

Development of an embedded driving style monitor using graphical system design

Dennis Motshagen, INCAA

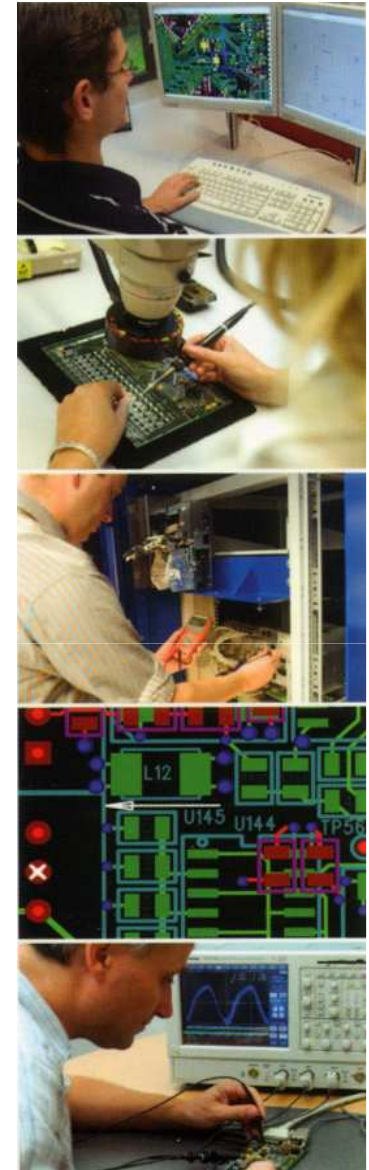
Erik van Hilten, National Instruments

Topics

- Background driving style monitor
- Requirements
- Graphical development process
- Experiences

About INCAA Computers

- Founded 1975
- Solutions provider
- Hardware, Software & Systems
- In-house design and fabrication



National Instruments - Profile

30 Years of growth out of 32 years

Fortune's 100 Best Companies to Work For
Eleven Consecutive Years

NI has a solid record:

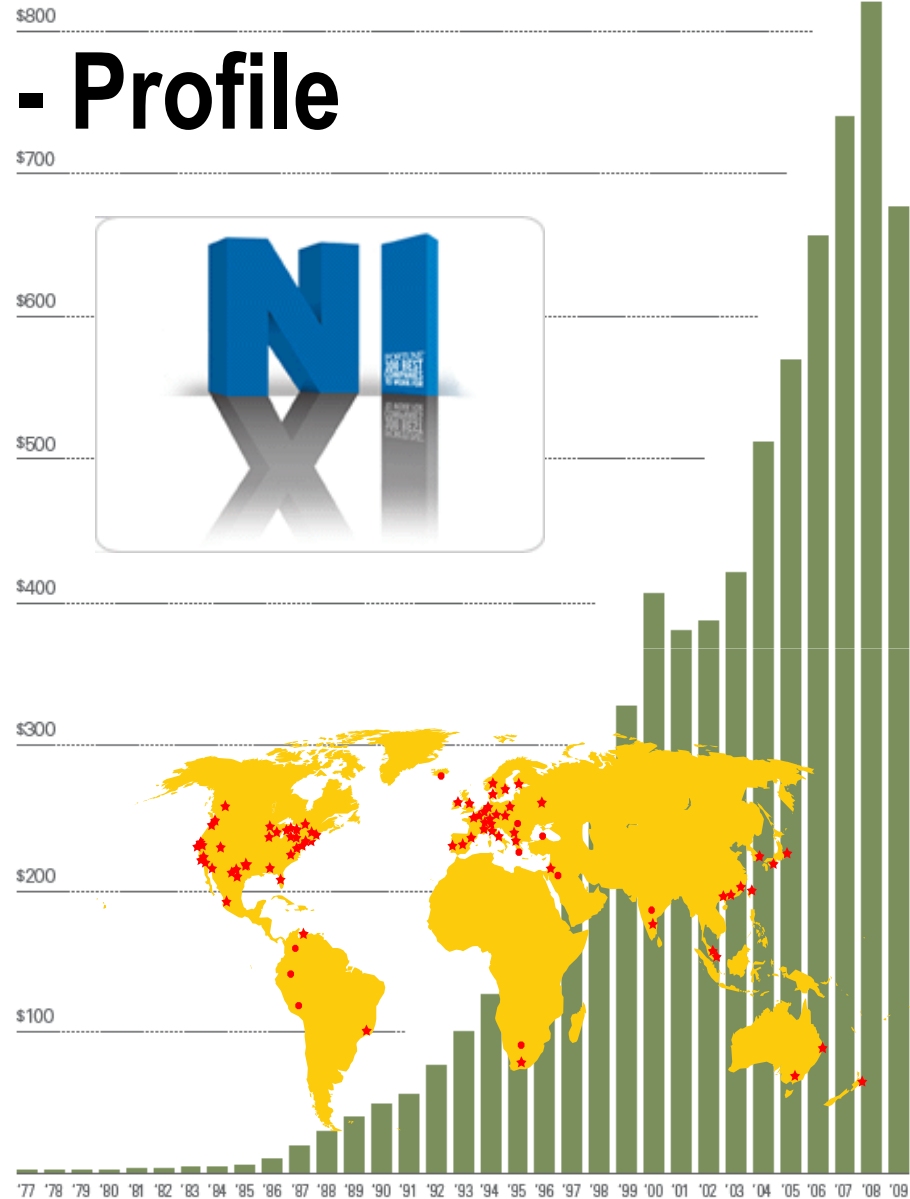
Strong sustained profitability

Leading revolution in virtual instrumentation

Diverse markets, products, customers, and industries

Leaders in Computer-Based Measurement and
Automation

Significant investment in research and
development > 18% of revenue in 2009



Product development stages

- Customer demand
- Feasibility and requirements
- Proof of Concept
- Testing
- Production ready

Driving style monitor – customer demand

- Requests from several customers to analyze driving style and driving comfort
- Different objectives:
 - Comfort
 - Reduce wear
 - Energy reduction
 - Independent quality measure
 - Blackbox



Solution

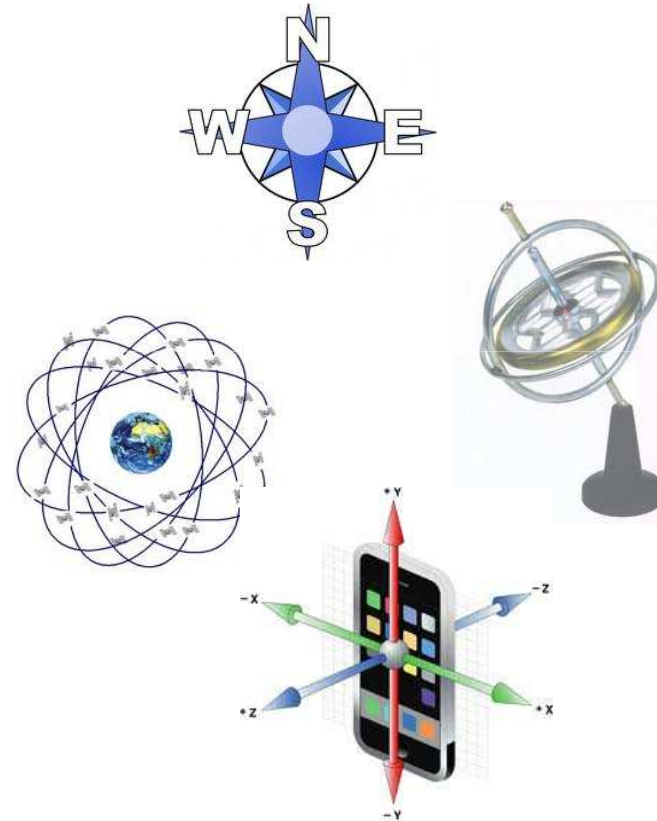
- Measurement and monitoring system needed
 - Need to monitor vibration and acceleration
- Requirements
 - Well maintained vehicle
 - Automotive grade hardware
- Outputs
 - Driving style driver
 - Road quality

How to qualify and determine driving comfort?

- Vibration, shocks, accelerate/decelerate, bracking,
- Tri-axial accelerometers
- Events detection needed
- Standard ride comfort ENV-12999:1999
- INCAA scale

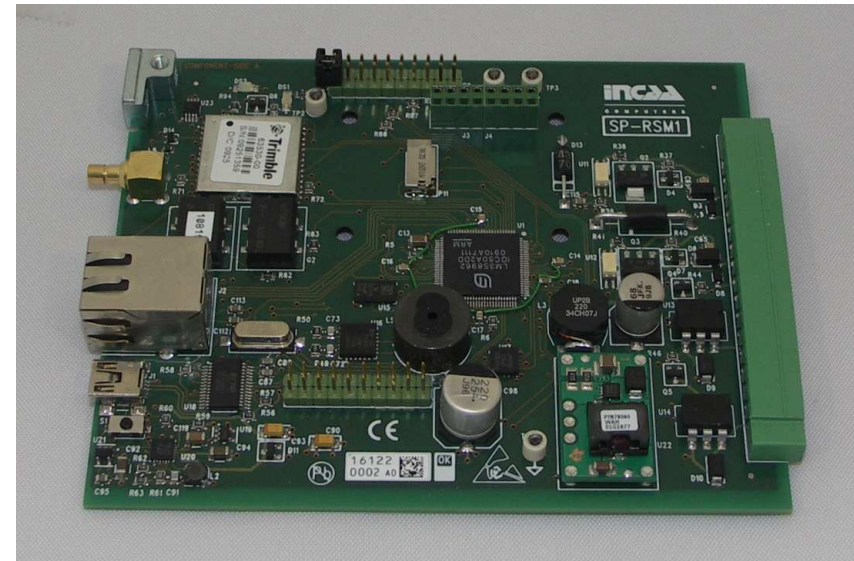
Required sensors

- GPS
- Electronic compass
- Gyroscope
- Digital I/O
- 3D accelerometers



Other hardware requirements

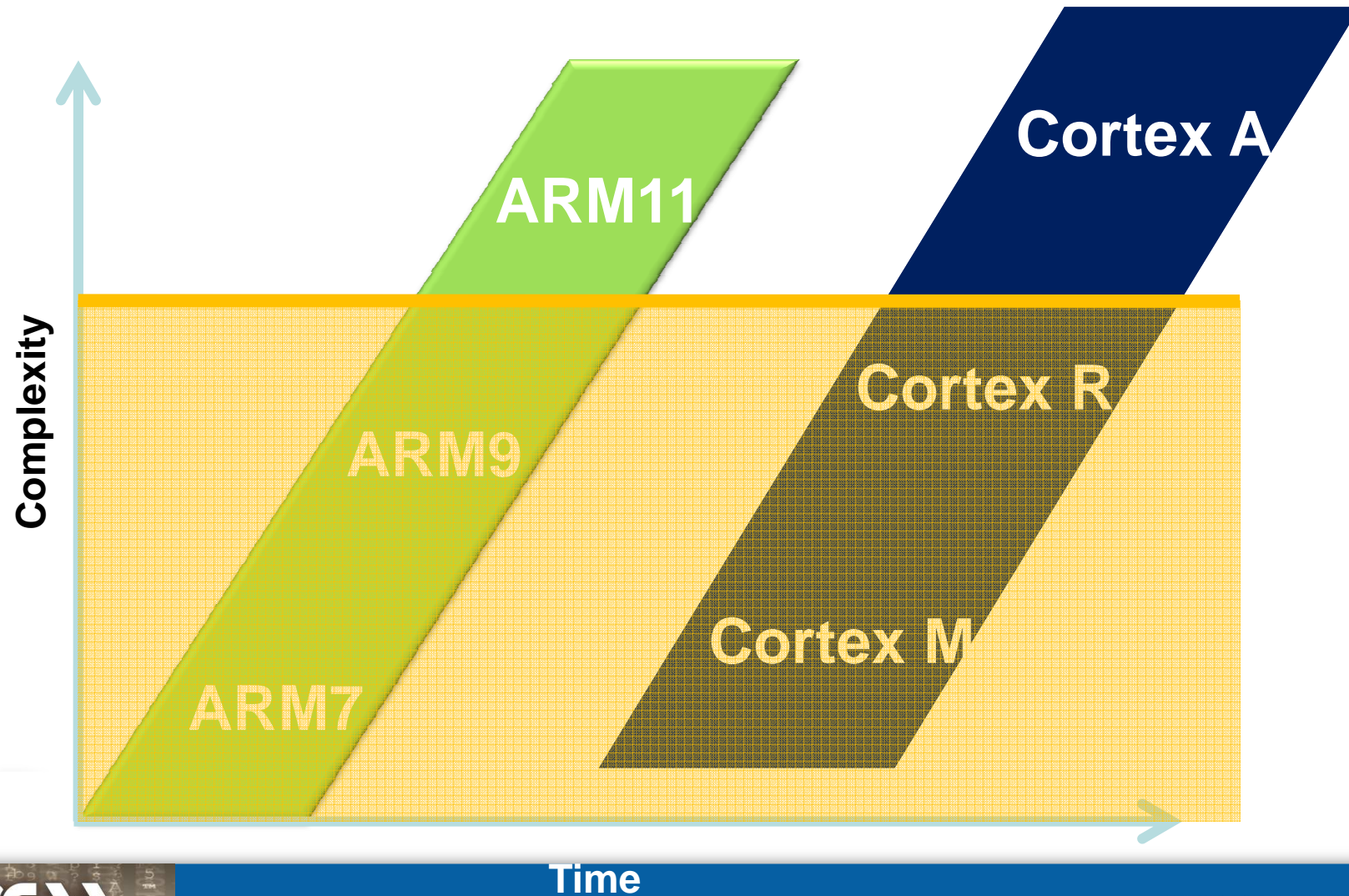
- Output to display
- Digital outputs
- Buzzer
- USB & Ethernet
- Data storage
- Automotive power supply



Embedded software requirements

- FAT32
- Ethernet
- USB
- Extrapolation GPS signal
- Dead reckoning GPS
- Google earth export
- Report generation

ARM Processor Family



Selecting a Microcontroller for our project

- Low cost deployment
- ARM microcontroller
- Graphical development support
- Texas Instruments Cortex-M3:
LM3S8962

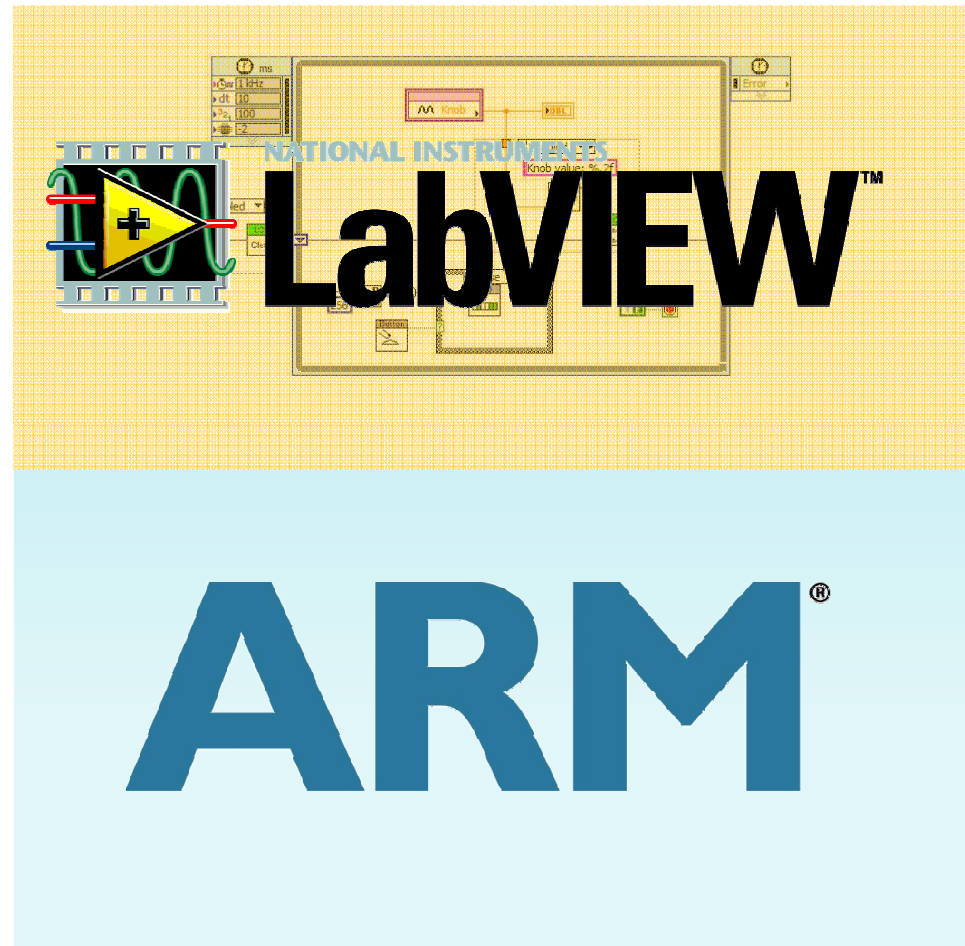


Graphical support

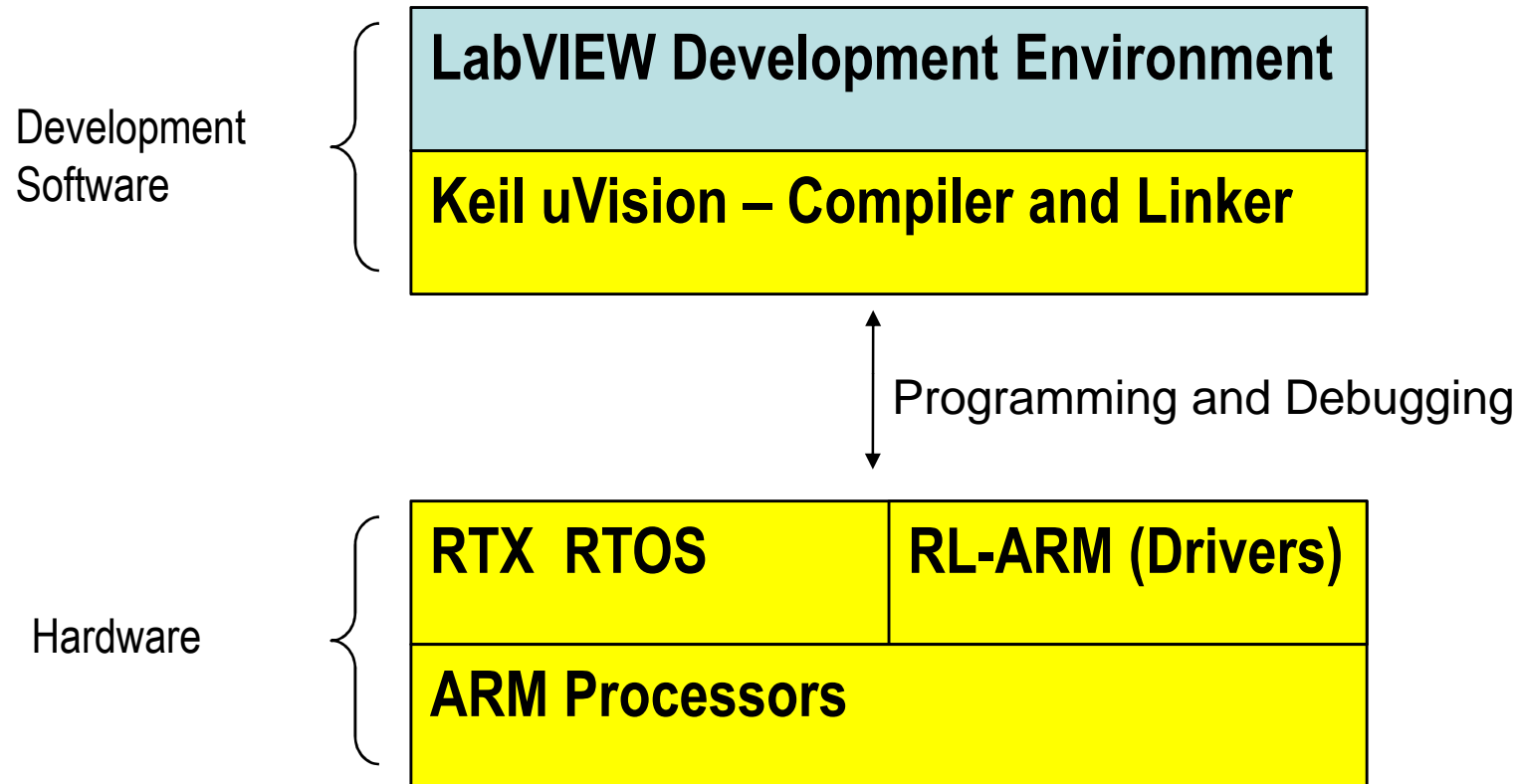
	Tier1	Tier2
Basic Programming Structures	✓	✓
Numeric, Boolean Logic	✓	✓
Arrays , Clusters, Matrices	✓	✓
Semaphores, Queues, FIFOs	✓	✓
Mathematics, Signal Processing	✓	✓
Statistics	✓	✓
TCP/IP, Serial Communication	✓	✗
Analog I/O	✓	✗
Digital I/O	✓	✗
PWM	✓	✗
CAN,I2C, SPI Communication	✓	✗
LCD	✓	✗
Interrupt Manager	✓	✗
Cycle-Accurate Simulation	✓	?

LabVIEW Embedded Module for ARM[®] Microcontrollers

- Over 380 supported processors
- Integrated drivers for analog, digital, and communications
- Desktop Simulation support for software development



ARM Development Environment



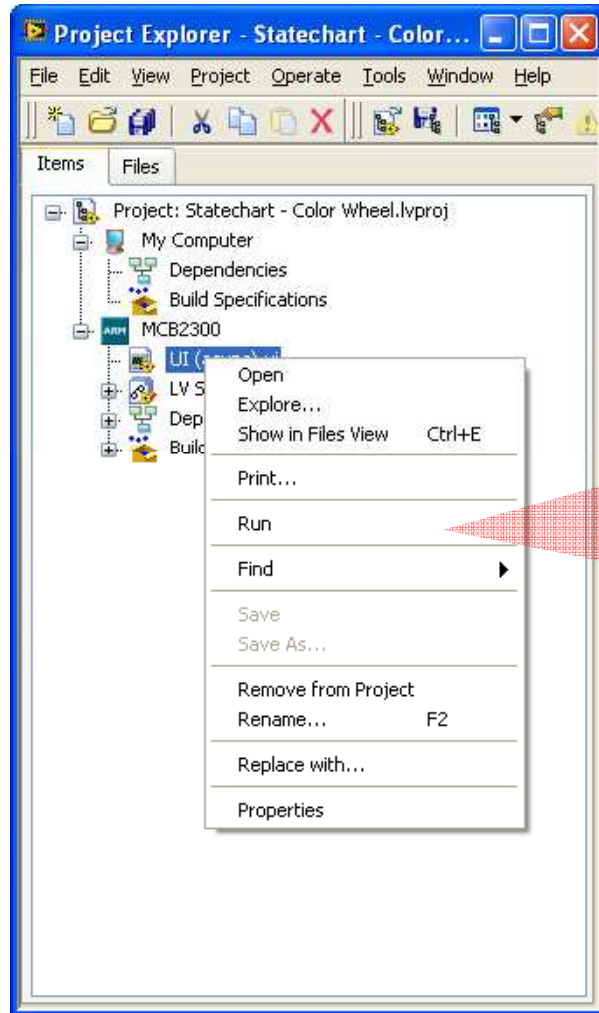
The screenshot displays the LabVIEW development environment with three main windows:

- Project Explorer - Untitled Project 1.lvproj**: Shows a tree view of the project structure. Under "MCB2300", there are sub-items for Digital Output (OverThreshold (LED1), LED2), Analog Input (Position (AIO)), PWM Output (Motor (PWM1)), and Pick and Place.vi.
- Processor Status**: Shows the status of the target hardware.
 - µVision Status: Ready
 - µVision Application: Unknown
 - Processor Status: Not in debug mode
 - Exception Status: Not in debug mode
 - Location: Not in debug mode
- Pick and Place.vi Block Diagram on Untitled Project 1.lvproj/MCB2300 ***: Contains two sub-diagrams:
 - Control Loop**: A loop with a 1 kHz sampling rate. It starts with a "Position" block, followed by a summing junction. The second input to the summing junction is an "OverThreshold" block. The output goes to a code block:


```
int y;
//calculate next position
NextPosition(x, y);
```

 The output of the code block is connected to a "Motor" block.
 - UI Loop**: A loop with a 1 kHz sampling rate. It features a "Moving" block and a "Comm Failure" block. The "Moving" block is connected to a "TCP" block. The "Comm Failure" block is also connected to a "TCP" block. The "TCP" blocks are connected to a "400" block and a "TCP" block.

How it works



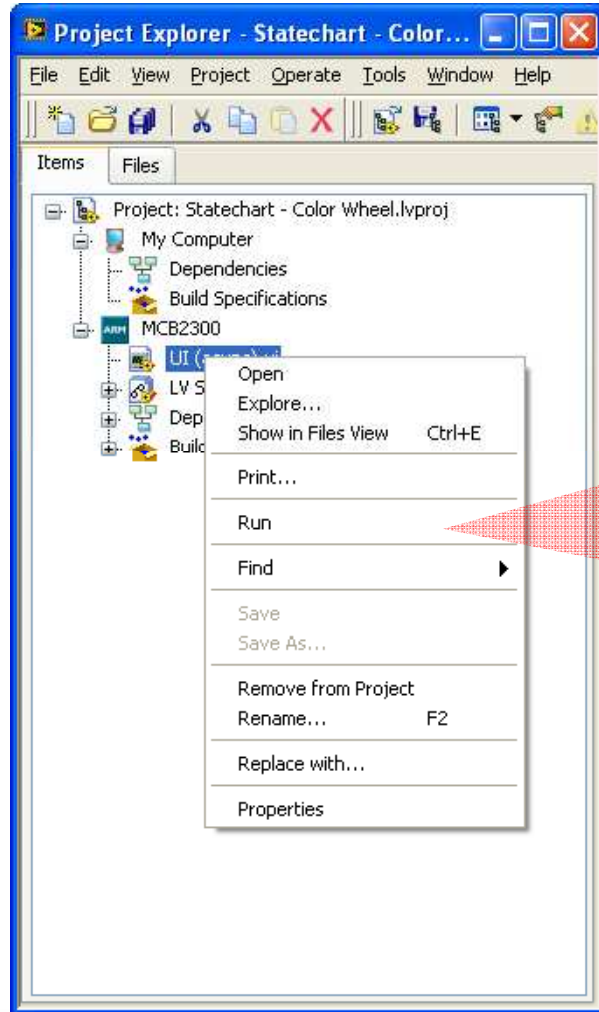
Run

My VI.vi

C Code Generation

My_VI.c

How it works



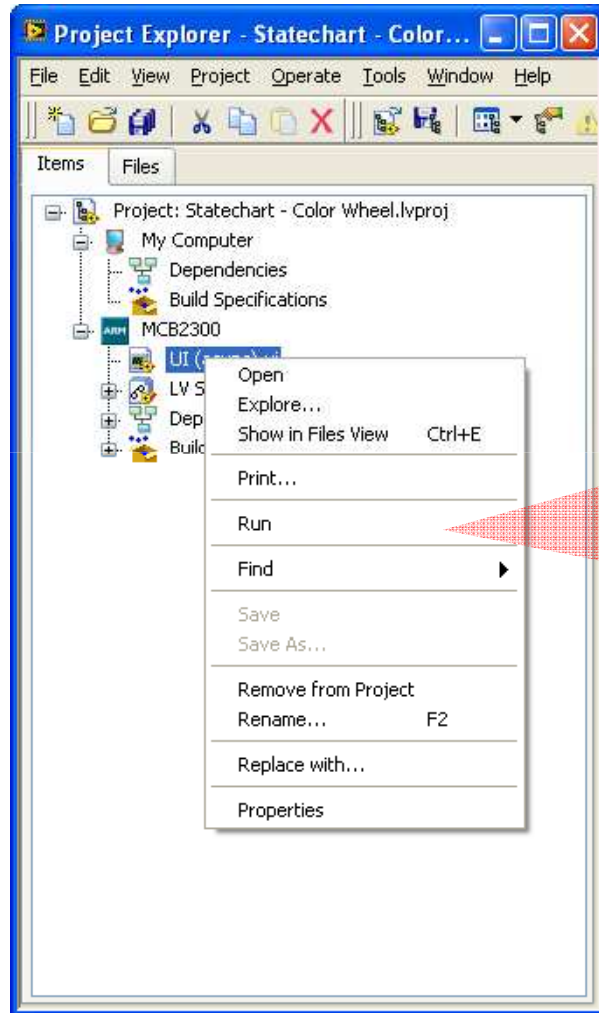
Run

My_VI.c

3rd Party Cross
Compiler

My_VI.exe

Deployment to Hardware

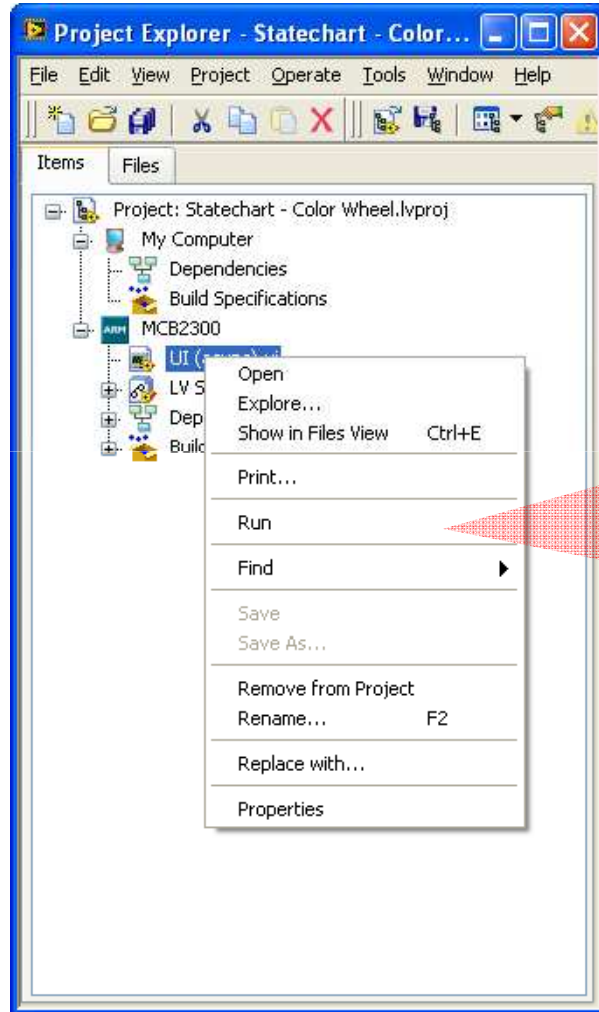


My_VI.exe

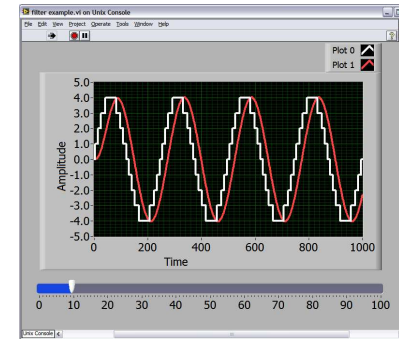
Download JTAG USB



Real-time Debugging



Run



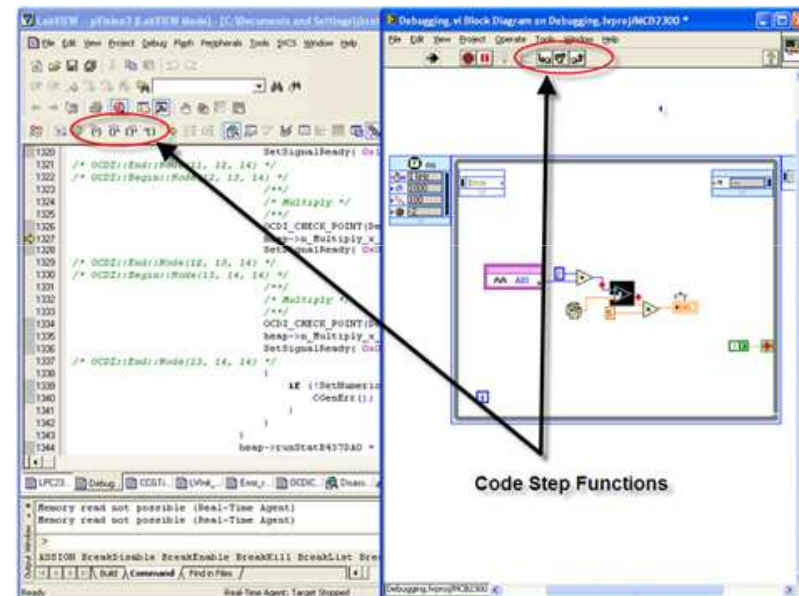
Debugging via TCP,
Serial, JTAG



Debugging ARM Applications



- Debug using LabVIEW techniques
 - Probes, breakpoints, front-panels
- Optionally debug C code using Keil μ Vision

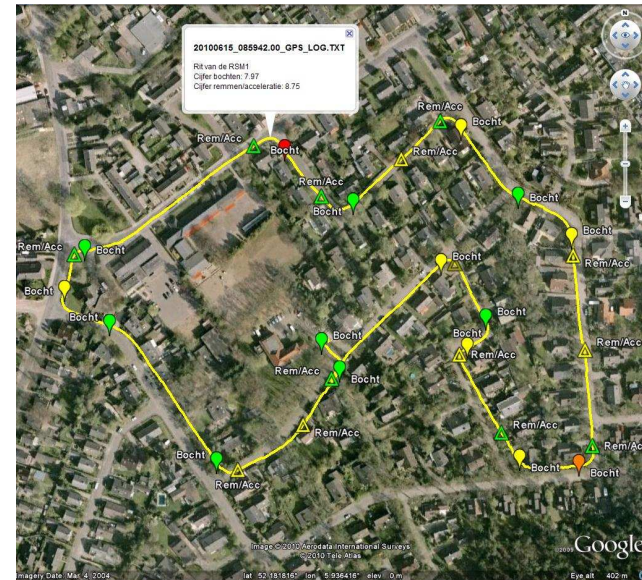
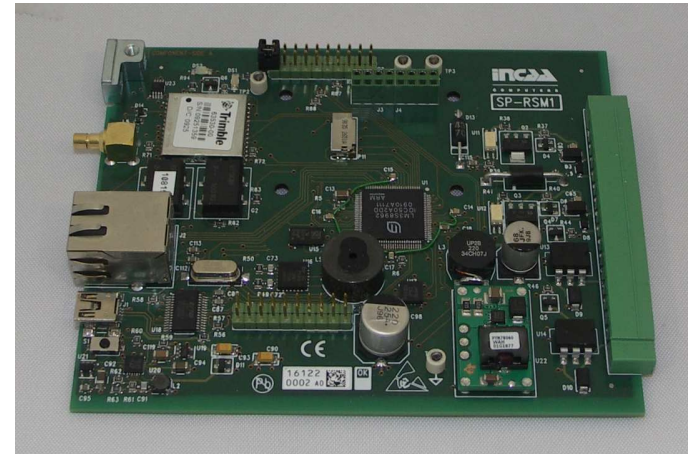


ARM Simulation Environment

- Provided with the Keil uVision tools
- Develop without having real hardware
- Cycle accurate software simulation
- Register-level access for simulating I/O

Result

- Intelligent automotive datarecorder
 - Multiple sensors
 - Onboard processing & logging
 - Real-time feedback
- Trials
- Applications



Conclusion

- Low cost deployment platform with ARM
- Complex system
- Graphical approach
 - Intuitive and fast prototype
 - C debugging possible
 - Inline C code



How can we serve you?

Visit our booth: 1.03

www.ni.com/embedded

www.incaacomputers.com

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THANK YOU