

SHWETHA VITTAL

About:

The more I research, the more I learn new things. And the more I learn, I appreciate the exceptional creativity and realize the greatest architect of the universe - The GOD (Generator, Operator, and the Destructor). There is no research without the power of GOD in it.

Objective:

To utilize my skills to the best, while being resourceful, innovative and flexible as part of an organization, which provides challenging opportunities, meaningful career growth and professional development.

Currently pursuing Ph.D in Computer Science & Engineering from IIT Hyderabad, India.

Summary

- Passionate in the telecommunication networking domain, especially 5G, LTE, NFV, SDN, Cloud computing, evolving new features, patents.
- Close to 15 years of Industry experience in telecommunications software development (5G, LTE, EPC, NFV, 3G, UMTS, VoIP), with strong analytical skills and broad range of technical expertise.
- Experience in design, development with C, C++, testing, maintenance and support.
- Strong skills in development and debugging in C on Linux.
- Good skills in leading the development team.
- Solid experience in customer interactions.

PROFESSIONAL BACKGROUND

Mavenir Systems India Private Limited	October 2014 to January 2019
Juniper Networks India Private Limited	July 2013 to Oct 2014
Radisys Corporation (Previously Continuous Computing India Private Limited)	November 2007 to 2012
Dataflex Design Communications Limited (Surrey, United Kingdom)	September 2006 to 2007.
Sasken Communications Technologies	August 2005 to 2006
Multitech Software Systems India Pvt Ltd	August 2003 to 2005.

Education

Degree	University	Percentage/CGPA	Year
Ph.D in Computer Science and Engineering	Indian Institute of Technology Hyderabad	8.29 on a scale of 10	Ongoing (Start: January 2019)
M.S in Software Systems (Work Integrated Programme)	Birla Institute of Technology and Science, Pilani (BITS)	8.92 on a scale of 10.	2009-2011
B.E in Computer Science	Manipal Institute of Technology, MAHE, Manipal	86% - First class with distinction.	1999-2003

Research Area

- 5G System and Networks
- Network Slicing in 5G system
- Network Slicing Orchestration and Management
- High Availability, Reliability, Load Balancing, Resiliency of Network Slicing
- Application of Artificial Intelligence with Machine Learning and Deep Learning in 5G network slicing.
- Influence and Impact of Network Function Virtualization (NFV), Software Defined Networking (SDN), and Multi-access Edge Computing on Network Slicing

Research Publications (Reverse chronological order)

- **Shwetha Vittal** and Antony Franklin A, "HARNESS: High Availability supportive Self Reliant Network Slicing in 5G Networks," in IEEE Transactions on Network and Service Management 2022.
- **Shwetha Vittal**, Sourav Sarkar, Prashanth P S, Antony Franklin A, "A Zero Touch Emulation Framework for Network Slicing Management in a 5G Core Testbed", in Proc. of the 17th IEEE Conference on Network and Service Management (CNSM), Izmir, Turkey 2021.
- **Shwetha Vittal** and Antony Franklin A, "Self Optimizing Network Slicing in 5G for Slice Isolation and High Availability", in Proc. of the 17th IEEE Conference on Network and Service Management (CNSM), Izmir, Turkey 2021.
- **Shwetha Vittal**, Aditya Chilukuri, Sourav Sarkar, Akshitha Shinde, and, Antony Franklin A "Performance Study of Large Scale Network Slice Deployment in a 5G Core Testbed", in Proc. of the 4th IEEE 5G World Forum (5GWF), Canada, 2021.

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- Mohit Kumar, **Shwetha Vittal**, and Antony Franklin A, “SERENS: Self Regulating Network Slicing in 5G for Efficient Resource Utilization”, in 3rd IEEE 5G World Forum, 2020.
- **Shwetha Vittal**, Mohit Kumar, and Antony Franklin A, “Adaptive Network Slicing with Multi-Site Deployment in 5G Core Networks”, in Proc of 6th IEEE Conference on Network Softwarization (NETSOFT), 2020.

Patents (Reverse chronological order)

- **Shwetha Vittal** and Antony Franklin A, “Method and System for Slice Identification in 5G RAN and Core for Secure Slice Service”.Provisional Application Filing Date: 11-Apr-2022, Application Number: 202241021594, Status: Patent Pending, India.
- **Shwetha Vittal**, “Services capability server triggered service capability exposure function connection establishment to support non IP data delivery”. US10945121B2 · Issued Mar 9, 2021

Honors

- Presented a demonstration at IEEE 5G World Forum 2020 on **An Emulation Framework for End to End 5G Systems** as part of the ongoing Indigenous 5G Testbed Project.
- Filed an Invention Disclosure on "Method of Fast Indirect Data Forwarding Path during handover in 3GPP access network and Evolved Packet System"
- Received Spot Award at Mavenir, for outstanding performance in MME development activities.
- Received appreciation from CCIN (Continuous Computing India) for executing and demonstrating the successful exchange of end to end IP data over the first time developed LTE nodes on Linux setup in the organization. This helped the organization to win many customer deals further.
- Published an article on “**Single Radio Voice Call Continuity over LTE**” in “FierceWireless” magazine in November 2010. <http://go.radisys.com/rs/radisys/images/paper-lte-srvcc.pdf>
- Involved in writing a white paper on “Performance benchmarking of home eNodeB stacks on Intel Calpella platform”.
- Received best performance award from CCIN for achieving high performance data rate over DL and UL directions in end to end LTE nodes setup over eNodeB executing in Intel and Freescale boards.
- Received appreciation award from CCIN for setting up the successful data exchange for both CS and PS calls over lu interface in the femtocell environment of Picochip.
- Received appreciation award from CCIN for technical expertise in contributing to the design of UA framework in the SIP SDK project.
- Certified “**White Belt**” on Kaizen from Organization wide training “**Kaizen Boot Camp**”.
- Received appreciation award from CCIN for introducing the Doxygen documentation successfully as part of SIP SDK project. This was the first time that the Doxygen was introduced for any project in the organization.
- Received appreciation for developing a bug free feature on Multiple Subscriber on BRI in MultiVoIP at Multitech Software Systems.
- Received an excellent grade for the dissertation work carried out as part of M.S in Software Systems, from Birla Institute of Technology. This was for the successful execution and demonstration of the project “IP data service over LTE”.
- Won 2nd prize for the best academic project in B.E from MIT, MAHE in Institute Project Exhibition.
- Ranked 4th to the branch for B.E from MIT, MAHE University.
- Given multiple technical training, demonstrations, and sessions to customers on LTE/SAE basic end to end architecture, NAS, EPC network elements and their functions for the end to end data flow across the nodes.

Participations

- ACM Winter School 2019-20 on **Hybrid Cloud Computing** co-sponsored by IBM Research India.
- Twenty fifth National Conference On Communications (NCC) 2019.

Expertise:

Programming languages	C and C++.
Operating systems and internals	Linux/Unix Network Programming Data Structures and Algorithms
Domain/Technology	<p>5G Network Slicing</p> <ul style="list-style-type: none"> • Architecture • Life cycle management • Orchestration • High Availability • Reliability • Load Balancing • Resiliency • Monitoring, Performance Measurement, • NFV MANO • SON <p>5G System</p> <ul style="list-style-type: none"> • Core Network: AMF, AUSF, UDM, SMF, UPF, PCF, BSF,UDSF • Protocols - NGAP, NAS, GTP, REST API - HTTP/2, JSON, HTTP/1.1 <p>Cloud Computing</p> <ul style="list-style-type: none"> • Micro Services • Docker Containers • Kubernetes, hybrid cloud computing <p>NFV: NETCONF, YANG, REST</p> <p>LTE-UMTS</p> <ul style="list-style-type: none"> • EPC (MME, S-GW, PDN-GW), eNodeB • NAS Protocols- EMM, ESM • X2AP, S1AP, GTP-C, GTP-U • X2, S1, S6a, S11, S5/S8 interfaces • Basics of MAC, RLC, RRC protocols • Basics of LTE Advanced • Femtocell • lu Interface <p>VoIP</p>

	<ul style="list-style-type: none"> • SIP <p>SDN, DHCP, DNS, HTTP/1.1, HTTP/2</p>
Tools/APIs	<p>Git, gdb, gcov, oprofile Wireshark network analyzer, eXpress Data Path (XDP), extended Berkeley Packet Filters (eBPF), Data Plane Development Kit (DPDK), Basic bash scripting. Python</p>

Project Details

Projects listed in reverse chronological order

Projects at Indian Institute of Technology Hyderabad

1. "Development of 5G Core Network as part of Indigenous 5G Testbed "

Technologies & Tools:

Role : Technical Architect

Duration: Ongoing

Description:

Project consists of developing the primary set of 5GC entities in a virtualized environment (like NFV, micro services) from scratch with full compliance to 3GPP Release specifications.

Responsibilities:

End to end detailed design, and complete development, integration testing of procedures features covered mainly on

- 5G core network control and data plane protocol entities namely AMF, SMF, AUSF, UDM, PCF, BSF, NRF and UPF.
- Network Slicing development, management, orchestration and monitoring framework.
- RESTful API and HTTP2 following 3GPP Rel. 15 at 5G Core Network control plane entities.
- NGAP, NAS protocol communication with RAN and UE

Projects at Mavenir Systems

Involved in development of L-GW at eNodeB. This includes developing, leading and mentoring for the complete functionality of LIPA Gateway integrated with eNodeB.

1. "DEVELOPMENT OF SCEF"

Technologies & Tools: SCEF, MTC, REST, Confd (Third Party code providing configuration management of VNF)

Role : Technical Analyst, Designer, Developer, Code reviewer, Debugger, Bug Fixer

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Duration: 7 Months

Description:

Project consisted of developing the SCEF product with NFV solution, from scratch with full compliance to 3GPP Release specifications.

Responsibilities:

Involved in technical study, analysis, concepts, detailed design and complete development, integration testing of features covered mainly on

- Overall product and application design
- NIDD
- Monitoring and Event Reporting

2. Study & Analysis on Multi-access Edge Computing

Presented a detailed analysis on the significance of MEC. This helped the senior management to evaluate and decide on investing in MEC, using Mavenir's C-RAN and vEPC solutions.

3. Analysis on evolving 5G EPC readiness with respect to development of AMF, SMF network functions.

Involved in detail with study on 5G related 3GPP release specifications for core network functions. Presented a detailed view of AMF, SMF network functions to the team.

4. "DEVELOPMENT OF NFV supportive platform for various applications /products at Mavenir"

Technologies & Tools: YANG, NETCONF, REST, Confd (Third Part code providing configuration management of VNF)

Role : Designer, Developer, Code reviewer, Debugger, Bug Fixer

Duration: 10 Months

Description:

Project consisted of developing the generic platform integrating existing Mavenir's mOne platform on VNF, to suit NFV framework. The platform would provide the generic framework for all the existing mOne based applications/products at Mavenir, to migrate to NFV solution architecture. The architecture consists of application VNF with mOne platform over OpenStack, VNFM and CMS adhering to NFV based solution.

Responsibilities:

Development of common Confd based device management library to provide FCAPS, OAM operations.

This includes

- Evolving YANG based configuration schema for VNF
- NETCONF communication between CMS and VNF
- REST communication between VNF and VNFM (Ve-Vnfm interface)
- Configuration management of VNF
- Created various presentations on YANG, NETCONF, REST
- Guided and coordinated various application teams for migrating to this NFV solution

5. "DEVELOPMENT OF 4G EPC node MME "

Company : Mavenir Systems India Private Limited.

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Technologies & Tools: LTE, SAE, EPC, MME, S-GW, PDN-GW, NAS, EPS Bearer,
Packet Filtering, Wireshark, Libpcap

Role : Principal Lead, Designer, Developer, Code reviewer, Debugger, Bug Fixer

Duration: 1.5 years.

Description:

Project consisted of developing the 4G EPC based MME with full compliance to Release 10 3GPP specifications.

Responsibilities:

Lead the design and complete development, integration testing of features covered mainly on

- Evolved Bearer Session Management
- Tracking Area Update
- Intra and Inter MME handovers, Inter nodal handovers
- SRVCC
- Redundancy

Guided team members for the technical understanding of EPC, MME communication with external nodes, ESM functionalities, interaction with other modules

Optimization of MME application, for capacity, performance measurement.

End to end support and debugging for MME capacity testing.

Provided end to end support on MME for various IOT activities with AltioStar, NETAS, CableLabs, Fujitsu, Contextream

Provided complete training on MME application to customers

Projects at Juniper Networks

Broadband Network Gateway to support various features, services for broadband subscribers. Services here refer to policy control, enforcement, subscriber tracking etc.

Projects at Radisys Corporation (CCPU)

Company Continuous Computing India Private Limited.

Development Language C/C++

Operating System Linux

Compiler gcc

1. "DEVELOPMENT OF LTE EPC NODES' APPLICATIONS FOR THE EXCHANGE OF IP DATA BETWEEN END TO END USERS."

Technologies & Tools: LTE, SAE, MME, S-GW, PDN-GW, NAS, EPS Bearer, Packet Filtering, Wireshark, Libpcap

Role: Principal Lead, Designer, Developer, Code reviewer, Debugger, Bug Fixer

Description:

Project consisted of developing the sample LTE EPC nodes, eNodeB and an UE simulator for demonstrating the IP data exchange between end to end users in both uplink and downlink directions. Intention was to showcase the capabilities of the different LTE nodes in turn the TAPA based protocol stacks at these nodes.

Responsibilities:

1. MME

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- Added code for NAS architecture, NAS to S1AP interaction at application.
- Lead the design and development of EMM module: Guided the team members for the technical understanding of EMM functionalities, interaction with ESM, NAS main modules.

2. PDN-GW

- Design and development of complete PDN-GW application involving:
 - Development of state machines to support eGTP-C messages exchange and maintain the UE context at different states/levels.
 - eGTP-C, GTP-U interactions with the respective stacks in the control plane.
 - EPS bearer setup, modification and deletion in control plane.
 - Packet filtering, GTP-U interactions during the end to end data exchange in the user plane.
 - Libpcap support at gateway end to support the exchange of incoming and outgoing IP data.

3. S-GW

Involved in the detailed review of the complete S-GW application.

Guided team members for technical understanding of the complete EPC architecture, functionality of these nodes, during all the stages of the development and testing work. I was recognized as the core technical strength of the team and an efficient reviewer throughout the project.

2. "PERFORMANCE MEASUREMENT OF ENODEB IN UL and DL DIRECTIONS"

Technologies & Tools: eNodeB Protocol stack, oprofile, top, rdtsc

Role : Lead, Developer, Code reviewer, Debugger, Bug Fixer

Description:

This essentially consisted of measuring the data path performance of eNodeB in uplink and downlink directions for end to end data exchange on Intel and Freescale boards. The eNodeB software binary was executed on these boards.

Responsibilities:

- Designing the test framework for performance architecture in eNodeB.
- Developing the UE simulator to attach to the network before starting the actual data path's performance measurement.
- Optimizing the code of complete eNodeB at different levels of Uu stack i.e. at MAC, RLC-PDCP level, application.
- Using rdtsc instruction on Intel board to calculate the data rate.
- Used different tools like oprofile, top to measure the CPU utilization.
- Fixed issues of coredump at application, MAC, PAL levels.

3. "DEVELOPMENT OF X2AP STACK"

Technologies & Tools: LTE, eNodeB, Wireshark, internal XML based test framework.

Role Designer, Developer, Code reviewer, Debugger, Bug Fixer

Description:

The project consisted of developing the complete X2AP protocol layer based on 36.423 8.5 version from scratch using TAPA standards.

Responsibilities:

- Added code for complete Handover module to enable interpreting the Handover based X2AP messages in the stack.
- Testing, debugging, and fixing the issues of the Handover module.

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- Developed test cases for the Handover module.
- Involved in the design, development of test framework code for testing the performance of developed X2AP stack.
- Testing the performance of X2AP stack with test framework code, debugging and fixing any issues.
- Lead the design, development and review of other modules in the layer.

Guided team members for technical understanding of the complete X2AP protocol, during the different stages of the design, development and testing work.

4. "DEVELOPMENT OF FEMTOCELL NODEB TO SUPPORT Iu INTERFACE FOR EXCHANGE OF IP DATA BETWEEN END TO END USERS."

Technologies & Tools: UMTS, FEMTOCELL, Iu, Wireshark.

Role Designer, Developer, Code reviewer, Debugger, Bug Fixer

Description:

Project consisted of developing the Femtocell nodeB application on an integrated stack while supporting TAPA based Uu and Iu integrated stacks. Intention was to showcase the capabilities of the femtocell and core network nodes to support the data exchange of CS and PS data for the real UEs.

Responsibilities:

- Added code at nodeB application for mapping the messages interpretation between RRC and RANAP in uplink and downlink directions, so as to support UE attach and detach.
- Added small state machines for GTP-U and IuUP protocols to enable the support of bearer establishment, control and deletion during the UE attach and detach modes.
- Added code for mapping of data passage between Uu stack and Iu user plane stacks.
- Lead the complete end to end testing of UE attach, UE detach and data exchange for both CS and PS calls.
- Fixed multiple core dump issues in the application, while testing the different test cases mentioned above.

Demonstrated the successful CS and PS call scenarios to multiple customers, visiting the organization. This project was very helpful to the organization for winning multiple deals in future.

5. "DEVELOPMENT OF SIP SOFTWARE DEVELOPMENT KIT (SDK)."

Technologies & Tools: SIP

Role Designer, Developer, Code reviewer, Debugger, Bug Fixer

Description:

Project consisted of developing a software development kit over TAPA based SIP protocol stack. The intention was to give a framework to the user in order to develop a user friendly SIP based application.

Responsibilities:

- I was completely responsible for the detail design of User Agent framework using Factory and state design pattern technique of C++. Developed and tested the code of UA framework.
- Developed new test cases as per the need of module testing of UA framework. Added code for sample application to test the same.
- Fixed issues in the framework, while testing the different test cases of UA based SIP call scenarios.

Projects at Dataflex Design Communications

1. "DEVELOPMENT AND ENHANCEMENT OF SOFTWARE ARCHITECTURE FOR ViNE ROUTERS AND GATEWAYS"

Company Dataflex Design Communications Limited.
Platform ISOS/ATMOS. *Development Language* C.
Development Platform Linux
Role Designer, Developer, Bug Fixer

Description:

ViNE (Voice Integration at Network Edge)s are product variants supporting Integrated Access Device (voice gateway and data router with firewall, QOS, ethernet) services. It includes VoIP gateways, VoDSL routers.

Responsibilities:

1. SIP

Design and development of basic DNS client to support SIP - RFC 3263 (Supporting A, SRV, NAPTR DNS record queries)
Added code to control sending P-asserted/P-preferred identities headers for SIP (RFC 3325).
Development of command line interface design for new SIP options & features required for product.
Fixed issues related to SIP interfacing at upper layer control tasks, which interacts with SIP stack.

2. SIP - ISDN

Design and development of complete ISDN Decoder to support raw Layer3 (Q.931), Layer2 (Q.921) messages for ISDN stack.
Design & development of ISDN <-> SIP calls related features for to support VoIP
Example 1: Selection of ISDN B channels in BRI based on active ports for incoming SIP calls.
Example 2: Validating ISDN user (both BRI & PRI) against a set of registering users from this IAD, for new SIP outbound call.
Fixed issues related to ISDN stack.

3. SIP - DHCP

Implemented complete RFC 3361.
-> Sip Servers option for both DHCP client and server
-> Added support for this RFC in SIP module.
Complete RFC 3442 implementation – Classless static routes option for both DHCP client and server
Fixed issues related to DHCP stack – memory leaks, crashes.

Projects at Sasken Communication Technologies

1. "DESIGN AND DEVELOPMENT OF A SYSTEM SUPPORTING BASIC VOIP ARCHITECTURE"

Company Sasken Communication Technologies.
Client Internal Project
Platform Linux.
Development Language C.

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RESPONSIBILITIES:

Design of RTP-RTCP Stack on the media controller side.

Projects at Multitech Software Systems

1. "ENHANCEMENT OF SOFTWARE ARCHITECTURE FOR MultiVoIP GATEWAYS"

Company Multitech Software Systems India Pvt Ltd.
Product Platform RTX Development Platform Windows 9X.
Development Language C.
Role Designer, Developer, Bug Fixer.

Description:

MultiVoIPs are a set of series of products, which includes Digital VoIPs and Next Generation Analog VoIPs. The MultiVoIP hardware has 4 MB FLASH, and 16/32 MB SDRAM. The hardware is based on a Motorola 860 processor, with 80 MHz speed. The design of the module was developed with those factors taken into consideration, such that the software will run on an embedded RTOS platform.

Responsibilities:

1. PSTN Signaling Stack:
2. ISDN Signaling Stack:
3. T1/E1 Transmission Systems with CAS protocol standard:
4. SIP:

ADDITIONAL INVOLVEMENTS/ACTIVITIES

Design and development of basic DHCP server stack

Platform: Linux

Language: C

Development tools: GNUC

Testing tools: Tested with windows DHCP client, third party open source DHCP Client.

Personal Details

Father's Name : Vittal B Naik.

Date Of Birth : 23/03/1982

Nationality : Indian

Marital Status : Married

References

Available on request.

I hereby declare that all the details furnished above are true to the best of my knowledge and belief.

Shwetha V.