FPGAs in Safety-Critical Systems
Advantages and Disadvantages

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March 22, 2012
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?
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• Many other safety-critical systems are dependent:
  – National Security
    • Military
  – Emergency Response
    • Police
    • Fireman
    • Emergency Notification
  – Power Distribution Systems
    • Nuclear Power Plants

We cannot survive without communication systems!
Satellite Network System

Satellite Modem

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
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