



# National Instruments Training and Certification

*What Does It Take To Get Certified?*

**Steven Hoenig**

**NJ Business Unit Manager**

**Certified LabVIEW Architect**

**Certified Professional Instructor**



# OverVIEW



- **About Bloomy Controls**
- **National Instruments Training**
  - Benefits of Training
  - Training Options
  - LabVIEW Training/Certification Track
- **Certification – LabVIEW Track**
  - Certified LabVIEW Associate Developer (CLAD)
  - Certified LabVIEW Developer (CLD)
  - Certified LabVIEW Architect (CLA)

# About Bloomy Controls



Bloomy Controls is a full service integrator providing turnkey solutions, consulting, and training for Test and Measurement systems.

- Founded in 1991
- Windsor, CT; Marlborough, MA; Fort Lee, NJ
- National Instruments Select Alliance Partner
- Industry Leader in NI LabVIEW development
- International System Deployment

# NI Certified Training Centers



- 2 Certified Training Centers
  - Windsor, CT; Marlborough, MA
- Qualified Instructors
  - 14 Certified Professional Instructors
  - 13 Certified LabVIEW Architects  
*(World Leader for CLA's in one company)*
  - 5 Certified LabVIEW Developers
  - 2 Certified TestStand Developers/Architects
  - 1 Certified CVI Developer



# Software Development



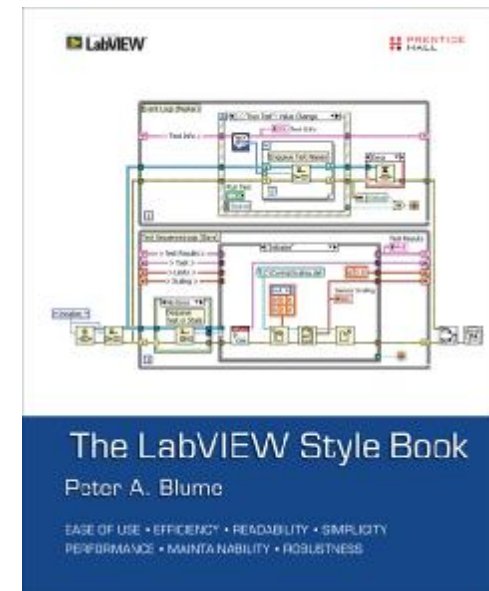
- **Software Experience:**

- LabVIEW, LabVIEW RT
- TestStand
- LabWindows / CVI
- C, C++, C#, .NET, Ladder Logic
- Data Management (DIAdem, SQL, Oracle)



- **Software Engineering Practices:**

- Mature development practices based on [The LabVIEW Style Book](#)
- Source Code Control
- Re-usable Code
- Bug Tracking



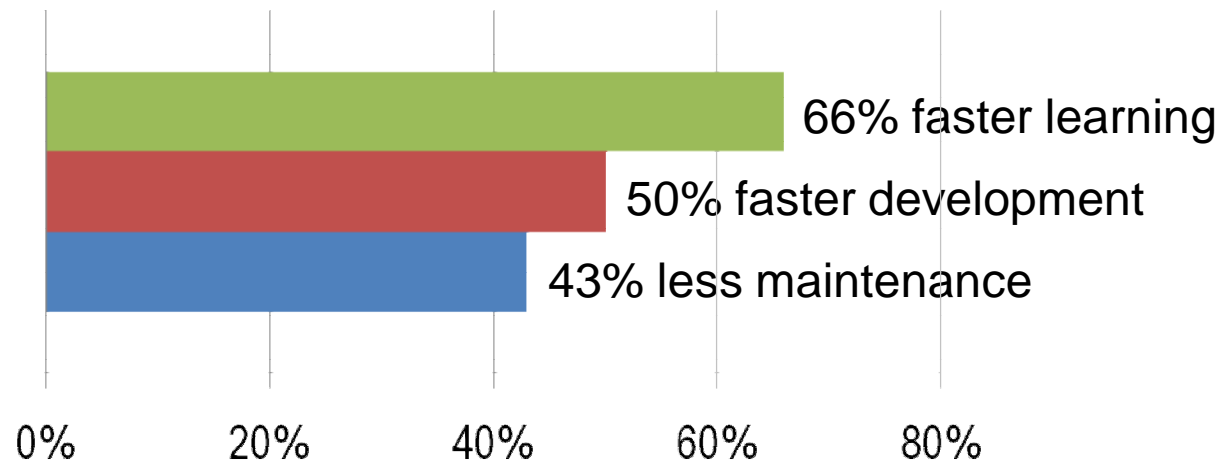


# TRAINING

# NI Training Saves Time and Money



- In a worldwide survey, NI training customers reported:



...as a result of NI training

- Lexmark reported 170% ROI from LabVIEW Basics training

\*Source: NI WW training customer survey, 2009, n = 640, from US, Canada, Germany, Spain, Poland, Mexico, Brazil, South America, Japan, Taiwan, ASEAN

# How Do These Savings Affect Project Costs?



- **Sample project:**
  - 6 month project with a 3 year life
  - 1 engineer, 60% of time spent on project
  - Annual cost of an engineer: \$100,000

Total Phase Costs	Self-Training	NI Training
Expected total labor cost of project - learning phase	\$12,000	\$7,378
Expected total labor cost of project - development phase	\$28,800	\$14,400
Expected total labor cost of project - maintenance phase	\$4,800	\$2,736
<b>TOTAL PROJECT LABOR COST</b>	<b>\$45,600</b>	<b>\$24,514</b>
<b>TOTAL PROJECT LABOR COST SAVINGS with NI training</b>		<b>\$ 21,086</b>
<b>TRAINING ROI</b>		<b>286%</b>

Details at [ni.com/training](http://ni.com/training)



# NI Training & Certification Program



## Worldwide Reach

- **>20,000 users trained annually worldwide**
- **6,000 active certified users worldwide (and growing)**
- **Courses taught in >40 countries**
- **Online training available in Americas, Europe, Japan**

# Standard NI Training Offerings



## Over 25 Courses

- LabVIEW
- Data Acquisition
- RF
- Real-Time
- FPGA
- Instrument Control
- CompactRIO
- And more...

## Four Training Formats

- Instructor-led
  - In a regional classroom
  - Onsite at your facility
  - Online
- Self-paced

## Three Purchasing Methods

- Individual courses
- Training memberships
- Training credits

# NI Training Courses



- **Software**
  - LabVIEW
    - Core 1, 2, 3
    - Connectivity
    - Advanced Architectures
    - Managing Software Engineering
    - Real-Time
    - FPGA
    - Performance
    - Object-Oriented Programming
  - LabWindows/CVI
    - Basics 1 and 2
  - TestStand
    - 1 and 2
  - DIAdem
    - Basics and Advanced
  - Multisim & Ultiboard
- **Hardware**
  - RF
    - Fundamentals
    - Application Development
  - CompactRIO
  - Modular Instruments:
    - DMMs
    - Switches
    - High-Speed Digital I/O
  - Data Acquisition and Signal Conditioning
  - Instrument Control
  - Machine Vision

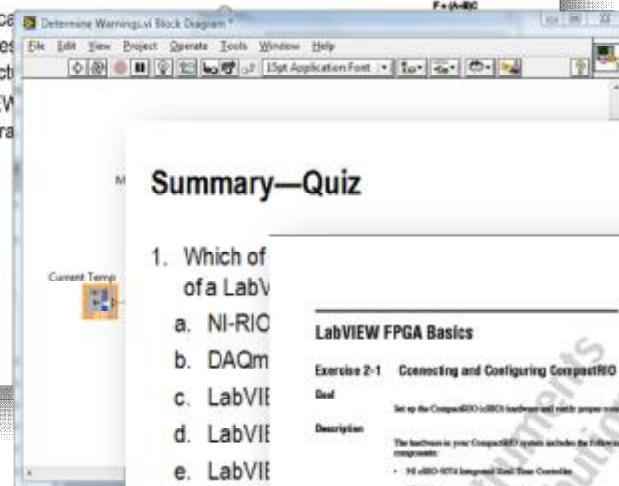
# What Makes Up NI Courses?



- Lecture
- Demonstrations
- Quizzes
- Hands-On Programming Exercises
  - Individual
  - Team-based (some courses)

## A. Parallel Loop Execution

- Graphics promotes architect
- LabVIEW true para



## Summary—Quiz

1. Which of a LabVIEW
  - a. NI-RIO
  - b. DAQmx
  - c. LabVIEW
  - d. LabVIEW
  - e. LabVIEW

## LabVIEW FPGA Basics

### Exercise 2-1 Connecting and Configuring CompactRIO

**Goal**  
Set up the CompactRIO (cRIO) hardware and write proper configurations.

**Description**  
The hardware in your CompactRIO system includes the following components:

- NI 9402 16-bit analog input module
- NI 9403 16-bit analog output module
- NI 9404 16-bit digital input module
- NI 9405 16-bit digital output module

**Note** The instructions on adapting the exercises in this manual for an alternate cRIO module, refer to Appendix A, Alternate CompactRIO Controller Instructions.

**Creating your CompactRIO system in the National Instruments Simulink and Vision Signal Generator** The NI 9402 analog input module measures the speed and the direction. A tachometer determines the speed by measuring rotation speed. A gear ratio accelerates or decelerates the rotation.

The NI 9403 measuring the speed provides accurate temperature.

If necessary, refer to the CompactRIO manuals located at [chassisman1](#) LabVIEW FPGA User Interface. Access for more information.

# Standard Purchasing Methods



## Individual course purchase

- Specific date and location
- Specific individuals

## Training and Certification Membership

- Unlimited courses and certification exams for an individual
- 6 month, 1 year, 2 year options available

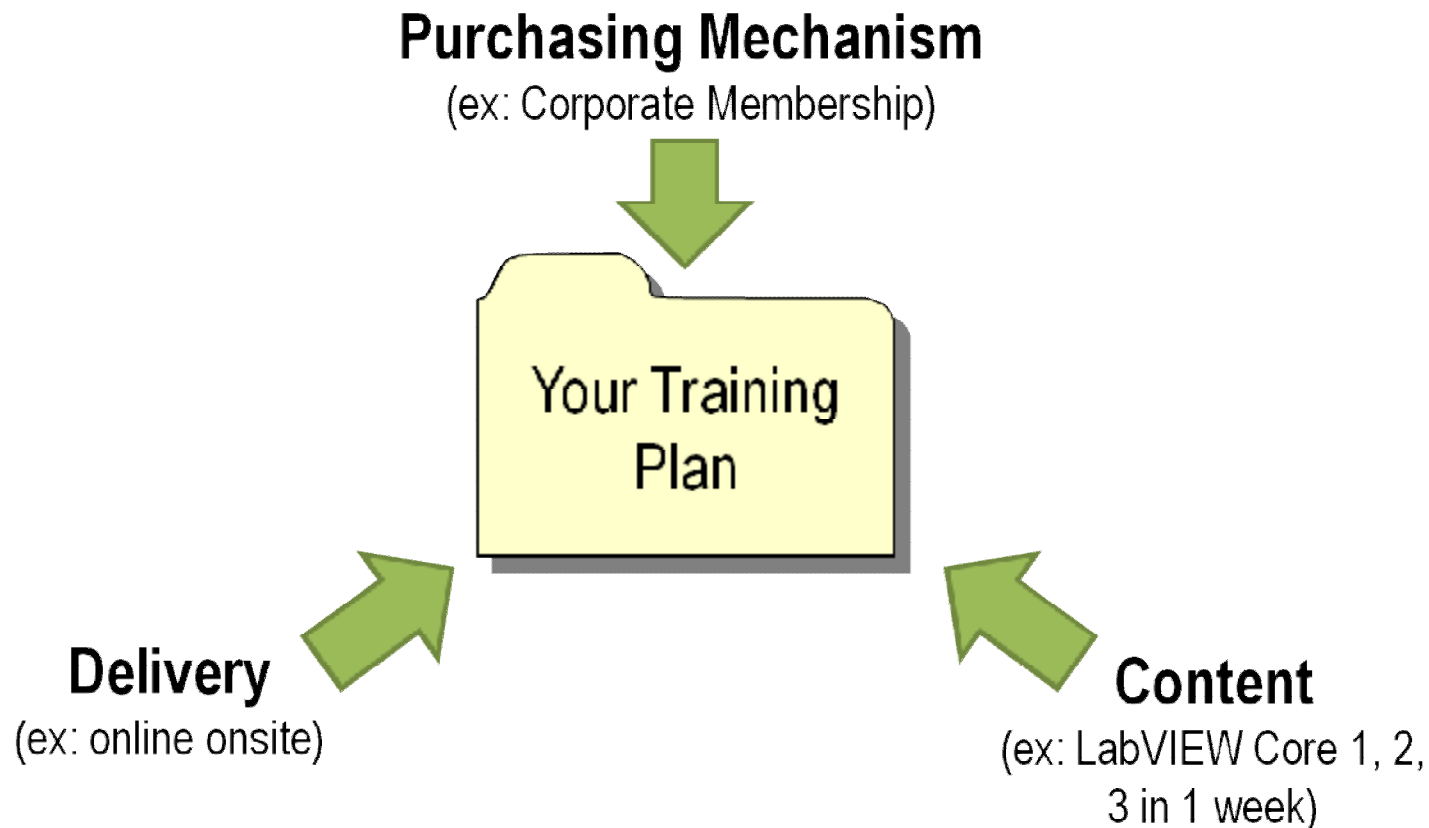
## Training Credits

- Similar to a gift card
- Flexibility to redeem for courses, certification exams, self-paced materials at a later date
- 1 training credit  $\approx$   $\frac{1}{2}$  day of basic training
- Expire in 1 year

# Custom Training Options



We can customize the training experience in three ways:

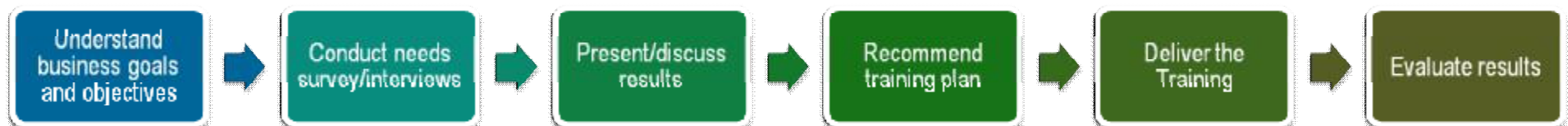


# Training Needs Assessment

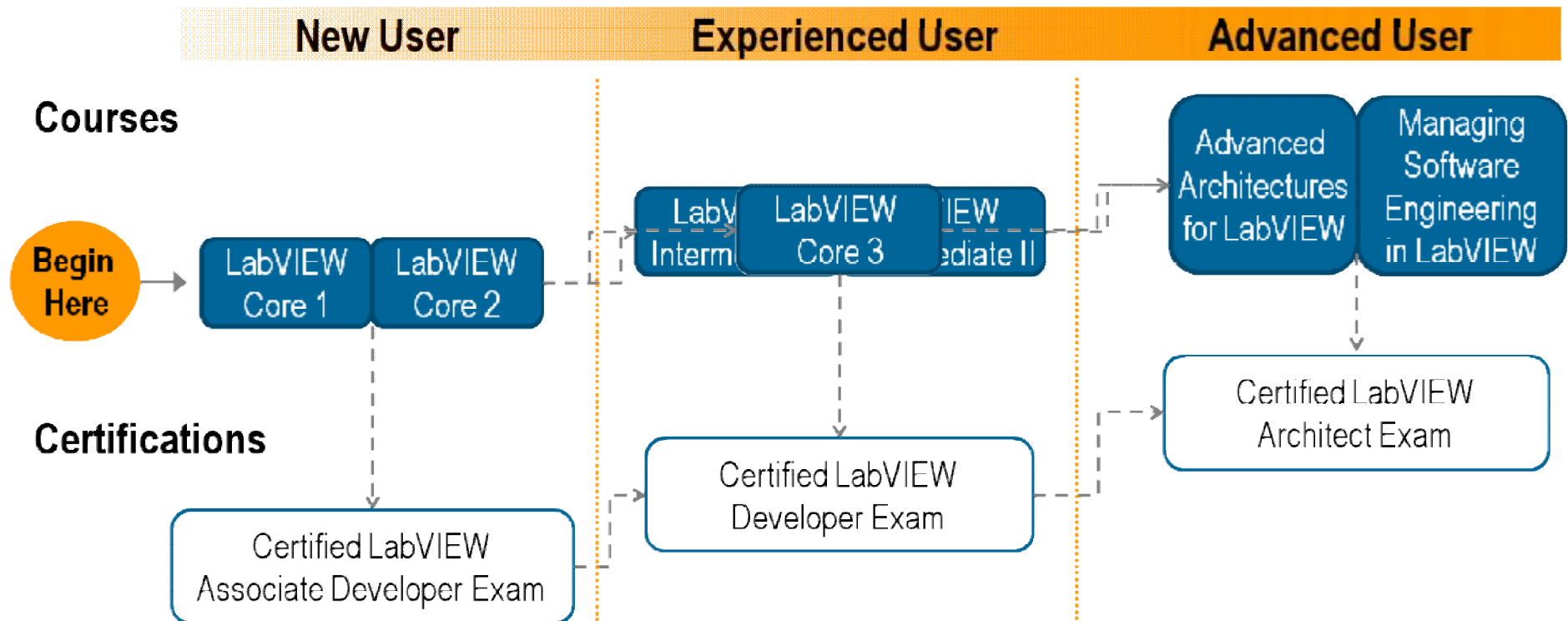


## Benefits:

- Understand skill level of your employees
- Identify technical lead candidates
- Uncover knowledge or process gaps
- Reflect your unique project needs
- Inform you of relevant training options and investment necessary to reach goals



# NI Certifications Align with Training

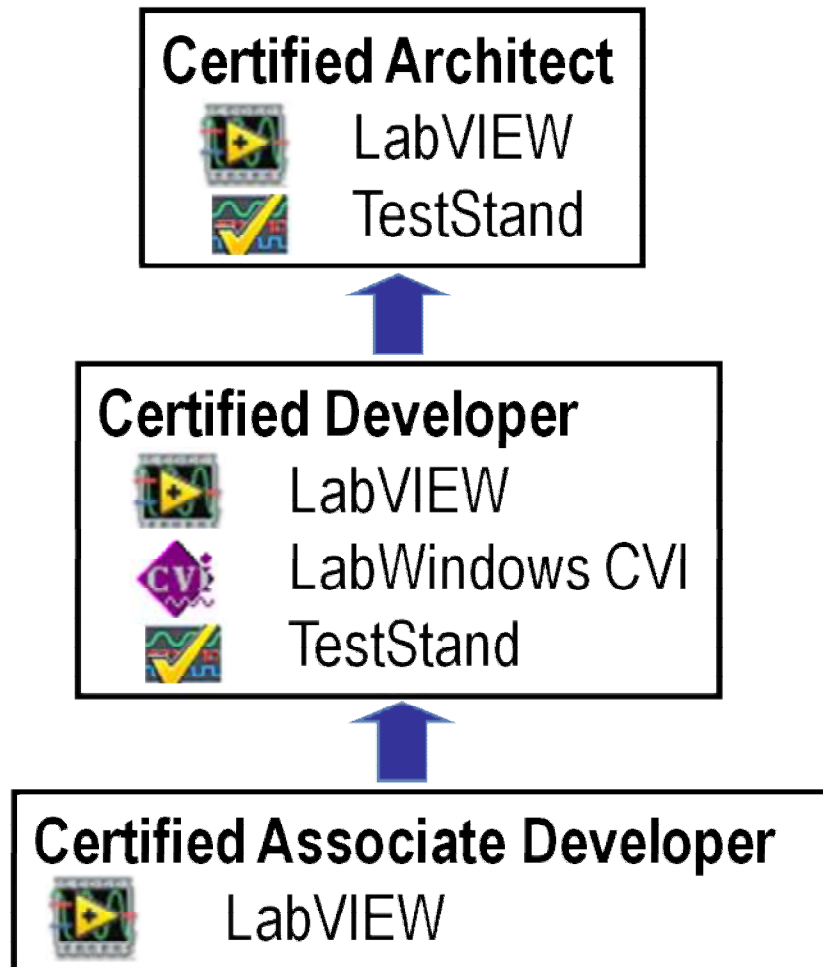


*"Certification is an absolute must for anyone serious about calling himself a LabVIEW expert... At our organization, we require that every LabVIEW developer be on a professional path to become a Certified LabVIEW Architect."*

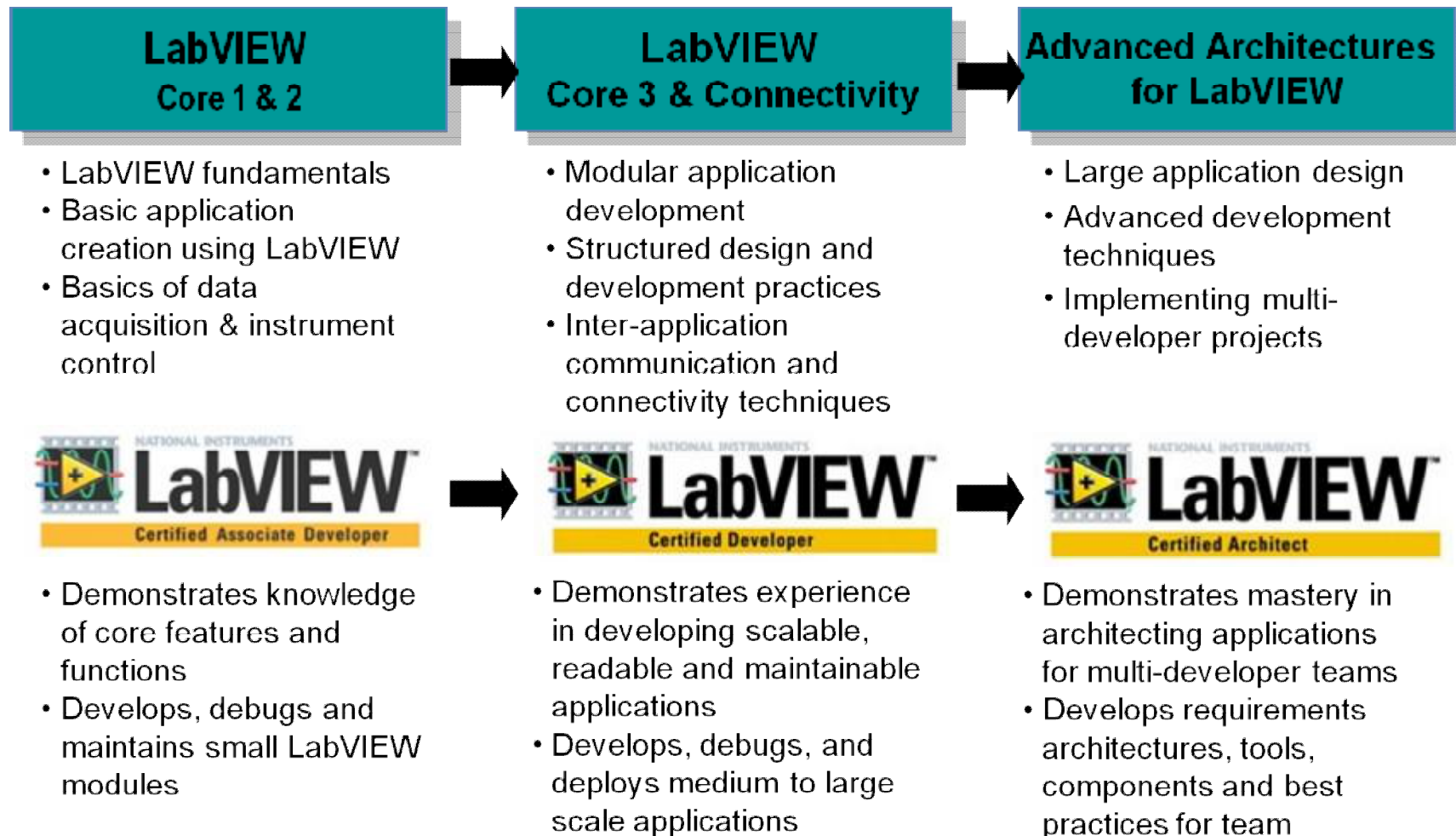
**James Kring, James Kring, Inc.**



# Certification Program Overview



# LabVIEW Training & Certification Path





# CERTIFICATION

# CLAD Exam: Format & Style



- Multiple choice style – 40 questions
  - 37 questions have one answer
  - 3 questions have multiple answers
    - These questions will be clearly identified
- Time allocated: 1 hour
- Computer Based Test
  - Mark questions for review – can go back to review items after completion
  - Skip questions – can go back to skipped items

# CLAD Exam Question Format & Style



- **Question format**
  - Multiple choice, application based
  - Graphical - Questions / answers may contain screen shots of VIs / functions
- **Question style**
  - Given a scenario, determine the best function / method for solving the problem
  - Given a block diagram, predict the outcome
  - Given a block diagram and missing function(s), determine the best function(s) to complete the functionality

# CLAD Preparation Steps



1. Review the exam topics in the [CLAD Exam Preparation Guide](#)  
([ftp://ftp.ni.com/pub/devzone/tut/clad\\_exam\\_preparation\\_guide.pdf](ftp://ftp.ni.com/pub/devzone/tut/clad_exam_preparation_guide.pdf))
2. Identify any knowledge gap
3. Attend NI Training courses or utilize resources (at the end of the CLAD exam preparation guide) to close the knowledge gaps
4. Assess yourself - Take the [Sample exams](#)  
(<http://zone.ni.com/devzone/cda/epd/p/id/5225>)
5. Webcast - [Understand the Most Missed Concepts within the CLAD Exam](#)  
(<http://zone.ni.com/wv/app/doc/p/id/wv-1950>)

# CLAD Exam Topics



1. LabVIEW programming concepts
2. LabVIEW environment
3. Software constructs in LabVIEW
4. Programming VIs and functions
5. Data communication and synchronization VIs and functions
6. VI Server VIs and functions
7. Error handling VIs and functions
8. Design patterns
9. SubVI design
10. Debugging tools and techniques
11. VI design and documentation (style) practices
12. Memory, performance, and determinism

# CLAD Exam Topic: Programming Concepts



- LabVIEW programming concepts:
  - Data flow
    - Identify programming practices that enforce data flow on the block diagram, in VIs, and SubVIs
    - Identify programming practices that break data flow



# CLAD Sample Question: Programming Concepts



You develop a SubVI that only outputs a value and need to use this SubVI in a (calling) VI. Which of the following is the best way to enforce dataflow to control the execution of the SubVI?

- a. Use the SubVI in a Sequence structure
- b. Modify the SubVI to have dummy inputs that can be used from the calling VI
- c. Modify the SubVI to have Error clusters that can be used from the calling VI
- d. Modify the SubVI to have a global variable and use it from the calling VI

# CLAD Sample Question: Programming Practices



Which of the following does not conform to data flow programming paradigm?

- a. Shift Registers
- b. Tunnels
- c. SubVIs
- d. Local Variables



# CLAD Exam Topic: Software Constructs

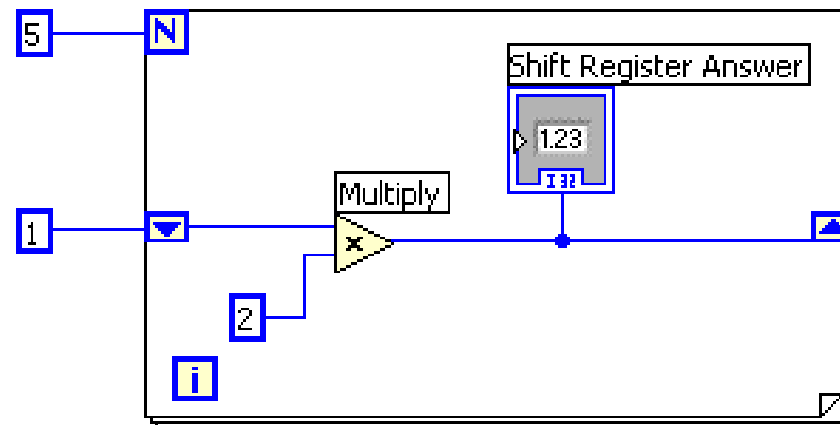


- Software constructs in LabVIEW
  - Program control structures and data storage
    - Determine the data values in the shift registers after a set number of iterations occur or upon loop termination

# CLAD Sample Question: Shift Registers



What is the value in **Shift Register Answer** after the following code has executed?



- a. 16
- b. 24
- c. 32
- d. 10



# CLAD Exam Topic: Programming



- Programming VIs and functions
  - Determine the output or intermediate values of data elements in an application that utilizes VIs and functions
  - Determine the most appropriate VI(s) or function(s) to complete a specified functionality

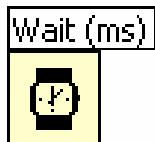
# CLAD Sample Question: Timing Functions



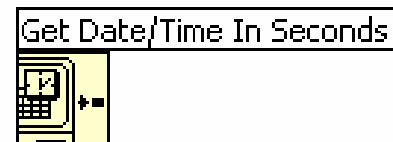
Which timing function (VI) is the best choice for timing control logic in applications that run for extended periods of time?



a.



b.



c.



d.

# CLAD Exam Topic: Design Patterns

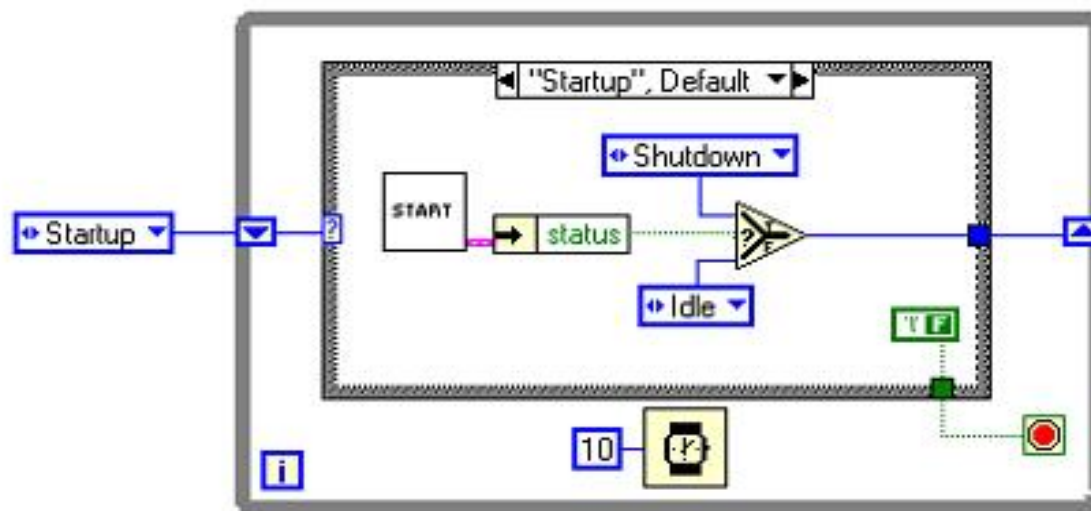


- Design patterns
  - Identify a design pattern, explain its pros and cons, and compare it with other design patterns

# CLAD Sample Question: Design Patterns



The following block diagram represents which common type of VI architecture?



- a. Multiple Case Structure VI
- b. General VI
- c. State Machine VI
- d. Parallel Loop VI





# CLAD Sample Question: Design Patterns



What is one disadvantage of using the State Machine VI architecture?

- a. A State Machine can only traverse states in order
- b. If two state changes occur at the same time, only the first state change will be handled and the second will be lost
- c. The diagram becomes significantly larger when changing from a general architecture to a State Machine
- d. State Machines cannot acquire data or use DAQ functions



# CLAD Exam Topic: Debugging Tools and Techniques



- Debugging tools and techniques
  - Given an error situation, select the most appropriate method to debug the error

# CLAD Sample Question: Debugging Techniques



In what instance would you use the Probe tool rather than Highlight Execution?

- a. To see the flow of data
- b. To see the value of a wire in real-time
- c. To look into a SubVI, as the process is running
- d. To slowdown the VI and show data values in wires

# CLAD Exam: What It Takes?



- **Understand the Environment**
  - Review Training Material – not just slides
  - Review NI Developer Zone review material
  - Understand concepts
- **Know What Questions to Expect**
  - Review Online Tests
  - Review Training Quiz material
- **Be sure to answer all questions**
- **Take practice exams – time yourself**
- **Program, Program, Program...**

# Next Step: CLD Exam



- CLD Exam Logistics
  - Process
  - Grading
- CLD Exam Objective and Theme
- CLD Exam Design
  - Design Patterns
  - Timing Methods
  - Development Style
  - Documentation
  - Error Handling

# CLD Exam: Process



- A PC with LabVIEW is provided
- Application development specification includes the following:
  - Screen shot of Front Panel
  - Description of the controls and indicators
  - General requirements
  - Functional specifications of the application
- LabVIEW documentation, Express VIs and examples may be used
- No external resources permitted
- Time allowed for exam: 4 hours

# CLD Exam: Grading Criteria



Grading Criteria	Points on Exam	Percentage
Functionality	15	37.5%
Style	15	37.5%
Documentation	10	25%
<b>Total Points</b>	<b>40</b>	<b>100%</b>

Passing grade is 75 % or higher



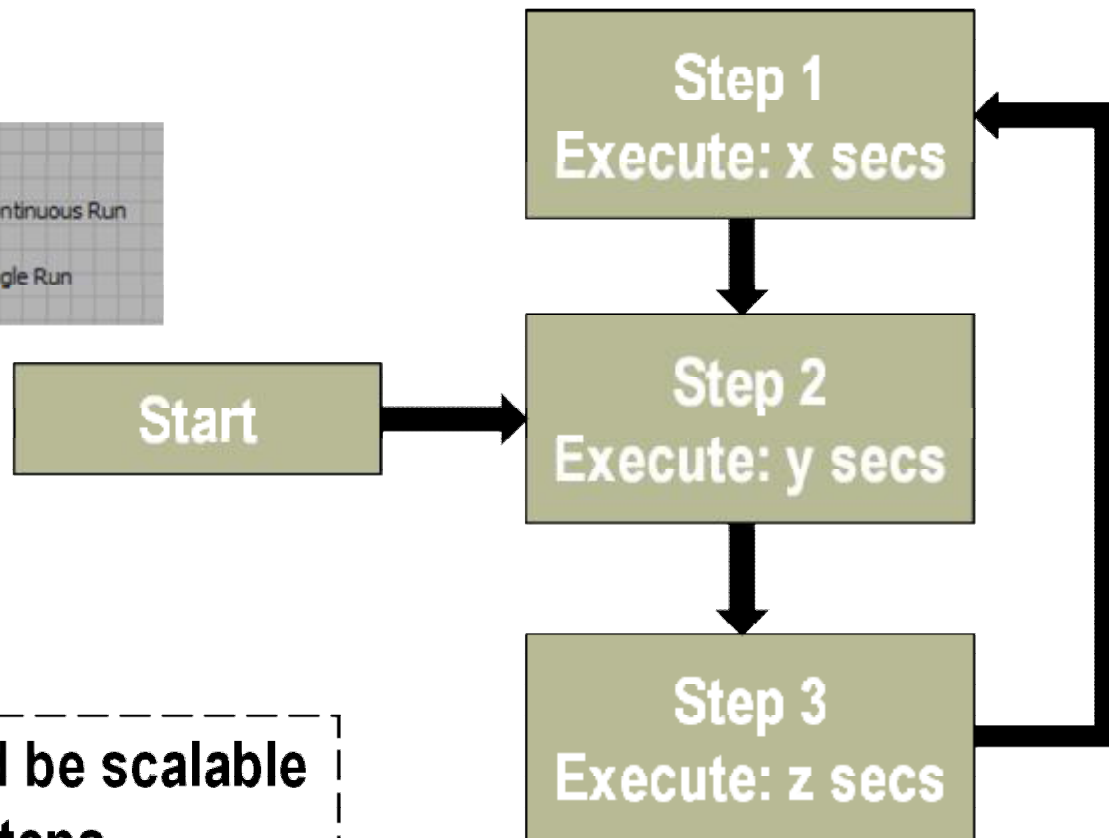
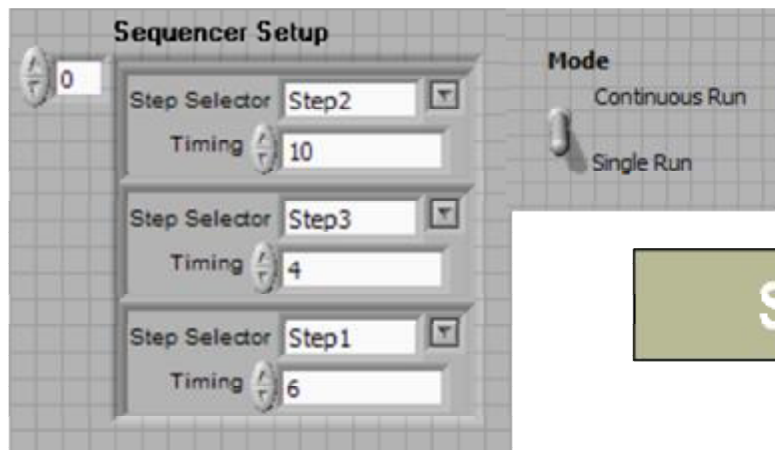
# CLD Exam: Demonstrates



- Problem solving skills
- LabVIEW competency
- Modular, scalable, and maintainable application design experience
- Consistent documentation
- Moderate development (wiring) speed
- Debugging and testing

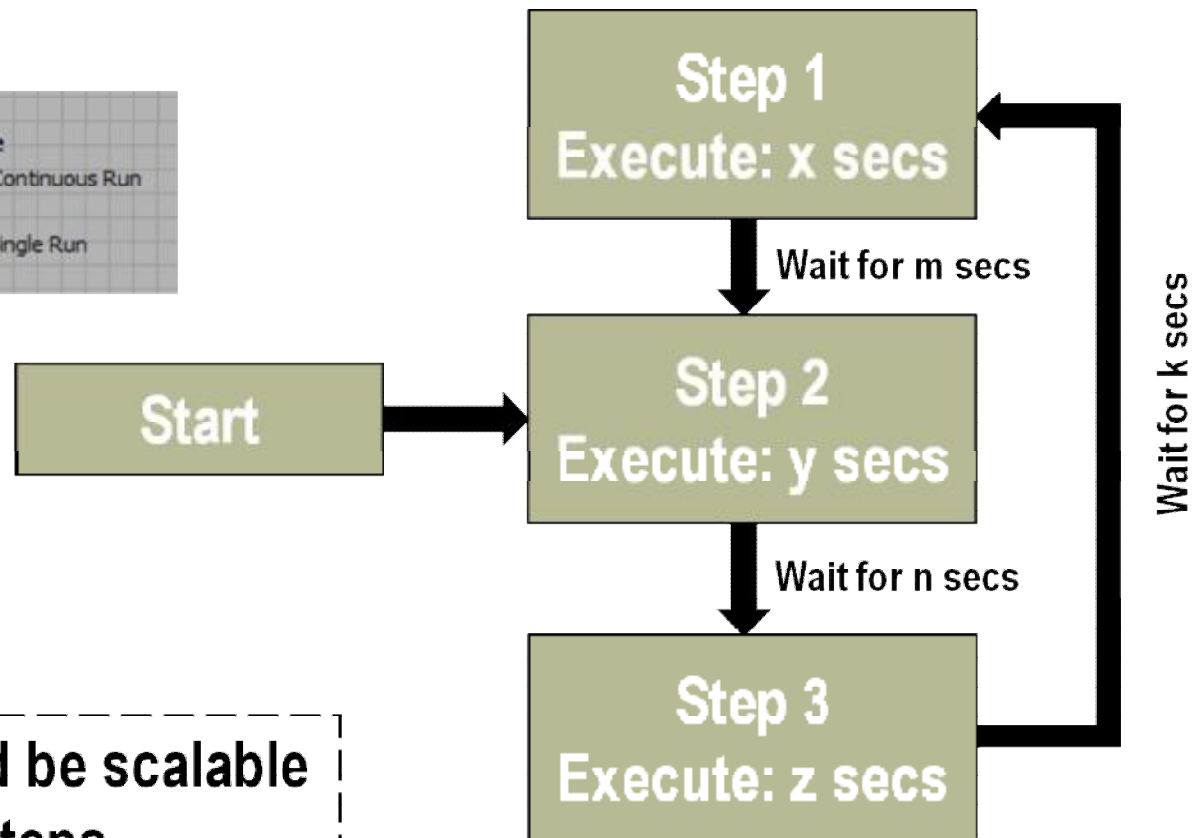
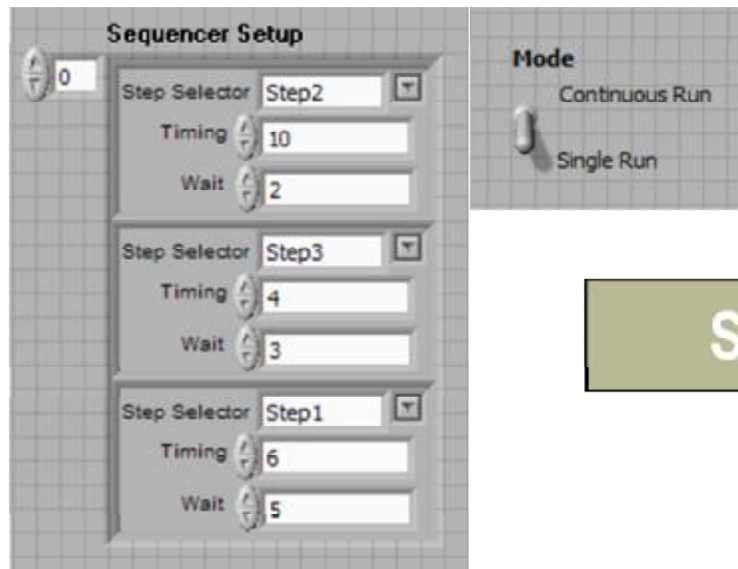


# CLD Exam: Theme Scenario Sequencer



**Program design should be scalable to adapt to additional steps**

# CLD Exam: Theme Scenario Sequencer



Program design should be scalable to adapt to additional steps

# CLD Exam: Theme Summary

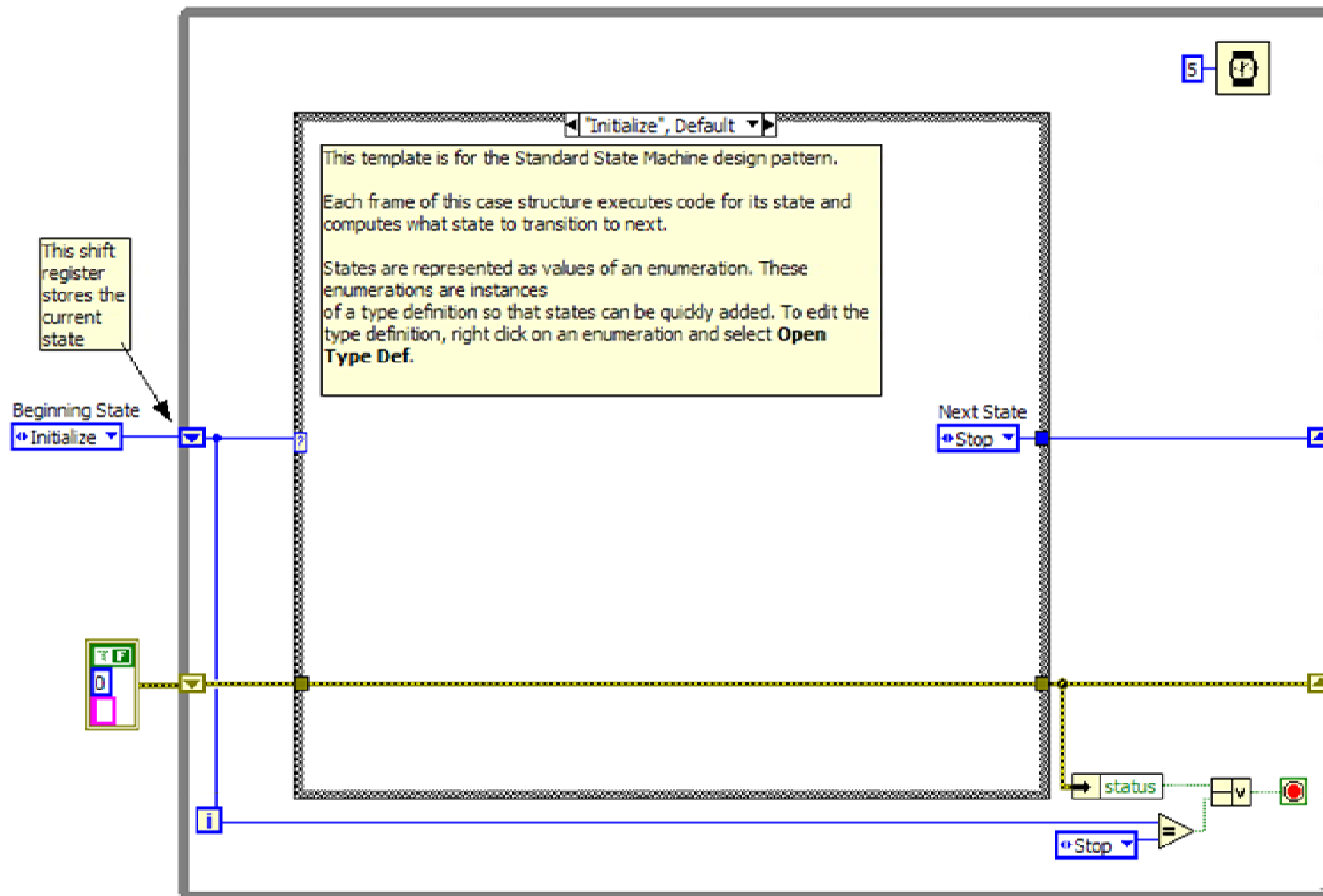


- Exams are based on a sequencer type application
- Step order is configurable via an input file or user interface
- Timing is an essential aspect of the application
- Output or log file may be required
- Application must respond to user interface activity within 100 msec.



# CLD Exam: Design

# Design Pattern - State Machine

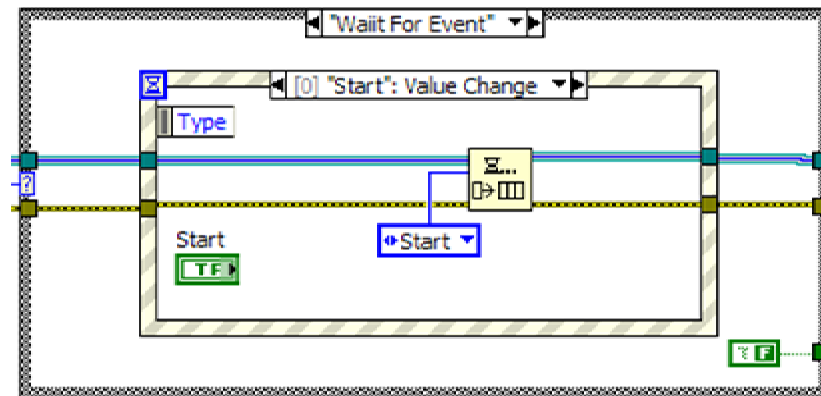
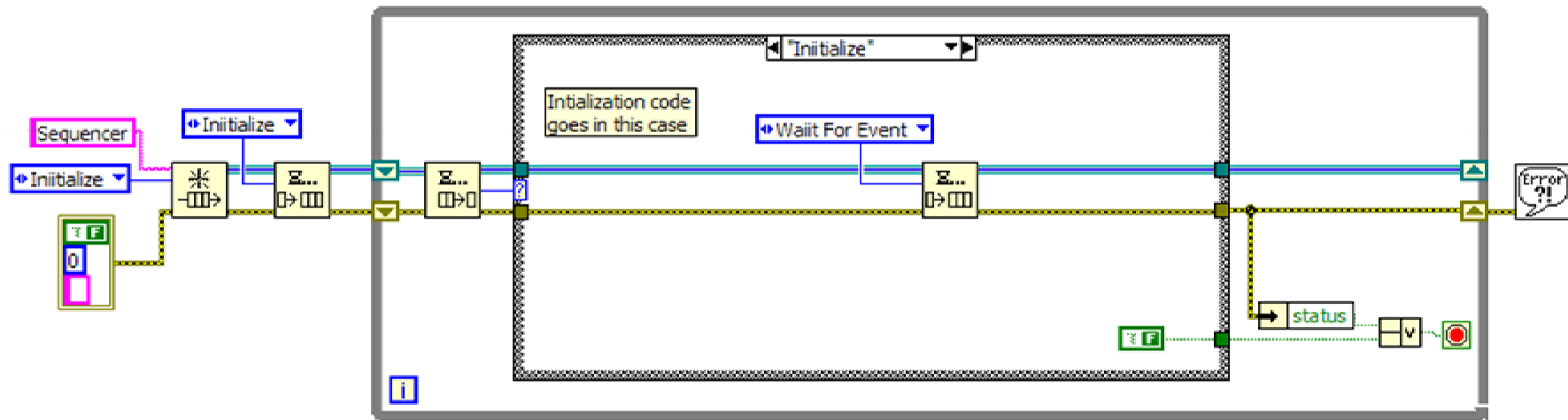


# CLD Exam Design Patterns



Design Pattern	Advantage	Disadvantage
State machine	<ul style="list-style-type: none"><li>• Handles sequence control</li></ul>	<ul style="list-style-type: none"><li>• Cannot handle storing of sequences</li><li>• May not be responsive enough to user interface events</li></ul>

# Design Pattern: Queue Based UI Event Handler



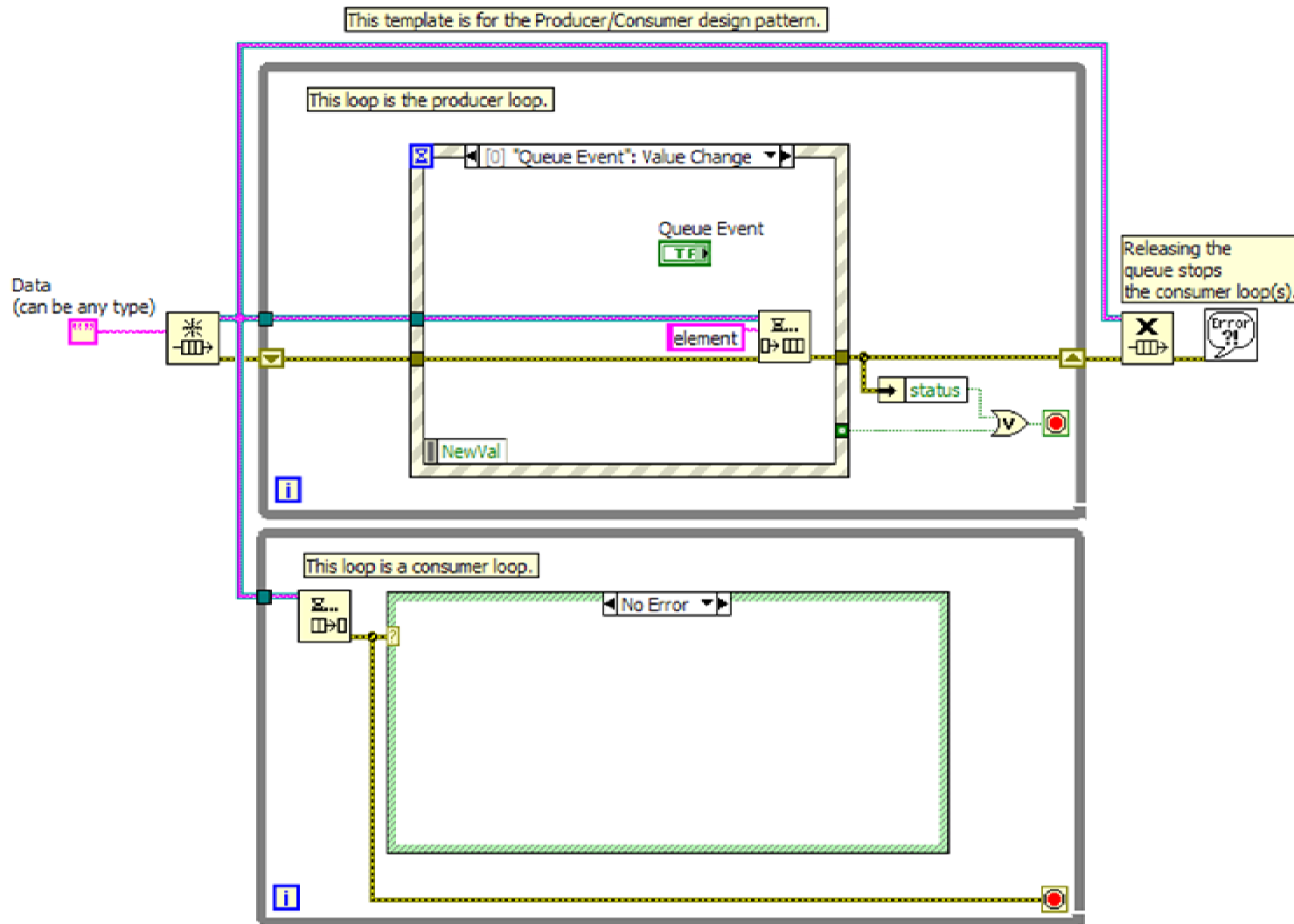
# CLD Exam Design Patterns



Design Pattern	Advantage	Disadvantage
State machine	<ul style="list-style-type: none"><li>• Handles sequence control</li></ul>	<ul style="list-style-type: none"><li>• Cannot handle storing of sequences</li><li>• May not be responsive enough to user interface events</li></ul>
Queue based user interface Event Handler	<ul style="list-style-type: none"><li>• Extends state machine to store sequences</li><li>• Handles user interface events</li></ul>	<ul style="list-style-type: none"><li>• Does not allow intensive event or sequence processing</li><li>• User interface events need to be controlled by limiting access to front panel controls</li></ul>



# Design Pattern: Producer Consumer



# CLD Exam Design Patterns



Design Pattern	Advantage	Disadvantage
State machine	<ul style="list-style-type: none"><li>• Handles sequence control</li></ul>	<ul style="list-style-type: none"><li>• Cannot handle storing of sequences</li><li>• May not be responsive enough to user interface events</li></ul>
Queue based UI Event Handler	<ul style="list-style-type: none"><li>• Extends state machine to store sequences</li><li>• Handles user interface events</li></ul>	<ul style="list-style-type: none"><li>• Does not allow intensive event or sequence processing</li><li>• User interface events need to be controlled by limiting access to FP controls</li></ul>
Producer / Consumer with Events	<ul style="list-style-type: none"><li>• Responsive to user interface events</li><li>• Allows intensive event and sequence processing</li></ul>	<ul style="list-style-type: none"><li>• Does not integrate non-user interface events well</li></ul>

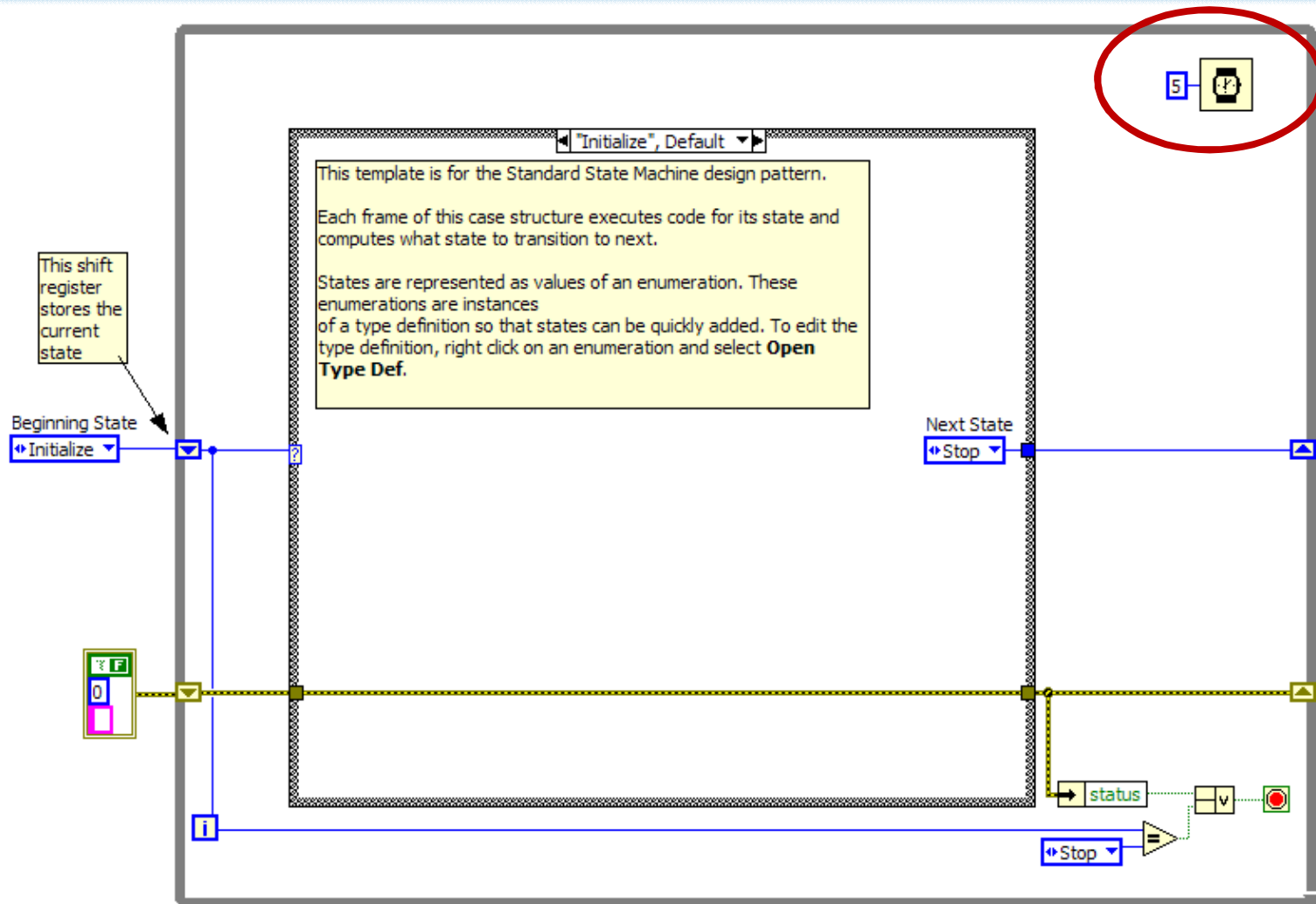
# CLD Exam: Timing Methods



Timing Type	Timing Method	Applications
Execution timing control	Wait (ms) Wait Until Next (ms) multiple	Regulate execution of state machine loop to allow other programs to run on the computer

- Execution timing control allows us to regulate how quickly a loop executes on the processor

# Execution Timing Control



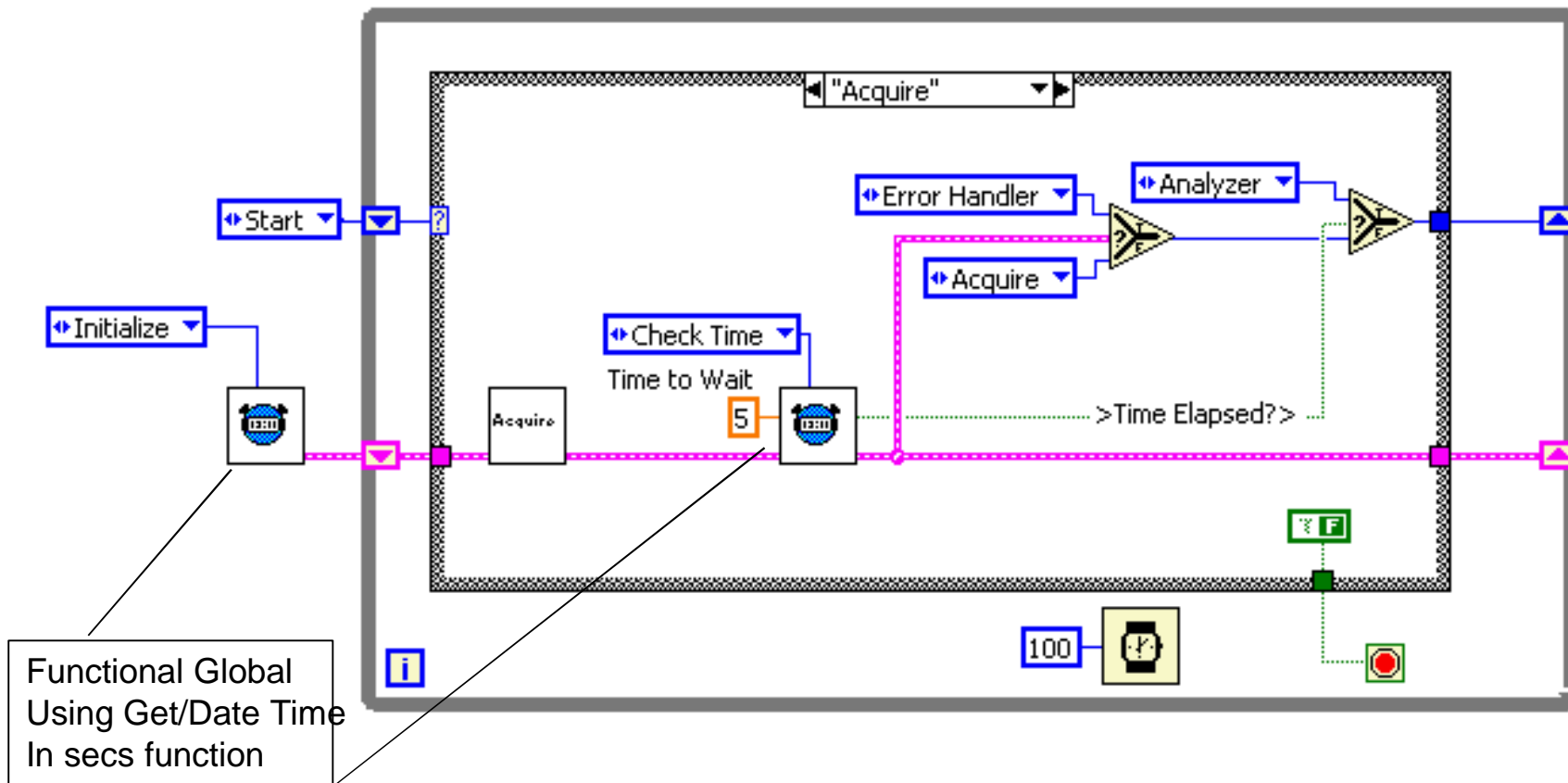
# CLD Exam: Timing Methods



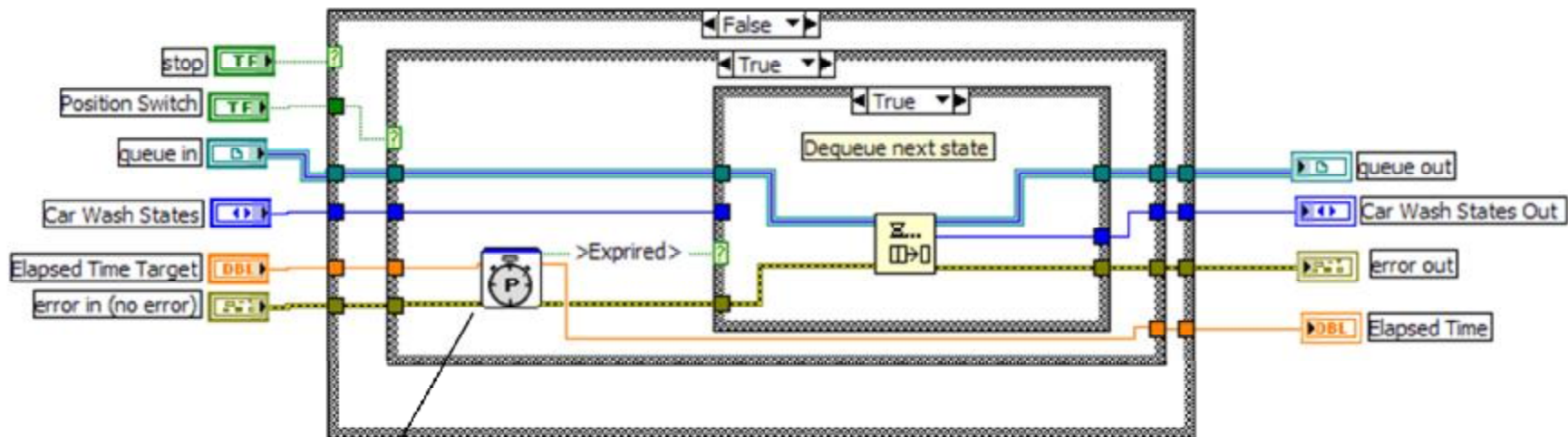
Timing Type	Timing Method	Applications
Software timing control	Get Date/Time in sec. Tick Count	Good general purpose timing method for timing a sequence operation. Encapsulate in functional global or SubVI
	Express Elapsed time VI	Measures Elapsed time with stop / reset control functions. Ready made solution !!

- Software timing control allows us to time a real-world operation to perform for a set time period.

# Software Timing Control



# Software Timing Control – Using an Express VI



Elapsed Time  
Express VI

This is a subVI from the  
Car Wash sample exam

# CLD Exam: Style - Small Things make a Big Difference



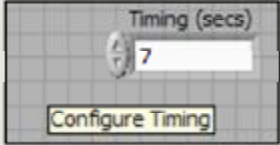

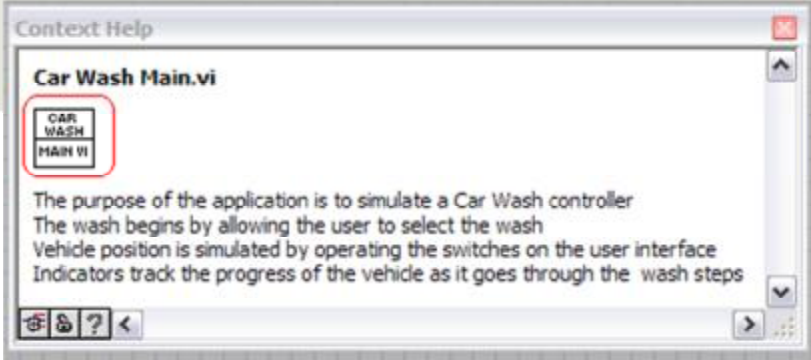


- Avoid the use of local variables when you can use a wire
- Use property nodes to modify control attributes and control values but not indicator values
- Typedefine reused enums and data structures
- Close references if opened explicitly
- Avoid data coercion and default tunnels
- Avoid copies of code - Develop SubVI if code is reused
- Create readable block diagram
  - Avoid unnecessary bends, overlapping objects, wires
  - code should flow left to right, top to bottom



# CLD Exam: Documentation

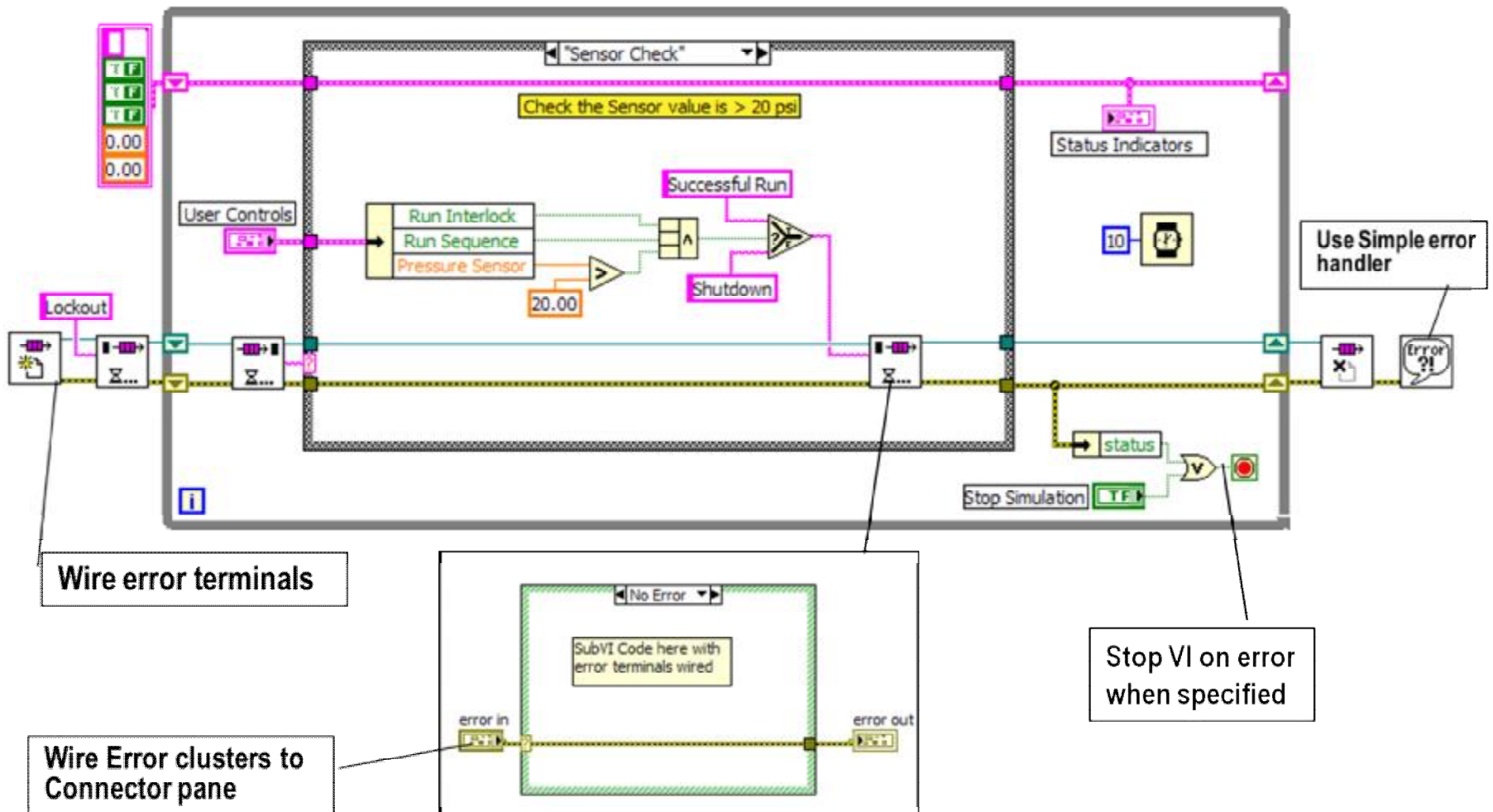


Documentation	Example
Label wires to identify their use	
Label constants	
Description and tool tips for UI controls	
Block diagram comments	
VI / SubVI Properties » Documentation	



**Tip: Brevity !!**

# CLD Exam: Error Handling



# CLD Exam: Preparation Tips



- Test yourself:
  - Time yourself through the sample exams
  - Evaluate your solutions using the Exam Preparation Guide and the evaluation criteria given at the end of the guide
- Do better:
  - Incorporate best practices in all your LabVIEW projects
  - Use the generic sequencer model to develop new scenarios
  - Improve your coding speed
  - Find optimal ways to solve problems in LabVIEW

# CLD Exam: Exam Tips



- Take a few minutes to plan your application
  - Decide on the best main VI architecture for the application
  - Decide which modules / SubVIs you will need to create
  - Decide on the timing method
- Focus on getting most of the core functionality working
- Document the VI and SubVIs
- Clean up block diagram towards the end
- Pace yourself... Time passes quickly when you are having fun!!

# CLD Exam: What It Takes?



- **Understand the Requirements**
  - Review NI Developer Zone review material
  - Sample exams are either fully representative or actually representative of what you will see on the exam
  - Functional Coding is only 37% of the exam !
- **Know What to Expect**
  - You will have to use a design pattern
  - You will have to use error handling
  - You will need to document – don't wait for the end
  - You will only have 4 hours – do not overcomplicate
- **Allocate time to design your application**
- **Take practice exams – time yourself**
- **Program, Program, Program...**

# Next Step: CLA Exam



- **CLA Exam Logistics**
  - Process
  - Grading
- **CLA Exam Objective and Theme**
- **CLA Exam Architecture**
  - Architectural Design
  - Architectural Coding
  - Documentation
  - Requirements

# CLA Exam: Process



- A PC with LabVIEW 2009 is provided
- Detailed application specification includes the following:
  - List of project deliverables
  - Sketch of Front Panel User Interface
  - Description of the controls and indicators
  - Functional requirements of the application – by component
- No external resources permitted - LabVIEW help and design patterns are allowed
- Time allowed for exam: 4 hours

# CLA Exam: Grading Criteria



Grading Criteria	Points on Exam	Percentage
User interface and block diagram style	10	10%
Documentation	20	20%
Requirements coverage	30	30%
Architecture development	40	40%
<b>Total Points</b>	<b>100</b>	<b>100%</b>

Passing grade is 70 % or higher





# CLA Exam: Demonstrates



- **Mastery of architecting LabVIEW applications for a multi-developer environment**
  - LabVIEW competency – VI development and design pattern usage
  - Software development expertise
  - Ability to break down a project specification into manageable component
- **Thorough and intuitive documentation abilities**
- **Ability to effectively utilize project management tools to see a project through**

# CLA Exam: Beyond Coding



- Only 10% of the exam involves actual functional LabVIEW code development
- You will be presented with a project similar to that of the CLD Exam
- Rather than coding a solution to the project, you will now be architecting a solution so that other developers can code the solution for you
  - Review and understand a set of technical requirements
  - Interpret requirements into a maintainable LabVIEW architecture
  - Set up key building blocks for future development
  - Plan and track project progress of development team

# CLA Exam: Develop an Architecture (40%)



- You will be required to answer essay type questions defining critical architectural decisions
  - Primary framework of project
  - Timing architectures
  - Design patterns, software architecture, user interfaces
  - Design decisions, guidelines
  - Error handling strategy
  - Project management decisions, tools
  - Team development strategies
  - How will you test your software
- The architectural decisions made in this phase will be implemented in the next

# CLA Exam: Implement Architecture (10%)



- Develop a project hierarchy
- Develop a core “main” VI - no functional code
  - User interface
  - Primary architecture / design pattern
  - Primary data structures
  - Error handling structure
  - Event and timing structures
  - Operational with fully connected modules
- Develop shell modules/subVIs - no functional code
  - Inputs / Outputs and Icons
  - Primary API, architecture, and data structure
  - Error handling and communication
  - Templates / reuse / classes – standardize

# CLA Exam: Developer Instructions (20%)



- Provide detailed instruction for “main” VI and functional modules
  - Your developers now need to know exactly how to complete the functionality of the module
  - Instructions should be specific and concise
- Follow standard LabVIEW development guidelines for documentation
  - All VI Descriptions must be completed
  - Use control documentation on Front Panel objects
  - Free label comments as appropriate on block diagrams
  - Data Structures must be labeled

# CLA Exam: Track Requirements (30%)



- All technical requirements must be addressed in the code
- Unique requirement ID must be used
- Use standard parts of architecture documentation to cover requirements
  - VI Description
  - Control Documentation Property
  - Project or Library Documentation Property
  - Front Panel or Block Diagram comments (free labels)
- NI Requirements Gateway will be used to verify – be sure to use correct syntax and cover ALL items

# CLA Exam: What It Takes?



- **Understand the Requirements**
  - Review NI Developer Zone review material
  - Sample exams are either fully representative or actually representative of what you will see on the exam
  - Functional Coding is only 10% of the exam!
- **Know What to Expect**
  - 4 hours go by very quickly – do not overcomplicate (mind the 80/20 rule)
  - Project deliverables don't change – the application does
  - The ability to direct and manage are critical
- **Read the whole exam material before diving in**
- **Prepare in advance how to handle each section**
- **Plan, Plan, Plan...**

# Why Train and Certify in LabVIEW



- **LabVIEW is a software development platform**
  - Offers a rich set of functions and syntax
  - Offers advanced development tools
  - Requires standard software development processes to enable successful designs
- All of the above are promoted through the training and certification process
- Invest in acquiring the necessary skills that will pay off in the long run
- Join a continually growing group of professional developers embracing the LabVIEW environment
- Prepare your company or group to take on the most challenging application development tasks



# Contact Bloomy Controls



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