Ethernet is receiving much attention as a communication interface in embedded systems used in the field of medical imaging. Medical manufacturers claim the design of imaging systems employ Ethernet to extract the most benefits from the infrastructure, while allowing physicians to effectively care for their patients.

Today, physicians in many hospitals and cancer treatment centers, use such a system called the TomoTherapy Hi-Art System®. The architecture for this system, designed and manufactured by TomoTherapy Inc. in Madison, Wisconsin, fuses a three-step process: treatment planning, patient positioning and treatment delivery. The result is the ability for physicians to deliver sufficient radiation to destroy a tumor without impairing an individual's physical well-being or damaging any healthy cells beyond repair.

To optimize the system’s investment, engineers at TomoTherapy chose Ethernet as the control and communications network. With Ethernet installations previously in place at the company, TomoTherapy engineers already possessed a good understanding of the technology.

In this application, the Ethernet switch was important to the network’s infrastructure. It translated to quicker throughput, enhanced reliability, the meeting of space requirements and the easy integration of different computers. Once the main concerns were defined, then engineers searched for a supplier of industrial Ethernet switches to provide reliable communications between the main components. They selected Contemporary Controls. This company, located in Downers Grove, Illinois, is a manufacturer of industrial networking equipment.

TomoTherapy opted for the company’s BAS switch, offering the newest in communication technology. The BAS switch (EIBA5-100T) is designed with a minimum number of components, packing more functionality and ease of installation into this compact device.

The System

To employ the proper amount of control for the TomoTherapy system, it was only necessary for the subsystems to provide real-time performance, not the Ethernet communications, to precisely track the position of the radiation beam.

Tim Holzmann, Lead Design Engineer for TomoTherapy, says the BAS switch is only accessible to service personnel. It’s under the fiberglass covers of the machine, mounted on the rotating gantry. The equipment resembles a CT machine, approximately 12 x 12 x 8 feet with a steel frame underneath. The two embedded computers on the machine’s rotating side are connected to the stationary computers using the BAS switch.

The selection of the BAS switch was necessary for this robust type of environment, specifically its EMI protection. Holzmann and other engineers at TomoTherapy recognized the key benefit of this device. “We were concerned about the small panel area (10 x 6 feet) for mounting,” explains Holzmann. “But the BAS switch allowed us to provide secure mounting on the rotating gantry with screw terminal positive locking power connectors. Good mounting holes. No need for receptacles or extension cords or duct tape. We had available low-voltage DC power for easy connection to the switch, saved on extra wiring expense.”

“What’s even more unique to us,” adds Holzmann, “is the label on this switch. The label on the unit can be written upon so that port connections can be documented as to the location of our other connected equipment.”

The BAS switch truly embraces the concept of Plug and Play (PnP) because no operator intervention is required. In case the power must be removed and reapplied, the unit is able to return to operation.

As for regulatory standards, the BAS switch is UL 508 Listed, C-UL Listed, CSA No. 22.2 14-M91, Industrial Control Equipment and carries the CE Mark to be sold in the European Union.

The infrastructure is not complicated. Holzmann says the two embedded computers and one RS-485 to Ethernet converter connect to the BAS switch. The computers use either 10 or 100 base communications with the switch. The switch connects to a media converter (CAT 5 to coaxial), across the slip ring, to another media converter, to the stationary machine network. Cable lengths are short, either 2 to 3 feet. There was no need for additional wiring.
How the System Works

The patient is positioned lying down on a bench that passes continuously through the bore of the rotating ring gantry. The gantry shelters a device known as the linear accelerator. The linear accelerator delivers radiation in a helical pattern around the patient as the bench moves simultaneously with the turning gantry.

The system delivers IMRT using a device called a multileaf collimator, or MLC. The MLC is comprised of a series of leaves. Each leaf opens or closes to emit or stop radiation. Prior to treatment, physicians calculate the radiation's required pattern of delivery. This is important to modulate the radiation's strength so it conforms to the shape and the location of the tumor.

Other elements of the system allow clinicians to take a CT scan of the patient's tumor prior to the procedure in order to properly position the patient.

There's even a reduction in the number of devices in the system's chain as compared to a radiotherapy department's workflow. “This is an innovation that's inevitable,” says Holzmann. “It's a fact that systems, such as ours, have advanced to fewer components, especially in the medical field, but these systems are providing more advanced functionality. And the BAS switch only adds to the right balance of effectiveness. The switch is operating great. We have experienced no failures.”