



**VEENA AND PRATAP SUBRAHMANYAM CENTRE  
FOR DIGITAL INTELLIGENCE, SECURITY HARDWARE  
AND ARCHITECTURE (V & PS - CDISHA)**

**IN SUBRAMONIAN SHANKAR BLOCK**

Department of Computer Science and Engineering

**CELEBRATING GENEROSITY**

**Mr. PRATAP SUBRAHMANYAM**



**Indian Institute of Technology Madras**  
Office of Alumni and Corporate Relations

## MESSAGE FROM THE DIRECTOR

**Prof. KAMAKOTI VEEZHINATHAN**  
Director, IITM



IIT Madras continues to retain her top position for the seventh consecutive year, in the National Institute Ranking Framework, thanks to the world class research of its faculty and students. The contribution and support of Alumni and wellwishers like you has crucially helped this standing and stature. Our achievements in research, education, innovation and entrepreneurship have also earned us the recognition of an 'Institute of Eminence' as well as the top position in the Atal Innovation Ranking from the Government of India. The institute is making an indelible mark with her 'research with impact' in several areas including quantum computing, drinking water technology, industrially relevant mathematical models for governance, rendering cancer-cure more effective. Our centres of excellence, the Center for Innovation, Nirmaan – the pre-incubator, the Incubation Cell, technology centres such as 'IITM-Pravartak' and others, work in unison for not just our nation's building, but societies world-wide. We aspire to be locally impactful and globally relevant through all these efforts.

Towards exploring new research frontiers, a Department of Medical Sciences and Technology is being launched to conjoin medicine and engineering. Similarly, a School of Sustainability is on the horizon to research sustainable practices in the Global South. The campus is moving towards 'carbon-net-zero' goal through water conservation by 100% recycling, efficient garbage disposal, and electrification of vehicles. The traditional education system is undergoing a paradigm shift, with our online Bachelor of Science programme in Data Sciences and the National Program of Technology Enhanced Learning, that have won Gold in the 'Lifelong Learning' category and Silver in the 'Best Online Program' category of the Wharton-QS Reimagine Education Awards 2022 respectively. Your alma mater is leading this revolution from the front.

Such achievements are not possible without the deep-rooted faith and support of alumni and well-wishers such as yourself. We are indebted to you for your generous, bountiful, and impactful contributions. On behalf of IIT Madras, I offer you our deepest gratitude for continuing to strengthen the Institute. Together with your support, we are confident of building an IIT Madras that is more inclusive, diverse, and enabled by an ecosystem to be nationally relevant and globally recognised.

Thank you!



## MESSAGE FROM THE DEAN

**Prof. MAHESH PANCHAGNULA**  
Dean, Alumni & Corporate Relations, IITM

Dear Mr. Pratap Subrahmanyam & Mrs. Veena,

I express my heartfelt gratitude to you for your generous support to IIT Madras. We appreciate your passion in supporting the causes you do and I assure you that your contributions will be optimally utilised.

This report has been compiled by your 'Donor Relationship Manager', to convey how your largesse has touched lives and made a difference at IIT Madras. In keeping with the rapid, contemporary strides in science, technology we have set ambitious goals for ourselves - your continued enthusiasm and support will help us greatly in these endeavours.

IIT Madras that you left behind as a graduating student is very different from the IIT Madras of today. It is far more diverse in its set of pursuits, more green and more research-focused. And yet it remains unchanged from your time that, it is still the best Institute in the country, and attracts the best students that India has to offer to come and make a mark.

I also cordially invite you to visit your campus to see for yourself, the impact of your contribution, and the growth and transformation the Institute has undergone over the years. We can never express our gratitude enough for all that you have done. Thank You!

**GIVING IS NOT JUST ABOUT  
MAKING A DONATION -  
IT'S ABOUT MAKING A DIFFERENCE**





# ABOUT Mr. PRATAP SUBRAHMANYAM



**Mr. Pratap Subrahmanyam**  
1985/BT/ME

## VMWARE FELLOW

Pratap Subrahmanyam joined VMware in 2000 and has been a pivotal player in the company's virtual machine monitor group. Subrahmanyam was recognized for his technical leadership and significant contributions to the company in 2013, when he got appointed as a VMware Fellow. Previously a principal engineer at VMware. Subrahmanyam has contributed to the design of the MMU virtualization. He also added to performance improvements, paravirtual interfaces design principles. And more recently symmetric multiprocessor fault tolerance for virtual machines. He has earned 26 issued patents, 21 of which he obtained while at VMware.

Before VMware, Subrahmanyam worked on code generation and low-level optimization techniques for the PA-RISC and the IA-64 processor architectures in the California Language Lab at Hewlett Packard. He received his bachelor of technology from the Indian Institute of Technology in Madras, India, and holds a master's degree in computer science from the State University of New York at Buffalo.

In his words **“One of the great things was my donation to IIT-M. I was able to tell my Dad that I donated before he declined. I know he comprehended what I said, and that he was happy I could help IIT-M in that manner”**.

We want to rejoice at your generosity towards your alma mater through this humble report. We are thankful & grateful, hoping our report makes an interesting read.

## INTRODUCTION

This write-up gives an overview of the activities undertaken in V & PS - CDISHA lab specifically with respect to the technical progress made in SHAKTI processor engineering efforts.

### Technical Activities Report of V & PS - CDISHA

The various activities currently being done on the SHAKTI processor engineering are as follows:

- RISC-V Architecture Compatibility Test (ACT) for RISC-V International
- Secure Shakti variant
- AI-ML Accelerator (Shaktimaan)
- Shakti IP Developments
- Out-of-order I-class variant of Shakti processor
- RISC-V Verification Activities
- DIR-V Initiative – Start-ups incubated from V & PS - CDISHA lab

### RISC-V Architecture Compatibility Test (ACT)

IIT Madras, as one of the founding members of RISC-V International, has been earmarked for contributing towards the Architecture Compatibility Test (ACT) for the various RISC-V extensions coming out of the RISC-V ISA. The ACT team in V & PS - CDISHA lab has been contributing towards the compatibility testing of the following RISC-V extensions:

- Single Precision Floating Point (F-Extension)
- Double Precision Floating Point (D-Extension)
- Zfinx extension
- Zdinx extension
- Zhinx extension
- Pointer Masking (On-going)
- Debug (On-going)

### Secure Shakti Variant

The Shakti C-class core has been updated with various new features and pushed in to open-source git repository. The following are a representative sample of the major features that has been added in the upgraded C-class core:

- Upgraded pipeline
- FPU support added
- Caches MMU upgraded with fixes
- Debug module upgraded to frozen debugger spec version
- Hypervisor extension implementation in the core





The secure Shakti variant has got the High Assurance Boot integrated along with the Hypervisor layer (CHESS). This can be used for a full fledged verification of the OS stack integrity right from the initial bootloader all the way to the Operating System.

### AI-ML Accelerator (ShaktiMAAN)

Traditional computers cannot handle the emerging AI applications because their architectures are more tuned towards general purpose computation. Running intelligence applications on the edge becomes even more challenging due to power constraints. The need of the hour is to have a new class of computers that meets the latency and power requirements of AI applications.

We are building such a computer at Shakti to address this particular need. This computer has a novel component which we call as ShaktiMAAN (MAAN stands for Multiply and Accumulate Network), which is specialized for handling Deep Learning Inference.

ShaktiMAAN works with the Shakti processor to accelerate Deep Learning workloads manifolds. There are 2 classes of computations that it does very fast: GEMM (General Matrix Multiplication) and Tensor ALU (Vector operations). These operations, combined with a high performance data access architecture can gracefully handle a wide variety of deep learning workloads with remarkably high performance.

Currently the product has been built as a highly reconfigurable ShaktiMAAN, and the basic verification has been completed. There has been a demonstration of ~50x speedup of convolution (a major workload in deep learning computations), running on the Shakti-ShaktiMAAN system with the smallest instance of ShaktiMAAN, on FPGA. The speedup is as compared to the basic Shakti C-class. Currently the developer library that will ease the implementation of AI applications on this computer is under development.

### Shakti IP Developments

SHAKTI team had already developed IP's for all low speed peripherals like I2C, GPIO, UART, SPI, PWM and validated it with a lot of use cases. Team is currently progressing on developing MIPI IP to its portfolio.

### Out-of-order I-class variant of Shakti Processor

The global high performance processor market is dominated by a very small number of companies. ISA licensing restrictions as well as the availability of an excellent software ecosystem helped x86 based processors dominate this market for a long time. However, the advent of the RISC-V ISA challenges that status quo and allows new designs to emerge.

The Shakti I-Class is a RISC-V based high-performance processing core that targets the compute, mobile, storage, and networking markets. It will serve as a building block for mobile and desktop SoCs as well as high-performance systems such as servers and HPC/AI supercomputers. The I-Class processor is a 64-bit out-of-order core supporting RV64GC (Integer, Multiply/Divide, Atomics, Single and Double precision FP and Compressed). Supervisor mode sv39 and OpenOCD based debug (1.0) through JTAG are supported. Linux boot has been tested on FPGA.

The configurable core has a 12-stage integer pipeline with 4-wide fetch, decode, dispatch and commit and up to 7-wide issue. Key performance features include multiple branch predictors, decoupled fetch, split register files, dependence speculation, pipelined functional units, data prefetching and non-blocking caches. Current work includes predictor tuning, scheduler improvements and memory system enhancements. Security features like high-assurance boot and hypervisor, debugger additions, additional extensions like "P" (packed-SIMD) and multi-core support are planned for future work.

### RISC-V Verification Activities

SHAKTI RISC-V Cores and SoCs are being verified using state-of-the-art Verification infrastructure. The SHAKTI RISC-V cores maintain the industry-standard quality by leveraging the Python methodology for processor verification and cloud infrastructure for rapid simulation and debug. Several SHAKTI Class of processors are verified in parallel using this framework that provides best-in-class tests covering all features of the core and the system. Along with simulation verification, FPGA-based verification methodology is being developed and deployed for verification acceleration for running applications and benchmarks.

Functional correctness, rapid debugging, coverage completeness, application of FPGA acceleration and formal techniques are the major pillars of making SHAKTI verification highly innovative without compromising on the verification quality.

### DIR-V Initiative – Start-ups incubated from V & PS - CDISHA lab

All the start up companies have been incubated at IITM Pravartak Technologies Foundation, which is a Technology Innovation Hub of IITM under Department of Science and Technology, Government of India.

Secure IoT chip based on C class from Mindgrove is expected by August 2023. Mindgrove has already received a funding of USD 2.3 million from Sequoia Capital and 2 other investors.

Vyoma Systems has received another seed capital of USD 11K from Tamilnadu government.

To view the website



Company Name	V & PS - CDISHA Members	Website
Mindgrove	Sharan and Shaswath	<a href="https://www.mindgrovetech.in/">https://www.mindgrovetech.in/</a>
SecurWeave	Dinakar and Gopa	<a href="https://www.securweave.com/">https://www.securweave.com/</a>
Vyoma Systems	Lavanya	<a href="https://vyomasystems.com/">https://vyomasystems.com/</a>
Shakra Innovations	Anand, Kottee and Gopi	<a href="https://shakrainnovations.co.in/">https://shakrainnovations.co.in/</a>





# PROJECT STAFF AND CONSULTANTS IN V & PS - CDISHA



## PHOTOS OF V & PS - CDISHA

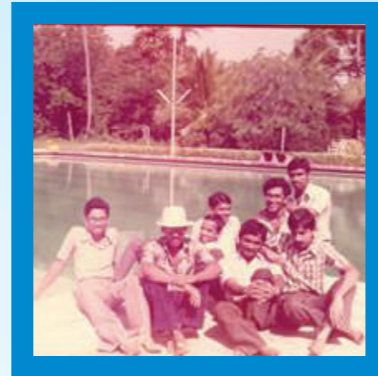


## POOJA EVENT - V & PS - CDISHA





# MEMORIES TO CHERISH



To view IITM Annual Report 1985



# 64<sup>TH</sup> INSTITUTE DAY

The 64th Institute Day of IIT Madras was held on Thursday, 20th April 2023 from 4 pm onwards at the Students Activity Centre, IIT Madras Campus. Dr Sridhar Vembu, Founder and CEO, Zoho Corporation was the Chief Guest.

Indian Institute of Technology Madras (IIT Madras) celebrated its 64th Institute Day (20th April, 2023) with students, faculty, teaching and non-teaching staff. A highlight of the event was the honouring of alumni, faculty and students for their achievements over the last year. The Chief Guest of this occasion was Dr Sridhar Vembu, Founder and CEO, Zoho Corporation.

Dr Sridhar Vembu is an alumnus of the 1989 batch of BTech in Electrical Engineering and a Distinguished Alumnus of IIT Madras. In 2009, Dr Vembu founded Zoho Corporation along with Dr Tony Thomas who graduated with a BTech in Electrical Engineering from IIT Madras in 1987, and Shaliesh Davey who graduated with a BTech in Metallurgical Engineering from IIT Madras in 1992. Over the course of the last few years, Zoho has built a domestic and international presence with a user base of 80 million people, through its offerings.

Presenting the student report, the outgoing Students General Secretary, Ajay Singh Sitole informed that the Student Mentorship Cell of IIT Madras received a record-breaking response in excess of 300 mentors for Freshers for a smooth induction into Institute life. The mentors are in constant touch with the mentees and act as the primary points of contact for mentees.

The students reported the establishment of 'Pragati,' a new initiative that guides and supports the Institute's students in their academic and competitive examination preparation such as UPSC-CSE, CAT. The Finance Club of IIT Madras conducted its offline fest in an attempt to connect the students of IITM to industry leaders in the finance domain including CFA Institute, Worldquant, Trexquant, Groww, Zerodha, Quantinsti among many others.



To view the Video Clips of 64th Institute Day





# WE ARE GRATEFUL TO YOU AND YOUR FAMILY!

Thank you for your sustained generosity to IIT Madras over the years. Contributors such as yourself enable our students and Professors to dream big and work towards a better and brighter future. We hope you are proud of your relations with IIT Madras and how it has remained steadfastly committed to academic and research excellence. You and your family have been instrumental in facilitating this significant growth.

Our efforts to nurture the culture of academic excellence that is the hallmark of IIT Madras - quality education, cutting-edge research, and unfettered creativity shall continue. We are privileged and humbled to have you and your family walking with us along this trail. We wish you and your family the best always in all walks of life!



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