

Samuel M. Karumba

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SUMMARY

I am a research engineer and data scientist with deep experience designing and deploying AI systems that connect data, automation, and real-world decision-making. My background spans work with IBM Research, CSIRO, and the University of New South Wales, where I led projects turning research into scalable, production-ready platforms. I have built privacy-preserving machine learning pipelines, cloud-integrated analytics systems, and intelligent agents for cybersecurity and energy management. I enjoy leading teams that experiment, prototype, and deliver, and I'm now focused on building the next generation of agentic and generative AI systems that make data-driven products more adaptive, secure, and useful at scale.

EDUCATION

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| May 2019 – Feb 2024 | PhD Computer Science & Engineering at University of New South Wales (UNSW) , Sydney, Australia UNSW Scientia Scholarship recipient (highly competitive award for top-tier doctoral students) <i>Supervisors:</i> Prof. Salil S. Kanhere (UNSW), Prof. Raja Jurdak (QUT), Dr. Subbu Sethuvenkatraman (CSIRO) <i>Thesis:</i> “ <i>Blockchain-based Decentralized Energy Systems: Advancing Scalability, Security, Privacy, and Interoperability.</i> ” Research focus: Distributed systems architectures and ubiquitous computing frameworks with specialized applications in distributed energy resource management and smart grid technologies |
| Sep 2013 – Jul 2017 | MSc Mobile Telecommunication Innovation & Development (Safaricom Academy) at Strathmore University , Nairobi, Kenya Joint industry-academia program by Safaricom PLC and Strathmore University focused on mobile systems innovation, telecommunications architecture, and applied R&D. Safaricom Academy Scholarship recipient (industry-backed full scholarship) <i>Supervisor:</i> Dr. Vitalis Gavole Ozianyi <i>Dissertation:</i> “ <i>Smart education: an event framework for cognitive blended learning.</i> ” Research focus: Mobile telecommunications systems, software innovation, and cognitive learning frameworks GPA: 3.56/4.00 |
| Sep 2009 – Dec 2012 | BSc Computer Science at Moi University , Eldoret, Kenya Second Class Honours — Upper Division Capstone Project: Developed a number plate recognition system for city council and parking lot management using artificial intelligence and computer vision techniques. |

WORK EXPERIENCE

- Research & Innovation Consultant, Secure Decentralized Systems** Jan 2025 – Present
- Leading design of data-centric AI systems that integrate machine learning, blockchain, and fintech infrastructure for startups across Africa.
 - Architecting cross-border payment frameworks that combine Layer-2 protocols, API gateways, and AML/KYC compliance modules, enhancing transaction throughput by up to 40%.
 - Developing data analytics and control frameworks for virtual power plant operations, integrating telemetry from small-scale energy assets using Python, SQL, PowerBI, Databricks, and Snowflake.
 - Building CI/CD and DevOps pipelines for intelligent financial platforms, automating model deployment, cryptographic verification, and continuous integration workflows.
 - Conducting technical due diligence and scalability audits for early-stage AI and fintech investments, assessing distributed ledger performance, data governance, and regulatory risk.
- Postdoctoral Research Engineer, CSIRO Data61, Sydney** Dec 2023 – Dec 2024
- Led engineering of cybersecurity and anomaly-detection models within *CAESER* (*Cybersecurity of Consumer Energy Resources*), producing a modular AI-driven threat intelligence framework later adopted by Australian utilities and vendors.
 - Designed and deployed a vulnerability-assessment API using Python and TensorFlow to assess risks across distributed energy systems, enabling automated compliance verification for over 50 industrial partners.
 - Authored **Systematic Study of Cybersecurity Threats for Smart Inverters** ([ACM e-Energy](#))—translating AI-based research insights into operational standards and regulatory recommendations.
- PhD Researcher, UNSW & CSIRO Energy Business Unit** May 2019 – Jul 2023
- Designed and implemented four blockchain and AI frameworks—**HARB**, **PlexiChain**, **CypherChain**, and **BAILIF**—focused on scalability, privacy, and data interoperability for distributed energy systems.
 - Delivered AI-enhanced R&D outputs integrated into CSIRO’s *Data Clearing House* platform (200+ smart buildings, 5 MW flexible capacity), enabling privacy-preserving energy data sharing and real-time analytics.
 - Published high-impact results in *IEEE IoT-J*, *IEEE ICBC*, and *ACM e-Energy*, demonstrating the translation of applied machine learning and blockchain research into production-scale deployments.
- Research Software Engineer, IBM Research Africa, Nairobi** Sep 2014 – May 2019
- Co-architected **TradeLens**, a global blockchain and data-sharing platform used by 100,000+ participants across 600 ports, improving data synchronization latency by 25%.
 - Developed AI-powered optimization tools for agricultural logistics and energy operations, increasing field efficiency by 20% and earning [US Patent 11,497,156 B2](#).
 - Led development of national-scale educational data systems across 100+ schools, improving data accuracy by 40% and integrating analytics dashboards for policy evaluation.
 - Filed three U.S. patents spanning distributed systems ([US 9,961,139 B2](#)), medtech ([US 2018/0189449 A1](#)), and agricultural analytics ([US 11,497,156 B2](#)), demonstrating consistent research-to-product translation.

PROJECTS

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|---|----------------------------------|
| CAESER — Cybersecurity of Consumer Energy Resources | ACM e-Energy '24 |
| Led design and validation of scalable cybersecurity frameworks for smart-grid infrastructure under CAESER (CSIRO, UNSW, ECU). Engineered a risk-assessment pipeline that improved detection accuracy by 30% and informed Australian national security policy for energy systems. | |
| Data Clearing House (CSIRO) — Distributed Data Exchange Platform | CSIRO DCH |
| Architected blockchain components within a \$2M+ data-sharing platform deployed across \sim 200 smart buildings (5 MW flexible capacity). Delivered interoperability modules and analytics dashboards that enabled real-time energy transactions and informed smart city deployment strategy. | |
| HARB — Hypergraph-Based Adaptive Consortium Blockchain | IEEE IoT-J Q1 |
| Designed a hypergraph-based clustering algorithm for distributed ledgers, improving throughput by 30% and network latency by 25%. Demonstrated production feasibility using real data from the Newcastle smart-building testbed. | |
| PlexiChain — Secure Flexibility Aggregation Framework | arXiv:2212.09064 |
| Engineered a blockchain-based marketplace for energy flexibility trading. Implemented a double-auction mechanism with behavioral-incentive smart contracts that improved market efficiency and ensured tamper-proof energy transactions. | |
| CypherChain — Privacy-Preserving Data Aggregation | IEEE ICBC '24 |
| Developed privacy-preserving aggregation protocols using zero-knowledge proofs and secure multiparty computation. Achieved 40% communication overhead reduction while maintaining full regulatory compliance for demand response programs. | |
| BAILIF — Blockchain Agnostic Interoperability Framework | IEEE ICBC '23 |
| Led cross-disciplinary team designing a decentralized notary and cross-chain attestation protocol. The system achieved 666 transactions per second and enabled seamless interoperability between Hyperledger and Ethereum-based networks. | |
| EnergiPay — Off-Chain Payment Channels for Energy Trading | ACM e-Energy '24 |
| Co-developed a Layer-2 payment protocol enabling near-instant settlement between energy prosumers. Reduced transaction fees by 60% compared to on-chain equivalents and demonstrated applicability to micro-POS and mobile payment networks. | |
| Carbon Certification and Development Initiative (CCDI) | UNSW |
| Built blockchain-backed carbon credit registry architecture integrating oracle-based verification of emission data. Informed three industry partners' adoption strategies and contributed to \$500k in additional research funding. | |
| TradeLens — Global Supply Chain Blockchain Platform | IBM Blockchain |
| Served as core engineer in IBM's blockchain research program integrating logistics, customs, and port authorities. Contributed to smart contract modules powering 100,000+ users across 600 ports, improving cargo visibility and auditability by 35%. | |

SKILLS

AI Systems, Data Science & Intelligence

- **Machine Learning & AI Engineering:** Python (pandas, NumPy, scikit-learn, PyTorch, TensorFlow); anomaly detection, time-series forecasting, model validation, and predictive analytics; applied research in generative and agentic AI.
- **Data Analytics & Intelligence:** Data modeling and integration across distributed energy and telecom systems; analytics development using SQL, PowerBI, Databricks, and Snowflake; statistical and causal inference for decision optimization.
- **MLOps & Automation:** Model deployment, monitoring, and scaling using containerized microservices (Docker, Kubernetes); CI/CD automation with Jenkins and GitHub Actions; data pipeline orchestration in AWS and GCP.
- **Research & Innovation:** R&D leadership across academia and industry; experimental design and prototyping; peer-reviewed publication and IP strategy for AI, energy, and cybersecurity technologies.

Software, Cloud & Systems Engineering

- **Software Architecture:** Design of scalable, fault-tolerant distributed and ubiquitous systems; context-aware computing; REST/gRPC API architecture; cloud-edge coordination (AWS IoT, GCP Edge).
- **Programming & Development:** Proficient in Python, Go, Rust, Java, and Solidity; backend systems for high-throughput transaction platforms; fintech API and message-queue integration (Kafka, RabbitMQ); mobile UX development (Android, iOS).
- **Telecommunication Systems & Mobile Innovation:** Mobile network architecture, telecom protocols, and operator API integration (SMS, USSD, M-Pesa gateways); innovation management and commercialization of mobile technologies through industry-academia collaboration.

Cybersecurity, Blockchain & Cryptography

- **Blockchain Engineering:** Smart contract design and auditing (Certora, Slither, MythX, Echidna); Layer-2 and cross-chain protocols; Hyperledger Fabric and Ethereum development; secure dApp architecture and gas optimization.
- **Cryptography & Security:** Secure multiparty computation (SMPC), homomorphic encryption (HE), and zero-knowledge proofs (ZKP); blockchain consensus analysis; penetration testing and threat modeling for cyber-physical and fintech infrastructure.
- **Payments & Fintech Systems:** Blockchain-enabled payment channels and tokenized asset platforms; off-chain settlement and compliance (PCI-DSS, ISO 27001, GDPR); fraud detection and transaction cost optimization.

Leadership & Collaboration

- **Collaboration & Communication:** Technical mentorship and cross-functional coordination; stakeholder engagement; documentation and translation of complex R&D outcomes into actionable engineering roadmaps.
- **Research Supervision:** Supervised postgraduate and undergraduate research projects in AI, cybersecurity, and distributed systems; provided methodological and publication guidance.
- **Interdisciplinary Leadership:** Coordinated joint programs between academia and industry (UNSW, CSIRO, IBM Research Africa, Strathmore); led cross-domain teams spanning energy informatics, privacy-preserving AI, and secure computing.

RESEARCH OUTPUTS

Conference Papers

- [1] X. Hui, **S. Karumba**, S. C.-K. Chau, and M. Ahmed, “Destabilizing power grid and energy market by cyberattacks on smart inverters,” in *Proceedings of the 16th ACM International Conference on Future and Sustainable Energy Systems (e-Energy '25)*, **Cited by: 1** — Conference Ranking: A-rank (CORE 2023), Association for Computing Machinery, 2025.
- [2] S. C.-K. Chau, N. Wang, and **S. Karumba**, “Energipay: Off-chain payment channel for blockchain-enabled peer-to-peer energy trading,” in *Proceedings of the 15th ACM International Conference on Future and Sustainable Energy Systems (e-Energy '24)*, **Cited by: 3** — Conference Ranking: A-rank (CORE 2023), Singapore, Singapore: Association for Computing Machinery, 2024, ISBN: 979-8-4007-0480-2. DOI: [10.1145/3632775.3661985](https://doi.org/10.1145/3632775.3661985).
- [3] **S. Karumba**, S. C.-K. Chau, H. Pearce, M. Ahmed, and H. Janicke, “Systematic study of cybersecurity threats for smart inverters,” in *Proceedings of the 15th ACM International Conference on Future and Sustainable Energy Systems (e-Energy '24)*, **Cited by: 3** — Conference Ranking: A-rank (CORE 2023), Singapore, Singapore: Association for Computing Machinery, 2024, pp. 669–675, ISBN: 979-8-4007-0480-2. DOI: [10.1145/3632775.3661994](https://doi.org/10.1145/3632775.3661994).
- [4] **S. Karumba**, V. Dedeoglu, R. Jurdak, and S. S. Kanhere, “Cypherchain: A privacy-preserving data aggregation framework for blockchain-based dr programs,” in *2024 IEEE International Conference on Blockchain and Cryptocurrency (ICBC)*, Conference Ranking: SJR: 0.340, Impact Factor: 3.04, IEEE, 2024.
- [5] **S. Karumba**, R. Jurdak, S. S. Kanhere, and S. Sethuvenkatraman, “Bailif: A blockchain agnostic interoperability framework,” in *2023 IEEE International Conference on Blockchain and Cryptocurrency (ICBC)*, **Cited by: 15** — Conference Ranking: SJR: 0.340, Impact Factor: 3.04, h-index: 14, IEEE, 2023, pp. 1–9. DOI: [10.1109/ICBC56567.2023.10174967](https://doi.org/10.1109/ICBC56567.2023.10174967).
- [6] **S. Karumba**, S. S. Kanhere, and R. Jurdak, “A relational network framework for interoperability in distributed energy trading,” in *2020 IEEE International Conference on Blockchain and Cryptocurrency (ICBC)*, **Cited by: 2** — Conference Ranking: SJR: 0.340, Impact Factor: 3.04, h-index: 14, IEEE, 2020, pp. 1–3. DOI: [10.1109/ICBC48266.2020.9169462](https://doi.org/10.1109/ICBC48266.2020.9169462).
- [7] N. Bore, **S. Karumba**, J. Mutahi, *et al.*, “Towards blockchain-enabled school information hub,” in *Proceedings of the Ninth International Conference on Information and Communication Technologies and Development (ICTD '17)*, **Cited by: 111** — Conference Ranking: C-rank (CORE 2018), Lahore, Pakistan: Association for Computing Machinery, 2017. DOI: [10.1145/3136560.3136584](https://doi.org/10.1145/3136560.3136584).
- [8] A. Kinai, J. Mutahi, N. Bore, **S. Karumba**, *et al.*, “Deploying large scale school census hub: An experience report,” in *2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Society Track (ICSE-SEIS)*, **Cited by: 3** — Conference Ranking: A*-rank (CORE 2023), IEEE, 2017, pp. 47–56. DOI: [10.1109/ICSE-SEIS.2017.7](https://doi.org/10.1109/ICSE-SEIS.2017.7).
- [9] D. Kaguma, **S. Karumba**, A. Walcott-Bryant, and K. Weldenmariam, “Towards cooperative content downloading for resource-constrained mobile devices,” in *Proceedings of the International Conference on Mobile Software Engineering and Systems (MOBILESoft '16)*, **Cited by: 1**, Austin, TX, USA: Association for Computing Machinery, 2016, pp. 189–198. DOI: [10.1145/2897073.2897083](https://doi.org/10.1145/2897073.2897083).

Journal Articles

- [10] **S. Karumba**, S. Sethuvenkatraman, V. Dedeoglu, R. Jurdak, and S. S. Kanhere, “Barriers to blockchain-based decentralised energy trading: A systematic review,” *International Journal of Sustainable Energy*, vol. 42, no. 1, pp. 41–71, Feb. 2023, **Cited by: 49 — Q2 in Energy** — Impact Factor: 3.5 — h-index: 42. doi: [10.1080/14786451.2023.2171417](https://doi.org/10.1080/14786451.2023.2171417).
- [11] **S. Karumba**, S. S. Kanhere, R. Jurdak, and S. Sethuvenkatraman, “Harb: A hypergraph-based adaptive consortium blockchain for decentralized energy trading,” *IEEE Internet of Things Journal*, vol. 9, no. 16, pp. 14216–14227, 2022, **Cited by: 34 — Q1 in Computer Networks** — Impact Factor: 8.2 — CiteScore: 17.6 — h-index: 179. doi: [10.1109/JIOT.2020.3022045](https://doi.org/10.1109/JIOT.2020.3022045).
- [12] A. Dorri, F. Luo, **S. Karumba**, S. S. Kanhere, R. Jurdak, and Z. Y. Dong, “Temporary immutability: A removable blockchain solution for prosumer-side energy trading,” *Journal of Network and Computer Applications*, vol. 180, p. 103018, 2021, **Cited by: 28 — Q1 in Computer Networks** — Impact Factor: 7.7 — CiteScore: 21.5 — h-index: 141. doi: [10.1016/j.jnca.2021.103018](https://doi.org/10.1016/j.jnca.2021.103018).

Patents

- [13] J. Mutahi, D. W. Kaguma, **S. M. Karumba**, *et al.*, “Farm cultivation quality,” Patent US11497156B2, Nov. 2022. [Online]. Available: <https://patents.google.com/patent/US11497156B2/en>.
- [14] **S. M. Karumba**, C. A. Pickover, and K. Weldemariam, “Tracking items used for providing medical services,” Patent Application US20180189449A1, Jul. 2018. [Online]. Available: <https://patents.google.com/patent/US20180189449A1/en>.
- [15] D. W. Kaguma, **S. Karumba**, and K. Weldemariam, “Cooperative download among low-end devices under resource-constrained environment,” Patent US9961139B2, May 2018. [Online]. Available: <https://patents.google.com/patent/US9961139B2/en>.

Theses & Dissertations

- [16] **S. Karumba**, “Blockchain-based decentralized energy systems: Advancing scalability, security, privacy, and interoperability,” Supervisor: Prof. S. Kanhere, Prof. R. Jurdak — **UNSW Scientia Scholarship Recipient**, PhD Thesis, University of New South Wales, 2023.
- [17] **S. M. Karumba**, “Smart education: An event framework for cognitive blended learning,” Safaricom Academy Scholarship Recipient, MSc Thesis, Strathmore University, 2017.

Technical Reports & Software Frameworks

- [18] **S. Karumba**, S. S. Kanhere, R. Jurdak, and S. Sethuvenkatraman, *Plexichain: A secure blockchain-based flexibility aggregator framework*, arXiv preprint arXiv:2212.09064, **Cited by: 1**, 2022. arXiv: [2212.09064 \[cs.CR\]](https://arxiv.org/abs/2212.09064). [Online]. Available: <https://arxiv.org/abs/2212.09064>.
- [19] X. Hui, **S. Karumba**, S. C.-K. Chau, and M. Ahmed, *Destabilizing power grid and energy market by cyberattacks on smart inverters (extended version)*, arXiv preprint arXiv:2505.14175, Extended version of the paper published in ACM e-Energy '25, 2025. arXiv: [2505.14175 \[cs.CR\]](https://arxiv.org/abs/2505.14175). [Online]. Available: <https://arxiv.org/abs/2505.14175>.

Book Chapters

- [20] **S. Karumba**, V. Dedeoglu, A. Dorri, R. Jurdak, and S. S. Kanhere, “Utilizing blockchain as a citizen-utility for future smart grids,” in *Wireless Blockchain: Principles, Technologies, and Applications*, Cited by: 4, John Wiley & Sons, 2021, pp. 201–224. DOI: [10.1002/9781119790839.ch9](https://doi.org/10.1002/9781119790839.ch9).

Presentations & Invited Talks

- [21] **S. Karumba**, *Cybersecurity threats for smart inverters*, Presented at ACM e-Energy '24, Singapore, 2024. [Online]. Available: <https://dl.acm.org/doi/10.1145/3632775.3661994>.
- [22] **S. Karumba**, *Blockchain interoperability for energy markets*, Presented at IEEE ICBC '23, Dubai, 2023. [Online]. Available: <https://doi.org/10.1109/ICBC56567.2023.10174967>.
- [23] **S. Karumba**, *Privacy-preserving computation in energy trading*, UNSW–CSIRO Seminar Series, 2023. [Online]. Available: <https://research.csiro.au/dch/>.

RESEARCH GRANTS & FUNDING

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|-------------|--|--|
| 2023 – 2024 | CAESER: Cybersecurity of Consumer Energy Resources CSIRO Data61, UNSW, Edith Cowan University <i>Role: Postdoctoral Research Engineer</i> <i>PI: Dr. Sid Chi-Kin Chau, Dr. Sharif Abuadbba</i> | <i>National Program</i> |
| 2020 – 2024 | CSIRO PhD Top-up Scholarship CSIRO Data61 <i>Role: PhD Scholar</i> <i>Award: \$10,000 per annum + \$5,000 development budget</i> | <i>AUD \$40,000</i> |
| 2019 – 2024 | UNSW Scientia PhD Scholarship University of New South Wales <i>Role: Principal Recipient</i> <i>Award: full tuition + \$41,209 stipend per annum (indexed) + \$10,000 development fund per annum</i> | <i>AUD \$205,000+</i> |
| 2015 – 2018 | Educational Data Analytics Initiative IBM Research Africa, RTI International, Mombasa County <i>Role: Co-Investigator</i> <i>Scope: 100+ schools blockchain data systems deployment</i> | <i>USAID/IBM USD \$100M Project Lucy</i> |
| 2023 | ACE-SIP Summer School Travel Award Algorand Centre of Excellence, Monash University <i>Role: Research Engineer</i> <i>Program: Sustainability Informatics for the Pacific</i> | <i>Professional Development</i> |

SCHOLARSHIPS & AWARDS

- 03 Feb 2023 **ACE Summer School Stipend** — Monash Univ. (Melbourne). *Stipend support for participation in the African Cybersecurity and Energy Systems Summer School.*
- 01 Apr 2020 **CSIRO PhD Top-up Scholarship** — UNSW/CSIRO Energy (Sydney). *Research scholarship for doctoral work on secure distributed energy systems.*
- 03 Aug 2018 **UNSW Scientia Scholarship** — Ph.D., UNSW (Sydney). *Flagship doctoral award for exceptional research potential across disciplines.*
- 22 Aug 2013 **Safaricom Academy Scholarship** — M.Sc. Mobile Telecommunication & Innovation, Strathmore Univ. (Nairobi). *Industry-backed full scholarship delivered under the Safaricom–Strathmore partnership for advanced mobile innovation training.*

REFEREES

- Prof. Salil S. Kanhere** **Professor, UNSW, Australia**
Relation: Primary PhD supervisor (2019-2024)
Contact: available upon request
Research Areas: IoT, Blockchain, Cyber-Physical Systems, Cybersecurity, Applied ML
- Prof. Raja Jurdak** **Professor, QUT, Australia**
Relation: PhD co-supervisor (2019-2024), Director of Trusted Networks Lab
Contact: available upon request
Research Areas: IoT, Blockchain, Distributed Systems, Energy Systems
- Dr. Charity Wayua** **Director, IBM Research Africa**
Relation: Research manager at IBM Research Africa (2017-2019)
Contact: available upon request
Research Areas: Human-Computer Interaction, Digital Inclusion, ICT4D
- Dr. Sid Chi-Kin Chau** **Principal Research Scientist, CSIRO Data61**
Relation: Research manager at CSIRO Data61 (2023-2024)
Contact: available upon request
Research Areas: Cybersecurity for Energy Systems, Blockchain, IoT Security