
Dr. Padmalochan Bera

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Qualification:

PhD (Doctor of Philosophy, 2011)

- in Indian Institute of Technology, Kharagpur.
- *Thesis:* Formal Analysis of Security Policy Implementations in Enterprise Networks.
- *Supervisor(s):* Dr. S. K. Ghosh and Dr. Pallab Dasgupta, IIT Kharagpur.

ME (Masters in Engineering, 2006)

- in Computer Science in Engineering from West Bengal University of Technology, Kolkata, India.
- *Specialization:* Embedded Systems, Distributed Systems
- Marks: 74.5%

BE (Bachelor in Engineering, 2001)

- in Computer Science in Engineering from Jadavpur University, Kolkata, India.
- *Specialization:* Databases, Graph Theory, Operating Systems, Data Structure and Algorithms
- Marks: 71.9%

H. Sc (10+2, 1995)

- in Science from Ramkrishna Mission Vidyamandir Belure Math, Howrah, India.
- Marks: 83.5%

Secondary (10, 1993)

- in Science from Ramkrishna Mission Vidyabhawan, Midnapore, India.
- Marks: 85%

Current Research Area:

Network Security Automation, Cyber Physical Systems Security, Software Security Testing, Internet of Things, Formal Modeling and Optimization.

Areas of Interest/Previous Research:

Network Security, Security Configuration Synthesis, Access Control Models, Formal Property Verification

Work Experiences:

- Working as Assistant Professor in School of Electrical Sciences, Indian Institute of Technology Bhubaneswar, India from September 2013 to till date.
- Worked as a Senior Research Scientist in Infosys Labs (Software Test Automation and Optimization Group), Bangalore, India from July 2012 to till date.
- Worked as a Researcher at General Motors India Science Lab (Control Software Validation Group), Bangalore, India from September 2011 to June 2012.
- Worked as a Post-Doctoral Research Associate in CyberDNA Research Center, University of North Carolina at Charlotte, NC, USA from October 2010 to September 2011
- Worked as a Senior Research Fellow in a Research Project titled “*Design & Development of Models and Tools for Vulnerability Assessment of Embedded Systems*” sponsored by Ministry of Defense, New Delhi in Indian Institute of Technology Kharagpur, India from July 2007 to September 2010.
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Research Projects (at Infosys Labs):

- Quantification of Preventive Maintenance Metric for Enterprise Software
- Test Case Generation and Optimization for System of Systems Testing
- Fault Injection based Software Security Testing in Cloud Infrastructure

Research Projects (at General Motors, India Science Lab):

Modern Technology Cars consist of a large number of Electronic Control Units (ECU) which are automatically managed by different embedded control software. These software essentially take inputs from different sensors at different time and accordingly triggers necessary actions to ensure consistent functionality and higher security and safety in different scenarios. My research at General Motors India Science Lab was focused on developing methodologies for automatic verification and validation of these control software in integration based on several safety-critical requirements and functional invariants/constraints. I was leading the following projects:

- RemoteGen: Requirement based Test Case Generation for Automotive Control software – End Applications: CSAV 2 Features (Supercruise, ACC)
- Modeling and Optimization of AUTOSAR based Control Design
- Model based Software Integration Testing

Previous Research (PhD and Post-Doc):

The major area of my research is Network Security and Formal Methods. I have more than 4 years of applied research experience in this domain. My work essentially focused on formal (mathematical) modeling of large-scale network configurations and verifying different safety and security constraints in the configuration model. The major challenges in this verification problem lies in (i) modeling distributed network configurations in a scalable manner; (ii) correct and conflict-free representations of security constraints or policies based on various standards and organizational requirements; and (iii) providing automated and proof-based methodology to ensure the satisfaction of the security constraints in the network configuration.

My PhD thesis is on “Formal Analysis of Security Policy Implementations in Enterprise Networks”. It primarily concentrates on formalizing organizational security policy and distributed ACL implementations in an enterprise network and verifying whether the implementation conforms to the policy under static and dynamic topology environments. Through this research, I have developed a Formal Integrated Network Security Analysis Tool, namely, FINSAT, for systematic analysis of security policy implementations in enterprise networks. The tool allows users/network administrators querying about various service access paths in the networks with different security constraints towards hardening the security perimeter over the networks. I have also worked on policy based security management in wireless networks (WLAN) supported by spatio-temporal role based access control models (STRBAC). I was actively involved in the following research activities throughout my PhD and Post-Doc tenure:

- Formal Verification of Access Control Models in IP Networks
- Fault Tolerant Policy based Security Implementations in IP Networks
- Formal Analysis of Security Threats in Smart-Grid Networks

Lead Research Projects (at UNC, Charlotte, USA):

- SmartAnalyzer: Framework for Analyzing Threats in Smart Grid Network Infrastructure sponsored by Duke Energy Systems, USA.
- ConfigLego: An Imperative approach of Security Configuration Analysis in Enterprise Networks sponsored by NSF, USA.
- ConfigSlider: Synthesizing Optimal and Usable Network Security Configuration using Constraint Satisfaction Checking sponsored by NSF, USA

Programming Skills and Verification/Testing Tools used

- Modeling and Test Tools: Simulink/Stateflow, Reactis, SDV toolset (Mathworks)
- SAT/BDD based verification Tools: zChaff, miniSAT, Cudd
- Model Checking Tools: SPIN, Z3 (SMT based), NuSMV, Bounded Model Checker
- Declarative Logic Programming: Prolog, Alloy
- Programming Languages: C, Java, C++
- Hardware Programming Language: VHDL, Verilog, systemC

Research Publications:

Journals:

- Soumya Maity, Padmalochan Bera, S. K. Ghosh, Ehab Al-Shaer, *FINSAT: Formal Query based Network Security Configuration Analysis*. **In IET Networks**, February 2014 (To appear).
- M. Ashiqur Rahaman, Ehab Al-Shaer, P. Bera, *A Noninvasive Threat Analyzer for Advanced Metering Infrastructure in Smart Grid* **In IEEE Transaction on Smart Grid** vol 4(1), pp. 273-287, March 2013

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- **P. Bera**, Pallab Dasgupta, S. K. Ghosh, *Policy based Security Analysis in Enterprise Networks- A formal approach*, In **IEEE Transaction on Network and Service Management (IEEE TNSM)**, vol. 7(4), pp. 231-243, December 2010.
 - **P. Bera**, Pallab Dasgupta, S. K. Ghosh, *Integrated Security Analysis Framework for an Enterprise Network-A Formal Approach*, In **IET Information Security Journal**, vol. 4(4), pp. 283-300, December 2010.
 - **P. Bera**, S. K. Ghosh and Pallab Dasgupta, *A WLAN Security Management Framework based on Formal Spatio-Temporal RBAC Model*, **Journal of Security and Communication Networks**, Wiley InterScience, vol 4(9), pp. 981-993, August 2011.
 - **P. Bera**, Pallab Dasgupta, S. K. Ghosh, *Formal Analysis of Security Policy Implementations in Enterprise Networks*. **International Journal of Computer Network and Communications (IJCNC)**, Vol. 1(2), pp. 56-73, July 2009.

Selected Conferences:

- S. Majhi, **P. Bera**, S. Kumar, E. Al-Shaer, M. Satpathy, *Synthesizing Optimal Network Security Configurations in Enterprise Networks – a formal approach*. In **9th IET System Safety and Cyber Security Conference**, Manchester, UK, October 2014 (Accepted)
- **P. Bera** and S. K. Ghosh, *A Query Driven Security Testing Framework for Enterprise Network*, In **IEEE SECTEST with IEEE ICST Conference**, Luxembourg, March 2013
- M. Ashiqur Rahaman, **P. Bera** and E. Al-Shaer, *A Non-invasive Security Threat Analyzer for AMI Smart Grid*, **IEEE INFOCOM 2012**, pp. 2255-2263, Florida, USA, March 2012
- **P. Bera** and A. Pasala, *A Framework for optimizing effort in Testing System-of-Systems*, In **IEEE ICSEM 2012**, December 12-15 2012, Mysore, India
- Saeed Al-Haj, **P. Bera** and Ehab Al-Shaer, *Build and Test Your Own Network Configuration*, 7th International ICST Conference on Security and Privacy in Communication Networks (SecureComm 2011), London, UK, September 2011
- **P. Bera**, Soumya Maity, S. K. Ghosh and Pallab Dasgupta, *Generating Policy based Security Implementations in Enterprise Networks*. In **ACM SafeConfig Workshop, ACM CCS 2010**, Chicago, USA, October 2010.
- **P. Bera**, Pallab Dasgupta, S. K. Ghosh, *A Spatio-temporal Role-based Access Control Model for Wireless LAN Security Policy Management*, In **4th International Conference on Information Systems, Technology and Management (ICISTM-10)**, LNCS, Springer pp 76-88, Bangkok, March 2010.
- **P. Bera**, Soumya Maity, S. K. Ghosh and Pallab Dasgupta, *A Query based Formal Security Analysis Framework for Enterprise LAN*, In **10th IEEE International Conference on Computer and Information Technology 2010 (CIT 2010)**, Bradford, UK, pp. 407-414, IEEE Computer Society, June 2010

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- **P. Bera**, Pallab Dasgupta, S. K. Ghosh, *Formal Verification of Security Policy Implementations in Enterprise Networks*, In **International Conference on Information Systems and Security (ICISS 2009)**, LNCS 5905, pp. 117-131, Kolkata, India, December 2009.
 - **P. Bera**, Pallab Dasgupta, S. K. Ghosh, *Fault Analysis of Security Implementations in Enterprise Networks*, In **IEEE International Conference on Network and Communication Systems (NetCom 2009)**, DOI: 10.1109/Netcom.2009.82, pp. 240-245, Chennai, India, December 2009.

Book Chapter:

- E. Al-Shaer, S.K.Ghosh, **P. Bera**, *Formal Analysis of Policy based Security Configurations in Enterprise Network*, In **Handbook on Securing Cyber-Physical Critical Infrastructure**, ISBN: 9780124158153, Morgan Kaufmann Publication, USA, June 2012

Technology Patents (filed):

- 4294/CHE/2013: A. Pasala, **P. Bera**, Tom Nedumgad. Methods, Systems and Computer Readable Media for Quantifying Bug Detection Efficiency of bug prediction technique,
- 1330/CHE/2014: **P. Bera**, A. Pasala. Method and System for Generating Stateflow Models from Software Requirements

Professional Activities (Seminars, Workshops & Courses):

- Attended IBM Faculty Residency Program on Cyber-Security at IBM Bangalore, India during June 4-6 2014.
- INSTEP Award for Thought and Leadership 2012-13 and 2013-14, Infosys Technologies Ltd., Bangalore
- Postdoctoral Fellow, CyberDNA Research Center, University of North Carolina Charlotte, USA
- ACM Travel Award for presenting paper in ACM Safeconfig, CCS 2010
- Delivered Talk on “Security and Safety Challenges in Smart Grid Advanced Metering Infrastructure” in IEEE CSS Symposium on Cyber Physical Systems at IISC Bangalore, India during November 2-3 2012.
- Delivered Lectures on Cyber Security Challenges and Scope of Formal Methods under Advanced Network Security Course in University of North Carolina Charlotte, USA, Fall Semester 2011
- Delivered Lecture on Formal Analysis of Security Configurations in Enterprise Networks at CyberDNA Research Seminar in University of North Carolina at Charlotte, USA, March 18 2011
- Presented papers in conferences: ICISS 2009, IACC 2009, NetCom 2009, ICISTM 2010, ICDCN 2010 (Poster), Safeconfig ACM CCS 2010, IEEE INFOCOM 2012, IEEE SECTEST 2013

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- Attended Microsoft Research (MSRI) summer school on Programming Languages, Analysis and Verification in IISC, Bangalore during 16-28 June 2008.
 - Attended 3 week UGC Refresher's Course on Natural Language Processing in Jadavpur University, Kolkata during November 25-December 16, 2003.
 - National Scholarship for results in Secondary Examination
 - National Scholarship for results in Higher Secondary Examination

References:

- Dr. S. K. Ghosh, Associate Professor, School of Information Technology, IIT Kharagpur-721302, India. Phone No: 91-3222-282332, Fax: 91-3222-255303, Email: skg@iitkgp.ac.in.
- Dr. Pallab Dasgupta, Professor, Dept of Computer Sc&Engg, IIT Kharagpur-721302, India. Phone No: 91-3222-283470, Fax: 91-3222-255303, Email: pallab@cse.iitkgp.ernet.in.
- Dr. S Ramesh, Technical Fellow, General Motors, India Science Lab, Tech Center, Warren, MI, USA, Tel.: 1-248-534-0440, Email: ramesh.s@gm.com.
- Dr. Ehab Al-Shaer, Professor& Director CyberDNA Research Center, University of North Carolina Charlotte, NC 28223, USA, Tel: 1-704-687-8663, Email: ealshaer@uncc.edu.
- Dr. Indranil Sengupta, Professor, Dept of Computer Sc&Engg, IIT Kharagpur-721302, India. Phone No: 91-3222-283496, Fax: 91-3222-277190, Email: isg@iitkgp.ac.in