Improving the Performance of Your NI LabVIEW Applications

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Agenda

- How to find performance problems
  - Benchmarking
  - Profiling
- Understanding LabVIEW under the hood
  - Memory usage
  - Execution system

Optimization Cycle

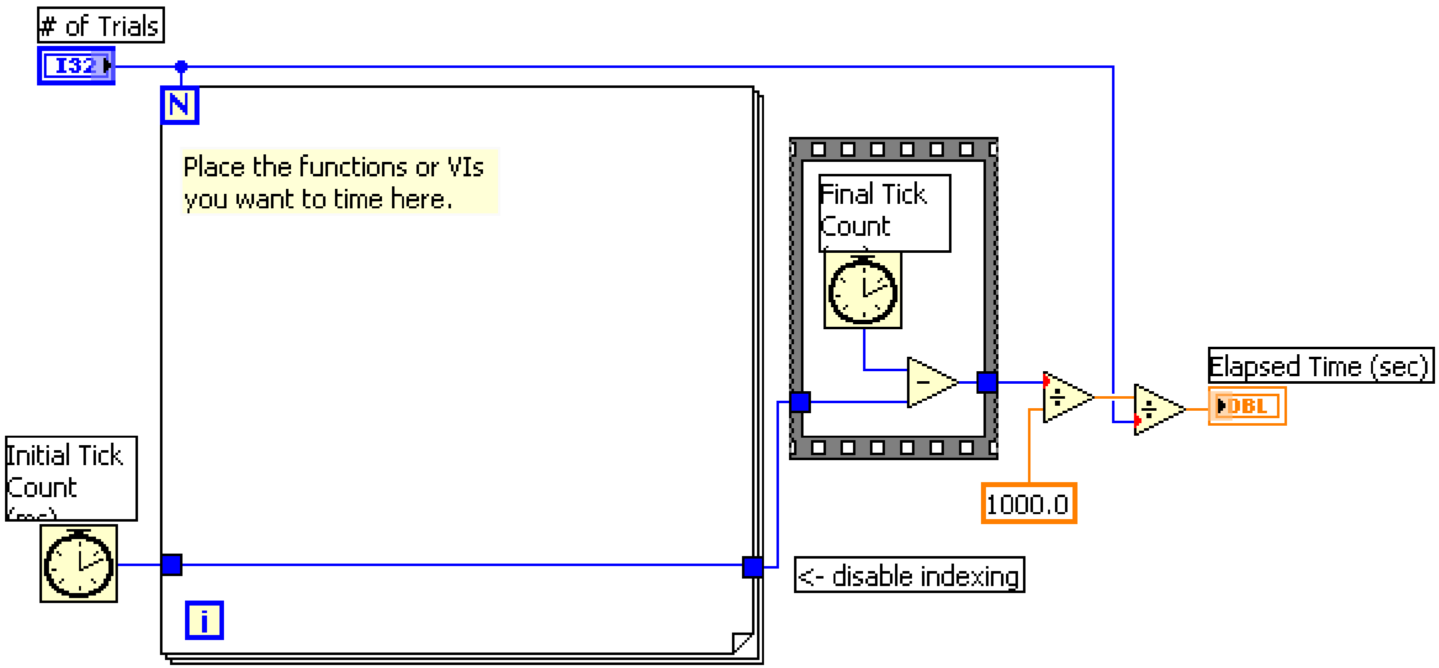
Benchmark

- Evaluate Performance
- Identify Problem Areas

Optimize

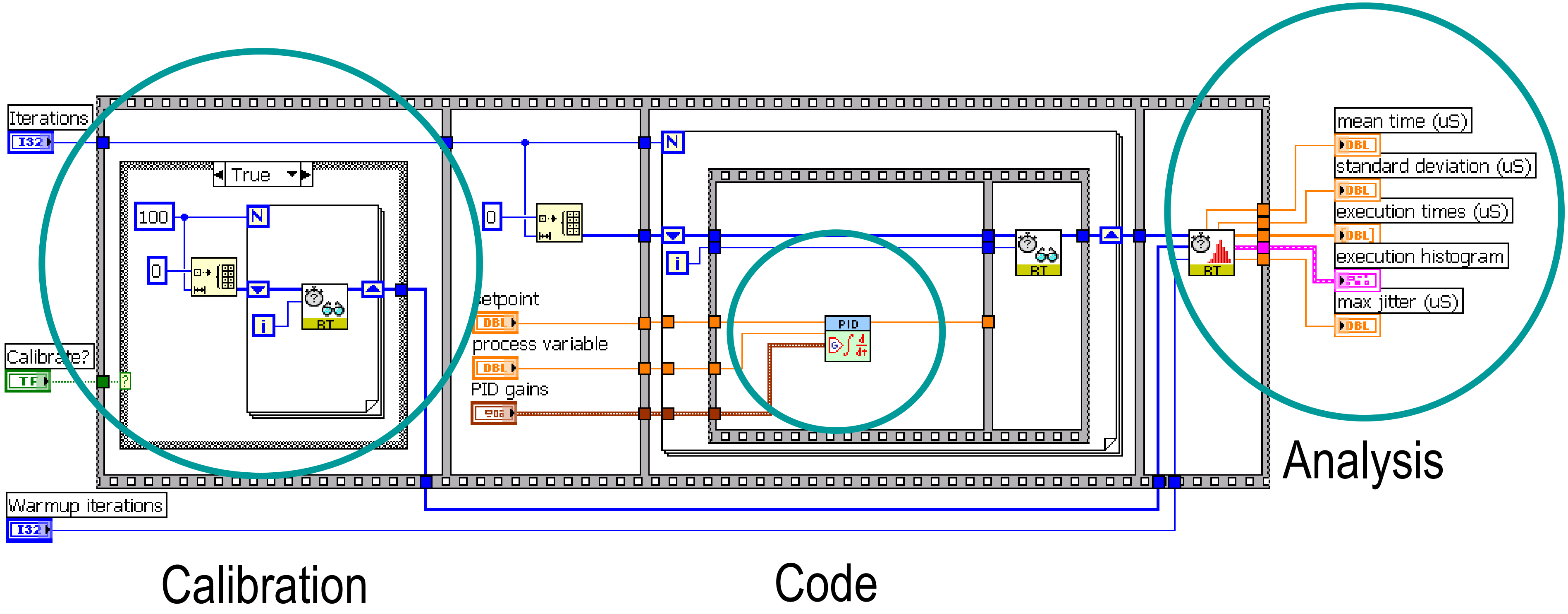
- Improve efficiency
- Improve Speed

Benchmarking Code Execution



"Timing Template (data dep)" – LabVIEW Shipping Example

Benchmarking Code Execution



"Benchmark Project" – LabVIEW Real-Time Shipping Example

Tools for Measuring Resource Usage (Windows)

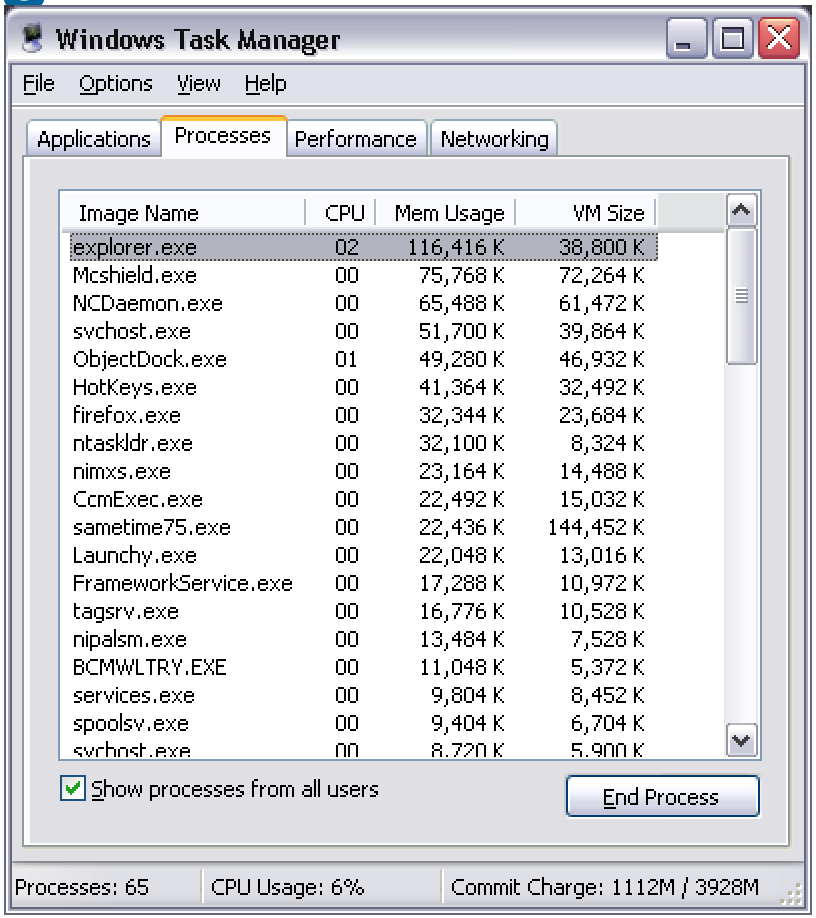
- Task Manager
- Perfmon

Windows Task Manager

•Gives user a rough idea of whether memory or CPU is the bottleneck

•Can be helpful in identifying memory leaks

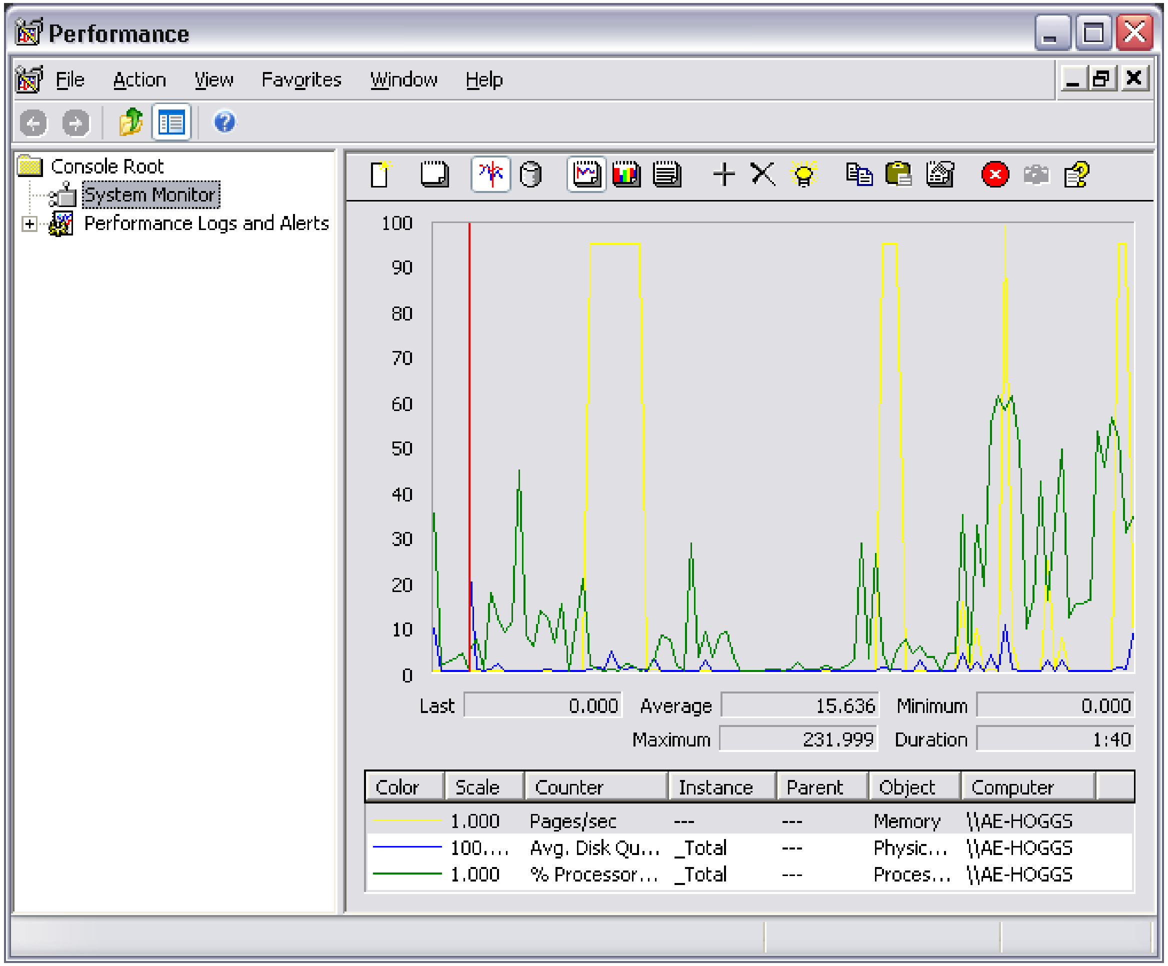
•**View»Select Columns …** allows you to add additional stats



Perfmon

- Allows you to monitor
  - Processors
  - Disk I/O
  - Network Tx/Rx
  - Memory/Paging

- Access by typing "**perfmon**" into the Windows Run dialog



Why Should You Profile Your VIs?

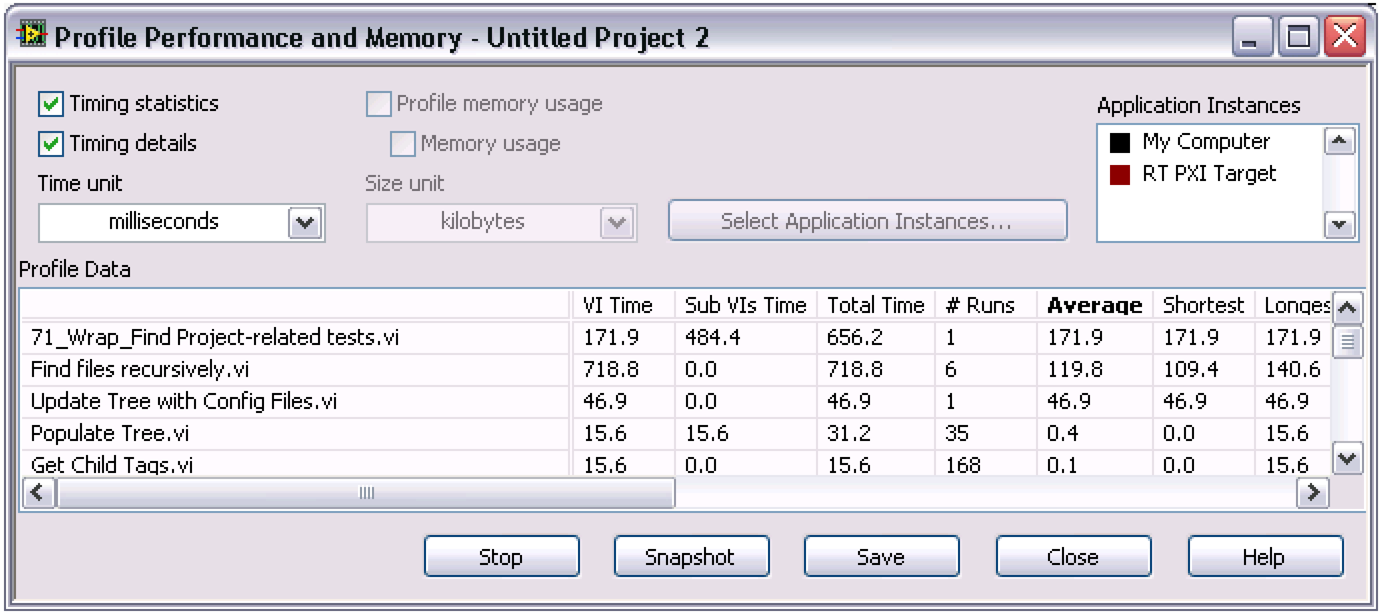
The 80/20 rule of software performance

- 80 percent of the execution time is spent in 20 percent of the code

- Performance improvements are most effective in the 20 percent
- Guessing which 20 percent is difficult

VI Profiler

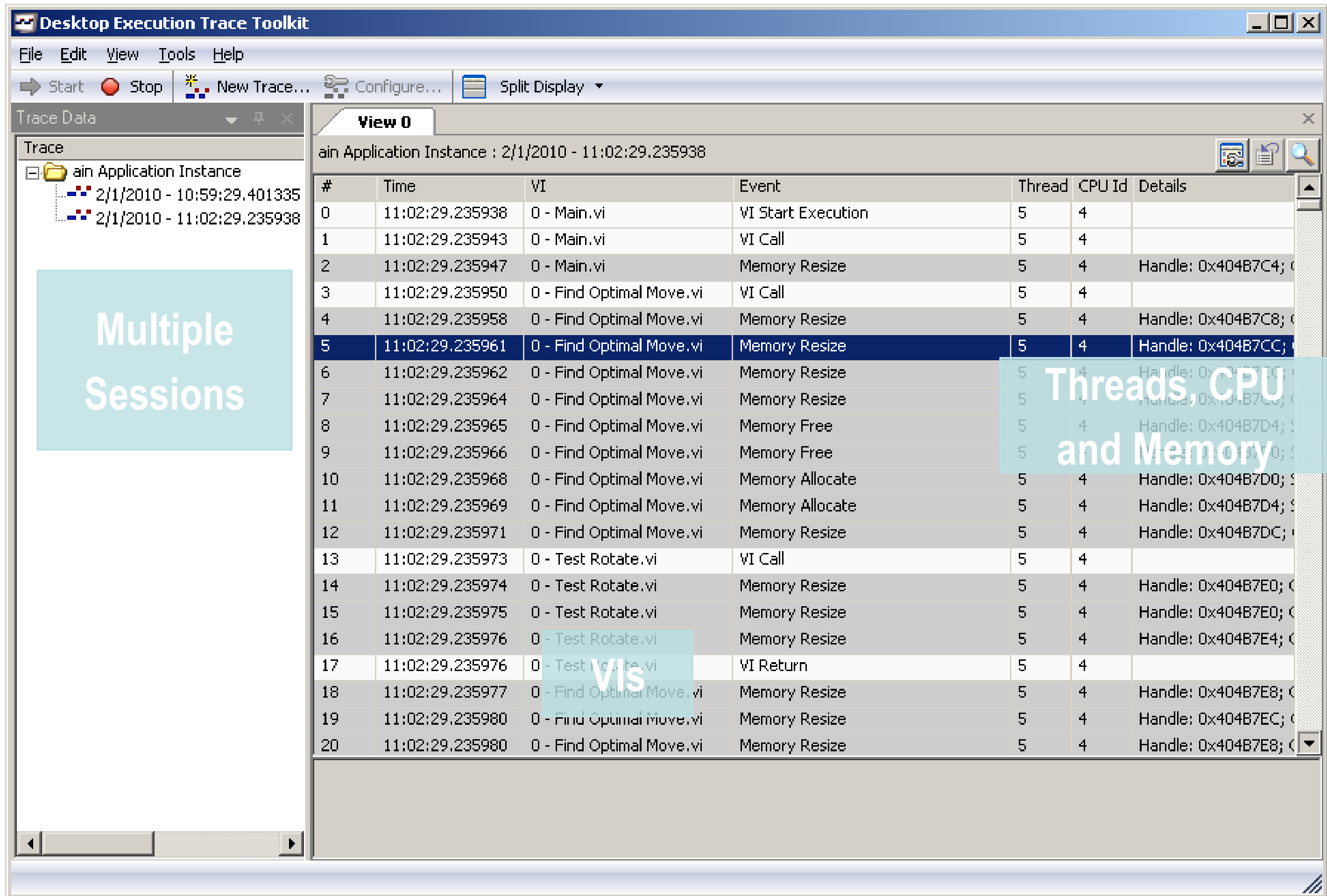
- Tools >> Profile >> Performance and Memory…



Demo – VI Profiling

LabVIEW Desktop Execution Trace Toolkit

- Detailed execution traces
- Thread and VI information
- Measurement of execution time



Profiling and Benchmarking Summary

To answer this question:	Use these tools:
What is my current performance?	Benchmark VIs
What are my limiting resources?	Task Manager, Perfmon
How much time are each of my VIs taking?	VI Profiler
In what order are events occurring?	LabVIEW Desktop Execution Trace Toolkit

Under LabVIEW's Hood

Memory Management

Execution System

What Is In Memory?

Panel

Diagram

Compiled Code

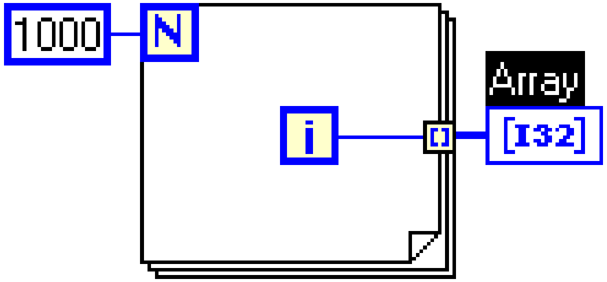
Data

VIs in Memory

- When a VI is loaded into memory
  - We always load the data
  - We load the code if it matches our platform (x86 Windows, x86 Linux, x86 Mac, PowerPC Mac)
  - We load the panel and diagram only if we need to (for instance, we need to recompile the VI)

Panel and Diagram Data

- How many bytes of memory does this VI use?
- The answer depends on:
  - Is the panel in memory?
  - Is the environment multi-threaded?



Execute, Operate and Transfer Data

4K Execute Data

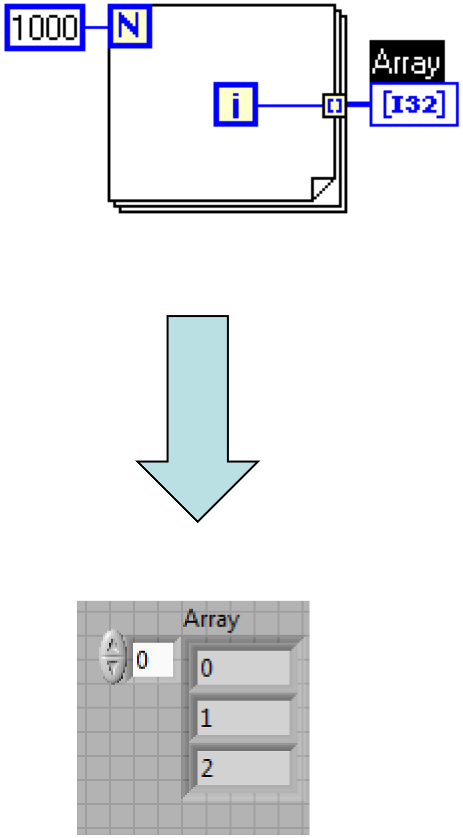
- Populated by Code

4K Transfer Data

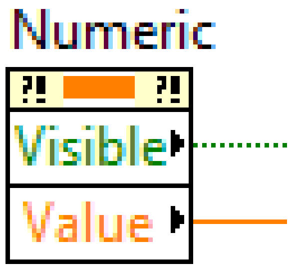
- Temporary Buffer

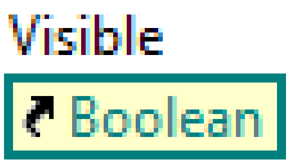
4K Operate Data

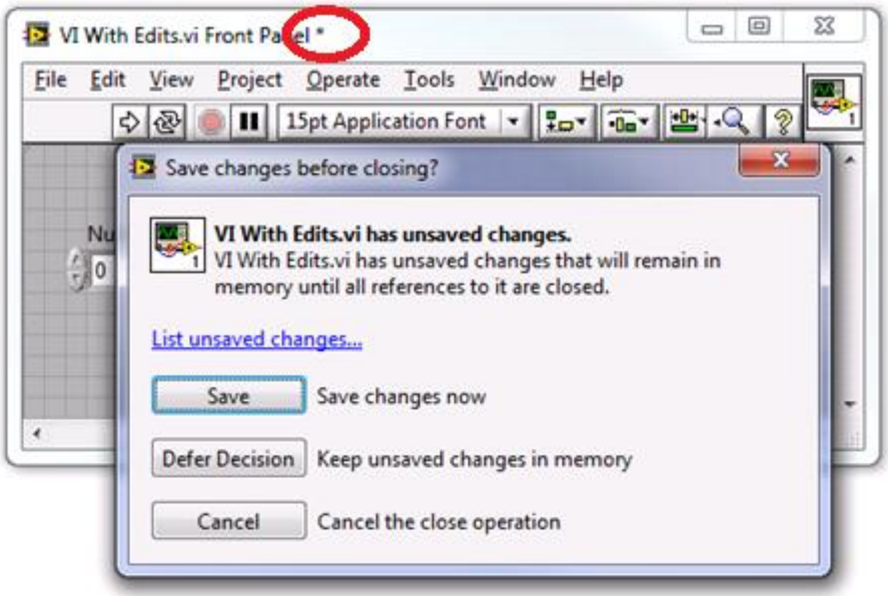
- Copy for Indicator



Avoid Loading Panels, Save Memory

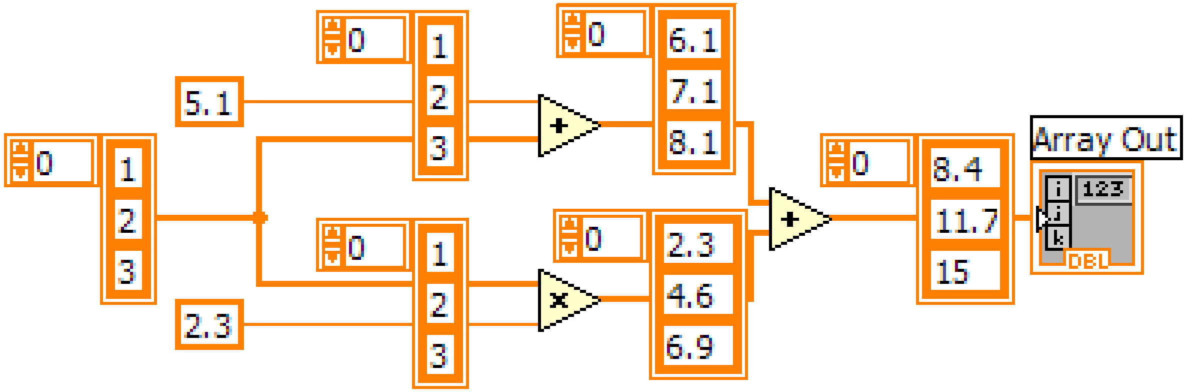






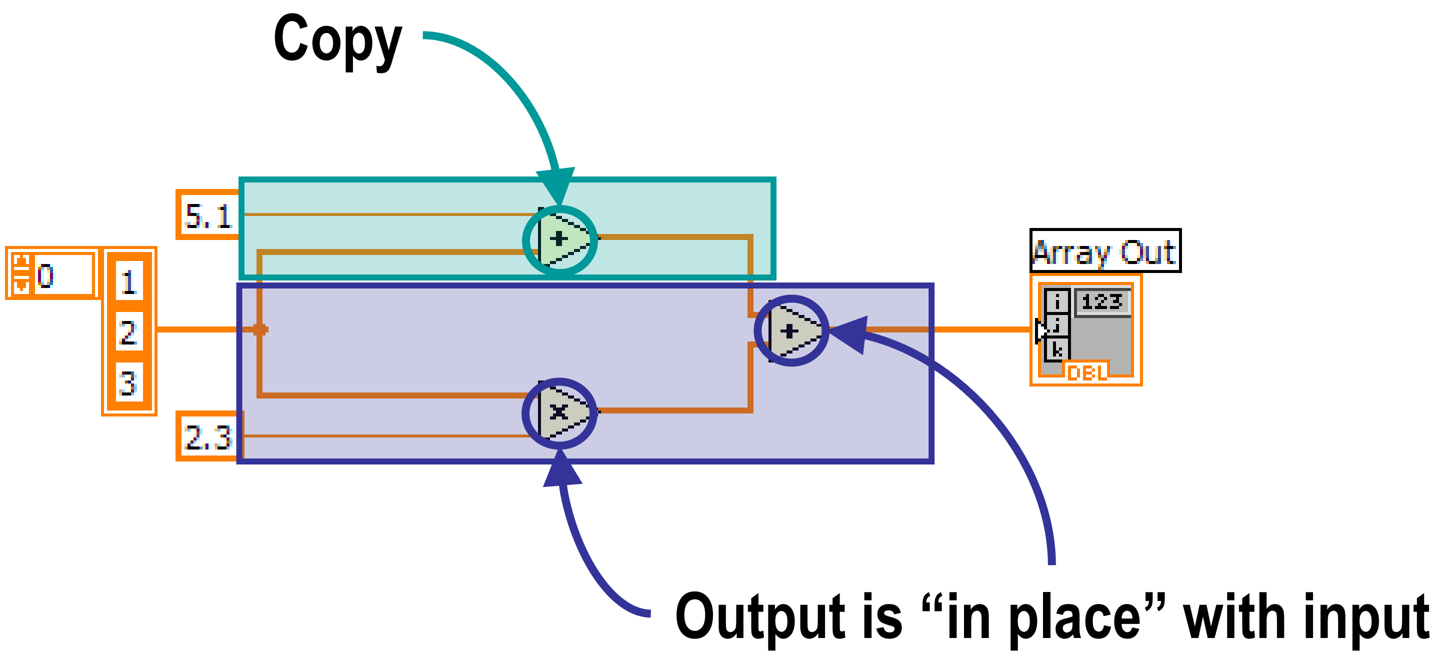
Wire Semantics

- Every wire is a buffer
- Branches typically create copies



Optimizations by LabVIEW

The theoretical 5 copies become 1 copy operation

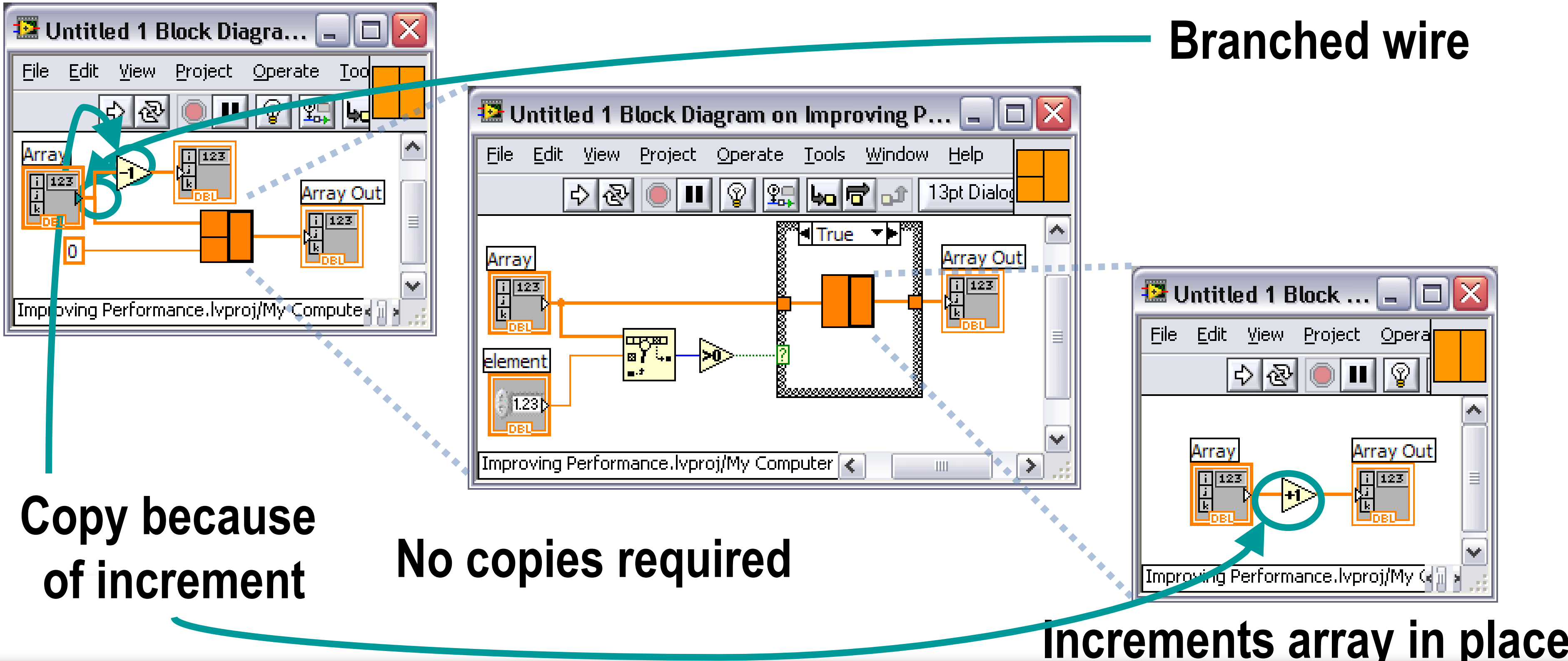


The "In Place" Algorithm

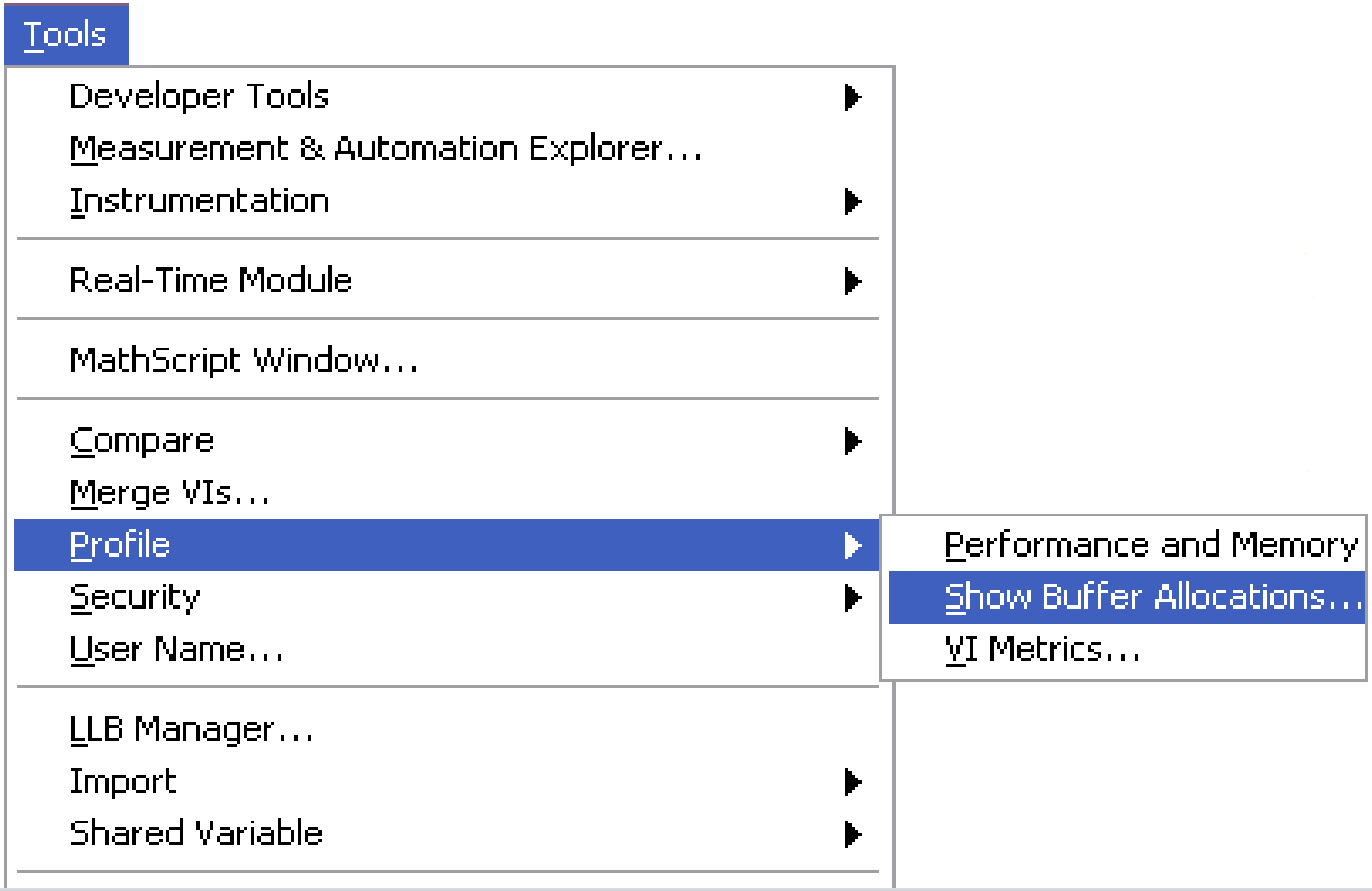
- Determines when a copy needs to be made
  - Weighs arrays and clusters higher than other types
- Algorithm runs during compilation, not execution
  - Does not know the size of an array or cluster
- Relies on the sequential aspects of the program
  - Branches may require copies

Bottom Up

In-place information is propagated bottom up

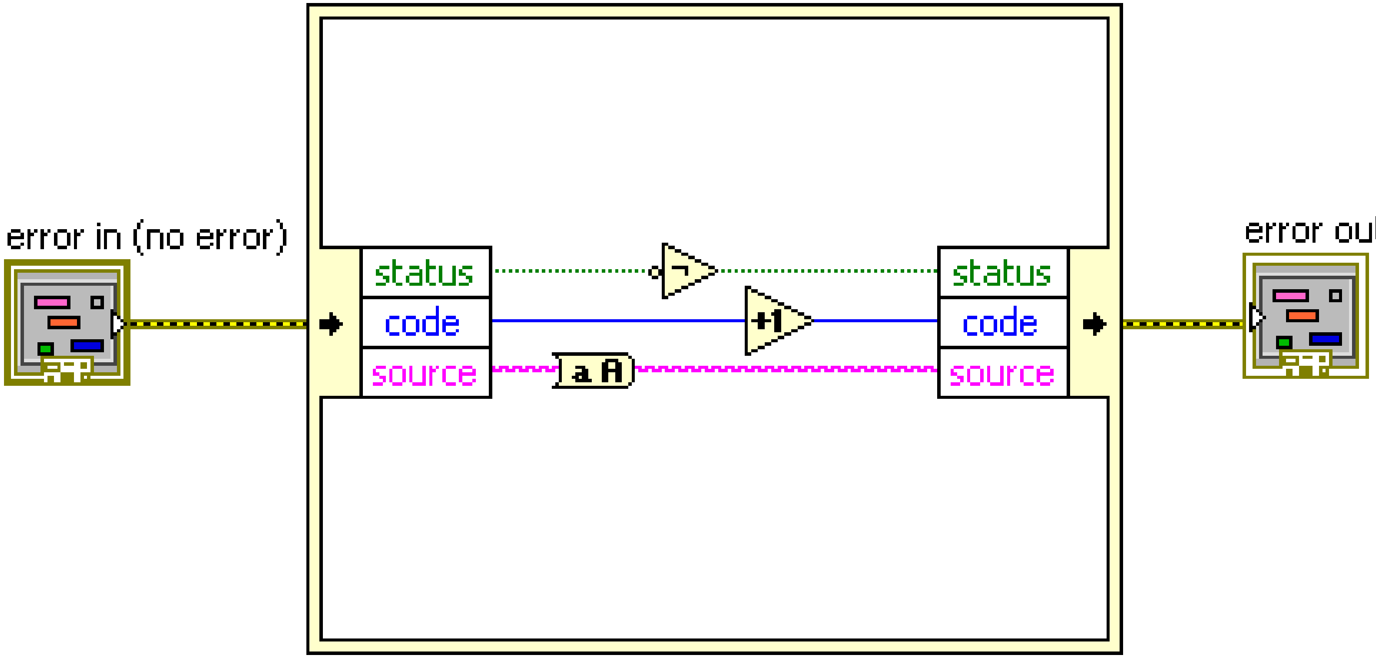


Showing Buffer Allocations



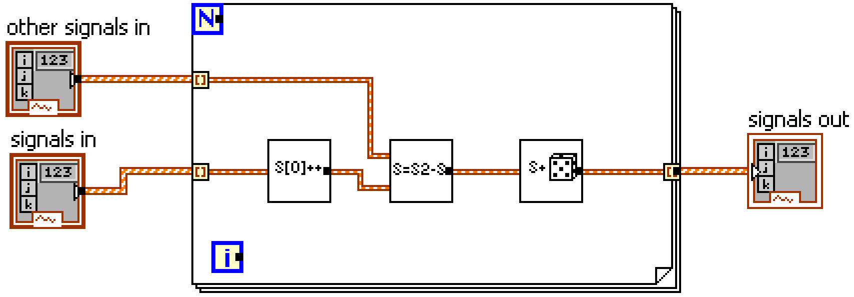
The In-Place Element Structure

Allows you to explicitly modify data “in place”

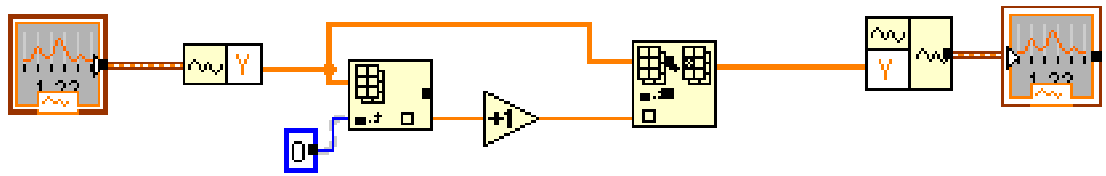


Example of In Place Optimization

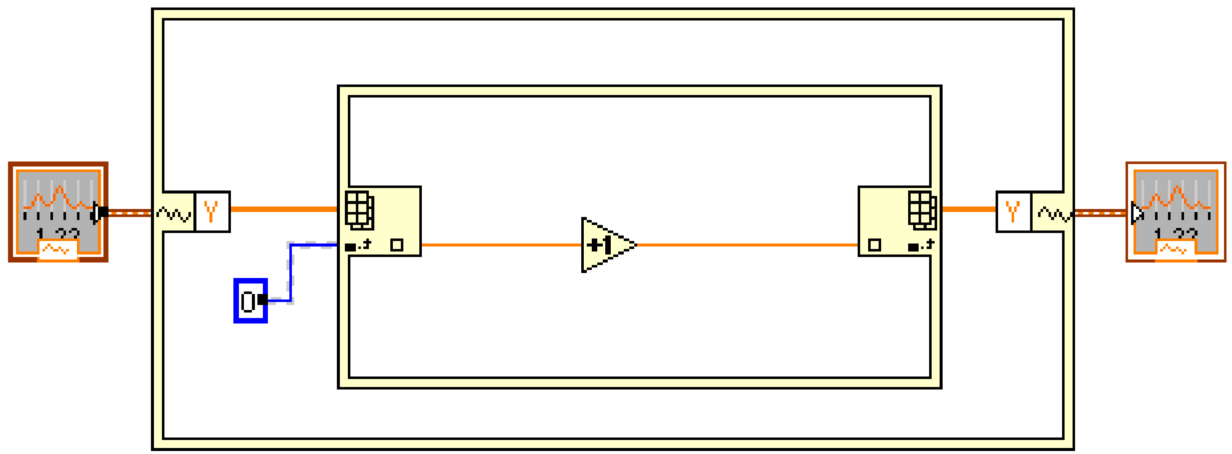
Operate on each element of an array of waveforms



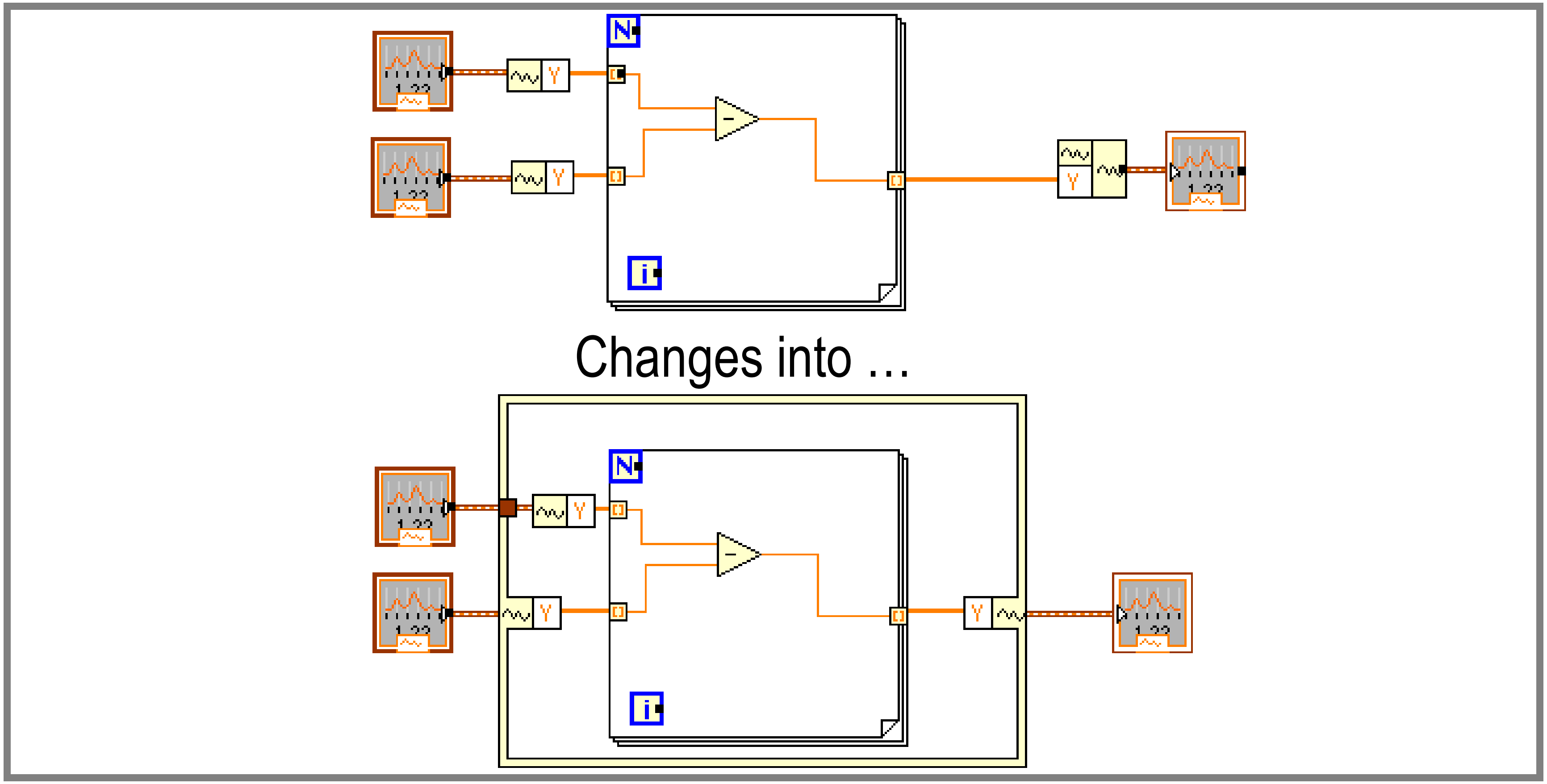
Make the First SubVI "In Place"



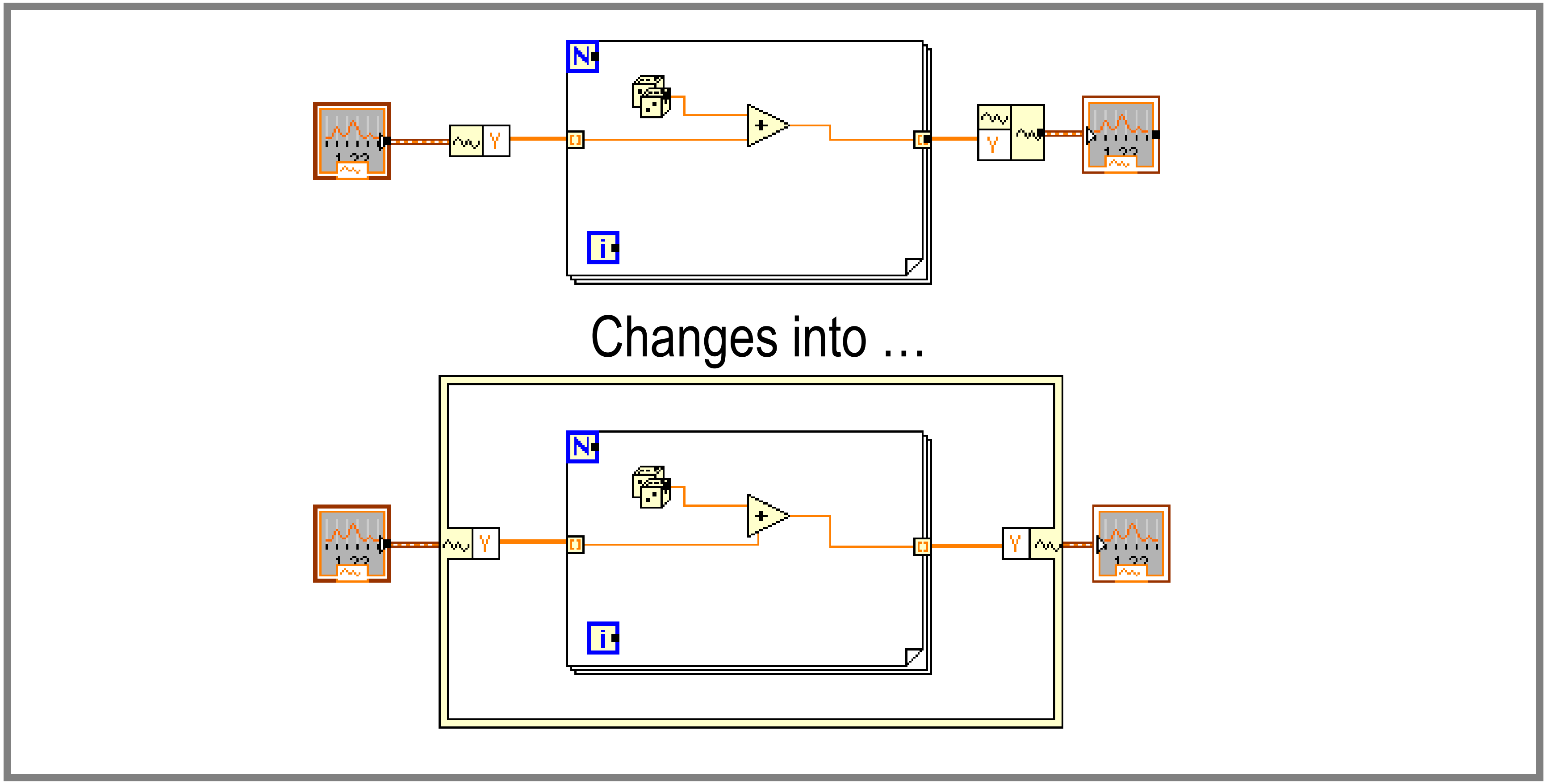
changes into…



SubVI 2 Is Made "In Place"

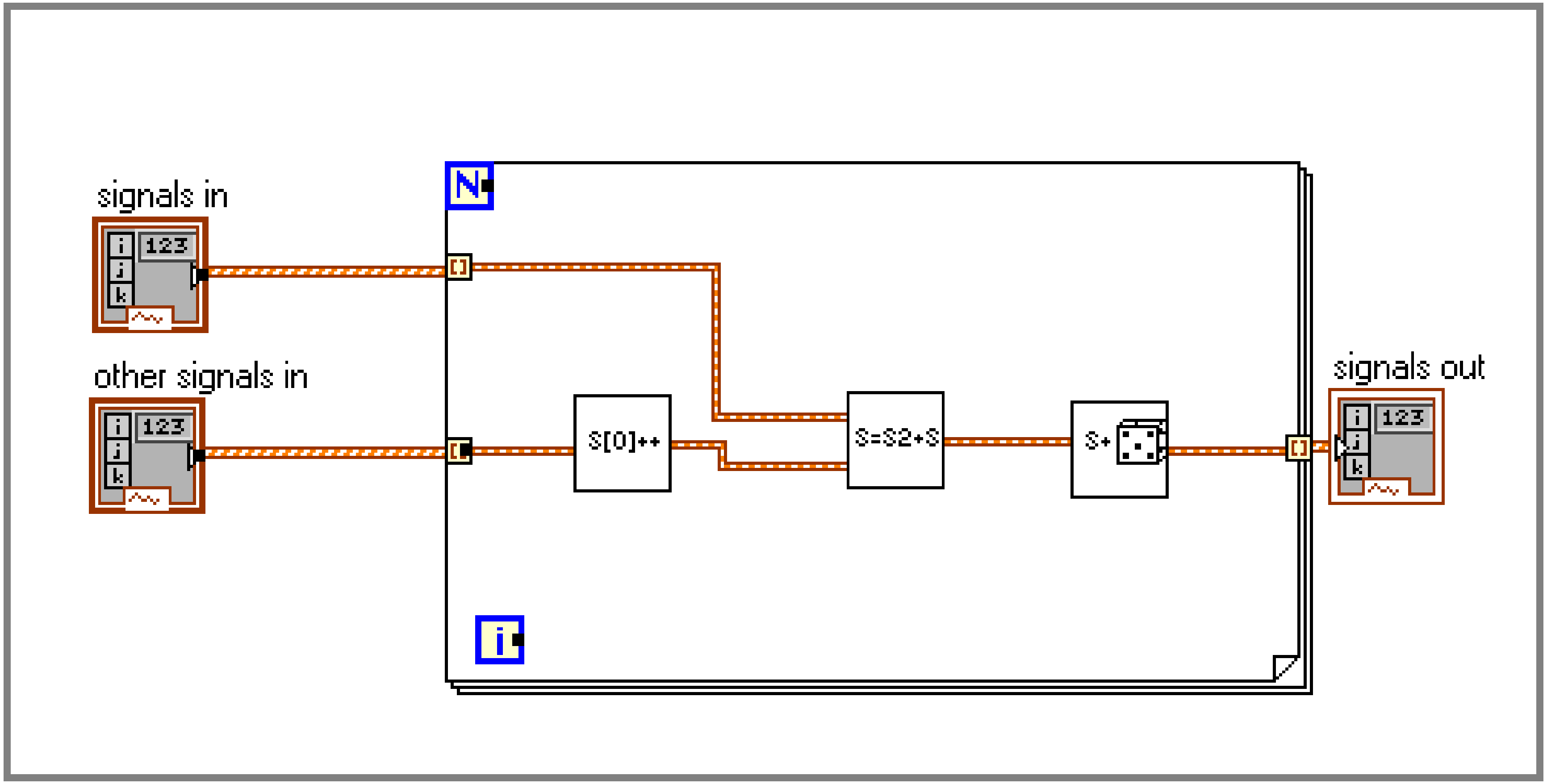


SubVI 3 Is Made "In Place"



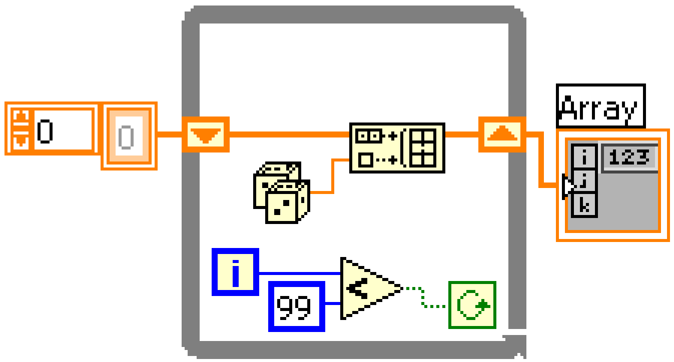
NATIONAL INSTRUMENTS

Final Result: Dots Are Hidden



Building Arrays

There are a number of ways to build arrays and some are better than others

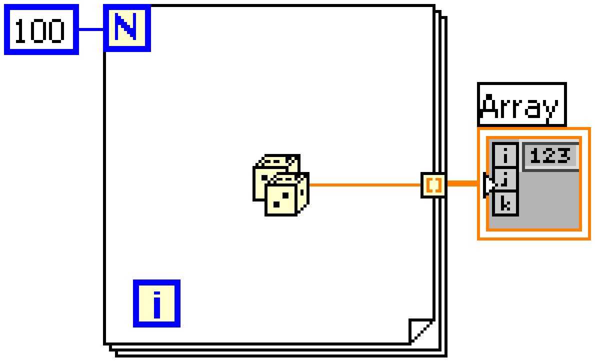


Bad

- •Reallocates array memory on every loop iteration
- •No compile time optimization

Building Arrays

There are a number of ways to build arrays. Try to minimize reallocations.



Best

- Memory preallocated
- Indexing tunnel eliminates need for copies

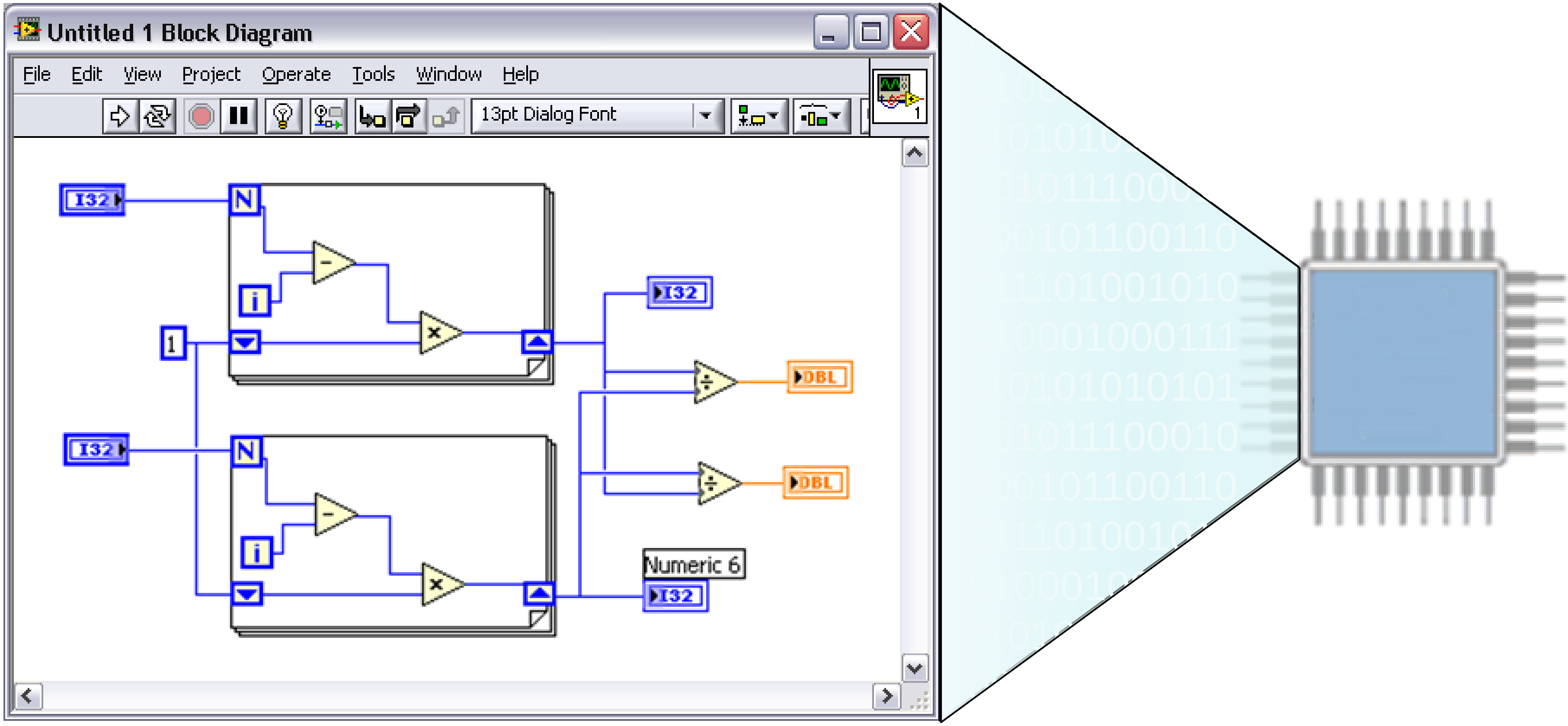
Demo – Effects of Memory Optimization

Under LabVIEW's Hood

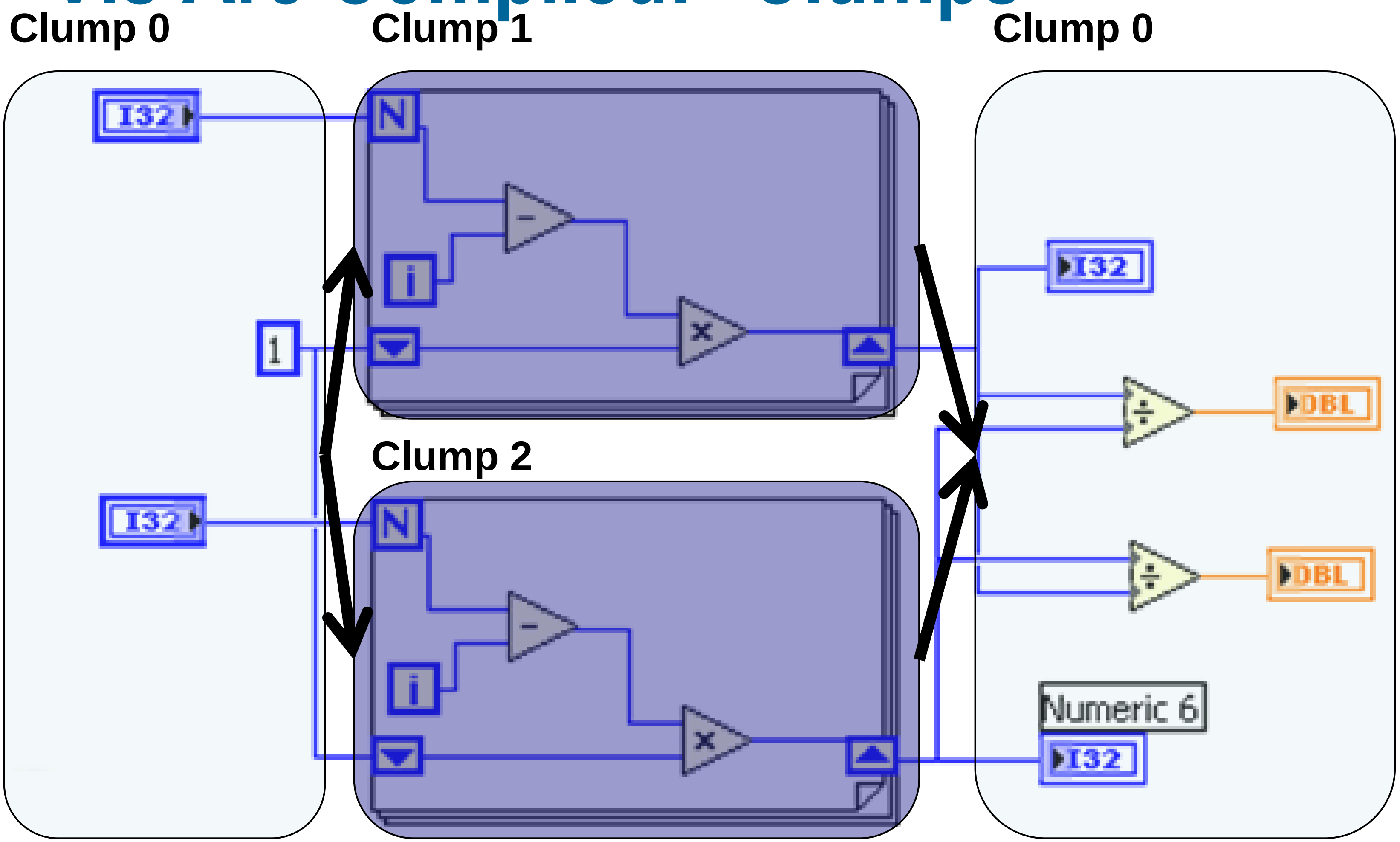
Memory Management

Execution System

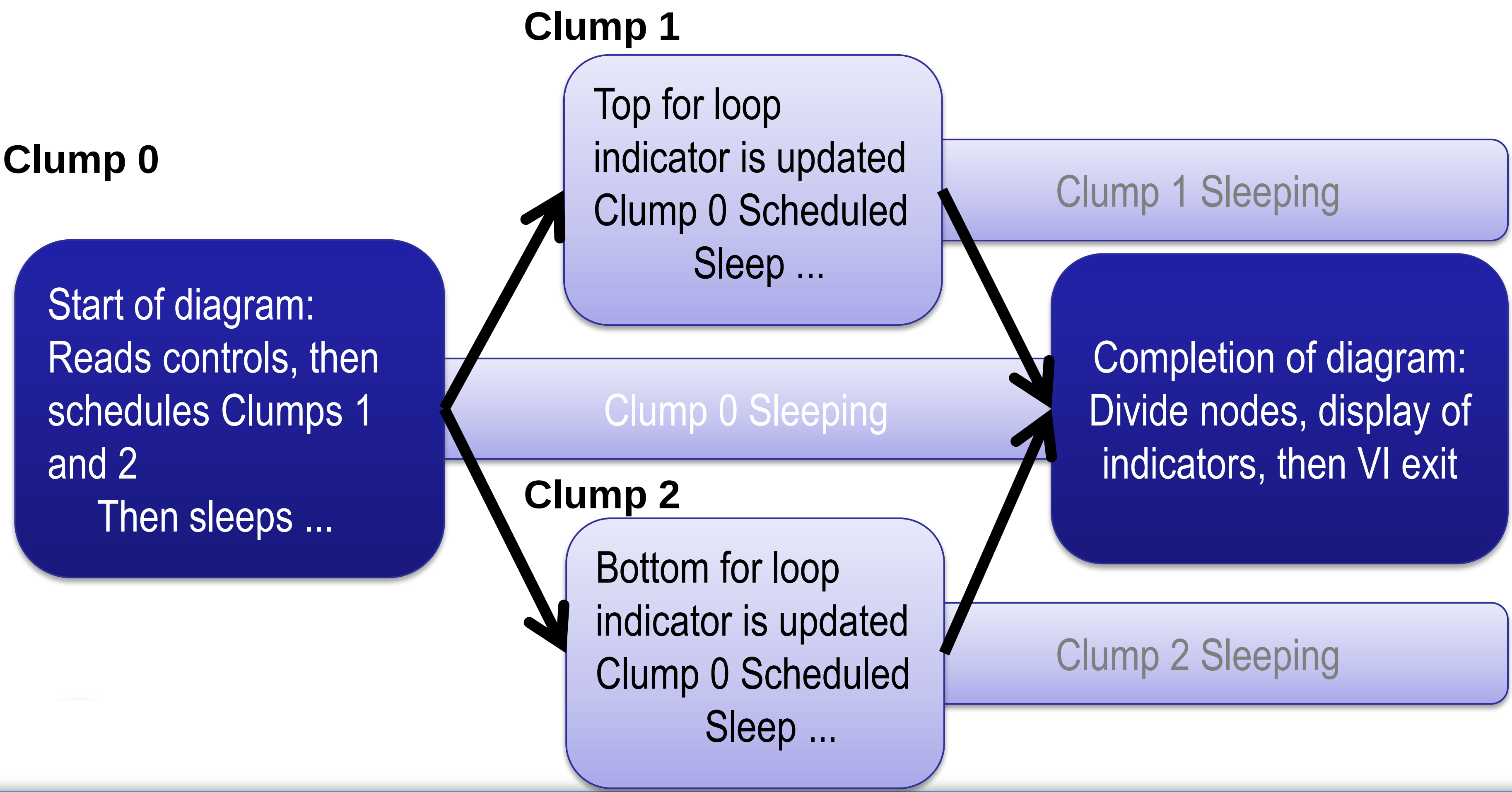
VIs Are Compiled



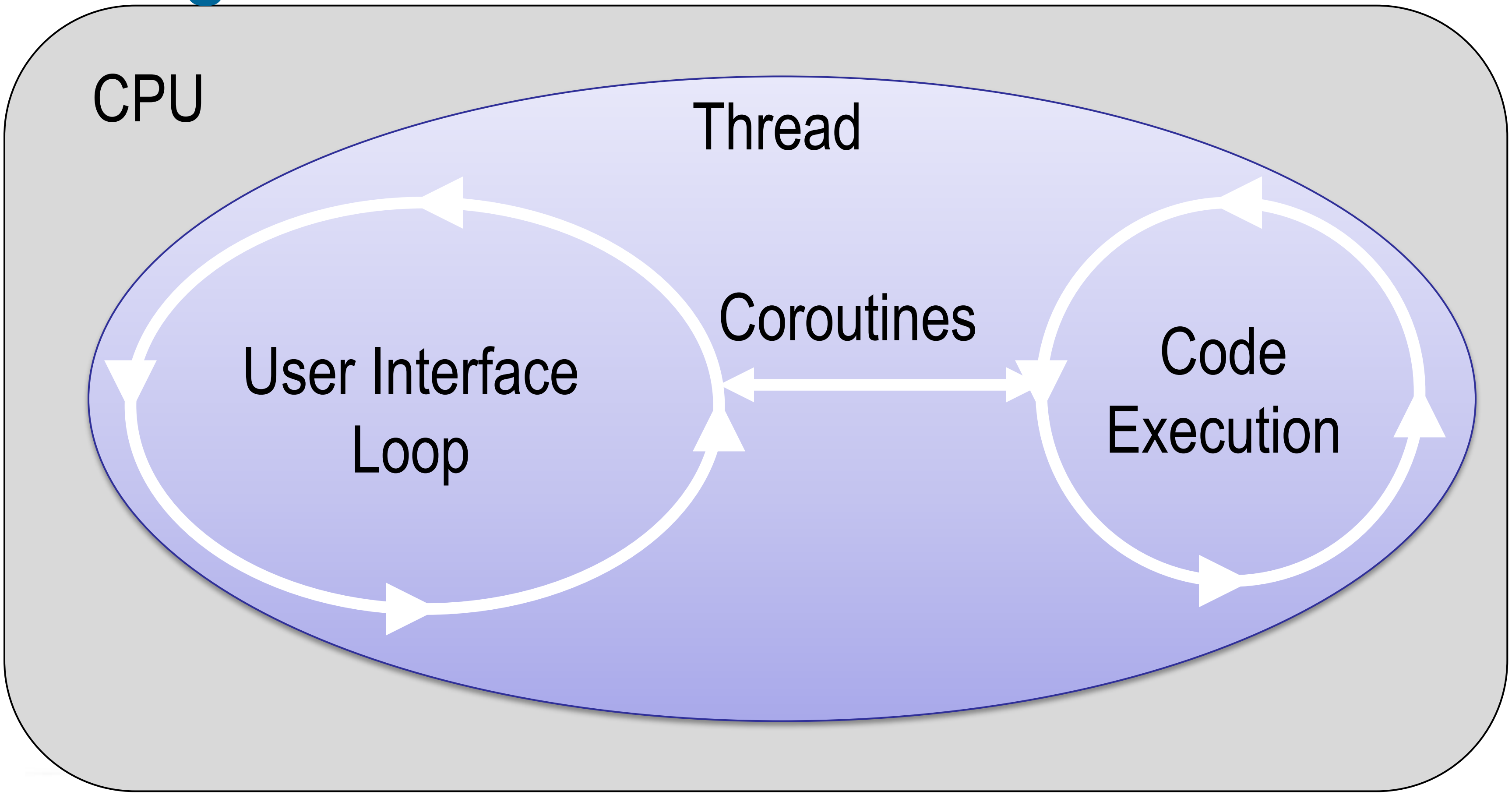
VIs Are Compiled: “Clumps”



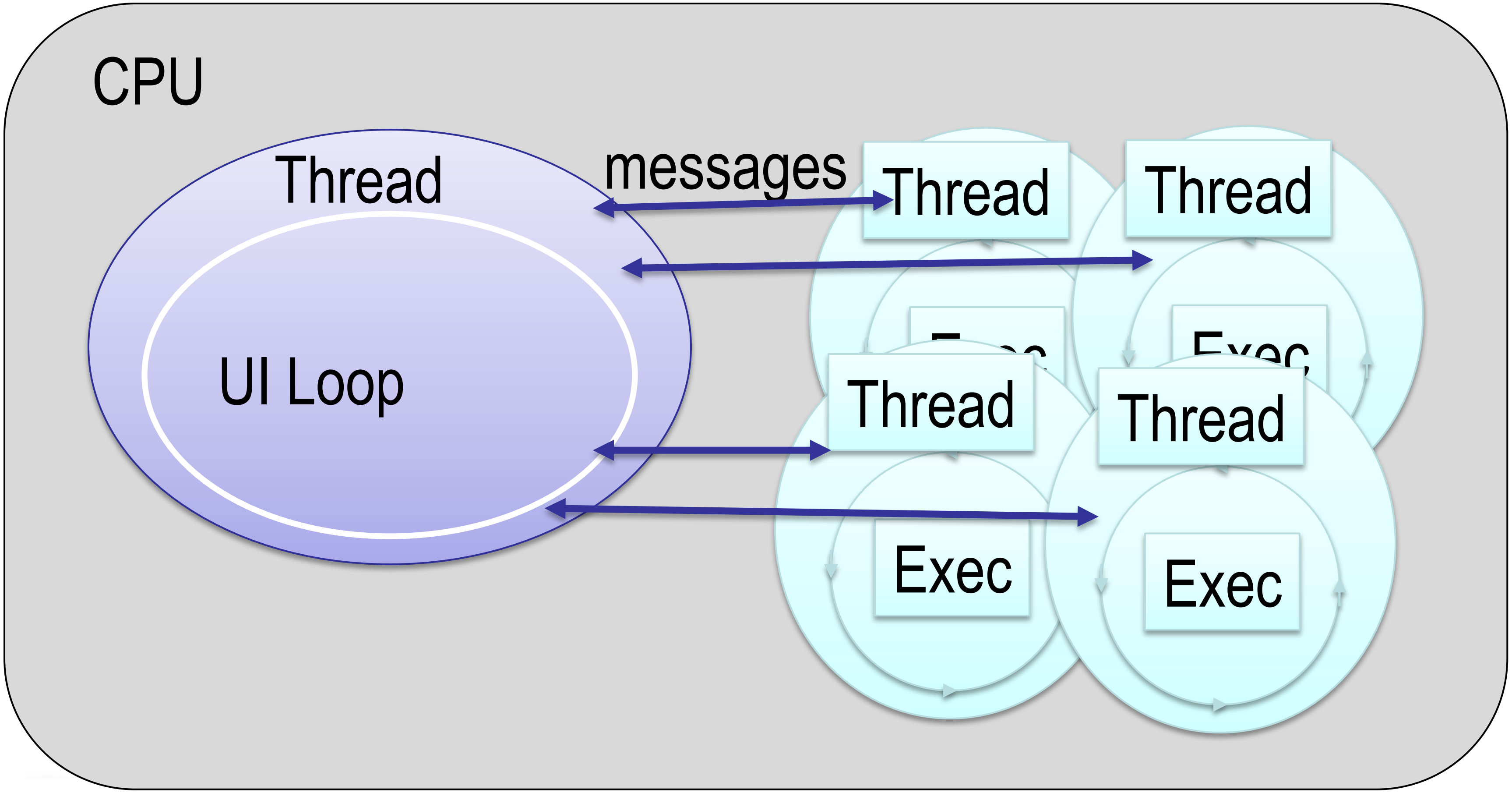
VIs Are Compiled: "Clumps"



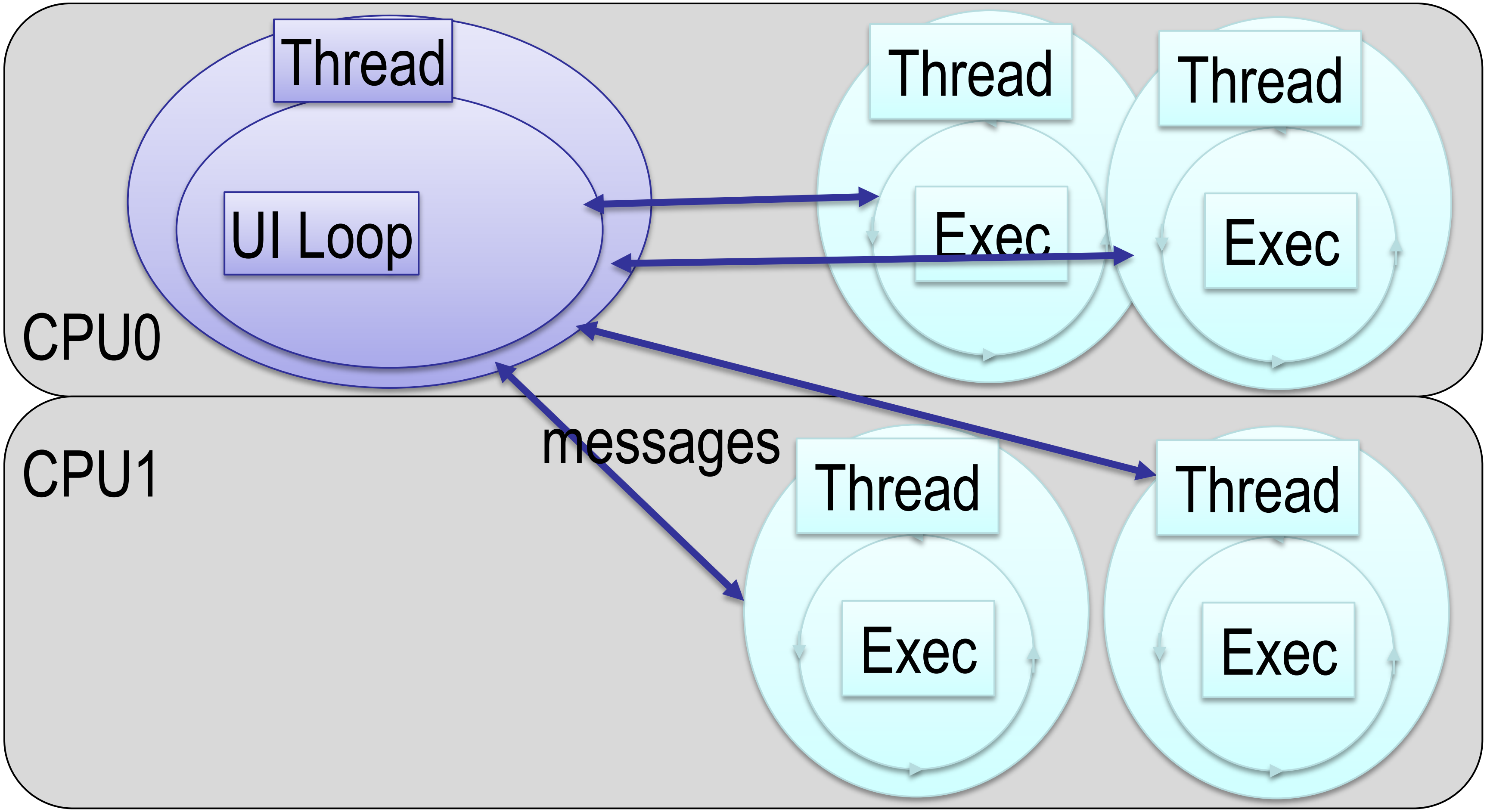
Single-Threaded LabVIEW



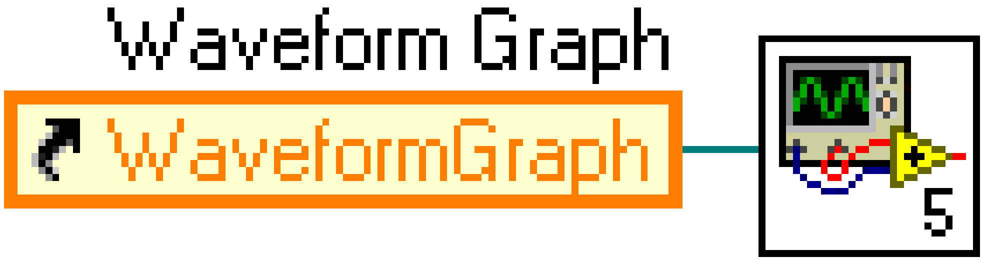
Multithreaded LabVIEW



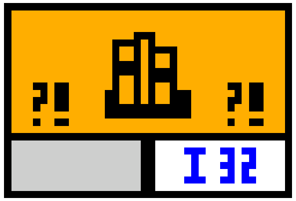
LabVIEW on a Multicore Machine



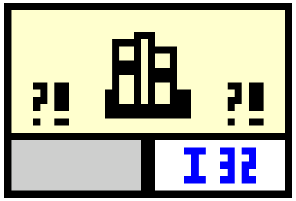
Some Operations Require the UI Thread

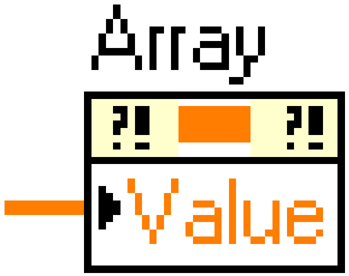


Front Panel Control References



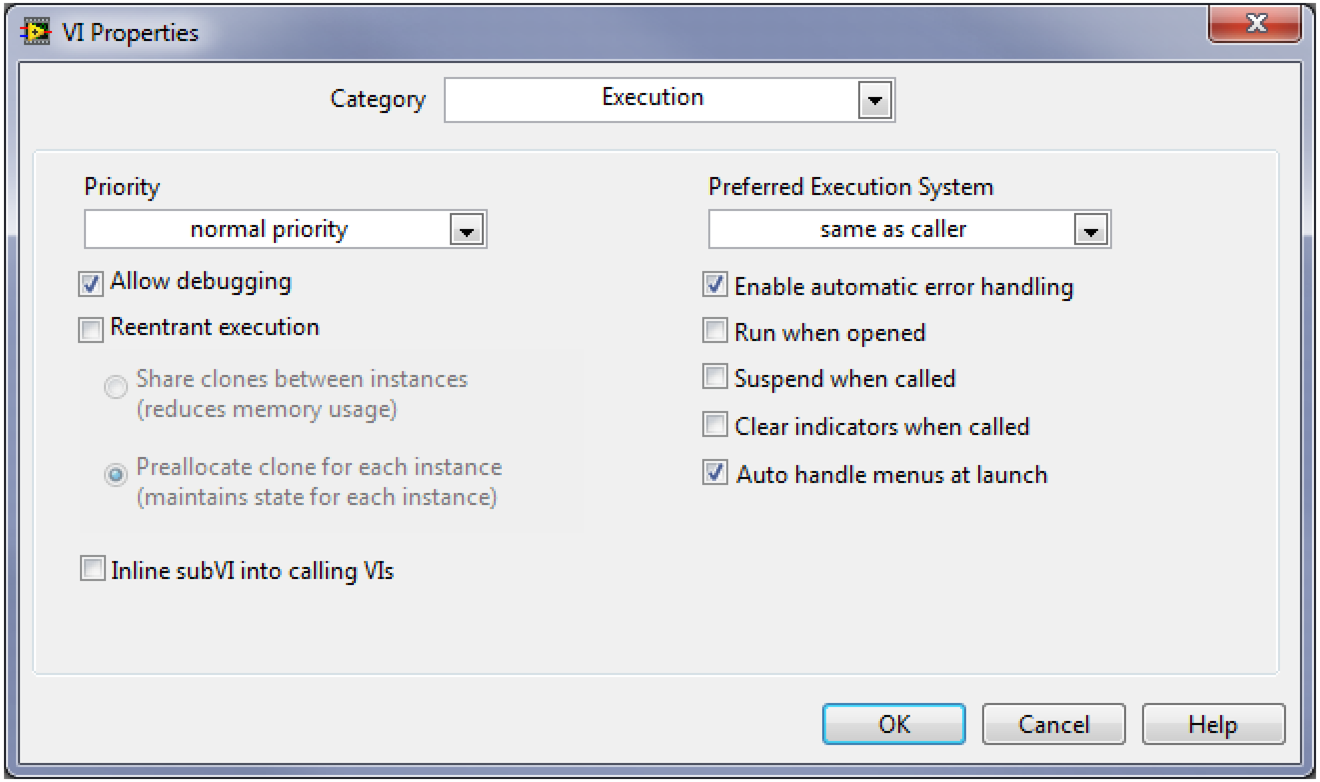
Call Library Nodes





Control/Indicator Property Nodes

Execution Properties



Reentrant VIs

- Reentrancy allows one subVI to be called simultaneously from different places
  - Requires extra memory for each instance
- Use reentrant VIs in two different cases
  - To allow a subVI to be called in parallel
  - To allow a subVI instance to maintain its own state

LabVIEW 2010 Compiler

- Generates code that runs faster, ~30%
- Takes longer to run (~5x-7x)

SSE Instructions

SubVI Inliner

Register Candidates

Dead Code Elimination

Loop Invariant Code Motion

Common Subexpression Elimination

And more

Demo – Effects of Execution Optimization

Next Steps

In LabVIEW

- LabVIEW Help

On the Web

- ni.com/multicore
- ni.com/devzone