IEEE CONSULTANTS' NETWORK OF CONNECTICUT
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NEWSLETTER
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CONSULTANTS' NETWORK OF CONNECTICUT (CNC)

CNC is associated with the Institute of Electrical and Electronics Engineers, Alliance of IEEE Consulting Networks (AICN). CNC members are expert, independent contractors who can provide quick help and a can-do approach. Advantages of using CNC members are objectivity and generation of new ideas. Further, CNC members can supplement existing staff very cost effectively.

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NEWSLETTER

This is the second quarterly newsletter. These newsletters are published electronically on the first of the month in which meetings are held.

Each newsletter contains general information and articles written by group members. The membership is invited to submit articles to the editor, Clem Skalski.

Reader feedback is invited and appropriate letters will be published.

The **Connector** (newsletter) of the IEEE Connecticut Section provides more general information to IEEE members and associates. To view the current Connector, go to www.ieee.org/ct.

MEETINGS

These are held quarterly on the third Wednesday of March, June, September, and December.

The next meeting is at ARRL, 225 Main Street, Newington on Wednesday, September 19 at 7:00 PM. The first half hour of the meeting is devoted to networking, with the business meeting starts at 7:30 PM. The atmosphere is casual and there is no admission fee.

INTRODUCTION TO ARTICLE

The attached article is by our chairman Bob Brown, who is an independent consultant. His company, Embedded Brain, specializes in the design and development of intelligent microprocessor based systems. He has created the "brains" for many diverse products including laser image setters, 3 dimensional robotic scanning systems, industrial motion controls and laboratory instrumentation. He maintains a web site at www.embeddedbrain.com and can be reached by e-mail at alta@ieee.org.

Introduction to **WIRELESS INTERNET-BASED REMOTE CONTROL USING A PAGER INTERFACE** by Bob Brown

The big media hype in Embedded Systems lately has been connectivity, especially Internet connectivity. Embedded Systems are what I like to call "devices with invisible computers inside". These embedded computers give the device its intelligence, but are invisible to the user. Embedded computers are in hundreds of devices that we use each day including VCRs, microwave ovens, printers, cars and even in your computer's mouse.

The media hype has been to connect these embedded computers together using either wired or wireless (i.e. Blue Tooth) networks. Of course, in reality each device has it's own purpose. In some cases connectivity offers little or no advantage. In other cases, fulltime Internet connectivity may be required to allow the device to perform its function. Other devices may require only limited internet connection for best price performance. This article describes such a device.

WIRELESS INTERNET-BASED REMOTE CONTROL USING A PAGER INTERFACE

Bob Brown
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INTRODUCTION

The big media hype in Embedded Systems lately has been connectivity, especially Internet connectivity. Embedded Systems are what I like to call "devices with invisible computers inside". These embedded computers give the device its intelligence, but are invisible to the user. Embedded computers are in hundreds of devices that we use each day including VCRs, microwave ovens, printers, cars and even in your computer's mouse.

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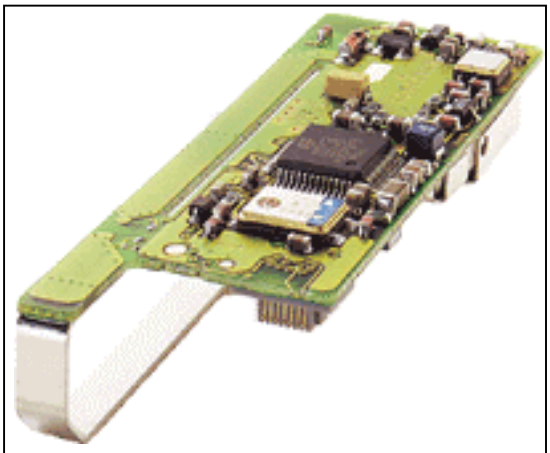
PAGER-INTERFACE EXAMPLE

It's all set. You've taken Friday off for a three-day weekend at your country place. You get on your Internet connection to tell your country home that it should go on its Friday schedule on Thursday to be ready for your arrival Thursday night. When you get there, the driveway and garage lights are on and the house is a comfortable 68°.



The CreataLink FLX receiver contains the antenna, 900-MHz FLEX receiver, and decoder in one small package

A few years ago, that scenario was thought of as futuristic. These days, with embedded Internet connectivity constantly hyped in the press, you would think that every house will soon be wired to the Internet. But the fact is, for these few simple control functions, a fully Internet-enabled house would be a bit of overkill (and over cost). In this article, I'll describe a much simpler manner of remote control over the Internet using some technologies that have been around for a while, which are stable, inexpensive, and do not require that your house be wired to the Internet.

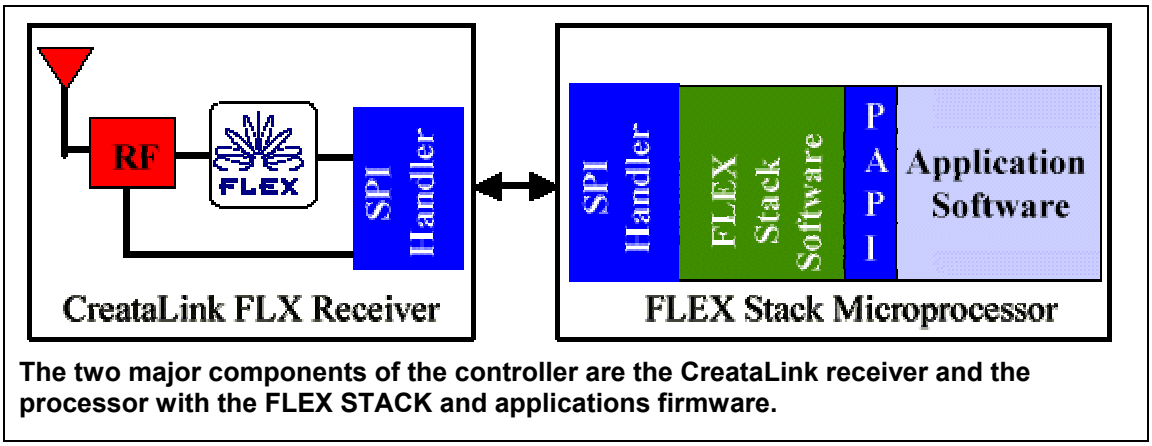
Alphanumeric pagers have been around for a few years now, and you can send e-mail messages to most pagers by sending a message to <the pager number>@skytel.com. For simple control tasks like turning on lights, a short message is plenty. If you add a pager receiver to a microcontroller and X10 interface, you have the hardware for a controller that can be directed remotely via the Internet. For a simple web-based interface, you only need an HTML form that, when submitted, calls a CGI script that sends the form data as an e-mail message to the controller's pager.

Several manufacturers make pager receivers that are suitable for embedding in the home controller. The one that I'll focus on is Motorola's CreataLink FLX receiver, which Motorola is coincidentally promoting as a solution for control links. It uses Motorola's industry standard 900-MHz FLEX system for pager data transmission

Motorola has created an API (provided through a block of software written in C) through what it calls the FLEX STACK that provides a standard interface for a microcontroller to the CreataLink receiver. Surprisingly, the FLEX STACK has only been ported to Toshiba and Hitachi microcontrollers, not Motorola's own. And at this time, Toshiba seems to be more active in supporting the FLEX STACK in the U.S. Figure 1 shows a block diagram of the basic controller system

CREATALINK HARDWARE

The CreataLink receiver contains the complete RF receiver, antenna, and microcontroller interface on a small PC board (see Photo 1). The CreataLink receiver interfaces to the rest of the system through a supplied 14-pin SMT connector.



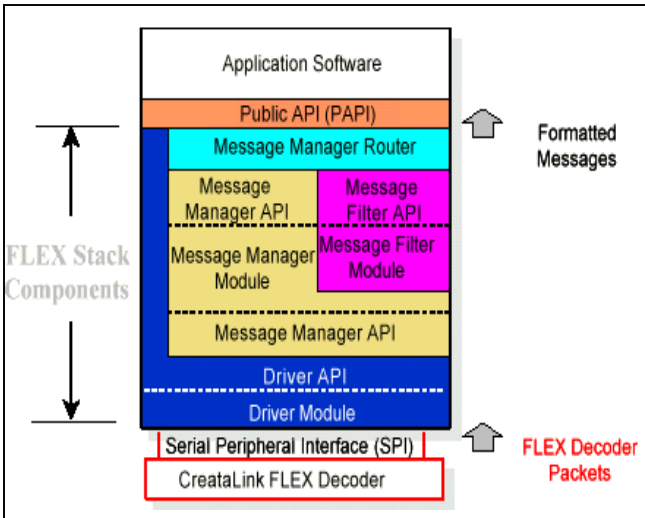
The two major components of the controller are the CreataLink receiver and the processor with the FLEX STACK and applications firmware.

The receiver requires two different supply voltages for operation, a 3.1 ±0.05-V V_{DD} supply and 1.25 ±0.25-V V_{BB} supply. The V_{DD} supply will be changed to 2.1 V in future versions of the receiver, so this should be taken into account in system design.

A key signal into the CreataLink receiver is a stable and accurate 76.8-kHz clock. Ideally this can be generated from the host microcontroller's master clock. This clock signal is AC-coupled in the CreataLink receiver and must be 200 mV_{PP} and stay between V_{DD} and ground. An RC network should be used to smooth the clock.

The remaining seven signals on the interface connector are the digital signals used in the microcontroller interface. For these signals, the high level is V_{DD} and the low level is ground. Three of the signals form a standard SPI serial data interface (data out, data in, and SPI clock). The three other signals that go into the receiver are two slave selects (SS1 and SS2) and a RESET line. And, an open-drain READY signal is driven by the CreataLink receiver.

FLEX STACK FIRMWARE



The FLEX STACK software module provides a high level interface to the CreatLink Receiver

The FLEX STACK software, which is written in ANSI C, handles the details of communicating with the CreataLink receiver. It defines an 11-function API that allows the application portion of the firmware to communicate with the low-level receiver drivers. Nine of the function calls reside within the FLEX STACK driver and are called by the application firmware. The remaining two functions are defined as notification functions, and the notification functions reside in the application portion of the firmware. These functions are called from the FLEX STACK driver to notify the application of receiver events, such as reception of a message. Figure 2 shows you a block diagram of the FLEX STACK firmware.

SELECTING A MICROCONTROLLER

The FLEX STACK has been ported to Toshiba's TLCS-900 and TLCS-870 series of microcontrollers. There are several dozen members to choose from between these two processor families. However, the requirements of the FLEX STACK driver, the CreataLink hardware interface, and your application requirements combined will reduce the number of processor options. The FLEX STACK driver requires about 500 bytes of SRAM, eliminating the processors in the TLCS-780 family that have only 256 bytes of SRAM. Unless you're sure that your application can get by with only a few bytes of SRAM, it also eliminates those processors with 512 bytes of SRAM.

The FLEX STACK also requires about 12 KB of ROM (EPROM or flash memory), so you need a processor with at least 16 KB, but more likely 24 KB or 32 KB of ROM. Also, a hardware SPI port is required by the FLEX STACK to interface with the CreataLink receiver.

If you wish to generate the CreataLink's 76.8-kHz clock from the microcontroller's master clock, you need to select a processor with a programmable pulse generator or PWM output from its internal counters. By using a standard 7.3728-MHz crystal and having the counter divide by 96, you can generate a 50% duty cycle, 76.8-kHz clock for the CreataLink receiver to use. (The 7.3728-MHz crystal also works nicely for producing exact data transfer rates for a UART.)

Your application will add some additional requirements for the processor. If, for example, you want a UART to communicate with an X10 transceiver, you'll need to select a processor with both a UART and an available counter for data transfer rate generation. After all things are considered, your choices will be reduced to a more easily manageable number.

PUTTING IT ALL TOGETHER

The final decision is how to allocate the intelligence within the complete controller system. If desired, the controller can be quite dumb and the intelligence can be on the Internet server side.

In this case, the controller would only perform an action on receipt of a message, and the server would handle sending commands at the proper time to perform an action. If the controller is more intelligent, it might be remotely or locally programmed to perform actions on its own at a given time. This behavior could then be modified by sending the controller a message that could be generated on a simple web page using a CGI script.

There are many uses for one-way wireless Internet-based remote control besides getting your weekend home ready for your arrival. The receiver can be configured to receive messages on one or more capture codes. If multiple controllers share a common capture code, they can all be sent a message with a single page. For example, this would allow for a price change on all vending machines within a given group with just one broadcast message. Of course, each controller can also be given a unique capture code and addressed individually. With the paging infrastructure well established, there may be no need to wait for the "wireless Internet" to have Internet-based wireless remote control.