THE LINUX FOUNDATION

OPEN SOURCE SUMMIT INDIA

# eSim – Democratizing Electronic Design Automation Through Open Source

Sumanto Kar & Shanthi Priya, FOSSEE, IIT Bombay

#OSSUMMMIT

THE LINUX FOUNDATION

# About Us

M.Tech in Industrial Engineering & Operations Research, IIT Bombay (2025 batch)
B.E. in Electronics Engineering - Mumbai University (2021 batch)

Shanthi Priya Kalabandi
Research Assistant – FOSSEE (IIT Bombay)
Digital & IC Design | RTL & Verilog
EDA Tools | ECE ’25 – IIITN

# MORE ABOUT ME

My interests:

- contributing to the open-source EDA tools.
- Speaker at OOSC 2025, Ubucon India 2025, Chennai FOSS 2026, Pune FOSS(upcoming) 2026
- Coordinated many nation-wide hackathons
- Actively involved with the FOSSEE project.
- Contributing to the development, integration, documentation, and outreach of eSim, an open-source EDA platform used across universities in India.
- My work focuses on strengthening open technical ecosystems, enabling reproducible engineering workflows, and bridging the gap between academic research and community-driven software development.
- Hobbies: Music, Art and Electronics stuff

**Connect with Me over LinkedIn**

**Mail Id: sumantokar@iitb.ac.in**
**Mob. No. 7718065095**

# About fossee



- Initiative at Indian Institute of Technology Bombay
- Promotes Free & Open Source Software in education
- Supported by Government of India (NMEICT)
- Focus on affordable & accessible engineering tools

# FOSSEE Tools



OpenModelica

OpenPLC

FLOSS Arduino

QGIS

Single Board Heater System

SBHS

R

Scilab

Python

eSim

Osdag

DWSIM

OpenFOAM

# Why EDA Still Isn’t Accessible

## Cost Barriers

Expensive proprietary toolsets often cost millions, locking out startups and smaller institutions.

## License Walls

Restrictive licensing models hinder global collaboration and slow down the design cycle.

## Educational Gap

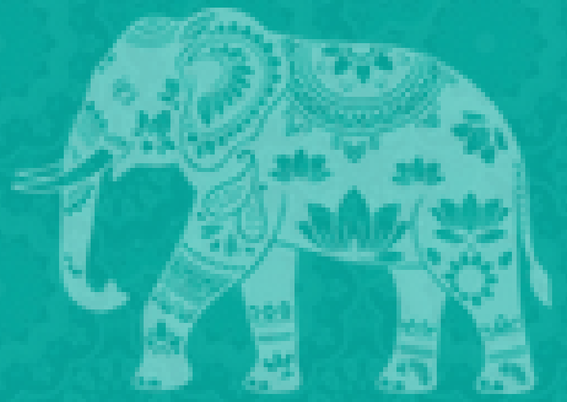
Limited access for students means graduating with theoretical knowledge but no hands-on tool experience.

## Poor Support

Proprietary software often lacks native support for the environments where developers actually work.

***"Innovation shouldn’t depend on license access."***

# The Missing Layer in Open Source: Hardware



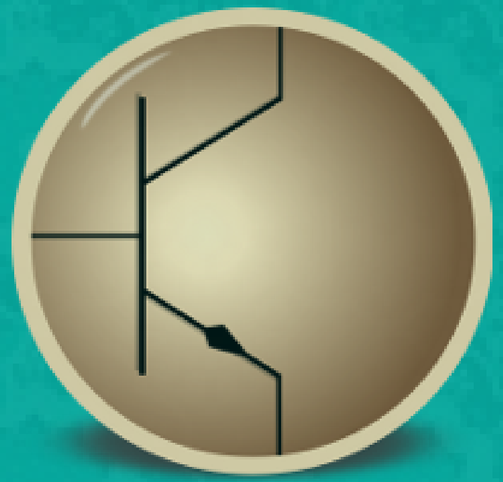
## </> Software (Success)

- Open source transformed software.
- Linux powers everything from servers to mobile devices.
- Accessibility drove the internet and AI revolution

## Hardware (Still Evolving)

- Hardware design hasn’t reached the same openness.
- Most EDA tools are still closed and proprietary.
- The ecosystem lacks open-source EDA.

# Introducing eSim



## Integrated EDA Stack

eSim is a free/libre and open-source EDA tool for circuit design, simulation, and analysis.

- **Linux-First:** Native, high-performance environment.
- **End-to-End:** Integrated circuit design flow.
- **Built on FLOSS:** KiCad, Ngspice, Verilator, etc.

https://esim.fossee.in

# How everything began?

Conceptualization of eSim(OsCAD): Work of PhD Students (Around 2012)

→ Integration of KiCad and Ngspice to create an open-source EDA environment 2013–2014

→ Early public releases for schematic capture, simulation, and PCB design 2015

→ Addition of Digital and Mixed-Signal Simulation using GHDL 2016-2018

↓ Enhanced educational adoption through workshops, FDPs, and academic outreach 2019–2020

← Support for Open-Source VLSI Design Flows (SKY130) 2021

← Addition of Digital and Mixed-Signal Simulation using Verilator and MakerChip 2022

← Expansion of cloud-based and web-enabled workflows Adding IHP PDK 2023–2025

# What eSim Provides



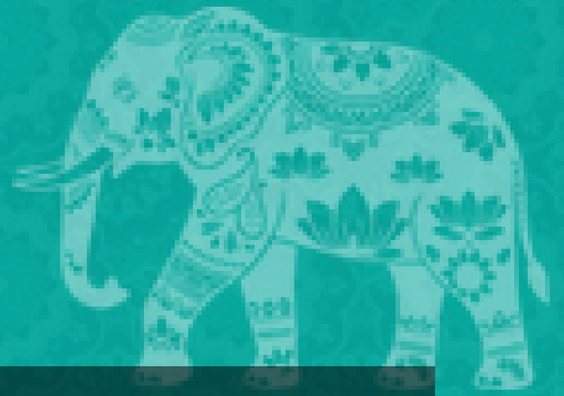
## Design & Simulation

- Schematic design
- SPICE-based analog simulation
- Digital & mixed-signal simulation

## Hardware & Modeling

- PCB design
- Device modeling
- Subcircuit (modular) design

# Comprehensive Features of eSim



- **Schematic Design**: Full-featured editor via KiCad.
- **Makerchip Integration**: Digital Web IDE simulation.
- **PCB Designing**: Multi-layer layout & Gerber output.
- **PDK Integration:** Compatible with SkyWater & PDKs.
- **Deployment**: Ubuntu, Windows and Docker support.
- **Converters**: PSpice & LTSpice to eSim conversion.
- **SPICE Simulation**: Analog verification using Ngspice.
- **Mixed-Signal**: Support via NgVeri and NGHDL.
- **Device Modeling**: Edit SPICE Device Model Files.
- **Modular Design:** Subcircuit designing support.
- **Interfacing:** Direct interface with OpenModelica.
- **Cloud Version**: Online accessibility anywhere.

# The PCB Design Workflow

CREATE PROJECT

SCHEMATIC CAPTURE (KICAD) NETLIST GENERATION

**SIMULATION ENGINE**

- ANALOG → NGSPICE
- DIGITAL → GHDL/VERILATOR/MAKERCHIP
- MIXED → NGHDL/NGVERI

Waveform Analysis

PCB Design

GERBER OUTPUT

FABRICATE PCB

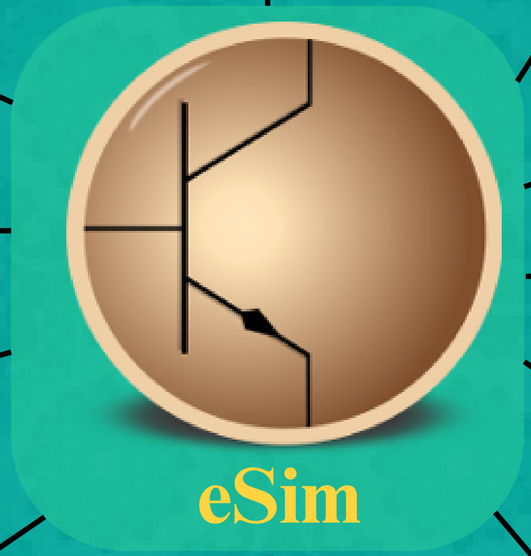
**ADVANCED FLOWS**

Makerchip → RTL Design

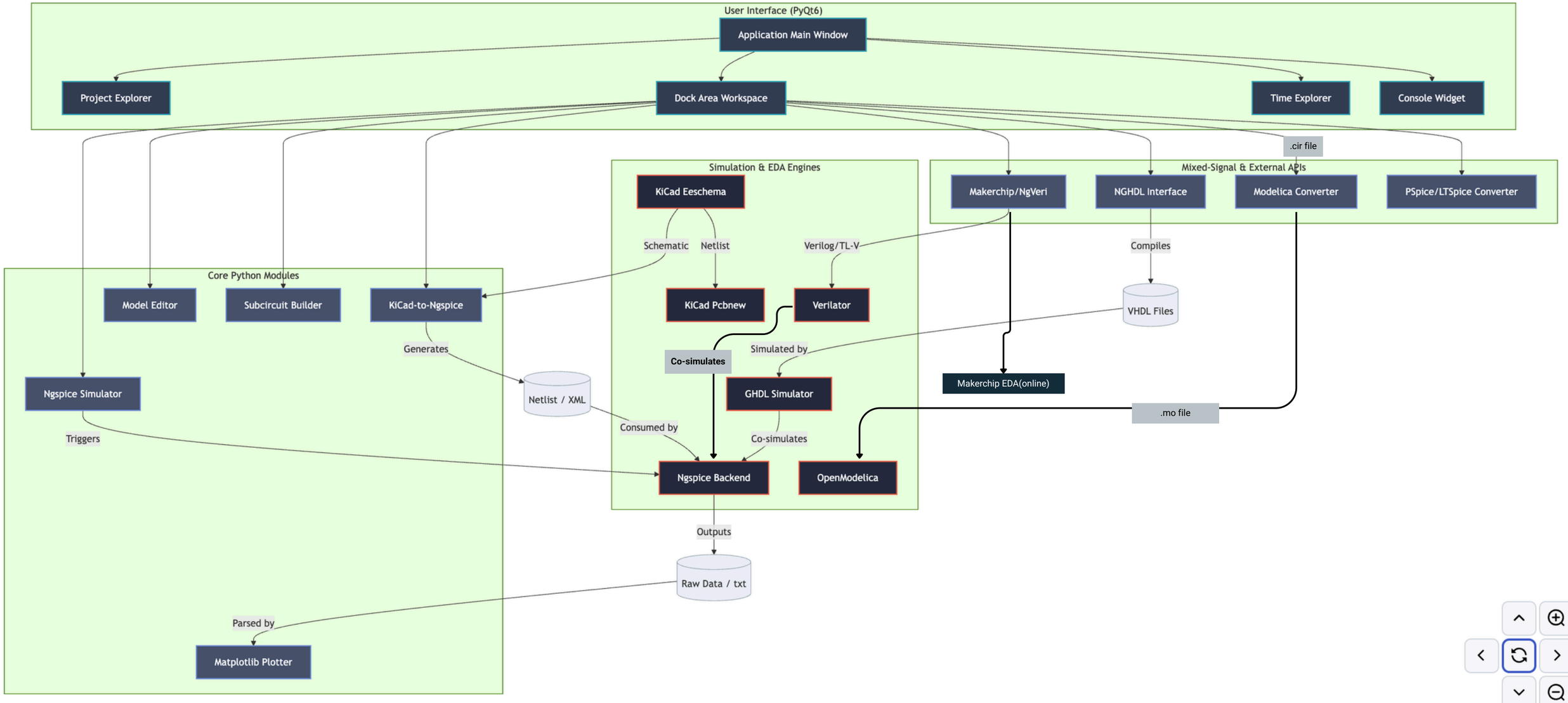
SKY130/IHP/OpenPDK → VLSI Design

OpenROAD → GDSII

# Tool Integration



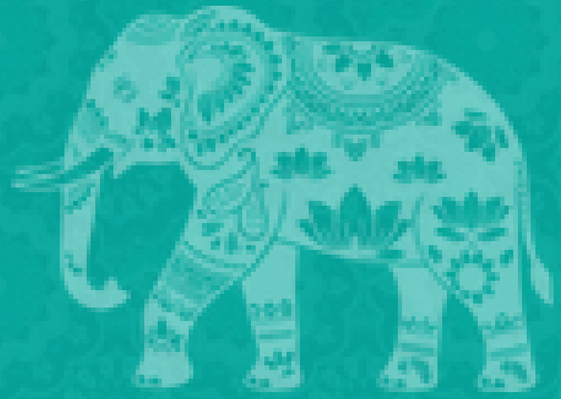

- Ngspice
- KiCad
- GHDL
- Verilator
- SKY130 PDK
- Makerchip EDA
- IHP 130nm PDK
- OpenROAD(WIP)
- Fritzing(earlier support)
- Scilab(earlier support)
- OpenModelica


User Interface (PyQt6)
Application Main Window
Project Explorer
Dock Area Workspace
Time Explorer
Console Widget
.cir file
Simulation & EDA Engines
KiCad Eeschema
Schematic
Netlist
Verilog/TL-V
KiCad Pcbnew
Verilator
Co-simulates
Simulated by
GHDL Simulator
Co-simulates
Ngspice Backend
OpenModelica
Outputs
Raw Data / txt
Mixed-Signal & External APIs
Makerchip/NgVeri
NGHDL Interface
Modelica Converter
PSpice/LTSpice Converter
Compiles
VHDL Files
Makerchip EDA(online)
.mo file
Core Python Modules
Model Editor
Subcircuit Builder
KiCad-to-Ngspice
Generates
Ngspice Simulator
Netlist / XML
Consumed by
Triggers
Parsed by
Matplotlib Plotter

# Demo Overview

Experience the End-to-End eSim Design Flow

# Unified Deployment Facilities



### Package Manager


Native **APT/DNF** support for seamless Linux distribution integration and system optimization.

### Snap & Flatpak

Universal Linux packages providing sandboxed stability and **one-click updates** across any distro.

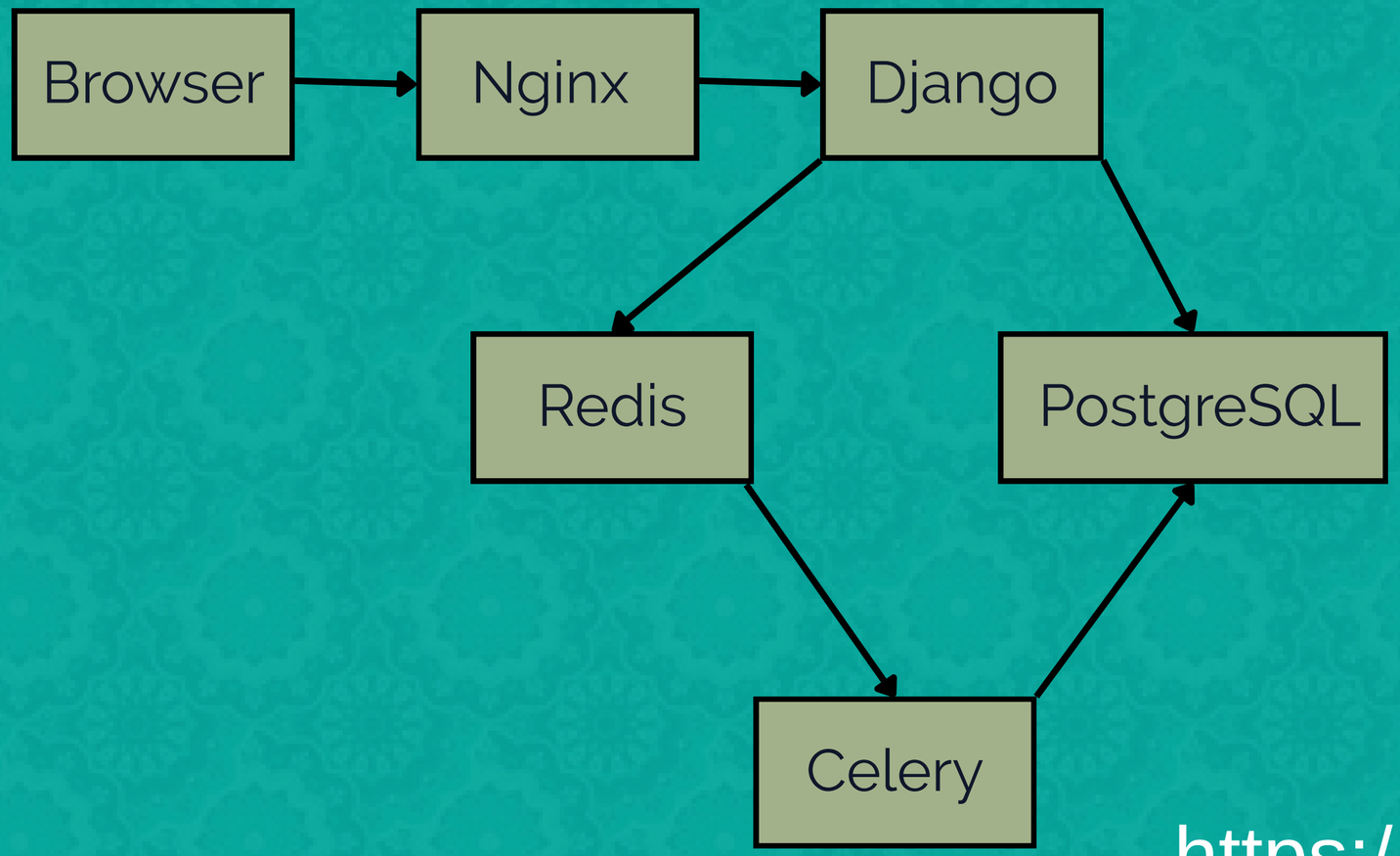
### Docker Containers

Isolated **containerized** environments for Windows, Mac, and Linux to ensure reproducible workflows.

### eSim on Cloud

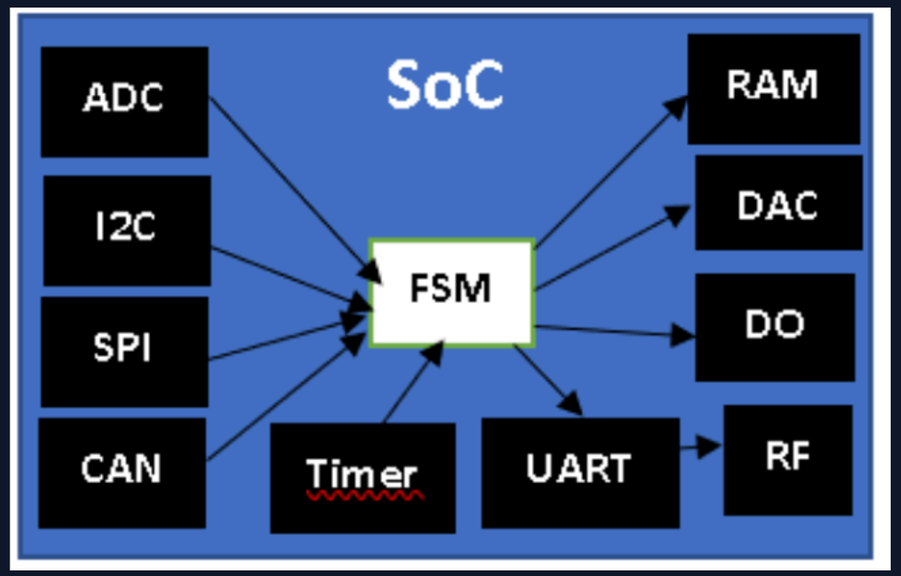
**Zero-installation** browser-based access for instant circuit design and simulation anywhere.

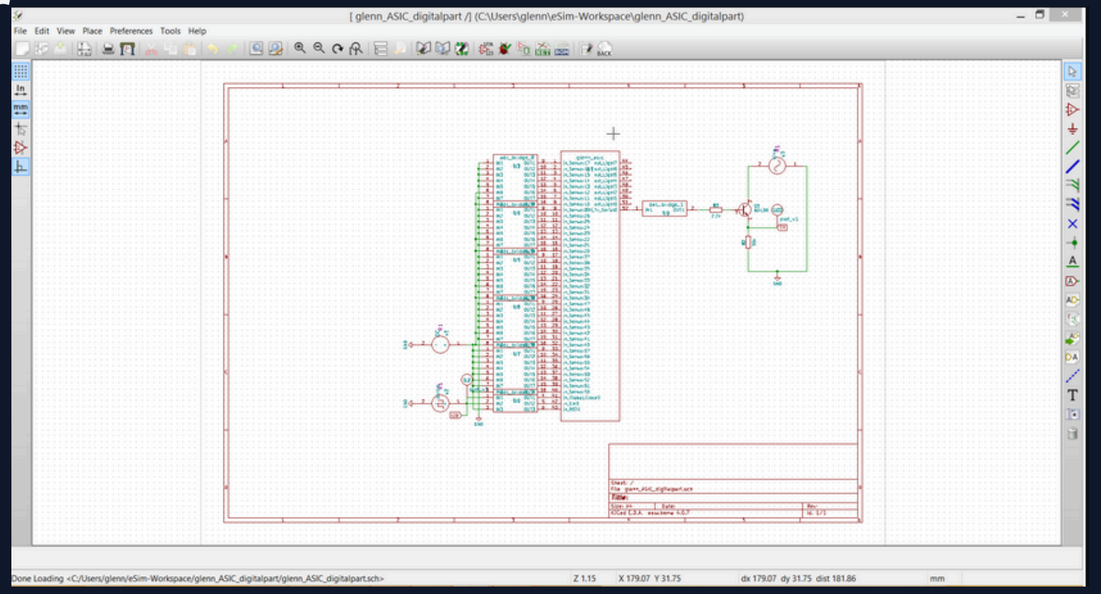
# Cloud Version Architecture



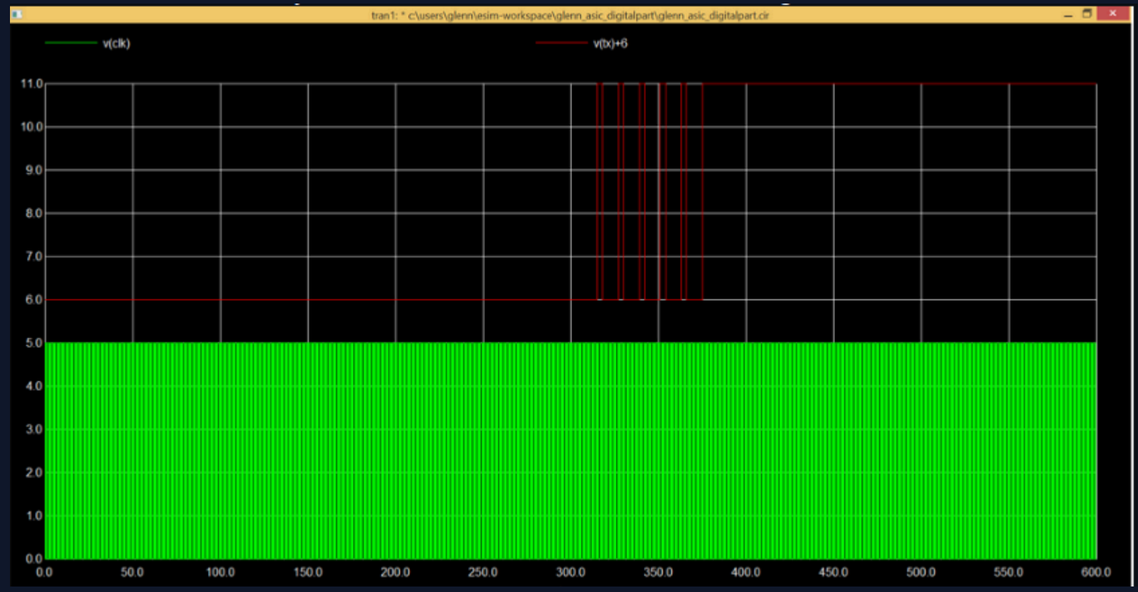

https://simulations.fossee.in/eda/

# Mixed signal Example
# FSM in ASIC with RF Transmitter

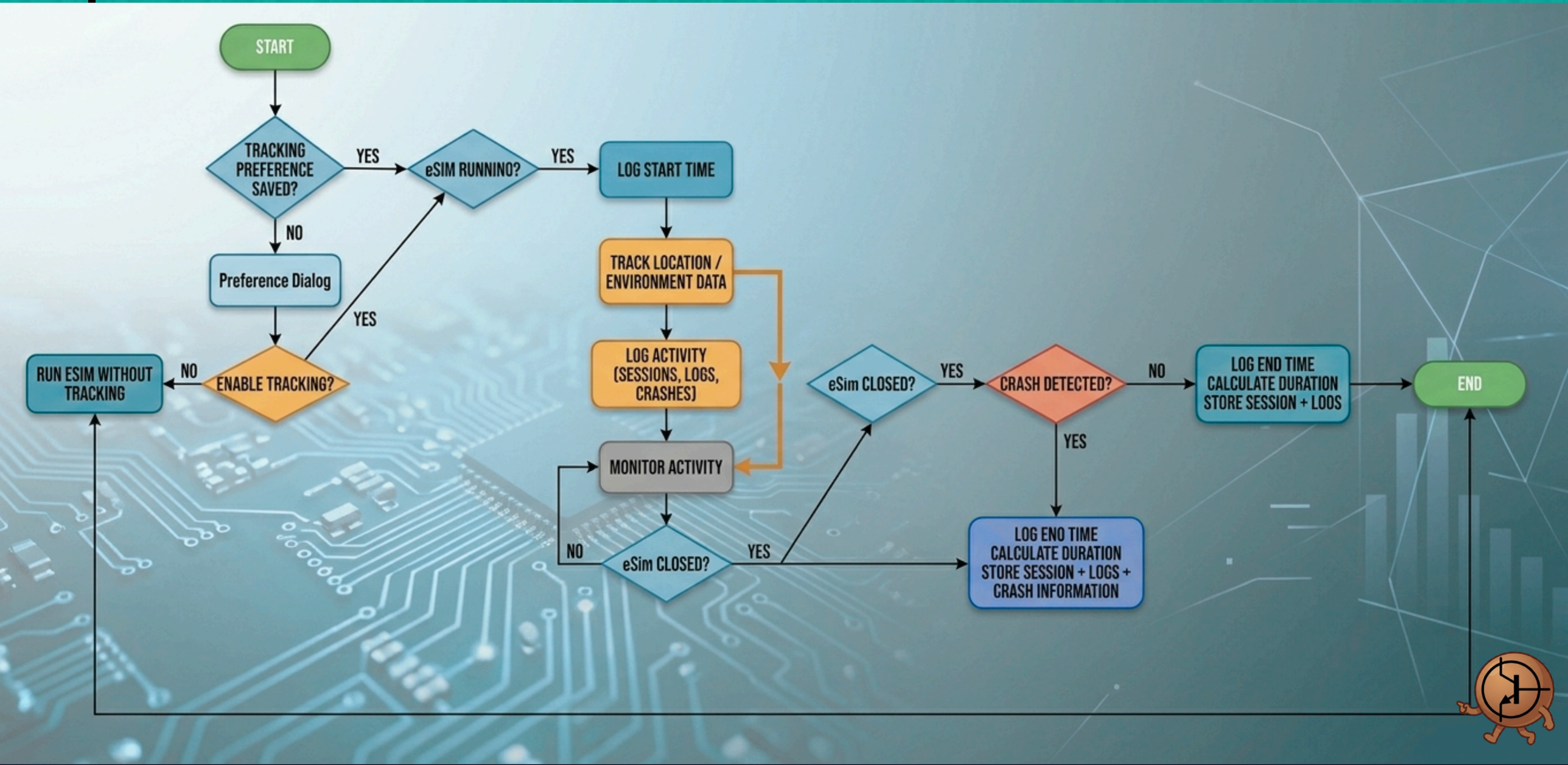






# eSim Tool Tracker



# Self-Paced Learning Support

Comprehensive learning modules are available to support independent mastery of the eSim platform.

**ACCESS TUTORIALS DIRECTLY**

Tutorials

# Activities & Engagement

FOSTERING OPEN HARDWARE SOVEREIGNTY

CORE DEVELOPMENT
**Research Migration**

ADVANCED MODELING
**Circuit Simulation**

INFRASTRUCTURE
**Lab Migration Projects**

SKILL BUILDING
**Workshops & Training**

MENTORSHIP
**Internships & Fellowships**

SCALE
**Nationwide Participation**

# Benefits of our activities

Certificates

Honorarium

Recognition

Community Partnership

# eSim Marathon

| | Year | Domain | Version | Partners |
|---|---|---|---|---|
| **Circuit Design and Simulation Marathon using eSim** | **May-June, 2021** | SKY130 circuits | eSim-2.1 | FOSSEE, IIT Bombay, VSD, MoE |
| **Mixed Signal Circuit Design and Simulation Marathon** | **Feb- March, 2022** | eSim NgVeri and NGHDL feature | eSim-2.2 | IIT Bombay, FOSSEE, Spoken-Tutorial, VSD, Redwood EDA, C2S |
| **Mixed Signal SoC design Marathon using eSim & SKY130** | **Sept-Oct 2022** | eSim SKY130 feature and eSim NgVeri and NGHDL feature | eSim-2.3 | IIT Bombay, Google FOSSEE, Spoken-tutorial, VSD |
| **Circuit Design & Simulation with IHP SG13G2** | **Oct-Nov 2025** | eSim NgVeri and NGHDL feature + IHP PDK | eSim-2.5 | IITB, FOSSEE, IHP, Spoken Tutorial, IEEE CEDA, IEEE CAS, EduPyramids |

# eSim Marathon Success Stories

- 10+ designs Taped Out
- High-Quality Technical Outputs
- Talent Discovery and Community Building
- Changing Career Paths

# Outreach

## Marathon Statistics

- 2000+ registrations
- Over 100 winners
- Around 10 designs sent to Fab
- Published Papers

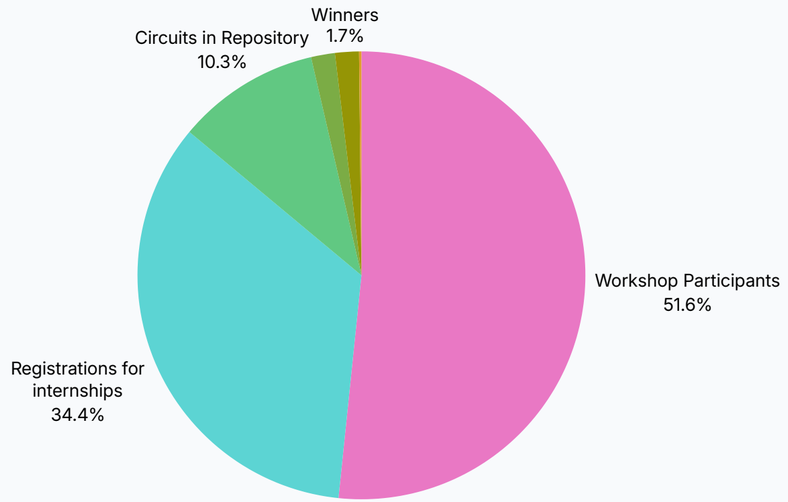
## eSim Hardware Workshop

- 3000 participants in 2019
- Around the globe
- Kits where even sent to Myanmar

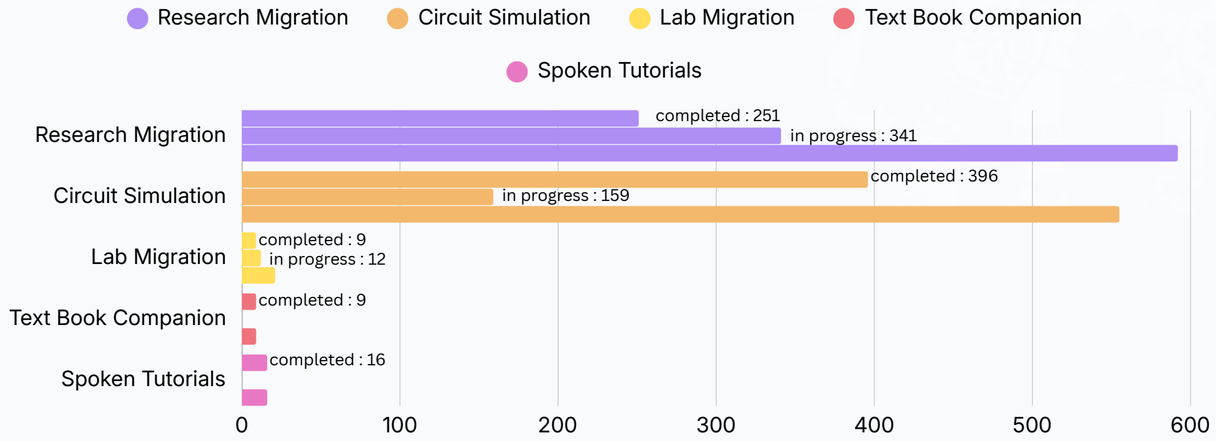
## Fellowship/Internships Statistics in 2026

- 100+ fellows and interns
- Interns from Myanmar/USA
- Working on Tool Development
- Working to adding up to the library

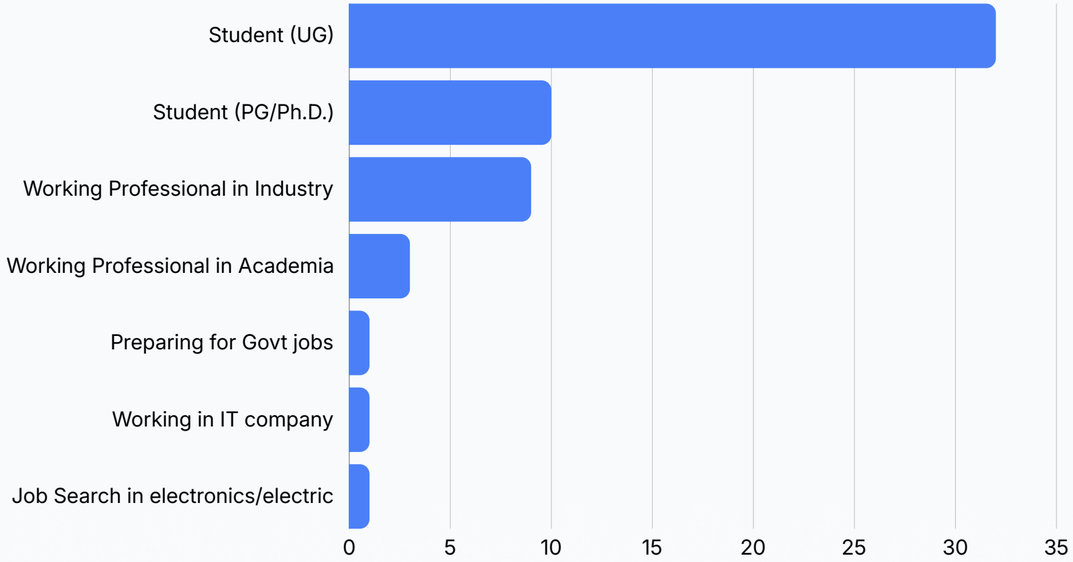
# Outreach and Marathon Impact Metrics



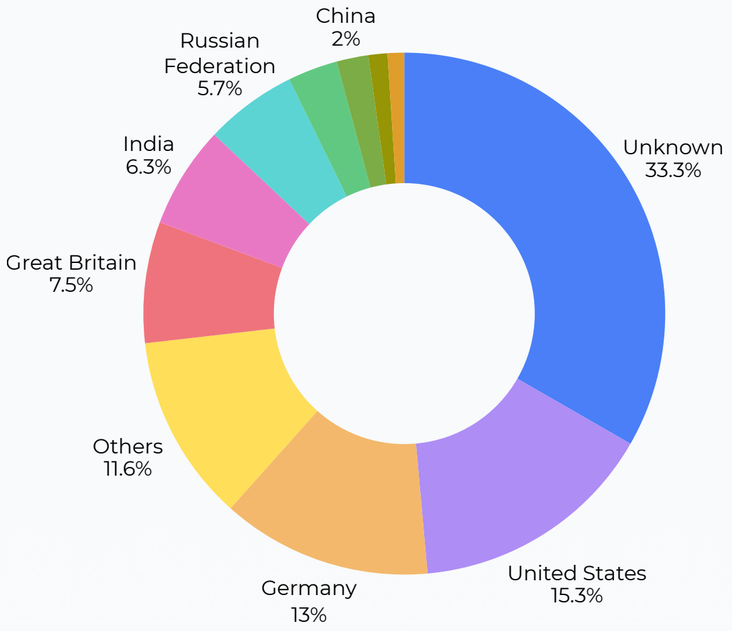

# Screening Tasks and Technical Simulations




# Participant Demographic Data

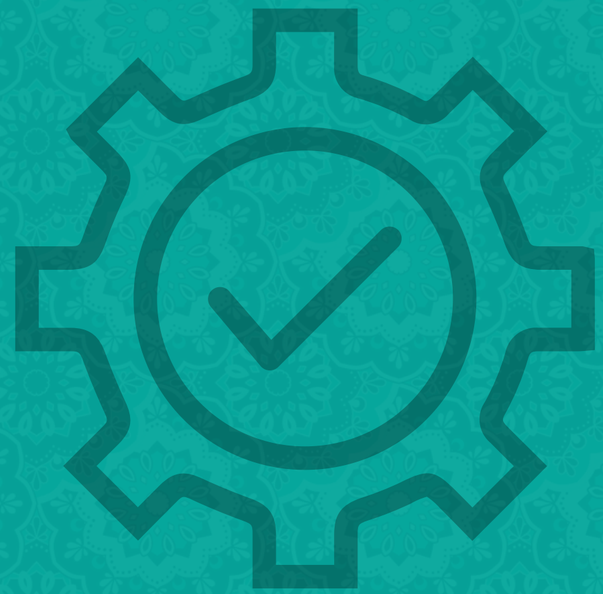



# Visitor Demographics Data



# Managing Strategy

1. Principal Investigator (Prof. Prabhu)
2. Sr. Project Managers
3. eSim Team Members
4. Teaching Assistants, Old Students, etc.
5. Students/Interns/Fellows



# Community & Collaborations

## Academic Network

Connecting **Undergraduates, Graduates, and Researchers** across national and international institutions to foster a global design community.

## Indigenous Tech

Strategic coordination with **Swadeshi Processors** like **AJIT, SHAKTI, and VEGA** to ensure software-hardware synergy.

## Global Strategic Alliances

Leveraging world-class partnerships with **Google SkyWater, IHP Fab, Germany** and **Open Power Foundation** for advanced design and fabrication. Also connected with the **RISC-V** ecosystem.

## National Missions

Associated with the **Indian Semiconductor Mission (ISM)** and collaborating with a vast network of **Open Source Fabs**.

# Future Directions

### HW Design

Expansion of open hardware design flows.

### PDK Support

Integration with emerging open source PDKs.

### FPGA Ecosystem

Support for open-source FPGA toolchains.

### AI Tools

AI-assisted design and debugging solutions.

# Impactful Stories & Testimonials

## Industry Impact

eSim was earlier named Oscad, but industry giant PSpice requested a name change as it sounded too similar to OrCAD.

**This immediate recognition proved the significant market impact of eSim from its inception.**

HISTORICAL MILESTONE

## Career Gateway

"The marathon was a gateway to placement events. My learnings and connections helped build a career in VLSI."

**Vital for students from Tier 3 colleges to gain a competitive edge in specialized engineering.**

— MARATHON PARTICIPANT

## Professional Success

"The outstanding classification I earned through eSim made me highly knowledgeable and proficient."

**This boost in motivation just before graduation directly led to securing a high-quality job.**

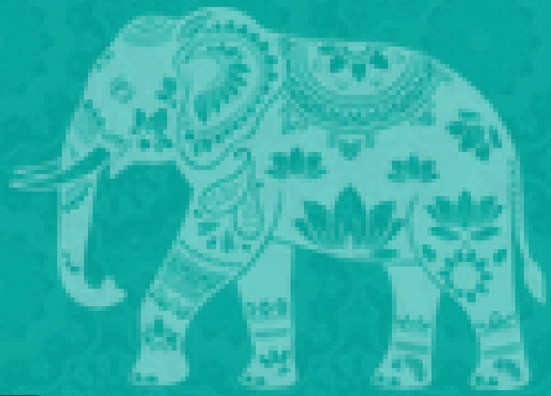
— MARATHON PARTICIPANT

# Where to contribute?

| Computer Science Domain | Electrical Domain |
| --- | --- |
| eSim on every Platform | Design ICs(e.g. 74xx series) |
| Support for the Cloud Version | Design System on Chips(SoCs) |
| Improving the UI | Power Devices Integration |
| Fixing the bugs | RF Components Integration |
| Integrating with OpenROAD | Create Device Models |
| Tool Manager Development | Create VLSI IPs |
| Create automated tests | Simulation for tapeout |
| Develop ChatBot | Testing  Thoroughly |

# Get Involved

Be part of the open hardware movement



- Use **eSim** in your upcoming projects
- Contribute to core EDA development
- Participate in FOSSEE programs
- Promote open-source EDA ecosystems

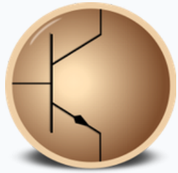
# Join Hands In Developing eSim !!

Please visit the GitHub repositories of the eSim

-

https://github.com/FOSSEE/eSim

https://github.com/FOSSEE/nghdl

**Project Link: https://esim.fossee.in**
**Email : contact-esim@fossee.in**

**eSim Team :**
**Mr. Sumanto Kar , Ms. Shanthi Priya K , Mr. Varad Patil**

**Sr. Project Manager : Mrs. Usha Viswanathan**
**Sr. Project Manager : Mrs. Vineeta Parmar**
**Sr. Project Manager : Mrs. Payel Mukherjee**

**Principal Investigator**
**Prof. Prabhu Ramachandran (Aerospace Engineering, IIT Bombay)**

**Former Principal Investigator**
**Prof. Kannan Moudgalya (EduPyramids)**

# Thank you

# Any Questions ?

# Feedback :

eSim - Democratizing Electronic Design Automation through Open Source