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Implementation of Digital Front End Processing Algorithms with Portability Across Multiple Processing Platforms

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A Process for Implementing Algorithms Across Hardware Platforms

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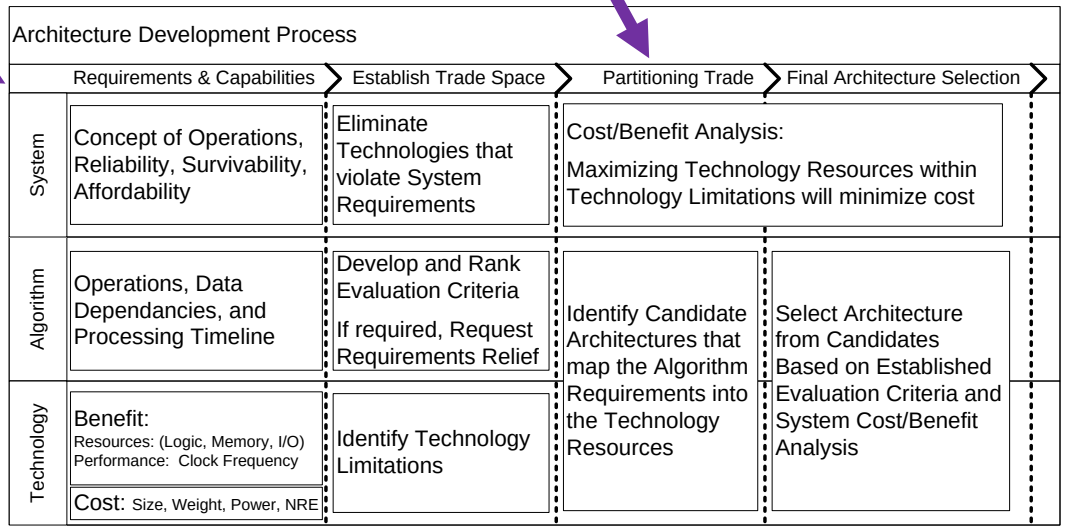
1) Requirements & Capabilities
   - Determine system algorithm requirements
   - Evaluate candidate hardware

3) Partitioning Trade
   - Partition the architecture into technologies



2) Establish Trade Space
   - Critical system requirements
   - Limitations on implementation

4) Final Architectural Selection

Can use this process with any algorithm and implementation

Example: Digital Beamforming

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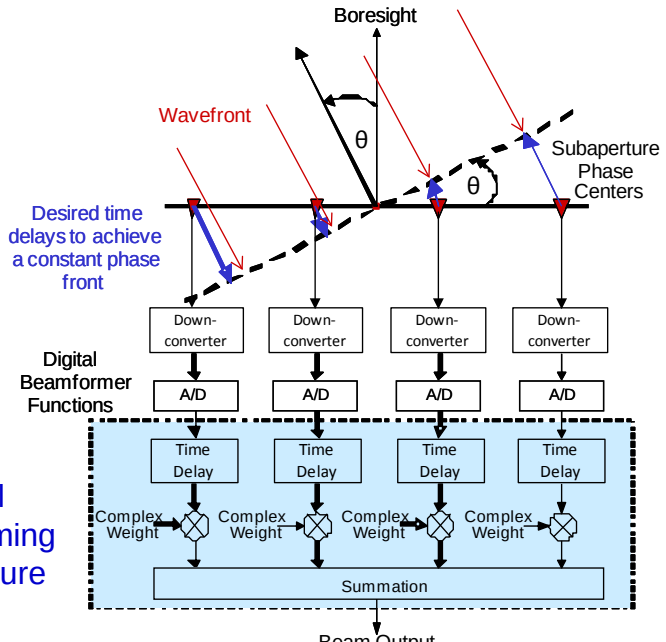
- Digital Beamforming
  - Architecture elements: time delays, phase shifts, synchronization
  - Key Parameters: number of channels, number of beams, signal bandwidth, data bandwidth
- Hardware Implementation Options
  - Devices: ASIC, FPGA, multi-core processors, GPUs
  - Boards:
    - COTS
    - Custom



Digital Beamforming Architecture

Hardware Platform Capabilities and Limitations

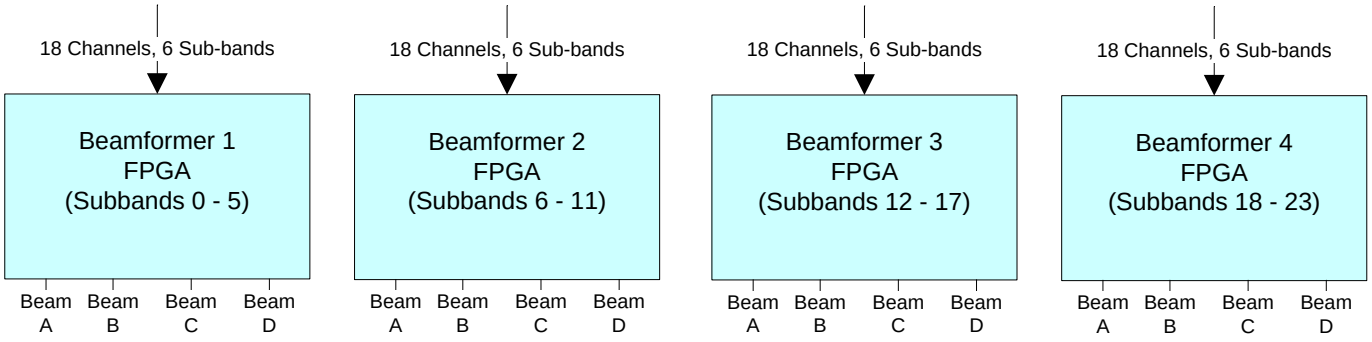
	Custom: ASIC, Board	Custom: FPGA, Board	COTS: FPGA Board	COTS: Processor Board
I/O Flexibility	Highest	High	Medium	Low
Capability	Highest	Medium	Medium	Low
Processing Efficiency	Highest	Medium	Medium	Lowest
Programmability	None	Medium	Medium	High
Complexity	High	Medium	Medium	Low
NRE Cost	Highest	Medium	Low	Lowest
Power	Lowest	High	High	Medium

Each implementation option offers a unique set of capabilities and limitations

Example Architecture: FPGAs on a Custom Board

- System Requirements
  - Process multiple channels
- Algorithm Requirements
  - Over 100 Giga-operations/second
- Trade Space Restrictions
  - Radiation-tolerant FPGAs

- Data Dependencies
  - None between sub-bands
  - Significant dependencies between beams
- Candidate Architectures
  - Minimize number of devices
  - Increase number of subbands in a given device



Architecture for FPGAs on a Custom Board

Architecture achieves a balance between capability, flexibility, and cost

Results: Beamforming Architectures for Land, Air, Sea, and Space

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- Full Custom – ASICs and Custom Board
  - Minimizes power, maximizes performance
- FPGA and Custom Board
  - Minimizes the number of FPGAs
  - Maximizes resource use
- COTS Modular Processor
  - Open system architecture using off-the-shelf hardware.
- COTS and Advanced Processors
  - Highly programmable

Full Custom Digital Beamformer

COTS Modular Processor Beamformer

An adaptable design process allows algorithm portability across platforms