Designing a Robust IIoT to SCADA Gateway

Class 3: Many Protocols, One Abstraction - GOAL

October 24, 2018

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Blue Ridge Advanced Design and Automation

This Week's Agenda

10/22 The Challenges of IIoT and Industrial Ethernet

10/23 Introduction to the RZ/N1

10/24 Many Protocols, One Abstraction - GOAL

10/25 Programming the R-IN Protocol Engine

10/26 Writing and Testing Our Application

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Many Protocols

- As we saw Monday, there are a number of powerful industrial Ethernet protocols in use, some with not only different protocols (levels 3-up), but some with custom PHY and MAC changes (levels 1-2)

- Yesterday we looked at the R-IN engine that is capable of plugging in these changes. But how do we program this?

Question1 – What is LEVEL 3 in the 7-layer model?
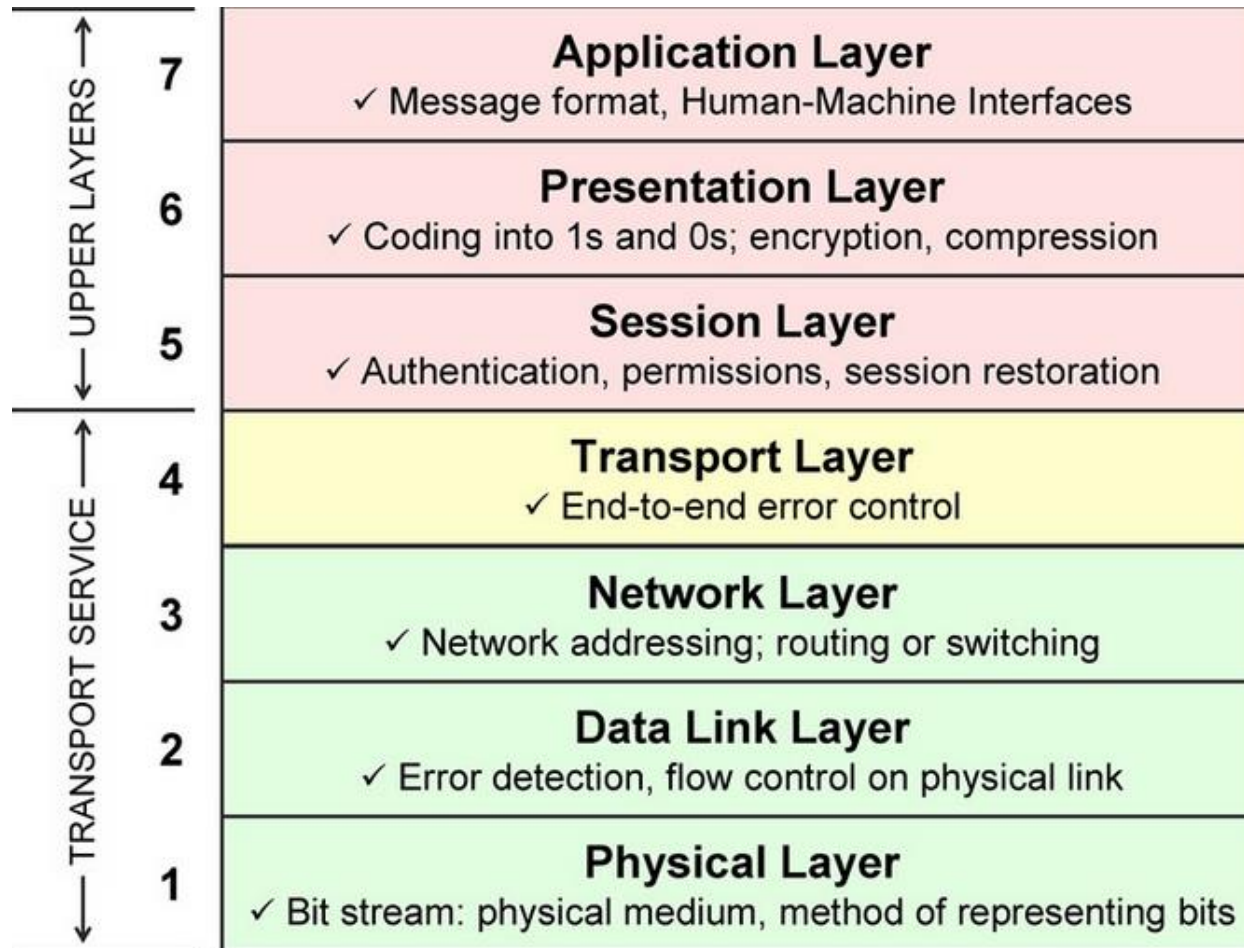
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Enter GOAL

- Generic Open Abstraction Layer from PORT GmbH

- Allows your application layer to control different protocols, even swapping out hardware changes, with a single API

- Let's look at the capabilities

- https://www.port.de/en/

If You Want to Follow Along

- Although you probably won't have the RZ/N1D and expansion board in front of you as you go through this class, you can follow along with all of the documentation and software by downloading the CONNECT IT! ETHERNET RZ/N DVD from Renesas

https://www.renesas.com/us/en/products/software-tools/boards-and-kits/eval-demo/connect-it-ethernet-rzn.html#downloads

ISO OSI 7-layer model

UPPER LAYERS	7	**Application Layer** ✓ Message format, Human-Machine Interfaces
	6	**Presentation Layer** ✓ Coding into 1s and 0s; encryption, compression
	5	**Session Layer** ✓ Authentication, permissions, session restoration
TRANSPORT SERVICE	4	**Transport Layer** ✓ End-to-end error control
	3	**Network Layer** ✓ Network addressing; routing or switching
	2	**Data Link Layer** ✓ Error detection, flow control on physical link
	1	**Physical Layer** ✓ Bit stream: physical medium, method of representing bits

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Network Management

- PHY Management

- Ethernet frame sending/receiving

- Switch Management / Interface Management

- IP Address Management (if supported by underlying OS/TCP/IP stack)

- HTTP Server

- Command line interface

Access and List Management, Threads

- Locks

- Mutex

- Binary and counting semaphore

- Linked Lists

- Thread creation and control

Configuration Management

- Central management of configuration variables

- Variables identified by module and id

- Callbacks for value validation and when values change

- Loading/saving of variables

- Variables can be marked as temporary and locked

- Customer storage systems can be integrated

Multi-Protocol

- PROFINET CCA / CCB RT1
- EtherNetIP
- Modbus TCP
- EtherCAT
- CANopen Master / Slave

GOAL Engineering Tools

- CANopen: CANopen Design Tool

- EtherCAT: EtherCAT Design Tool

- Powerlink: Powerlink Design Tool

- PROFINET: PROFINET Design Tool

- PROFINET Configuration Tool

- PROFINET Command Line Tool

GOAL Structure
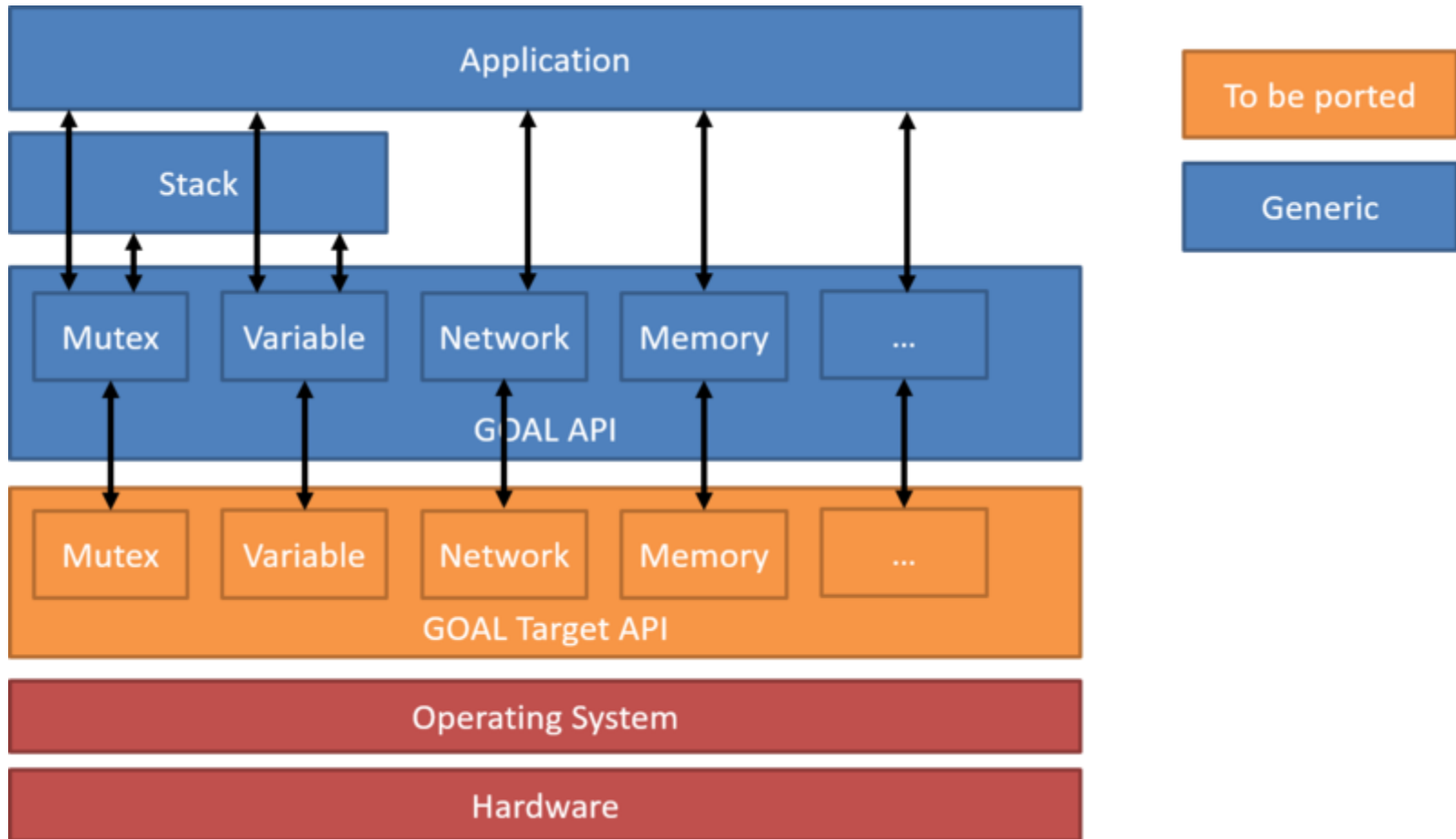
Traditional Stack Structure

Application

Application Programming Interface

RTOS	Middleware

Hardware Abstraction Layer

Board Support / Drivers

Hardware

GOAL is an OSAL

Application

Application Programming Interface

RTOS	Middleware

Hardware Abstraction Layer

Board Support / Drivers

Hardware
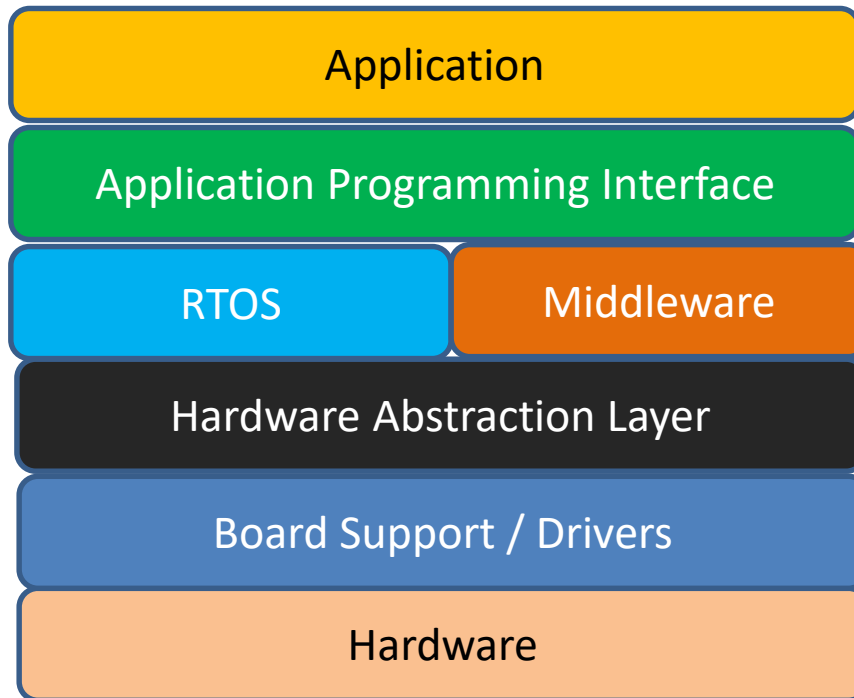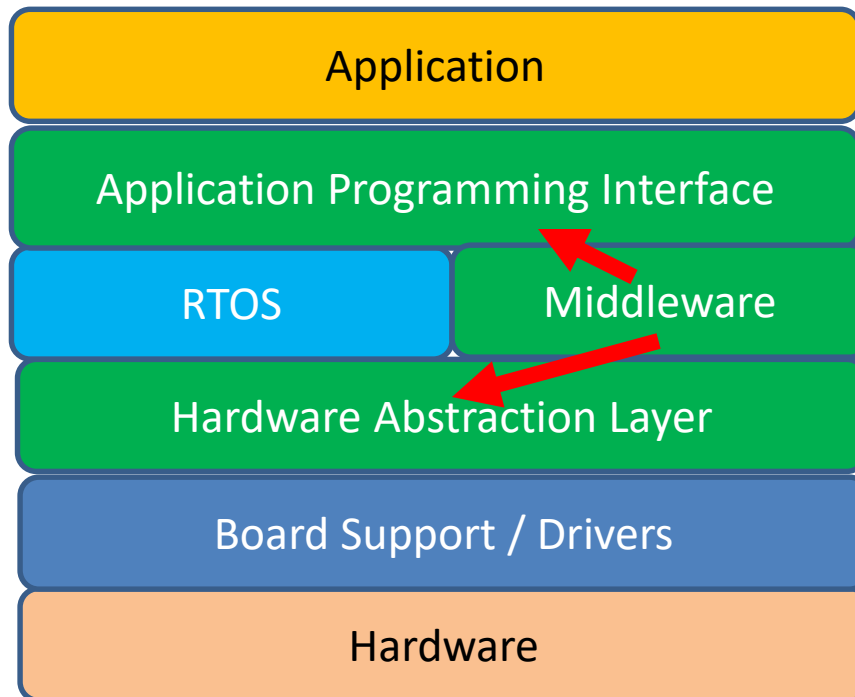
Operating System Abstraction Layer

Question 2 – Any experience with ITRON or µITRON?

How They Fit Together
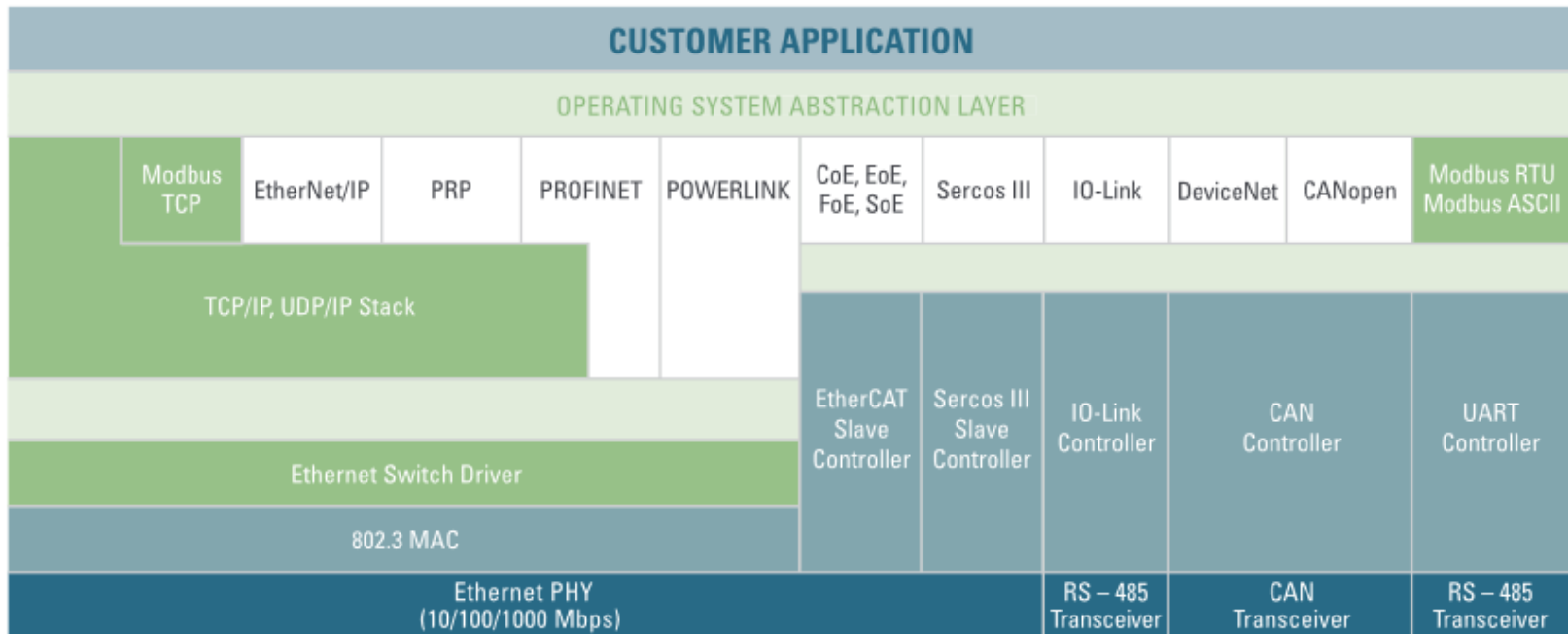
How GOAL works with interprocessor communications
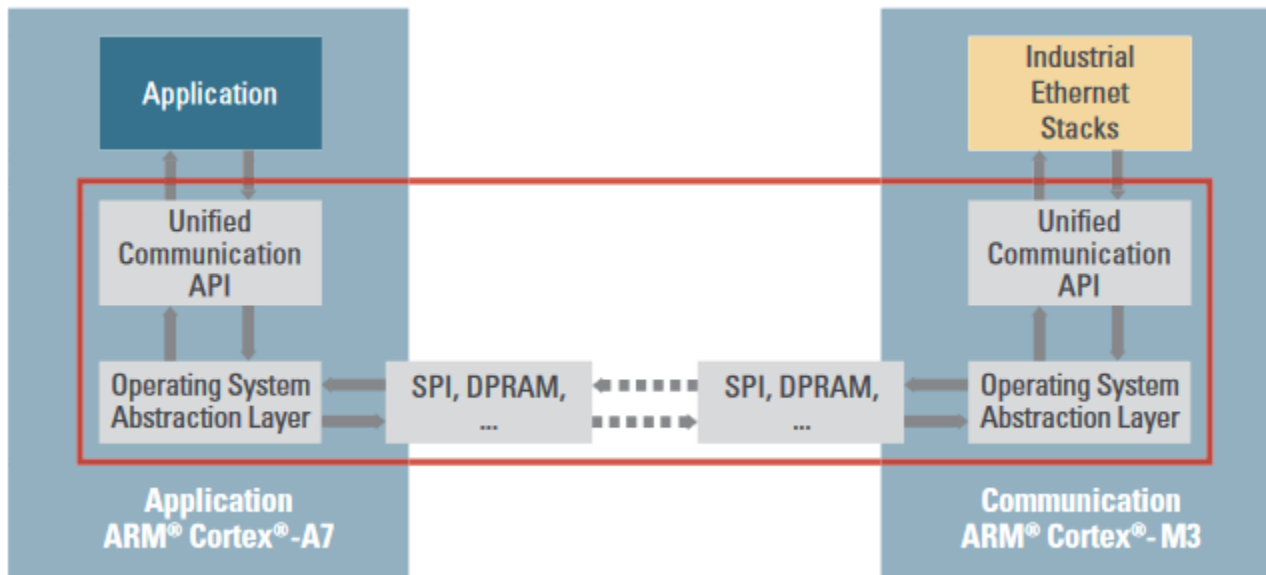
Basic modules in GOAL

Macro Name	Description
GOAL_CONFIG_LOGGING	logging module (DO NOT USE FOR RELEASE!)
GOAL_CONFIG_ETHERNET	Ethernet access module
GOAL_CONFIG_NVM	Non-volatile Memory module
GOAL_CONFIG_SWITCH_MANAGEMENT	Switch Management module
GOAL_CONFIG_PHY_ACCESS	PHY Access module
GOAL_CONFIG_TCPIP_STACK	TCP/IP stack module
GOAL_CONFIG_STATS	internal statistics (recommended to disable for release)

GOAL File Structure

- appl - Application source files for GOAL management projects and for protocol stacks example applications

- bsp - Board Support Package including HW-RTOS and register definition files

- ext - External code – code that was taken over externally

- goal – goal core source code

- plat - Platform specific code for Linux and R-IN32 and bsp (part 2) + drivers

- projects – IAR Projects including specific project settings for N1D, N1S and EB
- protos – Protocol Stack source code or libraries

- tools – Makefiles and scripts used when building goal applications for Linux

Just the Docs

Name	Date modified	Type	Size
2015026_GOAL_User_Manual.pdf	8/2/2018 5:03 AM	Adobe Acrobat D...	367 KB
r01an4239ej0090-rzn1-ethercat.pdf	7/31/2018 10:19 AM	Adobe Acrobat D...	636 KB
r01an4412ej0090-rzn1-modbus.pdf	7/31/2018 10:19 AM	Adobe Acrobat D...	3,265 KB
r11an0203ed0131-rzn1-goal-c2c.pdf	8/2/2018 2:54 AM	Adobe Acrobat D...	918 KB
r11an0205ed0131-rzn1-goal-user-manual-eip.pdf	8/2/2018 2:55 AM	Adobe Acrobat D...	604 KB
r11an0206ed0131-rzn1-goal-user-manual-powerlink.pdf	8/2/2018 2:55 AM	Adobe Acrobat D...	634 KB
r11an0207ed0131-rzn1-goal-user-manual-profinet.pdf	8/2/2018 2:56 AM	Adobe Acrobat D...	742 KB
r11an0208ed0131-rzn1-goal-changelog.pdf	8/2/2018 2:56 AM	Adobe Acrobat D...	316 KB
r11an0229ed0131-rzn1-goal-cli-guidelines.pdf	8/2/2018 2:56 AM	Adobe Acrobat D...	438 KB
r11qs0007ed0131-rzn1-goal-quick-startguide-eip.pdf	8/2/2018 2:57 AM	Adobe Acrobat D...	962 KB
r11qs0008ed0131-rzn1-goal-quick-startguide-management.pdf	8/2/2018 2:57 AM	Adobe Acrobat D...	847 KB
r11qs0009ed0131-rzn1-goal-quick-startguide-powerlink.pdf	8/2/2018 2:58 AM	Adobe Acrobat D...	1,210 KB
r11qs0010ed0131-rzn1-goal-quick-startguide-profinet.pdf	8/2/2018 3:02 AM	Adobe Acrobat D...	1,583 KB
r11qs0012ed0131-rzn1-goal-quick-startguide-canopen.pdf	8/2/2018 3:02 AM	Adobe Acrobat D...	637 KB
r11tu0004ed0131-rzn1-goal-filestructure.pdf	8/2/2018 3:02 AM	Adobe Acrobat D...	408 KB
r11tu0009ed0001-rzn1-goal-components-and-structure.pdf	8/2/2018 3:03 AM	Adobe Acrobat D...	682 KB
r11um0070ed0131-rzn1-goal-user-manual-canopen.pdf	8/2/2018 3:03 AM	Adobe Acrobat D...	593 KB
r11uz0009ed0131-rzn1-goal-cli-specifications.pdf	8/2/2018 3:04 AM	Adobe Acrobat D...	755 KB

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Example Projects

Name	Date modified	Type	Si
00410_goal	9/11/2018 8:21 PM	File folder	
goal_co_lib	9/11/2018 8:21 PM	File folder	
goal_co_rpc	9/11/2018 8:21 PM	File folder	
goal_co_rpc_lib	9/11/2018 8:21 PM	File folder	
goal_ecat	9/11/2018 8:21 PM	File folder	
goal_eip_lib	9/11/2018 8:21 PM	File folder	
goal_eip_rpc	9/11/2018 8:21 PM	File folder	
goal_eip_rpc_lib	9/11/2018 8:21 PM	File folder	
goal_epl_lib	9/11/2018 8:21 PM	File folder	
goal_epl_rpc	9/11/2018 8:21 PM	File folder	
goal_epl_rpc_lib	9/11/2018 8:21 PM	File folder	
goal_http	9/11/2018 8:21 PM	File folder	
goal_mbs	9/11/2018 8:21 PM	File folder	
goal_pnio_lib	9/11/2018 8:21 PM	File folder	
goal_pnio_rpc	9/11/2018 8:21 PM	File folder	
goal_pnio_rpc_lib	9/11/2018 8:21 PM	File folder	

Question 3 – Plan on downloading the documentation / software?

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More about µITRON

µITRON4.0 Specification
Ver. 4.00.00

http://www.ertl.jp/ITRON/SPEC/FILE/mitron-400e.pdf

ITRON Committee, TRON Association

Supervised by Ken Sakamura

Edited by Hiroaki Takada

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Tomorrow

- We will load some of these examples on our RZ/N1D with expansion board and see how GOAL allows us to program for the different communications buses.

- On Friday we will look at loading and booting Linux on the application processors (dual ARM Cortex A7) and show an example of communications with the R-IN engine using GOAL.

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Please stick around as I answer your questions!

- Please give me a moment to scroll back through the chat window to find your questions

- I will stay on chat as long as it takes to answer!

- I am available to answer simple questions or to consult (or offer in-house training for your company)
c.j.lord@ieee.org
http://www.blueridgetechnc.com
http://www.linkedin.com/in/charleslord
Twitter: @charleslord
https://www.github.com/bradatraining

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