



Safety Certification Challenges for Future Air Force Systems



AFRL

Jonathan Hoffman
Control Systems Development and Applications Branch
Air Vehicles Directorate
Air Force Research Laboratory
Jonathan.Hoffman@wpafb.af.mil
(937) 255-2541



Cooperative Aerospace Operations



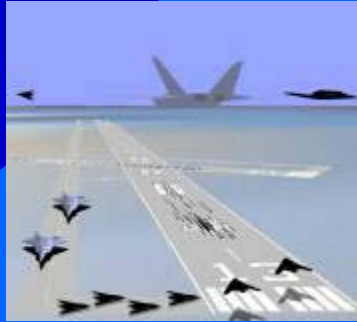
UAV Vision: Same Base, Same Time, Same Tempo

Critical System Attributes:

- *Reliable & Safe – Op's in proximity to man*
- *Responsive/adaptive to dynamic missions*
- *As autonomous as needed, as interactive as desired*
- *Operations transparency*
- *Affordable & Certifiable*



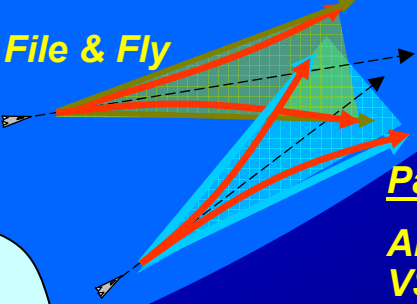
Collaboration & Teaming



Transparent Ground & Air Op's

Sense, Avoid, File & Fly

Approved for public release
AFRL/WS-05-0178



Safe Interoperability & Coordination

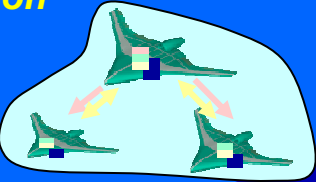
Partners in CAO:

AFRL: VA, SN, HE, MN, IF, VS, AFOSR

DoD: DARPA, Navy, Army

Other: NASA, Industry

System of Systems Decision Making



Reliable, Certifiable Systems & Software





Challenges for Future Systems Certification

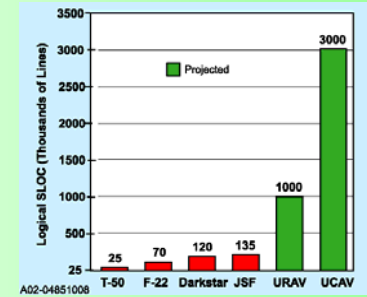


Realtime Prognostics and Health Information



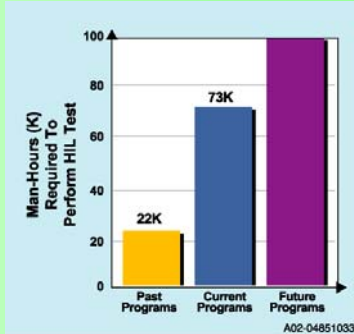
Advances in Functionality Taxing Current Software V&V And Certification Process

Increasing Lines of Code



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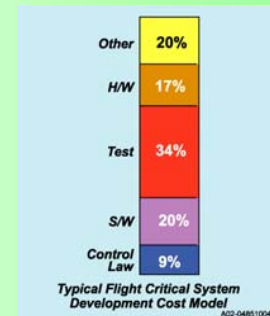
Increasing Test Time/Manhours



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CERTIFICATION
Performance Assurance Confidence

V&V Test is dominant driver



Intelligence and Autonomy will Require Advances in Certification Process



Multi-Vehicle Coordination



Intelligent, Adaptive and Reconfigurable



Manned and Unmanned Airspace Operations

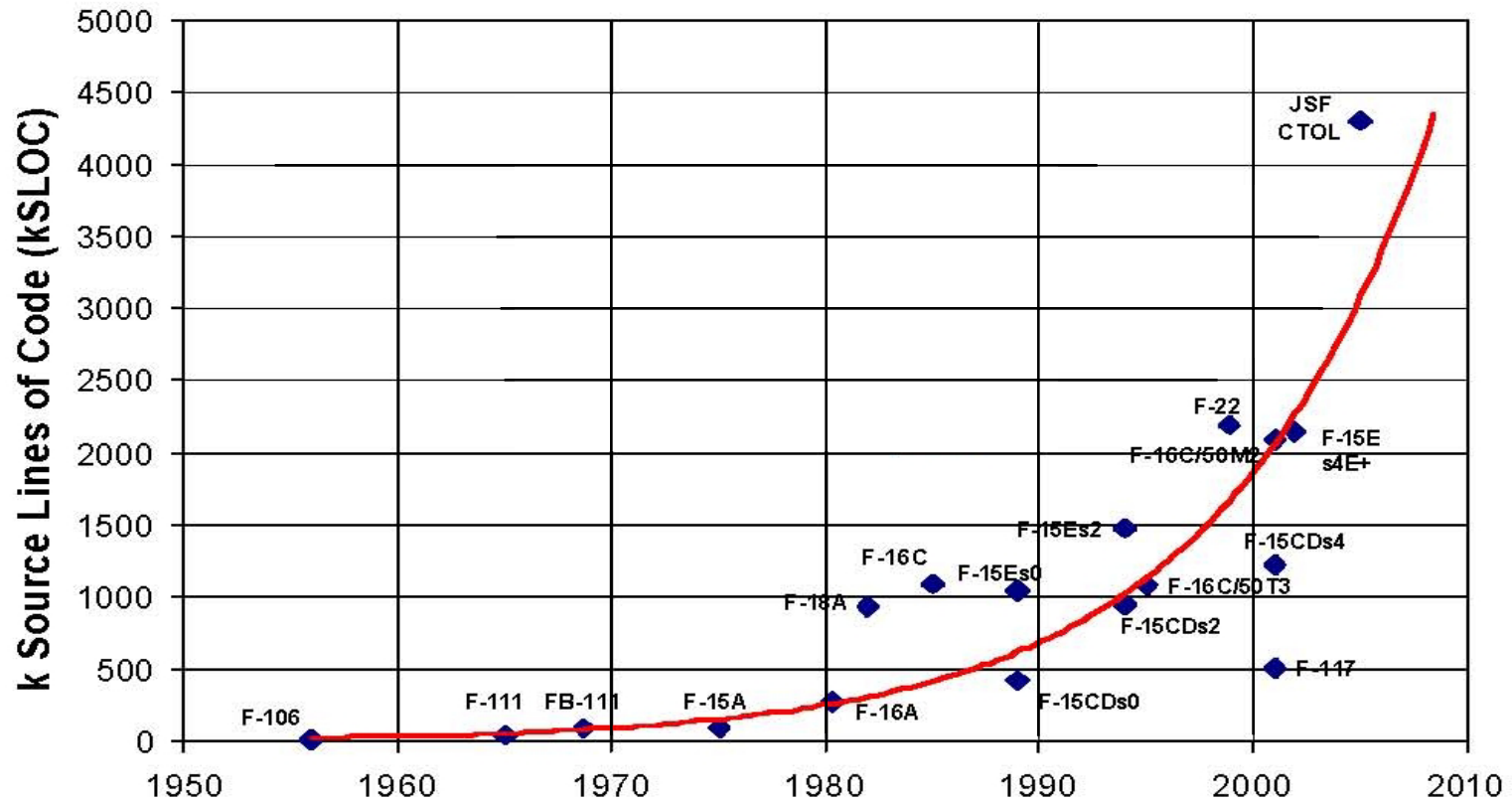




DoD software is growing in size and complexity



Total Onboard Computer Capacity (OFP)



Source: "Avionics Acquisition, Production, and Sustainment: Lessons Learned -- The Hard Way", NDIA Systems Engineering Conference, Mr. D. Gary Van Oss, October 2002.

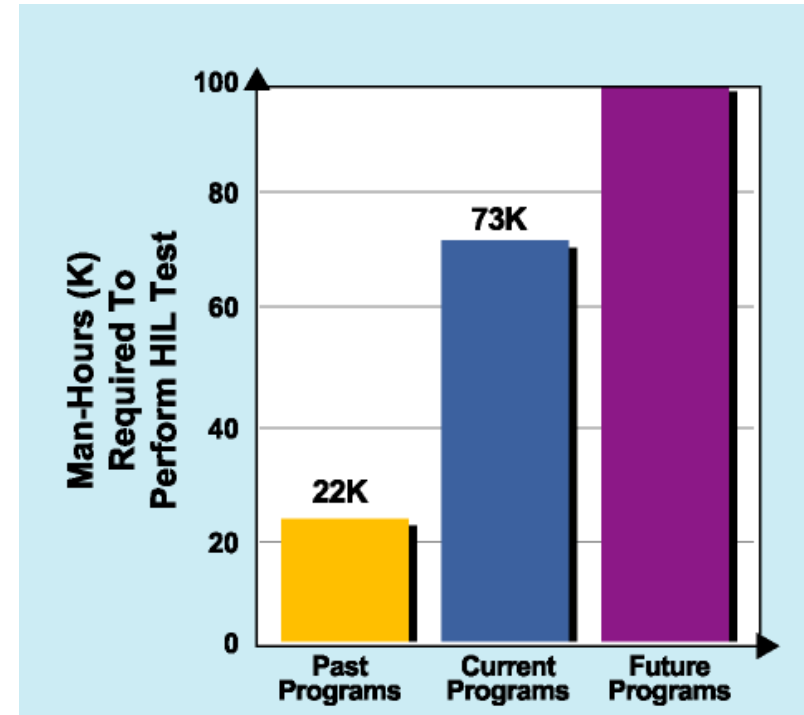
Robert Gold, OSD



Emerging System Costs



- Exponential growth in SW size and system complexity imply exponential growth system certification costs (e.g., projections for HIL testing)
- Test automation improvements will not reduce testing hours sufficiently for emerging intelligent and adaptive control systems
- Rigorous verification of the PLOC requirement may not be cost effective in the presence of these system enhancements.



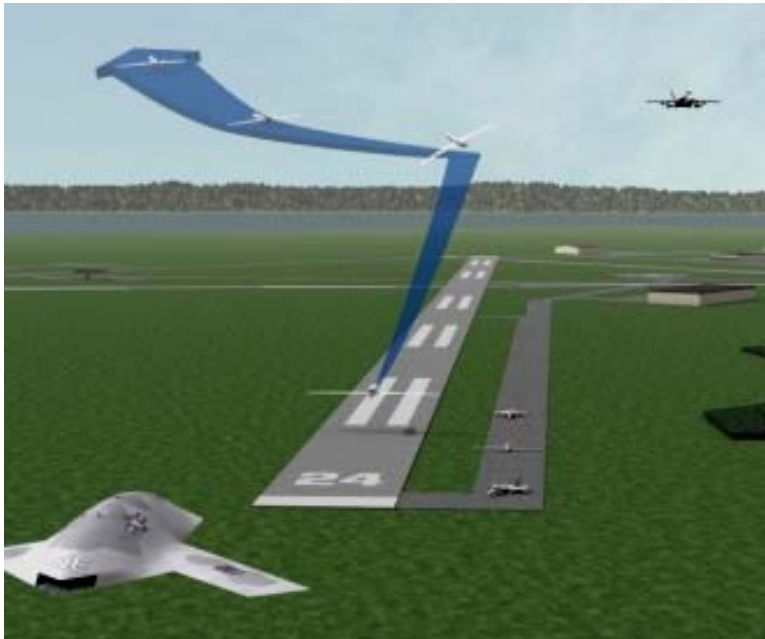
Size and Complexity Increase Costs



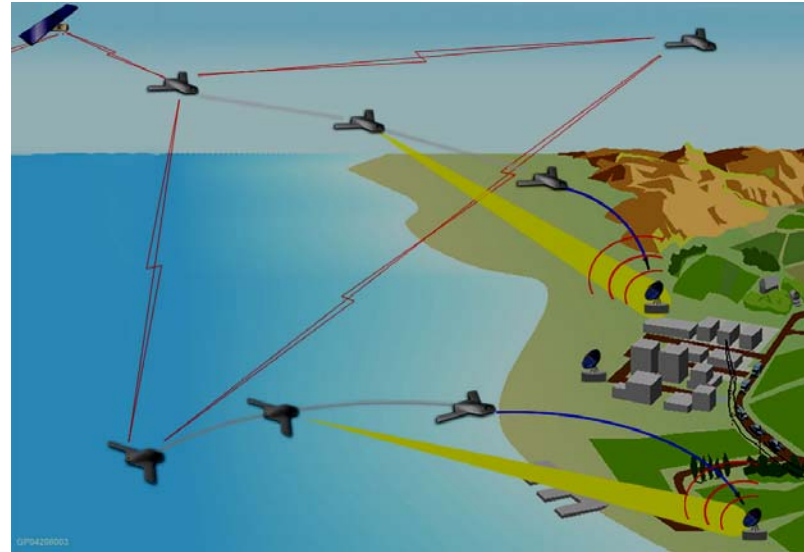
Future Vision for V&V

Goal/Objective :

Enable Critical Capabilities For UAS



Airspace Integration



Dynamic Mission Op's

Key Attributes:

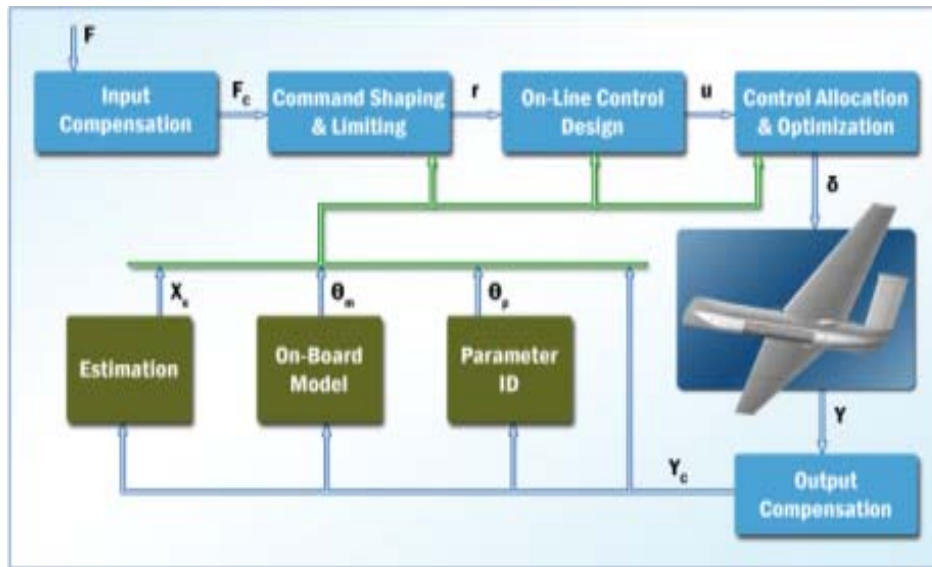
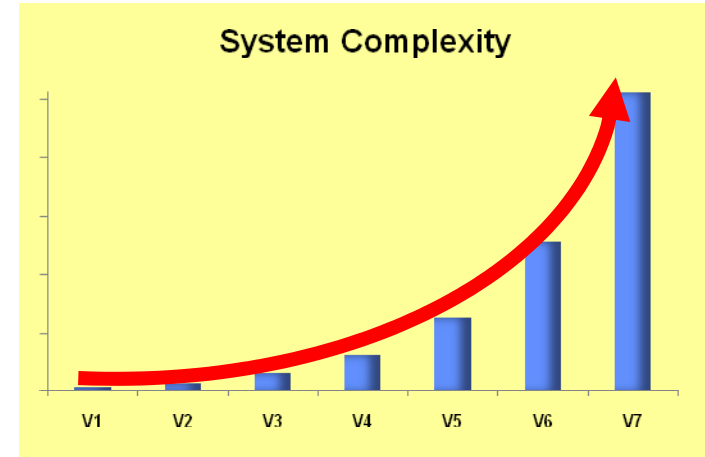
- **Adaptive**
- **Mixed Initiative**
- **System-of-Systems**



Future Vision for V&V

Technical Challenge:

*Advanced
Functionality Leads
to V&V State Space
Explosion*

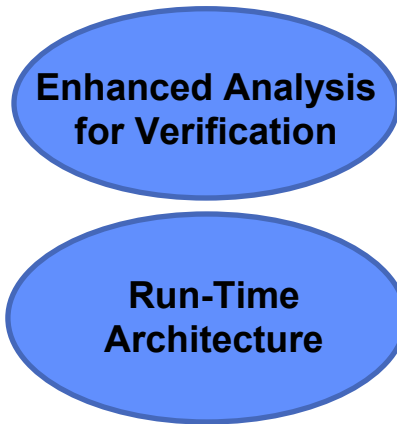


***Exhaustive
Testing Not
Feasible or
Affordable!***



Future Vision for V&V

FCSSI Approach:



Shift in Verification Paradigm

Shift in Assurance Paradigm

Reliance On:

Exhaustive Test



Analysis



Off-Line Assurance

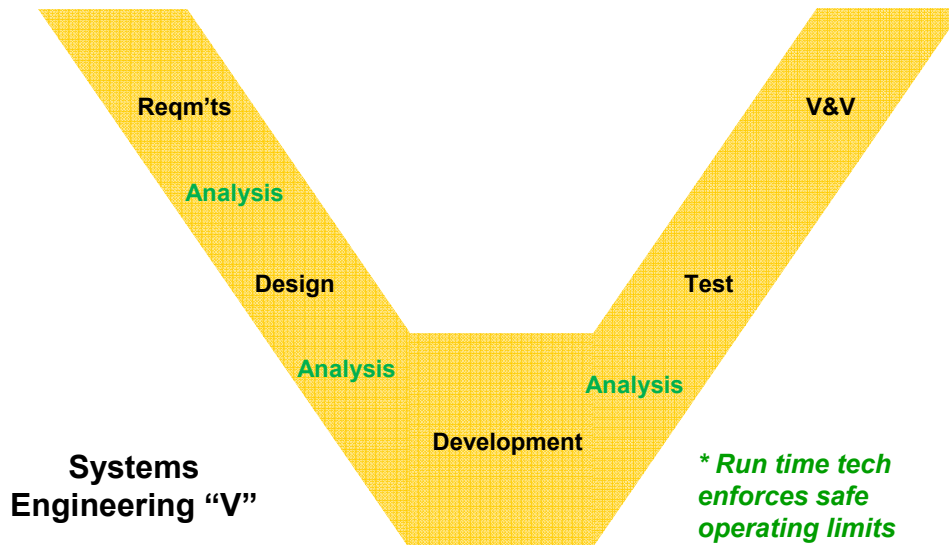


Run Time Assurance



Payoffs:

- Cost & Schedule
- Confidence & Assurance
- Catch errors earlier
- Less costly analysis
- Improved coverage





Flight Critical System Software Initiative

CerTA FCS CPI Technical Approach



Objective

- Apply innovative V&V Methods and Techniques to a challenge problem
- Demonstrate Improvements to Airworthiness Certification Process (Via Key Performance Parameters & Measures of Merit)
- Real World, Unique, Advanced Flight/Safety Critical System Application for V&V

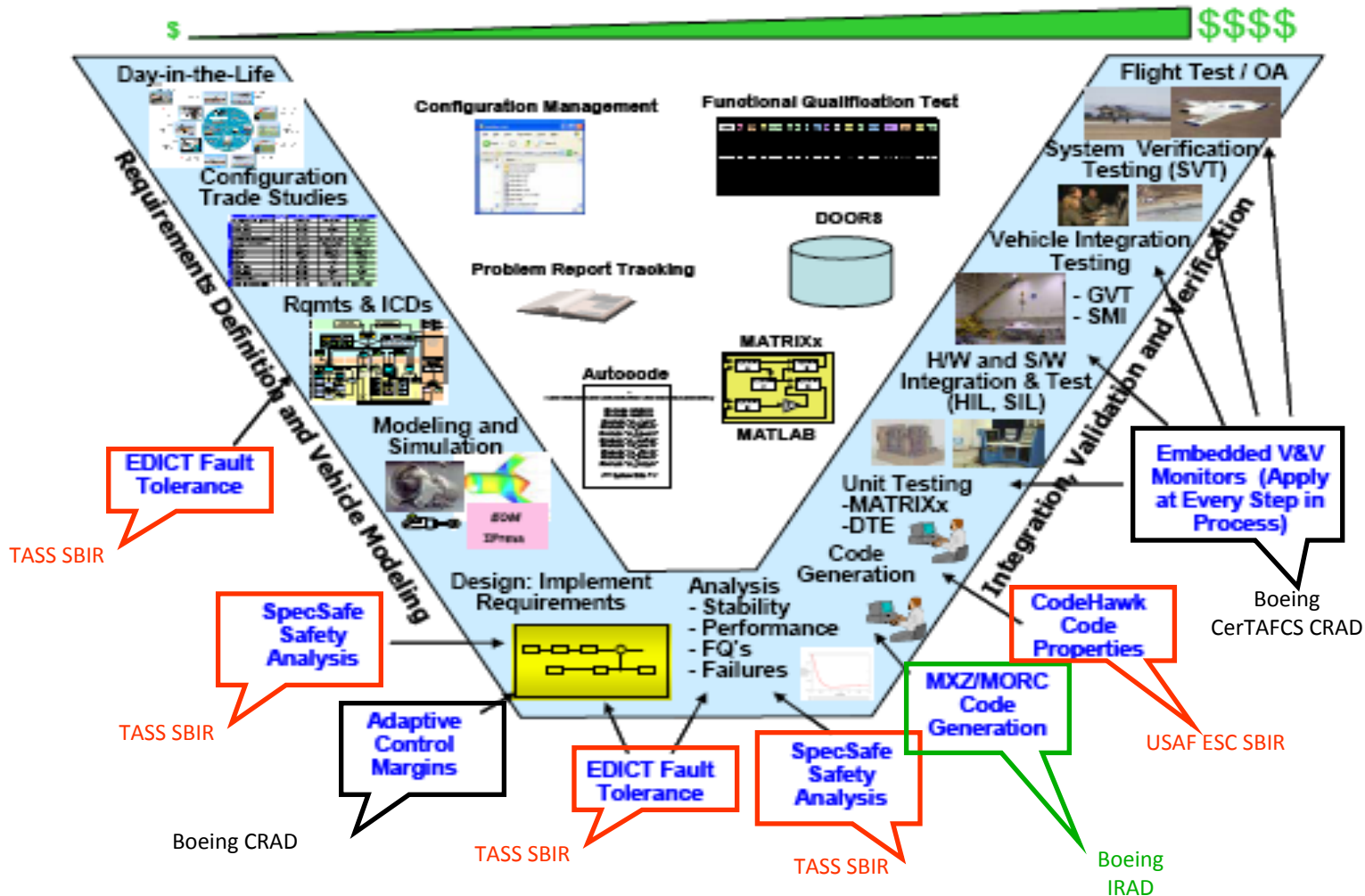
Approach

- Define Challenge Problem
 - Flight Safety/Critical Domain
 - Taxing-Burdensome to Current Airworthiness Cert Process
- Identify and integrate innovative V&V technologies into Airworthiness Process
- Develop MoMs and KPPs to evaluate V&V techniques effectiveness
- Demonstrate Effectiveness of V&V technologies
 - Quantify technological improvements (KPPs)
 - Qualify System/Mission Level Savings (MoMs)



Flight Critical System Software Initiative

CerTA FCS CPI Technical Approach

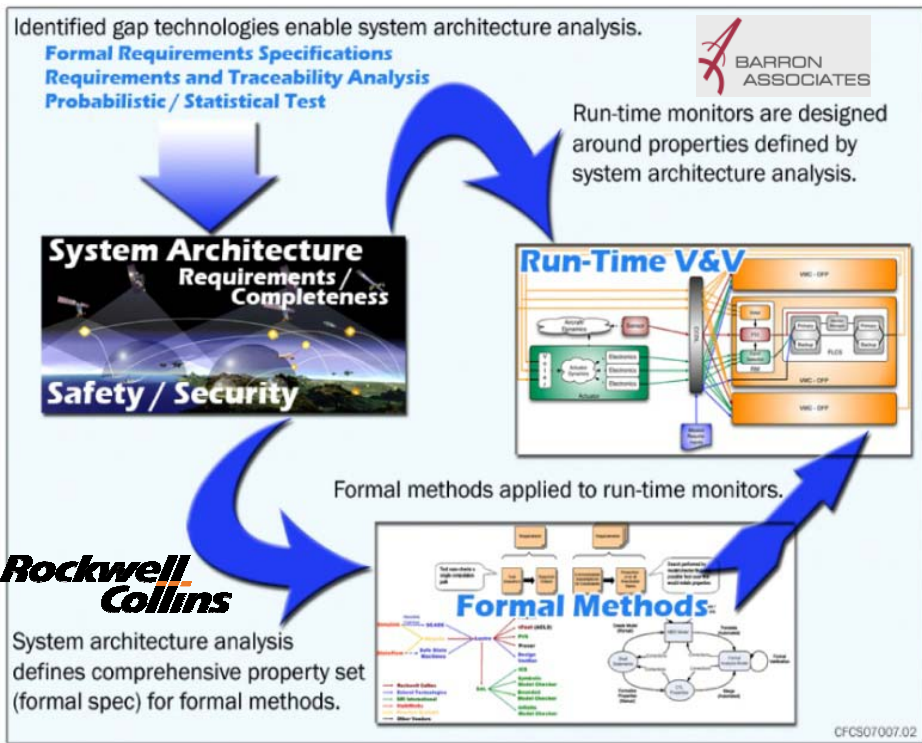




Flight Critical System Software Initiative



CerTAFCS CPI Technical Approach





Summary



- **Complexity of UAS control systems are driving V&V costs exponentially higher.**
- **New V&V techniques and methods are needed to certify this emerging complexity.**
- **Boeing and Lockheed Martin will show how they are using these technologies.**