Abhishek Chakraborty

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EDUCATION

PhD. Indian Institute of Space Science and Technology, [**2012 − 2018**]
    Research Area: Complex networks, computer networks, and communication networks
    Thesis: On the evolution of finite sized complex networks
    Advisor: Prof. B. S. Manoj

ME Electronics and Communication Engineering. Birla Institute of Technology Mesra, [**2010 − 2012**]
    Specialization: Wireless Communication
    Thesis: Capacity enhancement in indoor wireless communication systems
    Advisor: Dr. Sanjay Kumar

BTech Electronics and Communication Engineering. Maulana Abul Kalam Azad University of Technology [Formerly West Bengal University of Technology], [**2003 − 2007**]
    Institute: College of Engineering & Management, Kolaghat
    Project: Design and development of code for radiation pattern measurement of microstrip antenna
    Advisor: Dr. Debendra Kumar Panda

PROFESSIONAL EXPERIENCES

Post-PhD Experience

Senior Project Officer, [**Dec. 2020 − Present**]
    Department of Computer Science and Engineering, Indian Institute of Technology Madras

Indian Institute of Technology Madras Institute Post Doctoral Fellow, [**Aug. 2018 − Nov. 2020**]
    Department of Computer Science and Engineering, Indian Institute of Technology Madras

Senior Project Fellow, [**May 2018 − Aug. 2018**]
    Department of Avionics, Indian Institute of Space Science and Technology and Indian Space Research Organization

Pre-PhD Experience

Senior Project Fellow, [**Aug. 2017 − May 2018**]
    Department of Avionics, Indian Institute of Space Science and Technology

Teaching Assistant, [**Aug. 2012 − Jul. 2017**]
    Department of Avionics, Indian Institute of Space Science and Technology

        ⋄ Digital Communication Laboratory (AV332).

        ⋄ Computer Networks Laboratory (AV341).

        ⋄ Wireless Mesh Networks Course (AV484).

Teaching Assistant, [**Aug. 2011 − Jun. 2012**]
    Department of Electronics and Communication Engineering, Birla Institute of Technology Mesra

        ⋄ Digital Electronics Laboratory (EC4102).

        ⋄ Wireless Communication and Networking Laboratory (EC7102).

Programmer Analyst, [**Dec. 2007 − Jul. 2009**]
    Cognizant Inc., Kolkata, India

Industrial Training, [Jun. 2006 – Jul. 2006]
    Netaji Subhas Chandra Bose Telecom Training Centre, Kalyani, India

Industrial Training, [Jun. 2005 – Jul. 2005]
    Bharat Sanchar Nigam Limited, Siliguri Zone, India

PROFESSIONAL RESEARCH EXPERIENCE

Institute Post Doctoral Fellow. Indian Institute of Technology Madras, [**Aug. 2018 – Nov. 2020**]
    Project: Architecture and protocol solutions to enhance the QoS of next-generation networks: A complex network analysis-based approach

We worked towards the development of new architecture and protocol solutions to enhance the quality of services of the next-generation networks. Our proposed solutions also satisfied the diverse network-related stringent requirements in the context of upcoming 5G network specifications. In particular, our research works mainly focused toward the novel design and deployment of the next-generation networks which include the following: (i) delay-optimized design of industrial machine-to-machine networks, (ii) deployment of a few edge servers at the identified influential base stations to reduce the end-to-end transmission delay in cellular networks, (iii) latency-aware and reliable placement of virtual network functions at the 5G edge cloud, (iv) efficient and reliable deployment of service function chains (SFCs) for latency-critical services, and (v) the optimal and reliable allocation of virtual monitoring functions for better monitoring and decision-making purposes when the functioning of active SFCs are considered.

Senior Project Fellow. Indian Institute of Space Science and Technology, [**Aug. 2017 – Aug. 2018**]
    Project: Research and development of an integrated enterprise network security system

We worked on designing a novel distributed integrated enterprise network security system framework considering different elements of a typical enterprise network system. In particular, a novel API call transition matrix (API-CTM)-based detection technique was developed, using complex network analysis, that efficiently detects malware attacks on the basis of runtime behavior. With API-CTM recent threats such as polymorphic and metamorphic malware, which are difficult to identify with existing detection techniques (e.g., signature-based detection), can be efficiently detected. The proposed complex network-based malware detection technique can find applications in designing real-time malware detection when an enterprise network security system is considered.

ACADEMIC RESEARCH EXPERIENCES

PhD Thesis. Indian Institute of Space Science and Technology, [**Aug. 2012 – May 2018**]
    Title: On the evolution of finite sized complex networks

Any complex physical system, man-made or natural, consists of entities each of which interacts with other entities in the system. Such complex systems can be modeled as network graphs where the entities are nodes and their interactions are edges of the network graph. Earlier studies reported the possible mechanisms for the evolution of complex networks where size of the network is growing, in the context of nodes and edges, with time. However, the characteristics of finite sized complex systems, which can be seen in many real-world networks are not studied in depth.

This thesis aimed to study the characteristics behind the evolution of finite sized complex networks which can be seen in many real-world networks such as relationships in community networks, transportation networks, computer networks, and wireless sensor networks, to name a few. Here, *finite sized networks* mean that such complex physical systems are not growing in size when total number of nodes is concerned. We found that one of the key reasons behind many complex network formations is greedy optimal/near-optimal decision based optimization of certain network parameters such as minimizing average path length. We also applied our observations from finite sized complex networks to design efficient, when reducing end-to-end transmission delay as well as enhancing average network flow capacity are concerned, finite sized real-world networks.

ME Thesis. Birla Institute of Technology Mesra, [**Jun. 2011 – May 2012**]
    Title: Capacity enhancement in indoor wireless communication systems

We analytically derived the closed-form expressions of the system capacity in the context of single cell and multiple adjacent cells wireless indoor environments. The closed-form expressions also considered the optimal power constraints into account for better evaluation of the network system capacity. To further improve the system capacity, singular value decomposition technique was also incorporated to introduce space as another degree of freedom.

BTech Project. Maulana Abul Kalam Azad University of Technology [Formerly West Bengal University of Technology], [**Jan. 2007 – Apr. 2007**]
    Title: Design and development of code for radiation pattern measurement of microstrip antenna

We developed a Matlab based simulator to visualize the E-plane and H-plane radiation patterns, at a given frequency, in the context of cavity model of the microstrip antenna. The length and width optimizations were also taken into consideration while designing the algorithm. Our algorithm is an approximation model which compares well with the IE3D based simulation model.

LIST OF PUBLICATIONS (PUBLISHED/ACCEPTED)

⋄ **Book**

B1 B. S. Manoj, **Abhishek Chakraborty**, and Rahul Singh, "Complex Networks: A Networking and Signal Processing Perspective," Prentice Hall PTR, New Jersey, USA, February 2018.

⋄ **Book Chapter**

BC1 P. Singh, **A. Chakraborty**, and B. S. Manoj, "Complex network entropy," Chapter in the book titled "Soft Computing Applications in Sensor Networks," Edited by Sankar K. Pal and Sudip Misra, pp. 243-263, CRC Press (USA), August 2016.

⋄ **Refereed International Journals**

J10 Prabhu K. T., **A. Chakraborty**, A. Mathew, and C. Siva Ram Murthy, "Reliable placement of service function chains and virtual monitoring functions with minimal cost in softwarized 5G networks," Accepted in *IEEE Transactions on Network and Service Management*, 2021. (Early Access)

J9 **A. Chakraborty**, S. Babu, and B. S. Manoj, "On achieving capacity-enhanced small-world networks," *Elsevier Physica A: Statistical Mechanics and its Applications*, vol. 556, pp. 124729 (1 – 17), October 2020.

J8 S. Sai Avinash, **A. Chakraborty**, Shaijumon C. S., and B. S. Manoj, "Corporate linkages and financial performance: A complex network analysis of Indian firms," *IEEE Transactions on Computational Social Systems*, vol. 7, no. 2, pp. 339-351, April 2020.

J7 R. Singh, **A. Chakraborty**, and B. S. Manoj, "GFT centrality: A new node importance measure for complex networks," *Elsevier Physica A: Statistical Mechanics and its Applications*, vol. 487, pp. 185-195, December 2017.

J6 P. Singh, **A. Chakraborty**, and B. S. Manoj, "Link influence entropy," *Elsevier Physica A: Statistical Mechanics and its Applications*, vol. 465, pp. 701-713, January 2017.

J5 D. S. Yadav, **A. Chakraborty**, and B. S. Manoj, "A multi-backup path protection scheme for survivability in elastic optical networks," *Elsevier Optical Fiber Technology*, vol. 30, pp. 167-175, July 2016.

J4 **A. Chakraborty**, Vineeth B. S., and B. S. Manoj, "Analytical identification of anchor nodes in a small-world network," *IEEE Communications Letters*, vol. 20, no. 6, pp. 1215-1218, June 2016.

J3 **A. Chakraborty** and B. S. Manoj, "The reason behind the scale-free world," *IEEE Sensors Journal*, vol. 14, no. 11, pp. 4014-4015, November 2014.

J2 N. Gaur, **A. Chakraborty**, and B. S. Manoj, "Delay optimized small-world networks," *IEEE Communications Letters*, vol. 18, no. 11, pp. 1939-1942, November 2014.

J1 S. Das, **A. Chakraborty**, and S. Kumar, "Capacity calculation and sub-optimal power allocation scheme for OFDM-based systems," *Communications and Network*, vol. 4, no. 4, pp. 292-297, November 2012.

◇ **Refereed International Conferences**

C15 Prabhu K. T., **A. Chakraborty**, and C. Siva Ram Murthy, "Latency-aware and survivable mapping of VNFs in 5G network edge cloud," Accepted in *Proc. DRCN 2021*, Milan, Italy, April 2021.

C14 **A. Chakraborty**, B. S. Manoj, and C. Siva Ram Murthy, "An efficient scheme for constructing small-world machine-to-machine networks," in *Proc. IEEE ICC 2020*, pp. 1-6, Dublin, Ireland, June 2020.

C13 V. Mohana Sruthi, **A. Chakraborty**, B. Thanudas, S. Sreelal, and B. S. Manoj, "An efficient malware detection technique using complex network-based approach," in *Proc. NCC 2020*, pp. 1-6, Kharagpur, India, February 2020.

C12 M. Gudiseva, **A. Chakraborty**, and B. S. Manoj, "Social network aware dynamic edge server placement for next-generation cellular networks," in *Proc. COMSNETS 2020*, pp. 499-502, Bengaluru, India, January 2020.

C11 K. V. Niranjan Sai, B. Thanudas, S. Sreelal, **A. Chakraborty**, and B. S. Manoj, "MACA-I: A malware detection technique using memory management API call mining," in *Proc. IEEE TENCON*, pp. 527-532, Kochi, India, October 2019.

C10 **A. Chakraborty**, Vineeth B. S., and B. S. Manoj, "On the evolution of finite-sized complex networks with constrained link addition," in *Proc. IEEE ANTS 2018*, pp. 1-6, Indore, India, December 2018.

C9 V. Mohana Sruthi, B. Thanudas, S. Sreelal, **A. Chakraborty**, and B. S. Manoj, "ACTM: API call transition matrix-based malware detection method," in *Proc. IEEE ANTS 2018*, pp. 1-6, Indore, India, December 2018.

C8 G. Suresh, **A. Chakraborty**, and B. S. Manoj, "Deterministic evolution through indexed leaf node based attachment in complex networks," in *Proc. NCC 2018*, pp. 1-6, Hyderabad, India, February 2018.

C7 R. Singh, **A. Chakraborty**, and B. S. Manoj, "On spectral analysis of node centralities," in *Proc. IEEE ANTS 2016*, pp. 1-5, Bengaluru, India, November 2016.

C6 R. Singh, **A. Chakraborty**, and B. S. Manoj, "Graph Fourier transform based on directed Laplacian," in *Proc. SPCOM 2016*, pp. 1-5, Bengaluru, India, June 2016.

C5 P. Singh, **A. Chakraborty**, and B. S. Manoj, "Conflict graph based community detection," in *Proc. COMSNETS 2016*, pp. 1-7, Bengaluru, India, January 2016.

C4 **A. Chakraborty**, Vineeth B. S., and B. S. Manoj, "Influence of greedy reasoning on network evolution," in *Proc. Indo-US Bilateral Workshop on Large Scale Complex Network Analysis 2015 (LSCNA 2015)*, pp. 81-84, Kolkata, India, December 2015.

C3 **A. Chakraborty** and B. S. Manoj, "An efficient heuristics to realize near-optimal small-world networks," in *Proc. NCC 2015*, pp. 1-5, Mumbai, India, February 2015.

C2 Arun K. P., **A. Chakraborty**, and B. S. Manoj, "Communication overhead of an OpenFlow wireless mesh network," in *Proc. IEEE ANTS 2014*, pp. 1-6, New Delhi, India, December 2014.

C1 N. Gaur, **A. Chakraborty**, and B. S. Manoj, "Load-aware routing for non-persistent small-world wireless mesh networks," in *Proc. NCC 2014*, pp. 1-6, Kanpur, India, February 2014.

◇ **Technical Reports**

T3 **A. Chakraborty**, Vineeth B. S., and B. S. Manoj, "Optimal link addition for achieving small-world properties in linear wireless sensor networks," *Technical Report*, Systems and Networks Lab, Department of Avionics, IIST (ID: IIST-SNL-102-2017-09-21), 2017.

T2 **A. Chakraborty**, S. Babu, and B. S. Manoj, "On achieving capacity-enhanced small-world networks," *Technical Report*, Systems and Networks Lab, Department of Avionics, IIST (ID: IIST-SNL-101-2017-09-21), 2017.

T1 **A. Chakraborty**, Vineeth B. S., and B. S. Manoj, "A study on constrained long-ranged link addition in complex networks," *Technical Report*, Systems and Networks Lab, Department of Avionics, IIST (ID: IIST-SNL-100-2017-09-21), 2017.

RESEARCH INTERESTS

⋄ Network Science

⋄ Complex Networks

⋄ Algorithms for Complex Networks

⋄ Communication Networks

⋄ Wireless Mesh Networks

⋄ Wireless Sensor Networks

⋄ Future Wireless Network Design

⋄ Softwarized 5G Networks

SKILLS

Programming: MATLAB, Python, and Network Simulator 2
Data Visualization Tools: Gephi and Pajek
Language: Bengali (native), English (fluent), and Hindi (fluent)

AWARDS & RECOGNITIONS

⋄ Selected for SERB National Post Doctoral Fellowship (SERB N-PDF) 2018 in Engineering Sciences under SERB, DST, GoI (File Number: PDF/2018/003828).

⋄ Recipient of the Institute Post Doctoral Fellowship at Indian Institute of Technology Madras from August 2018 to November 2020.

⋄ Recipient of the Springer Best Student Paper Award for the research paper titled "Graph Fourier transform based on directed Laplacian" at the 2016 11th International Conference on Signal Processing and Communications (SPCOM 2016), IISc Bangalore, India, June 2016.

⋄ Recipient of the IIST Scholarship (Sponsored by Department of Space, GoI) from August 2012 to July 2017.

⋄ Recipient of the Student Travel Grant to attend ACM MobiHoc 2013, Bangalore, India, from July 29, 2013 to August 01, 2013.

⋄ Recipient of the MHRD Scholarship (Sponsored by MHRD, GoI) from July 2010 to May 2012.

⋄ Qualified GATE (**G**raduate **A**ptitude **T**est in **E**ngineering, All India Entrance examination to Master's program, conducted by MHRD, GoI) Examination, 2010 with 94.13 Percentile.

Professional Affiliations, Activities, & Services

◇ Member, IEEE

◇ Member, ACM

◇ Member, IEEE Communications Society

◇ Chair, IEEE Student Branch at Indian Institute of Space Science and Technology [**2012–2013**]

◇ Student Member of the International Conference of Devices and Communication (ICDeCom) at Birla Institute of Technology Mesra [**2011**]

◇ IEEE Graduate Student Member Volunteer for IEEE RAICS 2013, 2015

◇ IEEE Graduate Student Member Volunteer for 2016 IEEE Shannon Centennial Workshop on Communications and Information Theory (SCWCIT 2016)

◇ Graduate Student Member Volunteer for Trivandrum School on Communications, Coding, and Networking 2017

◇ Reviewer of the following International Journals:

    – IEEE Transactions on Network Science and Engineering

    – IEEE Transactions on Communications

    – IEEE Sensors Journal

    – IEEE Communications Letters

    – IEEE Networking Letters

    – Elsevier Computer Networks

    – Elsevier Physics Letters A

    – Elsevier Physica A: Statistical Mechanics and its Applications

    – Springer Nature: SN Computer Science

◇ Reviewer of the following International Conferences:

    – IEEE WF-IoT 2021

    – IEEE WCNC 2020

    – NCC 2020

    – CoCoNet 2019, 2020

    – IEEE GHTC-SAS 2013

    – IEEE RAICS 2013, 2015, 2018

References

References are available upon request.