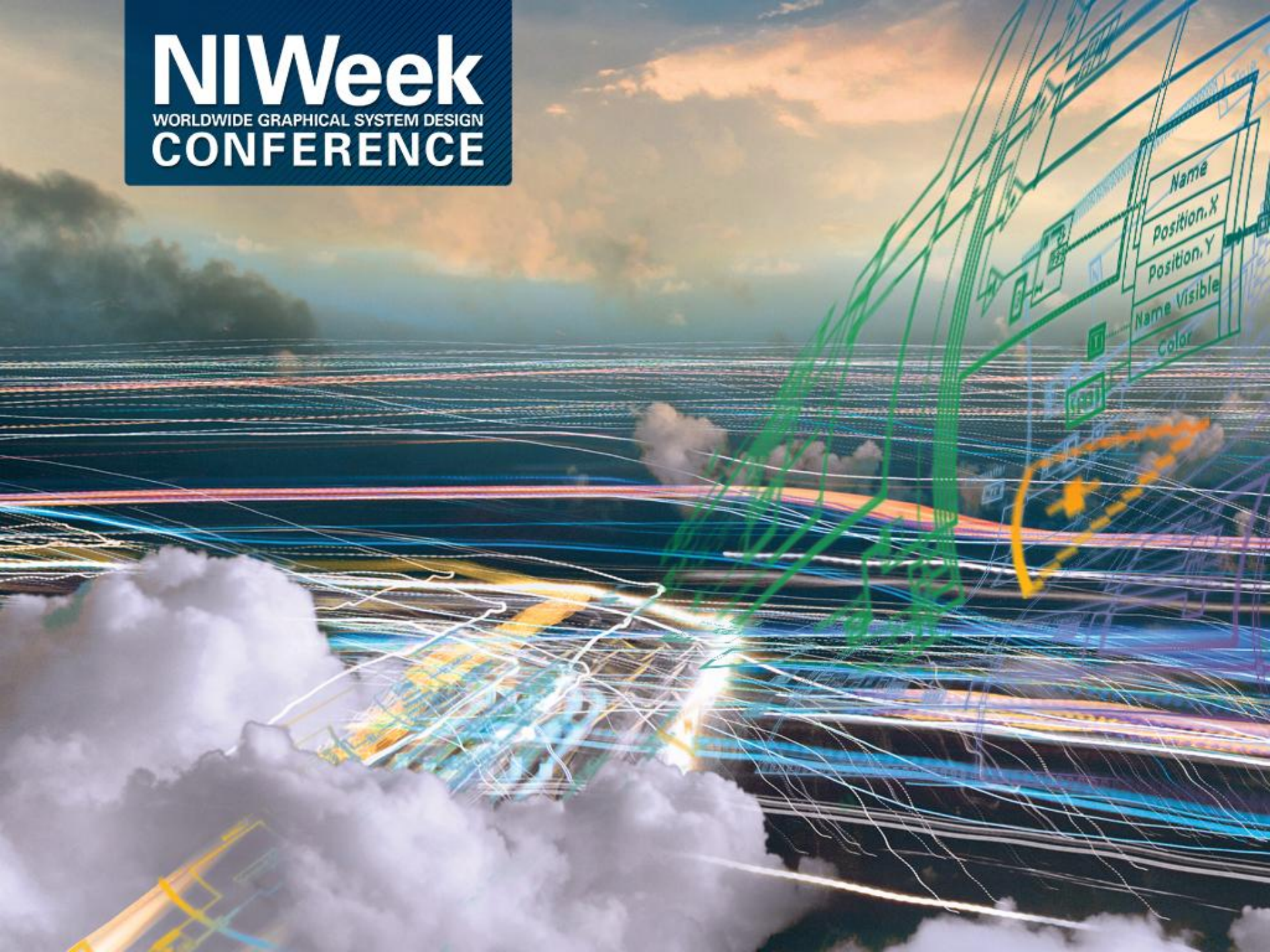
NIWeek

WORLDWIDE GRAPHICAL SYSTEM DESIGN CONFERENCE




NATIONAL
INSTRUMENTS™

Part 1: Introduction to NI Linux Real-Time

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Michael Phillips: Group Manager, RTOS Team

NATIONAL INSTRUMENTS

Agenda

1. Background & Core Technology

2. File System & Connectivity

3. Flexible Development & Vast Community

Hardware Supported by NI Linux Real-Time

In 2013...

In 2014…

"Within 24 hours of receiving a cRIO-9068 controller, we ran our existing LabVIEW application software without any problems."

– Bob Leigh, CEO of LocalGrid™

Power Monitoring

LocalGrid

NI Linux Real-Time

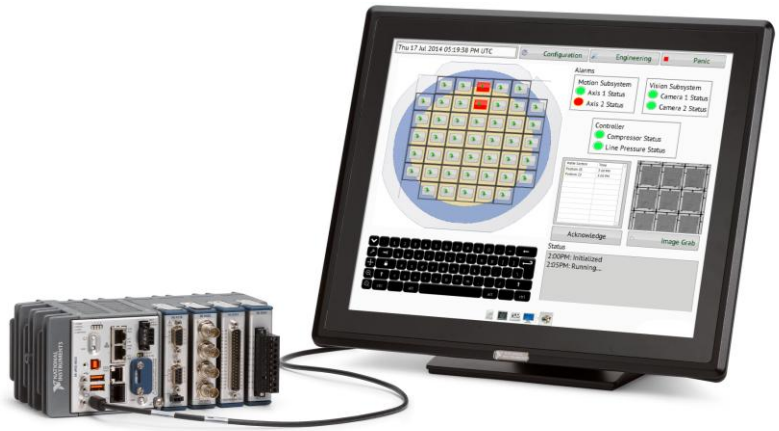
- Enjoy the flexibility of Linux, with the determinism and reliability of a real-time operating system.
  - Desktop UI, Peripherals, System Administration, Real-Time schedulers
- Leverage the vast ecosystem of tools and IP
  - Networking, Configuration Management, Simulation, Monitoring, etc.
- Reuse C/C++ code in and alongside LabVIEW Real-Time built applications
  - FPGA Interface C API, System Configuration C API

NI Linux Real-Time

- Owned and maintained by NI
  - Custom built and optimized for NI embedded hardware
    - Supports ARM and x86_64, with cross-compilers provided
  - New: NI Package Repository: download.ni.com/ni-linux-rt/
    - Over 3,000 packages
  - New: OS source: github.com/ni
- PREEMPT_RT
  - Enables real-time reliability through pre-emption, priority inheritance, and scheduling
  - Standard approach to real-time performance on Linux

Quality of Life on NI Linux Real-Time

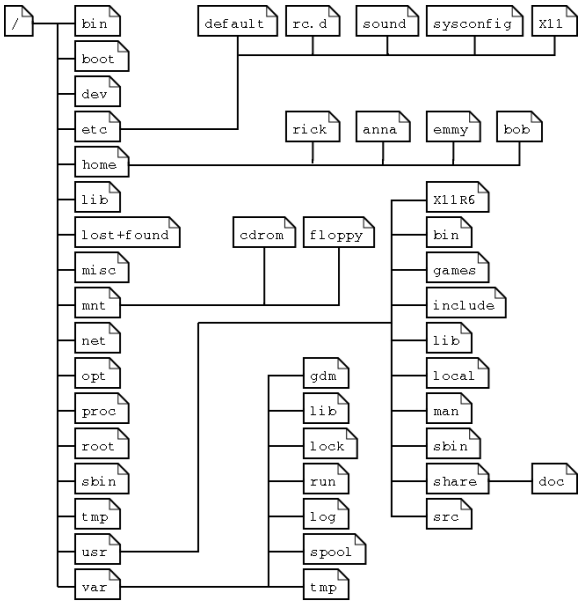
- Convenience of a General Purpose OS
  - New: Desktop UI, File Manager, Terminal Emulator, Text Editor
  - Permissions, Application Isolation, Virtual Memory, no reboot required for Time Zone and IP Configuration changes
- Access to popular interpreters
  - Python, Perl, etc.
- Common Linux utilities
  - top, ps, netstat, etc.



File System & Connectivity

File Systems on NI Linux Real-Time

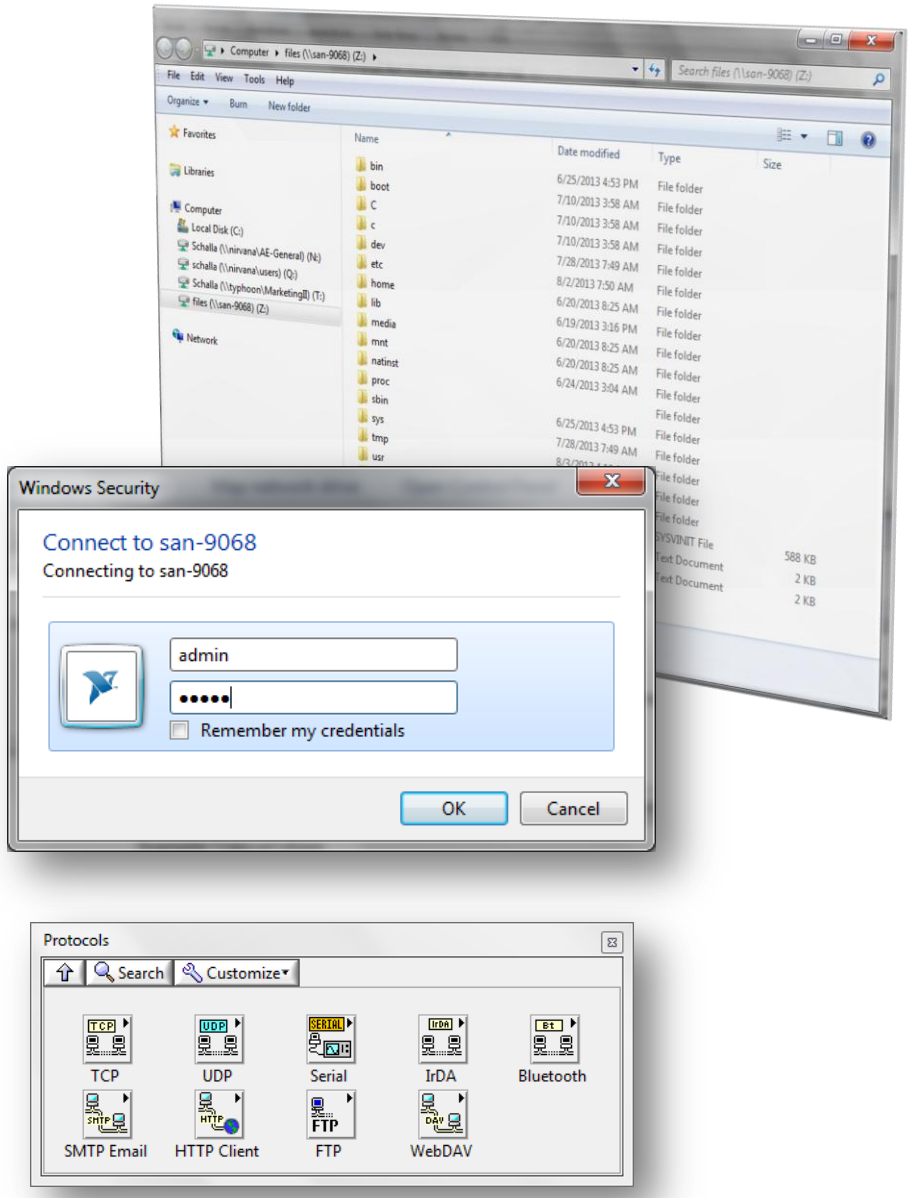
- Reliable File Systems
  - UBIFS on ARM
  - ext4 on x86_64
- File Path changes
  - Unix style, case sensitive
  - Locations of system files have changed



- Symbolic links for basic backwards compatibility
  - Example: /u/ is the USB mount point
  - Readme on the system that has additional information

File Transfer: WebDAV

- Industry Standard Protocol
- Manage files on targets remotely over HTTP
- Secure File Access
  - Authentication & Encryption
- Supported by all modern OSes and Web Browsers
- LabVIEW API for programmatic access
- New: WebDAV File Browser



File Transfer: Unsecure FTP

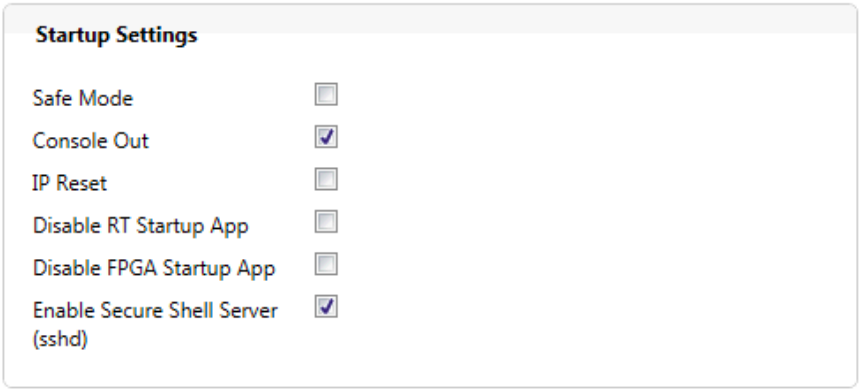
- No unsecure FTP server installed by default on NI Linux Real-Time systems

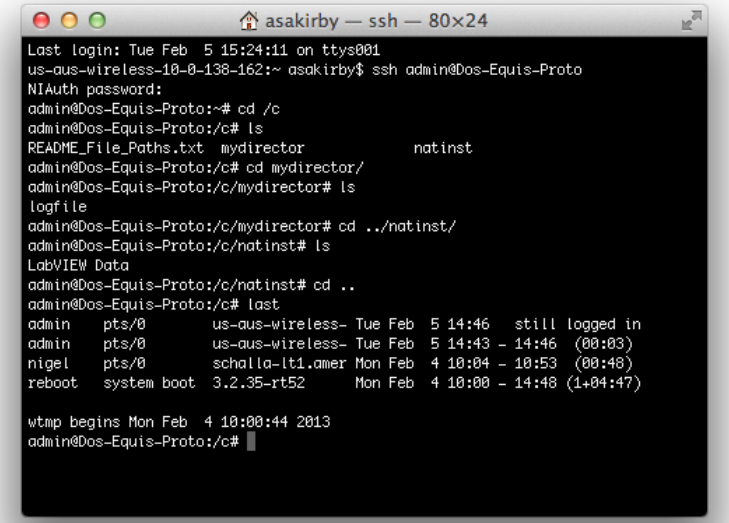
- Unsecure FTP server can be manually installed for compatibility
  - Must be accessed as the 'anonymous' user
  - Has root privileges similar to current cRIO

Not Recommended

Secure Shell (SSH)

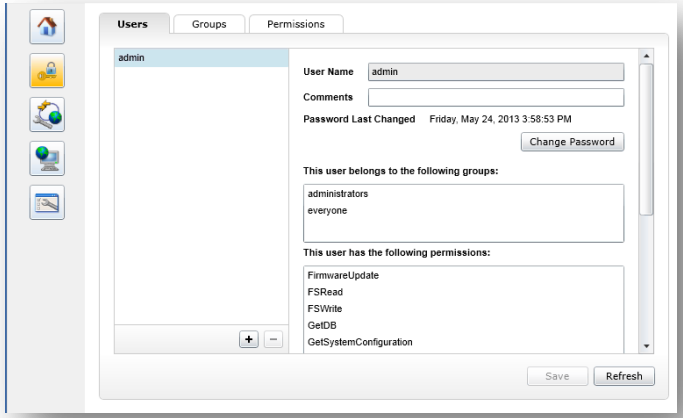
- Enable through MAX and/or Web Interface
- Can be used as a console
- Can be used to transfer files
  - Permissions based on login
  - SFTP
- Credentials synchronized with NI-Auth (Web Interface)





NI-Auth and NI Linux Real-Time Integration

- All user authentication goes through NI-Auth
- Use the Web Interface to manage users
- PAM Integration
  - Users in NI-Auth are users in Linux
  - admin user is superuser
- If admin password is lost, target must be reset to factory default
  - Must contact NI



Demo

CONNECTIVITY ON NI LINUX REAL-TIME

Security on NI Linux Real-Time

- SSL enabled by default
  - Can programmatically install software over SSL
  - Can use public keys for SSH
- HTTPS-only communication possible
  - Can turn off HTTP version of the System Web Server
- IPTables* available for setting up a firewall

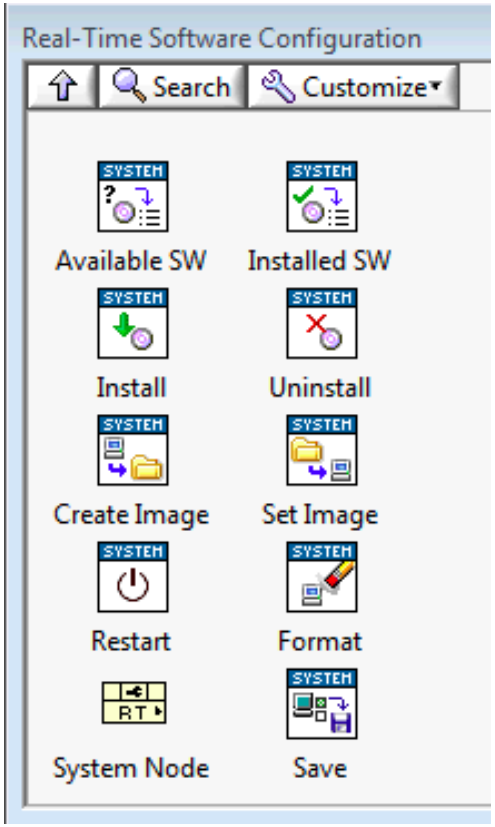
- OpenVPN* available for setting up a VPN

OPENVPN™

*Not supported by Applications Engineering. Requires experience. No LabVIEW API

System Updates on NI Linux Real-Time

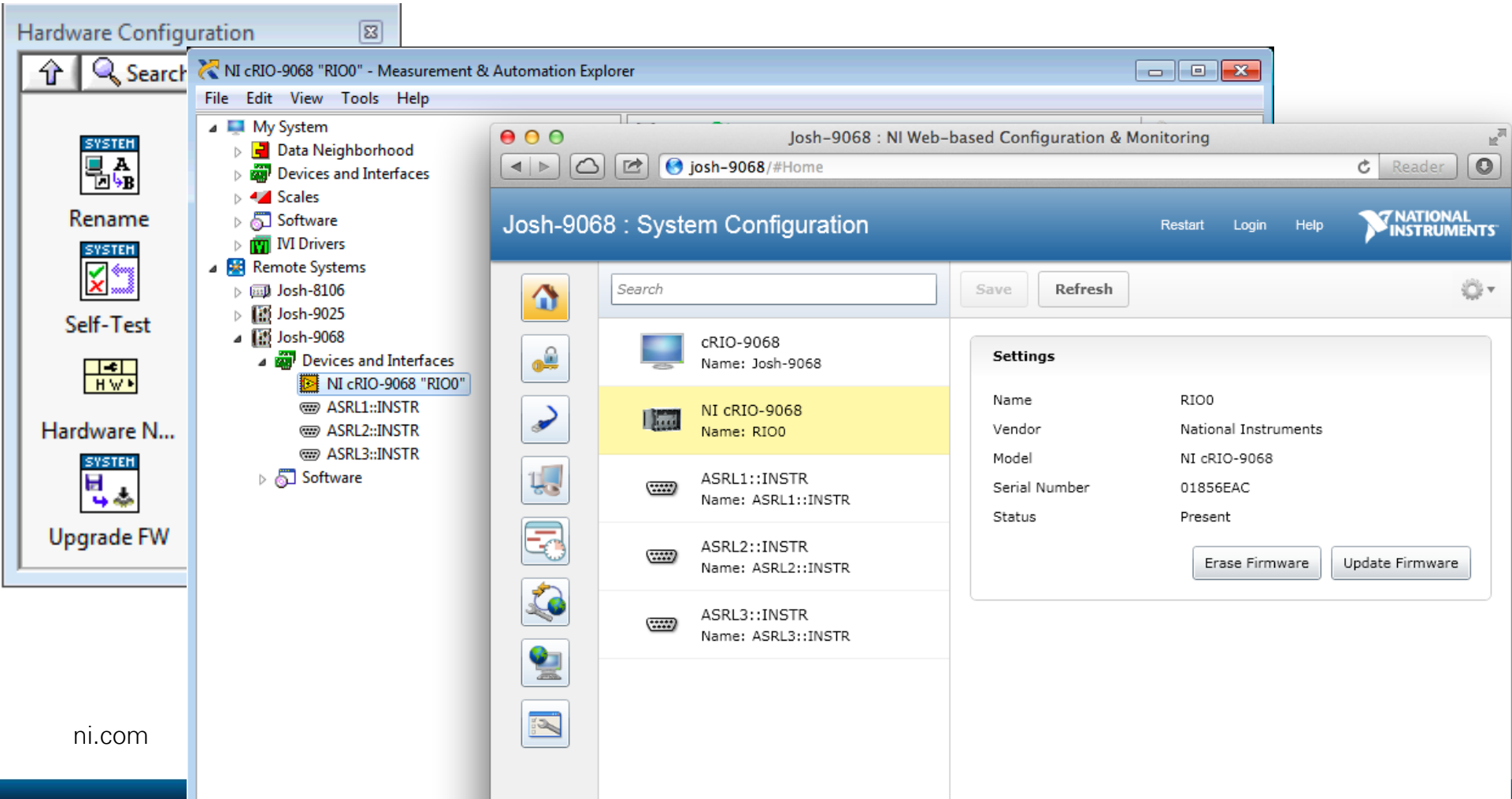
- Locally call "Set Image"
  - Enables targets to reimage themselves
  - Images can be pulled down from the network or stored on a USB drive
- Wildcards for Get/Set Image Blacklist
  - Globbing: "*" and "?"
  - Character set matches: [abc]
- Advanced: Pre and Post Image Scripts*
  - SCRIPT_PRE=/etc/natinst/share/nisystemimage_pre
  - SCRIPT_POST=/etc/natinst/share/nisystemimage_post



*Implementation subject to change

Manage FPGA Bit Files

- Update and erase the FPGA bit files on NI Linux Real-Time targets programmatically, from MAX, and the web



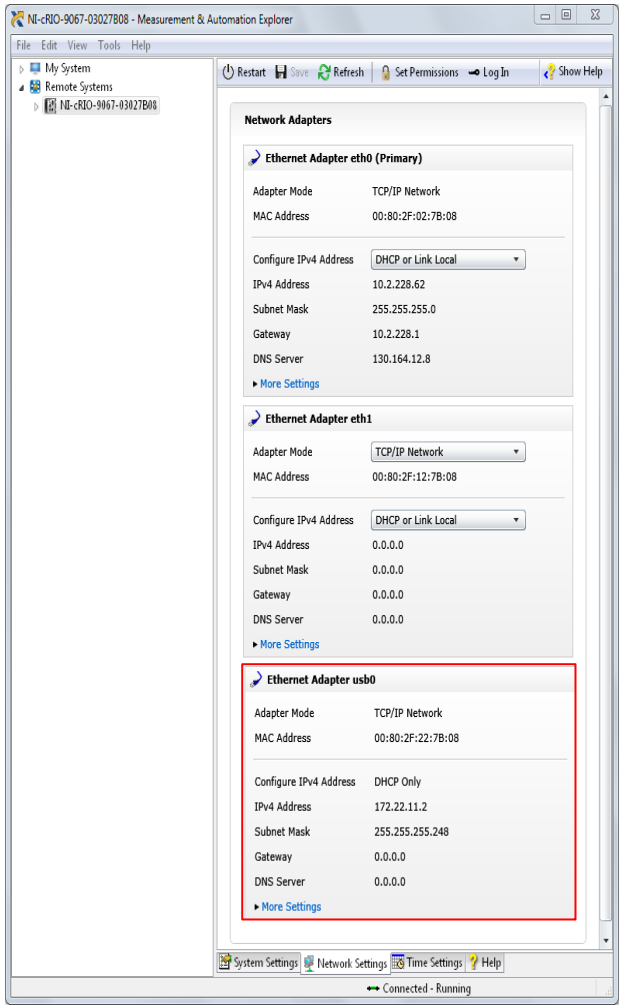
Simplified Connection to Real-Time Targets

Connect with USB

New NI Linux Real-Time targets use Ethernet over USB to connect to the host computer

Simple IP Discovery

Automatic DHCP network is created independent of physical Ethernet connections



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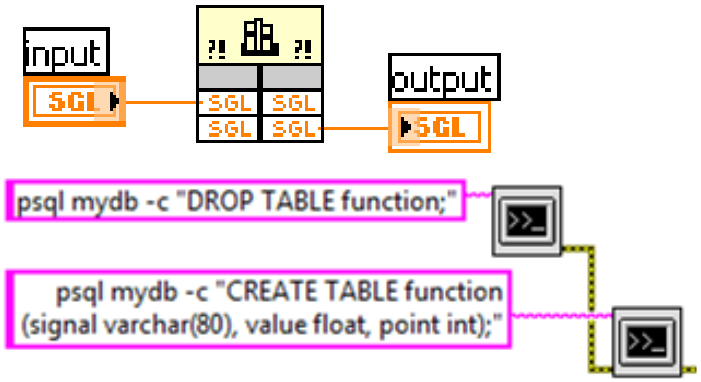
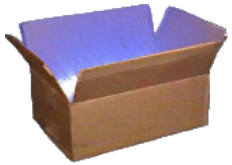
Flexible Development & Ecosystem

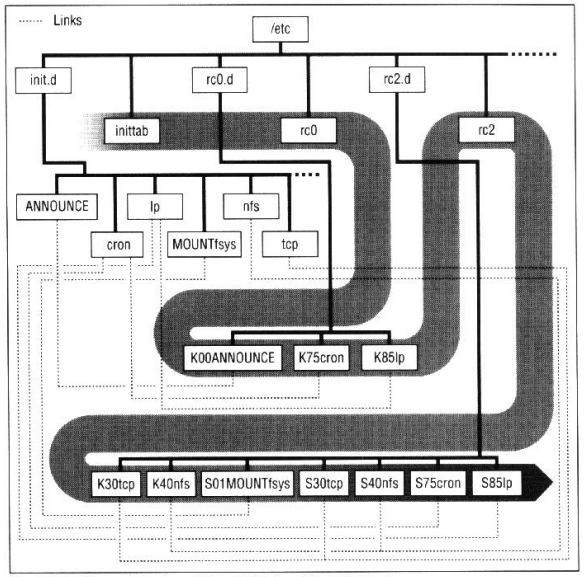
Interacting with Code on NI Linux Real-Time

- To/From LabVIEW
  1. Call Library Function Node
  2. System Exec VI
  3. Localhost TCP communication



- Beyond LabVIEW
  1. Init scripts – for initializing at startup
  2. Cron – for periodic execution
  3. Network-enabled SSH programs





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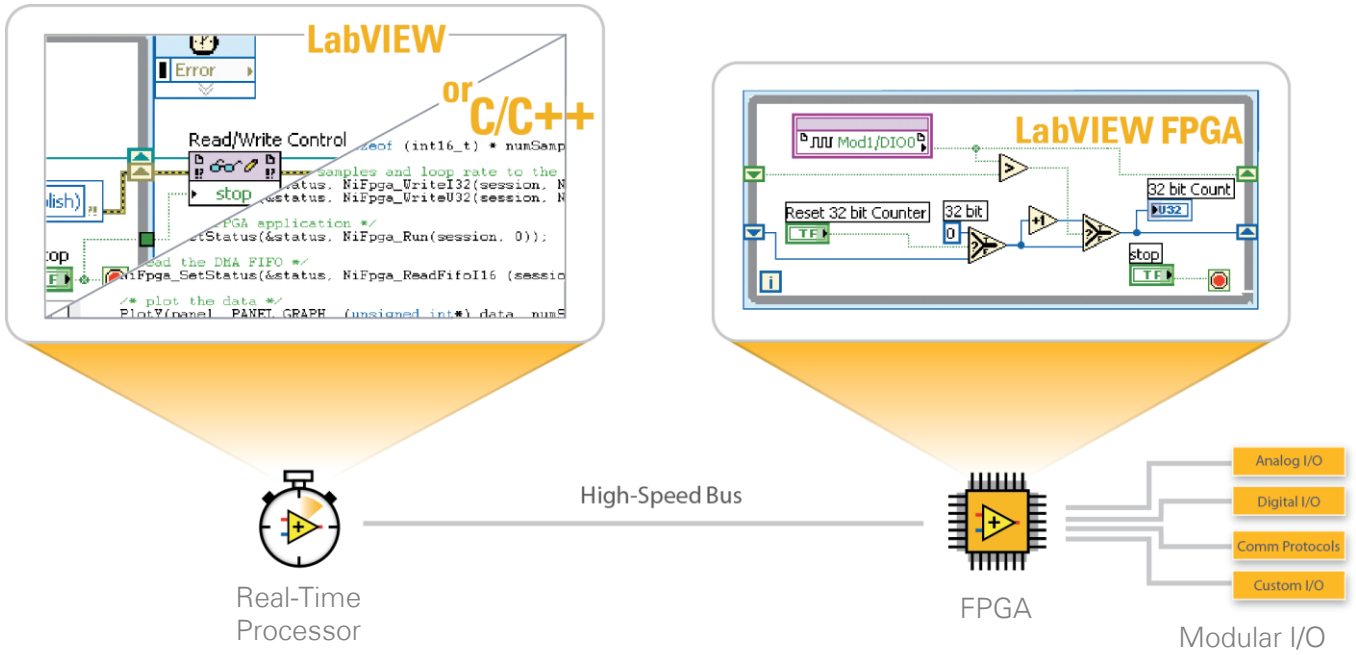
Flexible Software Integration



Code Reuse

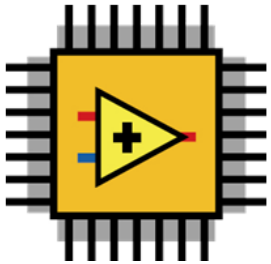
- Develop, debug and deploy C/C++ code
- Integrate existing applications and IP
- Interoperate with LabVIEW-programmed FPGA

Programmable Hardware

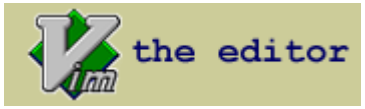
- Offload critical decision-making to FPGA
- Reliable, precise timing
- Access FPGA technology without HDL expertise

Elements to the C/C++ Development Option

- LabVIEW FPGA
  - FPGA Interface C API



- C/C++ IDE
  - Develop, debug, deploy



- Cross-compiler(s)
  - NI provides cross compilers, but you may choose your own
  - armv7a and x86_x64 compatible compiler(s) depending on target

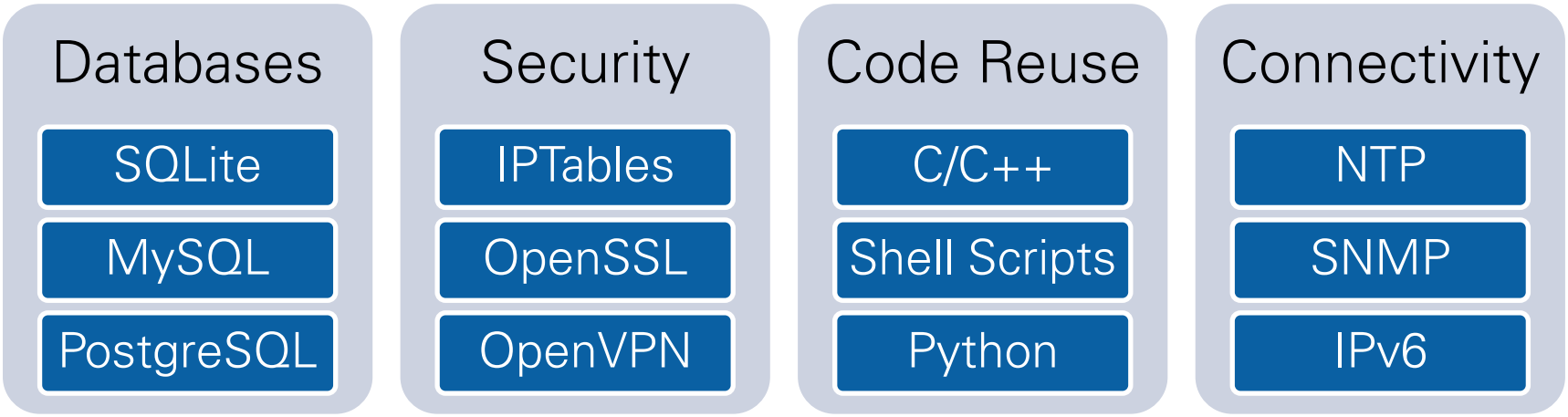
Access the Ecosystem: Linux Package Manager

- What is a package manager?
  - Set of software tools for installing, updating, configuring and removing utilities and libraries
  - Similar in concept to the App Store, VI Package Manager, etc.
- NI Linux Real-Time relies on the opkg package manager
  - Note: opkg does not take the place of MAX
- Access to thousands of freely available utilities and libraries

Demo

OPKG DEMO

Leveraging the Linux Community



- New: NI Package Repository: download.ni.com/ni-linux-rt/
- New: OS source: github.com/ni
- New: Kernel Driver Support
  - Advanced feature; avoids rebuilding kernel modules/drivers against all kernel updates

"By leveraging the open Linux-based real-time operating system on a commercial off-the-shelf controller, we could port our existing Linux software components in a very short time. That saved us at least four months of development time."

- Wolfram Koerver, executive director of S.E.A.

Structural Monitoring

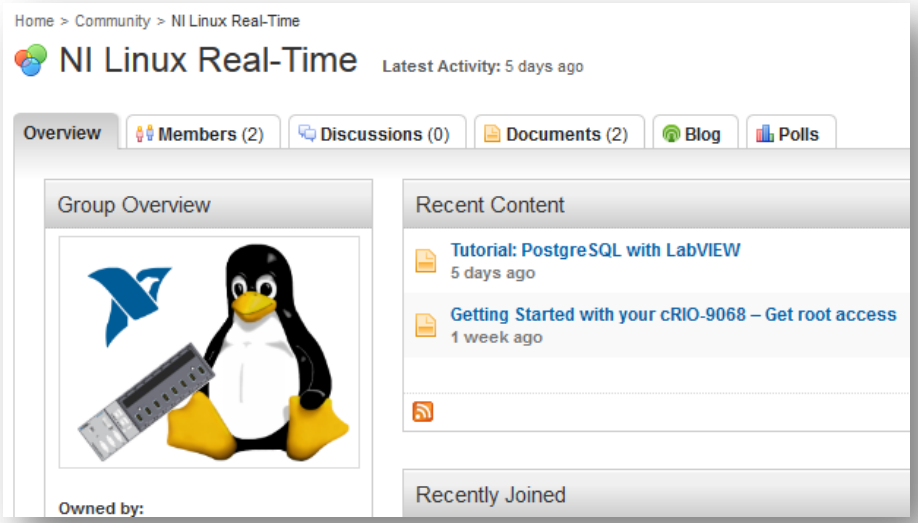
S.E.A

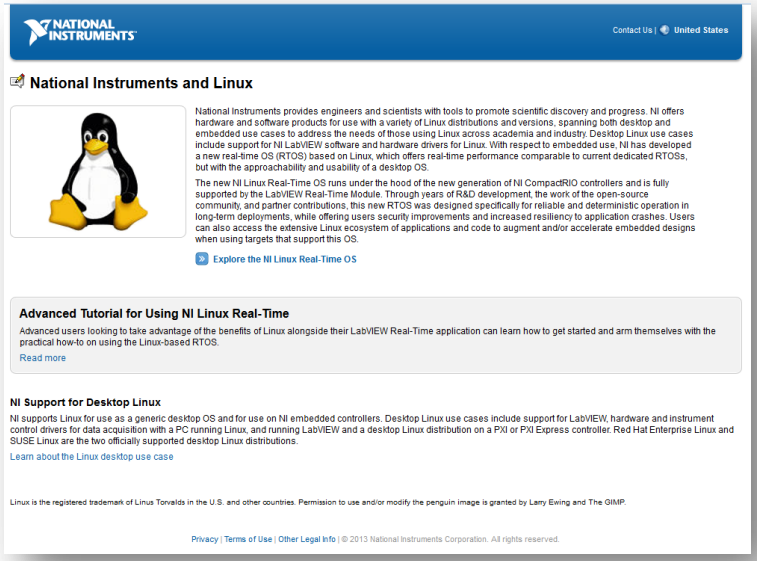
Support Policy

- Limited user mode support
  - Equivalent to 3rd party C code with Call Library Nodes on Desktop
- No support for kernel mode changes
  - NI Linux Real-Time source available at github.com/ni
- Feel free to innovate and explore
  - Can restore to factory default state without having to RMA

Key Resources

- ni.com/linuxrtforum
  - Tutorials
  - Documentation
  - Forum for discussions
- ni.com/linux
  - Links to whitepapers
  - Embedded and Desktop uses
- download.ni.com/ni-linux-rt/
  - Package Repository
- github.com/ni
  - OS Source





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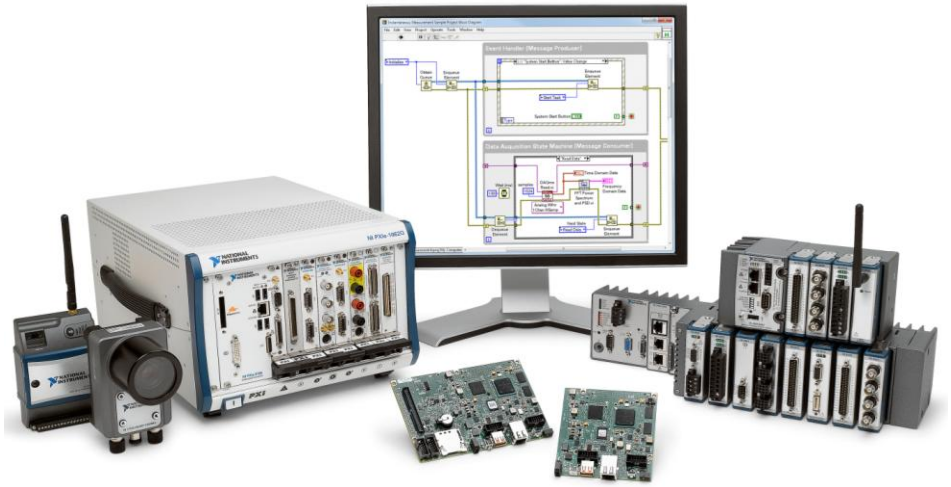
National Instruments is now offers the Certified LabVIEW Embedded Developer Exam

Learn more **ni.com/cled**



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