Sangeeta Kakati

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August 28, 2025

Recruitment Committee
Human-Environment-Technology (HET) Systems Centre
Mykolas Romeris University
Vilnius, Lithuania

Dear Members of the Recruitment Committee,

I am writing with great enthusiasm to apply for the **Senior Researcher in Internet of Things and Automation (Position 2)** at the Human-Environment-Technology (HET) Systems Centre, which I discovered on the MRU employment website. As a final-year PhD researcher at the University of Luxembourg, my work focuses on the core challenges of the edge-cloud continuum, containerization, and IoT systems, making this role a perfect alignment with my expertise and research ambitions.

Why the HET Systems Centre and This Role?

The HET Centre's mission to tackle complex, interdisciplinary problems at the nexus of human, environmental, and technological systems deeply resonates with my research philosophy. My doctoral work, conducted in collaboration with the industrial partner Proximus, has not been purely technical; it has involved designing systems that account for real-world constraints, dynamic infrastructure, and practical deployment challenges which is a key consideration for any IoT and automation solution aimed at societal impact. The Centre's focus on areas like critical infrastructure and digital transformation represents the exact kind of meaningful, applied research environment where I am eager to contribute.

Alignment with Position 2: IoT and Automation

My research provides a strong foundation for this position: * **IoT Systems Development:** I have hands-on experience in full-stack IoT projects, from sensor integration (e.g., IR, LDR) and cloud communication (e.g., Thinkspeak) to developing end-user Android applications for monitoring and control. * **Fog/Edge Automation:** My work on "Mobility-aware Task Offloading in Fog-Assisted Networks" directly addresses automation in distributed systems. I developed algorithms for optimal, reproducible offloading and service migration, minimizing latency and resource usage in dynamic environments akin to smart transportation or energy grids. * **Cross-Platform Deployment:** A significant part of my PhD involves creating execution models for heterogeneous hardware (x86, ARM64, RISC-V). I have practical experience

enabling seamless automation across the edge-cloud continuum using technologies like Docker, WebAssembly, and k3s, which is crucial for scalable IoT solutions.

I am confident that I can immediately contribute to the Centre's existing projects while also helping to develop new research lines in IoT and automation for smart infrastructure, environmental monitoring, or sustainable mobility.

What I Bring to the HET Centre

Beyond my technical skills, I am a proactive researcher with a proven record of publications in high-impact conferences (CCGrid, GLOBECOM, etc.) and a winner of a Best Paper Award. I am keen to collaborate on interdisciplinary grant proposals to attract external funding. Furthermore, my experience as a Teaching Assistant has equipped me with the skills to effectively supervise student projects and contribute to the Centre's educational goals in digital transformation.

I am excited by the prospect of joining a young, dynamic, and international team at the HET Systems Centre and am confident that my background in IoT, distributed systems, and applied computer science will allow me to contribute significantly to your research objectives.

Sincerely,

Sangeeta Kakati
PhD Researcher, University of Luxembourg

Sangeeta Kakati

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Education

University of Luxembourg, Proximus — Luxembourg
Doctoral Researcher (PhD) Computer Science and Computer Engineering — *Oct'2022-Dec'2025*
- Interdisciplinary Centre for Security, Reliability and Trust (SnT)

Indian Institute of Information Technology — Guwahati, India
Master of Technology in Computer Science — *July'2020-July'2022*
- CGPA: 8.78

Central Institute of Technology — Kokrajhar, India
Bachelor of Technology in Information Technology — *July'2016-June'2020*
- CGPA: 9.12

Kendriya Vidyalaya — Assam, India
AISSCE (Class 12) — *2014-2016*
- Percentage: 84.6

Kendriya Vidyalaya — Assam, India
AISSE (Class 10) — *2014*
- CGPA: 10

Experience

Project ACE5G, Luxembourg FNR
Industrial Partner: Proximus
- Execution model for heterogeneous hardware capabilities available at a higher abstraction level, common for all architectures
- Demonstrate seamless provisioning of cloud resources for applications with constraints and GPU acceleration
- Dealing with changing hardware infrastructure and how to deploy dynamically.
- Technologies allowing software containers to be executed on dynamic nodes without being modified
- Relieve developers of distributed applications from the need to match their software artifacts to the current platform(s), their compute infra-structure supports and from the need to deploy their software to specific nodes (e.g. certain edge nodes)
- Tools Used: Containerd, k3s, runwasi, WebAssembly, Multi-arch containers

Teaching Assistant
Multiple
- Data Structures and Algorithm, Databases, Computer Systems
- Computer Architecture, Operating Systems, Frontend Web development, Hands-on IoT
- Languages Courses: Python, C++

Research Intern
Indian Institute of Technology Guwahati (IITG)
- Security in IoT in terms of: Authentication, Authorization, and Access Control

Software Intern
Indian Oil Corporation Limited
- Application for fetching semester results of an institute

Collaborative Projects

Cross-architecture support for edge-cloud continuum Oct 2022 – Oct 2025

- Implement best software development practices by developing support for heterogeneous hardware architectures in multi-platform containerization.
- Enhance support for WebAssembly in cloud servers(AWS bare metals) and embedded devices
- A reproducible experimental platform for the use of alternative runtimes in Docker
- A general GPU interface with handlers
- Implementation: Wasm, Rust, C++, Docker, Containerd, AWS
- Hardwares: Nvidia Jetson Nano (AARCH64), Starfive VisionFive2(RISCV64)

Mobility aware task-offloading in fog assisted networks July 2021 – July 2022

- Reproducible optimal offloading mechanism for mobile end-users in distributed systems
- Performing migration in services with long term analysis(vehicular services)
- Minimize the case of migration while performing offloading until it is an essential requisite
- Implementation: MobFogSim,iFogSim
- Overall Domain: IoT, Cloud, Fog, Edge

IoT based automated outdoor lighting system | *IoT, Android, Sensors* June 2019 – June 2020

- Enhance the maintenance of current outdoor lighting systems
- Used Thinkspeak as the cloud server to send sensor's data
- Integrated IR, LDR, current sensors to detect the presence of an obstacle
- Detection of faulty lights and real-time display in an Android application

Technical Skills

Subjects: Data Structures, Databases, Networks, Architecture, OS
Languages: C/C++, Rust, Python, Go
Frameworks: Containerd, Docker, AWS, WebAssembly, k3s, Tensorflow, iFogSim, Netsim, Spin
Areas of Interest: Cloud Platforms, Fog/Edge Computing, Containerization, Runtimes, IoT Security
Skills: Programming, Cross-Architecture, Operating Systems, Software Development

References

Dr. Nurzaman Ahmed
Engineering Research Scientist
Donald Danforth Plant Science Center, USA
Email: nahmed@danforthcenter.org

Dr. Braulio Blanco
Information Systems Architect and Data Scientist
Yoba SA, Luxembourg
Email: braulio.blanco@scriptrating.com

Research Experience, Interests, and Intended Contribution

Position 2: Internet of Things and Automation — HET Systems Centre, MRU

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Research Vision

My research advances **reliable, portable, and secure IoT systems** spanning the edge–cloud continuum. I focus on (i) **heterogeneous deployment** across CPUs/GPUs and multiple ISAs, (ii) **lightweight runtimes** (e.g., WebAssembly) for safe, near-native execution at the edge, and (iii) **automation** for orchestration, observability, and resilience in dynamic, resource-constrained environments. At the HET Systems Centre, I will develop *automation-by-design* methods to make IoT stacks easier to deploy, verify, and adapt in real-world settings such as energy, mobility, and agriculture.

Track Record and Experience

- **Edge/Cloud portability**
  University of Luxembourg (SnT), ACE5G (FNR) with Proximus. I designed cross-architecture containerization workflows and evaluated **WebAssembly (Wasm)** and **multi-arch containers** on x86_64 and ARM64 (NVIDIA Jetson) targets. I investigated GPU acceleration, task throughput, and memory footprint, and built reproducible pipelines with `containerd`, `k3s`, and `runwasi`.
- **Automation and orchestration**
  Built end-to-end CI-driven experiments for cold/cached startup, image pull time, and execution latency, enabling **policy-based scheduling** (e.g., energy-, latency-, or trust-aware placement) across heterogeneous nodes.
- **IoT offloading and mobility**
  Proposed **mobility-aware task offloading** strategies in fog/edge systems (vehicular scenarios), reducing unnecessary service migrations while meeting latency budgets.
- **Applied IoT prototyping**
  Delivered an **IoT lighting system** integrating sensors, cloud backends, and Android monitoring with real-time fault detection.

Intended Work at HET: Position 2 (IoT & Automation)

I propose a **three-year research line** (initial one-year plan below) to build an *Automation Fabric for Heterogeneous IoT (AutoHetIoT)*, a set of methods and open tooling to simplify secure deployment, runtime adaptation, and trustworthy operation of IoT applications across edge and cloud.

Year 1 Objectives (1-year fixed term)

1. **Portable Edge Runtime Toolkit:** Hardened Wasm-based edge runtime profiles for ARM64 and RISC-V with *capability-oriented sandboxes*, deterministic resource quotas, and **zero-downtime** hot-swapping.
2. **Automation Policies & Scheduling:** Constraint-aware placement (latency, energy, carbon intensity, data locality) for `containerd`/`k3s`, with **explainable decisions** and fallbacks for degraded networks.

3. **Resilience & Observability:** Lightweight **SLO guards** (latency/throughput/ML inference accuracy) and **self-healing** actions (restart, migrate, scale-to-zero) driven by online telemetry.
4. **Security-by-Design:** Supply-chain attestations (SBOMs), signed artifacts, and per-node trust policies to **automate** secure upgrades and rollbacks.

Methodology

- **Experiment Platforms:** AWS bare metal and on-prem ARM64 clusters (e.g., NVIDIA Jetson), with synthetic (TPC-like) and domain traces (mobility/energy).
- **Runtimes:** `containerd`, `k3s`, `runwasi`/Wasm, and GPU offloading where appropriate.
- **Metrics:** Startup/latency SLOs, energy per task, memory footprint, service availability, upgrade MTTR/MTBF.
- **Reproducibility:** Open repositories, containerized pipelines, and **artifact evaluation** scripts.

Use-Case Pilots (co-designed with HET partners)

- **Smart Mobility:** On-vehicle and roadside edge nodes running Wasm microservices for perception pre-processing and incident detection, with live migration under handovers.
- **Energy Microgrids:** Forecasting/control loops at the edge with constraint-aware placement to reduce peak loads; verifiable firmware-style updates via Wasm.
- **Digital Agriculture:** Sensor fusion and anomaly detection with intermittent connectivity; local-first analytics and privacy-preserving aggregation.

Contribution to the HET Centre

- **Interdisciplinarity:** Co-develop datasets and pilots with colleagues in CPS security, data science, and digital twins; provide the *automation layer* consumed by these workstreams.
- **Funding & Networks:** Contribute to Horizon Europe / COST / EIC proposals (IoT, Edge AI, trustworthy computing); leverage ongoing industry links (telecom, mobility, energy).
- **Education:** Develop a *Portable IoT Systems* module and supervise student projects aligned with Centre pilots; promote **open, reproducible** practices.

12–18 Month Milestones

- Open-source **AutoHetIoT** toolkit (runtime profiles + policy engine + SLO guards).
- Two pilot demonstrators (mobility, energy) with quantified SLO/energy improvements.
- Co-authored funding proposals and joint publications with HET collaborators.

Summary of Teaching Experience and Interests

Teaching Philosophy

My teaching philosophy centers on creating an inclusive, hands-on learning environment that bridges theoretical concepts with practical implementation. I believe in empowering students to become independent problem-solvers by providing them with the foundational knowledge and critical thinking skills needed to tackle real-world challenges in computer science and engineering.

Teaching Experience

- **University of Luxembourg** (2022–Present)
  - *Data Structures and Algorithms*: Conducted laboratory sessions and tutorials focusing on implementation and complexity analysis
  - *Computer Systems and Architecture*: Assisted in hands-on sessions covering processor architecture, memory hierarchy, and performance optimization
  - *Operating Systems*: Guided students through process management, synchronization, and file system implementation projects
- **Indian Institute of Information Technology Guwahati** (2020–2022)
  - *Database Management Systems*: Supervised laboratory sessions on SQL query optimization, transaction processing, and database design
  - *Python Programming*: Conducted beginner to advanced programming workshops with focus on data structures and algorithm implementation
  - *Frontend Web Development*: Guided students through HTML, CSS, JavaScript, and modern framework fundamentals
  - *Hands-on IoT*: Supervised practical sessions on sensor integration, data acquisition, and IoT system prototyping

Teaching Interests

My teaching interests align closely with my research expertise and include:

- Edge/Cloud Computing Systems and Distributed Architectures
- Containerization Technologies and Runtime Environments
- Internet of Things (IoT) and Fog/Edge Computing
- WebAssembly and Portable Code Execution
- Performance Analysis and Optimization
- Operating Systems and Computer Architecture
- Programming Languages (Rust, C/C++, Python, Go)

Student Mentoring

- Supervised 4 undergraduate students in their final year projects on IoT security and edge computing
- Provided research guidance to junior PhD students on experimental methodology and reproducibility

Teaching Development

Incorporating active learning techniques and project-based assessments and creating inclusive and intuitive learning materials that accommodate diverse learning styles for different levels of students.

Complete Publication List

Journal Articles

1. **Kakati, S.** & Brorsson, M. (Under Review). Accelerating the Edge: Wasm Containers and the Future of Portable Compute. *Springer Nature Computer Science Journal*.

Conference Proceedings

1. **Kakati, S.** & Brorsson, M. (2025, April). Performance and Usability Implications of Multiplatform and WebAssembly Containers. In *Proceedings of the 15th International Conference on Cloud Computing and Services Science* (pp. 15-25). DOI: 10.5220/0013203200003950. (**Best Paper Award**)
2. **Kakati, S.** & Brorsson, M. (2024, May). A Cross-Architecture Evaluation of WebAssembly in the Cloud-Edge Continuum. In *2024 IEEE 24th International Symposium on Cluster, Cloud and Internet Computing (CCGrid)* (pp. 337-346). IEEE.
3. **Kakati, S.** & Brorsson, M. (2024, September). An Investigative Study of WebAssembly Performance in Cloud-to-Edge. In *2024 International Symposium on Parallel Computing and Distributed Systems (PCDS)* (pp. 1-5). IEEE.
4. **Kakati, S.** & Brorsson, M. (2023, June). WebAssembly Beyond the Web: A Review for the Edge-Cloud Continuum. In *2023 3rd International Conference on Intelligent Technologies (CONIT)* (pp. 1-8). IEEE.
5. **Kakati, S.**, Alam, M., Matam, R., Barbhuiya, F. A., & Mukherjee, M. (2022, December). Mobility-aware Task Offloading in Fog-Assisted Networks. In *GLOBECOM 2022-2022 IEEE Global Communications Conference* (pp. 2897-2902). IEEE.
6. **Kakati, S.**, Ray, K., & Deka, R. (2022, June). Cloud and Fog Computing based Industrial IoT Production Management. In *2022 2nd International Conference on Intelligent Technologies (CONIT)* (pp. 1-5). IEEE.
7. **Kakati, S.** & Deka, R. (2022, June). Computational and Adaptive Offloading in Edge/Fog based IoT environments. In *2022 2nd International Conference on Intelligent Technologies (CONIT)* (pp. 1-6). IEEE.

Book Chapters

1. **Kakati, S.**, Chouhan, D., Nag, A., & Panja, S. (2022). Survey on Recent Malware Detection Techniques for IoT. In *Pattern Recognition and Data Analysis with Applications* (pp. 647-659). Springer, Singapore.
2. **Kakati, S.**, Mazumdar, N., & Nag, A. (2022). Green Cloud Computing for IoT Based Smart Applications. In *Green Mobile Cloud Computing* (pp. 201-212). Springer, Cham.