EWSN 2024 Sustainability Competition

(co-located with the EWSN conference – Abu Dhabi, UAE – December 10-13, 2024)
https://ewsn24.tii.ae/competition.html

Call for Competitors

The 21st International Conference on Embedded Wireless Systems and Networks (EWSN) will host a sustainability competition that aims to quantitatively benchmark the performance of intermittently-powered embedded systems against the same baseline. The competition will take place remotely between June and October 2024. The winners will be announced and awarded at EWSN in Abu Dhabi in December 2024.

Competition entries from both academia and industry are encouraged. Contestants will be tasked to develop a solution that maximizes the number of tasks executed while a battery-free system based on the MSP430FR5994 device is powered by an intermittent source of energy.

The competition will use the E-Cube testbed facility hosted at TU Graz (https://iti-ecube.tugraz.at/overview), which will be available from April 15 until May 31 for testing and for getting acquainted with its functionality.

Why are we holding this competition?

Research on battery-free systems has been around for more than a decade, with plenty of results available on software frameworks, hardware platforms, and applications [please refer to "*The Internet of Batteryless Things*" (CACM, March 2024, https://dl.acm.org/doi/10.1145/3624718) for a recent overview of battery-free technologies]. However, so far, there has been no large-scale evaluation of battery-free systems in a common sensing ecosystem. Therefore, **together with you**, we want to evaluate different approaches to designing efficient intermittently-powered sensing systems against the same baseline. EWSN 2024 will be the first place where such an evaluation will take place!

Why should you participate?

- **Develop** a more practical application-oriented approach to building sensing systems.
- **Push** the performance of your intermittently-powered solutions to their limits!
- Street-creds of being **boss at intermittent computing**!
- **Money**! The three top teams will receive generous cash awards sponsored by the Technology Innovation Institute (https://www.tii.ae):
    - *First place*: 6.000 EUR
    - *Second place*: 3.000 EUR
    - *Third place*: 1.500 EUR

  The above prizes are awarded per team. Teams are free to use the award funds as they please.

Competition format

In order to compete, contestants must submit a one-page abstract listing all team members as well as their affiliations, and describing briefly the tentative approach/solution that will be followed to tackle the challenge. Selected teams will be invited to participate in the competition, and at least one member of each participating team must register and attend the event in person in Abu Dhabi (December 10–13, 2024). The competition encompasses the following stages, accompanied by a testing phase, as detailed next.

- **April 15 – May 31, 2024 (Informal testing phase).** The E-Cube testbed facility on which the contestants' code will be run and evaluated is going to be available for testing to everyone interested in participating in the event. The testbed is hosted by TU Graz and can be accessed at https://iti-ecube.tugraz.at/overview, where also detailed tutorials about its use as well as the structure of the expected firmware will be available and updated continuously. We strongly recommend prospective participants to get familiar with the testbed facility early on and to get in touch with us!

- **June 1, 2024 (Competition entry deadline).** After the informal testing phase, the teams that plan to participate in the event are expected to send a one-page abstract (listing all team members as well as their affiliations and describing briefly the tentative approach/solution that will be followed to tackle the challenge) via e-mail to all competition organizers listed below. Please use as subject: "*EWSN 2024 Sustainability Competition: Submission*".

- **June 8, 2024 (Notification of accepted teams).** Selected teams will be notified and invited to participate in the competition. At least one member of each participating team is expected to register and attend the event in person in Abu Dhabi. Travel and lodging expenses are the responsibility of each team, but please note that *several grants for female researchers and students will be available* to cover their accommodation and/or conference registration costs (see for more information https://ewsn24.tii.ae/grants.html).

- **June 15 – October 15, 2024 (Remote competition).** During this phase, each team will develop and run its solutions on the E-Cube testbed facility, which will be accessible to all participating team members throughout the competition. Please note that each team will be assigned a unique ID (e.g., 'Team-04') in E-Cube to ensure the anonymity of results, as the performance of the various teams will be visible on a public leaderboard (knowledge of each other's performance is one of the salient aspects of the competition). Participants and their affiliations will be published on the competition webpage, but the mapping to team IDs will not be disclosed: only the identity of the top-performing teams will be revealed at the EWSN 2024 conference. Hence, we expect that contestants will abstain from publicly announcing their team ID via social media or other means.

- **October 15, 2024 (Submission of final firmware and competition abstract).** All teams must submit their final firmware (only a *.hex* file is needed, no source code needs to be delivered) for evaluation, together with a two-page abstract summarizing their contribution to the competition. The competition abstracts will follow the same requirements as poster and demo abstracts and should be submitted via HotCRP together with the final firmware (a link will be provided at a later stage). Accepted competition abstracts will be part of the EWSN conference proceedings and appear in the ACM digital library unless teams explicitly mark their submission as confidential.

- **October 16 – December 9, 2024 (Evaluation of the final firmware).** During this phase, all submitted firmware will be run on E-Cube by the competition organizers, using the same set of energy-availability traces that were provided throughout the *remote competition phase*, as well as new traces which were previously not available. Each team will score points based on the number of challenges solved via a proof-of-work algorithm (see *Competition objectives evaluation procedure*).

- **December 10–13, 2024 (EWSN 2024 Conference in Abu Dhabi)**. During the EWSN 2024 conference, all competing teams must present their solution at a dedicated poster session, during which they will have the possibility to engage in lively discussions with the other conference attendees. The winners of the competition will be announced and awarded during a plenary session and will be expected to present their solution as a "lightning talk." Details about the lightning talks and poster formats will be provided at a later stage.

Competition objectives and evaluation procedure

The winning team will be the one maximizing the number of challenges solved over a predefined time window, during which the competition organizers will emulate varying degrees of available energy. To solve a challenge, contestants have to utilize hashcash, a SHA1-based proof-of-work algorithm for which a reference implementation is provided by the organizers.

Example. Using a challenge 'EWSN2024' and a difficulty of 16-bit, we first create a starting string with a well-known format, e.g., '1:16:240403:EWSN2024::WXhnFeDleN:1'. The segments of the string separated by a colon are: version (always 1), bits (16 as per difficulty), date (6 digits, fixed for the competition), resource (the

challenge word given), extension (empty), random (a user-chosen random string), and a counter. We now need to check if this string's SHA1 hash has 16 (as per the chosen difficulty) leading zeros (most significant bits). Our string (with the counter of 1) has a SHA1 hash of '`20db26cb6b1e17a2079fc3daf05fd01a7ed08cb5`', which only has two leading zeros. Thus, we increment the counter to 2 and hash the updated string and keep incrementing the counter until we find a string that has a hash with the required leading zeros. In this example, after 96620 attempts, the string with counter 96620 '`1:16:240403:EWSN2024::WXhnFeDleN:96620`' has a hash of `0000babe195c81d00ecec4cd8f0dc1572ebd46d4` with 16 leading zeros (0x0000) as required. The string '`1:16:240403:EWSN2024::WXhnFeDleN:96620`' is hence the solution to the challenge.

At the start of an experiment, an external I2C FRAM memory will contain a list of challenges similar to the above example, to which contestants need to supply a solution despite the intermittent energy supply. At the end of an experiment, the computed solutions are automatically collected by E-Cube, the number of correct solutions is tallied against any incorrect solutions, and points awarded accordingly. Additional technical details, a reference solution, and the exact evaluation procedure will be posted on the competition's website.

Eligibility

Both academia and industry submissions are encouraged. Please note that there is no limit to the number of participating teams from a single organization and the number of members in each team. Teams can be diverse in terms of age, experience, gender, and academic/industrial background. There is also no requirement on the originality of the competing solutions: the demonstration of good use of well-known or previously-published intermittent-computing/battery-free solutions is strongly encouraged. No source code needs to be submitted as part of this competition (the submission of a *.hex* file is sufficient), but we encourage contestants to do so, if possible, in the spirit of open and collaborative research. There is also no restriction on the operating system, or codebase used to program the devices.

Disclaimer

The EWSN 2024 sustainability competition will take place if at least six teams respond to this preliminary call.

Important dates

- Informal testing phase: April 15 – May 31, 2024
- Competition entry deadline: June 1, 2024 (11:59 PM AoE)
- Notification of accepted teams: June 8, 2024
- Remote competition: June 15 – October 15, 2024
- Submission of final firmware and competition abstract: October 15, 2024 (11:59 PM AoE)
- EWSN 2024 conference: December 10–13, 2024
  - Poster presentations from each competing team: December 11, 2024
  - Plenary session with award ceremony and lightning talks: December 12, 2024

Competition organizers

- Nivedita Arora (nivedita@northwestern.edu), Northwestern University, USA
- Przemysław Pawełczak (p.pawelczak@tudelft.nl), TU Delft, The Netherlands
- Markus Schuß (markus.schuss@tugraz.at), TU Graz, Austria

Questions?

For any inquiries regarding the EWSN 2024 sustainability competition, please contact all three organizers via email. For technical questions about the use of the E-Cube testbed facility, please contact Markus Schuß.