



# **Software Defined Radio Qualification Approach**

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# Introduction

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## Dual Focus:

- Design Philosophy and Test Methodology

## Work Hand in Hand

- Create a design meeting all critical requirements
- Reduce the risk of Qualification through early test intervention

# Transitional Radios

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- **F-22 Integrated CNI**
- **MIDS LVT**
- **JSF Integrated CNI**
- **MIDS JTRS**

# Historic Deployment Perspective

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- **Current Designs cost and schedule prohibitive**
  - ◆ Qualification testing
  - ◆ Re-qualification from performance enhancements
- **Current Architectures**
  - ◆ Not designed with upgrades in mind
  - ◆ Design process severely limits ability to make changes

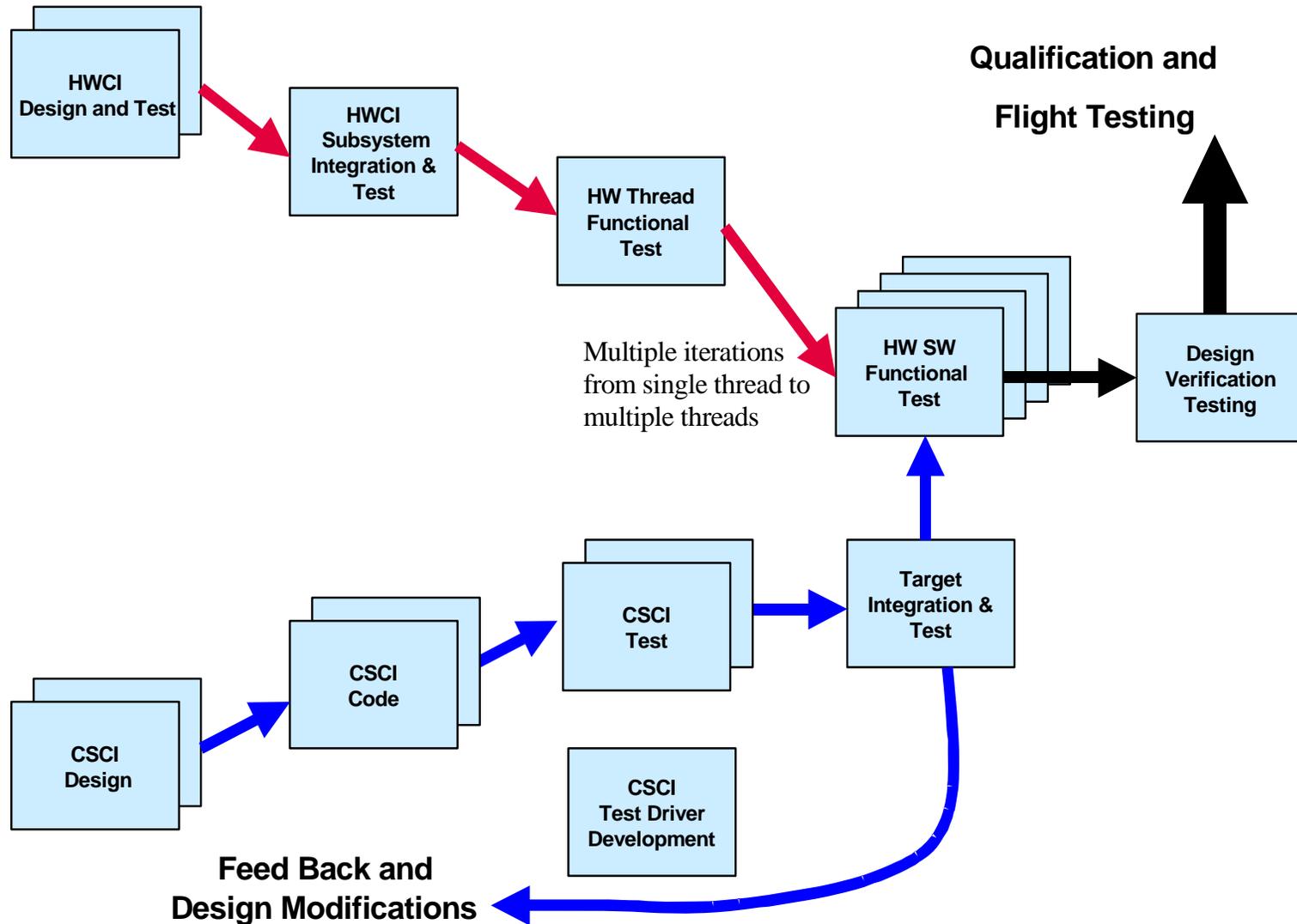
**Future designs must be upgradeable  
without significant regression testing**

# Software Defined Radios

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- **SDR provides cornerstone for software designs that allow growth and added capability**
- **Combat cost and schedule Risk**
  - ◆ SDR provides software and functional independence
  - ◆ Combination of System Architecture, design process improvement and detailed testing

# Typical Waterfall Process

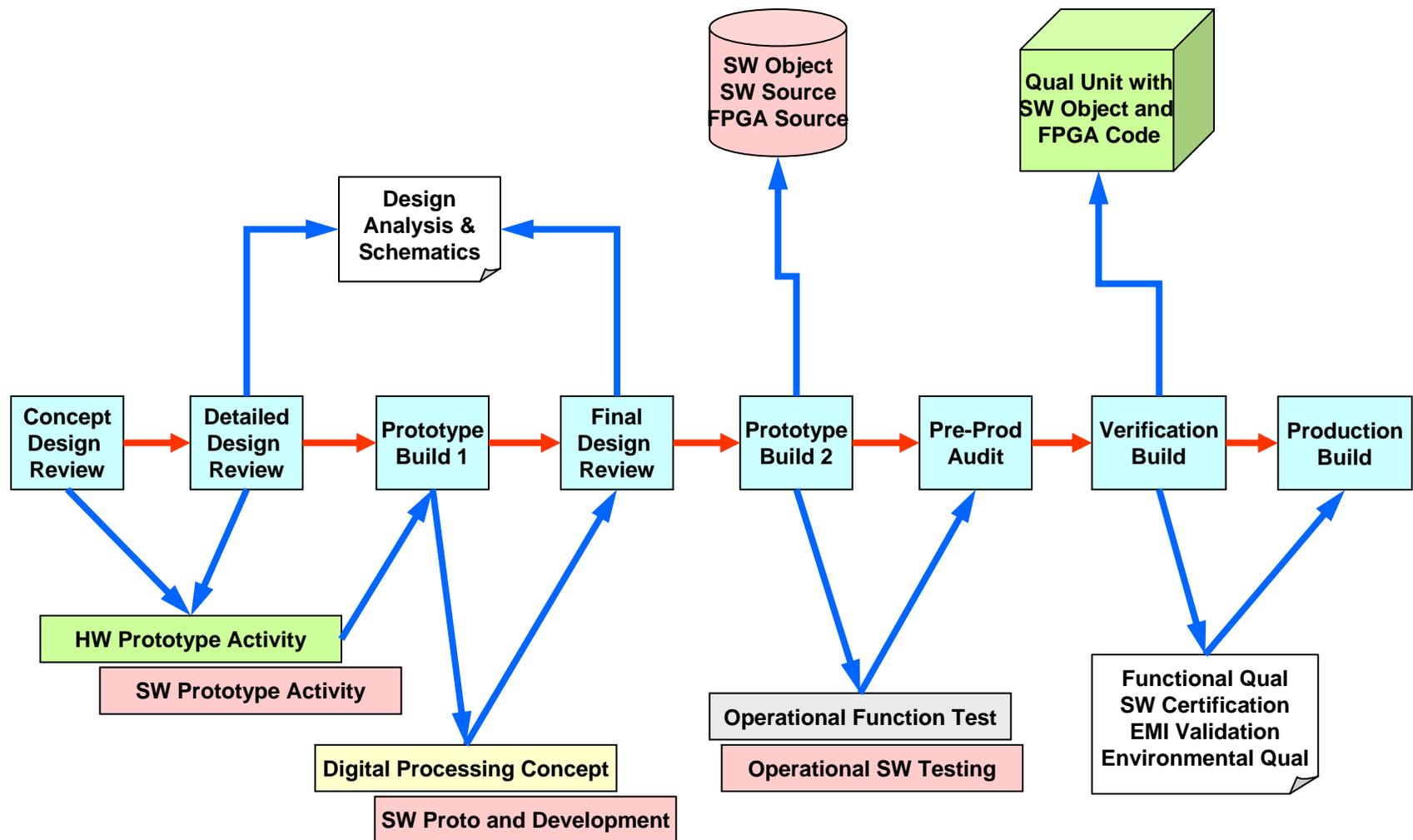


# Waterfall Approach

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- **SW Coding is wasted if started prior to completion of design**
- **Serialization of tasks has potential for significant late changes and redesign**
- **Requirements discovered late in process force:**
  - ◆ Significant regression in design, coding and test
  - ◆ Delay introduction of software to processing target
- **Testing is conducted on separate tracks**
  - ◆ Hardware Testing pointed to environmental
  - ◆ Software Testing focused on processor throughput and timing

# Incremental Build and Test Flow



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# Incremental Approach

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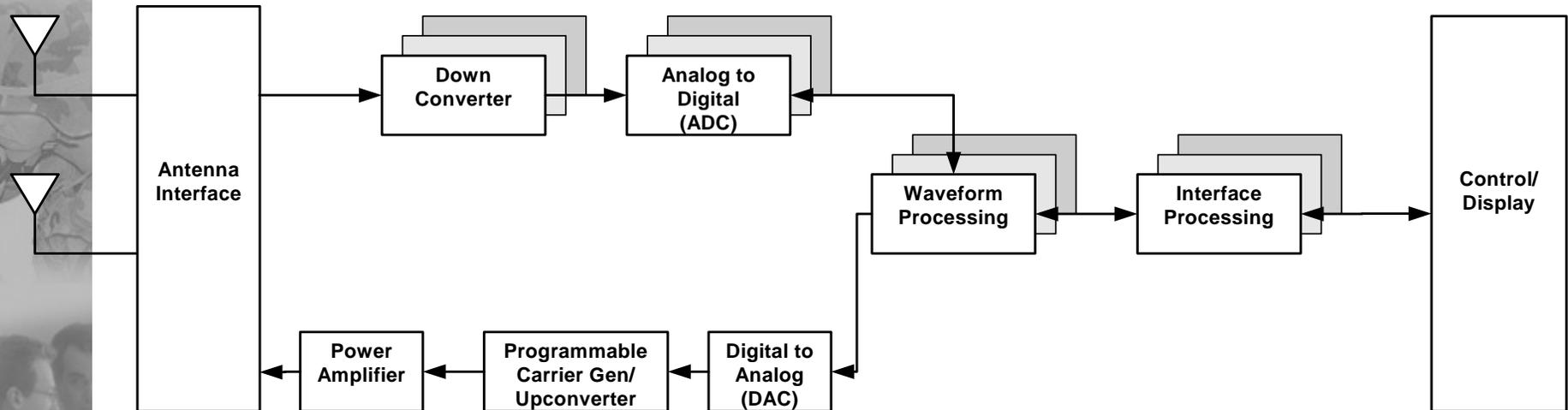
**Known as the Spiral Development Model:**

- **Multiple Build and Test Cycles**
- **Maturation of both Hardware and Software prior to final acceptance**
- **Testing is based on the maturity level of the product at each incremental design and build phase**
- **Hardware interfaces are fixed early in the development phase**
- **Testing success based on identification of key performance parameters early and tracking performance of each during iterative testing**

Advantage of incorporating requirements  
Changes in future stages prior to qualification

# SDR Generic Architecture

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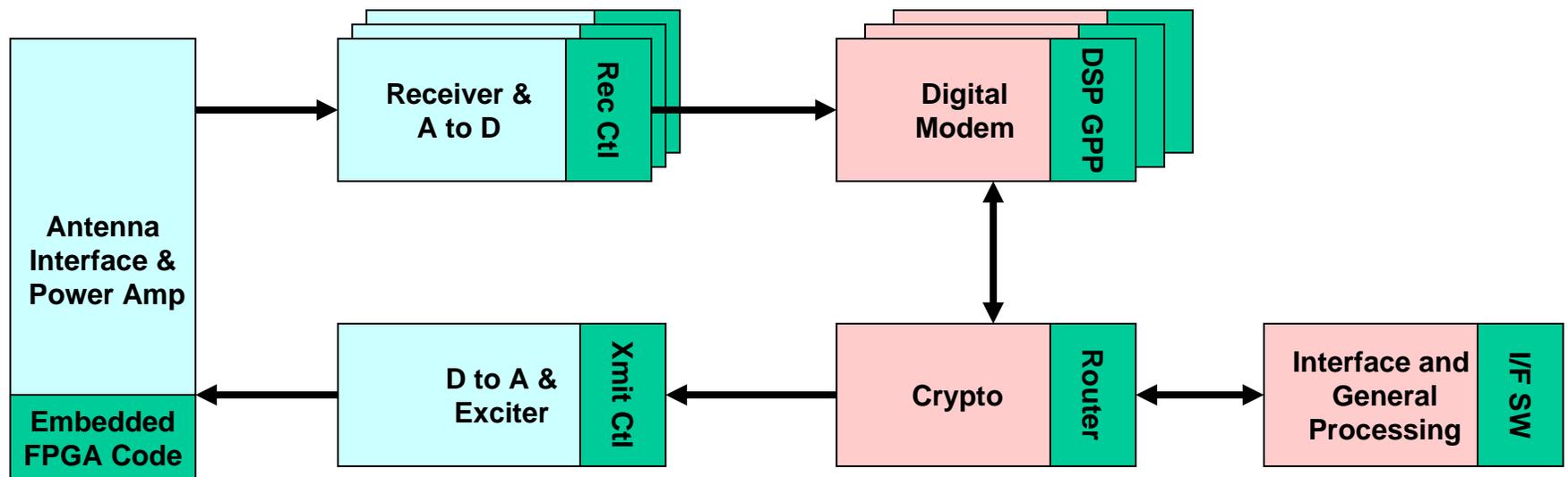
*One or more Power Amps or a Multi-mode Power Amp dependent on Functionality within MMDA*

- Common Hardware/Open Architecture
- Commercial Level Cryptography
- SEI/SCA Based Software Architecture
  - OSIL/CORBA implementation

**Multiple functionality and performance in the presence of failures**

# HW/SW Thread View

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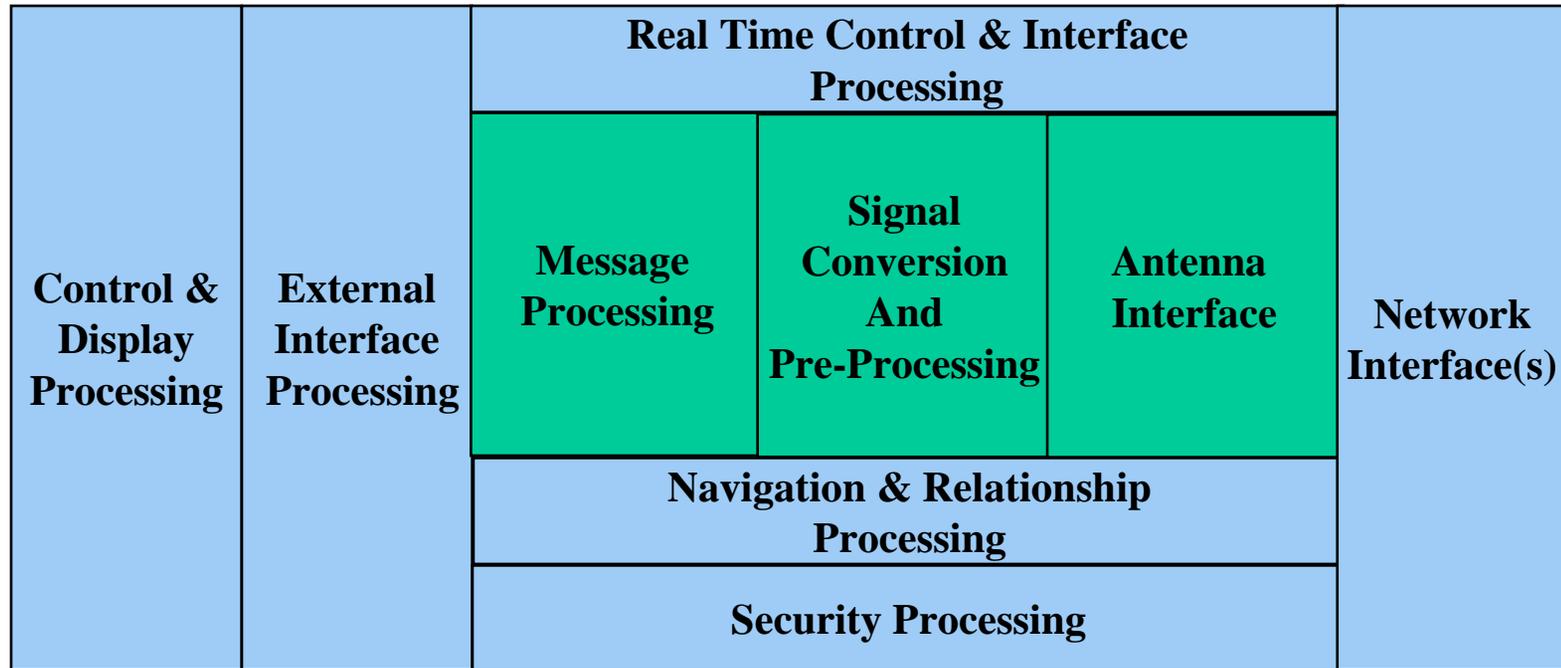
# SDR Architecture Advantages

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- **Common Assets capable of performing any of the functions in the radio**
  - ◆ Common hardware
  - ◆ Open Architecture
  - ◆ Software Modularity
- **Graceful Degradation in failure conditions**
- **Open Architecture features allow additional functionality to be added with minimal impact**

- 
- **Software Common Architecture (SCA) Approach**
    - ◆ Well defined Interfaces enable the independence of SW modules
    - ◆ Operating System Isolation Layer (OSIL)
  - **Modifications to SCA approach based on routing of secure data**
    - ◆ Isolation of key data Paths
    - ◆ No multi-tasking of processors to ensure security measures are implemented

# HW/SW Processing View





**SDR's used for ATC purposes will require at least commercial cryptography to prevent the networks from penetration**

- **Anti Hi-Jack**
- **Anti Spoofing**
- **Positive Identification of participants**

# Testing for HW/SW Independence

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- **Identification of Testable Requirements during the Systems Requirements phase**
- **Test Early and Test Often**
  - ◆ Conduct performance testing at lowest levels possible
  - ◆ Identify key performance points proving functional independence
  - ◆ Stress testing of data busses, data processors, critical timing and interfaces

# System Buildup (At the outset)

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- **Primary objective: prove independence of Software and Hardware modules**
  - ◆ Without independence system will suffer significant regression testing
- **During Systems Engineering**
- **Define testable requirements**

# System Buildup (Early Testing)

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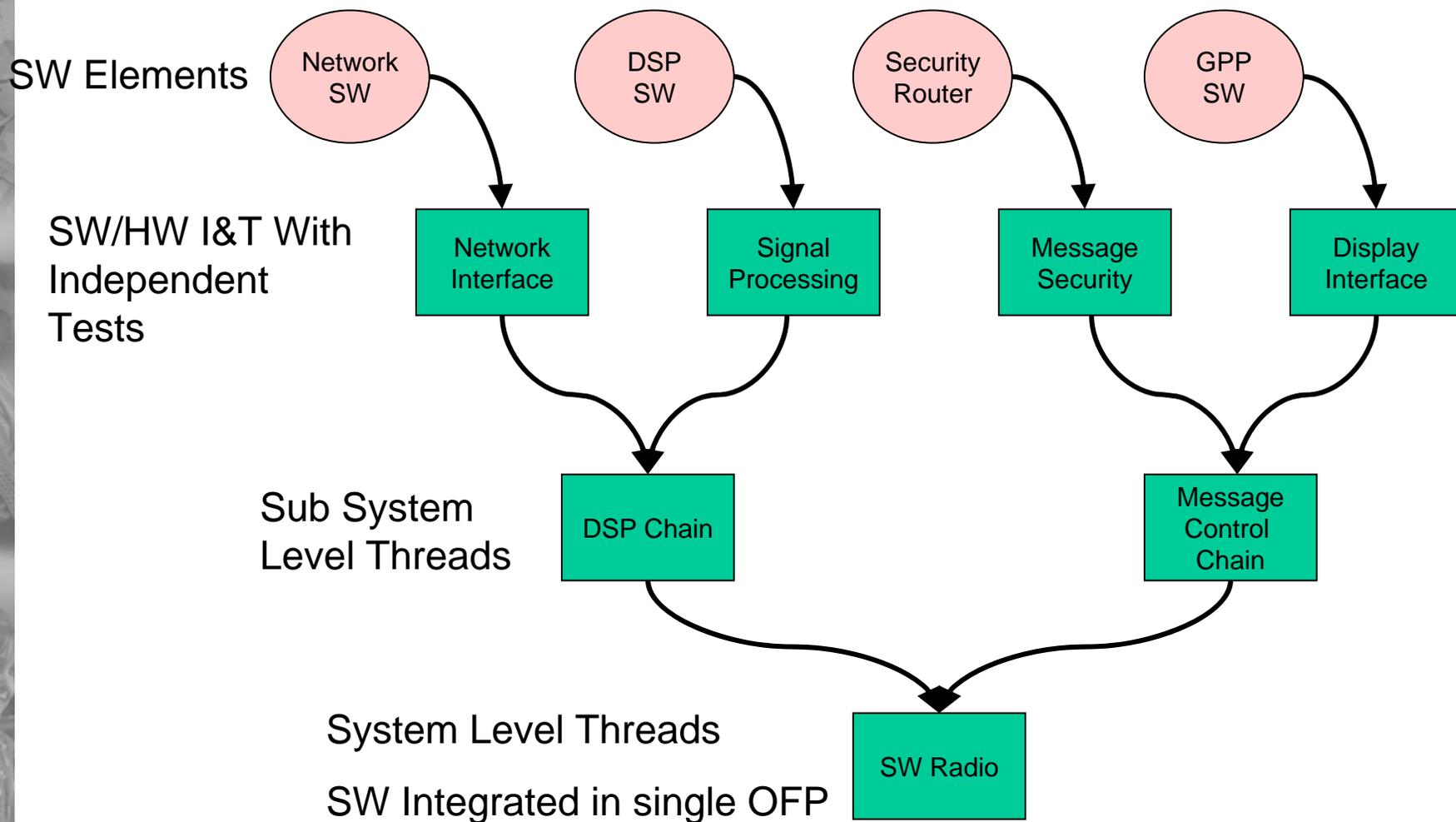
- **Independence of functions must be tested at the lowest possible levels**
- **Test Early and Test Often**
  - ◆ Provides key data and results determining independence
  - ◆ Ensures key interfaces are solid
  - ◆ Proves hardware and software meet the standards of open architecture

# System Buildup (Initial Integration)

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- **Early indication of design or manufacturing margins**
  - ◆ Hardware and software benchmarks
  - ◆ Timing and throughput issues
  - ◆ Bus Loading
- **Test to Fail**
- **Allows design improvements at next iteration to be accomplished w/o regression testing**
  - ◆ Highlights design weaknesses
  - ◆ Illustrates over design conditions

# Initial I&T



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# System Buildup (Design Iterations)

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- **Integration and Test takes place at each stage or iteration of the development**
- **At each design iteration there is an associated integration and test phase**
- **Test complexity and level are commensurate with complexity of the iteration**
  - ◆ Early testing generally collects low level data
  - ◆ Later testing collects system level functional testing

# System Testing

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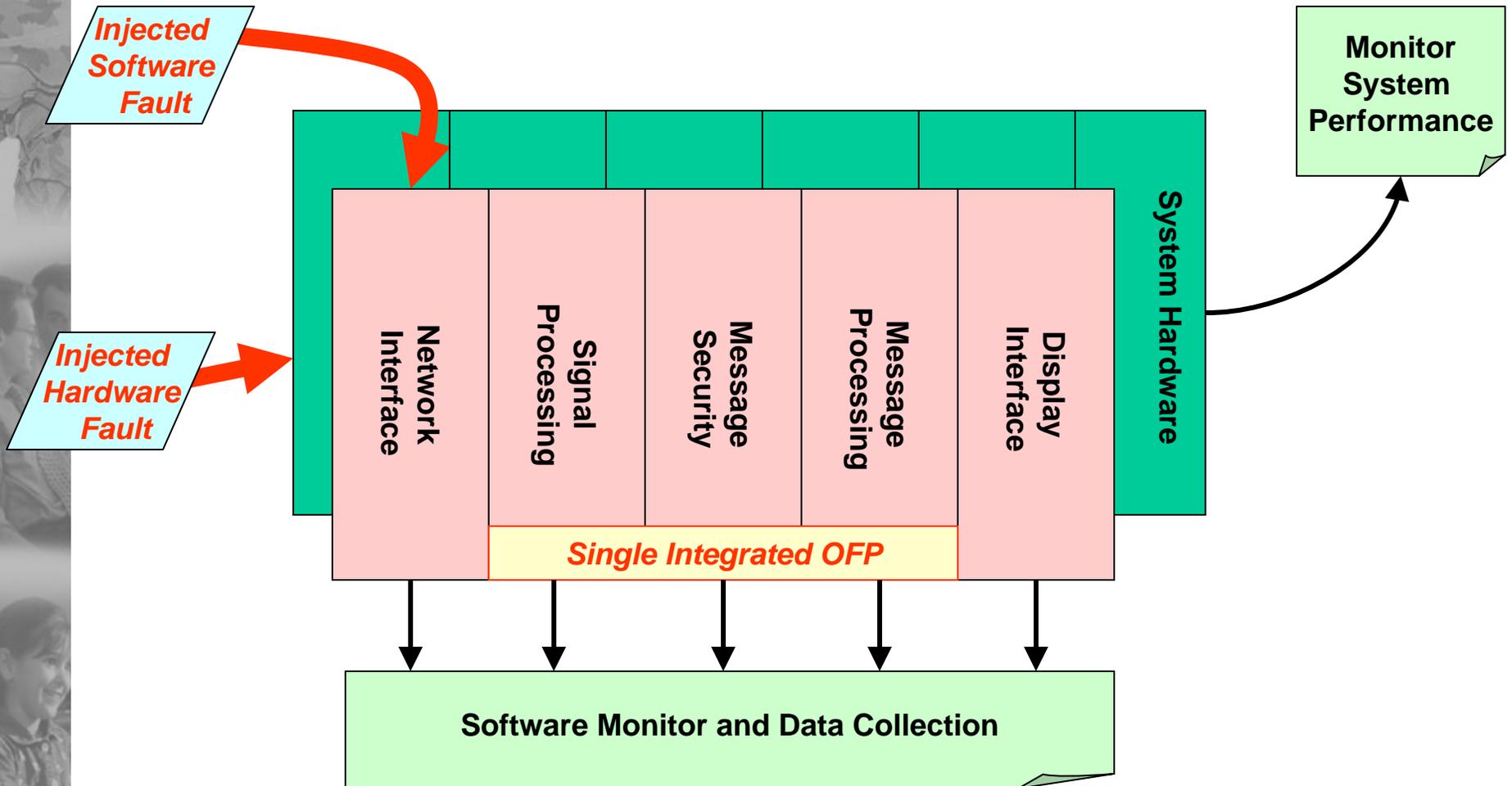
- **Accomplished with a Single Operational Flight Program (OFP)**
- **Testing in the presence of software and hardware failures**
- **Proves capability and robustness of the individual waveforms**
- **Allows post deployment of upgraded functions**
  - ◆ Addition of new function will directly impact basic system performance if independence does not exist

## Testing Sequence

1. **Fault Single Software Element**
2. **Fault Single Hardware Element**
3. **Fault Two Software Elements**
4. **Fault Two Hardware Elements**
5. **Fault Multiple Software Elements**
6. **Fault Multiple Hardware Elements**

# System Software Testing

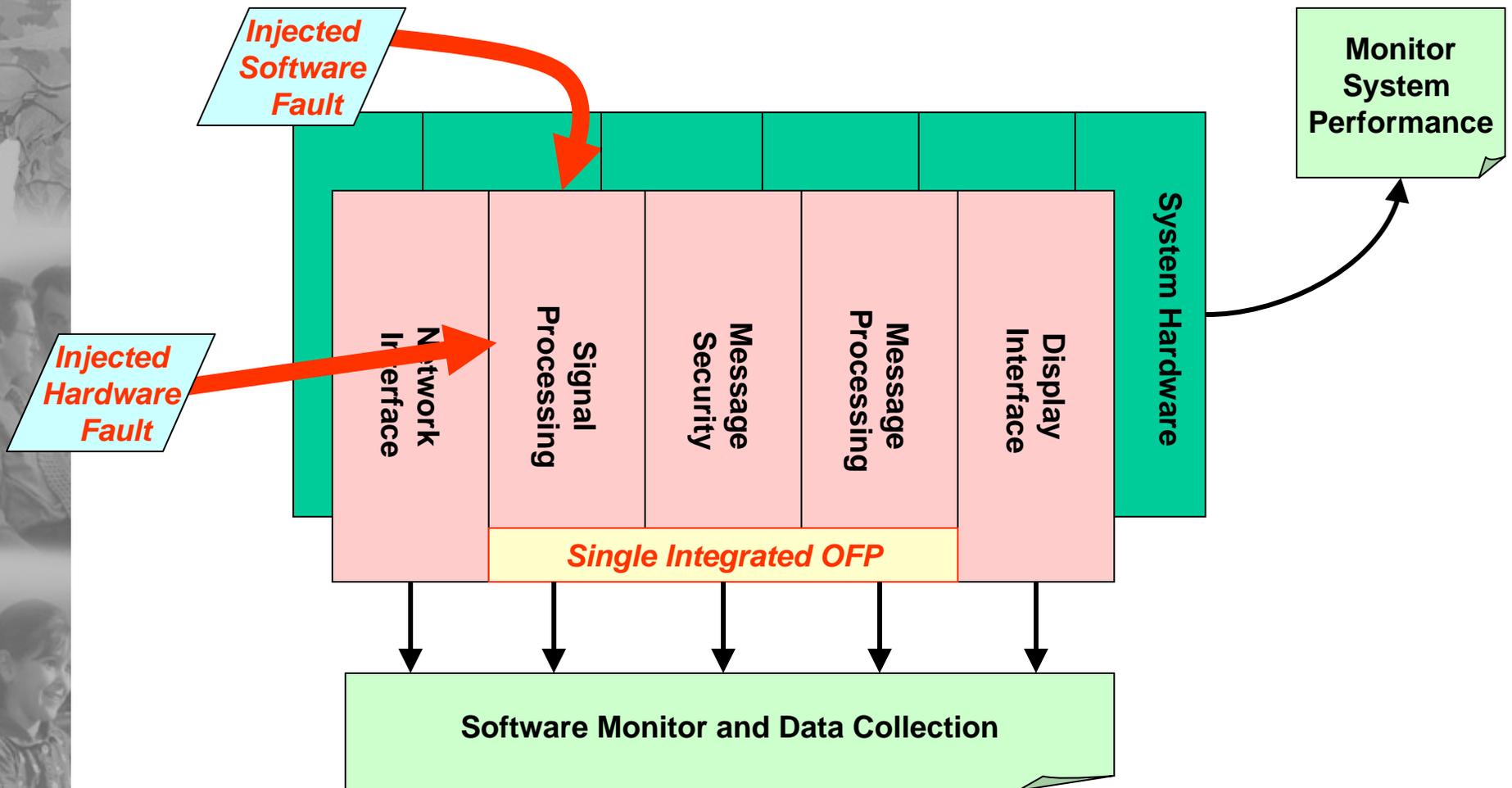
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# System Software Testing

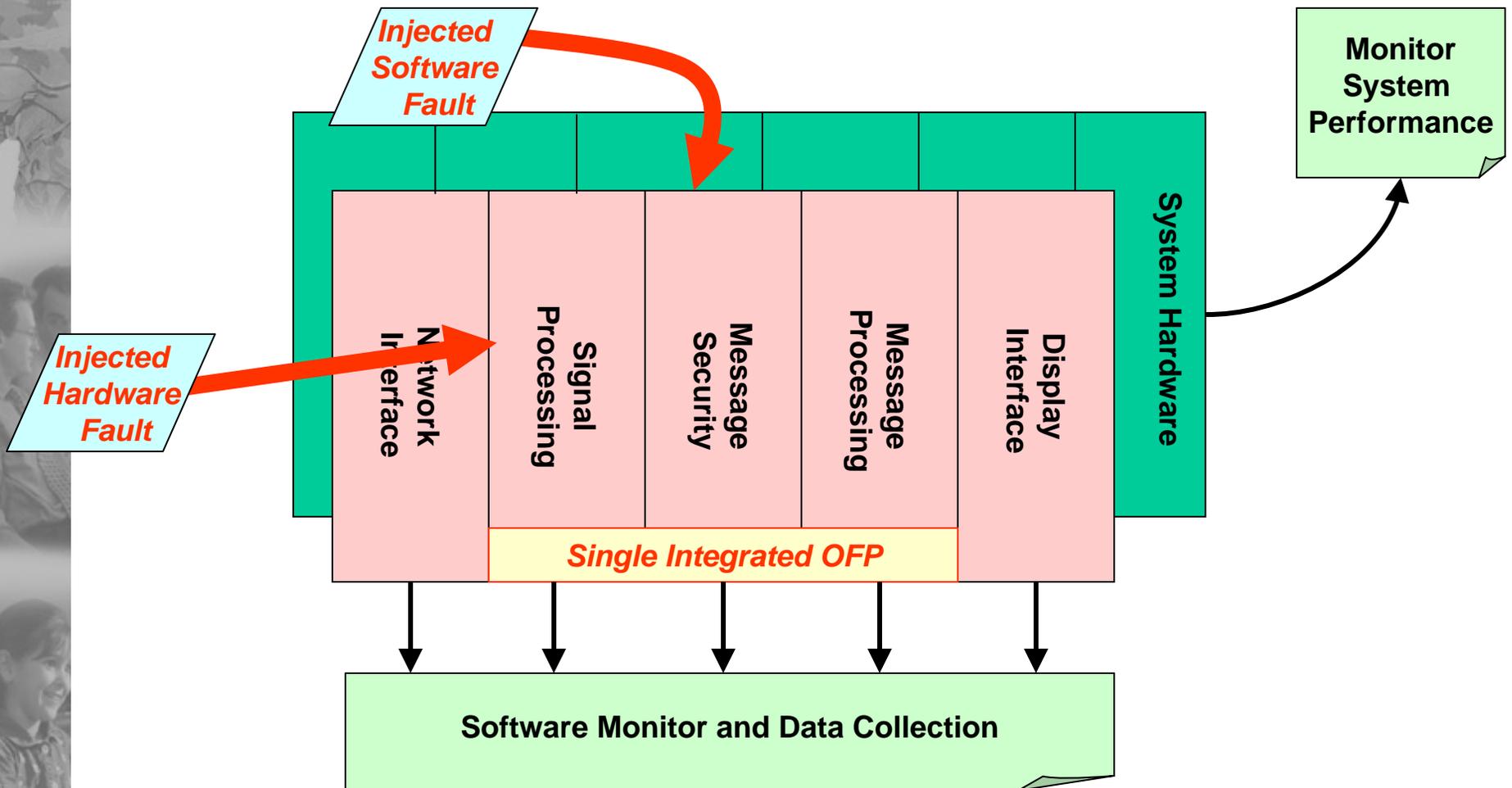
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# System Software Testing

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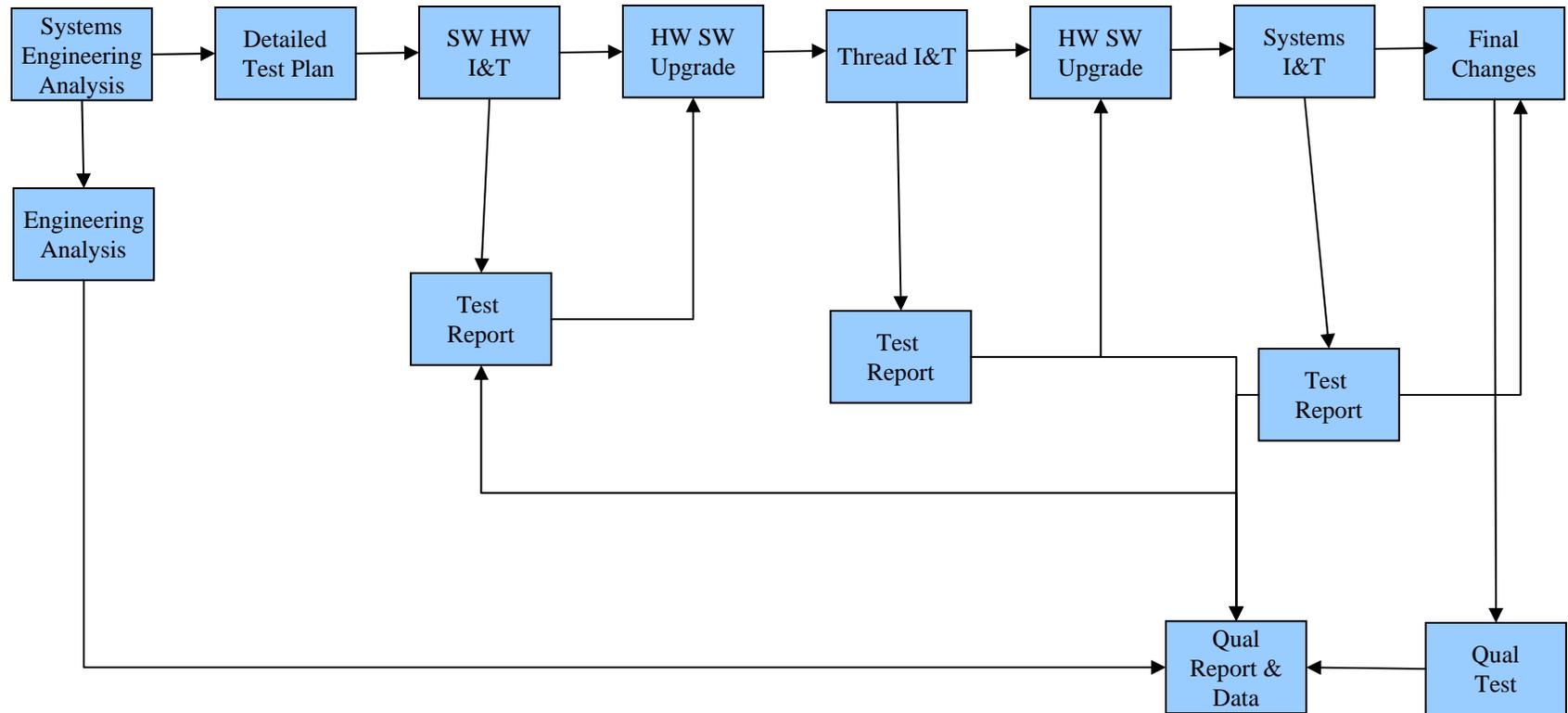
# Keys to Successful Testing



## Proving Software/Hardware element independence:

- **Single Faults in the System do not affect other functions**
- **Multiple Faults do not cause other avionic systems to fail or fault**
- **Inject faults until you find the weak portions of the design.....test until you create failures**
  - ◆ You need to know the limits of the software and the hardware in order to minimize risk of adding functions later

# Documentation and Certification Flow



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# Summary

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- **Software Defined Radios are an enabler to change deployment of radio systems**
  - ◆ Open Architecture
  - ◆ Iterative Design process
  - ◆ Lower Qualification risk
- **Issues still need investigation**
  - ◆ Pilot initiated Reconfiguration
  - ◆ Operations in the presence of failures
    - Maintenance or fly?
- **Test Early and Often**
  - ◆ Performance Based Specifications with testable requirements
  - ◆ Test to failure to discover the true system limits