Background

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System-on-a-Chip in the Pittsburgh Region

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System-on-a-Chip (SoC) technology is designed as a programmable platform that integrates most of the functions of the end product into a single chip. System-on-a-Chip essentially packages all of the necessary electronic circuits and parts for a system onto one single integrated circuit, generally known as a microchip.

System-on-a-Chip designs usually incorporate at least one processing element (microprocessor) that runs a system's embedded software, and they also can contain elements for memory, graphics processing, wireless communications and/or analog functions.

Advantages of SoC technology include the ability to pack more processing power and memory into ever smaller, faster and more portable devices. With SoC, designers also can create ever more complex electronic systems for easy transport that will require little power at no cost to reliability.

(more)

In addition, SoC radically changes how new products are designed. Engineers can reuse design content or intellectual property, thereby dramatically decreasing time-to-market cycles.

Good examples of System-on-a-Chip applications include cell phones, digital cameras and video equipment for which the sound-detecting devices alone might include an audio receiver, an analog-to-digital converter, a microprocessor, necessary memory and the input/output logic control for a user – all on a single microchip.

The Internet also is a key driver of SoC development, because as access to the Internet grows, the need for more bandwidth also increases. System-on-a-Chip technology helps to meet this challenge. With SoC technology, handheld computers with small whip antennas might someday be capable of browsing the Internet at megabit-per-second speeds from any point on the surface of the earth.

Challenges for Development

The broad-based application of SoC demands very complex design methodology. Major challenges for SoC development are linked to time, power and cost constraints.

Expert engineering talent also is a requirement. System-on-a-Chip development requires a highly skilled design team with extensive system-level knowledge, very high quality tools, the availability of embeddable memory elements, logic and processor cores and a stable manufacturing process.

The ability to verify the system in a virtual environment before committing to manufacturing also is essential, and the tools to accomplish this are not yet widely available on the market.

Meeting the Challenge – The Technology Collaborative

The Technology Collaborative is a strategic economic development initiative, created by the merger of the Pittsburgh Digital Greenhouse and the Robotics Foundry in January of 2005. The new organization’s mission is to help stimulate Pennsylvania's technology-based economy by developing collaborating industry clusters that leverage the region's world-class assets in robotics, advanced electronics and cybersecurity.

The objectives of the Collaborative are to grow the number of technology companies in the region, to increase the number of high-value jobs and to develop the talent, infrastructure, capital and partner networks necessary to support the long-term growth of the SoC and agile robotics subclusters. One example of the latter cluster’s development is that after hosting 900 roboticists for the 2006 RoboBusiness Conference, Pittsburgh also had been chosen to host the 2008 conference.

Collaborative efforts combine resources and support from local universities, private foundations, regional development organizations, federal, state and local government and industry. As of the end

of the 2008 fiscal year, the commonwealth had invested in excess of $35 million to support the Collaborative's statewide economic development efforts.

As a member-driven initiative, The Technology Collaborative delivers value-added programs that start-up and expanding businesses need, including:

- collaborative research and development and technology commercialization
- talent recruitment
- university education support
- workforce development and training
- start-up and expansion services.

Collaborative R&D and Technology Commercialization

As a predecessor to The Technology Collaborative, the Pittsburgh Digital Greenhouse historically has funded approximately $3 million annually in precursor design and embedded-system solutions that reach beyond the current generation of available products and services. This funding reaches into such areas as micro-electromechanical systems; mobile and low-power systems; wired, optical and wireless networking; human-computer interface technologies; piezoelectric elements; cybersecurity; and multimedia applications. In 2004, robotics was added to the technical areas of interest.

Through fiscal year 2008, 434 proposals totaling $91 million in funding requests have been submitted. To date, 138 technology commercialization projects have been selected for a total of $23.4 million in awards to universities and startups.

The universities included Carnegie Mellon University, the University of Pittsburgh and The Pennsylvania State University. The companies included Accipiter Systems, Blueroof Technologies, Bridge Semiconductor, Caracal, Concurrent Design Automation, Coroware Test Labs, Freedom Sciences, Intrigue Technologies, NanoLambda, RedZone Robotics, RemComm, Sensible Machines, Valley Technologies, VideoMining Corporation, Xigmix and ZedX.

In October of 2006, Carnegie Mellon University was awarded a six-year, $4.2 million grant from the Defense Advanced Research Projects Agency to create the next generation of chips that can reconfigure themselves to perform in new ways.

The grant is being used to establish the Center for Memory Intensive Self Configuring Integrated Circuits. Today it is either prohibitively expensive or technically impossible to manufacture high-performance chips using current technology unless they are produced by the millions. To overcome

these limitations, the CMU researchers plan to build an integrated circuit with mechanical probes that can physically rewire the chip's electrical connections with nanoscale-level accuracy.

This general-purpose chip could be made cheaply en masse and then be reconfigured for a countless array of end-use applications regardless of volume at little additional cost. The mechanical components of the chips would allow them to store substantial amounts of data, too.

Talent Recruitment

On the talent front, The Collaborative's talent recruitment program identifies, attracts and retains the best digital, analog/mixed-signal and mechanical engineering and management talent in the world. Services include:

- technical and university recruiting
- representing TTC member companies at job fairs
- posting and screening internet career sites
- coordinating internship and co-op programs.

The total number of digital and robotics-related jobs created since 2000 is now 2,296. Some jobs were lost due to economic downturns, reducing the net gain to 1,406. That may signify only modest growth, but at least Pittsburgh has been spared the comparatively heavy losses of thousands of jobs and hundreds of firms endured by other communities after the dot.com collapse in 2000 through 2001 as well as the recession of 2008-2009.

University Education Support

Three distinct university programs create additional educational and professional training development efforts targeting SoC. The University of Pittsburgh, Carnegie Mellon University and The Pennsylvania State University offer a graduate level SoC certificate program that helps build a critical mass of engineers to develop the SoC industry in the region. Students can elect to take courses at any of the universities to fulfill requirements for their master's degree in electrical engineering.

Students at the universities are linked through a virtual design program called the Digital Sandbox, a virtual SoC design facility that provides industrial hardware, software, workflows and technical support staff to all three member universities, thereby enabling all students to work on the same design problem. Students have access to the same technology and common sets of design tools in order to encourage cooperation and shared solutions, much like the team environment found in the industry.

To date, more than 115 students have earned a SoC certificate and several of those recent graduates were able to secure jobs in the region.

Start-up and Expansion Support

The Technology Collaborative also is committed to making it easy and financially attractive to locate new chip design and research facilities in southwestern Pennsylvania, as well as to establish new local start-up companies developing SoC and related technologies. Expansion and support services include incubation facilities, access to the regional investment community, business networking events, and business support services, such as mentoring and business plan consultation.

Regional Companies

Southwestern Pennsylvania's System-on-a-Chip companies span a range of industries that design, develop, and/or use SoC-related technologies. These companies include integrated device manufacturers, fabless semiconductor companies, integrated circuit designers, embedded system integrators and advanced electronic component companies.

The Technology Collaborative currently boasts a membership of more than 65 company members that had a net gain of 244 jobs in fiscal 2008. In addition, the Collaborative administers the Agile Robotics Alliance for the Department of Defense, which is the membership organization for the National Center for Defense Robotics (NCDR). It has more than 150 members, about one-half of which are located in Pennsylvania. The NCDR has spent more than $6 million linking DoD with firms and researchers developing robotic technologies for military applications.

Notable among TTC member companies are industry leaders, like Bombardier Transportation, Bridge Semiconductor, Caterpillar, Compunetix, John Deere, FedEx Ground, IBM, ECI Telecom (formerly Laurel Networks), NetApp, Seagate Technology and Vocollect.

ECI Telecom's data networking division also is indicative of the scope of this emerging industry subcluster. The company provides data service delivery architectures comprised of a single packet-switched network. By bringing together the best of switching and routing technology into a single device, the company enables more flexible, scalable architecture that translates to dramatic cost reductions.

Another example is Pittsburgh-based Akustica, which introduced the world's first acoustic system-on-a-chip. The microphone and speaker chips are based on patented MEMS technology that integrates the functionality of multiple microphones or speakers with microelectronics and software onto a single, standard semiconductor. The result is a new class of acoustic solutions that deliver unprecedented capabilities for capturing, processing and reproducing sound.

Other *Fortune* 1,000, growth-oriented and entrepreneurial companies with forceful R&D initiatives make up the bulk of southwestern Pennsylvania's SoC industry subcluster. With the addition of The Technology Collaborative's initiatives, prospects for growth in the region's SoC technologies continue to be high.

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