Statement of Purpose

My primary research objective and interest are in the area of distributed computing, storage, and database systems. At present, I am working at DDN storage: a leading storage company in HPC (high-performance computing) domain and actively involved in research and development of distributed storage systems.

I believe, in the contemporary world, data processing is crucial in every field, from data science to machine learning. It is inevitable to have systems, which can handle these ever-increasing data-intensive workloads. Although efforts are being made to build efficient storage systems, many non-holistic piece-by-piece optimizations have resulted in sub-optimal solutions, hence, inevitably dragging down the end-user experience. Through my research, I want to address different workload requirements by contributing towards, developing a "workload-aware storage system" which will enhance the usability of the system with less human intervention. I am aware of the kind of efforts and dedication that is needed to conduct the research required for this. Considering my aptitude and type of work that I enjoy the most, I am convinced that I want to take it up as a career. Pursuing a Ph.D. program in computer science would be a significant step towards realizing this goal.

I started developing my research interests in systems during my master's program. That interest got intensified with hands-on experience in various kernel subsystems of Linux kernel, when, I got an opportunity to do an internship at Intel India in their Wireless Platform Research and Development. During this period, I worked in a research group, exploring ways to perform behavior analysis of the device under test in SOC(System On Chip). As an outcome of this internship, I designed and implemented a test harness for Device drivers on Mobile platform, which eventually morphed into my master thesis and got published in VLSI-SATA 2015 [an IEEE conference][1].

My area of interest started getting streamlined towards storage systems during my work tenure in Seagate. Here, I got chance to work on Lustre file system(a distributed parallel file system). I solved many critical issues that required a solid understanding of file system and kernel concepts. For instance, I recollect when our customer reported a critical issue of kernel crash while using Lustre client exported through NFS(Network File System). Educating myself more on the subsystem and by systematic debugging, I narrowed down to a problem in the 'namei' algorithm that is used to resolve filename into inodes. I have proposed a solution for this which got accepted in the open source community of Lustre and followed by Linux kernel.

[1] Design and implementation of test harness for device drivers in SOC on mobile platforms, International Conference on VLSI Systems, Architecture, Technology and Applications 02 March 2015 at Bangalore, India

I also worked on ldiskfs (ondisk file system based on Ext4[2]). I remember we had an issue where we observed a very high inode number was getting allocated to the root directory. I studied different inode allocation policies and an algorithm used in Ext4, known as Orlov algorithm. While investigating this algorithm, I found potential optimization in the code to reduce the time required for inode allocation. I discussed this optimization in the open-source community and successfully submitted a patch for it. This work allowed me to get exposure to the design of a disk-based file system. After these contributions, I got motivated, which resulted in successful submissions of several patches. All these contributions are available in the official Lustre and Linux git repository. While working on these file systems for some time, I started appreciating the design of each subsystem and realized the importance of design decisions goes behind, making all these subsystems work together seamlessly.

Based on my performance at Seagate, I got the highest rating in each quarter for my contributions. My director has rewarded me with the Key Contributor Performance Bonus (KCPB) for my contribution to Seagate‟s achievements against pre-established goals. Seagate's Board of Directors approved the bonus based on the approved funding level, my job level, and my performance

In my current profile at DDN, I am working with a burst buffer[3] called IME (Infinite Memory Engine) which is the cutting edge technology solution in the storage domain. Here, I worked on a feature that makes burst buffer to work as a cache. This work involved an exhaustive survey of different caching techniques and read patterns. Based on which I have designed and implemented a prefetch engine which used these read patterns to prefetch relevant data in IME, resulting in enhanced prefetch coverage and eventually reduced the latency of the read operation.

Recently, I was exploring ways to make IME compatible with AI (Artificial Intelligence) workloads in a containerized software stack As part of this work, I did a POC (proof of concept) to integrate IME client in Docker[4] container. Getting good performance from the container was a complicated task; it needed a solid understanding of parameters, required for tuning network fabrics like Infiniband[5], Omni-path[6], and their impact on latency after connecting it to different NUMA nodes. I showcased a performant containerized IME client, in a short span of time, which got recognized very well by product management and got showcased at SC18 (Supercomputing

---

[2] Ext4 is a journaling file system for Linux.

[3] Burst buffer is a fast and intermediate storage layer positioned between the front-end computing processes and the back-end storage systems.

[4] Docker is a computer program that performs operating-system-level virtualization, also known as "containerization"

[5] InfiniBand (abbreviated IB) is a computer-networking communications standard used in high-performance computing

[6] Omni-Path is a high-performance communication architecture owned by Intel.

conference 2018), as an added feature to attract AI customers.

I feel excited about the new era of enterprise architecture that involves processing of massive datasets that enables intelligent systems to drive decision-making and as I already have worked in the industry, I gained good experience of working in these systems which adds an advantage and enables me to execute any tasks required for engaging actively in the research part of these.

With my current understanding, I am open to work on research problems in distributed storage systems and related fields, specifically,

- Use of new efficient data structures to design storage systems.
- Custer management. (problems in resizing storage clusters.)
- Transaction Management (Reducing latency to commit metadata transactions.)
- Storage Security in Enterprise domain.
- Make the storage parameters adaptive based on the type of workload.
- Data recovery: researching better techniques to avoid metadata replication and erasure coding to avoid penalty of extra memory required for it.
- Performance penalty due to random reads.
- Adaptability of the new hardware technology to gain maximum performance with reliability.

Computer science department of UCSC (University of California Santa Clara) is attractive to me from its record to conduct quality research. I am intrigued by several exciting research projects, carried on by its faculty members. Mainly, Prof. Ethan Miller and Prof. Carlos Maltzahn's work in distributed storage domain is remarkable. I am impressed by some of their recent work, where they have identified the root cause of wear and tear of cells. While the general perception is that number of writes are effects power consumption and durability of [7]PCM(Phase Change Memory), they have identified that it is bit flips that consume power and wear out cells, not writes. In other project they have optimized They have Optimized scatter/gather data operations for parallel storage. There are large numbers of quality research going on actively with projects like Fabric connected object storage devices, declarative programmable storage, Archival storage and Reliable storage which makes UCSC perfect place for me to pursue Ph.D.

I hope my academics combined with relevant work experience will satisfy the criteria for Ph.D. program in the computer science department at UCSC. I eagerly await a mutually valuable relationship with the computer science department at UCSC.

[7] Phase-change memory (also known as PCM, PCME, PRAM, PCRAM, OUM (ovonic unified memory) and C-RAM or CRAM (chalcogenide RAM)) is a type of non-volatile random-access memory.