OpenGL-Based Applications for Certifiable Avionics
Presagis Overview

> A recognized leader in embedded HMI graphics
  > Certifiable, safety critical avionics
> Headquartered in Montreal, Canada with 200+ employees
> In business since 1987
> Worldwide presence
  - Presagis USA: Richardson, Texas
  - Presagis Canada: Montreal
  - Presagis Europe: Vélizy, France
  - Sales & Support Offices
  - Distributors
> Contributing member of
  > RTCA SC-205: DO-178C
  > ARINC 661 Committee
  > Khronos OpenGL SC
Software in Safety Critical Applications

> Exponential growth of Software Lines of Code (SLoC) in on-board systems over the last 25 years

Estimated Onboard Software Lines of Code (SLOC) growth

> Mitigate risk in safety critical software development
  > Guidance and standards
  > Cert-ready COTS software solutions
OpenGL

- OpenGL
  - Open Graphics Library
  - A specification defining a cross-language, cross-platform API for writing applications that produce 2D and 3D computer graphics
- Consists of >250 different function calls
  - Used to draw complex three-dimensional scenes from simple primitives
- Developed by Silicon Graphics Inc. in 1992
  - Widely used in CAD, virtual reality, scientific visualization, information visualization, and flight simulation
  - Also used in video games
- Managed by non-profit technology consortium, the Khronos Group
OpenGL Taxonomy

> Desktop OpenGL
  > OpenGL 1.0 - Silicon Graphics
  > OpenGL 2.0 & 2.1 - 3Dlabs, first Shading Language
  > OpenGL 3.0 & 3.1 - Radical revisions for completely programmable GPUs; Unified Shader Model
  > OpenGL 4.3 Released on August 2012

> Embedded OpenGL
  > OpenGL for Embedded Systems
    • Cellphones, PDAs, Video games, etc.
  > OpenGL ES 1.0 ↔ OpenGL 1.3
  > OpenGL ES 1.1 ↔ OpenGL 1.5
  > OpenGL ES 2.0 ↔ OpenGL 2.0
    • OpenGL ES 2.0 eliminates fixed-function rendering pipeline
    • Completely programmable rendering - no shaders, no display
OpenGL SC
The Safety Critical Profile
OpenGL SC - The Safety Critical Profile

- OpenGL® SC Safety Critical Profile is defined to meet the unique needs of safety-critical markets
  - Avionics
    - Including D0-178 certification
  - Military
  - Medical
  - Automotive
- Simplifies safety-critical certification
- Allows compliance with real-time requirements
- Facilitates porting of legacy safety-critical applications.
Presagis is a Khronos Group contributing member

> Definition of future “Open” subsets of OpenGL® APIs for 2D and 3D

> Presagis is now Chair of Group
  - Khronos work undertaken with the blessing of OpenGL ARB

> Presagis will support OpenGL ES SC
  - Considerable benefit can be taken from an already developed, certifiable subset
  - Requirements-based test harness already exists for our current certifiable subset
SeaWind-178
Certifiable OpenGL
SEAWIND-178

> Scalable OpenGL® graphics products for DO-178B certifiable embedded systems
  > FIRST COTS OpenGL® subset specifically developed for safety-critical avionics applications
  > From-scratch implementation of subsetted OpenGL® API, providing maximum functionality and minimum complexity
  > All DO-178B artifacts have been created during the development process, not reverse-engineered
  > Certifiable up through Criticality Level A (the highest level)
  > Appropriate for both 2D and 3D applications
  > Subset supports VAPS XT-178
  > LynxOS-178, VxWorks 653 and INTEGRITY-178 fully supported
  > Already delivered on many programs and platforms
POWER OF PRE-INTEGRATED SOLUTIONS

> Pre-tested solution stack
  > VAPS XT-178
  > SeaWind-178 OpenGL
  > DO254 Packages

> Optimized

> Reduced Risk

> Reduced integration effort

> Reduced time to deployment

> Better out-of-box experience
VAPS XT-178 Environment

> VAPS XT-178
  > Qualifiable OpenGL based HMI Development Environment for DO-178B
  > VAPS XT-178 ensures all output remains DO-178B compliant
  > Allows user to automatically generate DO-178B certifiable code
  > Ready for Certification up to Level A

> VAPS XT-178 CertKit
  > All test cases and documentation to support VAPS XT-178
  > Allows user to claim credit for low level requirements in DO-178B
  > Ready for Certification up to Level A
  > Optional ARINC 661 Certification
ADVANCED GUI
GLOBAL WORKFLOW

VAPS XT-178 supports all phases of embedded development:
INTEGRATED UML-BASED STATE CHARTS
FONTS AND MENUS

> Rich font support, including multiple languages

> Advanced menu transparencies and overlapping effects
VAPS XT-178 CertKit

> Complete set of test cases and documentation fully supporting applications developed in VAPS XT-178

> Three major components to CertKit:
  1. DO-178B plans (PSAC, etc.)
  2. Artifacts for certifiable runtime libraries
  3. Artifacts for qualifiable CODE nGEN

> Advantages
  > No need to inspect generated code
  > No need to perform dynamic analysis on generated code
  > Eliminate massive testing
    • ~85 000 Test Cases run for VAPS XT-178
  > Engineers can invest their energy where it counts:
    • High Level System HMI Development
  > Flexible pricing structure, depending on certification level required
VAPS XT-178 CertKit

DO-178B Artifacts:

- Tool Qualification Plans (PSAC, SDP...)
- Design and LLRs
- Test Cases and Procedures
- Structural Coverage
- Review Records
- Trace Matrices
- Other Certification Evidences

CertKit is available for inspection and purchase today
ARINC 661

> A standard which aims to normalize the definition of a Cockpit Display System (CDS), and the communication between the display and User Applications (UA) which manage aircraft avionics functions.
ARINC 661

Objectives

- Minimize costs for new display capabilities
- Minimize costs for changes to new display capabilities
- Minimize costs for the management of hardware obsolescence
- Support the means of developing standard HMI

Elegant but not trivial

- Introduces a technology overhead not related to core avionics competence
- Leveraging COTS for tools and certification mitigates risk
  - Presagis ARINC 661 Development Suite
VAPS XT ARINC 661

> A certifiable architecture
AgustaWestland selected certifiable COTS tools for an ARINC 661 program

Why a COTS solution?

1. Specialist tool designed to exploit new HMI concepts and approach
2. COTS suppliers have greater market exploitation to support the development of their capabilities
3. Reduced COO and obsolescence protection
4. Turn key solution for HMI element
5. Availability of certification package
6. AW to concentrate on core competence of HMI development
7. Reduce project risk
8. Provides reuse on other hardware platforms
9. Supports ‘rapid’ HMI changes
10. Support reuse of HMI in other phases i.e. simulation, training systems
Summary

> Software development for safety critical avionic systems involves risk above and beyond the functional system requirements

> While standards and guidance provide assurance for the correct implementation of safety critical software, they carry additional requirement for expertise in how to apply them

> Leveraging domain experience and expertise from COTS suppliers mitigates the additional risk and represents substantial savings in time and cost
Thank You