

Adaptive Real-Time Profile Manager (ART-PM)

Authors:

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NI Products Used:

LabVIEW 2011
NI cFP-2120
NI cFP-AI-111
NI cFP-AO-210
NI cFP-CB-1
NI cFP-RLY-425
NI cFP-BP-4
NI cRIO-9025
NI 9208
NI 9264
NI 9481
NI cRIO-9112

Category:

Advanced Control Systems

The Challenge

The client needed a Real-Time system capable of automatically detecting C-Series hardware configurations and automatically adapting the Real-Time application. The software adaption needed to include code specifically designed to utilize all C-Series hardware and its ability to integrate with LabVIEW Real-Time using the NI Scan Engine FPGA Module.

The Solution

Using LabVIEW Real-Time & FPGA toolkits along with the NI Scan Engine FPGA Module, Data Science Automation was able to create a Real-Time software application that could adapt to multiple C-Series hardware configurations while simultaneously manipulating multiple operational modes by overwriting system profile files.

Introduction

Data Science Automation (DSA) is the premier National Instruments Alliance Partner. DSA integrates commercial off-the-shelf (COTS) components from automation technology vendors to create custom, adaptive automation solutions for a diversity of research, manufacturing, government and business operations to:

- acquire, analyze, present and manage data
- design, simulate, test and validate products
- monitor, predict, control and optimize processes
- invent, draft, prototype and build machines

for maximum productivity, quality, profit and understanding.

DSA is a certified member of the Control Systems Integrators Association (CSIA) and staffs multiple National Instruments Certified Training Centers with more certified LabVIEW Architects than other integrators.

DSA was selected by the client because of our depth of experience in the development of complex, integrated systems containing a wide diversity of components. DSA's extensive number of Certified LabVIEW Architects with extensive industrial experience also provided the client a level of confidence that his investment would be compounded.

Background

The Adaptive Real-Time Profile Manager (ART-PM) was created due to Data Science Automation's client needs for a single software application that could automatically detect hardware configurations on a cRIO backplane. Once the hardware configuration detection occurred the Real-Time application would manipulate operating modes and system profile files to allow the application to re-launch with a different software profile. The software profile would include different operational parameters along with multiple operating procedures while using a variety of FPGA and NI Scan Engine configurations.

Previous Obstacles

Prior to the development of ART-PM, Data Science Automation created a NODE configuration application that would allow our clients to select a specific Real-Time application that would be deployed to a Real-Time target. By using this method, the client was limited in the abilities of the cRIO to adapt to real world hardware failures and changes to system requirements. The prior configuration method would force the client to take a system off-line and apply a new real-time deployment to the hardware for the correct system profile to execute. This method was time consuming, costly and, due to operator failures in the software configuration, possibly even hazardous (Figure 1).

ART-PM conception

The Adaptive Real-Time Profile Manager was conceived due to Data Science Automation's client needs for a reliable, robust and efficient real-time application that has the ability to adapt to the ever changing real-world environment. The foundation of the ART-PM software was created while creating the previous NODE Configuration software. From the previous software, Data Science Automation recognized the seamless integration of the LabVIEW Real-Time software and the statically configured C-Series modules. What was needed for the system was a seamless integration of reconfigurable hardware with the LabVIEW Real-Time software. To accomplish this task new tools had to be created while utilizing toolkits National Instruments (NI) had provided.

Data Science Automation used LabVIEW Real-Time software toolkits from available toolkits for tasks such as file manipulation, changing FPGA operational modes and programmatically re-booting the Real-Time target. Also a key feature in selecting NI products was the readily available and easy to use NI Scan Engine Toolkit. The Scan Engine Toolkit gave Data Science Automation a simple and efficient mechanism for communicating with C-Series modules on a cRIO backplane. Without this toolkit Data Science Automation would have had to create custom FPGA code to access the functionality of the C-Series modules which would have significantly increased the cost of the project.

While National Instruments provided a majority of the toolkits, Data Science Automation created custom toolkits for module configuration and system profile file manipulation to allow the Real-Time target the ability to adapt to the ever changing hardware configurations. Data Science Automation did a significant amount of research to determine how individual profiles differed based on Scan Engine configuration and the C-Series Module configuration.

ART-PM impediment and National Instruments Support

The ART-PM application, while being designed by Certified LabVIEW Architects at Data Science Automation, was directly influenced and supported by multiple interactions with both the National Instruments local sales representative and the National Instrument's Research & Development staff. The National Instruments technical support staff had created multiple "White Paper" articles on seamlessly integrating the NI Scan Engine and FGPA but at the time of development ART-PM was the only application combining these two capabilities along with programmatic reconfiguration of the NI Scan Engine. The hard work and dedication to perfection of not only multiple Data Science Automation Certified LabVIEW Architects but also the National Instruments support personal allowed ART-PM to complete its objectives for being a reliable, effect and robust software toolkit for adaptive programming of a Real-Time Target.

Benefits of ART-PM

The Major benefit of the ART-PM application was the client's ability to efficiently change hardware and software profiles simply by changing the C-Series module configuration and resetting. For the client, what use to take approximately 30 to 40 minutes was reduced to approximately 3 minutes. By decreasing the downtime tenfold, Data Science Automation was able to increase the overall productivity of the client's operators. Also while removing multiple operator procedures, such as deleting the previous Real-Time software configuration, deploying the updated Real-Time software along with its configuration; Data Science Automation was able to greatly reduce procedural errors which were causing even more downtime.

Also an added benefit to the client was ART-PM's ability to be backwards compatible with previously released version of their control software developed and deployed on Compact FieldPoint (cFP) controllers. This allows the client to maintain hardware previously purchased but advanced the client's ability to control newer systems with greater productivity. Figure 2 illustrates the ability of ART-PM to handle a variety of control hardware configurations over multiple generations.

Benefits of Partnership

The partnership between Data Science Automation as an Alliance member to National Instruments has given insight on engineering solutions for tough real world questions while maximizing time and overall costs to the clients. The ART-PM project was no exception, by selecting LabVIEW Real-Time Data Science Automation was able to create a software package that not only reduced the overall downtime during reconfigurations but also greatly reduced the clients production lose due to operational mistakes. Also by using National Instruments hardware and software, the ART-PM application was able to allow the client to reuse existing equipments investments, specifically in the area of cFP hardware, while allowing additional investment in research and development applications.

Conclusion

Overall, the ART-PM application was able to reduce the client's overall operational costs by reducing the downtime between changing real-time software profiles and reducing operational errors created by operator interactions. By utilizing Certified LabVIEW Architects with National Instruments hardware and LabVIEW software Data Science Automation was able to create the ART-PM application which reduced the overall project risk at a lower total cost of ownership for the client. With the ability to apply innovative approaches using National Instruments products Data Science Automation was able to methodically apply adaptive automation technologies to solve client challenges while reducing client risk and cost.

Contact Information

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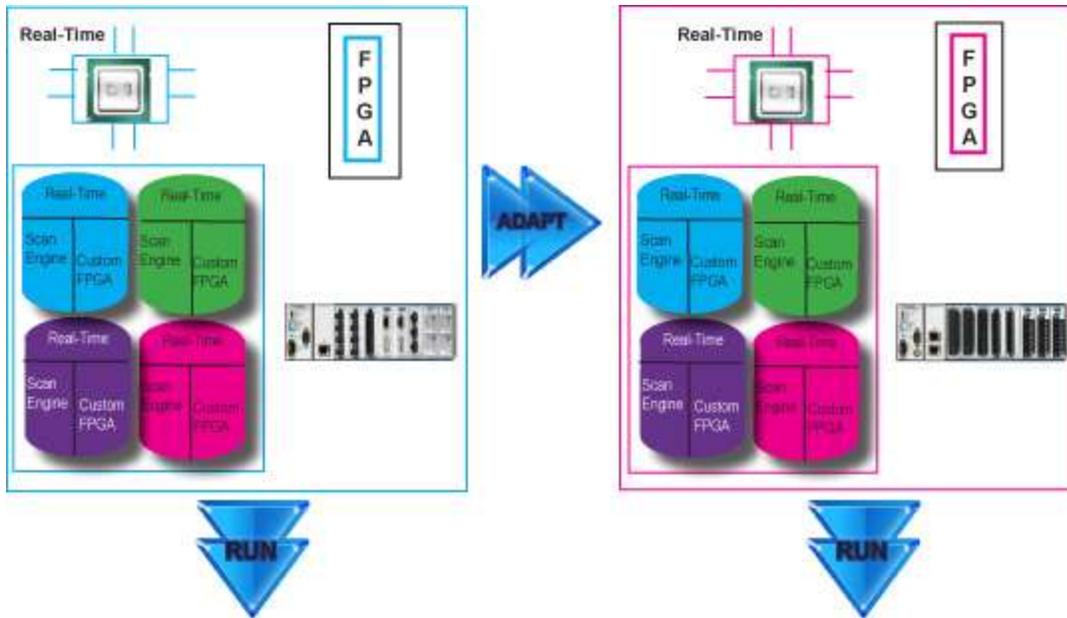


Figure 1. Schematic of Reconfiguration Process



Figure 2. ART-PM Supports a Variety of Control Hardware Spanning Multiple Generations