Wireless sensors with embedded controllers and the use of LabVIEW

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CIT Engineering

4th International workshop on
Embedded Systems 2005

Agenda

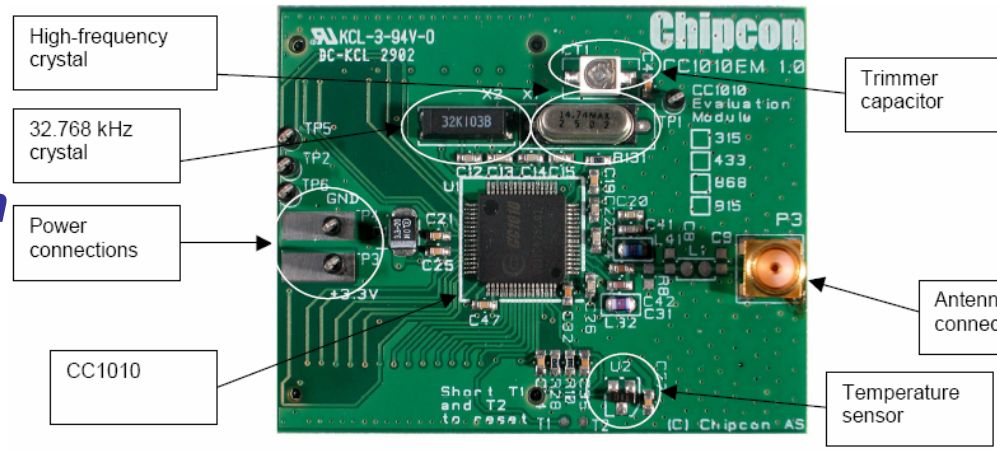
- **Applications with Single Chip RF Transceiver with 8051-Compatible microcontroller from Chipcon**
  - **Measurement agent with emails and Get-HTTP**
  - **Greenhouse 3D-measurements**
  - **Transfer of energy pulses**
- **Open LabVIEW sources for further applications**
- **LabVIEW for embedded applications**
  - **FPGA into CompactRIO**
  - **Analog Device: Blackfin**
  - **C-code for 32 bit processors**
- **Steps to Zigbee**

Chipcon C1010

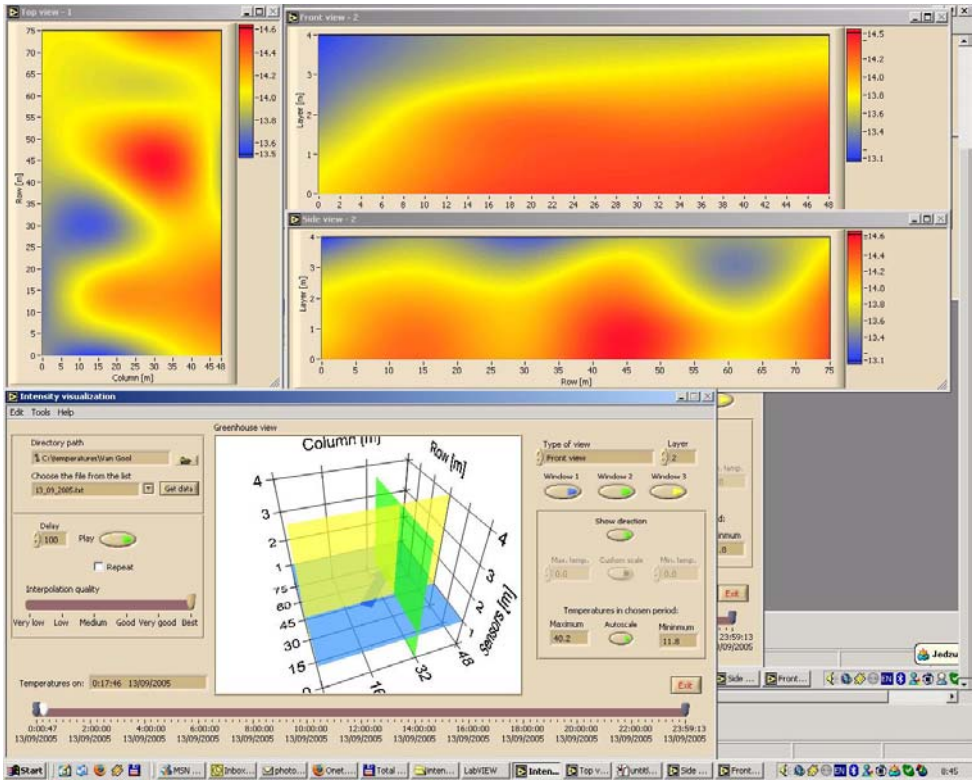
Single Chip Very Low Power RF Transceiver with 8051-Compatible Microcontroller

Applications

- *UHF wireless data transmitters and receivers*
- *315 | 433 | 868 and 915 MHz ISM/SRD band systems*
- *Home automation security*
- *Automatic Meter Reading*
- *Remote Keyless Entry with acknowledgement*



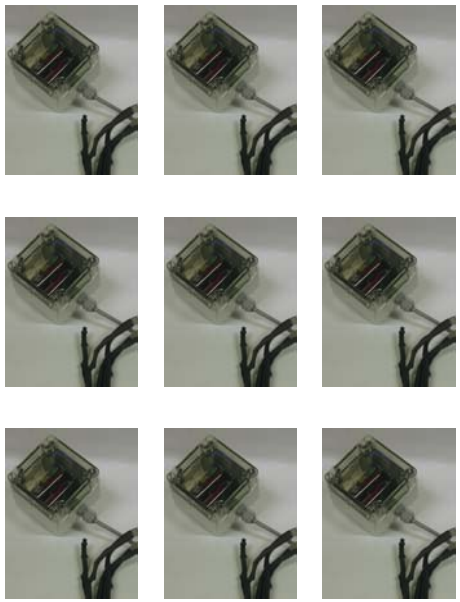
Greenhouse/silos



Sensors?

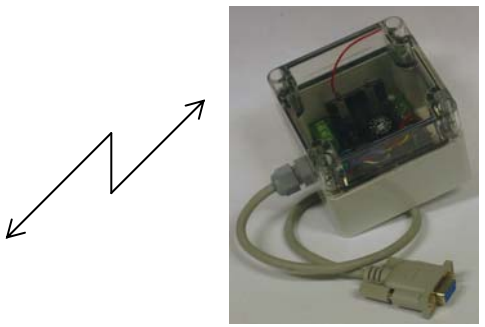
- 1-wire
  - Temperature
  - Digital
  - analog
- Pulses

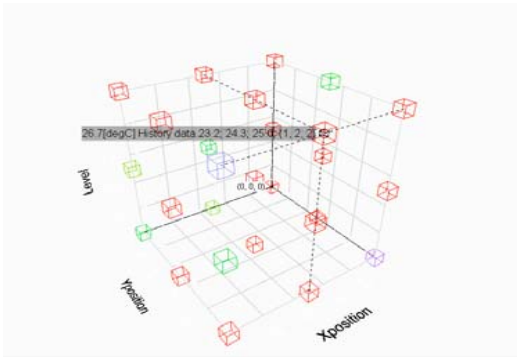
Idea chain



Remote 1-wire nodes
5 sensors per node

433/868MHz Host transceiver





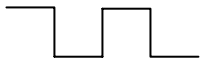
3D visualisation open source software

Measurement Agent

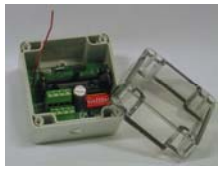
Key features:
- up to 8 remote pulse counter inputs (100Hz)
- up to 6 remote 1-wire nodes
- 433MHz and 868MHz band for RF link
- 100Base-T Fast Ethernet interface
- configurable through web interface
- measurements transmission over SMTP
- redundant transmission by GET HTTP method

Idea chain

Energy meter with pulse transmitter



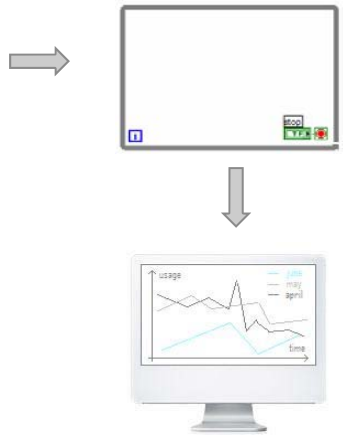
Pulse counter with 433MHz Trx (3 inputs)



Multipoint termomether with 433MHz Trx + DS18B20 Sensors cable

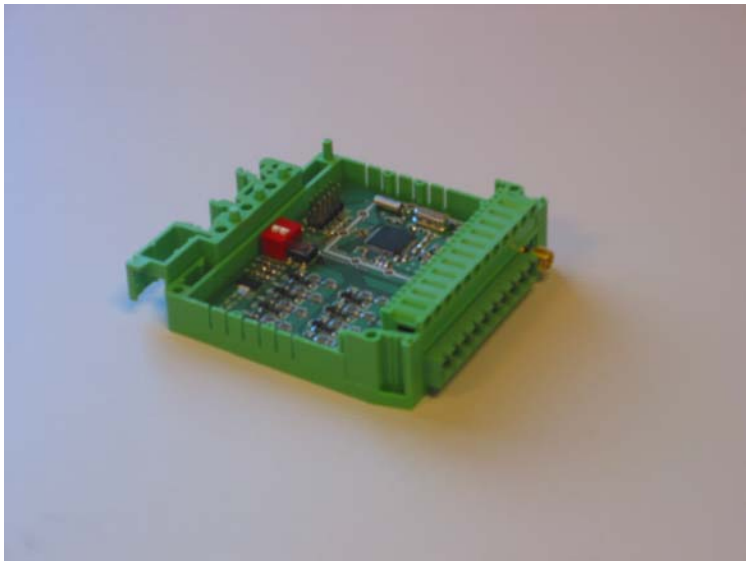
Measurement Agent

SMTP and HTTP file receiver
Open source LV data server
Supporing both data transmission methods: SMTP, HTTP GET



Pulse Wireless link

Key features:
- up to 8 remote pulse counter inputs (100Hz)/temp sensors
- up to 8 remote clients
- 433MHz and 868MHz band for RF link
- battery powered clients
- configurable gate time
- 10Hz pulse generator output



Idea chain

Wire distance
problems...

Energy Dataloger

RF Link @ 433MHz

Energy Dataloger

Energy meters with
pulse transmitter

Another advantage:
PERFECT isolation☺

Protocol

S imple P acket P rotocol:

(used with MA and PWL)

- 255 physical network addresses, and a special broadcast address
  (SPP_BROADCAST). Packet acknowledging is not supported for broadcasts.
- Error detection through CRC8 (message header) and CRC16 (data)
- Automatic retransmissions (variable)
- Reception timeouts (variable)

Protocol

GH application requires real syncronised network protocol :

- RTClocks synchronisation
- Packets routing (node hoping)
- CRC + retransmissions

LabVIEW open source

Why open source?

- Provides easy way to interface with Hardware
- Makes applications more flexible
- With open source IDEA counts...

RF future (now?)

ZigBee systems – on – chip:

- Chipcon:

CC2420 ZigBee compiant transceiver + 8051 core (32MHz single cycle, up to 128k flash, ultra low power mode…)

- Ember:

IEEE 802.15.4 compliant radio + XAP - 2 (16bit 24MHz, up to 128k flash, ultra deep sleep mode…)

LabVIEW for all systems

- Complete Graphical programming environment for Measurement and Automation.
- Embedded real-time hardware targets with reliable operation.
- 100,000's of Users exposed to or using LabVIEW in Commercial and University.

POWERED BY
NATIONAL INSTRUMENTS
LabVIEW™

CIT Engineering NV

Graphical System Design

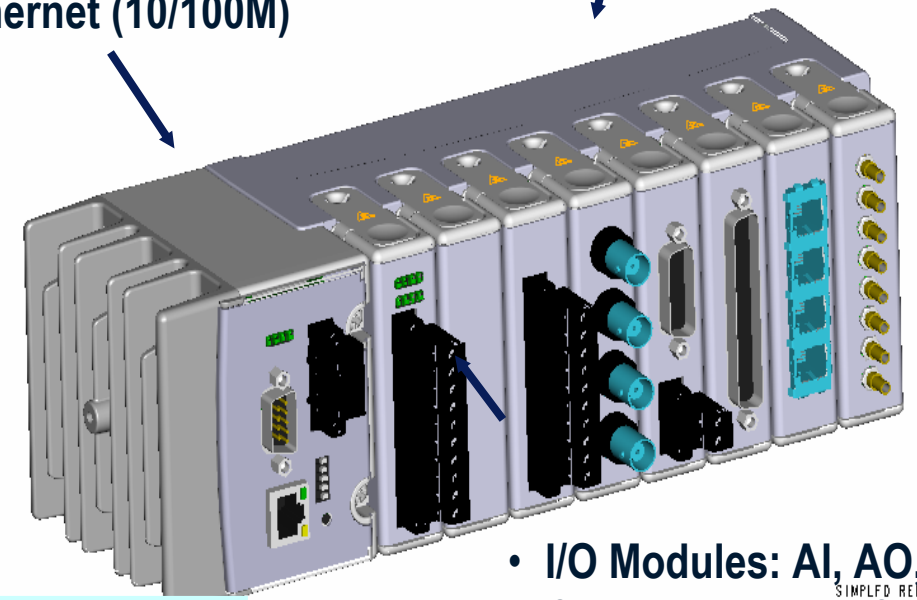
Design → Prototype → Deploy

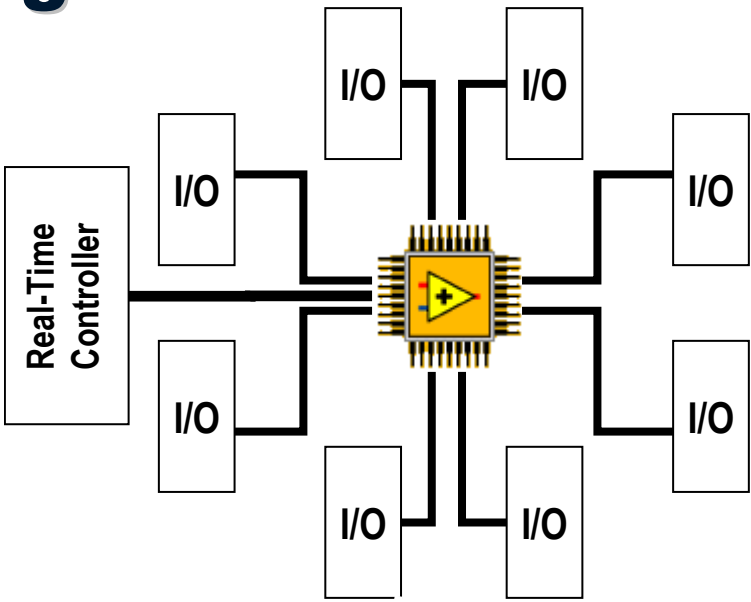
4th International workshop on Embedded Systems 2005

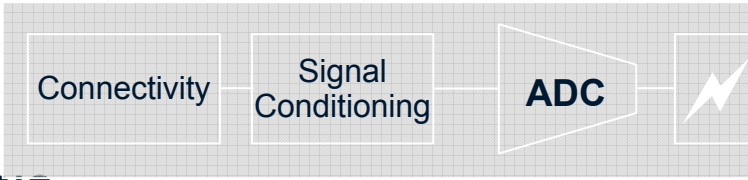
NI CompactRIO™ Reconfigurable Embedded System

Backplane
- RIO FPGA manages I/O, timing, synch., etc

Controller
- LV RT controller
- Ethernet (10/100M)



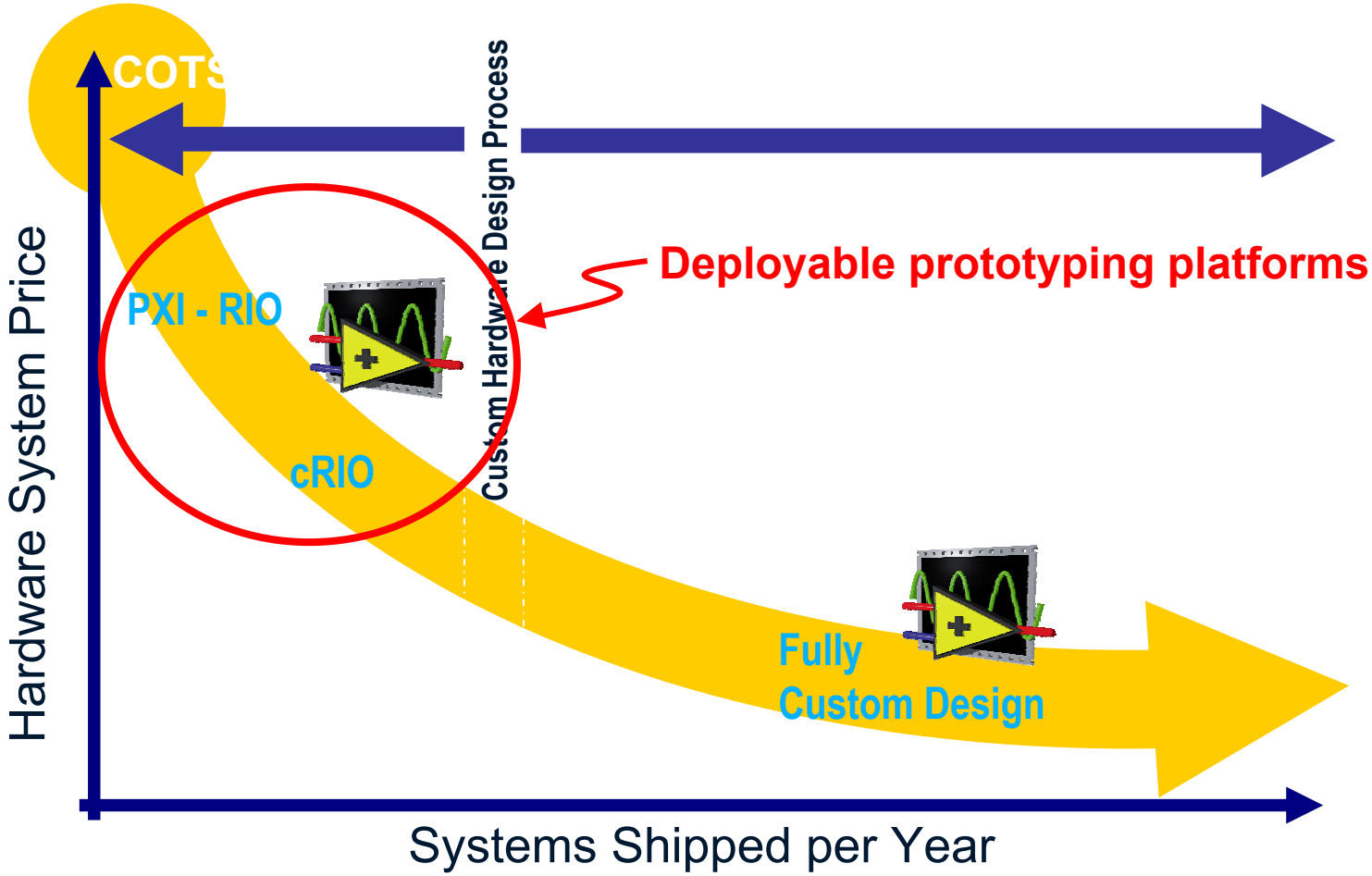




- I/O Modules: AI, AO, DIO
- Communication (CAN, 485)
- Removable Storage

C powered
0 to 70 °C
nock/vibration rated

Virtual Instrumentation in Embedded Systems

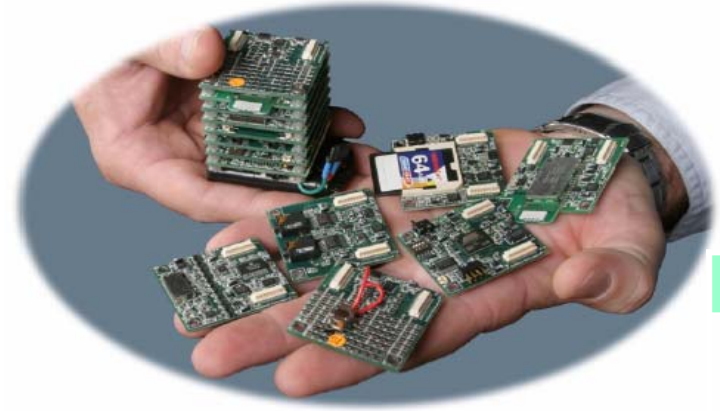


QBX – Low Power Measurement and Control Node

abVIEW platform for
attery powered and
ireless applications

xample applications

- –Wireless sensing, remote monitoring
- –Intelligent datalogger
- –Embedded measurement and control



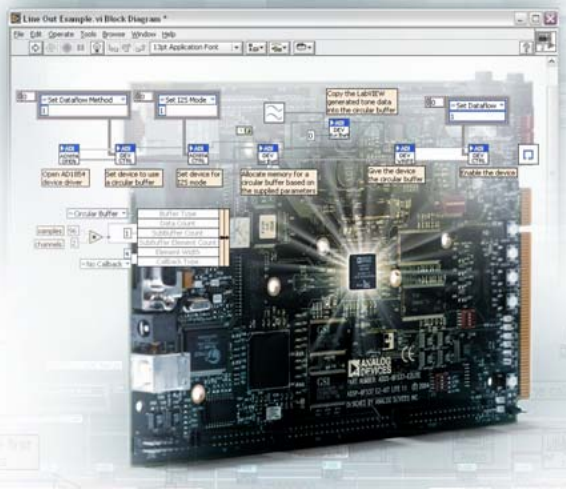
QBX Boards

- ARM7 Processor
- Power
- Bluetooth
- RS-232
- DAQ
- Storage (MMC)
- Debug Bd (LEDS)
- Breadboard

LabVIEW Embedded Module for ADI Blackfin

Faster time to market for embedded system development

- **Graphical programming combined with high-performance silicon**
- **Better, easier reuse of IP**
- **A single development methodology through the product life cycle**
- **Integrate tests throughout the design flow**
- **Rapid prototyping and validation with silicon integration**
- **Easily access low-level control when needed**



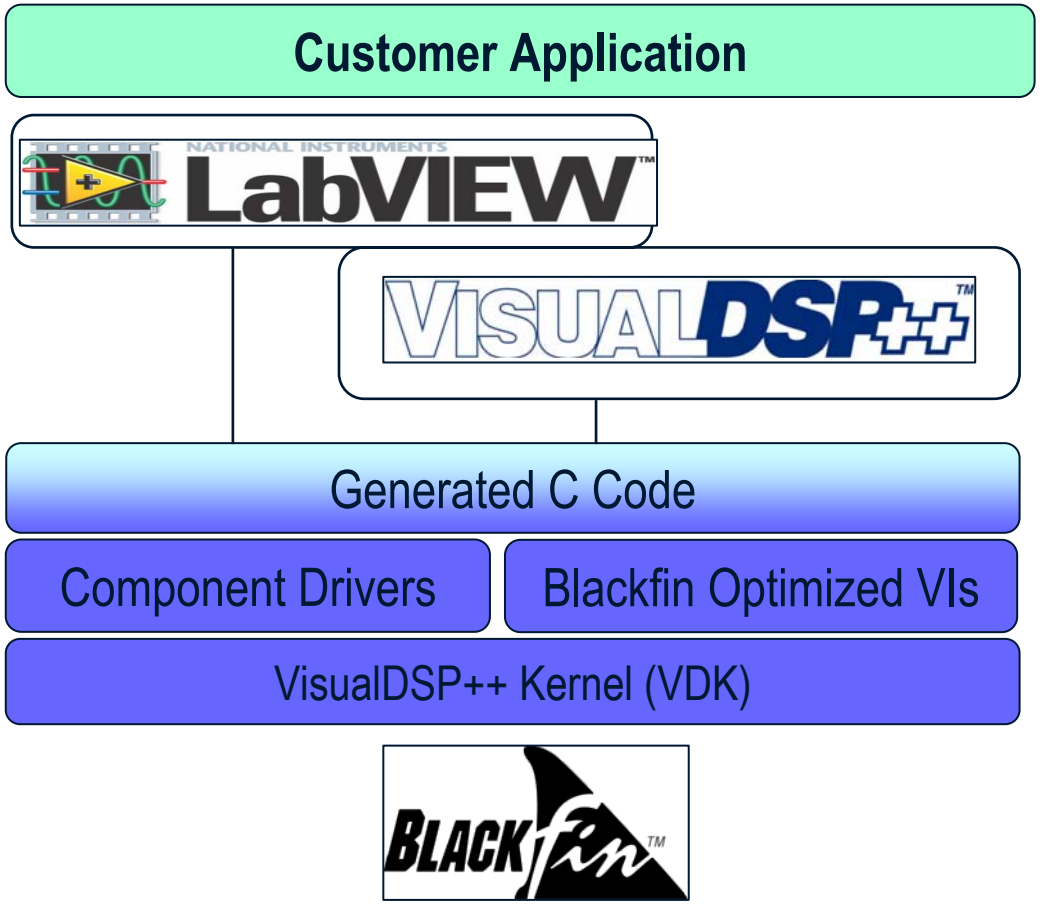
BLACKfin™

NATIONAL INSTRUMENTS LabVIEW™

What is Blackfin?

- High Performance 16/32-bit processor enables next generation embedded applications
- Signal processing, control processing, communications on a single processor
- High performance - Up to 756MHz
- Low power - As low as 0.23 mW/MHz
- Low cost - Sub $5.00 devices
- Supported by the award winning VisualDSP++ development tool suite

Architectural Overview

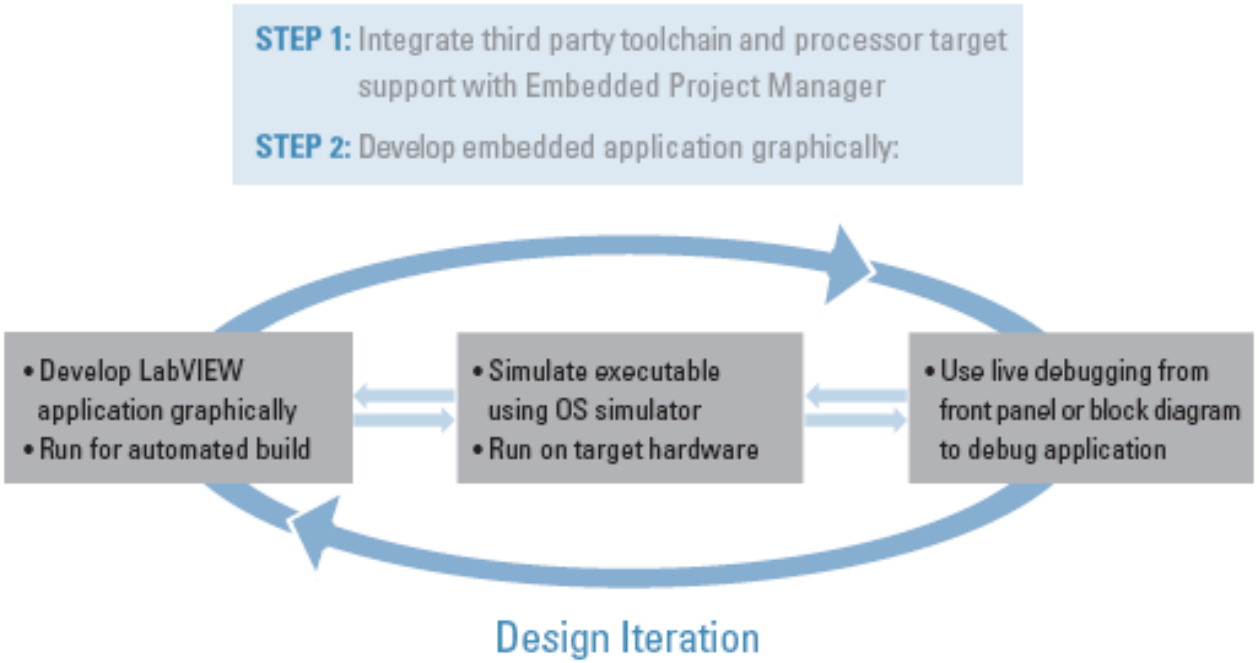


LabVIEW for Embedded Development

igh-level graphical programming
•More than 400 built-in numerical analysis and signal processing VIs
• Embedded Project Manager for target
processor platforms
• Plug-in examples for toolchain, board, and OS support
• Interactive front panel and block diagram based debugging
• Built in OCDI (on-chip debug interface)
• Code Generator for breadth of toolchain/target support

Required Software
• Third-party embedded toolchai
for 32-bit processors
Compatible Software
• Examples provided for:
• Wind River Tornado/VxWorks
• GCC and eCos
Compatible Hardware Targets
• 32-bit microprocessors with a C-supported toolchain
• Examples provided for:
• Axoim CMD565
• Intel IXDP 425

Embedded Application Development Process



http://www.designnews.com/article/CA632568.html