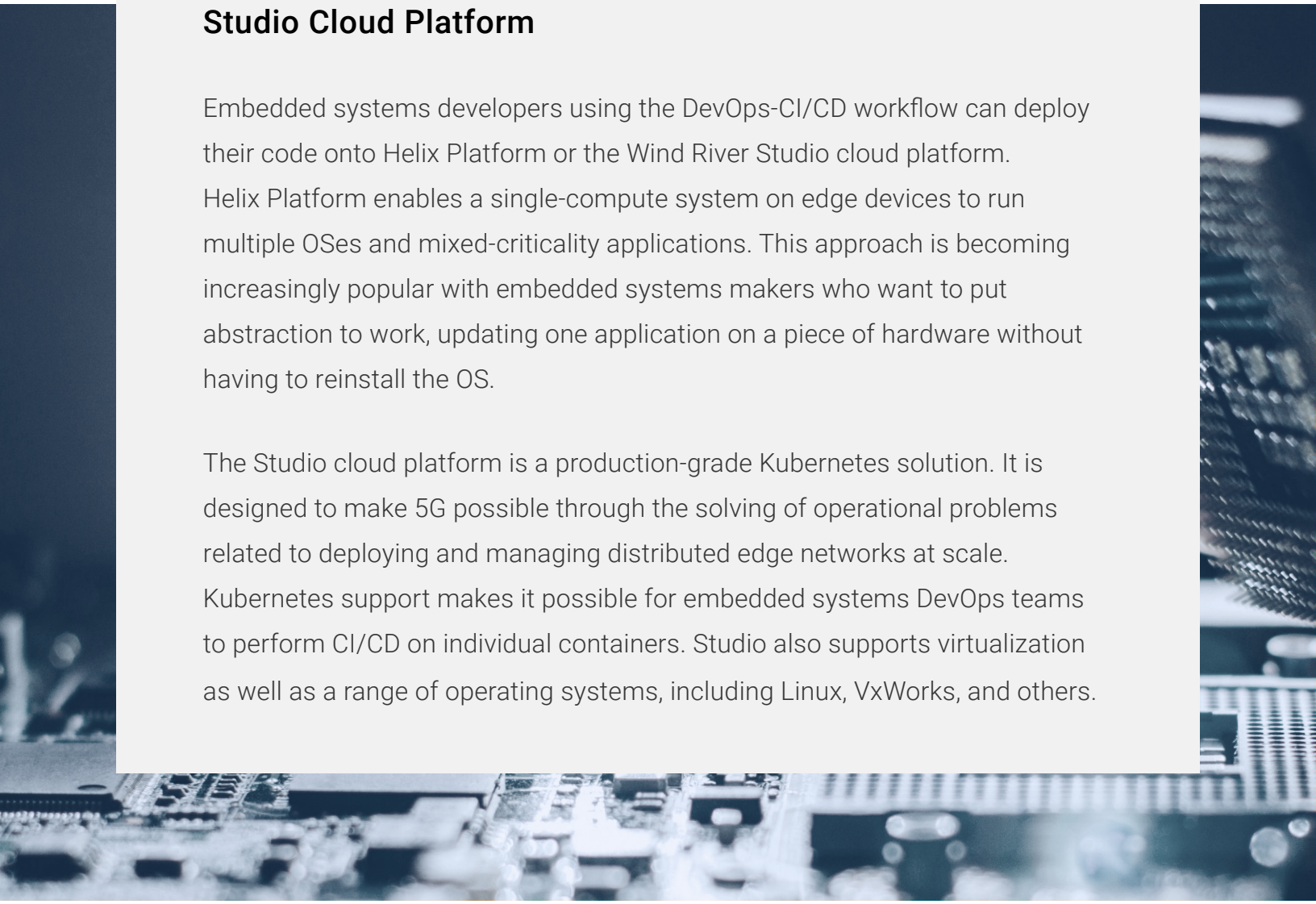
- **Adaptive AUTomotive Open System ARchitecture (AUTOSAR):** A worldwide development partnership of automotive entities that creates an open and standardized software architecture for automotive electronic control units (ECUs)

- **The Open Group's Future Airborne Capability Environment (FACE™) Technical Standard:** An open real-time standard for avionics that makes safety-critical computing operations more robust, interoperable, portable, and secure

Wind River Helix Virtualization Platform and Wind River Studio Cloud Platform

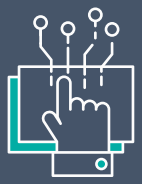
Embedded systems developers using the DevOps-CI/CD workflow can deploy their code onto Helix Platform or the Wind River Studio cloud platform. Helix Platform enables a single-compute system on edge devices to run multiple OSes and mixed-criticality applications. This approach is becoming increasingly popular with embedded systems makers who want to put abstraction to work, updating one application on a piece of hardware without having to reinstall the OS.

The Studio cloud platform is a production-grade Kubernetes solution. It is designed to make 5G possible through the solving of operational problems related to deploying and managing distributed edge networks at scale. Kubernetes support makes it possible for embedded systems DevOps teams to perform CI/CD on individual containers. Studio also supports virtualization as well as a range of operating systems, including Linux, VxWorks, and others.



Testing and Monitoring

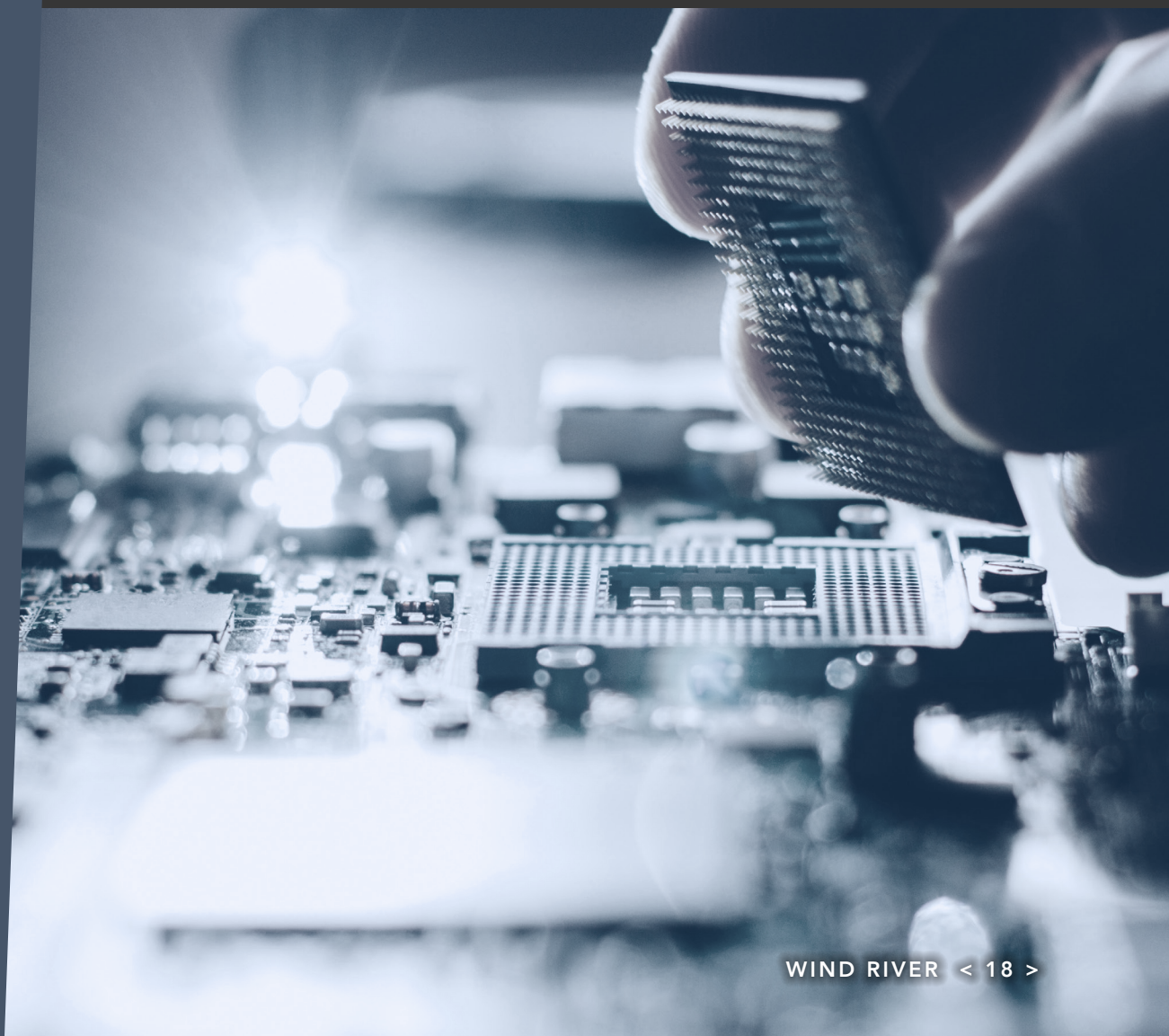
As the DevOps-CI/CD workflow releases code into production, either on Helix Platform or Studio, Wind River tools provide essential functions for testing and monitoring the code. Wind River WASP is a proven testing framework for code entering production. WindShare manages software delivery, while Wind River Panorama facilitates the release program. In addition, Wind River supports industry-standard tools for many of these functions, including Coverity for static analysis, Nessus for security vulnerability scanning, and Achilles for robustness testing.



HARDWARE ACCESS

Hardware can be a barrier too. In traditional development, the dev team had to code for a known piece of target hardware, such as a specific operating system on a familiar processor and circuit board combination. As the overall process accelerates, it gets harder to provide target hardware quickly enough for the DevOps team. Some hardware may be extremely expensive, of limited availability, or not even built yet.

Using the right tools eliminates hardware roadblocks, enabling the development of high-quality embedded products faster.



Wind River Simics

Simics, a full system simulator, solves this problem. Simics' advanced software can replicate the functionality of many kinds of hardware and operating systems. It can also model an array of peripherals, boards, and networks. This technology allows developers and QA teams to code for a piece of hardware they don't have or that may not even exist. For instance, Simics can mimic hardware functions based on the "tape up" of a proposed circuit or board.

Simics enables developers, QA, and Ops teams to model large, interconnected systems. For example, they can show how a piece of software will run on multiple combinations of devices, architectures, and operating systems. Once your developers have created a model of a system in Simics, you can simulate many different operational scenarios, such as deterministic bug re-creation.

These capabilities, paired with built-in collaboration tools, help radically speed up Dev, QA, and Ops processes. The Dev and QA teams don't have to spend time setting up physical development labs, and the Ops teams get an advance look at how the hardware deployment will work. The result is higher-quality code that's easier to support — because it's already been tested in many different potential configurations.

CONCLUSION

DevOps and CI/CD are becoming imperative in embedded systems software development. They provide an answer to the market's demand for the production of increasingly complex systems on accelerated delivery schedules. Even without the market forces, DevOps offers a solution to the industry's serious shortage of skilled, security-cleared developers. The new development and releasing methodologies drive faster time-to-market, support better team cohesion, and result in better code overall.

The Wind River portfolio of software and tools enables DevOps and CI/CD in the embedded systems world. The portfolio adheres to the established DevOps and CI/CD workflow. Wind River Linux, VxWorks, Helix Platform, and Studio offer developers, QA teams, and IT Ops features that facilitate DevOps. They either provide the features needed in the workflow or support industry-standard tools. Simics, with its hardware and complex system simulation, speeds the process up while enabling DevOps for a wide range of hardware.

DevOps and CI/CD represent the future of embedded systems software development. Wind River is at the head of the trend as the provider of operating systems, platforms, and simulation tools.

ABOUT WIND RIVER

Wind River is a global leader in delivering software for the intelligent edge. The company's technology has been powering the safest, most secure devices in the world since 1981 and is found in more than 2 billion products. Wind River offers a comprehensive portfolio supported by world-class global professional services and support and a broad partner ecosystem. Wind River software and expertise are accelerating the digital transformation of critical infrastructure systems that demand the highest levels of safety, security, and reliability.

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