

DeviceMate, an Integrated C Development System for Network-Enabling Embedded Devices

Overview

In addition to meeting traditional challenges, designers of embedded control and equipment are often expected to provide Ethernet and/or Internet connectivity as part of their standard product design, or as a product option. Retrofitting legacy products with network capabilities is also a common request. This can be a time-consuming and expensive task, even for designers with experience involving network hardware and TCP/IP software. Designers with little experience in these areas may find no recourse but to outsource the design (with significant risk) to some third party, or even worse, a combination of third parties—one for hardware and one for software.

Embedded Internet Challenges

- ◆ Quick time to market
- ◆ Low cost
- ◆ Technical risk, hardware and software
- ◆ Excessive extra loading on the main processor
- ◆ Getting vendor support

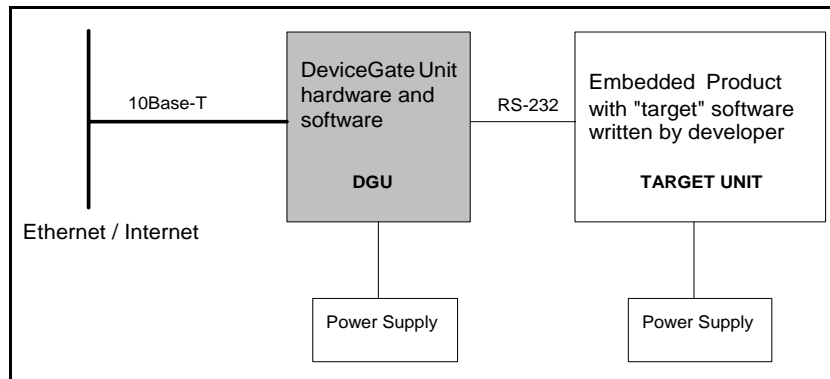
Even companies with experienced network designers may find themselves in a situation where there is a pressing need to Ethernet-enable the product quickly, and there is no time for a design from scratch. Designers may also find themselves in a situation where they may want or may need to segregate their network code and hardware from non-network code and hardware, perhaps for performance reasons.

Z-World now has available an extensive array of inexpensive hardware platforms and suites of networking software to allow most new or legacy products to be network-enabled quickly and reliably at low cost. Three general categories of solutions are available, and they are referred to collectively as the “DeviceMate.”

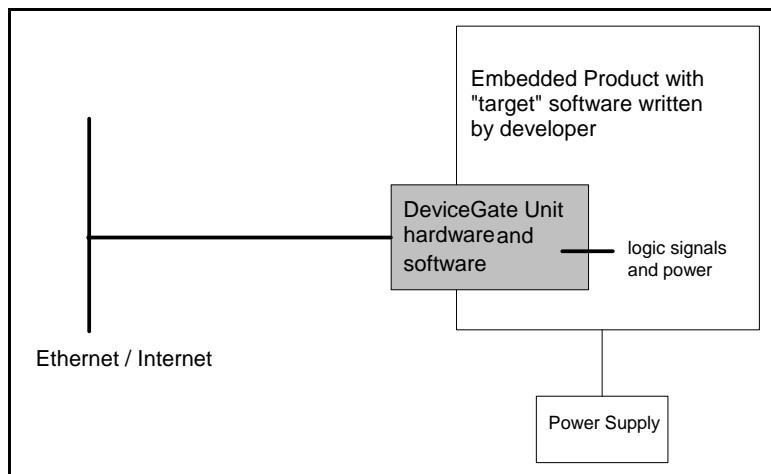
- DeviceGate =**
- + Ethernet capable satellite Hardware (SBC, Core Module, R2000 reference design)
 - + DeviceGate Unit software
 - + Target software interacting with DeviceGate Unit

The three general categories of solutions are listed below.

- External Ethernet-enabled hardware and software, which interfaces to another product via an RS-232 port.



- Ethernet-enabled hardware and software, which is designed to be tightly integrated into a product as a daughter board, with communication via logic-level signals.



- Chip-level hardware based on an Ethernet-compatible reference design with supporting software.

Blending Z-World's expertise in embedded hardware, royalty-free low-cost Dynamic C software, and top-notch technical support, the total DeviceMate solution is available from one company with minimal technical, cost, and schedule risk to the designer. A DeviceMate Development Kit is also available to allow hands-on experimentation and evaluation of the DeviceMate solution.

The term "network-enabled" is very broad, but generally means one or more of the following.

- Allowing data in the embedded product/device to be monitored, sometimes in a Web page format, sometimes with dynamic data, sometimes with no direct human interaction.
- Sending supervisory data to the embedded product/device, sometimes manually from a Web page, sometimes from a supervisory computer.
- Allowing the embedded device to initiate an event-driven e-mail message, or providing other means for the embedded device to send an e-mail message.
- Providing transparent TCP or UDP connections between the embedded device and a remote computer or device.

A Total Package

DeviceMate provides all of this functionality, and more. Although the DeviceMate software is essentially provided as a canned solution (some macros must be configured, e.g., to set IP address), the source code can also be modified by experienced C and TCP/IP designers to add special functions or meet unusual end-user requirements. This flexibility to modify source code is not available in many other network interface solutions. The target-side software *does* require programming to take advantage of the features provided by the DeviceMate hardware platform, but this is easily done by experienced programmers. Library API functions are provided in Dynamic C for Rabbit-based and nonRabbit-based target devices. Sample communication drivers are provided for 386EX-based target devices, and for target devices running Unix or Linux. The DeviceMate software is built on Dynamic C, a product with a long and distinguished history in high-volume embedded applications.

In addition, the Dynamic C DeviceMate extensions provide several other functions that are related to networking or support a target processor in other ways. These functions include the following.

- A mechanism to upgrade software in the target device via a remote network download.
- Routines to allow the DeviceMate hardware platform to be used as an external watchdog for the target device.
- Routines that allow the DeviceMate hardware platform to be used as a file storage and message logging peripheral for the target device.

Note: Remote program download is available only to Rabbit-based targets.

Scalable Solutions

Past experience dictates that in spite of the best-laid plans, the scope of projects sometimes grows beyond initial requirements. Initially, only one or two of the above features are planned. As the project evolves, more are added. It is therefore important that the network-enabling software and hardware support future growth in these areas. It is also possible that once a solution has been implemented for one target product, there is a desire to implement a similar solution on additional target products based on different hardware.

It is usually not cost- or time-effective to develop a totally new solution for essentially similar requirements. Z-World provides multiple hardware solutions that can serve as the DeviceMate hardware platform using a common software solution in a stable framework that allows migration from one DeviceMate hardware platform to another in a relatively painless fashion. Software changes on the target device can migrate similarly with minimal effort. Although the hardware changes, the software remains almost the same, which further minimizes expense and time-to-market for the additional products.

Selecting DeviceMate Hardware

There are several key decisions to be made when selecting DeviceMate hardware.

Interfacing Legacy Products

If you need to Ethernet-enable a legacy product, you probably need a DeviceMate hardware platform that “stands alone” and interfaces to the legacy product via an RS-232 connection. Z-World currently has the following products available that can act as a standalone hardware platform.

- BL2000 Wildcat Series
- BL2100 Smartcat Series (available November, 2001)
- OP6700
- TCP/IP Development Kit Board
- OP6800 (available January, 2002)
- EG2100 Rabbitlink

These hardware platforms are all essentially low-cost single-board computer (SBC) platforms that include a 10Base-T Ethernet port, various I/O points, and at least one serial port. Only the Ethernet and serial ports are required for any of these products to serve as a DeviceMate hardware platform to interface with the legacy product.

However, the availability of on-board I/O opens the door for additional features to be implemented. For example, using an output point or a relay on the DeviceMate hardware platform, the designer could hardware-reset or power-cycle the legacy product. Or the user interface might provide critical information to a customer at a remote site, and prevent a costly on-site support visit by field service staff. It would also be possible to use analog inputs to monitor supply voltages on the target device, and send an e-mail if voltages are out of spec.

Even if the I/O and user interfaces are not considered, these hardware platforms address the fundamental need for low-cost external network interfaces to the existing hardware or application.

The DeviceMate software is loaded into the hardware platform, which is connected to the target device via RS-232. Since the DeviceMate hardware platform interacts in a pre-defined fashion with the legacy product, the legacy product must be programmed as a target device to exercise the features resident on the DeviceMate hardware platform. Since the DeviceMate hardware platform can be powered independently of the target device, it has the capability to monitor the target device for power failures, software crashes, and other unfortunate situations.

Refer to the hardware specifications for the above products, and the DeviceMate manuals for additional information. All are available at www.zworld.com.

Designing DeviceMate into a New System

If you need to network-enable a new product, you have the option of using the external standalone solution described above, or you can use a more cost-effective hardware platform (RabbitCore module or Rabbit chip).

Z-World's RabbitCore modules are compact PCBs designed to function as CPUs, which plug into a mother board of the customer's design. RabbitCore modules in the RCM2200 series are ideal as embedded DeviceMate hardware platforms. RCM2200s include a 10Base-T Ethernet port, the Rabbit CPU, flash memory, SRAM, logic level I/O, and logic level serial ports.

RabbitCore modules are often used as the single CPU in new designs because they provide a quick time-to-market "known good" CPU solution. In the context of DeviceMate, however, the RabbitCore module is intended to be used only to execute the DeviceMate code. The "target" CPU on the mother board continues to be responsible for the mainline tasks of the embedded product. By off-loading these responsibilities to the RabbitCore module, the main processor can concentrate on its mainline functions.

The mother board needs to provide power and interface signals to the RabbitCore module (DeviceMate hardware platform). The RabbitCore module normally communicates to the mother board CPU (acting as a target device) via the logic-level asynchronous serial ports.

Note that if the target device is based on the Rabbit microprocessor, and design recommendations have been followed, then it can be programmed remotely over a LAN or the Internet via the DeviceMate.

Cost-Sensitive, High-Volume, or Special Applications

Sometimes it is not desirable to have either external hardware or a core-module-based DeviceMate hardware platform. This can be for cost reasons, or perhaps there space is not available for a daughter board. Z-World offers a solution to this situation. Reference designs for DeviceMate hardware platform based on the Rabbit microprocessor are available which can be integrated into an overall single board design. The DeviceMate hardware platform must be based on a Rabbit microprocessor. This approach offers the lowest potential product cost, but at the expense of development time.

Target Software

Regardless of which type of DeviceMate Unit is used, some software will need to be written or modified for use on the target device. The target device can be Rabbit-based, or it can be based on some other processor. If the target device is based on a Rabbit processor, then pre-written routines are available to minimize the software development task at the target. If the microprocessor on the target device is not a Rabbit, ANSI C routines are available, but the hardware level drivers must be ported for that processor. If the target CPU is not supported out of the box, then experienced programmers can examine the sample target code and port it to their own CPUs.

Implementation Summary

Situation	DG Platform	DG Software	Target HW	Target SW	Connection
Legacy or new product	ZW external single-board computer	Pre-written and tested routines	Rabbit CPU	Pre-written and tested routines, some user code	RS-232 serial
	ZW external single-board computer	Pre-written and tested routines	Other CPU	ANSI C routines + user code + port HW drivers	RS-232 serial
New product	ZW RabbitCore module (RCM2200)	Pre-written and tested routines	Rabbit CPU	Pre-written and tested routines, some user code	Logic-level serial
	ZW RabbitCore module (RCM2200)	Pre-written and tested routines	Other CPU	ANSI C routines + user code + port HW drivers	Logic-level serial
	Rabbit chip reference design	Pre-written and tested routines	Rabbit CPU	Pre-written and tested routines, some user code	Logic-level serial
	Rabbit chip reference design	Pre-written and tested routines	Other CPU	ANSI C routines + user code + port HW drivers	Logic-level serial

Development Kit

Given the variety of potential solutions available in the marketplace, it is often difficult to make decisions about the correct path to follow. To make this task easier, Z-World offers a low-cost DeviceMate Development Kit. This kit includes an RCM2200 RabbitCore module, a sample Rabbit-based target device (also a RabbitCore module), a Demonstration Board to mount both the DeviceMate hardware platform and the sample target. DeviceMate software with extensive sample programs and other related items which can be used to investigate the DeviceMate concept. For more information refer to the Z-World Web site www.zworld.com.

Summary

- Adding Ethernet/Internet connectivity to embedded devices is becoming more important to many OEMs.
- Critical issues usually involve low cost, quick time-to-market, finding top-notch vendor support, and low technical risk in both hardware and software.
- This connectivity may need to be implemented for both legacy products and on new products.
- This trend is likely to continue for future products, so a scalable solution is desirable.
- A low-cost, low-risk method of evaluating possible networking solutions is needed.
- The DeviceMate hardware, software, and Development Kit from Z-World address these issues, and provide additional features and benefits as well.
- For new designs, a satellite processor with known-good software (acting as a DeviceMate hardware platform) off-loads main processor bandwidth to the DeviceMate hardware platform, and allows the opportunity for the DeviceMate hardware platform to act as an independent monitor of basic functions on the main processor.
- The DeviceMate hardware platform must be based on the Rabbit CPU. For enabling legacy products (or new products) with RS-232 ports, this usually takes the form of an off-the-shelf standalone single-board computer from Z-World. For new designs, the DeviceMate hardware platform can be a Z-World RabbitCore module or the Rabbit processor itself.
- The DeviceMate target can be based on the Rabbit CPU or another CPU.
- The hardware connection between the DeviceMate hardware platform and the customer's target device is RS-232 for the external standalone solution, and (usually) logic-level asynchronous serial where the DeviceMate hardware platform is core-module-based.
- The standalone solution is loosely coupled to the target device, and can act as an independent monitor of the target, in addition to being the network interface.
- Target API functions and demo programs are available for Rabbit-based products in Dynamic C format, and in ANSI C format for other CPUs. Sample drivers are provided for 386EX and Unix/Linux platforms. The supplied hardware-level drivers must be ported to the target system by the developer.
- DeviceMate software is a suite of library extensions to Dynamic C, an easy-to-use IDE with a proven history in the industrial arena.



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