

FATIMA MUHAMMAD ANWAR

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Networked & Embedded Systems Lab (NESL), 1762 Boelter Hall,
Electrical & Computer Engineering Department, UCLA,

RESEARCH INTERESTS

My interests lie in the intersection of **system design**, **security**, and **quality of time** in distributed Cyber-Physical Systems. In particular, I design **trustworthy systems** around **abstractions** to provide key services to **IoT applications** running on commodity platforms and operating systems.

EDUCATION

University of California, Los Angeles

September 2014 - Present

PhD. in Electrical & Computer Engineering (ECE)

GPA: 4/4

- Supervisor: Professor Mani Srivastava, Joint faculty in ECE and CS, UCLA
- Research: Trustworthy and high performance systems for IoT applications under timing variations and vulnerabilities
- Awards: Qualcomm Innovation Fellowship Finalist 2018, Grace Hopper Scholar 2017, Departmental Fellowship 2014

Ajou University, South Korea

March 2009 - Feb 2011

MS. in Computer Engineering

GPA: 4.44/4.5

- Thesis: Spherical Mapping based load-aware Routing for Wireless Sensor Networks
- Awards: BK21 - Brain Korea 21 Scholarship Program for Leading Universities & Students

University of Engineering & Technology, Lahore Pakistan

September 2004 - August 2008

BSc. in Electrical Engineering: Electronics & Communication

GPA: 3.85/4.0

- Project: Autonomous Chasing Robot
- Class Rank: *top 10 among 350 students*

RESEARCH EXPERIENCE

Networked & Embedded Systems Lab, UCLA

September 2014 - Present

Graduate Student Researcher

Los Angeles, CA

- Design **secure service architectures** for applications running in the cloud or at the edge leveraging trusted execution environments such as Intel SGX, ARM TrustZone, and Trusted Platform Module.
- Devise operating system abstractions and implement API to enable **quality of time** in system stack.
- Build programming tools for **high precision** time support over commodity platforms and operating systems in **uncertain environments**.
- Propose secure and **resource-aware** time synchronization protocols.
- Design protocols for **distributed systems** to coordinate tasks and choreograph acts.
- Investigate **side channel attacks** notably timing & micro-architectural side channels attacks.

Internet Lab, Ajou University

March 2009 - February 2011

Research Assistant

South Korea

- Design protocols for load-aware routing, reliability in communication, and automatic service discovery in Wireless Sensor Networks. Implement on network simulators such as ns-2 and Qualnet.

Electronics Lab, UET

Research Assistant

September 2007 - August 2008

Lahore, Pakistan

- Hands-on experience on robotics sensing, control, and actuation leveraging off-the-shelf microcontrollers, sensors, and motors.
- Design efficient sensor sampling, and fuzzy logic controller for an autonomous robot.

INDUSTRIAL EXPERIENCE

Advanced R&D Group, Mobile Communications Division, Samsung Electronics March 2011 - December 2013

Software Engineer

South Korea

- Developed services for Smart Health project (SHealth) by leveraging pedometer, sensor service framework and communication of mobile devices with galaxy gear.
- Implemented WiFi Direct and Location based WiFi auto-connection.
- Designed Music Hub's albums display and music streaming application
- Gained experience of Android multi-threaded application design, UX design, and software testing.

PUBLICATIONS

1. Joseph Naor, Sandeep Singh, [Fatima M. Anwar](#), Mani Srivastava. Quantifying and Mitigating Poor Quality of Time Across Smartphones in Distributed Sensing Applications (under review)
2. [Fatima M. Anwar](#), Luis Garcia, Xi Han, Mani Srivastava. Securing Time in Untrusted Operating Systems with TimeSeal, IEEE REAL TIME SYSTEMS SYMPOSIUM (RTSS'19).
3. [Fatima M. Anwar](#), Mani Srivastava. Applications and Challenges in Securing Time, USENIX WORKSHOP ON CYBER SECURITY EXPERIMENTATION AND TEST (CSET'19).
4. Joseph Naor, Sandeep Singh, [Fatima M. Anwar](#), Mani Srivastava. Exploiting Smartphone Peripherals for Precise Time Synchronization, IEEE SYMPOSIUM ON PRECISION CLOCK SYNCHRONIZATION FOR MEASUREMENT, CONTROL, AND COMMUNICATION (ISPCS'19).
5. [Fatima M. Anwar](#), Mani Srivastava. A Case for Feedforward Control with Feedback Trim to Mitigate Time Transfer Attacks, ACM TRANSACTIONS ON PRIVACY AND SECURITY (TOPS) (in revision).
6. [Fatima M. Anwar](#), Amr Alanwar, Mani Srivastava. OpenClock: A Testbed for Clock Synchronization Research, IEEE SYMPOSIUM ON PRECISION CLOCK SYNCHRONIZATION FOR MEASUREMENT, CONTROL, AND COMMUNICATION (ISPCS), Oct 2018, CERN, the European Organization for Nuclear Research.
7. [Fatima M. Anwar](#), Mani Srivastava. A trust in time saves millions, USENIX SUMMIT ON HOT TOPICS IN SECURITY, Aug 2018, Baltimore, USA.
8. Muhammad Taqi Raza, [Fatima M. Anwar](#), Songwu Lu. Exposing LTE Security Weaknesses at Protocol Inter-Layer, and Inter-Radio Interactions, 13TH INTERNATIONAL CONFERENCE ON SECURITY AND PRIVACY IN COMMUNICATION NETWORKS (SECURECOMM), Oct 2017, Niagra Falls, Canada.
9. [Fatima M. Anwar](#), Mani Srivastava. Precision Time Protocol over LR-WPAN & 6LoWPAN, ISPCS, Aug 2017, California, USA.
10. Amr Alanwar, [Fatima M. Anwar](#), Yi-Fan Zhang, Justin Pearson, Joao Hespanha, Mani Srivastava. Cyclops: PRU Programming Framework for Precise Timing Applications, ISPCS, Aug 2017, California, USA.
11. [Fatima M. Anwar](#), Sandeep D'souza, Adwait Dongare, Anthony Rowe, Raj Rajkumar, Mani Srivastava. Timeline: An Operating System Abstraction for Time-Aware Applications, IEEE REAL TIME SYSTEMS SYMPOSIUM (RTSS), Dec 2016, Porto, Portugal.

12. Zhou Fang, Mulong Luo, Fatima M. Anwar, Hao Zhuang, Rajesh K. Gupta. Go-realtime: a lightweight framework for multiprocessor real-time system in user space, ACM SIGBED REVIEW - SPECIAL ISSUE ON REAL-TIME COMPUTING AND DISTRIBUTED SYSTEMS IN EMERGENT APPLICATIONS (REACTION 16) archive Volume 14 Issue 4 Pages 46-52.
13. Amr Alanwar, Fatima M. Anwar, Joao Hespenha, Mani Srivastava. Realizing Uncertainty-Aware Timing Stack in Embedded Operating Systems, ACM EMBEDDED OPERATING SYSTEMS WORKSHOP IN CONJUNCTION WITH ESWEEK, Oct 2016, Pittsburgh USA.
14. Fatima M. Anwar, M. Taqi Raza, Seung wha Yoo, Ki hyung Kim. Spherical Mapping based Load Aware Routing for Wireless Sensor Networks, TECHNICAL REPORT, 2011.
15. Fatima M. Anwar, M. Taqi Raza, Seung wha Yoo, Ki hyung Kim. ENUM based service discovery architecture for 6LoWPAN, IEEE WIRELESS COMMUNICATION AND NETWORKING CONFERENCE (WCNC), April 2010, Sydney, Australia.
16. Fatima M. Anwar, Seung wha Yoo, Ki hyung Kim. Survey on service discovery for Wireless Sensor Networks, ICUFN, June 2010, Jeju Island, Korea.
17. M. Taqi Raza, Fatima M. Anwar, Seung wha Yoo, Ki hyung Kim. Requirements and Design Architectures of Sensor Service Portal (SSP) in Ubiquitous Pervasive Environment, HANDBOOK OF RESEARCH ON MOBILE SOFTWARE ENGINEER DESIGN, IMPLEMENTATION AND EMERGENT APPLICATIONS, IGI Publishing, 2011.
18. Ali Tufail, Syed Ali Khayam, Amna Ali, Waleed Akram Baig, Fatima M. Anwar, Ki-Hyung Kim, Seung-Wha Yoo. On the reliability of backbone-assisted end-to-end transmissions in WSNs, PROCEEDINGS OF UBIQUITOUS AND FUTURE NETWORKS, July 2009, Hong Kong.

OPEN SOURCE TOOLS & TESTBEDS

- QoT Stack: Timeline centered Quality of Time (QoT) architecture
- wPHC: Wireless Precise Hardware Clock enables PTP over WPAN & 6LoWPAN
- OpenClock: A testbed for clock synchronization research
- Cyclops: Cycle level operations for timing detriminism
- TimeSeal: A secure time architecture

INVITED TALKS

- Quality of Time: A New Perspective in Designing Cyber-Physical Systems, UVA 2019
- Quality of Time: A New Perspective in Designing Cyber-Physical Systems, Georgia Tech 2019
- Quality of Time: A New Perspective in Designing Cyber-Physical Systems, UMASS Amherst 2019
- Stale time is a security threat, ENGR 191 Research Seminar, UCLA 2018
- Lip Sync: Achieving perfect synchrony in audio and video, Grad Slam 3 minute research talk, UCLA 2018
- Clocks & Time Synchronization, CS/ECE M119 guest lecture, UCLA 2018
- TNT: Trusted Notion of Time for Resilient Autonomous Driving, QInF'18 Finalist talk 2018
- Quality of Time in Cyber Physical Systems, at System Energy Efficiency Lab (SeeLab), UCSD 2017
- Embedded Linux Time Stack, EEM202A guest lecture, UCLA 2017
- Timing Abstractions & Programmable Clocks in Network Programming, SIGCOMM lightning talk 2017
- Timeline: An Operating System Abstraction, ECE Annual Research Review, UCLA 2017
- Introduction to Embedded Systems, Los Angeles Computing Circle, UCLA 2017-2018
- Introduction to Energy & Power Efficiency, Los Angeles Computing Circle, UCLA 2016

HONORS & AWARDS

- Qualcomm Innovation Fellowship (QInF) Finalist 2018
- Best lightning talk award at N2Women Workshop SIGCOMM 2017

- Grace Hopper Scholar 2017
- University of California Los Angeles EE Departmental Fellowship 2014
- Promotion at Samsung Electronics 2013
- Korean Govt. Scholarship, Brain Korea (BK21) for Masters Studies 2009 - 2011
- Received 2nd prize in robotics engineering project competition in SOFTEC 4th International & 13th National Event 2008
- Recipient of HSS Bright Students Scholarship from Government of Pakistan 2004

MENTORING EXPERIENCE

1. *GPS-synced indoor Phasor Measurement Unit (PMU)* UCLA

- This was a Capstone project of a Masters student.
- We designed a PMU that measures three phases of a power grid to monitor its health. We used a Programmable Real-time Unit (PRU) for precise timestamping, and interfaced PRU with a Linux processor for data streaming, and clock synchronization.
- We developed a timing stack for sub-microsecond clock synchronization among distributed PMUs, and a signal processing unit that filters the phasor measurement.
- We implemented our PMU SoC and interfaced it to a beaglebone black platform and a PRU.

2. *Crazyflie Control with Ultrawideband radios* UCLA

- This was a Capstone project of a Masters student.
- We designed platforms that transmit ultrawideband beacons and do time of flight measurements for crazyflie relative localization.
- We developed ROS based communication and control of crazyflie.

3. *Data Distribution Service (DDS) in QoT architecture* UCLA

- This was a summer project of an undergraduate student.
- We designed a data distribution service that disseminates clock metadata to distributed nodes.
- We developed a best master selection algorithm that decides which node's clock acts as a reference for all other nodes to synchronize to.
- During this process, the student learned Linux, kernel development, and project management that helped him secure a good job.

TEACHING EXPERIENCE

ELENGR M16-1: Logic Design of Digital Systems Spring quarter 2017 *Teaching Assistant* UCLA

- Prepared assignments, solutions, and design projects covering concepts such as number systems, combinational and sequential logic, moore and mealy FSMs, parallelism and pipelining.
- Conducted honorary part of the class by giving 10 students hands-on experience on Verilog programming and Vivado (Xilinx FPGA design environment) development. The final project was to design FSMs for Morse code and display LED patterns for Morse code on the FPGA.
- Taught 2 hours long two discussion sections along with weekly office hours.
- Got 8/10 average student rating.

Circuit Theory & Control Systems Fall semester 2008 *Lecturer & Lab Instructor* University of Central Punjab, Pakistan

- Co-taught weekly classes, and associated labs that covered concepts from circuits theory, analog electronics, and control systems in different classes.

- Office hours for students to guide them voluntarily in robotics projects
- Got 9/10 average student rating.

TECHNICAL STRENGTHS

Programming Languages	Linux Kernel programming, Java, C/C++, Python, Assembly, Verilog HDL, VHDL
System Software	Intel SGX Linux SDK & PSW, Arm TrustZone, TPM, ROS, OpenUAV
Hardware	Beaglebone black, raspberry Pi, mbed, AVR, Atmel AT86RF233, DW1000, TI chips, Xilinx FPGA, PIC uC
Design	Embedded systems design, Electric VLSI design, PCB design

PROFESSIONAL ORGANIZATIONS AND SERVICE

- IEEE and ACM member 2016 - present
- Reviewed Journals for Transactions on Dependable and Secure Computing (TDSC), and Distributed Sensor Networks
- Volunteer for annual Los Angeles Computing Circle (LACC) Workshop, and Engineering Day for Girls at UCLA
- Inspire high school students for engineering through fun embedded projects 2016 - 2018
- Served as a Panelist in Students with Dependents Working Group 2018
- Organize community building events under University Apartments South Residents' Association 2018
- Member of Graduate Division Society of Women Engineers (Grad SWE)
- Graduate/Undergraduate panel discussions, Master's and PhD Engineering and Technology Industry Networking events 2015
- English TA for Winter Intensive English Camp at Ajou University 2010
- Organized ICEE (International Conference on Electrical Engineering) at UET and conducted FPGA and PCB design workshops during undergraduate studies 2005-2007