Why move from Chips to FPGA and IP?
Example with Mil-Std-1553 IP Cores

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Agenda

- Mil-Std-1553 history
- FPGAs
- Why use IP cores
  - Advantages
  - Emerging needs
- Requirements from IP cores
- Existing 1553 IP cores

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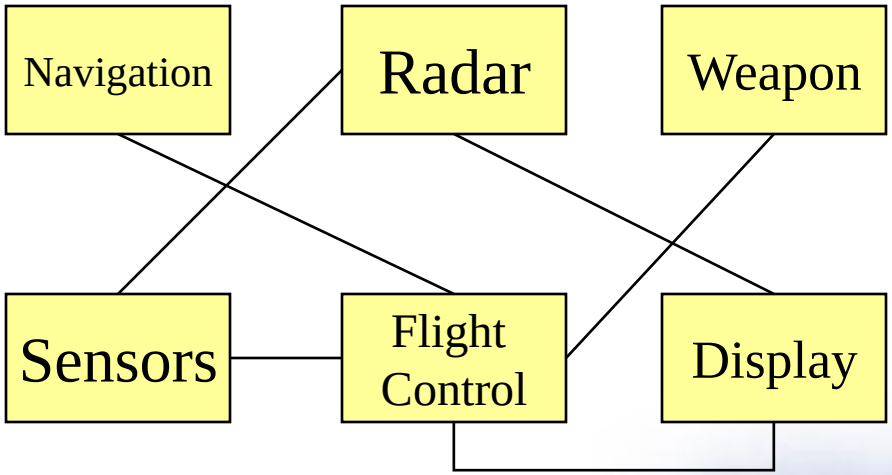
Before 1553

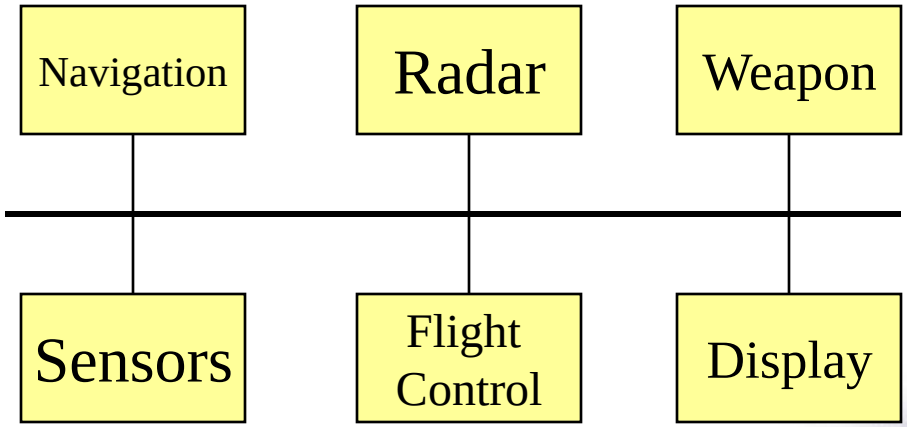
- In 50's and 60's:



  - Too complex to add functionality
  - Weight of aircraft increased

1553 Bus

- In the 70's:



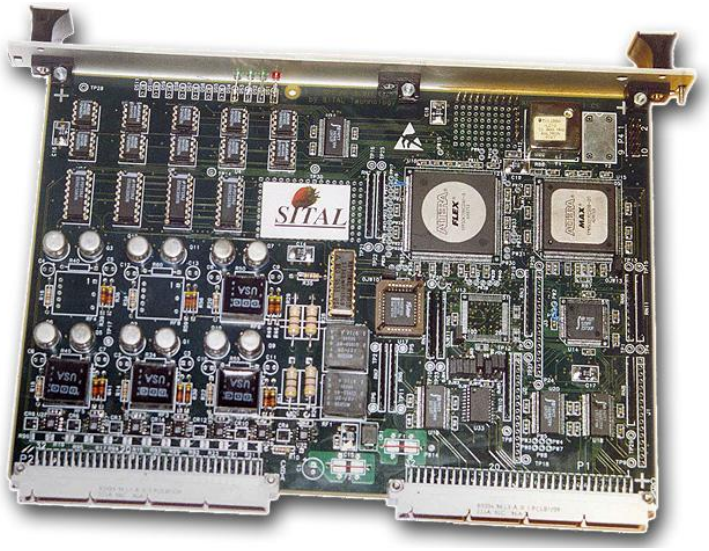
  - Digital data, high-speed
  - A single, shared bus for all units

Mil-Std-1553 History

- 1st release – August 1973
- First used in F-16 A/B, and many others since.
- 1553B – released in 1978
- The standard specifies everything from PHY layer to Application.
  - The protocol, including the message formats, word types, and command and status words.
- 1980 – Notice 1 – restricted options
- 1986 – Notice 2 – definition of usage of options

Mil-Std-1553 Technology

- In 80’s – first IC of 1553 decoder/encoder
- In 90’s – fully integrated 1553 devices, including
  - transceivers,
  - decoder/encoder
  - protocol
- In 2000’s – 1’x1’ devices and less



The Future of 1553

- Smaller size
- Lower price
- Higher speed
  - 10, 20, 200Mbps

- **Mil-Std-1553 is here to stay!**

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What is FPGA?

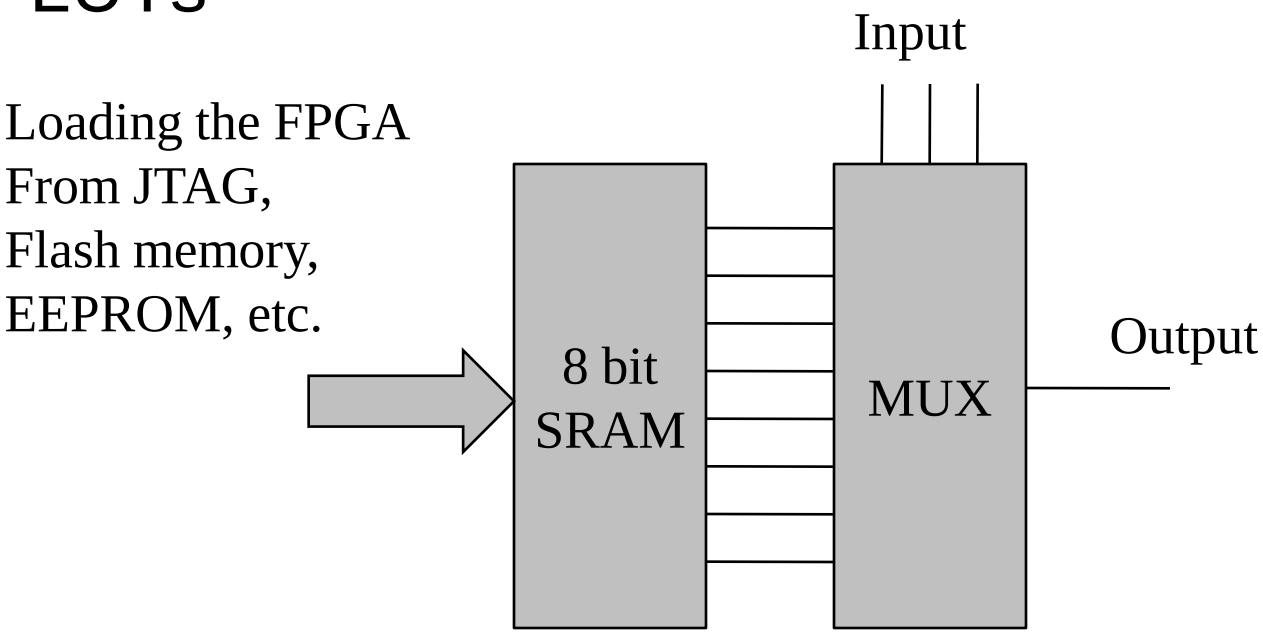
- FPGA = Field Programmable Gate Array
- Millions of logic cells that can be programmed and connected as desire
- Also contains memory arrays, flip-flops, PLLs, counters, and other specific functions that can be programmed.
- Main vendors: Xilinx, Altera, Actel, Lattice
- Come in different families, sizes, shapes, prices, etc.
- Selecting FPGA – by performance, size, memory, IP cores, design tools, radiation tolerance, etc.

Types of FPGAs

- SRAM based
  - Information is loaded into the FPGA on boot-up
  - SRAM memory stores the design
  - Advantages: performance, size
  - Disadvantages: long boot, requires external component, not tolerant to radiation
- Flash based
  - Information within the FPGA on flash memory cells
  - Advantages: instant on, tolerance to radiation
  - Disadvantages: slower, smaller gate-count
- Combined SRAM/FLASH
  - Internal flash load information into SRAM

What is FPGA - LUT

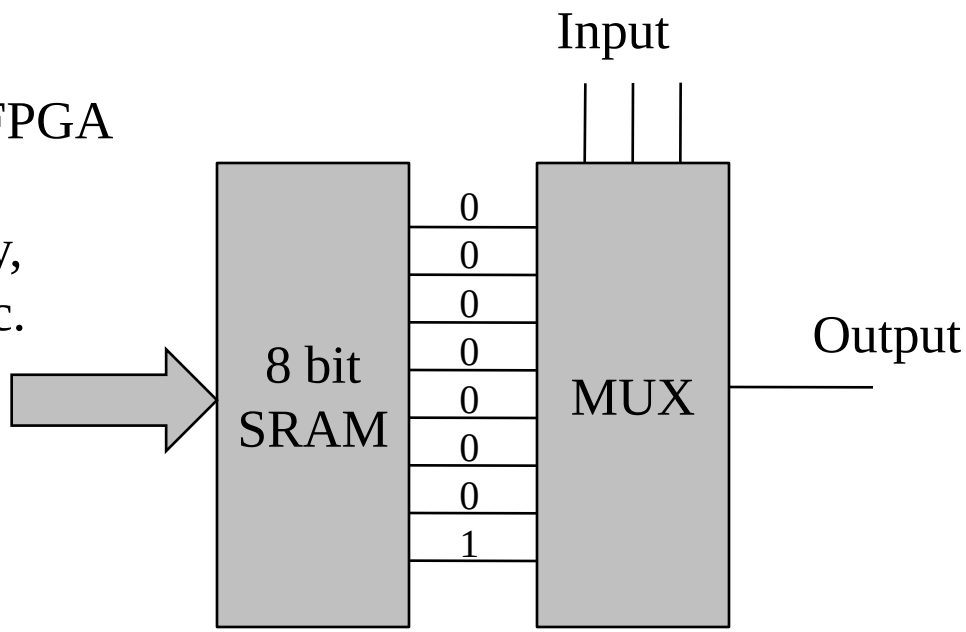
- LUT = Look Up Table
- An FPGA contains thousands to tens of thousands LUTs



What is FPGA - LUT

- The content of the SRAM determines the functionality of the gate – for example AND:

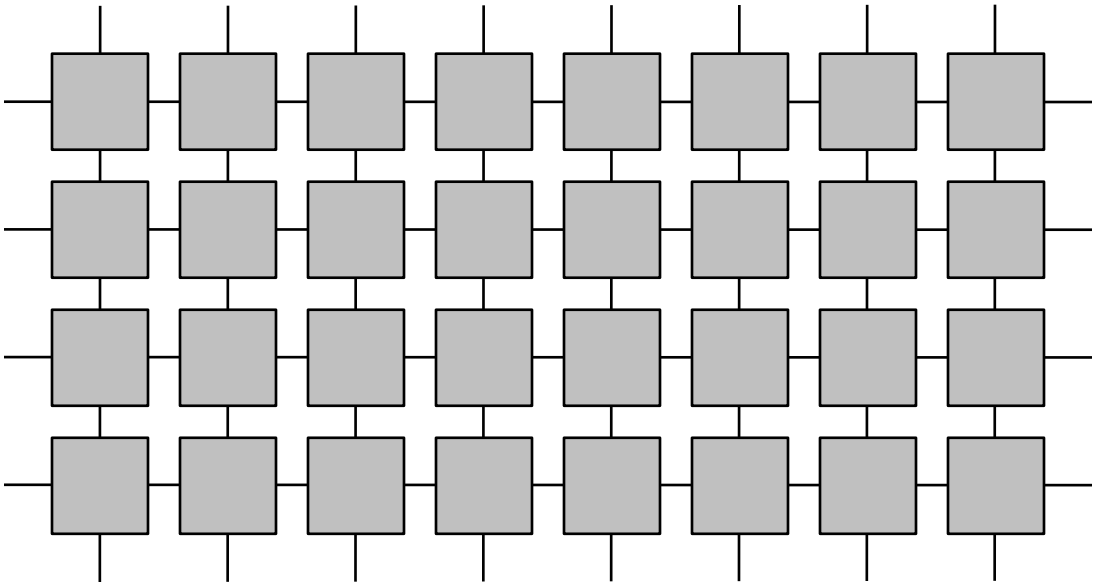
Loading the FPGA
From JTAG,
Flash memory,
EEPROM, etc.



Input	Output
000	0
001	0
010	0
011	0
100	0
101	0
110	0
111	1

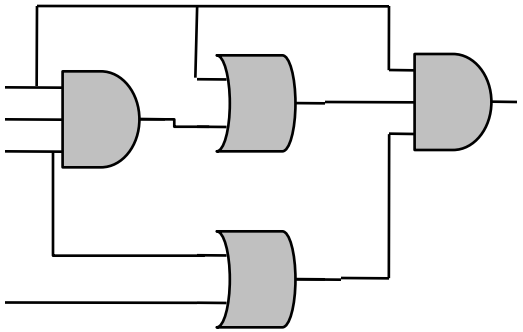
What is FPGA

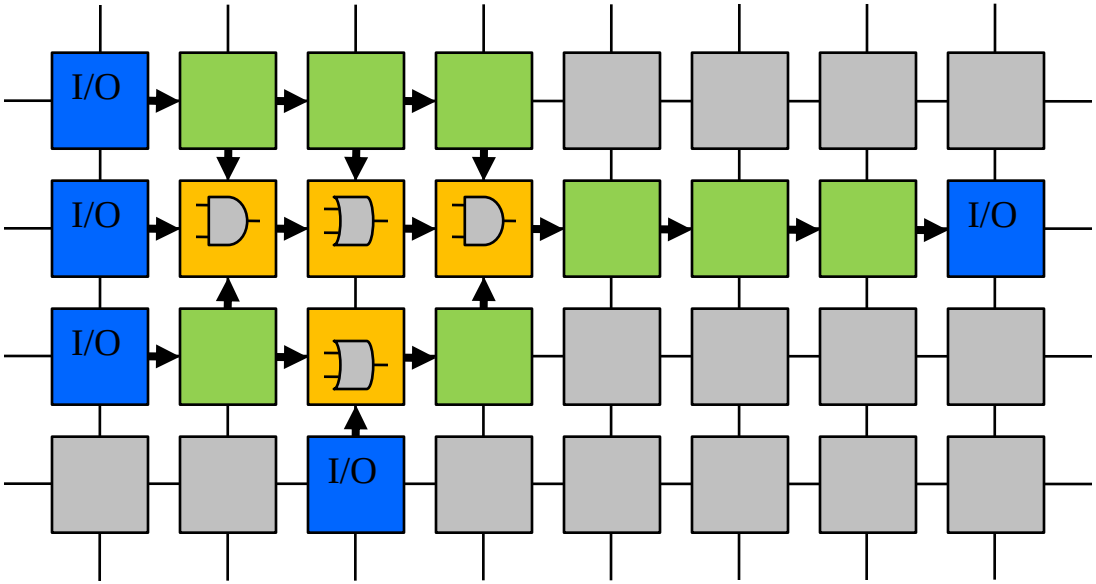
- LUTs are arranged as an array of LUTs
- Other programmable logic within the LUTs determines the connectivity and routes between LUTs, FF, memory, etc.



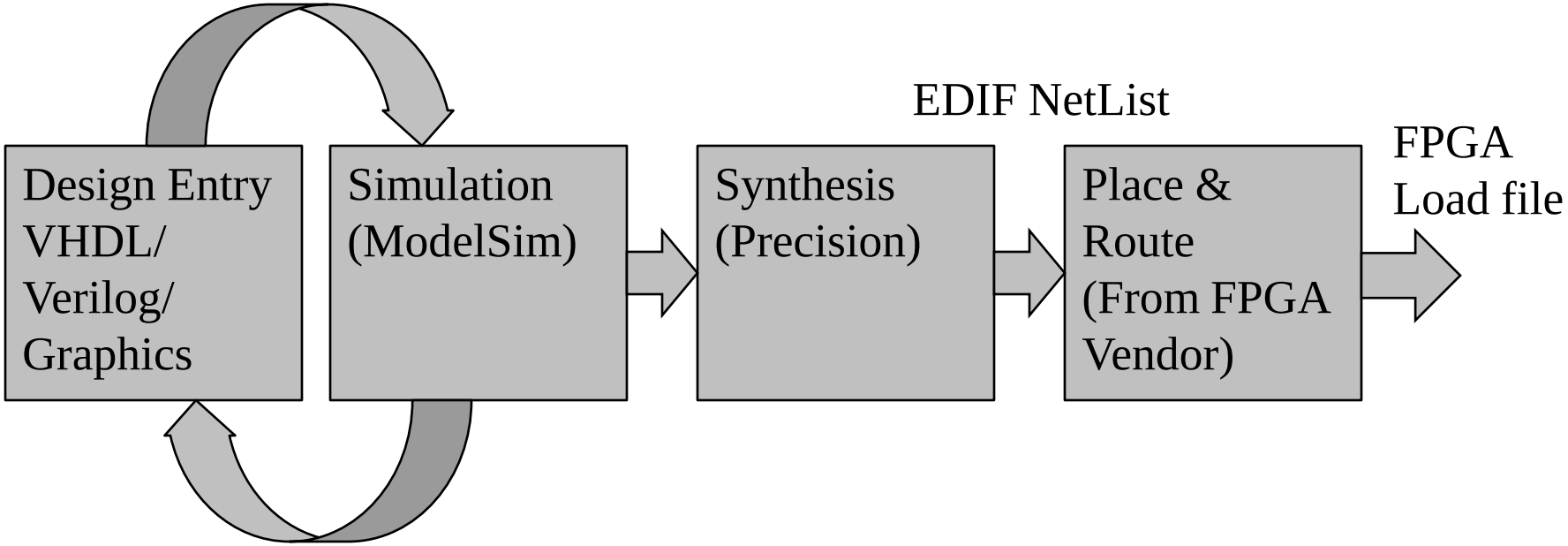
Logic Implemented in FPGA

- For example:





FPGA Design Flow



- We provide EDIF Netlist

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Why IP Cores?

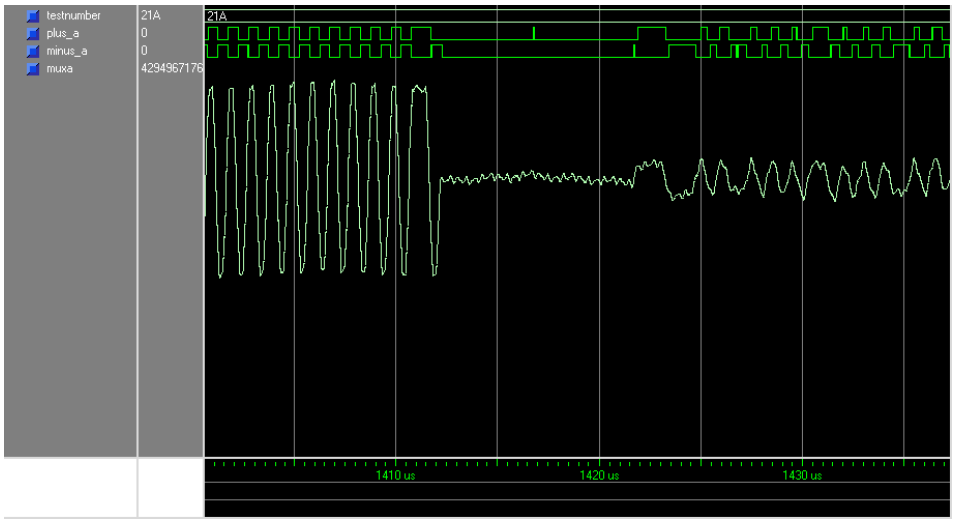
- Functional
  - Flexibility
  - Simplicity
  - Easy evaluation
  - Small footprint
- Cost
  - Cheaper than IC
  - 2nd source to existing vendors
- Future proof

Flexibility of IP Cores

- Use of programmable devices such as FPGAs
  - Single hardware design for various functionalities
    - BC, RT, MT
    - Memory configuration - 4K, 8K, 16K… 64K
    - Support various protocols – Digibus, Mil-Std-1760, PP194, HOO9
  - Stay current with the latest FPGA technology
    - Same design can work with any FPGA
  - Re-program the FPGA for upgrades, bug-fixes or during development
    - Even via 1553 bus
  - Re-program FPGA during operation
    - Used in space environment

Simplicity of IP Cores

- IP Core can be easily integrated with other parts of the design
  - Implementation in FPGA is simpler than PCB
  - Interface can be easily manipulated
- VHDL or NetList is easy to simulate
  - Using any simulation tool, like ModelSim, etc..
  - All functionality can be simulated

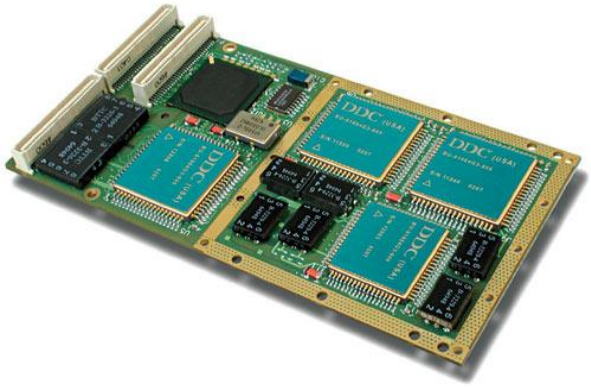


Easy Evaluation

- IP cores can be downloaded or sent by Email
  - No need to wait for hardware to arrive
- Limited versions of IP cores may be available for evaluation
  - full test bench
  - No commitment
- Can be evaluated either by simulation or in a FPGA design kit

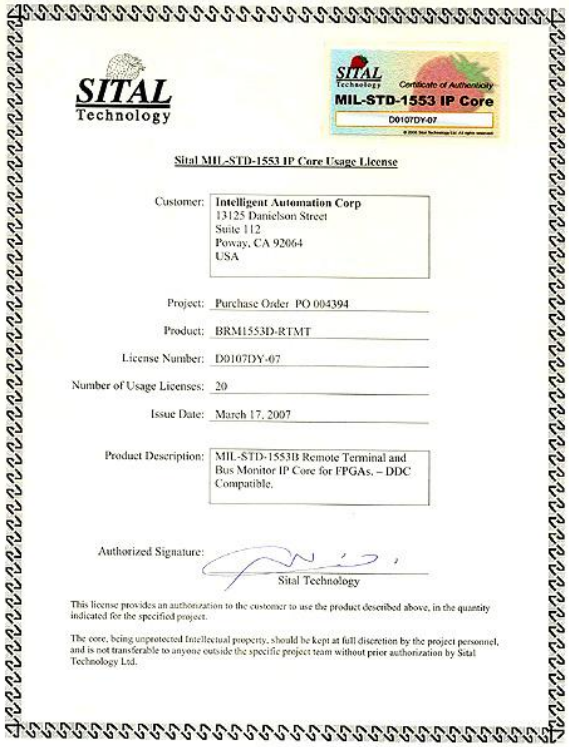
Small Footprint

- In most cases users already have FPGA on board
- Most IP cores require small percentage of FPGA
- Some applications require several 1553 implementations.
  - With IC's, each implementation takes a square inch
  - With IP cores you just need a bigger FPGA (or not)



Cost of IP Cores

- ICs combine both the IP assets of the IC producer and costs of manufacturing, shipping and stocking
- NRE of IC's is high
- IP Cores include only the IP assets
  - No shipping, stocking or manufacturing costs



SITAL Technology

SITAL Technology Certificate of Authenticity
MIL-STD-1553 IP Core
D0107DY-07

Sital MIL-STD-1553 IP Core Usage License

Customer: Intelligent Automation Corp
13125 Danielson Street
Suite 112
Poway, CA 92064
USA

Project: Purchase Order PO 004394

Product: BRM1553D-RTMT

License Number: D0107DY-07

Number of Usage Licenses: 20

Issue Date: March 17, 2007

Product Description: MIL-STD-1553B Remote Terminal and Bus Monitor IP Core for FPGAs. – DDC Compatible.

Authorized Signature:
Sital Technology

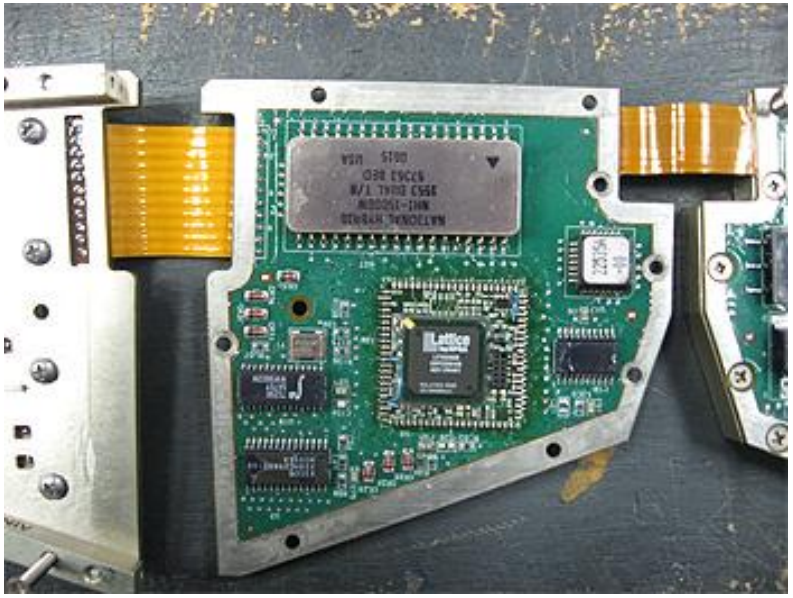
This license provides an authorization to the customer to use the product described above, in the quantity indicated for the specified project.

The core, being unprotected Intellectual property, should be kept at full discretion by the project personnel, and is not transferable to anyone outside the specific project team without prior authorization by Sital Technology Ltd.

2nd Source, Obsolete replacement

- IP Cores can serve as 2nd source to existing ICs
  - Drive price down
  - Reduce risks
  - Obsolete replacement

- Obsolete Replacement
  - Use existing form-factor and pinout



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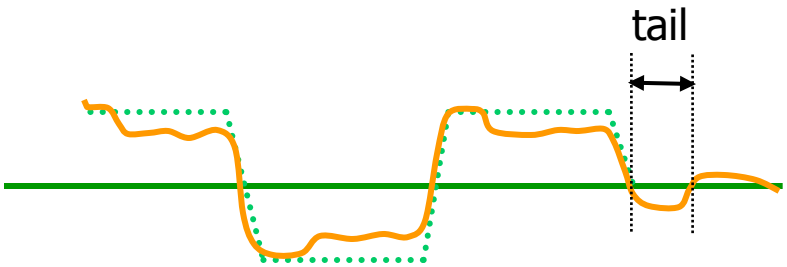
Emerging Needs in 1553

- Cost reduction
  - With ICs – around ~750$ per channel
- Smaller footprint
  - Boards are smaller
  - More channels
- Added functionality
  - Bus testability
  - More interfaces
  - Better integration

Innovation in 1553

- “Tails-Code-Key™” technology for bus maintenance
  - Parametric testing of bus quality and connectivity
  - Real-time measurements of signal quality
  - Pin point bus problems
  - Single failure event recording



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Requirements from IP Cores

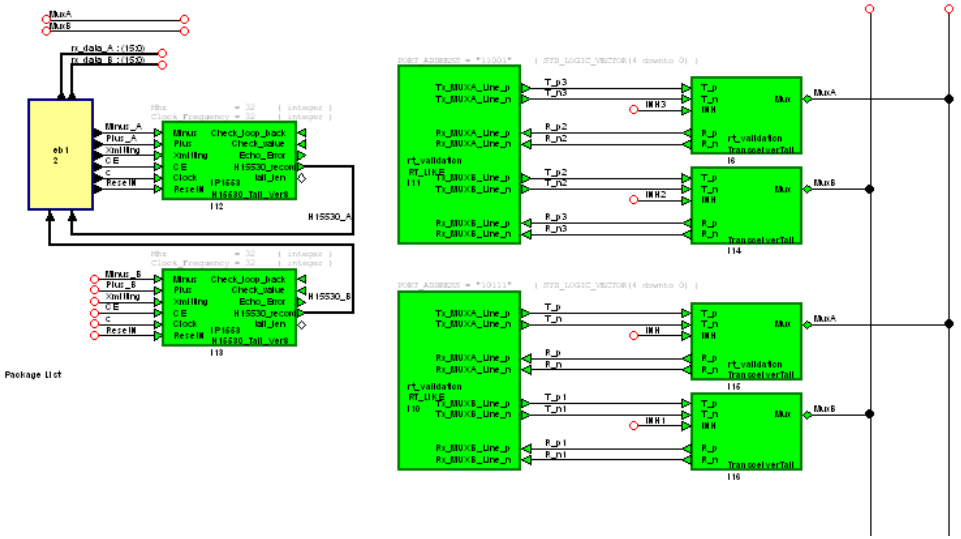
- 1553 Validation
  - Like any other 1553 device
- Support all FPGA vendors and families
  - General purpose FPGA to Rad-Hard
  - Independent VHDL/Verilog code
- Small size
  - To fit into any design, with any FPGA

Requirements from IP Cores (cont.)

- Support any clock frequency
  - Less clock domains
  - Synchronized design
- Simple integration
  - Simple interface
  - Legacy interface
  - Provided with test bench
  - Documentation

Requirements from IP Cores (cont. 2)

- Test bench
  - 1553 signal generator
  - Transceiver model
  - Data flow from 1553 bus to the back-end interface



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Who Offers IP Cores for 1553?

- Condor Engineering (GE Fanuc)
  - FlightCORE-1553
  - Supports Altera and Xilinx
  - Requires personality module
  - Don’t have transceivers
  - NRE + Royalties
  - Works at 40MHz

- DDC
  - SSRT-Core, ACE Flex-Core
  - Compatible to DDC MiniAce®
  - NRE + Royalties (via transceivers)
  - Works at 40MHz

*Products and company names listed are trademarks or trade names of their respective companies.

Who Offers IP Cores for 1553?

- Actel
  - Core1553BRM
  - Works only with Actel FPGAs
  - Very basic functionality
  - Don’t provide transceiver
  - Practically free

*Products and company names listed are trademarks or trade names of their respective companies.

Who Offers IP Cores for 1553?

- Sital Technology
  - Avionics
    - BRM1553FE
      - BC, RT, MT, Front End
    - BRM1553D
      - BC, RT, MT, DDC Compatible
  - Space
    - BC1553ERL
      - BC, Extended Reliability
    - RT1553ERL
      - RT, Extended Reliability

- Very small gate count
- Can work with any even clock frequency (12, 14, 16…50, 66, …Mhz), reduces design complexity
- Can work with any transceiver
- Does not require CPU for management and interface
  - No SW integration required
  - Reduces total system size
- Software compatible to DDC drivers
- State machine can recover from any XXXX state

– Made in Israel

Summary

- 1553 is here for 20-30 year more
- The future implementation is on FPGA, using IP Cores
- IP Cores are flexible, simple, can be easily evaluated, reduces board size, cheaper than IC and can be 2nd source to existing IC vendors
- IP Cores can add functionality to 1553
- IP Cores need to be validated for 1553, work with any FPGA, small, flexible and include test bench
- Condor, DDC, Actel and Sital Technology are the main vendors of 1553 IP Cores.

Thank you!

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