Current Experiences and Capabilities of Open-Source EDA Tools for Mixed-Signal Chip Design

Juan Sebastian Moya-Baquero
International Iberian Nanotechnology Laboratory / SymbioticEDA

Motivation and Context - Why open-source EDA is important today.

Traditional barriers in IC design

- Licenses installation
- Tool setup
- PDK access
- Reproducibility.

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Open-source PDKs and EDA tools

- Broadening Access to IC design

ELECTRON DEVICES SOCIETY

IEEE Solid-State Circuits Society IC Innovation

CAS IEEE CIRCUITS AND SYSTEMS SOCIETY

IEEE OPEN SILICON

IEEE

Universidad de los Andes

Technology Arts Sciences TH Köln

BROWN UNIVERSITY

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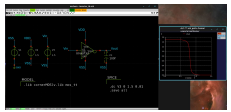
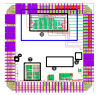
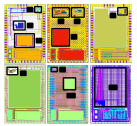
Real Opportunity

- Hands-on Training
- Prototyping
- Collaboration
- Real tape-out experiences







Current Open Source Ecosystem

Open Source PDK

Current Open Source Ecosystem

Open Source PDK

	sky130A	gf180mcuD	ihp-sg13g2	icsprout	icl
Technology	150nm triple pwell process	180nm CMOS	130nm triple well BICMOS process	55nm CMOS process	180nm CMOS
Main application	General purpose, digital-oriented CMOS	Mixed-signal / MCU technology	Analog, mixed-signal and RF	Digital-oriented	-
Core / device voltages	1.8V core CMOS	1.8V / 3.3V / 5V / 6V MOS devices LVT / RVT / HVT / MOSFET options (low, regular, high-VT), Native NMOS (low-VT) devices	1.2V / 3.3 V CMOS	-	-
High-voltage support	3.3V and 5V / 10.5V / 11V / 16V high-voltage options	LVT / RVT / HVT native devices	-	-	-
Bipolar devices	Parasitic lateral PNP and vertical NPN	Optional parasitic vertical NPN / lateral PNP	Optional parasitic vertical NPN / lateral PNP	-	-
Diode options	Schottky and ESD diodes (standard, HV, antenna, photo)	Signal, ESD, and high-voltage junction diodes	Schottky and antenna diodes	-	-
Resistors	Polysilicon resistors (low-R, high-R), diffusion and well resistors (N+, P+, P-well)	Polysilicon resistors (high-R and low-R variants)	3 poly resistor options	-	-

Current Open Source Ecosystem

Open Source PDK

Tools

Current Open Source Ecosystem

Open Source PDK

Tools

What already works well

- Schematic-Level Simulation
- Layout Implementation
- DRC/LVS
- Parasitic Extraction
- Post-Layout Simulation

Current Open Source Ecosystem

Open Source PDK

skywater

GlobalFoundries

ihp

icsprout 浙 | 江 | 创 | 芯

Tools

XSCHEM

NGSPICE

Magic VLSI Lay
Current distribution version 8.3

LibreLane

24h
OpenROAD

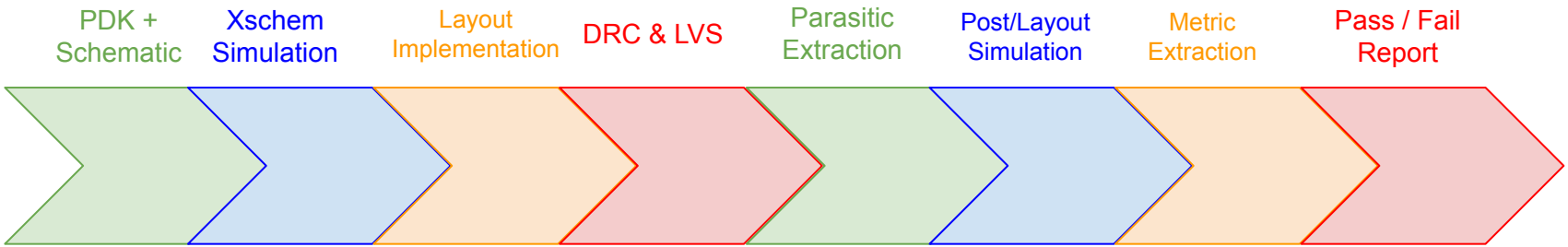
What already works well

- Schematic-Level Simulation
- Layout Implementation
- DRC/LVS
- Parasitic Extraction
- Post-Layout Simulation

Current limitations

- Documentation Gaps
- Flow Integration
- Analog Verification Automation
- Reproducibility Across Users and Machines

Practical Mixed - Signal Design Flow



LibreLane

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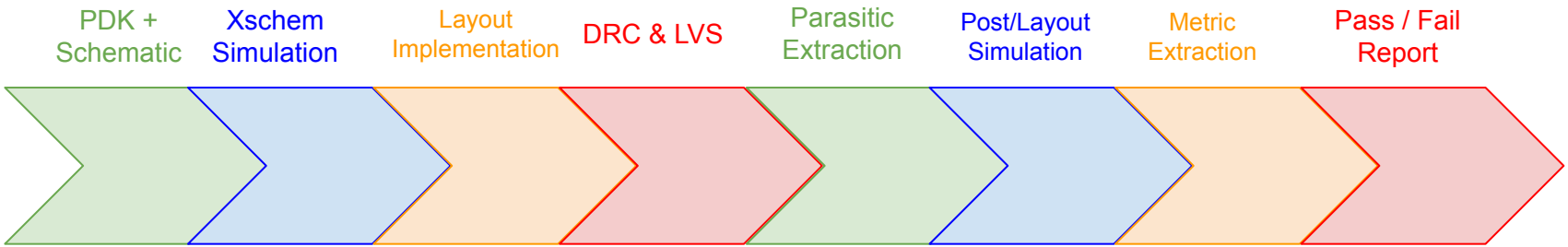
XSCHEM NGSPICE

GitLab

GitLab

go

Practical Mixed - Signal Design Flow



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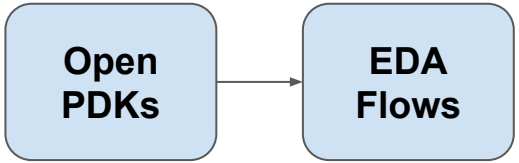
Open-source tools can already support a complete mixed-signal design flow, from schematic to post-layout verification.

Open-source silicon needs an ecosystem, not just downloads

Open PDKs

Open-source silicon needs an ecosystem, not just downloads



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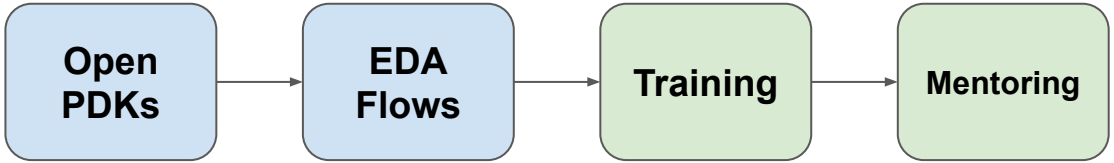

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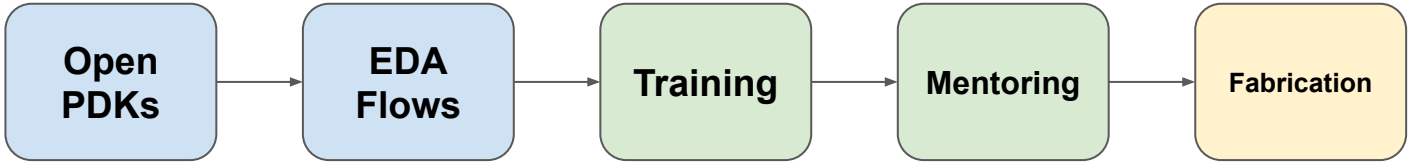

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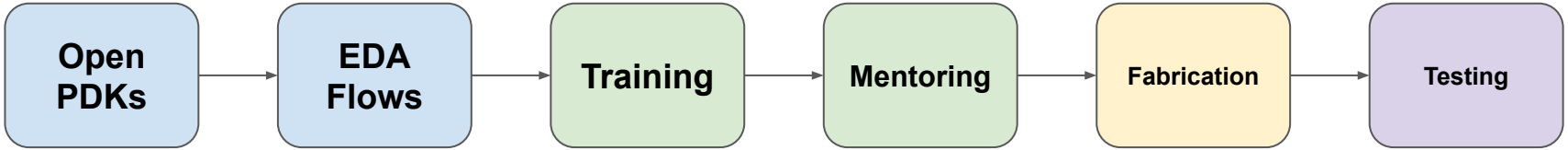

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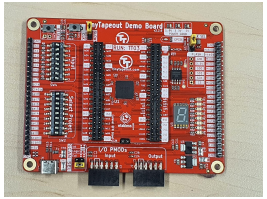

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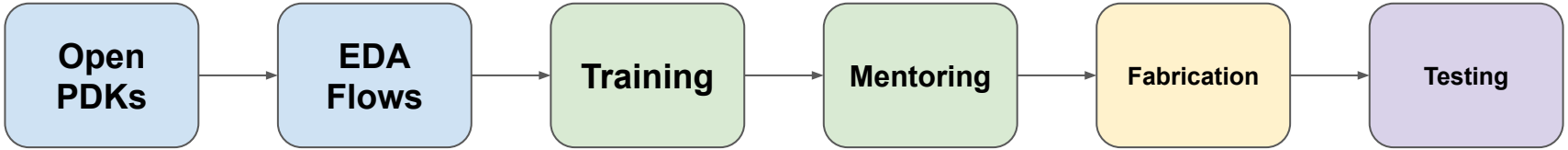

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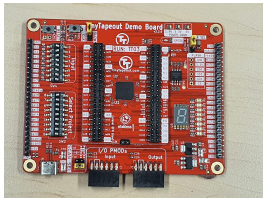
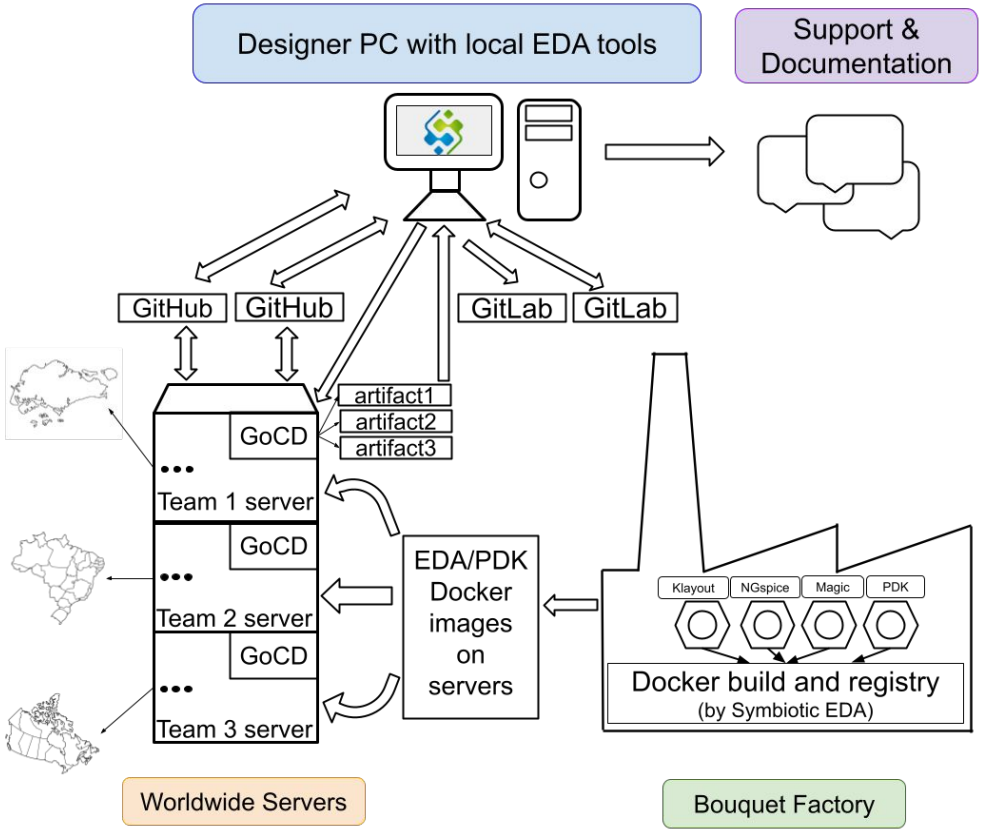


Bluegarden


Managed environment for FPGA and IC design
and verification using open source tools
PDP.EDU.VN

About Bluegarden



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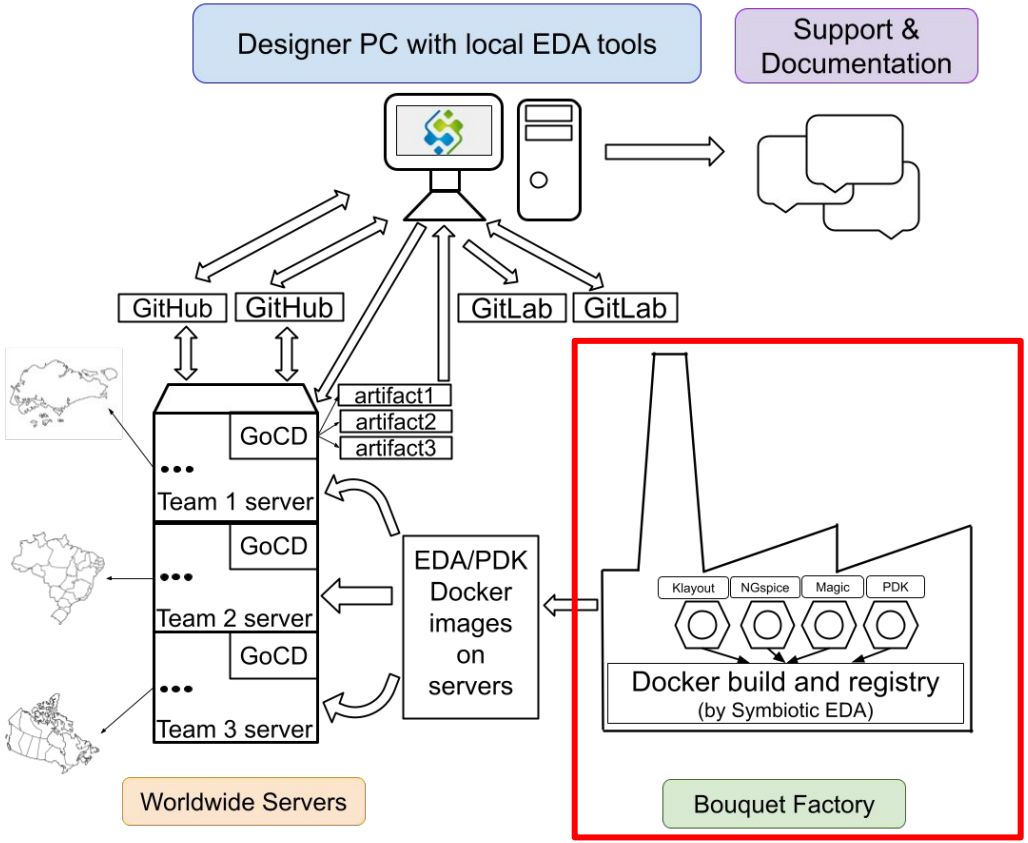
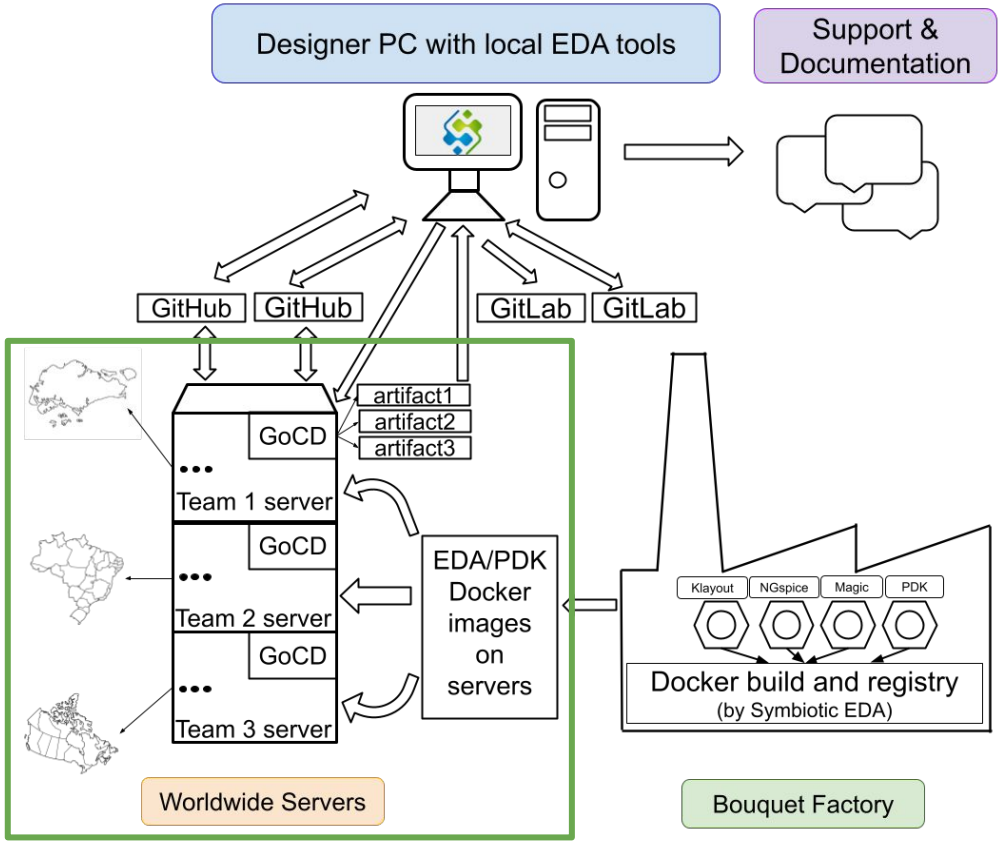


Customized Docker container based on client requirements (=**Bouquet**)

About Bluegarden

We rent worldwide servers that are associated with specific teams in order to improve security.



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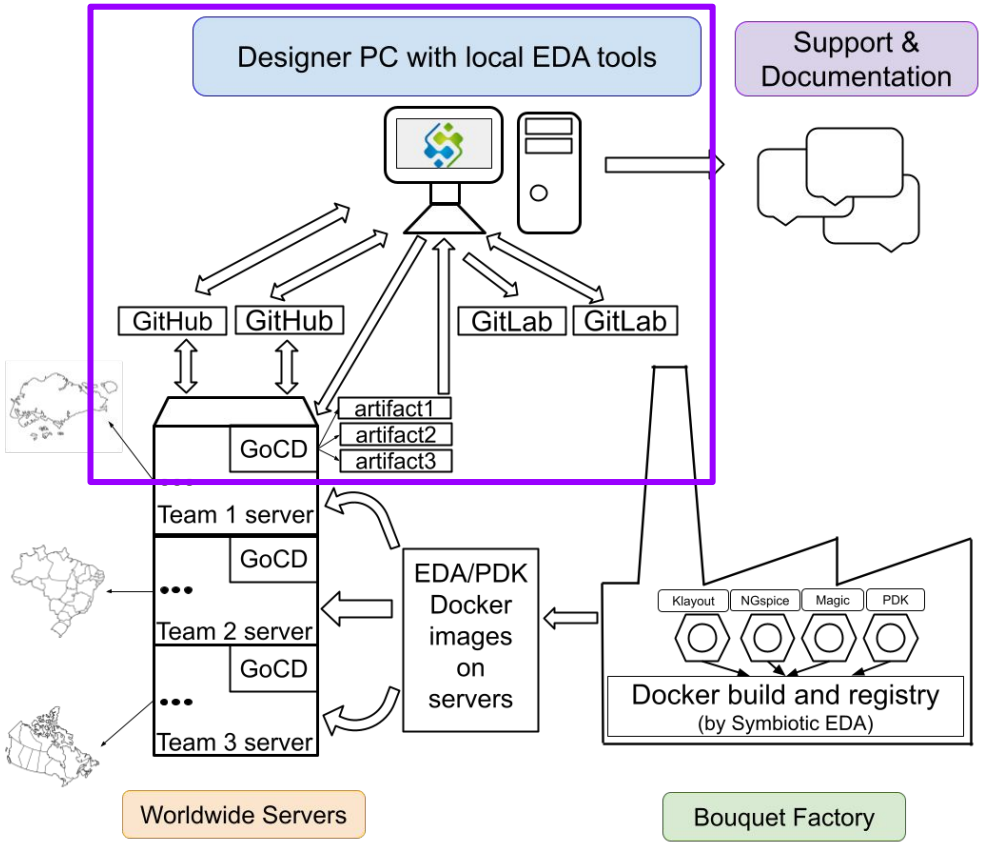
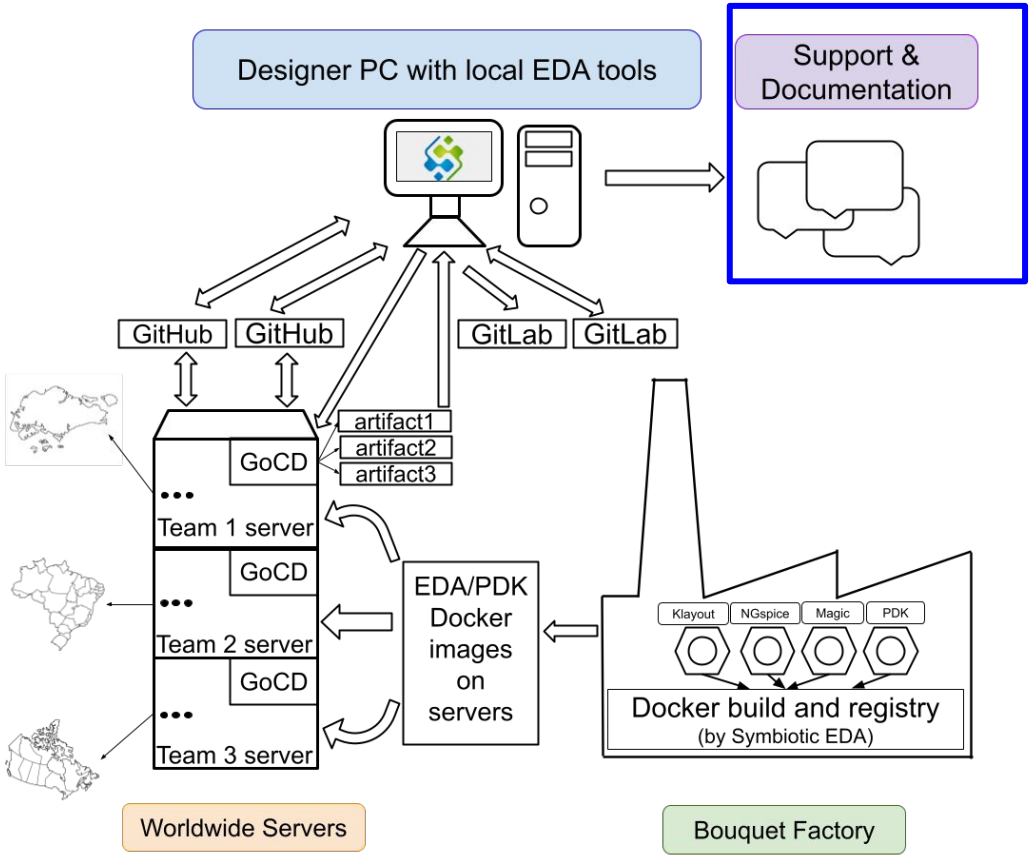


Users get Gitlab accounts and possibility to CI/CD flow.

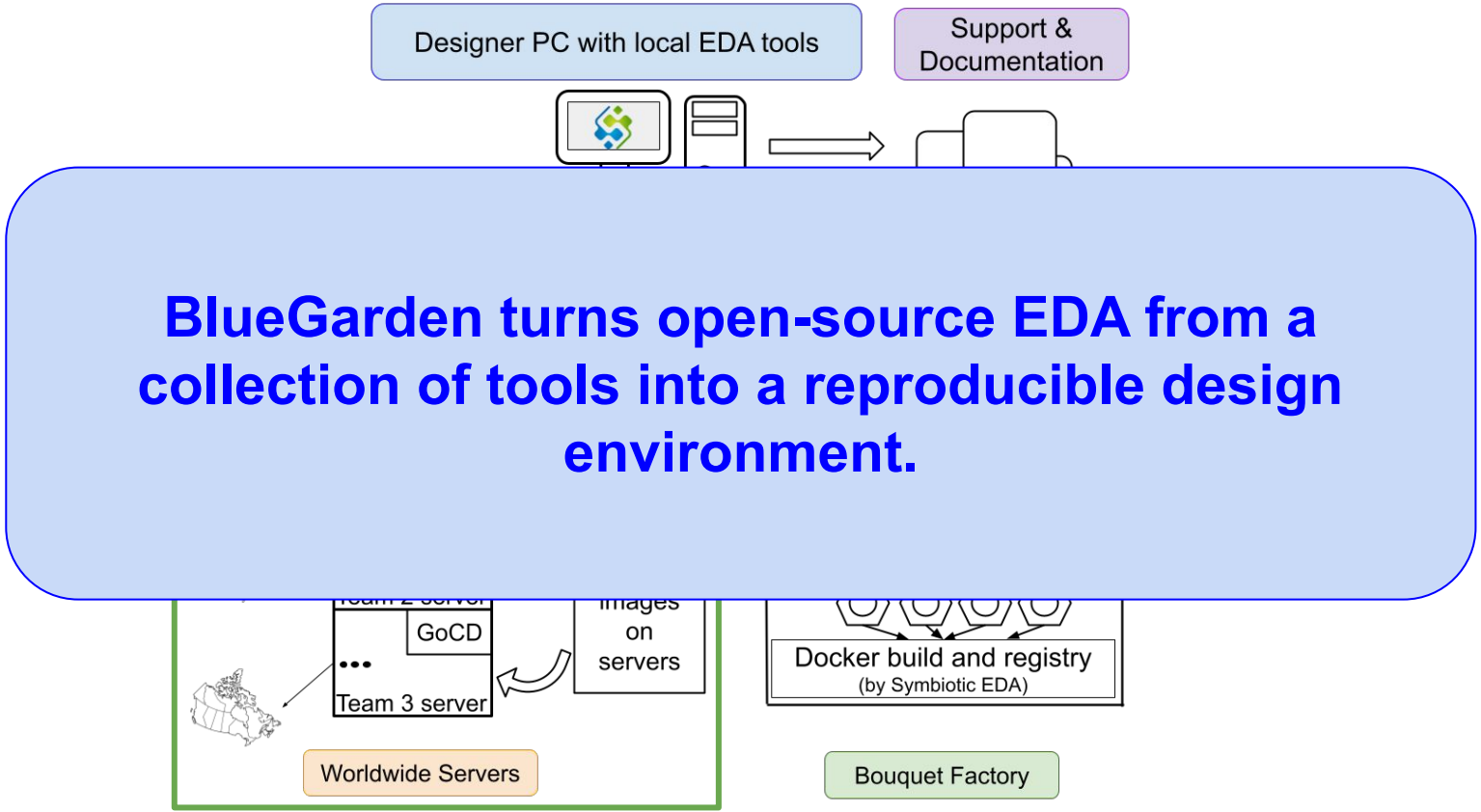
Option to install Docker container locally

About Bluegarden



We provide you support regarding building and deploying the bouquets, getting familiar with the tools and with the different flows.

About Bluegarden



Bluegarden demo

Bluegarden Summary

	Is it working correctly?
Analog Flow	✅
Digital Flow	✅
Mixed-signal Flow (digital circuit / analog circuit)	Verilog +PEX✅ Gate Level + PEX ✅ PEX + PEX ❌
RF Flow	✅
CI/CD pipeline	✅

Bluegarden Summary

	Is it working correctly?
Analog Flow	✅

Open-source EDA is not only about accessing tools. It is about building reproducible flows, training designers, and enabling real silicon experiences.

Aveiro and Colombia workshops

Aveiro University (PT) May 2026:
2h hands-on session
~ 30 participants

Colombia 2025/02:
4 workshops in 4 different universities

Cali

Barranquilla

Tunja

Armenia

IEEE activities supporting IC design

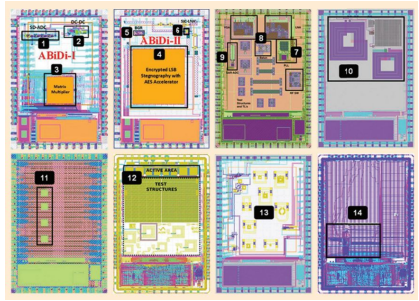
SSCS

CAS
IEEE CIRCUITS AND SYSTEMS SOCIETY

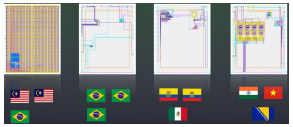
ELECTRON DEVICES SOCIETY

LATINPRACTICE

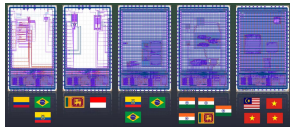
2021: 61 submissions, 18 selected (11 taped out)
2022: 54 submissions, 22 selected (14 taped out)
2023: 10 selected (3 taped out)
2024: Postponed
2025: 23 selected (4 taped out)



2023

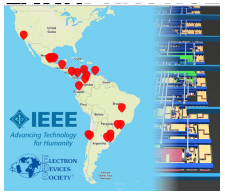


2024

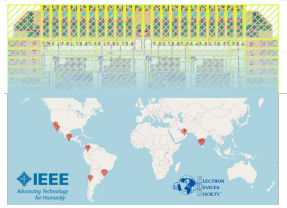


Results achieved:

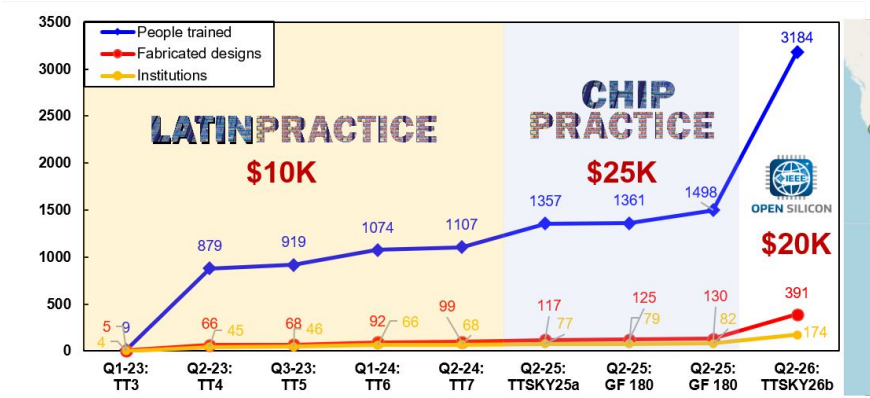
- 23 VLSI bootcamps organized
  - 11 countries
  - 3 languages
  - 68 institutions
- 99 VLSI circuits fabricated
- **1,107 people trained**



CHIP PRACTICE



IEEE activities supporting IC design



Ngspice supporting Degradation Simulations (Presented at FSIC2026 1 week ago)

NGSPICE - status update and recent developments with OpenPDK support

Dietmar Warning, Holger Vogt, Giles Atkinson
NGSPICE development team

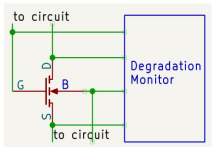
http://ngspice.sourceforge.net

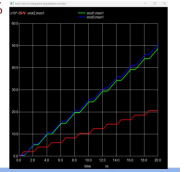
Free Silicon Conference 2026 – FSiC2026

Monitor device DEGMON

Code model automatically attached parallel to each transistor

- Implements the degradation model
- Reads an input the degradation model parameter deck
- Measures device voltages over a transient simulation period
- Calculates degradation parameters for each device
- Simulation time overhead is only 10-15%





Degradation Simulation

- Electronic integrated circuits may degrade and malfunction
  - Over lifetime by voltage, current or temperature stress
  - In a radiation environment (e.g. space applications)
    - By total ionizing dose (TID)
    - By single event effects (SEE)

DE:Sign project Flowspace with ngspice to support the IHP Open Source PDK in a space environment, funded by BMFTR, https://www.elektronikforschung.de/projekte/di-flowspace

Conclusions

- Open-source PDKs and EDA tools can already support practical mixed-signal design flows from schematic to post-layout verification.
- The next challenge is integration: reproducible environments, automated verification, and scalable training workflows.
- Self-checking analog tests and CI/CD enable more systematic simulation, metric extraction, pass/fail evaluation, and reporting.
- BlueGarden helps transform open-source EDA tools into a managed, reproducible, team-based IC design environment.
- Real impact requires more than tools: training, mentoring, fabrication, testing, and community-driven tape-out experiences.

Thank you!

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More info: https://www.symbioticeda.com/