

# Conference Report

## Report on the 2022 Embedded Systems Week (ESWEEK)

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■ **EMBEDDED SYSTEMS WEEK** (ESWEEK) is the premier event covering all aspects of hardware and software design for intelligent and connected computing systems. By bringing together *three* leading conferences [the International Conference on Compilers, Architecture, and Synthesis for Embedded Systems (CASES); the International Conference on Hardware/Software Codesign and System Synthesis (CODES+ISSS); and the International Conference on Embedded Software (EMSOFT)] and a variety of symposia, hot-topic workshops, tutorials, and education classes, ESWEEK presents to the attendees a wide range of topics unveiling state-of-the-art embedded software, embedded architectures, and embedded system designs.

After two years of holding ESWEEK virtually, ESWEEK 2022 embraced a truly hybrid event. The main in-person event covering the three conferences took place between October 10 and 12 in Shanghai, China, and another in-person event covering one of the workshops took place on October 14 in Phoenix, AZ, USA. The virtual event covering all the ESWEEK program components was organized online between October 7 and 14. Besides the three conferences, ESWEEK 2022 hosted *two* symposia [the International Symposium on Formal Methods and Models for System Design (MEMOCODE) and the International Symposium on Networks-on-Chip (NOCS)], *seven* hot-topic workshops, *seven* advanced tutorials, and *ten* popular education classes. Throughout

the week, the event featured keynote and short keynote (SKY) speeches, paper sessions with live talks, and interactive poster presentations. The combined in-person and virtual event provided ample opportunities for the community across the globe to come together, interact and absorb the latest advances in embedded software, hardware, and systems.

ESWEEK 2022 included several new/recently initiated program components.

- The 20th MEMOCODE joined the ESWEEK family. MEMOCODE focuses on formal methods and models for developing computer systems and their components.
- The widely successful educational classes initiated in ESWEEK 2021 proved to be popular again; this time on “Security, Privacy, and Trust.”
- To highlight the industry perspective, ESWEEK 2022 organized two SKY talks from industry leaders.
- To further improve industry participation, ESWEEK 2022 organized a separate industry track, with its own submission and review process. More than ten articles were submitted, and ultimately four were accepted and presented.
- To attract more student participation, ESWEEK 2022 hosted ACM SIGBED Student Research Competition. It attracted more than 20 submissions!
- To attract even more students, ESWEEK 2022 organized a PhD forum for the first time. The PhD forum accepted six entries for presentation and poster.

ESWEEK 2022 set a record for the number of total submissions. A total of 393 full-length articles were submitted. As in previous years, ESWEEK 2022

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implemented a journal-integrated publication model for the three conferences (CASES, CODES+ISSS, and EMSOFT), where all journal-track articles are published in IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS (TCAD). To this end, the three conferences conducted the review in a journal-style two-stage peer-review process with the opportunity of minor/major revision before the final decision. Acceptance rates for the conferences were about 22%—the lowest ever. In addition, the ESWEEK Proceedings contain two invited articles and 25 accepted work-in-progress (WiP) articles. In addition, ESWEEK 2022 set new records for the total number of poster presentations (121), and the total number of oral presentations (123).

The main conference program from Monday to Wednesday was scheduled in three different time segments on each day: 8:30 A.M.–12 P.M., 2 P.M.–5:30 P.M., and 10 P.M.–1 A.M., Shanghai time. This segmented schedule ensured that regardless of where an attendee was located, s/he would be able to attend some of the sessions at her/him prime time in the day. The program started with an opening session on Monday and ended with an award and closing session on Wednesday. The program on each day comprised a 1-hour keynote or panel, 60–120 min of technical sessions held in parallel tracks for the three conferences, and a final networking session to allow further networking among the attendees. A virtual yoga session led by an instructor was also included in the networking session time slot. The virtual components were hosted in Gather.town, and the virtual presentations were delivered over Zoom.

The main conference days were preceded by five tutorials on Friday, and two tutorials on Monday. Tutorials aim to provide opportunities to get in-depth knowledge of new trends and hot topics. The seven tutorials with speakers from both academia and industry covered a wide range of topics from quantum controlling software and computing based on superconducting qubits, manycore processing-in-memory systems for accelerating deep-learning applications, to design and optimization for embedded machine learning, taming delays in cyber–physical systems, and hardware security and trust verification. Furthermore, an education track containing ten classes was held on Saturday and Sunday. These education classes invited top researchers in the world to teach 2-hour topical

lectures on emerging/newer, but well-established embedded system concepts, tools, and methods that are not readily available in textbooks in an exciting, engaging, and hands-on way to students across the globe, especially the ones that do not have access to high-quality educational content. The theme for ESWEEK 2022 Education is security, privacy, and trust. The tutorials and education classes were all delivered live virtually.

Thursday and Friday after the main conference hosted virtually the two symposia (MEMOCODE and NOCS) as well as two workshops [rapid system prototyping (RSP) and compilers, deployment, and tooling for Edge AI (CODAI)]. Three in-person workshops were held in Shanghai covering a wide range of exciting topics in embedded systems including memory and storage computing (MSC), heterogeneous edge computing for embedded systems (HEC), and edge intelligent computing (EIC). In the Phoenix location, the International Workshop on Secure RISC-V (SECRISC-V) Architecture Design Exploration took place in person on Thursday.

Highlights of the ESWEEK program included three distinguished keynote talks, two SKY talks, and one panel by prominent leaders in academia, industry, and research funding agencies, covering exciting trends in future embedded and cyber–physical systems and providing deep insights into technology and application drivers.

On Monday, Prof. Jie Li from Shanghai Jiao Tong University presented his keynote talk on “Blockchain, Big Data, and AI Empower High-Quality Development of Industrial Internet.” In his keynote, Prof. Li highlighted the importance of using trusted big data collected from smart sensors and actuators to enhance manufacturing and industrial processes with the power of AI and real-time analytics. He further addressed the deployment and challenges in applications of big data, AI, and blockchain for the Industrial Internet.

On Tuesday, the keynote talk, titled “Training the World’s Best Gran Turismo Racer,” was given by Dr. Pete Wurman, the director of Sony AI America and project lead for the Gran Turismo Sophy project. Automobile racing represents an extreme example of real-time decision-making in complex physical environments. In his keynote, Dr. Wurman described how his team at Sony AI trained agents for Gran Turismo, a modern racing simulator, that can compete with the world’s best e-sports drivers

by combining state-of-the-art model-free deep reinforcement learning algorithms with mixed scenario training to learn an integrated control policy that combines exceptional speed with impressive tactics. He engaged the audience by his story of winning a head-to-head competition against four of the world's best Gran Turismo drivers. Dr. Yu Huang, EDA Chief Architect of HiSilicon, delivered his SKY talk titled "AI for EDA," in which he discussed a few examples that apply AI to electronic design automation (EDA) to demonstrate how AI technologies can help improve the traditional EDA technology and transferring the IC design experiences from old designs to new designs or from old technologies to the new ones.

Finally, on Wednesday, Prof. Margaret Martonosi, the head of the U.S. National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE), presented her keynote talk titled "The Computing and Information Science and Engineering Landscape: A Look Forward." In her talk, Prof. Martonosi elaborated on how CISE is developing programmatic opportunities to advance research related to the key technical themes in the field. She particularly noted how ESWEEK topic areas relate to these technical priorities. The final SKY talk was given by Tomas Evensen, Chief Technology Officer, Open Source at AMD/Xilinx. Evensen noted in his talk that most traditional embedded software stacks are optimized for a single operating environment running on one or more CPUs and need to be extended to handle the new complexity. This talk introduced the Xilinx SoCs and the various open-source projects that handle both the runtimes (communication, management, separation, etc.) and tooling (compilation, configuration, debugging, etc.) for these execution units.

ESWEEK 2022 also featured a high-profile panel titled "Waferscale Computing Systems: Are We There Yet?" The panel was organized by Prof. Puneet Gupta (UCLA) and Dr. Saptadeep Pal (Auradine Inc.), and the panelists included prominent researchers from academia and industry. The panelists held a lively discussion on the "Promised Land" of waferscale computing regarding its current state, future promises, key challenges/roadblocks, and killer applications. Two special sessions were organized on Monday and Tuesday. The Monday special session, titled "Brain-Inspired Hyperdimensional Computing for Ultra-Efficient Edge AI," featured four

invited talks covering the design and application of energy-efficient, secure, hyperdimensional computing architectures and platforms. The Tuesday special session, titled "Programming Autonomous Machines," included five invited talks discussing the programming theory and practices tied to producing real-life autonomous machines.

As the premier event in embedded and cyber-physical systems, ESWEEK 2022 hosted several prestigious award ceremonies. On Tuesday, the "Test of Time" awards were presented to the recipients by each of the three conferences. On Wednesday, the best paper awards for the three conferences and other awards were presented. During the networking sessions on each day, the attendees had the opportunity to interact with each other and the conference organizers as well as the test of time or best paper award winners.

ESWEEK 2022, with its unique hybrid format, presented several new challenges, especially in terms of how to "synchronize" in-person and virtual events and how to maximize accessibility. Overall, the event was a great success. The event recorded 618 registrations, with more than 75% of them being nonmandatory registrations—as in they were not the organizers of any event in ESWEEK. ESWEEK 2022 continued its tradition of providing need-based registration fee waivers to attendees across the globe.

Both the in-person and virtual sessions were generally well attended. The technical paper sessions and tutorials had 20–30 people in each one of them, with up to four sessions in parallel. A big highlight is the virtual poster sessions, with an attendance of about 70 per session. Many individual and small group discussions took place in the poster sessions hosted on Gather.town. On average, the videos and live streams of each technical paper session had 20 views from a very conservative estimate. Post-conference survey feedback from conference attendees included positive comments specifically about the opportunity for live interactions with authors and attendees.

ESWEEK 2022 hosted the annual ACM Special Interest Group on Embedded Systems (SIGBED) Student Research Competition (SRC), the main student research competition in the real-time, embedded, and cyber-physical systems community. Champions of the undergraduate and graduate categories will represent SIGBED and compete against other SIGs in the ACM Grand Finals. All

grand finalists together with their supervisors will be invited to the Annual ACM Awards Banquet, where the Turing award is given.

The ACM SIGBED, ACM Special Interest Group on Design Automation (SIGDA), and IEEE Council on Electronic Design Automation (CEDA) Programs provided generous support toward student participation at the event.

**THE NEXT EDITION** of ESWEEK will take place in Hamburg, Germany, on 17–22 September. Visit <http://www.esweek.org/> for more details. ■

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