Wind River® is the market-leading ARINC 653 solutions provider with good financial health, technical capability, a strong ecosystem, support of open standards and architectures, and a proven commercial off-the-shelf (COTS) certification strategy. We believe customers should make informed decisions when selecting vendors.

There are four main groups of questions and answers in this document:

- Questions and answers about corporate/company health
- Questions and answers about the ARINC 653 development environment
- Questions and answers about the ARINC 653 operating environment
- Questions and answers about certification issues

QUESTIONS AND ANSWERS ABOUT CORPORATE/COMPANY HEALTH

Q1. How financially stable is your company? Are your books publicly available?
A1. Wind River, a wholly owned subsidiary of Intel® Corporation (NASDAQ: INTC), is a world leader in embedded software for intelligent connected systems. The company has been pioneering computing inside embedded devices since 1981, and its technology is now found in nearly 2 billion products.

In the fiscal year ending in 2013, Wind River parent company Intel reported a total revenue of $52.7B, and net income of $9.6B.

Q2. How many engineers are available to support your development effort?
A2. Wind River has more than 1,800 employees worldwide, including 170 support engineers, 200 professional services engineers, and over 450 development engineers.

Q3. How many active aerospace and defense customers do you have?
A3. Wind River has more than 600 active A&D customers, including fundamental design wins with Airbus A350, Airbus A400M, Airbus MRTT, Boeing 787 Dreamliner, Boeing P8-MMA, Lockheed Martin F-22 and F-35, and Northrop Grumman X-47B UCAS-D. Many of these projects are deploying both federated (VxWorks®) and Integrated Modular Avionics (IMA/VxWorks 653/VxWorks MILS) platforms.

Wind River has over 175 VxWorks 653 customers, encompassing hundreds of developers using VxWorks 653 in over 325 programs on over 70 aircraft. Wind River leads the global market for IMA and ARINC 653 platforms.
QUESTIONS AND ANSWERS ABOUT THE ARINC 653 DEVELOPMENT ENVIRONMENT

Q4. What operating systems does your development environment support?
A4. The Wind River Workbench development environment is based on Eclipse, the open environment supported by Eclipse Strategic Members Hewlett Packard, IBM, Intel, Wind River, and others (see www.eclipse.org). Workbench supports Android, Wind River Hypervisor, Wind River Linux/Linux Secure, VxWorks 5, VxWorks 6, VxWorks 7, VxWorks 653, and VxWorks MILS. In addition, our Workbench product can support other third-party partner tools, enabling a wide range of integrated development solutions on a common, open platform.

Q5. What other industry tools are available for your development environment?
A5. The Workbench development environment has the largest array of tools available in the embedded industry. In addition, the Wind River partner ecosystem offers the widest range of Workbench and Eclipse plugin tools—from requirements and design to test, integration, and management—enabling a broad spectrum of tool interoperability.

Q6. How easily can my own tools plug into your environment?
A6. The Eclipse foundation of Workbench allows for the integration of any in-house or commercial tool, along with any operating system environment. This capacity to plug in any tool, regardless of ownership or pedigree, enables developers to use Workbench with a wide array of device software products.

Q7. Does your development environment have an open, public interface?
A7. The Wind River Eclipse environment has an open interface for plugging any device software or enterprise tool into this powerful framework. Note that most device software and enterprise tool vendors already have created Eclipse plugins for their products.

Q8. Do you have a host-based simulator for your ARINC 653 product?
A8. Yes. Wind River supplies its proven Wind River VxWorks Simulator for rapid test of development ARINC 653 software and XML load modules on host-based systems. This capability is unique—most simulators in the industry only support flat memory model execution environments with static configurations, or very slow instruction set simulators for singular software modules.

Q9. Do you have a system-level simulator for your ARINC 653 product?
A9. Yes. Wind River Simics® is a full system simulator used by software developers to simulate any target hardware, from a single board computer to a large, complex avionics system containing multiple cores, processors and/or boards. Simics enables Agile development methods for avionics projects by enabling software development and system integration even before physical hardware is available. Simics is also used for developing and debugging requirements-based and structural-based tests for avionics systems. By putting a virtual hardware system on every engineer's and tester’s desk, Simics improves productivity by providing target hardware for everyone.
Q10. What are my language and compiler choices? Can I use C/C++/Ada/Ada 95/Ada 2005/Ada 2012?

A10. Yes. Wind River VxWorks 653 Platform enables the use of either C or C++ compilers from Wind River or our C compiler partners, and supports the GNU C compiler by default for application development. Robust Ada and Ada 95 language support is supplied by our Ada partners (AdaCore and Atego) and is fully integrated with our Workbench debug and development environment. AdaCore also delivers an Ada 2012 product that is integrated with Workbench. Atego and aicas also supply Java run-times for our VxWorks environment.

VxWorks 653 now includes a C++ Subset Definition that can be used for DO-178C certification efforts. This subset excludes C++ features that can cause non-determinism, like pure virtual functions, run-time type information (RTTI), C++ exceptions, the delete operator, and garbage collection.

Q11. Is a JTAG target connection supported?

A11. Yes, JTAG connections are fully supported with VxWorks 653 Platform. This connection eliminates the need for expensive debug ports on airborne hardware platforms and therefore reduces complexity and DO-178C certification costs on airborne systems. VxWorks 653 users can now test, validate, and debug complex single partitioned environments without the need for connection target monitors, added instrumentation, or network communications.

Q12. Do you support advanced multiplexed input and output (AMIO)?

A12. Yes. AMIO is a feature of VxWorks 653 that allows the multiplexing and de-multiplexing of data channels from different partitions into a single channel, enabling different partitions in the ARINC 653 system to share a single serial port in a partition-safe manner. AMIO enables advanced communication capabilities that greatly enhance debugging ARINC 653 applications without adding additional hardware or instrumentation.

Q13. Which VxWorks 653 product tools are qualified as development tools under DO-178B/DO-330 (or FAA 8110.49, Chapter 9 under DO-178B)?

A13. To address the challenge of loading new and updated software modules without affecting the certification of the entire ARINC 653 system, Wind River supplies a qualified XML compiler that translates the platform, core OS, partition OS, and health management XML configuration data into binary run-time data (no run-time translation or compilation required). This tool removes significant risk when qualifying your ARINC 653 system for certification and updating platforms with new software loads. This tool is qualified as a development tool under DO-178B and as a TQL-1 tool under RTCA DO-330.
QUESTIONS AND ANSWERS ABOUT THE ARINC 653 OPERATING ENVIRONMENT

Q14. What percentage of the ARINC 653 API Part 1 Supplement 3 is implemented and tested?

A14. VxWorks 653 is 100% conformant to ARINC 653 Part 1 Supplement 3.

Furthermore, Wind River has contracted with a third-party testing firm to independently test ARINC 653 compliance based on ARINC 653, Part 3.

Q15. What percentage of the ARINC 653 API has supporting certification artifacts?

A15. Wind River delivers DO-178C Level A certification evidence for 100% of the ARINC 653 API with its VxWorks 653 Certification Evidence product. This product also includes all required certification documentation for the DO-178C DAL A qualified development and verification tools that are part of the product.

Q16. Do you have a full implementation of the ARINC 653 Health Monitor? Which functions must I complete in the BSP? Which functions need to be created with my applications?

A16. Wind River has implemented 100% of the ARINC 653 Health Monitor (HM) capabilities. This is a complete, independent implementation of the HM, with zero capabilities left for the user to implement in the BSP. This enables a clean implementation of HM solutions, where changes in the HM configuration do not affect the rest of the system. Standard HM modules are supplied in the VxWorks 653 product. However, if the user requires specific functionality for any health monitoring event, then this capability may be added by reference in the HM configuration tables.

All Health Monitor capabilities can be easily configured using XML.

Q17. What happens when a failure occurs? Is a partition restarting the only alternative?

A17. The VxWorks 653 Health Monitor enables three levels of failure management: process, partition, and module (core OS). The health management framework is hierarchical, where errors that cannot be handled at the level where they occur are propagated up to the next level. The configuration of the VxWorks 653 HM is easily configured by the system integrator using our XML table editor, which feeds our DO-178C/DO-330 TQL-1 qualified XML compiler.

Q18. How many customers use your ARINC 653 product?

A18. VxWorks 653 is the ARINC 653 industry standard, used on over 325 projects on over 70 aircraft. Wind River has more than 600 A&D customers in more than 33 countries worldwide.
Q19. What large applications and projects does your ARINC 653 product support?
A19. We support the most challenging ARINC 653 environments in the world. The most ambitious VxWorks 653 deployment to date is the Boeing 787 Dreamliner, which uses the Wind River VxWorks 653 (ARINC 653) operating system as the sole OS component in its Common Core System, delivered by Tier 1 supplier GE Aviation, and certified to DO-178B Level A in 2011. In this deployment, VxWorks 653 supports more than 70 hosted functions provided by more than 15 suppliers. VxWorks is also a key component in almost every other modern aircraft, including Airbus A350, Airbus A400M, Airbus MRTT, Airbus Helicopter EC-225, Boeing 767 Tanker, Boeing C-130 AMP, Gripen, Lockheed Martin F-22, Lockheed Martin F-35, and Northrop Grumman X-47B UCAS-D.

Q20. Does your ARINC 653 solution support the Future Airborne Capability Environment (FACE™)?
A20. VxWorks 653 2.5 supports the FACE Minimum Safety Profile (and by definition, the Security Profile POSIX APIs).

We expect to certify VxWorks 653 with FACE conformance shortly after the release of both the FACE conformance infrastructure and our next VxWorks 653 product releases.

Q21. Can your ARINC 653 operating system support multiple DO-178C (or other safety specification) safety levels on a single instance of silicon?
A21. Yes. VxWorks 653 supports multiple safety levels of applications executing simultaneously on a single microprocessor, from DO-178C Level A through Level D/E.

Q22. Which OS APIs are available for my ARINC 653 environment? ARINC 653? POSIX? VxWorks? FACE?
A22. The Wind River VxWorks 653 product supports mixed, simultaneous partition OS environments, including a pure ARINC 653 partition OS API, a VxWorks API (200+ system calls), a subset of POSIX system calls, and, in late 2014, the FACE Technical Reference Minimum Safety Profile. VxWorks 653 also can support proprietary and in-house operating systems inside our user partitions.

Q23. Do you support shared libraries?
A23. Yes. VxWorks 653 supports shared libraries and other technologies to optimize memory access performance while maintaining robust memory management unit (MMU)-based hardware partitioning.

Q24. Which processors are supported with VxWorks 653?
A24. VxWorks 653 currently supports a wide range of processors from Intel and Freescale. Wind River has early-access prototypes available for the ARM® architecture.
Q25. Do you support independent build, independent link, independent load (IBLL)? Can I rebuild my applications separately?

A25. Yes. This is a key capability of VxWorks 653 and a key requirement of any Integrated Modular Avionics (IMA) environment that needs to support multiple application groups or third-party hosted function suppliers, delivering software builds asynchronously.

VxWorks 653 Platform fully supports IBLL. Independent build means that one does not need the entire source code of the system to build one piece of the system, and that there is no longer the demand to create a “system” project that builds all software modules in the system. Independent link means that one does not need the OS binaries to link an application, and independent load enables the loading, updating, or flashing of binaries to be done separately.

Why is IBLL important? IBLL is a modular and flexible capability that is easily adapted to customer environments. This build/link/load independence reduces the scope and impact of change, accelerates software updates and maintenance, and makes it easier for multiple suppliers to work together.

Q26. Can I alter the XML configuration of one application in one partition without testing the entire platform? What tools are available to enable this capability?

A26. Yes. This is a fundamental capability of VxWorks 653.

We supply a DO-178C/DO-330 TQL-1 qualified XML compiler that enables the reconfiguration and reinsertion of new or updated applications that limit the impact of this update solely to those partitions affected by the software under change. This qualified compiler, along with VxWorks 653 IBLL capabilities, drastically reduces the costs of maintenance, support, and deployment.

ARINC 653 vendors that do not have a robust, proven, and tested strategy for changing system configurations and hosted function software loads will cause a fundamental increase in support costs for an IMA system, for they must re-certify the entire platform when any change is made to any application or operating system module. Note that ARINC 653 XML configuration data on a complex platform can well exceed 300,000 lines of code.

Q27. Do you support RTCA DO-297 and EUROCAE ED-124?

A27. VxWorks 653 Platform has full compliance with DO-297, defining and separating the roles of system integrator, platform provider, and each application/hosted function supplier on a complex IMA project. This is essential to minimize the impact of XML configuration changes, protect the intellectual property (IP) of hosted function suppliers, and enable teams to work asynchronously and independently when building multi-vendor ARINC 653 IMA systems.
Q28. How can I change the Health Monitor characteristics without retesting the entire platform?
A28. The VxWorks 653 three-tiered hierarchical HM system can easily be reconfigured by the system integrator, who can change the XML tables using an XML table editor supplied with the product. These changes are then converted into executable binaries using the DO-178C/DO-330 TQL-1 qualified XML compiler. These binaries are then loaded on the ARINC 653 target environment, where only the applications impacted by this change will need to be tested.

Q29. How can I change the port configuration of a partition without retesting the entire platform?
A29. Changing the port configuration in a VxWorks 653 target is easily accomplished by changing the XML configuration data for a particular port and the XML connection table, which describes how the ports are interconnected. This change will then be input into our DO-330 TQL-1 qualified XML compiler for generating revised binaries for system load. At the application level, the application developer must make port change adjustments to the application code, but no system-level code needs modification.

Q30. Do I configure the system using a C include file or an XML file?
A30. All system configuration data is performed using XML and deployed using our DO-178C/DO-330 TQL-1 qualified XML compiler. Note that if other vendors require a change in a C include file for their ARINC 653 OS, this will force a retest of the entire operating system and application environment, adding significant testing costs and deployment delays to every configuration update.

Q31. How do I test the configuration data in my include file or XML data?
A31. With VxWorks 653, there is no configuration data in any include file, and all XML data does not need to be tested in its entirety by the user. This qualified tool strategy enables our commercial-grade ARINC 653 environment to save users significant testing costs, and also accelerates time-to-market and deployment.

Q32. How do I monitor the performance of my applications?
A32. Wind River includes verification tools that monitor ARINC port utilization and traffic, CPU execution time, and memory utilization inside the user partitions. These tools include a tiny monitor, which gets deployed with the system and incurs the same amount of execution time whether the monitor is enabled or disabled (in order not to affect timing or execution of software during test).
Q33. What are the implications of removing the tools used in monitoring and verifying my ARINC 653 system?

A33. There are no certification or performance implications. Our VxWorks 653 performance monitoring tool requires only a small monitor, which gets deployed with the system and incurs the same amount of execution time whether the monitor is enabled or disabled (in order not to affect timing or execution of software during test). Therefore, removing the tools from the system will not affect the execution of the platform and hosted function supplier software.

Q34. What kind of communication ports do you support?

A34. For a wide choice in application designs, VxWorks 653 supports four types of communication ports:

- Local Ports: Buffered, 1-to-many, memory-based inter-partition communication ports
- Pseudo Ports: Buffered, 1-to-many, transport-based inter-partition communication ports, enabling the use of AFDX or other physical transport/network system
- Direct Access Ports: Fast, unbuffered, 1-to-1, transport-based inter-partition communication ports
- Partition Pseudo Ports: Fast, unbuffered, 1-to-1, direct access communications ports based upon a user-mode driver

Q35. Do you have a network stack available with complete DO-178C certification evidence?

A35. Yes. VxWorks 653 has a network stack that can be used for both debugging systems and deployment environments.

Q36. Do you have a file system available with complete DO-178C certification evidence?

A36. Yes. A power-fail-safe transactional file system is available on the latest version of VxWorks 653.

Q37. Do you have certified graphics design solutions for your ARINC 653 product?

A37. Yes. VxWorks 653 has integrated design solutions from partners Esterel Technologies (SCADE) and Presagis (VAPS).

Q38. Do you have certified OpenGL drivers for your ARINC 653 product?

A38. Yes. VxWorks 653 has certified OpenGL graphics drivers from both CoreAVI and Presagis.

Q39. How can I transition my ARINC 653 environment into a multilevel secure (MLS) or Common Criteria certified environment?

A39. The robust time and space partitioning that is the foundation of VxWorks 653, along with the XML configuration of this partitioning, can be easily migrated into a Multiple Independent Levels of Security (MILS) environment supported by Wind River VxWorks MILS platform. This will enable a common platform that can support both RTCA DO-178C and Common Criteria EAL6+ with robust partitioning for safety and security.
Q40. How can I transition my ARINC 653 environment into a FACE platform?
A40. The FACE Technical Reference builds upon both the ARINC 653 standard (managed by ARINC (www.arinc.com)) and the POSIX specification (managed by the Open Group (www.opengroup.org)). ARINC 653 applications should migrate easily to FACE platforms.

QUESTIONS AND ANSWERS ABOUT CERTIFICATION ARTIFACTS AND DOCUMENTATION

Q41. What certification evidence is available for your ARINC 653 environment?
A41. Wind River VxWorks 653 certification evidence leads the industry in both quality and depth. Unlike most certification packages, which only supply the approximately 25 documents required by DO-178C, the VxWorks 653 certification evidence includes all documents related to the DO-178 verification activities as well as source code build files and test cases/results of the entire VxWorks 653 product—more than 70,000 hyperlinked files on a single DVD. Our requirements are some of the most complete in the industry, with an average of one requirement for every 5–10 lines of C code.

Q42. Does Wind River prepare the certification evidence using its own processes, or is it prepared externally?
A42. Wind River now relies on an organic DO-178 software development process to build and create its safety critical products. In some cases, we rely on independent testing of DO-178C certification products to ensure the highest quality and robustness. When all verification and review activities are successfully completed, Verocel, an independent certification service firm, generates our VxWorks 653 Certification Evidence DVD. This DVD contains all requirements, design, test, tool qualification, and review documents, along with complete source code and build environment.

Q43. What is the form of this certification evidence?
A43. All VxWorks 653 certification evidence is delivered on a DVD independently created by an external certification firm, Verocel. These documents are hyperlinked for ease of certification audit review and requirements traces. The package contents include an OS Certification Evidence DVD and a Tools Qualification Evidence DVD. There are currently more than 70,000 hyperlinked support files on the Wind River VxWorks 653 Certification Evidence DVD.

Q44. Who has used this certification evidence successfully to certify a Level A system?
A44. Multiple avionics systems programs have reviewed the Wind River VxWorks certification evidence, including the Boeing 787, where the package was certified to DO-178B Level A as part of the Common Core System provided by GE Aviation.
Q45. Can this evidence be used in the United States?
A45. Yes. The VxWorks 653 certification evidence was prepared using DO-178C Level A guidelines, and it can be used in any avionics certification project in the United States under any FAA or military guidelines.

Q46. Can this evidence be used in Canada?
A46. Yes. The Wind River VxWorks 653 DO-178C Level A certification evidence is ready for presentation to any Transport Canada certification official.

Q47. Can this evidence be used in the European Union?
A47. Yes. The VxWorks 653 certification evidence was prepared under ED-12B and DO-178C guidelines, and it is ready to be used in any avionics project in the European Union or under EASA guidelines.

Q48. Is the evidence a standard product or a custom service?
A48. The Wind River VxWorks 653 DO-178C certification evidence is available as a standard product. Our VxWorks 653 customers plan to use this product in over 200 avionics programs worldwide. This is a COTS product, which enables Wind River to amortize the cost of creating this extensive set of evidence over multiple programs. This saves our VxWorks 653 customers millions of dollars in product and maintenance investment, and enables a more rapid review of the common set of certification evidence.

Q49. Can the certification evidence be used in certification efforts in other industries with differing certification standards?
A49. Yes. The VxWorks 653 evidence can be used in certification efforts in other industries, including automotive, industrial control, medical, military, and nuclear environments. The Wind River certification team can assist with using this data for other certification standards by creating document maps between DO-178C and other certification requirements.

Q50. Can the certification evidence be used in Reusable Software Component (RSC) environments?
A50. Yes. The design of our VxWorks 653 product and all the related VxWorks 653 certification evidence can be used immediately in projects with RSC requirements. VxWorks 653 comes with additional documentation that supports RSC objectives, including an integration guide for certification evidence, a BSP interface document, a partitioning analysis, and a software vulnerability analysis.

For more information on Wind River VxWorks 653 Platform, visit www.windriver.com/products/platforms/safety_critical_arinc_653/.