



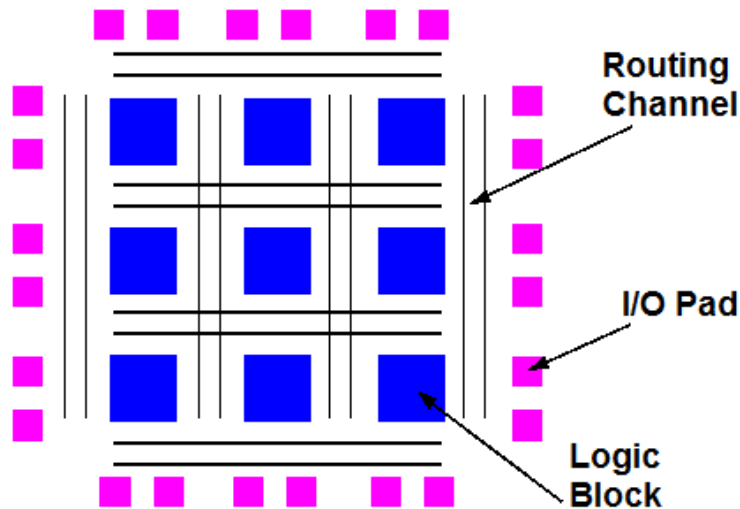
“Using FPGAs to Accelerate Embedded Vision Applications”

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National Instruments

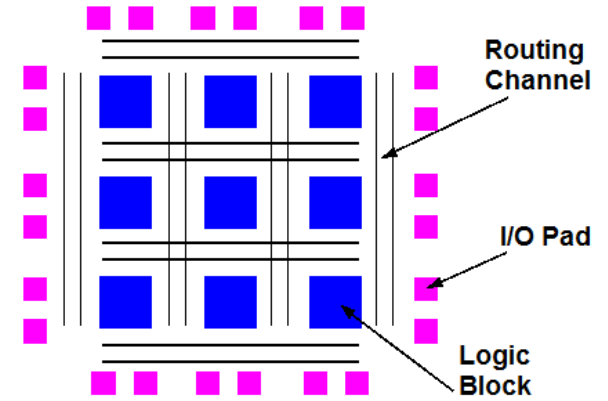


Software-Defined Hardware = FPGA

- Software Programmable (and Reconfigurable)
- Hardware Reliable (and Repeatable)
- High-speed Signal Processing (and Parallel Processing)
- Extreme Determinism (and clock-cycle control)

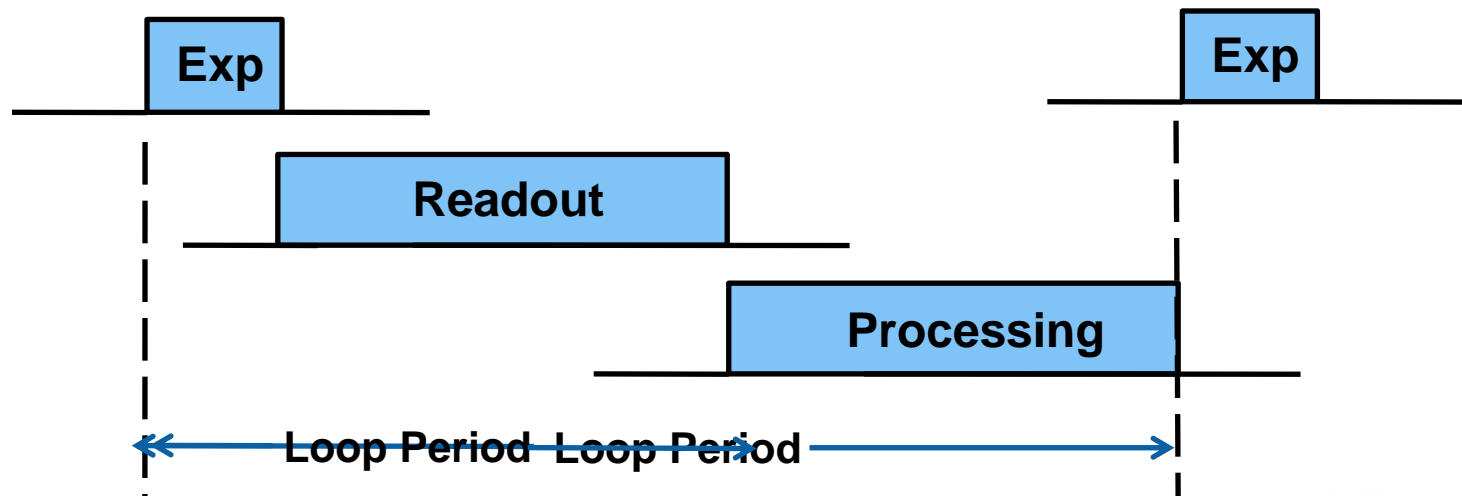
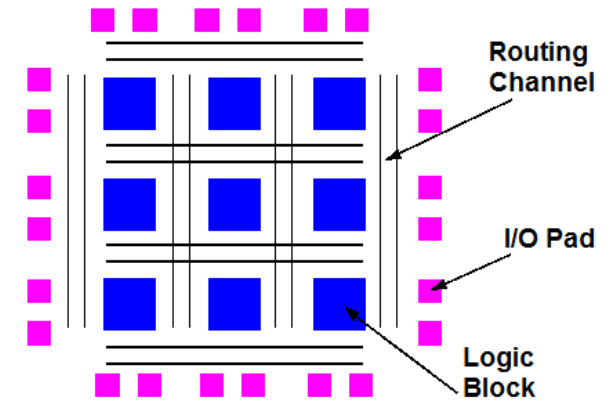


FPGA Considerations



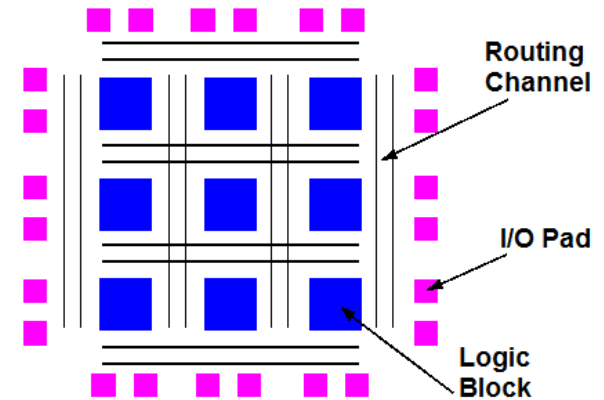
FPGA Considerations

✓ Low latency



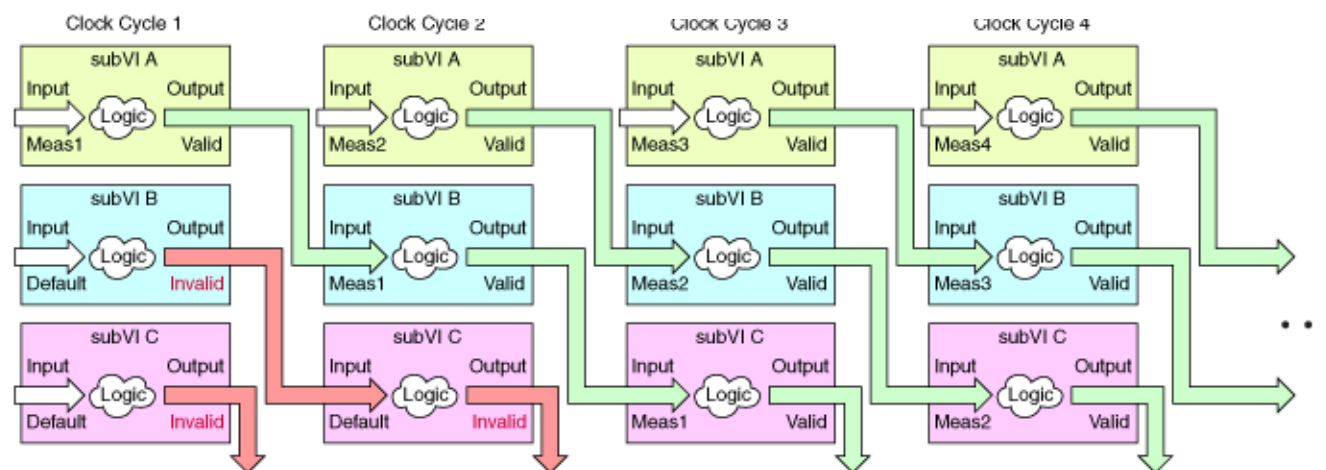
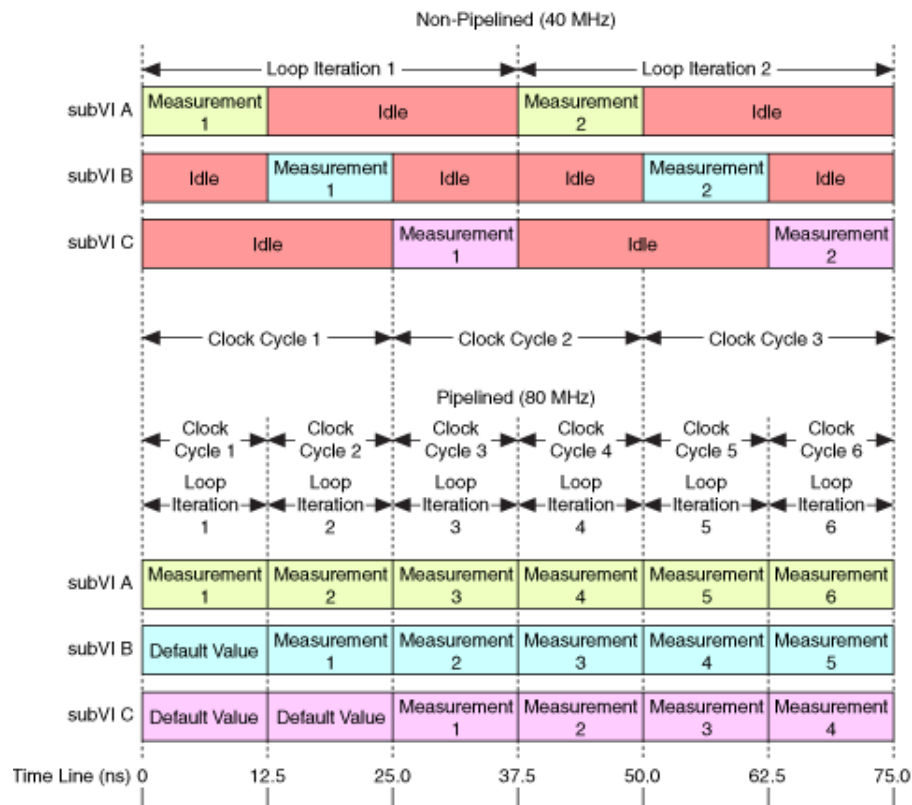
FPGA Considerations

✓ Compute power
through parallelization



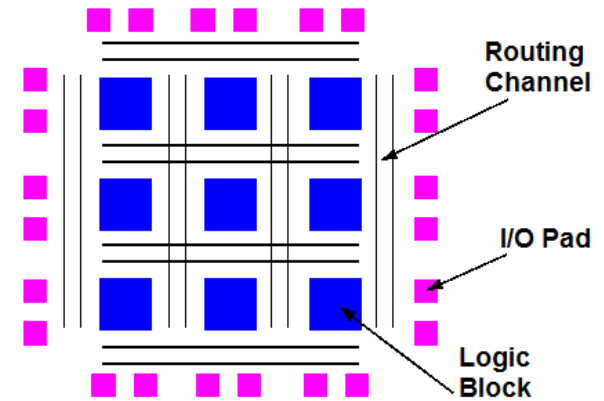
FPGA Considerations

✓ Pipelining



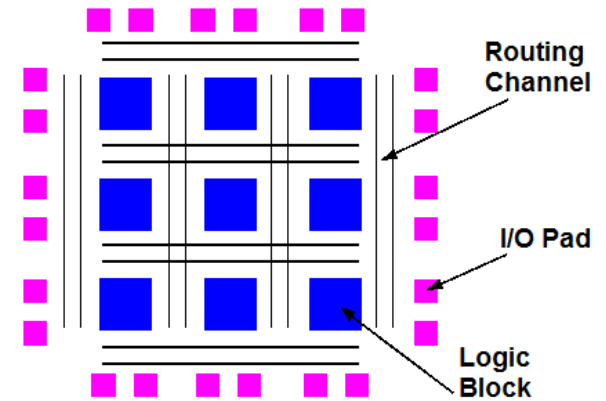
FPGA Considerations

- ❌ Raw clock rates
- ✅ Clock rate control



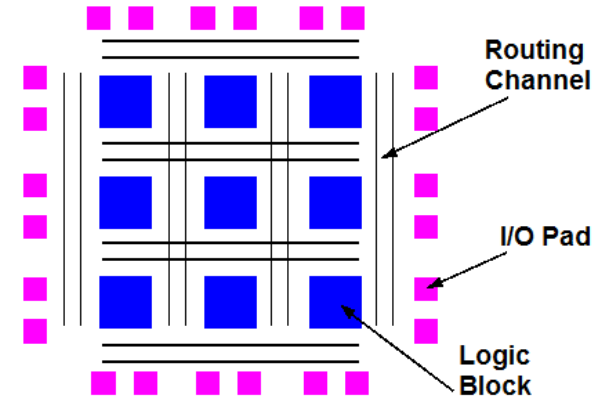
FPGA Considerations

❌ Floating Point Support



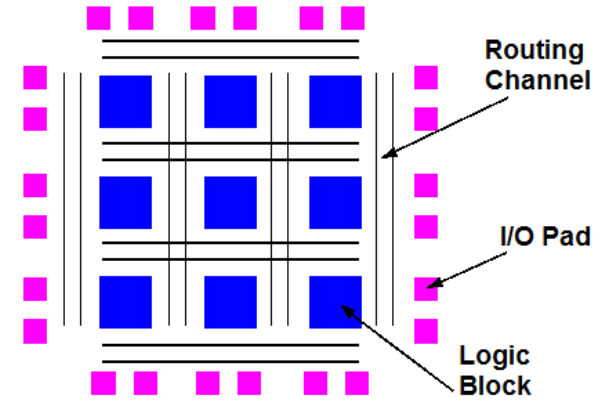
FPGA Considerations

✗ Programming complexity



FPGA Considerations

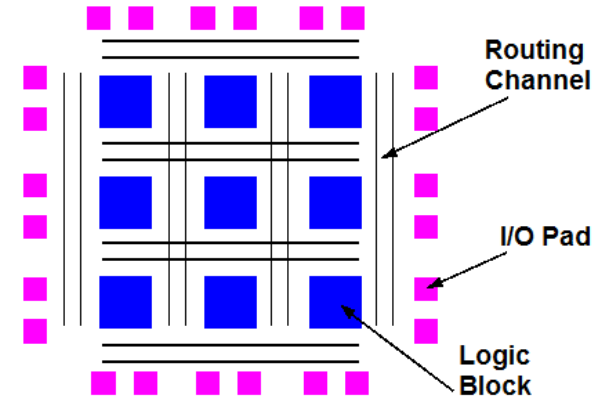
 Security



FPGA Considerations



Power consumption



FPGAs

- ✓ Jitter
- ✓ Low latency
- ✓ Computer power
- ✓ Pipelining
- ✗ Raw clock rates
- ✓ Clock rate control
- ✗ Floating point support
- ✗ Programming complexity
- ✓ Security
- ✓ Power consumption

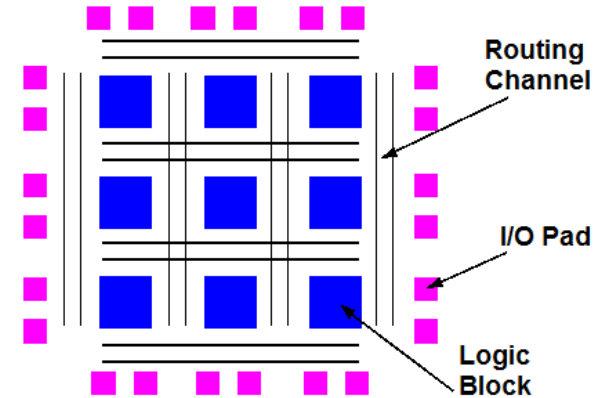


Image Processing Functions

FPGAs suitable to improve images and extract basic features

- Preprocessing
 - Image transforms
 - Image operators
 - Shading correction
 - Bayer decoding
 - Color space conversion
 - 1D & 2D FFT
 - Filtering (smooth/sharpen)
 - Binary morphology
- Feature Extraction
 - Edge, lines corners
 - Binary objects
 - Color
- Measurements
 - Centroid
 - Area measurements

Image Processing Functions

FPGAs not suitable for certain high-level algorithms

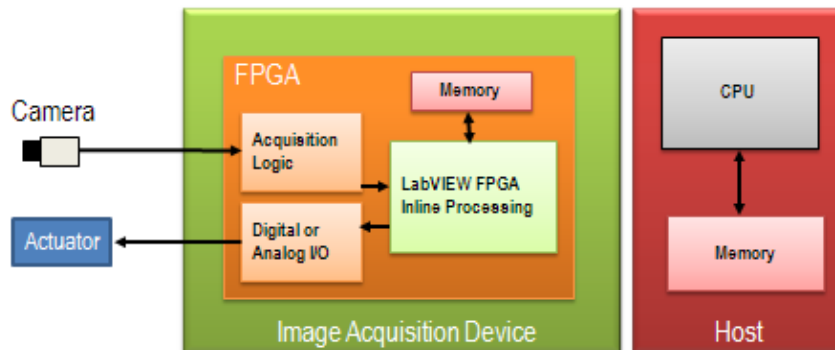
- Object-level vision functions
 - Pattern matching
 - OCR/OCV
 - Barcode reading
 - Some geometric measurements
 - Classification

You Might Want to Use an FPGA for Vision...

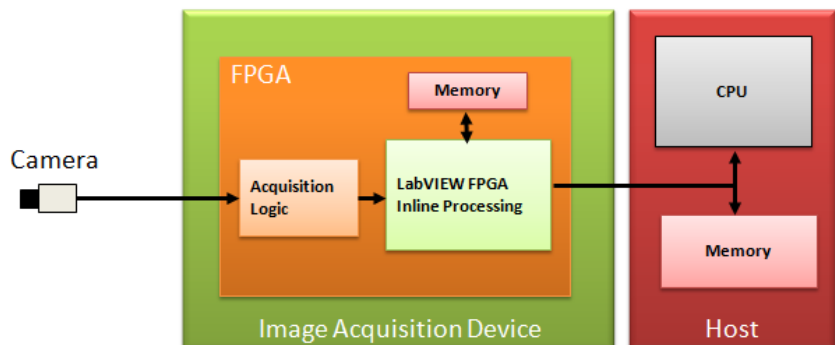
- If latency or jitter is critical
- If power consumption is critical
- If you have to speed up throughput
- If you can pipeline your algorithms
- If you have to reduce the amount of data or aggregate multiple high-speed channels
- If you are using algorithms that can take advantage of the FPGA architecture
- If the FPGA is already in the image path
- If any of the above give you a competitive advantage

FPGA Vision Use Cases

- High-speed control



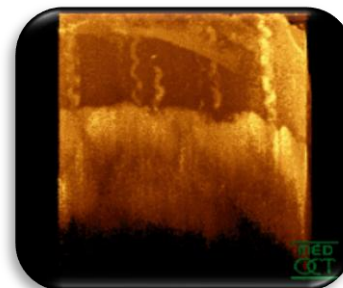
- Image pre-processing



Alignment
& Tracking



High-Speed
Sorting



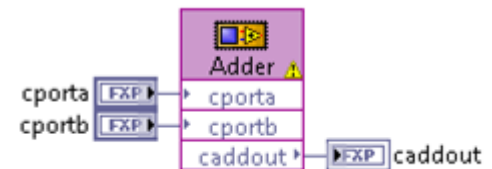
Optical Coherence
Tomography



Web & Surface
Inspection

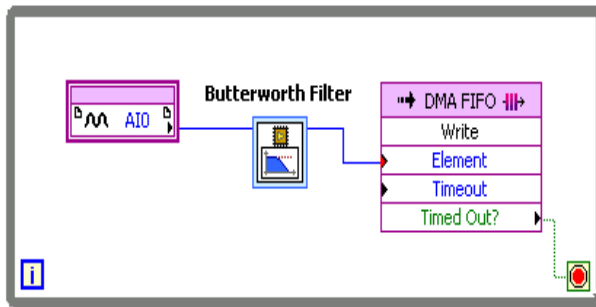
Application Development Considerations

- Prototype application first using Vision tools on CPU (Host)
- Define FPGA value statement
 - Speed
 - Scalability
 - Determinism
 - Size, weight, power
- Is IP readily available?



Abstraction Tools vs. RTL Design

- Abstracted programming tools: ex. LabVIEW FPGA



A large grid representing a VHDL design, consisting of many small rectangular blocks arranged in a 20x20 grid. Each block contains text, likely representing lines of code or configuration data.

VHDL ~4000 lines

- C-to-Gates tools
- High-Level Synthesis (HLS) tools

