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Customer Success Is Our Mission

Industry Challenges in Embedded Software Development

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Industry Challenges in Embedded Software Development

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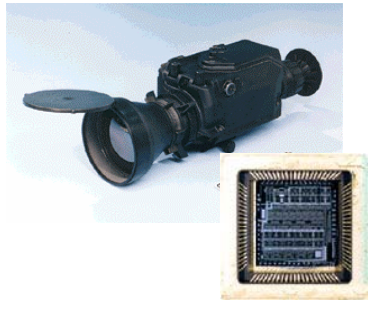
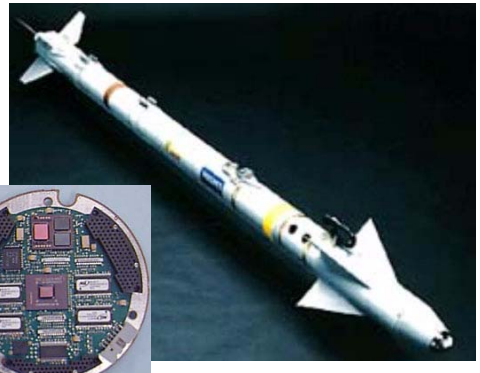
- Embedded software development at Raytheon
- What are key challenges in embedded software development?
- Thoughts on research and advances to address these challenges

Raytheon – Embedded Systems





- 80,000 employees
- $20B+ sales
- 8-10,000 software developers
- Broad spectrum of embedded systems
  - Commercial, military, space, international
- Distributed workforce

Real World Development @ Raytheon

- **Large gap between research and industry development**
  - **Typical embedded software development @ Raytheon**
    - **Limited modeling, limited component use**
    - **C/C++, Commercial RTOS, Custom hardware, hand coded and integrated**
  - **Productivity growth is slow**
  - **Small groups using current research and technology**

- **Non-Technical Challenges in industry development**
  - **Developers of varying skill levels**
  - **Long product lifetimes influence technology**
  - **Risk aversion is extreme**
  - **Related domains – but we don't share solutions well**
  - **Complexity growth is relentless**

Reducing the gap between research and industry is critical

What advances would be most critical to our future?

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- Components that are inherently real-time and configurable
- Mature real time architectures
- Dependability and quality in embedded systems

Components that are inherently real-time and configurable

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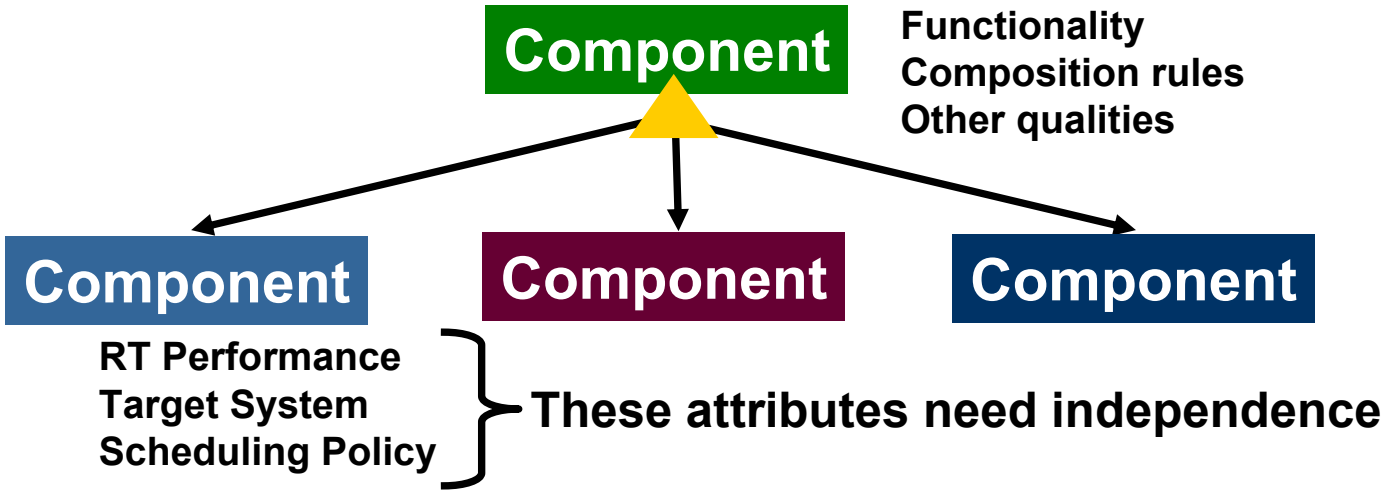

- *Today's development incorporates RT performance based on design experience*
  - *Actual performance is tested into the system and varies over time*
  - *Nearly all systems must operate in multiple target environments*

Research has not reached US industry

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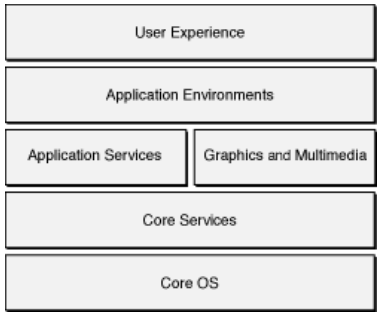
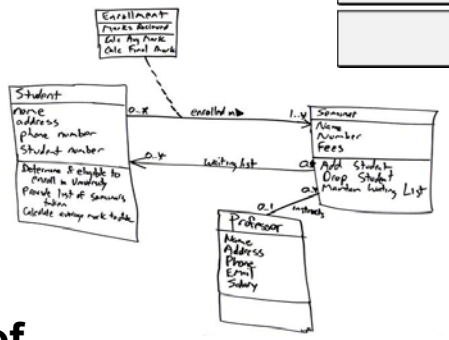
Mature real time architectures

- There is little commonality in representation and structure of software architectures across industry and Raytheon
- We lack a language to discuss, document, research and compare embedded system architectures
  - This reduces leverage from past successes
  - It is difficult to cross boundaries (industry, academia, different domains)
- Research, publication and standardization of embedded software architectures would
  - Improve architectural use and evolution
  - Support maturation of tools and techniques
  - Allow development of components that are composed into known architectures





Architectural Views
My View
Your View
His View
Her View

What should a SW architecture of an embedded system consist of?
What are known solutions to different domains of embedded systems?
How do we compose components into a successful SW architecture?

Dependability and quality in embedded systems

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- Raytheon customers want “no doubt” system performance
  - Even early tests must be low risk
  - Reliable, real world correctness and testing methods are critical
- Formal methods for dependability and correctness are insufficient today
  - Must encompass real world complexity levels
  - Methods for specifying quality attributes are insufficient
    - Availability, resource consumption, reliability
- Expanding formal methods to entire systems (not just software) would be valuable

Other Challenges

- There is a shortage of software developers with real time embedded education and experience
- Tools coming out of research are limited in use unless adopted by commercial tool vendors
- Standards that would support real-time modeling, formal methods, etc are needed

Raytheon Initiatives

- Develop and support a variety of model driven software development programs
  - Internal Research and development, University partnerships, ESCHER
- Shape embedded systems software architecture standards, representation and communication
  - Standardize across Raytheon where possible
- Support embedded real time standards to facilitate commercial tool development

Conclusion

- Raytheon is interested in closing the gap between research and industry

  RT standards, partnerships with vendors, partnerships with academia, Maturation and risk reduction via testbeds, research support

- Formal methods for complex embedded systems

  Raytheon supports the development of techniques or methodologies that can dramatically improve system dependability, correctness and quality