

First 'Open Systems' Chip

By Bob Ofenstein

The buildings industry now has a powerful new integrated circuit (IC) chip with built-in support for both BACnet®/IP and LonWorks® ANSI/EIA-709.1 networks. Many manufacturers and product designers have now focused their efforts higher up the system architecture. The fact that there is now an Ethernet-based “dual protocol” chip on the market makes it even more apparent that the goal for next-generation embedded products is to integrate the facility and concentrate on the important issue of bringing value to enterprise applications.

Development of the LC3020 chip was a combined effort of Loytec Electronics GmbH (ANSI/EIA-709.1) and Cimetrics, Inc. (BACnet) experts.

Loytec hardware designers worked with well-known IC chip manufacturer NEC to create a system-on-a-chip (SoC) with features needed for next-generation BAS products. Loytec added its Orion™ protocol stack, which supports ANSI/EIA-709.1 networks, and Cimetrics added its BACstac/32™ protocol stack for BACnet support.

Many of the latest BAS and information technologies (IT) are supported by this chip: BACnet, LonWorks, Ethernet, TCP/IP, Open Source OS, Web servers, XML/SOAP servers, DHCP, routing, and others.

Fusing Building Systems and IT

Facility value is enhanced when enterprise-wide control and information sharing is implemented. The immediate benefit is improved comfort, fewer maintenance surprises and lower facility

management costs, but additional benefits are to come.

Many manufacturers are working on systems that will allow a unified approach to facility systems that combine the features of HVAC, fire and life safety, vertical transport, lighting and energy usage.

Enabling this value usually starts with the inclusion of Ethernet connectivity. By adhering to existing Ethernet and TCP/IP standards, BAS products can leverage existing IT technologies such as consumer PCs, routers, and HTML browsers that combine multiple disparate systems on common wiring, automatic address assignments, and client/server architectures.

An example of the way in which IT technologies are being embraced by the BAS community is the “BACnet/WS Web Services Interface,” Addendum c to ANSI/ASHRAE Standard 135-2004, *BACnet®—A Data Communication Protocol for Building Automation and Control Networks*. The addendum has been released for public review.

This specification uses HTTP, XML, and SOAP to enable machine-to-machine

data exchange between BACnet networks and enterprise applications or databases.

Forces Driving Embedded Designs

The trend toward more intelligent building systems has dramatically increased demand for computing power, memory, I/O and sensor connections, networking, and emerging IT technologies. As a result, product developers are looking for IC solutions that support the following:

- Enabling higher levels of integration between infrastructure systems within the building (HVAC, fire systems, lighting, access control, elevators, etc.);
- Enabling the monitoring and control and of a very large number of I/O points;
- Enabling distributed control and analysis architectures;
- Finding ways to reduce product and development costs;
- Leveraging technologies, which lower installation and commissioning costs;
- Enabling communications between previously isolated building systems and enterprise business systems; and
- Creating products that open up new applications or new markets.

Addressing BAS Requirements

The LC3020 system-on-a-chip (SoC) is based on a very popular 32-bit RISC processor, the ARM7-TDMI. More than one billion ARM processors are used today in products such as cell phones and PDAs. Pricing is highly competitive and development tools are plentiful.

Loytec's hardware designers worked with NEC to design the special functions needed for building automation protocols and implemented these in custom coding inside the chip. By leveraging NEC's design and manufacturing expertise, the engineers were able to incorporate a broad range of state-of-the-art features and performance. This SoC has a built-in Ethernet controller for cost savings when implementing embedded TCP/IP control applications. Various serial port configurations and twisted pair networks are also supported. The design architecture of a SoC is shown in *Figure 1*.

BACnet Example 1: What needs to be implemented?

BACnet is an object-oriented protocol specifically designed for distributed control applications. This architecture is widely used by programming languages (such as C++) and distributed

databases (such as Oracle) and is known for its ability to freely connect and exchange information between diverse hardware and software systems.

BACnet's value is in defining the unique BAS-related object types and the behaviors needed to implement a distributed object building system. For example, our industry needs an object that represents temperature. This is implemented by using an Analog Input object that has a set of properties that include the current temperature, sensor type, location, high and low limits, and more. BACnet currently defines 25 standard object types (see *Figure 2*).

One of the main advantages of this model is that it is "transport agnostic," meaning that it can be used to define data over RS232, RS485, TCP/IP, Web services, wireless or almost any communications technology in the future.

When designing a BACnet-enabled product, software is created that presents objects and object behavior to "neighbor products" on the network. Some of the objects represent physical values or names, but some are conceptual, like a Schedule object, which might tell a lighting

controller which lights to turn on or off at different times during the day, or a Trend-Log object accumulating local or remote value changes for future reference by other devices. Each object contains a list of properties whose values indicate the current state of the control equipment. The BACnet standard specifies mandatory and optional properties for the standard objects, as well as mandatory behavior associated with these properties.

Object interactions are defined by a set of more than 30 applications services that your BAS product uses to communicate with other products on the network. For example, to find out the status of a fan, you use a "ReadProperty" service request, or if you want to turn the fan ON, you use a "WriteProperty" service request. Any product on the network can also find out the capabilities of its "neighbors" by using Who-Is and Who-Has broadcasts. These illustrate just a few of the BACnet services that need to be implemented to enable the control flexibility inherent in distributed object architecture.

BACnet Example 2: Creating the BACnet software

Creating the software code that implements the objects and services defined by the BACnet standard is not easy, but this complexity can be simplified by using a BACnet protocol stack.

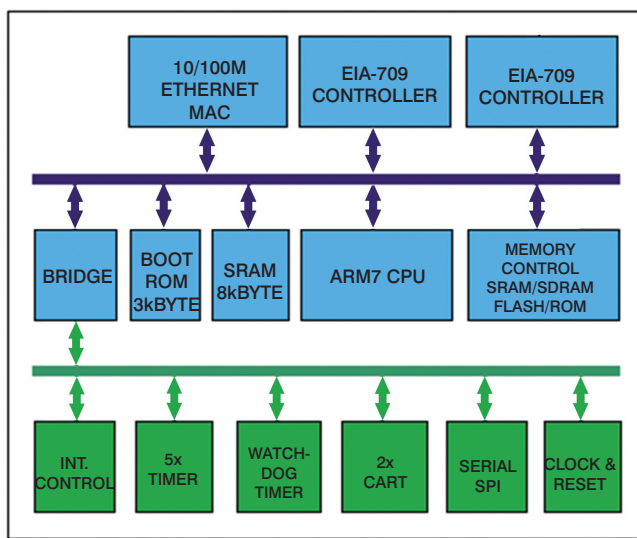


Figure 1: Design architecture of system-on-a-chip (SoC).

The trend toward more intelligent building systems has dramatically increased demand for computing power, memory, ... and emerging IT technologies.

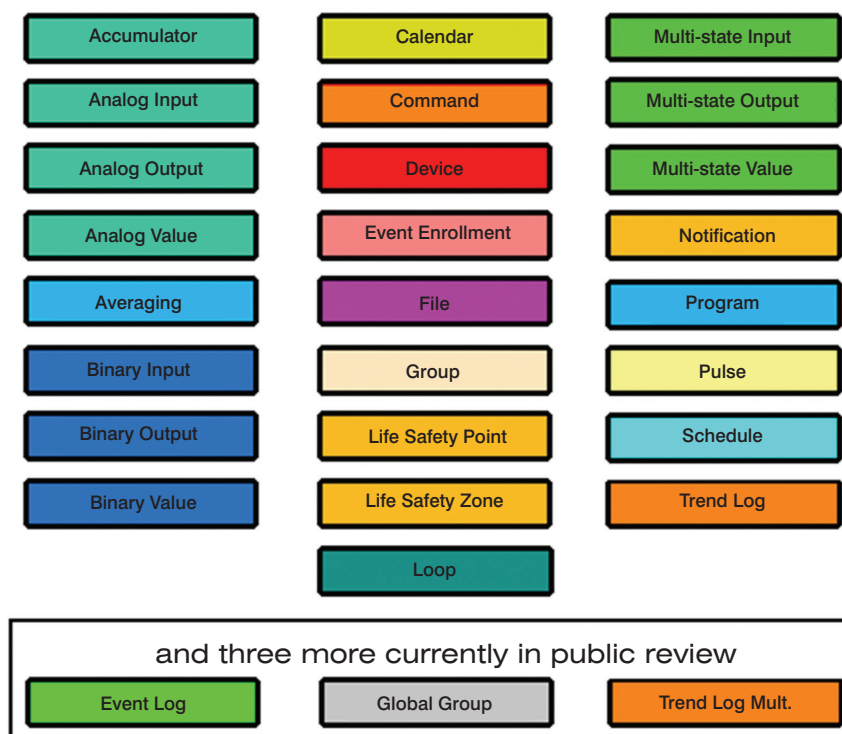


Figure 2: BACnet® defines 25 standard objects. Another three are in public review.

A BACnet protocol stack is a set of proven software routines that implement many of the BACnet functions and offers simplified services to a user's application. The LC3020 BACnet SDK includes a mature stack called BACstac™ that simplifies the development of an embedded processor product.

The software keeps local images of remote devices and objects that are to be manipulated by your device and your software code, then reads or writes to these local images as if all of these items were physically located within your device. This concept can be scaled to let your program manipulate up to 64,000 devices and objects.

By having these local images, your application code can easily read and write to the properties of objects within your device as well as properties within any other device on the network.

It is the responsibility of your device to state which objects you have and which object properties are available for manipulation by other devices (not write-protected). The fact that all of the details about these control devices are available to everyone on the network makes BACnet a very powerful and flexible system architecture.

Leveraging the advantages of the IT community, the LC3020 chip is designed for use with open source development tools. Software development is done within an Integrated Design Environment (IDE) using a program called the "Eclipse IDE Platform."

The Eclipse tools have a strong following in the open-source community and features a wealth of robust, full-featured software for product design, version control, and project management.

The LC3020 also uses an open source operating system called "Real Time Operating System for Multiprocessor Systems (RTEMS)." This is a strongly supported real-time operating system that features multitasking, dynamic memory allocation, modular construction, and a broad range of network support with an assortment of client services, servers, file systems, and debugging support.

Focusing on the hardware within your product, the LC3020 SoC offers high-performance computational abilities, multiple program timers, 58 bits of I/O, two UARTs, a watchdog timer, external RAM and flash support, low power requirements and more. These features make it an appropriate choice for many embedded products such as pump controllers, variable speed drive controllers, lighting controllers, fire panels, access controllers, general I/O controllers, gateways, routers, and more.

Conclusion

The LC3020 IC chip was developed by a partnership that leveraged expertise from chip manufacturers and technologies from the IT industry. This is a prime example of highly integrated components that makes the creation of a next generation "open systems" products cheaper to produce and much easier to develop.

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