



# A Smart Way to Drive ECU Consolidation

How to Integrate More Functionality onto a Smaller Number of More Efficient ECUs—Without Increasing the Complexity of the Testing Effort

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**WHEN IT MATTERS, IT RUNS ON WIND RIVER**

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## EXECUTIVE SUMMARY

We fall in love with cars because of their hardware—their sleek frames, the growls of their engines, the luxurious amenities within them. But today it is software, not hardware, that truly delivers on the demands of consumers. Software drives the electronic control units (ECUs) that power everything from dashboard instruments to safety features to powertrain components to in-vehicle infotainment (IVI) systems.

But the success of ECUs in delivering state-of-the-art functionality has created a new challenge: The number of these devices in the average car has doubled in the past ten years, and many cars now incorporate more than 125 separate ECUs. These units take up increasing amounts of space; they draw power; and their weight decreases energy efficiency.

Consolidation of ECUs is an obvious solution, but how? How do you deal with the increasing software complexity? How do you consolidate without an explosion of integration issues? How do you avoid a massive new testing effort that could jeopardize time-to-market? And what can you learn from other industries to help answer these questions?

This article summarizes a new approach to ECU consolidation that can tame the complexities with minimal impact to the testing process. It's an approach that can actually accelerate innovation in ECU-based functionality—and drive new competitive advantages for forward-looking auto manufacturers.

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**A CLOSER LOOK AT THE CHALLENGES OF ECU CONSOLIDATION**

The sheer number of ECUs in today’s cars is not the only complication for consolidation. The functions performed by ECUs are also becoming increasingly sophisticated and complex. New features and capabilities such as adaptive cruise control, digital instrument clusters, and car-to-car or car-to-fleet communication are great for consumers, but they add complexity to an already difficult software development and testing process.

Each ECU also has its own infrastructure components (such as power supply, bus, and diagnostics) and its own requirements with regard to functionality, safety, security, and dynamic behavior, requiring the use of multiple platforms and toolsets for development and testing. In addition, ECUs may have differing Automotive Safety Integrity Levels (ASIL) and ISO 26262 requirements.

Selecting from among the array of proprietary and open source development, testing, and management options further complicates matters. How do you test and debug with all these permutations and complex interactions and interdependencies? How do you meet certification requirements in this environment?

Above and beyond the technical intricacies of ECU consolidation, there are business issues to consider. Currently, ECUs are typically purchased as separate items, potentially from separate Tier 1 suppliers. If ECUs are consolidated and combined, who builds them? Who manages the multi-vendor sourcing, integration, and licensing issues? Who is responsible for maintaining and upgrading their functionality? How are faults isolated to an individual function?

No single technology partner can resolve the business challenges of ECU consolidation; but the Wind River® perspective is that a technical solution to consolidation will accelerate the resolution of the business challenges. Therefore we have dedicated our resources to that effort.

We can certainly learn from other markets that have already solved the technical and business challenges. A great example is the aerospace industry, where integrated avionic systems have been launched successfully. The technical solution of consolidation—and the clear definition of roles such as platform provider, application provider, and software integrator—has helped to overcome the business challenges. With its long record of automotive experience, Wind River is in a position to combine the expertise of these markets.

**CONVENTIONAL OPTIONS FOR ECU CONSOLIDATION**

Several approaches to ECU consolidation have been attempted, with mixed success. The most obvious approach (shown below) focuses on software integration: Multiple applications run on a single ECU using a common operating system, such as OSEK or AutoSAR, with communication via a controller area network (CAN) or other standard bus.

However, there are multiple issues with this approach. The integration process itself is difficult and complex; it requires all applications to be optimized for the selected operating system; the memory model may propagate errors without isolating faults; and it dramatically expands the test effort.

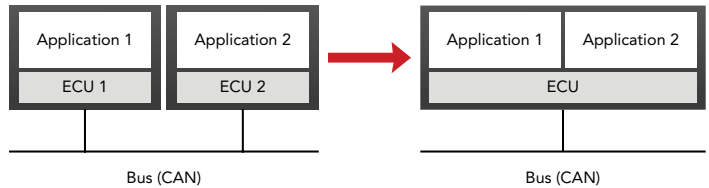


Figure 1: ECU consolidation via software integration

Because of these complications, Wind River and other vendors have worked on a new approach that virtualizes the ECU. A virtualization layer is used to run multiple ECU operating systems simultaneously on a single processor, as shown below.

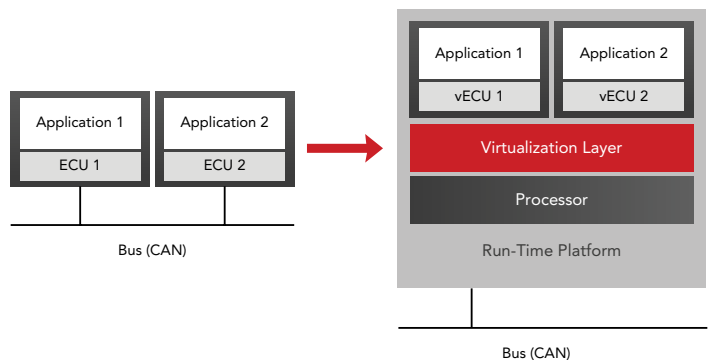


Figure 2: ECU consolidation via virtualization

This virtualization model makes it possible to choose the appropriate solution for each application, and it provides clear fault isolation. The integration effort can be split into teams for higher efficiency. However, it requires an additional integration step, potentially slowing down the process.



## A SMARTER APPROACH: VIRTUALIZED ECU COMBINED WITH MULTI-CORE

More recently, Wind River has been further evolving the virtualized ECU approach by adding multi-core processing capabilities. The basic concept is to centralize compute power into function-oriented regions, decouple software functionality from the underlying hardware using virtualization technology, and deploy virtual ECUs on multi-core processors so there is little interference between them, as shown below.

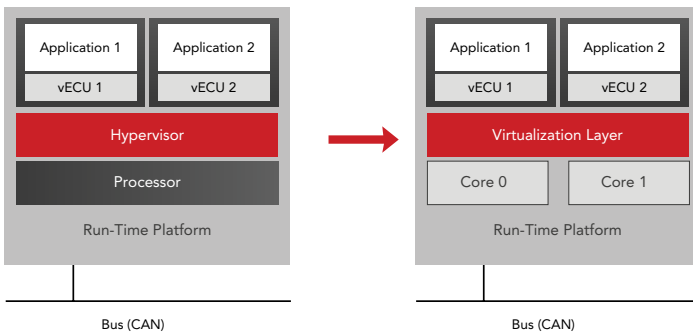


Figure 3: A better option: Virtual ECU + multi-core

This model creates the opportunity to consolidate a large number of software-driven functions onto a smaller number of more powerful hardware platforms. Equally important, it helps solve the separation/latency trade-off dilemma. Each application is “walled off” from the others, but each can still receive configurable, adjustable CPU resources to meet performance requirements.

The virtual ECU/multi-core approach also moves integration to an earlier stage of the project, so development and testing teams can identify bugs and other issues sooner, solve problems faster, and accelerate time-to-market. And legacy software and individual functions can be upgraded or replaced at any time—over the air—eliminating the need to bring the car in for servicing to deal with software issues.

From a security perspective, there are several advantages to the ECU/multi-core approach. First, it fundamentally simplifies threat analysis, because it is possible to build a virtual security appliance into the ECU once, rather than build a separate one for each individual ECU. This approach saves time and money and minimizes the performance impact of security inspection and analysis.

Second, security researchers can use sophisticated simulation tools such as Wind River Simics® to systematically test and gain a deeper understanding of every aspect of system behavior than is possible through traditional methods. Simulation can help create an improved integration and testing environment, and it can also expose flaws in hardware and software design and allow systems to be debugged faster and more effectively.

Third, the Wind River approach makes it possible to combine safe and unsafe functions without increasing risk to other software elements or impacting compliance.

## CONCLUSION

ECU consolidation has been a goal of automakers for years. It's time to turn the vision into reality. The approach outlined in this brief article is based on mature technology, it has been proven in real-world implementations, and it is financially practical. Business leaders in the automotive industry can now have their development, testing, and security teams take a closer look at the underlying technology of this new approach—and take a closer look at the possibilities for improving the efficiency of new automobiles, the safety and security of future automobiles, the satisfaction and brand loyalty of consumers, and the bottom-line profitability of the business.

For more information about ECU consolidation, visit our website at <http://www.windriver.com/solutions/automotive>.

