Curriculum vitae Last update: November 3, 2024

Sarath Babu

Department of Electrical and Computer Engineering, Iowa State University
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CAREER OBJECTIVE

- Pursue research focusing on the design and development of secure and next generation wireless networking infrastructures.

RESEARCH INTERESTS

- **Next Generation Wirleess Plaforms:** Design and deployment of real-world wireless testbeds to enable research in future wireless communication systems such as 5G and beyond, and Open Radio Access Networks (Open RAN).
- **Software Defined Wireless Networks:** Application of Software Defined Networking (SDN) approach in different classes of wireless networks including wireless local area networks, mesh networks, disruption tolerant networks, sensor networks, and satellite networks.
- **Internet of Things (IoT):** Design and development of light-weight wireless solutions for sensor networks for future applications.
- **Intelligent Transportation Systems:** Involves the analysis of road networks using tools such as complex networks and explore hidden patterns that leads to existing problems. Further, use the analysis for the characterization, design, and development of mobility models, routing protocols, and security frameworks.
- **Systems Security:** Analysis of different attacks on SDN architecture as well as the design and development of solutions to defend the attacks.
- **Complex Networks:** Besides wireless networks and road networks, exploiting complex networks in analyzing any system of social importance.

EDUCATION

- **Doctor of Philosophy (Ph.D.)** Feb 2014 – May 2021
  Indian Institute of Space Science and Technology Thiruvananthapuram, India
  Thesis: *Software defined disruption tolerant networks* CGPA: 9.25/10
  Advisor: Prof. B. S. Manoj

- **Master of Technology (M.Tech.)** Jul 2009 – May 2011
  National Institute of Technology, Calicut Calicut, India
  Specialization: Computer Science & Engineering (Information Security) CGPA: 8.97/10
  Thesis: *A usage control based model for multi-domain environments with distributed attributes*
  Advisor: Prof. Priya Chandran

- **Bachelor of Technology (B.Tech.)** Aug 2005 – Aug 2009
  Mahatma Gandhi University Kottayam, India
  Specialization: Information Technology Percentage: 82.28
  Project: *Remote system access through universal serial bus*

EXPERIENCE

- **Research Scientist II** Oct 2021 – Present
  Iowa State University Ames, USA
  Center for Wireless, Communities, and Innovation (WiCI), Department of Electrical and Computer Engineering
  Focus: ARA: Wireless Living Lab for Smart and Connected Rural Communities

- **Graduate Teaching Assistant** Feb 2014 – May 2021
  Indian Institute of Space Science and Technology Thiruvananthapuram, India
  Department of Avionics

- **Teaching Assistant** Jul 2009 – May 2011
  National Institute of Technology Calicut, India
  Department of Computer Science and Engineering

AWARDS | SCHOLARSHIPS | CERTIFICATES

- Best Demo, Midscale Experimental Research Infrastructure Forum 2024 (MERIF 24), Kansas City, MO, USA Sep 2024

- Honorable Mention for the Paper, IEEE Future Networks World Forum, Baltimore, MD, USA — Nov 2023
- Best Paper Award, ACM Workshop on Wireless Network Testbeds, Experimental evaluation & Characterization (WiNTECH '23) — Oct 2023
- Outstanding Teaching Assistant Award, Department of Avionics, IIST — Nov 2019
- IIST scholarship from Department of Space, Government of India — Feb 2014 – Jan 2019
- MHRD scholarship from Government of India — Jul 2009 – May 2011
- Graduate Aptitude Test in Engineering (GATE) 2009, MHRD, Government of India, Percentile: 96.84 — Mar 2009
- Completed Infosys Campus Connect Program — Sep 2009
- Red Hat Certificate on Linux 4.0 Essentials, Linux 4.0 System Administration, and Network and Security Administration — Apr 2007

RESEARCH PROJECTS INVOLVED

1. **Real-Time Liquid Wireless Networking for Data-Intensive Rural Applications** — Oct 2022 – Present
   Objective: Design and develop a framework for real-time data-intensive rural wireless applications using fountain codes to provide probabilistic real-time packet delivery guarantees.
   Collaborators: Iowa State University, International Computer Science Institute, and Boston University.

2. **ARA—Living Lab for Smart and Connected Rural Communities** — Oct 2021 – Present
   Objective: Develop at-scale real-world experimental infrastructure for rural wireless applications.
   Collaborators: Iowa State University (ISU), Ohio State University (OSU), International Computer Science Institute, and industry partners.

3. **OPERA: An Open-Source Ecosystem for Broadband Prairie** — Sep 2022 – Aug 2024
   Objective: Provide leadership (in terms of organization, partnership, and infrastructure) in building open-source ecosystem in addition to contribute toward open source software, open source hardware, and open source datasets.
   Collaborators: Iowa State University

4. **MICRONet—Mobile Infrastructure for Coastal Region Offshore Communications & Networks** — May 2014 – Aug 2017
   Objective: Provide wireless mesh network based offshore communication platform for fishermen at sea.
   Collaborators: Indian Institute of Space Science and Technology (IIST); Amrita University; Indian Institute of Information Technology and Management - Kerala (IIITM-K); Information Technology Research Academy (ITRA).

5. **Indo-US Collaborative Research on Pervasive Computing for Disaster Response** — Feb 2014 – Jun 2016
   Objective: Design and develop efficient mechanisms for information gathering and service delivery in shanty town emergency response systems.
   Collaborators: Indian Institute of Space Science and Technology (IIST); University of California Irvine (UCI); California Institute of Technology (Caltech).

6. **IIST MeshNet: A Programmable Hybrid Wireless Mesh Network Testbed** — Mar 2013 – Mar 2016
   Objective: Design and build a software defined wireless mesh network testbed for wireless research at IIST.
   Collaborator: Indian Institute of Space Science and Technology (IIST).

PUBLICATIONS

JOURNALS

1. D. Dalai, **Sarath Babu**, B. S. Vineeth, and B. S. Manoj, "*A Novel Space Based Hosting Approach for Ultra Low Latency Web Services,*" **IEEE Access**, vol. 12, pp. 142838-142862, Sep. 2024. DOI: 10.1109/ACCESS.2024.3462252
2. **Sarath Babu**, A. Rajeev, and B. S. Manoj, "*A medium-term disruption tolerant SDN for wireless TCP/IP networks,*" **IEEE Transactions on Network and Service Management**, pp. 2318–2334, Dec. 2020. DOI: 10.1109/TNSM.2020.3023889
3. A. Chakraborty, **Sarath Babu**, and B. S. Manoj, "*On achieving capacity-enhanced small-world networks,*" **Physica A: Statistical Mechanics and its Applications**, vol. 556, p. 124729, Oct. 2020. DOI: 10.1016/j.physa.2020.124729
4. **Sarath Babu** and B. S. Manoj, "*Toward a type-based analysis of road networks,*" **ACM Transactions on Spatial Algorithms and Systems**, vol. 6, no. 4, pp. 28:1–28:45, Aug. 2020. DOI: 10.1145/3397579
5. P. Koshy, **Sarath Babu**, and B. S. Manoj, "*Sliding window blockchain architecture for Internet of Things,*" **IEEE Internet of Things Journal**, vol. 7, no. 4, pp. 3338–3348, Apr. 2020. DOI: 10.1109/JIOT.2020.2967119
6. **Sarath Babu**, P. V. Mithun, and B. S. Manoj, "*A novel framework for resource discovery and self-configuration in software defined wireless mesh networks*", **IEEE Transactions on Network and Service Management**, vol. 17, no. 1, pp. 132–146, Mar. 2020. DOI: 10.1109/TNSM.2019.2922107

7. N. Anand, **Sarath Babu**, and B. S. Manoj, "*On detecting compromised controller in software defined networks,*" **Computer Networks**, vol. 137, pp. 107–118, Jun. 2018. DOI: 10.1016/j.comnet.2018.03.021
8. D. S. Yadav, **Sarath Babu**, and B. S. Manoj, "*Quasi path restoration: A post-failure recovery scheme over pre-allocated backup resource for elastic optical networks,*" **Optical Fiber Technology**, vol. 41, pp. 139–154, Mar. 2018. DOI: 10.1016/j.yofte.2018.01.011

CONFERENCES

1. M. Nadim, T. Islam, S. Reddy, T. Zhang, Z. Meng, R. Afzal, **Sarath Babu**, A. Ahmed, D. Qiao, A. Arora, H. Zhang, "*AraSync: Precision time synchronization in rural wireless living lab*", accepted in **ACM Workshop on Wireless Network Testbeds, Experimental evaluation & Characterization (WiNTECH '24)**, Nov. 2024, Washington D.C., USA.
2. J. O. Boateng, T. Zhang, G. Zu, T. U. Islam, **Sarath Babu**, H. Zhang, and D. Qiao, "*AraSDR: End-to-end, fully-programmable living lab for 5G and beyond*"", in the Proceedings of **IEEE International Conference on Communications (ICC)**, Jun. 2024, pp. 1758–1763. DOI: 10.1109/ICC51166.2024.10623061
3. E. K. A. Permatasari, E. Gosling, M. Nadim, **Sarath Babu**, D. Qiao, H. Zhang, M. Luby, J. W. Byers, L. Minder, and P. Aggrawal, "*Real-time liquid wireless transport for video streaming in rural and agricultural applications*", in proceedings of 3rd **ACM Mile High Video (MHV)**, Feb. 2024, pp. 54–60. DOI: 10.1145/3638036.3640806
4. G. Zu, M. Nadim, S. Reddy, T. U. Islam, **Sarath Babu**, T. Zhang, D. Qiao, H. Zhang, and A. Arora, "*AraHaul: Multi-modal wireless x-haul living lab for long-distance, high-capacity communications*", in Proceedings of the 2023 **IEEE Future Networks World Forum (FNWF)**, Nov. 2023, pp. 1–6. DOI: 10.1109/FNWF58287.2023.10520543
5. T. Zhang, G. Zu, T. U. Islam, E. Gossling, **Sarath Babu**, D. Qiao, and H. Zhang, "*Exploring wireless channels in rural areas: A comprehensive measurement study*", in the Proceedings of the 2023 **IEEE Future Networks World Forum (FNWF)**, Baltimore, MD, USA, Nov. 2023, pp. 1–6. DOI: 10.1109/FNWF58287.2023.10520408 [**Honorable Mention**]
6. T. U. Islam, T. Zhang, J. O. Boateng, E. Gossling, G. Zu, **Sarath Babu**, H. Zhang, and D. Qiao, "*AraMIMO: Programmable TVWS mMIMO living lab for rural wireless*", in Proceedings of the 17th **ACM Workshop on Wireless Network Testbeds, Experimental evaluation & Characterization (WiNTECH '23)**, Oct. 2023, pp. 9–16. DOI: 10.1145/3615453.3616512 [**Best Paper Award**]
7. M. Shahid, **Sarath Babu**, H. Zhang, D. Qiao, Y. Guan, J. O. Boateng, T. U. Islam, G. Zu, A. Kamal, and M. Zheng, "*Wireless guard for trustworthy spectrum management*", in Proceedings of the 16th **ACM Workshop on Wireless Network Testbeds, Experimental evaluation & Characterization (WiNTECH '22)**, Oct. 2022, pp. 32–39. DOI: 10.1145/3556564.3558241
8. K. Keahey, J. Anderson, M. Sherman, C. Hammock, Z. Zhen, J. Tillotson, T. Bargo, L. Long, T. U. Islam, **Sarath Babu**, H. Zhang, and F. Halbach, "*CHI-in-a-Box: Reducing operational costs of research testbeds*", in Proceedings of **ACM Practice and Experience in Advanced Research Computing (PEARC)** Conference Series, Jul. 2022, pp. 1–8. DOI: 10.1145/3491418.3530768
9. T. Abhiroop, **Sarath Babu**, and B. S. Manoj, "*A machine learning consensus based light-weight blockchain architecture for Internet of Things*", in Proceedings of 14th **International Conference on Communication Systems & Networks (COMSNETS)**, Jan. 2022, pp. 1–6. DOI: 10.1109/COMSNETS53615.2022.9668487
10. A. Salas, **Sarath Babu**, and B. S. Manoj, "*A light-weight delay tolerant networking framework for resource-constrained environments*", in Proceedings of the 27th **National Conference on Communications (NCC)**, Jul. 2021, pp. 1–6. DOI: 10.1109/NCC52529.2021.9530075
11. **Sarath Babu**, I. Ghosh, and B. S. Manoj, "*Effort: A new metric for roadside unit placement in 5G enabled vehicular networks,*" in Proceedings of the 3rd **IEEE 5G World Forum (5GWF)**, Sep. 2020, pp. 263–268. DOI: 10.1109/5GWF49715.2020.9221228
12. D. Dalai, **Sarath Babu**, and B. S. Manoj, "*On using edge servers in 5G satellite networks,*" in Proceedings of the 3rd **IEEE 5G World Forum (5GWF)**, Sep. 2020, pp. 553–558. DOI: 10.1109/5GWF49715.2020.9221366
13. R. Suraj, **Sarath Babu**, D. Dalai, and B. S. Manoj, "*DebriNet: An opportunistic software defined networking framework over PSLV debris*", in Proceedings of the **IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)**, Dec. 2019, pp. 1–6. DOI: 10.1109/ANTS47819.2019.9118082
14. **Sarath Babu**, P. Rathod, and B. S. Manoj, "*On optimizing information gathering in shanty town emergency response,*" in Proceedings of the **IEEE Region 10 Conference (TENCON)**, Oct. 2019, pp. 129–134. DOI: 10.1109/TENCON.2019.8929340
15. T. Abhiroop, **Sarath Babu**, and B. S. Manoj, "*A machine learning approach for detecting DoS attacks in SDN switches,*" in Proceedings of the 24th **National Conference on Communications (NCC)**, Feb. 2018, pp. 1–6. DOI: 10.1109/NCC.2018.8600196
16. P. V. Mithun, **Sarath Babu**, and B. S. Manoj, "*On resolving network view inconsistencies in SDN control plane,*" in Proceedings of the **IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)**, Dec. 2017, pp. 1–6. DOI: 10.1109/ANTS.2017.8384108
17. G. Gupta, **Sarath Babu**, and B. S. Manoj, "*Dual-mode TCP: An alternative approach for delay tolerant networks,*" in Proceedings of the 23rd **National Conference on Communications (NCC)**, Mar. 2017, pp. 1–6. DOI: 10.1109/NCC.2017.8077040

18. **Sarath Babu** and B. S. Manoj, "*On the topology of Indian and Western road networks,*" in Proceedings of the 8th **International Conference on Communication Systems and Networks (COMSNETS)**, Jan. 2016, pp. 1–6. DOI: 10.1109/COMSNETS.2016.7440027
19. R. Raj, **Sarath Babu**, K. Benson, G. Jain, B. S. Manoj, and N. Venkatasubramanian, "*Efficient path rescheduling of heterogeneous mobile data collectors for dynamic events in shanty town emergency response,*" in Proceedings of the **IEEE Global Communications Conference (GLOBECOM)**, Dec. 2015, pp. 1–7. DOI: 10.1109/GLOCOM.2015.7417610
20. A. V. Mamidi, **Sarath Babu**, and B. S. Manoj, "*Dynamic multi-hop switch handoffs in software defined wireless mesh networks,*" in Proceedings of the **IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)**, Dec. 2015, pp. 1–6. DOI: 10.1109/ANTS.2015.7413638
21. G. Jain, **Sarath Babu**, R. Raj, K. Benson, B. S. Manoj, and N. Venkatasubramanian, "*On disaster information gathering in a complex shanty town terrain*"," in Proceedings **IEEE Global Humanitarian Technology Conference - South Asia Satellite (GHTC-SAS)**, Sep. 2014, pp. 147–153. DOI: 10.1109/GHTC-SAS.2014.6967574

DEMOS | POSTERS

1. T. U. Islam, M. Nadim, G. Zu, O. J. Perrin, V. Lee, J. O. Boateng, M. Shahid, T. Zhang, S. Reddy, W. Xu, X. Li, A. Atalar, **Sarath Babu**, A. Ahmad, M. Soliman, A. Hussain, D. Qiao, M. Zheng, Y. Guan, O. Boyraz, A. Arora, M. Selim, M. B. Cohen, H. Zhang, "*ARA PAWR: Enabling wireless experiments with programmable COTS RAN and x-Haul platforms,*" in **Midscale Experimental Research Infrastructure Forum (MERIF '24)**, Sep. 2024. [**Best Demo Award**]
2. T. U. Islam, J. O. Boateng, G. Zu, M. Shahid, M. Nadim, W. Xu, T. Zhang, S. Reddy, X. Li, A. Atalar, Y. Chen, **Sarath Babu**, H. Zhang, D. Qiao, M. Zheng, Y. Guan, O. Boyraz, A. Arora, M. Selim, and M. B. Cohen, "*ARA PAWR: Wireless living lab for smart and connected rural communities,*" in Proceedings of the 29th Annual **International Conference on Mobile Computing and Networking (ACM MobiCom '23)**. ACM, Article 98, Oct. 2023, pp. 1–3. DOI: 10.1145/3570361.3614068

BOOK CHAPTERS

1. A. D. Dhruva, **Sarath Babu**, A. Chakraborty, and B. S. Manoj, "*Computing platforms for the Internet of Things,*" In: Abraham, Martin A. (eds.) **Encyclopedia of Sustainable Technologies**, 2nd Edition, 2024, vol. 3, pp. 780–799. Oxford: Elsevier. DOI: 10.1016/B978-0-323-90386-8.00068-1

ARXIV PREPRINTS

1. T. U. Islam et al., "*Design and implementation of ARA wireless living lab for rural broadband and applications,*" **arXiv** preprint arXiv:2408.00913v1, Aug. 2024. DOI: 10.48550/arXiv.2408.00913
2. D. Dalai, **Sarath Babu**, and B. S. Manoj, "*Satellite-6G network integration roadmap on reference architectures,*" **TechRxiv**. Preprint. (2022). DOI: 10.36227/techrxiv.20624685.v1
3. **Sarath Babu**, G. Jain, and B. S. Manoj, "*Urban Delay Tolerant Network Simulator (UDTNSim v0.1),*" **CoRR**, vol. abs/1709.05645, Sep. 2017. DOI: 10.48550/arXiv.1709.05645

TECHNICAL REPORTS

1. S. Kota, G. Giambene, et al., "*Satellite, IEEE INGR International Network Generations Roadmap, 2023 Edition,*", 2023 **IEEE Future Networks World Forum (FNWF)**, Baltimore, MD, USA, 2023, pp. 1–195. DOI: 10.1109/FNWF58287.2023.10520529
2. S. Kota, G. Giambene, et al., "*Satellite, IEEE INGR International Network Generations Roadmap, 2022 Edition,*" 2022 **IEEE Future Networks World Forum (FNWF)**, Montreal, QC, Canada, 2022, pp. 1–182. DOI: 10.1109/FNWF55208.2022.00141

PATENTS

1. P. Koshy, A. S. Ananthakrishnan, **Sarath Babu**, and B. S. Manoj, "*IoT enabled biomedical wearable clothing system for healthcare assistance,*" **IN 449773**, 2023.

SOFTWARE DEVELOPED

1. **OpenFlow Software Switch with Controlled Buffering**
   Objective: Enable an SDN switch capable of controlled buffering of packets in order handle link disruptions in software defined wireless environments.
2. **Software Defined Optimized Link State Routing (SD-OLSR) Protocol**
   Objective: Provide an automated SDN resource discovery and self-configuration scheme for software defined wireless environments involving mobile switches and controllers.
3. **Urban Delay Tolerant Network Simulator (UDTNSim)** [Available at: https://github.com/4sarathbabu/UDTNSim]
   Objective: Design and develop mobility models and routing protocols for ad hoc vehicular networks in real-world road network environments and analyze the performance.

AFFILIATIONS | POSITIONS HELD

- Member, IEEE Smart Cities Community — Jan 2022 – Present
- Member, IEEE — Dec 2021 – Present
- Member, IEEE Communications Society — Dec 2021 – Present
- Member, IEEE Computer Society — Dec 2021 – Present
- Member, IEEE Future Networks Community — Jan 2021 – Present
- Member, IEEE Internet of Things Community — Jan 2021 – Present
- Professional member, ACM — Dec 2020 – Present
- Member, IEEE Software Defined Networks Community — Jan 2019 – Present
- Member, IEEE Sensors Council — Jan 2015 – Present
- Member, IEEE Systems Council — Jan 2015 – Present
- Graduate student member, IEEE — Jan 2014 – Nov 2021
- Student member, IEEE Communications Society — Mar 2014 – Dec 2014, Jan 2016 – Nov 2021
- Student member, IEEE Computer Society — Mar 2016 – Nov 2021
- Student member, ACM — Mar 2014 – Nov 2020
- Executive Committee member — Feb 2018 – Feb 2020
- Secretary, IEEE Student Branch, IIST — Dec 2014 – Jan 2018

PROFESSIONAL ACTIVITIES

TECHNICAL PROGRAM COMMITTEES

- IFIP Networking 2024
- IEEE Future Networks World Forum (FNWF) 2024, 2023
- COMSNETS 2025, 2024, 2023
- ACM WiNTECH 2024, 2023, 2022

AS REVIEWER

- **Journals**
  - IEEE Transactions on Network and Service Management (IEEE TNSM)
  - IEEE Transactions on Wireless Communications (IEEE TWC)
  - IEEE Transactions on Communications (IEEE TCOM)
  - IEEE Journal of Selected Areas in Communications (IEEE JSAC) - Series on Network Softwarization & Enablers
  - IEEE Internet of Things Journal
  - IEEE Sensors Journal
  - IEEE Communications Letters (IEEE COMML)
  - IEEE Networking Letters (IEEE LNET)
  - IEEE Systems Journal
  - IEEE Communications Magazine
  - IEEE Access
  - ACM Transactions on Asian and Low-Resource Language Information Processing
  - Elsevier Computer Networks
  - Springer Nature Computer Science
- **Conferences**
  - IEEE INFOCOM 2024, 2023
  - IEEE Globecom 2023
  - IEEE ICCC 2023
  - IEEE INDICON 2022
  - IEEE World Forum on Internet of Things (WF-IoT) 2021, 2022
  - IEEE RAICS 2015

AS VOLUNTEER

- IEEE Shannon Centennial Workshop on Communications and Information Theory (SCWIT) — Dec 2016
- IEEE Recent Advances in Intelligent Computational Systems (RAICS) — Dec 2015
- 7th International Conference on COMmunication Systems & NETworkS (COMSNETS) — Jan 2015

TALKS DELIVERED | WORKSHOPS CONDUCTED

- Talk on "*Real-World Experimental Testbed for 5G and Beyond Communication Systems*", IEEE Student Branch, IIST. Oct 2024
- Talk on "*Type-based Analysis of Road Networks*", Avionics PhD Talk Series, Department of Avionics and IEEE Student Branch, IIST. Sep 2020
- Workshop on "*Programming in Python*", IEEE Student Branch, IIST. Aug 2019, Oct 2018
- Workshop on "*Introduction to Software Defined Networking*", AV484 Wireless Mesh Networks, IIST. Oct 2016
- Workshop on "*LaTeX: An Introduction*", Conscientia, IIST. Mar 2018, Mar 2019

SKILLS

- Programming Languages: C, C++, Python, Bash Shell Scripting
- Documentation & Editors: LaTeX, GNU Emacs
- Plotting & Visualization: Gnuplot, Ti*k*Z, Inkscape, draw.io
- Operating Systems: Linux, TinyOS
- Cloud: OpenStack
- Hypervisors/Containerization: VirtualBox, Docker
- Database Management System: MariaDB, MySQL, SQLite
- Software Defined Networking: OpenFlow, Open vSwitch, Ryu, POX
- Simulators: UDTNSim, SUMO, Mininet, STK
- Languages: Malayalam (Native), English