FPGAs in Safety-Critical Systems

Advantages and Disadvantages

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Topics For Discussions

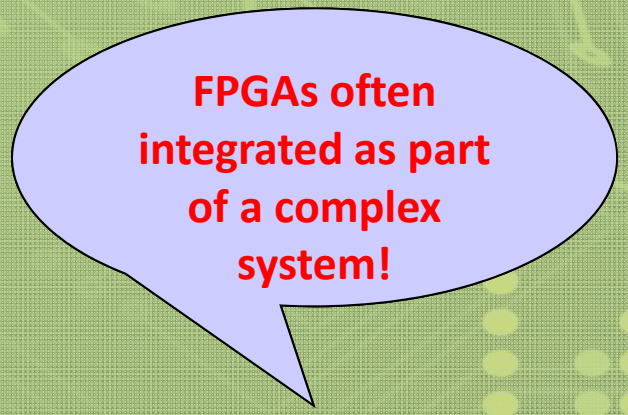
- Overview of FPGA Technology
- Modern applications of FPGAs
- Benefits of FPGAs in Safety-Critical Systems
  - Comparison against other technologies
- Example of a safety-critical system
  - Satellite Communication System
- Demonstration
- Questions

What is an FPGA?

- Field-Programmable Gate Array
  - Integrated Circuit
  - User-defined functionality
    - Flexible function
  - Array of high-density logic elements
    - Memory
    - Interconnect
    - DSP elements
    - High-speed Interconnects
    - Analog and Digital I/Os

Modern FPGA Applications

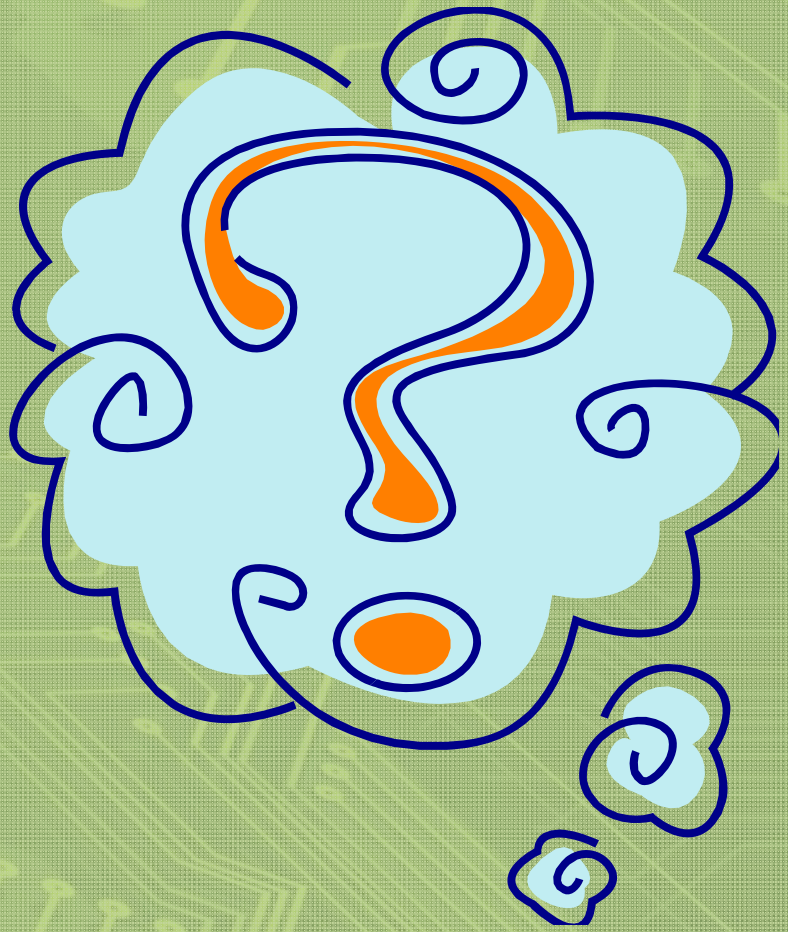
- Telecommunication
  - Satellite Communication
  - Digital signal processing
- ASIC prototyping
  - System-on-Chip (SoC)
  - Embedded processing
- Safety-Critical Systems
  - Medical Imaging
  - Built-In-Self Testing (BIST)
  - Telecommunication Networks
    - **Satellite Communication Systems**



Leveraging FPGAs in Safety-Critical Systems

- Advantages
  - Performance (vs. uProc)
  - Time to Market (vs. ASIC
  - Cost (vs. uProc)
  - Reliability (vs. uProc)
  - Long-Term Maintenance (vs. ASIC)
  - Reprogrammable (vs. ASIC)
  - Increased reliability (vs. uProc)
  - Logical redundancy
- Disadvantages
  - Non-volatile (vs. CPLD)
  - Power consumption (vs. ASIC)
  - Large Package size (vs. ASIC)
  - Embedded processing are implementation-specific (vs. uProc)
  - Cost (vs. ASIC)

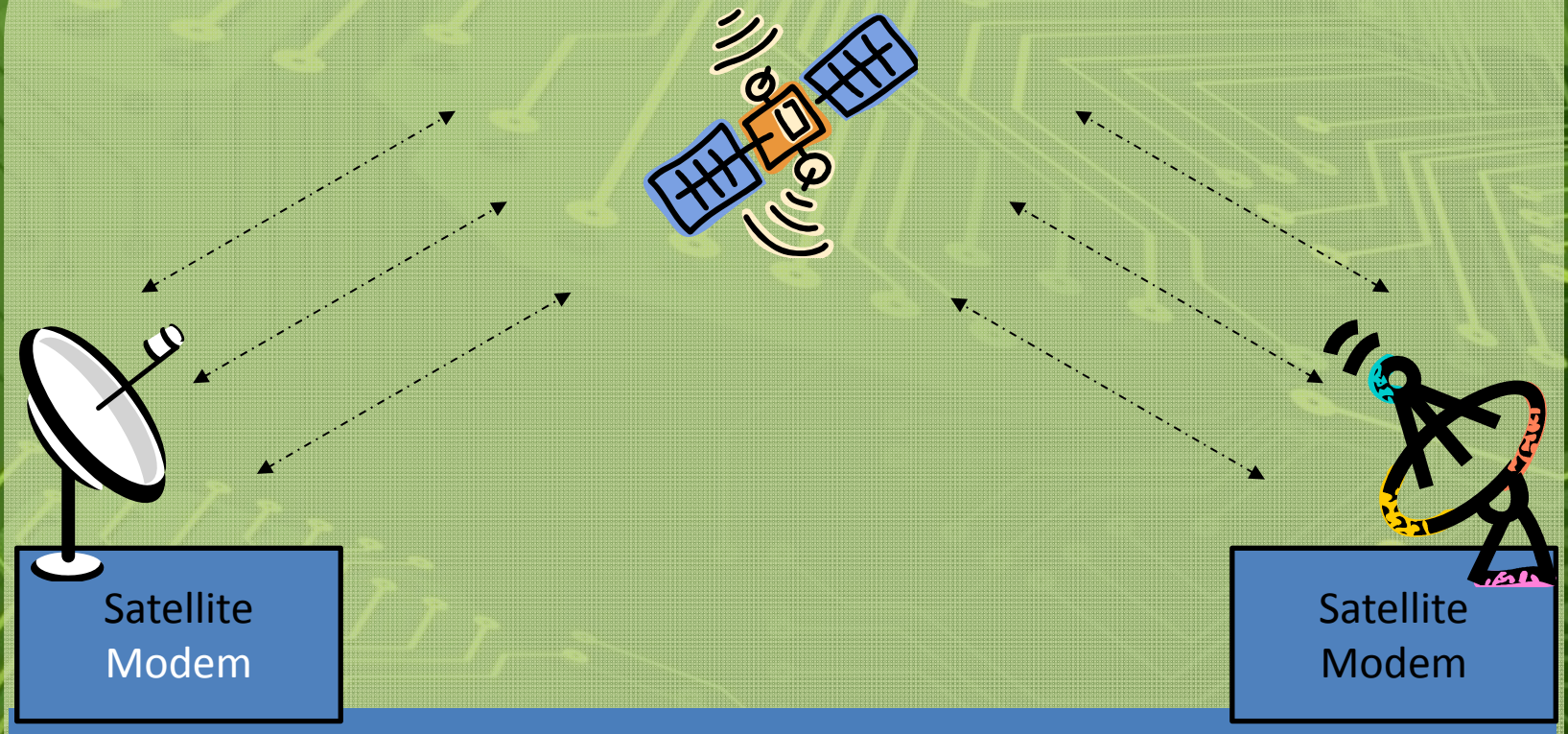
Are Communication Systems Safety-Critical?

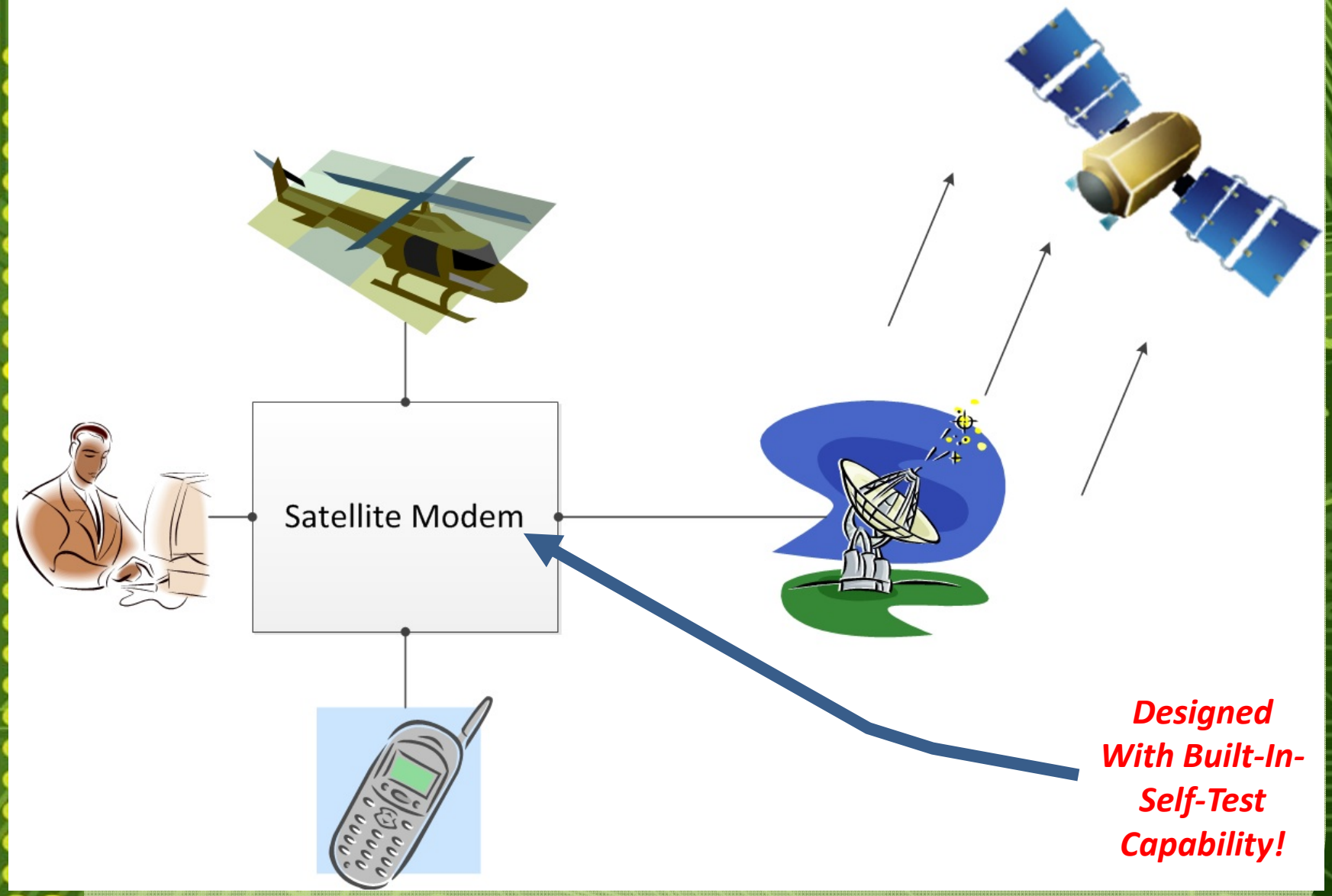


Are Communication Systems Safety-Critical?

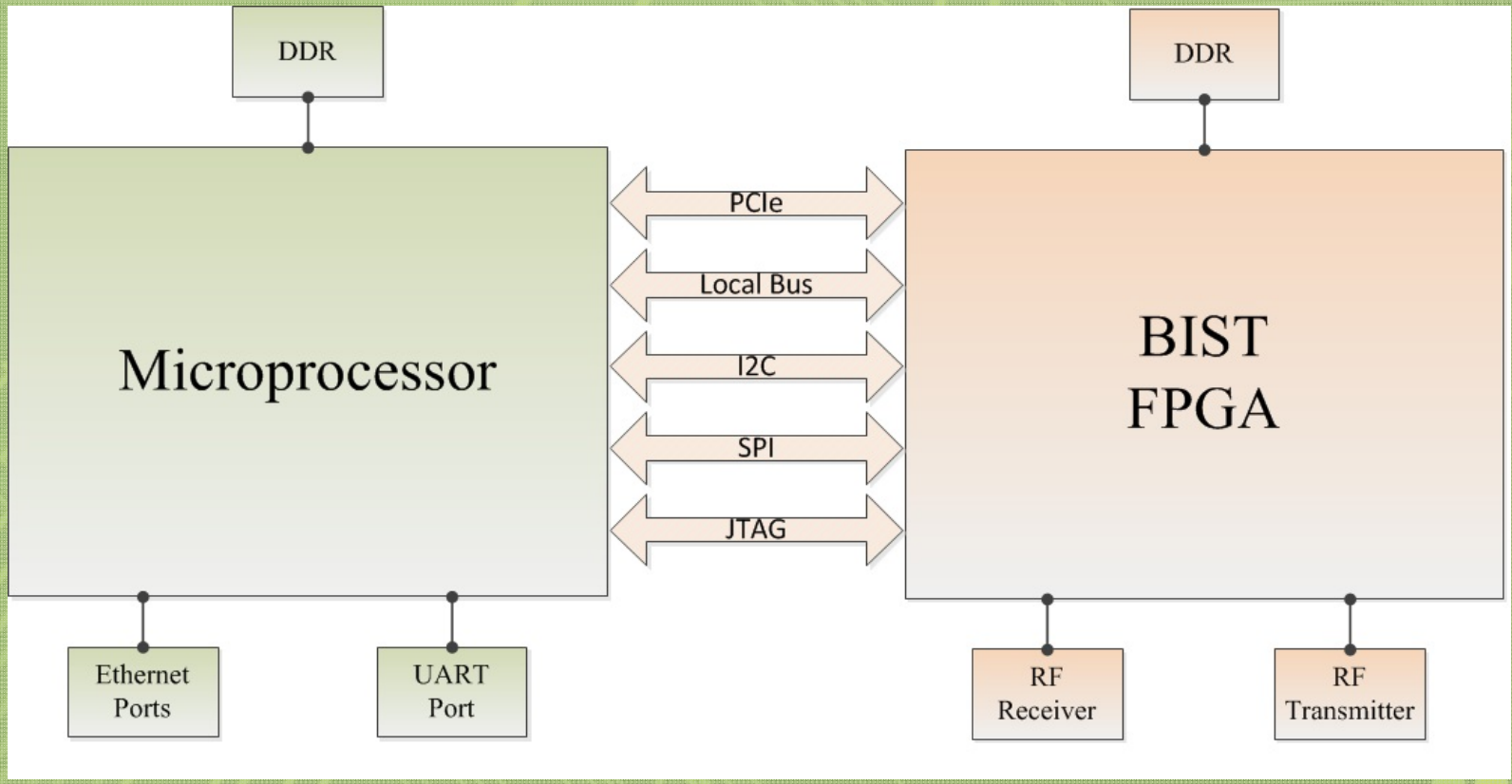
- Many other safety-critical systems are dependent:
  - National Security
    - Military
  - Emergency Response
    - Police
    - Fireman
    - Emergency Notification
  - Power Distribution Systems
    - Nuclear Power Plants

Satellite Network System

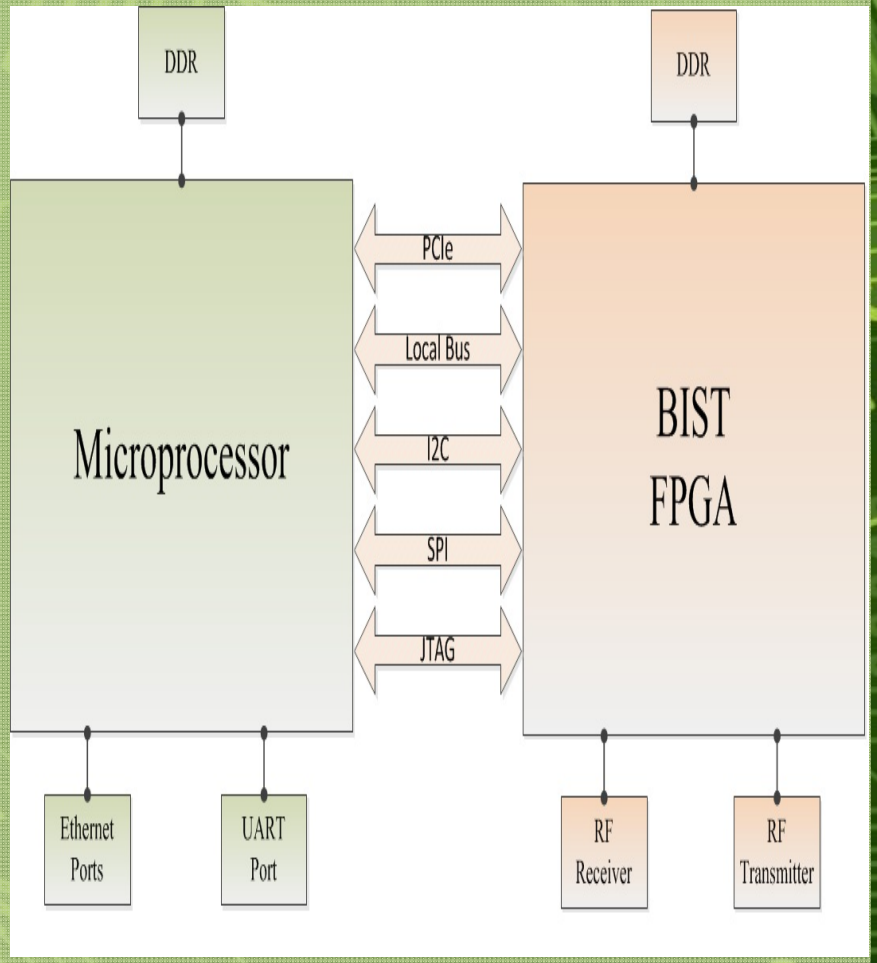



Satellite Modem
Designed With Built-In-Self-Test Capability!

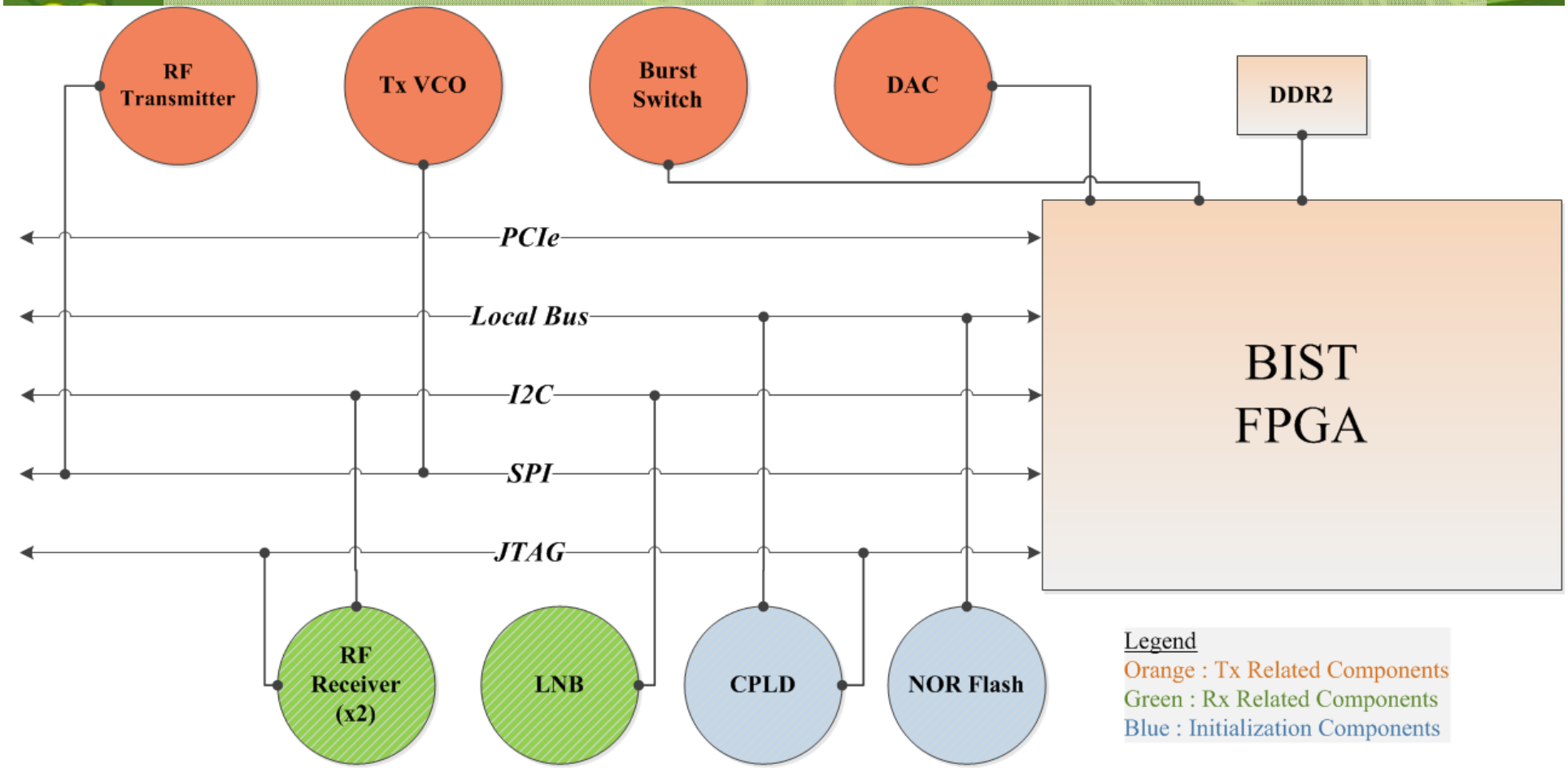
Schematic Of Satellite Modem



- The Processor:
  - Provides console interface
  - Buffers data packets
  - Implements IP stack
- The FPGA :
  - Interfaces with RF signals
  - Validates interfaces and communication to connecter peripherals
  - Communicates status to processor



FPGA Test Coverage



FPGAs Role In Safety-Critical Systems

- Continuous testing
  - Passive, self checking
  - Detection of faulty parts
  - Useful for manufacturing testing

Demonstration

- FPGA provides BIST
  - Interface testing
- Component configuration
- RF Testing and characterization
- RF loopback testing
- Interactive test capabilities
- Embedded scripting support
  - Provides ability to for specialized test scenarios
  - Embedded Interface

Summary

- FPGAs are commonly used for testing PCB
- Embedded processing
- Self-checking
- Fast turn around time
- Easier to update for changes in future