Wind River
Aerospace and Defence
COTS Products

Alex Wilson
Senior Program Manager
Aerospace and Defence
<table>
<thead>
<tr>
<th>Market share leader</th>
<th>$360M in revenue (FY’09)</th>
<th>$132M in deferred revenue (FY’09)</th>
<th>$84M in research and development (FY’09)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30+% of commercial market</td>
<td>9% increase year-over-year</td>
<td>30% from A&amp;D</td>
<td></td>
</tr>
<tr>
<td>$169M in cash, cash equivalents and investments (FY’09)</td>
<td>1,673 employees (as of Jan 31, 2009)</td>
<td>42,000+ developers in over 800 A&amp;D customers</td>
<td>500 million deployed devices</td>
</tr>
</tbody>
</table>
Key Aerospace & Defense Device Issues

**Increasing Functionality**
- Performance, Size, and Cost
- Mixed Control and HMI Requirements
- Platform-Specific Capabilities
- Acceptance / Certification Needs

**Increasing Connectivity**
- Global Information Grid (GIG)
- SDR / JTRS / Waveforms
- Commercial Comm (IPTV, VoIP, VoD)
- Wireless (Wi-Fi & 3G/4G)

**Business Constraints**
- Time-to-Market Constraints
- Reduced program funding
- Reduced headcount
- Government cost cutting
- Competitive Pressures
- Build versus Buy – COTS
- Higher functionality, availability
- Quality / reliability improvements

**Higher Safety and Security**
- DO-178B / ED-12B Certification
- CC EAL 4+/6+ Certification
- Information Assurance
- Application Partitioning
- Intrusion Protection
- Multilevel Secure (MLS)
- Multi-OS Hypervisor systems

**Platform Integration**
- ARINC 653 and MILS partitioning
- SMP – Symmetric multiprocessing
- AMP – Asymmetric multiprocessing
- Virtualization

**Integrated Partitioning / Multicore**
- Platform and hardware consolidation
- Smaller, lighter and stealthier systems
- Integrated multi-vendor platforms

**Safe & Secure**

**Reduced Space, Weight, Power (SWaP)**
- Platform and hardware consolidation
- Smaller, lighter and stealthier systems
- Integrated multi-vendor platforms

**Space, Weight, and Power**
Wind River On-Chip Debugging

Wind River PROBE
- 100 Mhz JTAG Clock
- USB 1.x and 2.0 Compliant
- Autovoltage
- Bus Powered

Wind River ICE
- 20 Mhz JTAG Clock
- Multicore
- Multisession

Wind River Trace
- High-speed real-time trace buffer (up to 200 MHz)
- Filtered trace
- Modular hardware design
- Graphical User Interface
- Target versatility
- Ability to capture up to one million lines of code
- 200 MHz Trace Speed
Federated and Integrated Modular Avionics (IMA)
Federated Avionics Systems

Flight Controls
Flight Management
Inertial Reference System

Displays
Navigation Computer
Mission Computer

Engine Controls
Engine Monitoring
Fire Control

Weapons Control
Stores Management
Targeting Computer

Radar
Sensor Systems
FLIR

© 2010 Wind River. All Rights Reserved.
Integrated Modular Avionics (IMA)

Flight Controls
Flight Management
Inertial Reference System

Displays
Navigation Computer
Mission Computer

Engine Controls
Engine Monitoring
Fire Control

Weapons Control
Stores Management
Targeting Computer

Radar
Sensor Systems
FLIR
Federated Systems
Wind River VxWorks DO-178B Platform

Wind River Workbench 3.1
- Eclipse framework
- C, Ada*, Java*
- Wind River GNU Compiler 4.1.2
- Wind River Compiler 5.6.0
- VxWorks Simulator
- Uncertified projects
  - All Workbench tools
  - Certified projects with WDB
    - WDB agent-based debugging
    - Host shell (subset)
    - On-chip debugging
    - Source-code browsing; other editor capabilities
  - Certified projects without WDB
    - On-chip debugging
    - Editor capabilities
- Host OS support
  - Windows XP Professional, Windows Vista (Business and Enterprise)
  - Solaris 9, 10
  - Red Hat Enterprise Linux Workstation 4, 5; Fedora 9
  - OpenSUSE Linux 10.2, 11
*Partner integration

Partner Support
- Ada run-time (AdaCore, Aonix)
- Java VM (Aicas, Aonix)
- OpenGL (Presagis)
- SCADE Suite (Esterel)
- VAPS (Presagis)
- Other VxWorks 6 partners

VxWorks 6.6
- Standard VxWorks 6.6
- VxWorks 6.6 for DO-178B and VxWorks 6.6 for IEC 61508
  - Cert API subset
  - No RTP, SMP, VxBus, or TrueFFS
  - Network stack optional
    - IPv4/UDP/TCP stack with multicast

Hardware Support
- MPC8349E
- MPC7447 (CW SVME/DME-183)
- Intel Core 2 (IDP945)
Federated based on VxWorks

Flight Control (FC) Application
Level A
VxWorks
BSP
Hardware

Radar Application
Level B
VxWorks
BSP
Hardware

Graphics Generator Application
Level C
VxWorks
BSP
Hardware

Display Application
Level D
VxWorks
BSP
Hardware

Avionics Bus (MIL STD 1553, ARINC 429, TTEthernet...)

© 2010 Wind River. All Rights Reserved.
ARINC 653 for Integrated Modular Avionics

- Industry specification for Integrated Modular Avionics (IMA)
- Includes API of approximately 55 routines
  - Time and space partitioning
  - Inter- and intra-partition communications (IPC)
  - Health monitoring (error detection and reporting)
- ARINC 653 OSes and applications are typically certified to DO-178B
## Federated vs. Integrated Modular Avionics

<table>
<thead>
<tr>
<th><strong>Federated</strong></th>
<th><strong>IMA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Advantages</strong></td>
</tr>
</tbody>
</table>
| ▪ Independence of design and certification | ▪ Lower SWaP requirements  
  - Multiple functions on single LRU |
| ▪ Well-understood methodology | ▪ Better software reuse, refresh |
| ▪ Established supply chain | ▪ Better portability, modularity |
| **Challenges** | **Challenges** |
| ▪ Greater space, weight, and power (SWaP) requirements  
  - Each function is separate LRU | ▪ More efficient platform certification |
| ▪ Less software reuse | ▪ Greater complexity of system integration |
| ▪ Less portability, less modularity | ▪ Greater complexity of design and certification |
| ▪ Cannot scale into larger platforms | ▪ Less experienced supply chain |

**Diagram**
- **Federated**  
  - Radar  
  - Flight Control  
  - Graphics  
  - ARINC 429
- **IMA**  
  - Flight Control  
  - Radar  
  - Graphics  
  - Time and Space Partitioning  
  - ARINC 653 Operating System

© 2010 Wind River. All Rights Reserved.
ARINC 653 Systems Architecture

- User Mode
  - Application 1
  - ARINC 653 Partition OS
  - ARINC 653 Application Executive
  - Partition Scheduler
  - Architecture Support and Drivers

- Kernel Mode
  - Hardware

© 2010 Wind River. All Rights Reserved.
ARINC 653 Challenges

1. Host Debug Tools
2. Performance
3. Supplier Independence and DO-297
4. Health Monitor
5. Certification
6. Middleware XML Configuration
7. XML Test and Qualification
8. XML Certification
9. Application code migration
10. Target debug tools
11. Target application performance and state capture
12. Certification of partition applications
13. Proving partition and platform multi-level robustness
14. Platform Robustness - multi-level DO-178B certification on single platform
15. Multiple Vendor Integration on single platform

See VxWorks 653 Technical presentation for details
Wind River COTS Certification Evidence
## Required DO-178B Documentation

<table>
<thead>
<tr>
<th>Plan for Software Aspects of Certification (PSAC)</th>
<th>Software Test Plan (STP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Development Plan (SDP)</td>
<td>Software Unit Test Procedure</td>
</tr>
<tr>
<td>Software Verification / Test Plan (SVP)</td>
<td>Software Unit Test Plan</td>
</tr>
<tr>
<td>Software Code Standards</td>
<td>Software Unit Test Report</td>
</tr>
<tr>
<td>Software Requirements Standards</td>
<td>Software Integration Test Procedure</td>
</tr>
<tr>
<td>Software Design Standards</td>
<td>Software Integration Test Plan</td>
</tr>
<tr>
<td>Software Change History</td>
<td>Software Integration Test Report</td>
</tr>
<tr>
<td>Software Problem Report History</td>
<td>Source Code</td>
</tr>
<tr>
<td>Software Quality Assurance (SQA) Data</td>
<td>Test Coverage Report</td>
</tr>
<tr>
<td>Software Design Description</td>
<td>Test Results Report</td>
</tr>
<tr>
<td>Software Requirements Specification</td>
<td>Software Correlation / Trace Matrix</td>
</tr>
<tr>
<td>Software Verification Test Procedure</td>
<td>Version Description Document (VDD)</td>
</tr>
<tr>
<td>Software Verification Test Procedure</td>
<td>Software Accomplishment Summary (SAS)</td>
</tr>
</tbody>
</table>
VxWorks 653 DO-178B and ED-12B Level A Certification Evidence Package

- Plan for Software Aspects of Certification (PSAC)
- Software Quality Assurance Plan
- Software Configuration Management Plan (SCMP)
- Software Development Plan (SDP)
  - Software requirements standards
  - Software design standards
  - Software coding standards
- Software Veriﬁcation Plan (SVP)
- Software Requirements Speciﬁcation (SRS)
  (7,000 requirements)
- Software Design Document (SDD)
- Software Life Cycle Environment Conﬁguration Index (SECI)

- Traceability Matrix
- Software Development Folder
  - Design reviews
  - VxWorks 653 source ﬁles and binary code
  - Code reviews (40,000 LOC)
  - Test reviews (7,500 tests)
  - Functional tests (270,000 LOC)
  - Coverage results (object level)
- Software Accomplishment Summary (SAS)
- Tools Qualiﬁcation Documents (TQD)
  - Test Harness for VxWorks 653
  - VerOcode, VerOLink, VeroSource-A, VeroTrace
  - WindSH
- Software Vulnerability Analysis
  - Required by DO-178C

2.9GB sealed DVD with certification artifacts and more than 70,000 hyperlinked files
DO-178B Level A
Qualified Development Tool Suite

Verification Tools (per FAA 8110.49 Chapter 9)
- XML file checker
- XML table generator
- Host shell
- Agent for certification environment (ACE)
  - ARINC ports
  - CPU time
  - Memory utilization

Development Tools (per FAA 8110.49 Chapter 9)
- XML compiler

Qualification Tools Data Package
- Tool Qualification Plan (TQP)
- Tool Test Plan
- Software Quality Assurance Plan
- Software Configuration Management Plan (SCMP)
- Software Development Plan (SDP)
- Software Verification Plan (SVP)
- Software Requirements Specification (SRS)
- Software Life Cycle Environment Configuration Index (SECI)
- Software Design Document (SDD)
- Traceability Matrix
- Software Coding Standards (C and XML)
- Software Development Folder
- Tools Accomplishment Summary (TAS)

Sealed DVD with independent certification artifacts supplied as part of the product certification data package
## Certification Track Record – Partial

<table>
<thead>
<tr>
<th>Customer</th>
<th>Program</th>
<th>Standard</th>
<th>OS1</th>
<th>Level</th>
<th>Agency</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>BARCO</td>
<td>Tupolev 201/214</td>
<td>DO-178B</td>
<td>653</td>
<td>Level C</td>
<td>NIIAO</td>
<td>2007</td>
</tr>
<tr>
<td>Boeing/GE</td>
<td>KC-767 AFMC</td>
<td>DO-178B</td>
<td>653</td>
<td>Level B-D</td>
<td>FAA</td>
<td>2007/04/12 STC</td>
</tr>
<tr>
<td>Boeing/GE</td>
<td>KC-767 MCDU</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level B</td>
<td>FAA</td>
<td>2007/04/12 STC</td>
</tr>
<tr>
<td>Boeing/GE</td>
<td>KC-767 Hose Deploy</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level B</td>
<td>FAA</td>
<td>2007/04/12 STC</td>
</tr>
<tr>
<td>DeWalt Review</td>
<td>KC-767 Tanker</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A</td>
<td>FAA</td>
<td>2006</td>
</tr>
<tr>
<td>EADS Eurocopter</td>
<td>EC 225 LP</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level A</td>
<td>EASA</td>
<td>2004/04/27 TC</td>
</tr>
<tr>
<td>LogicaCMG</td>
<td>FC BISA</td>
<td>IEC 61508</td>
<td>5.4</td>
<td>SIL 2</td>
<td>UK MoD</td>
<td>2004</td>
</tr>
<tr>
<td>Selex</td>
<td>Multiprotocol Switch</td>
<td>Com. Crit.</td>
<td>pSOS</td>
<td>EAL4</td>
<td>Classified</td>
<td>2004/07</td>
</tr>
<tr>
<td>Classified</td>
<td>Classified</td>
<td>Com. Crit.</td>
<td>VxWorks</td>
<td>EAL4</td>
<td>Classified</td>
<td>2004</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>Pipeline Valve Control</td>
<td>IEC 61508</td>
<td>5.4</td>
<td>SIL 3</td>
<td>TUV</td>
<td>2003</td>
</tr>
<tr>
<td>Raytheon</td>
<td>WAAS</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level B</td>
<td>FAA</td>
<td>2000</td>
</tr>
</tbody>
</table>

### Will Be Certified as Part of Various Aircraft

<table>
<thead>
<tr>
<th>Customer</th>
<th>Program</th>
<th>Standard</th>
<th>OS1</th>
<th>Level</th>
<th>Agency</th>
<th>Aircraft Program Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>BARCO</td>
<td>MOSart Modular OS</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A-D</td>
<td>EASA</td>
<td>2005</td>
</tr>
<tr>
<td>Boeing/GE</td>
<td>C-130 AMP FMS, Comm, others</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A-D</td>
<td>FAA</td>
<td>2002</td>
</tr>
<tr>
<td>Boeing/GE</td>
<td>787 Common Core System</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A-D</td>
<td>FAA</td>
<td>2004</td>
</tr>
<tr>
<td>Cobham FR</td>
<td>900E Wing Pod</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level A</td>
<td>EASA</td>
<td>2005</td>
</tr>
<tr>
<td>EADS CASA</td>
<td>A330 MRTT Tail Boom</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A-D</td>
<td>EASA</td>
<td>2004</td>
</tr>
<tr>
<td>EADS CASA</td>
<td>A330 MRTT MIC</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level C</td>
<td>EASA</td>
<td>2004</td>
</tr>
<tr>
<td>EADS CASA</td>
<td>A400 MIC</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level C</td>
<td>EASA</td>
<td>2004</td>
</tr>
<tr>
<td>Indra Sistemas</td>
<td>A400M IFF</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level B</td>
<td>EASA</td>
<td>2004</td>
</tr>
<tr>
<td>GosNIIAS</td>
<td>International IMS</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A-D</td>
<td>EASA</td>
<td>2006</td>
</tr>
<tr>
<td>Northrop Grumman</td>
<td>UCAV Vehicle Management</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level A</td>
<td>FAA</td>
<td>2006</td>
</tr>
<tr>
<td>Northrop Grumman</td>
<td>UCAV Mission Management</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level B</td>
<td>FAA</td>
<td>2006</td>
</tr>
<tr>
<td>Rockwell Collins</td>
<td>C-130 Tactical MFD</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A-D</td>
<td>FAA</td>
<td>2002</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>A400M System</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A-D</td>
<td>EASA</td>
<td>Confidential</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>A400M System</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level C</td>
<td>EASA</td>
<td>Confidential</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>Avionics System</td>
<td>DO-178B</td>
<td>653</td>
<td>Level A</td>
<td>EASA</td>
<td>Confidential</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>Helicopter System</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level D</td>
<td>EASA</td>
<td>Confidential</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>Helmet System</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level C</td>
<td>EASA</td>
<td>Confidential</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>Classified System</td>
<td>DS 00-56</td>
<td>5.4</td>
<td>SIL 3</td>
<td>UK MoD</td>
<td>Confidential</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>UAV</td>
<td>DS 00-56</td>
<td>5.4</td>
<td>SIL 3</td>
<td>UK MoD</td>
<td>Confidential</td>
</tr>
<tr>
<td>EMEA Supplier</td>
<td>UAV Flight Computer</td>
<td>DO-178B</td>
<td>5.4</td>
<td>Level A</td>
<td>EASA</td>
<td>Confidential</td>
</tr>
</tbody>
</table>

1 653=VxWorks 653; 5.4=VxWorks 5.4 Cert  
2 STC=Supplemental Type Certificate; TC=Type Certificate
DO-178B Network Stack for VxWorks 653

- Same network stack codebase as VxWorks DO-178B Platform
- Developed for DO-178B Level A certification
  - Certification Evidence available for earlier VxWorks 653 Platform 2.2.x releases
- Features
  - Support for IPv4, UDP, TCP, IGMPv4, multicast
  - High-performance implementation
  - Small memory footprint
  - Flexible configuration options for memory optimization
  - Runs in Module OS (MOS), available for all partitions
- Optional, add-on product to VxWorks 653 Platform
DO-178B File System for VxWorks 653

- Developed for DO-178B Level A certification
  - Certification Evidence not yet available

- Features
  - Power fail-safe capability
  - High-performance implementation
  - Small memory footprint
  - Runs in Module OS (MOS), available for all partitions

- Optional, add-on product to VxWorks 653 Platform
VxWorks 653 COTS Graphics Stacks

- Industry leading design tools for certified graphics
  - Esterel SCADE Display
  - Presagis VAPS XT
- Certified OpenGL drivers
  - ALT Software
  - Presagis / Seaweed Systems
- Leading hardware vendor support
  - Curtiss-Wright
  - GE Intelligent Platforms

Complete COTS graphics stacks
Proven in multiple RTCA DO-178B Level A programs
Customer Successes

Wind River Certification Platforms
VxWorks 653 in Boeing 787 Common Core System

- Eliminated over 100 different LRUs
- 17 Boeing suppliers, dozens of teams

VxWorks 653 now leads the industry with over 180 projects, used by over 100 customers in over 40 aircraft

Photo by LongBachNguyen.com · All Rights Reserved.
Boeing P-8A Poseidon

VxWorks 653 used for Common Core Computer
EADS/Airbus A330 MRTT

3 VxWorks Systems
- Tail Boom (EADS CASA in Spain)
  - VxWorks 653, DO-178B Levels A–D
- MIC (EADS CASA in Spain)
  - VxWorks, DO-178B Level C
- 900E Wing Pods (Cobham FR, UK)
  - VxWorks, DO-178B Level B
EADS/Airbus A400M

- IFF (Indra Systemas in Spain)
  - DO-178B Level B
- MIC (EADS CASA in Spain)
  - DO-178B Level C
- Classified Project (France)
  - DO-178B Level C
- Classified Project (Germany)
  - ARINC 653, DO-178B Levels C, D
- Classified Project (Holland)
  - ARINC 653, DO-178B Level C
Boeing KC-767A Tanker

Certified under DO-178B Levels B and C (April 2007)

- Four subsystems platform-certified (RTOS and hardware)
  - VxWorks Cert 5.4
    - Multipurpose control display unit
    - Hose deploy unit
  - VxWorks 653 (IMA)
    - Avionics
    - Flight management computer
Rapid Growth of ARINC 653 and IMA
nEUROn
Unmanned Combat Air Vehicle

VxWorks 653 used for Flight Controls, Flight Management, Data Link
WIND RIVER