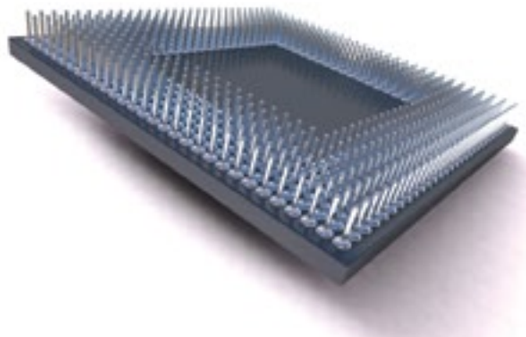
Mobile Analysis Made Possible with One Little Chip

USING SMALLER AND MORE PORTABLE DEVICES CAN MAKE ALMOST ANY JOB EASIER. JUST AS THE LAPTOP AND BLACKBERRY SEVERED THE CHAINED-TO-A-DESK WORK ENVIRONMENT, SYSTEM-ON-CHIP TECHNOLOGY CAN GIVE INDUSTRIAL, MILITARY, AND HEALTH CARE PROFESSIONALS MORE MOBILITY.



System-on-chip (SoC) technology means exactly what it sounds like it would—putting all the components of a computer or electronic system onto a single chip. Strong demand for better electronics from industries and consumers fuels the expansion of SoC technology, with revenues exceeding $200 billion. Miniaturization and integration of more advanced electronic devices necessitate a SoC design approach, which is made possible with the latest chip-fabrication technologies.

These devices incorporate embedded processors, embedded memory, specialized accelerators, and more recent on-chip communication networks for dramatically reduced cost, very high performance, and low power consumption. Devices such as cell phones that provide voice communication, Internet access, camera, video, and music functionality within a very small, portable package would not have been possible without SoC technology.

Professors Jafar Saniie and Erdal Oruklu are developing an adaptable SoC platform for several applications. Their team has made major contributions in the Embedded Computing and Signal Processing Laboratory and VLSI & SoC Research Laboratory, including introducing a SoC for real-time, advanced ultrasonic imaging applications. It can be integrated into a portable, handheld testing system that can provide diagnostic images for in-mission critical environments such as mobile and remote test sites, field hospitals, structural health sensing of bridges, nondestructive testing (NDT) in nuclear power plants, NDT in transportation vehicles, and underwater sonar imaging applications. This means that the SoC integrated devices can use ultrasound, radar, or sonar to locate anything from a moving target to a crack in a steel bridge to a small tumor in the human body, depending on their intended application.

The SoC developed by Saniie and Oruklu is so desirable because it is the first parametric imaging system ever designed to replace a desktop imaging system, which can only be used in test labs. It also provides powerful data compression and can facilitate access to the ultrasonic information from remote locations. The locally obtained ultrasonic images can be transferred through wireless or wired communication channels to off-site experts for analysis and diagnosis.

Saniie and Oruklu discuss their system-on-chip architectural plan.

Exacting Sports Stats and Smart Skin for Aircraft with RFID Technology

WANT TO USE YOUR CELL PHONE TO PAY FOR YOUR DAILY COFFEE? IF SO, YOU ARE NOT ALONE. IN JAPAN, USERS CAN DOWNLOAD AN APPLICATION TO THEIR CELL PHONE THAT ALLOWS THE RADIO FREQUENCY IDENTIFICATION (RFID) CHIP IN THEIR PHONE TO PAY FOR PURCHASES FROM SPECIFIC MERCHANTS. ONE OF THE EARLY ADOPTERS OF THIS TECHNOLOGY IS FAST-FOOD GIANT McDONALD'S, BUT PROFESSOR KEN CHOI SEES LARGER POTENTIAL FOR IT THAN SIMPLY MAKING FAST FOOD FASTER.

An RFID chip, or tag, is what makes "smart cards" work. It is a passive chip imbedded in cell phones, access cards, or credit cards that lay dormant until they come within a few inches of an active reader with a matching code. When the reader recognizes a tag, it pulls information from the chip, which in turn either grants or denies an action. RFID tags are used in everything from "touch and go" bus passes to student IDs to deduct money from a linked account. They are also used in secured parking lots and buildings so employers can track who enters and exits.

"Basically, RFID applications are limited only by imaginations, and with the current level of progress in RFID, its market is set to rise to $28 billion in 2017," Choi says. "RFID tags with built-in sensors can open up a wide range of new applications such as temperature monitoring, care giving for the elderly, sports-event timing tracking, medical monitoring under skin, and personal activity-based prompts. A key requirement is low-power sensors as well as tag circuits that can be powered from the energy harvested from the radio wave of a reader. In my laboratory, we've been developing ultra-low power RFID system design, and working closely with industry, we have a plan to set up an RFID research center at IIT."

This tiny VLSI chip is the gateway that makes Choi's research possible. When his research is complete, wireless sensor networks will use low-power RFID reader technology to monitor everything from sports statistics to intelligent tires and smart skin for aircraft.

Choi is designing a compact system in which the reader is just as tiny as the chip but is extremely sensitive and uses very small amounts of power. Using system-on-chip technology, in which an entire computing system is shrunk down to fit on one tiny chip, Choi can integrate RFID readers into any handheld device without draining the battery. His plan is to implement a wireless sensor network that can use low-power RFID technology to monitor everything from protected animal habitats to intelligent tires and smart skin for airplanes.

Smart aircraft skin, for example, can benefit from these sensor-integrated tags by continually gathering safety readings from all over a plane's surface while in flight or on the ground. Theoretically, this system will immediately alert pilots and ground-control personnel of safety hazards. The system also has the potential to keep airlines on schedule with regular safety checks because it can constantly feed information to the operator for storage. This is just one of the many daily tasks that can be improved by low-power RFID technology, and with the help of Choi's research, consumers will be seeing more and more RFID-integrated devices in the next few years.

Smart City Streaming
Urban Crisis Management Through Wireless Networks

IN A MAJOR URBAN CRISIS SUCH AS A FIRE, TRAIN WRECK, OR STRUCTURE COLLAPSE, EMERGENCY PERSONNEL CAN LOSE VITAL TIME BECAUSE OF LAGS IN COMMUNICATION AND INFORMATION SHARING. USING SECURE, SELF-ORGANIZING COMMUNICATION NETWORKS, FIRE, RESCUE, AND POLICE PERSONNEL CAN LINK TOGETHER AND ACCESS SHARED INFORMATION IN REAL TIME, GIVING THEM THE TOOLS THEY NEED TO WORK QUICKLY.

The first responder to an emergency site is charged with surveying the damage and informing other responders of the situation as they arrive. Professor Tricha Anjali is making this task more streamlined by allowing the first person on the scene to quickly establish a secure, efficient communication network among emergency personnel with remote connections to a command control center. Other fire and police personnel can link to the network as they get close to the site, immediately access all of the information gathered so far, and communicate with the command center.

Because an emergency response needs a flexible network as a crisis evolves, the system allows them to place wireless mesh routers in locations around a site so that a wireless mesh network (WMN) can be quickly established using self-organization. In effect, as mesh routers are added around a location, the network is easily adapted to meet their needs. This gives the group an efficient and fast solution for information sharing. The deployment of broadband WMN can provide applications like real-time broadcast of critical alerts, mobile access to the control center and critical information, and real-time mobile video sharing.

Anjali's overarching goal is to help emergency management in cities in as many ways as possible. Her proposed architecture can provide capabilities for network establishment, access control, path selection, medium access control, and interoperability.

Self-organizing communication networks provide a way for onsite video, audio, and logistical data to be monitored at a central command center, linking together emergency personnel and helping them work more efficiently.

The architecture can also provide the base for a citywide surveillance system. Cameras at high-risk locations with the ability to connect to state and federal resources are mandatory in a post-9/11 world. By streaming video footage from local areas directly to a police station, Anjali's system can make it easier for police officers to monitor and respond to crimes at any location viewable by camera. Because the wireless mesh routers are easily moved and added, their stealthy presence can act as a crime deterrent, making it harder for criminals to detect and predict the location of the cameras.