Sarath Babu

301 Durham Center, 613 Morrill Road, Ames, IA, USA 50011
+1 515-294-1223 sarath4@iastate.edu 4sarathbabu.github.io

Career Objective

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

Research Interests

Next Generation Wireless 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

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

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

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

Experience

Iowa State University **Feb 2025 – Present**
Research Assistant Professor, Department of Electrical and Computer Engineering *Ames, IA, USA*
Center for Wireless, Communities and Innovation (WiCI)

Iowa State University **Oct 2021 – Feb 2025**
Research Scientist II, Department of Electrical and Computer Engineering *Ames, IA, USA*
Center for Wireless, Communities and Innovation (WiCI)

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

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

Recognitions | Scholarships | Certifications

- **Midscale Experimental Research Infrastructure Forum 2024 (MERIF '24)** **Sep 2024**
  Best Demo Award *Kansas City, MO, USA*
- **IEEE Future Networks World Forum (FNWF '23)** **Nov 2023**
  Honorable Mention for the Paper *Baltimore, MD, USA*

- **ACM Workshop on Wireless Network Testbeds, Experimental evaluation & Characterization (WiNTECH '23)** — **Oct 2023**, *Madrid, Spain*
  Best Paper Award
- **Indian Institute of Space Science and Technology** — **Nov 2019**, *Thiruvananthapuram, India*
  Outstanding Teaching Assistant Award in the Department of Avionics
- **Department of Space, Government of India** — **Feb 2014 – Jan 2019**, *Thiruvananthapuram, India*
  Ph.D. Scholarship, Indian Institute of Space Science and Technology
- **Ministry of Human Resource Development, Government of India** — **Jul 2009 – May 2011**, *Calicut, India*
  Master's Scholarship, National Institute of Technology, Calicut
- **Ministry of Human Resource Development, Government of India** — **Mar 2009**
  Graduate Aptitude Test in Engineering (GATE), Percentile: 96.84
- **Infosys** — **Sep 2009**
  Campus Connect Program
- **Red Hat** — **Apr 2007**
  Linux 4.0 Essentials, Linux 4.0 System Administration, and Network and Security Administration

Projects Involved

Real-Time Liquid Wireless Networking for Data-Intensive Rural Applications — **Oct 2022 – Present**

- Role: Develop the infrastructure for Real-time liquid wireless networking
- 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*

ARA—Living Lab for Smart and Connected Rural Communities — **Oct 2021 – Present**

- Role: Research Scientist; Co-lead the Software Working Group; Develop the ARA software ecosystem;
- Objective: Develop at-scale real-world experimental infrastructure for rural wireless applications.
- Collaborators: *Iowa State University, Ohio State University, International Computer Science Institute, University of California Irvine,* and *industry partners*

OPERA: An Open-Source Ecosystem for Broadband Prairie — **Sep 2022 – Aug 2024**

- Role: Develop the open-source software framework for OPERA
- 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.
- Collaborator: *Iowa State University*

MICRONet—Mobile Infrastructure for Coastal Region Offshore Communications & Networks — **May 2014 – Aug 2017**

- Role: Graduate student
- 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),* and *Information Technology Research Academy (ITRA)*

IIST MeshNet: A Programmable Hybrid Wireless Mesh Network Testbed — **Mar 2013 – Mar 2016**

- Role: Graduate Student
- 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 (IEEE TNSM)**, 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 (ACM TSAS)**, 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 (IEEE TNSM)**, 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,*" **Elsevier 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,*" **Elsevier Optical Fiber Technology**, vol. 41, pp. 139–154, Mar. 2018. DOI: 10.1016/j.yofte.2018.01.011

Conferences

1. M. Shahid, K. Das, H. Ushaq, H. Zhang, J. Song, D. Qiao, **Sarath Babu**, Y. Guan, Z. Zhu, A. Ahmad "*ReVeal: A Physics-Informed Neural Network for High-Fidelity Radio Environment Mapping,*" accepted in **IEEE International Symposium on Dynamic Spectrum Access Networks (IEEE DySPAN '25)**, London, UK, May 2025.
2. 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,*" in Proceedings of the 30th Annual **International Conference on Mobile Computing and Networking (ACM MobiCom '24)**, Nov. 2024, pp. 1758–1763. DOI: 10.1145/3636534.3697318
3. 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 the **IEEE International Conference on Communications (IEEE ICC)**, Jun. 2024, pp. 1758–1763. DOI: 10.1109/ICC51166.2024.10623061
4. 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 the 3rd **ACM Mile High Video (ACM MHV)**, Feb. 2024, pp. 54–60. DOI: 10.1145/3638036.3640806
5. 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 (IEEE FNWF)**, Nov. 2023, pp. 1–6. DOI: 10.1109/FNWF58287.2023.10520543
6. 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 (IEEE FNWF)**, Baltimore, MD, USA, Nov. 2023, pp. 1–6. DOI: 10.1109/FNWF58287.2023.10520408 [**Honorable Mention**]
7. 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 (ACM WiNTECH '23)**, Oct. 2023, pp. 9–16. DOI: 10.1145/3615453.3616512 [**Best Paper Award**]
8. 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 (ACM WiNTECH '22)**, Oct. 2022, pp. 32–39. DOI: 10.1145/3556564.3558241
9. 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 the **ACM Practice and Experience in Advanced Research Computing (ACM PEARC)** Conference Series, Jul. 2022, pp. 1–8. DOI: 10.1145/3491418.3530768
10. T. Abhiroop, **Sarath Babu**, and B. S. Manoj, "*A machine learning consensus based light-weight blockchain architecture for Internet of Things,*" in Proceedings of the 14th **International Conference on Communication Systems & Networks (COMSNETS)**, Jan. 2022, pp. 1–6. DOI: 10.1109/COMSNETS53615.2022.9668487
11. 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
12. **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 (IEEE 5GWF)**, Sep. 2020, pp. 263–268. DOI: 10.1109/5GWF49715.2020.9221228
13. 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 (IEEE 5GWF)**, Sep. 2020, pp. 553–558. DOI: 10.1109/5GWF49715.2020.9221366
14. 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 (IEEE ANTS)**, Dec. 2019, pp. 1–6. DOI: 10.1109/ANTS47819.2019.9118082

15. **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 (IEEE TENCON)**, Oct. 2019, pp. 129–134. DOI: 10.1109/TENCON.2019.8929340
16. 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
17. 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 (IEEE ANTS)**, Dec. 2017, pp. 1–6. DOI: 10.1109/ANTS.2017.8384108
18. 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
19. **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
20. 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 (IEEE GLOBECOM)**, Dec. 2015, pp. 1–7. DOI: 10.1109/GLOCOM.2015.7417610
21. 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 (IEEE ANTS)**, Dec. 2015, pp. 1–6. DOI: 10.1109/ANTS.2015.7413638
22. 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 of the **IEEE Global Humanitarian Technology Conference - South Asia Satellite (IEEE 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. M. Shahid et al., "*Wireless Spectrum in Rural Farmlands: Status, Challenges and Opportunities,*" **arXiv** preprint arXiv:2407.04561v1, Jul. 2024. DOI: 10.48550/arXiv.2407.04561
3. 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
4. **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 (IEEE 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 (IEEE 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)**
   URL: 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.

Professional Affiliations

Institute of Electrical and Electronics Engineers (IEEE)

- **Member** — **Dec 2021 – Present**
  - Societies
    - IEEE Communications Society (ComSoc) — **Dec 2021 – Present**
    - IEEE Computer Society — **Dec 2021 – Present**
  - Communities
    - IEEE Smart Cities — **Jan 2022 – Present**
    - IEEE Future Networks — **Jan 2021 – Present**
    - IEEE Internet of Things — **Jan 2021 – Present**
    - IEEE Sensors Council — **Jan 2015 – Present**
    - IEEE Systems Council — **Jan 2015 – Present**
- **Graduate Student Member** — **Jan 2014 – Nov 2021**
  - Societies
    - IEEE Communications Society (ComSoc) — **Mar 2014 – Dec 2014, Jan 2016 – Nov 2021**
    - IEEE Computer Society — **Mar 2016 – Nov 2021**
- **IEEE Student Branch, Indian Institute of Space Science and Technology**
  - Execute Committee Member — **Feb 2018 – Feb 2020**
  - Secretary — **Dec 2014 – Jan 2018**

Association of Computing Machinery (ACM)

- **Professional Member** — **Dec 2020 – Present**
- **Graduate Student Member** — **Jan 2014 – Nov 2021**

Services

Journal Reviews

- IEEE Transactions on Network and Service Management (IEEE TNSM)
- IEEE Transactions on Wireless Communications (IEEE TWC)
- IEEE Transactions on Communications (IEEE TCOM)
- IEEE Transactions on Aerospace and Electronic Systems (IEEE TAES)
- 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

Technical Program Committees (TPCs)

- **2025:** COMSNETS
- **2024:** ACM WiNTECH, COMSNETS, IEEE FNWF, IFIP Networking
- **2023:** ACM WiNTECH, COMSNETS, IEEE FNWF
- **2022:** ACM WiNTECH
- **2015:** IEEE RAICS

Conference Reviews (In addition to TPCs)

- **2025:** IEEE INFOCOM
- **2024:** IEEE INFOCOM
- **2023:** IEEE GLOBECOM, IEEE ICCC, IEEE INFOCOM
- **2022:** IEEE INDICON, IEEE WF-IoT
- **2021:** IEEE WF-IoT

Volunteering

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

Talks | Workshops

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

Technical Skills

- Programming Languages: *C, C++, Python, Bash Shell Scripting*
- Documentation & Editors: *LaTeX, GNU Emacs*
- Plotting & Visualization: *Gnuplot, TikZ, 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*