

# Cost Constrained CHIP Design

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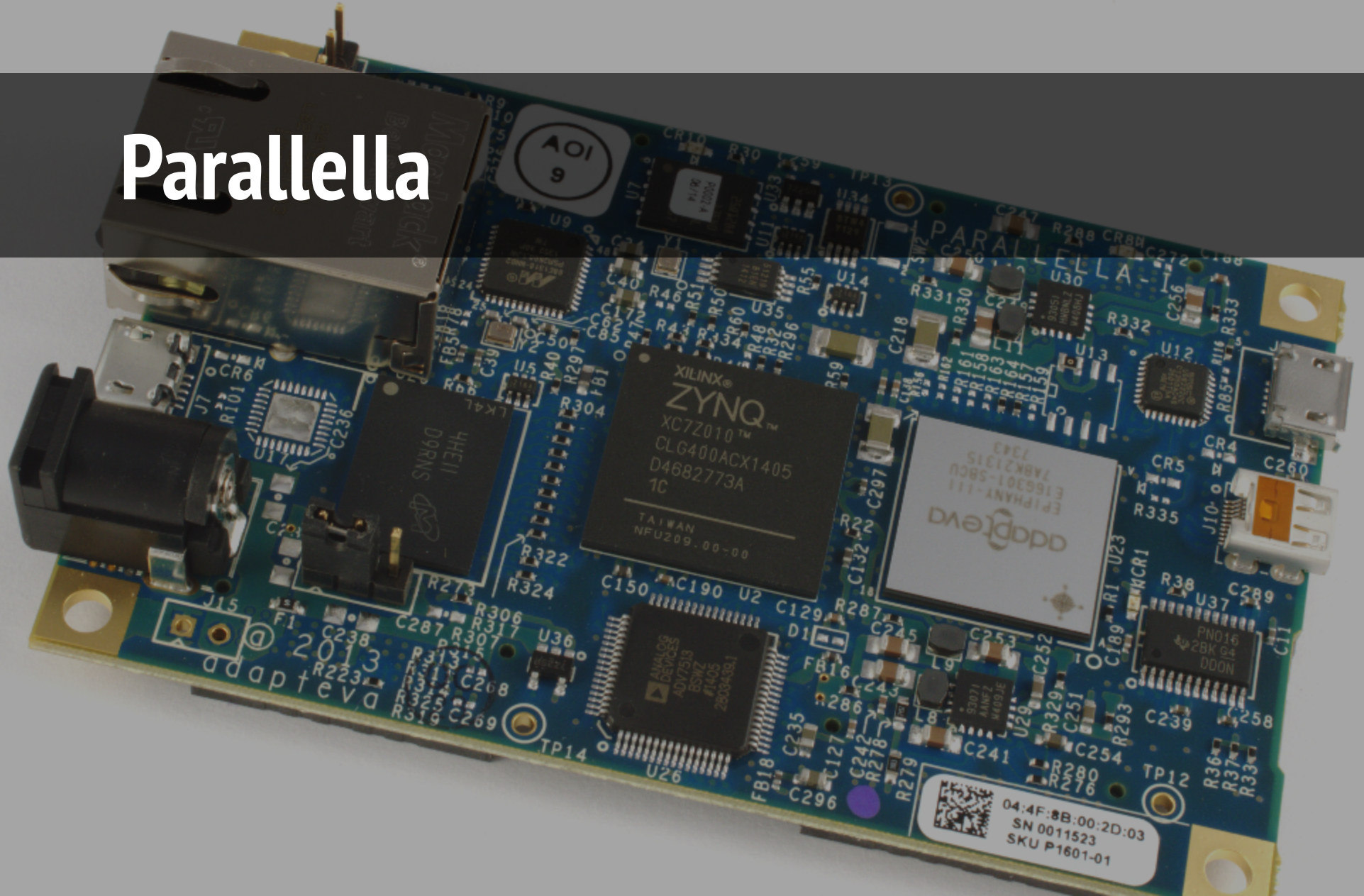


# Adapteva History

- 2008: Founded (Lexington, MA)
- 2011: 16-core 25 GFLOPS/W 65nm product
- 2012: 64-core 50 GFLOPS/W 28nm product
- 2012: Parallella Kickstarter chip crowd funding
- 2014: Parallella shipped to over 10K users, 200 Universities
- 2016: Tapeout of Epiphany-V: 1024-core 64-bit processor



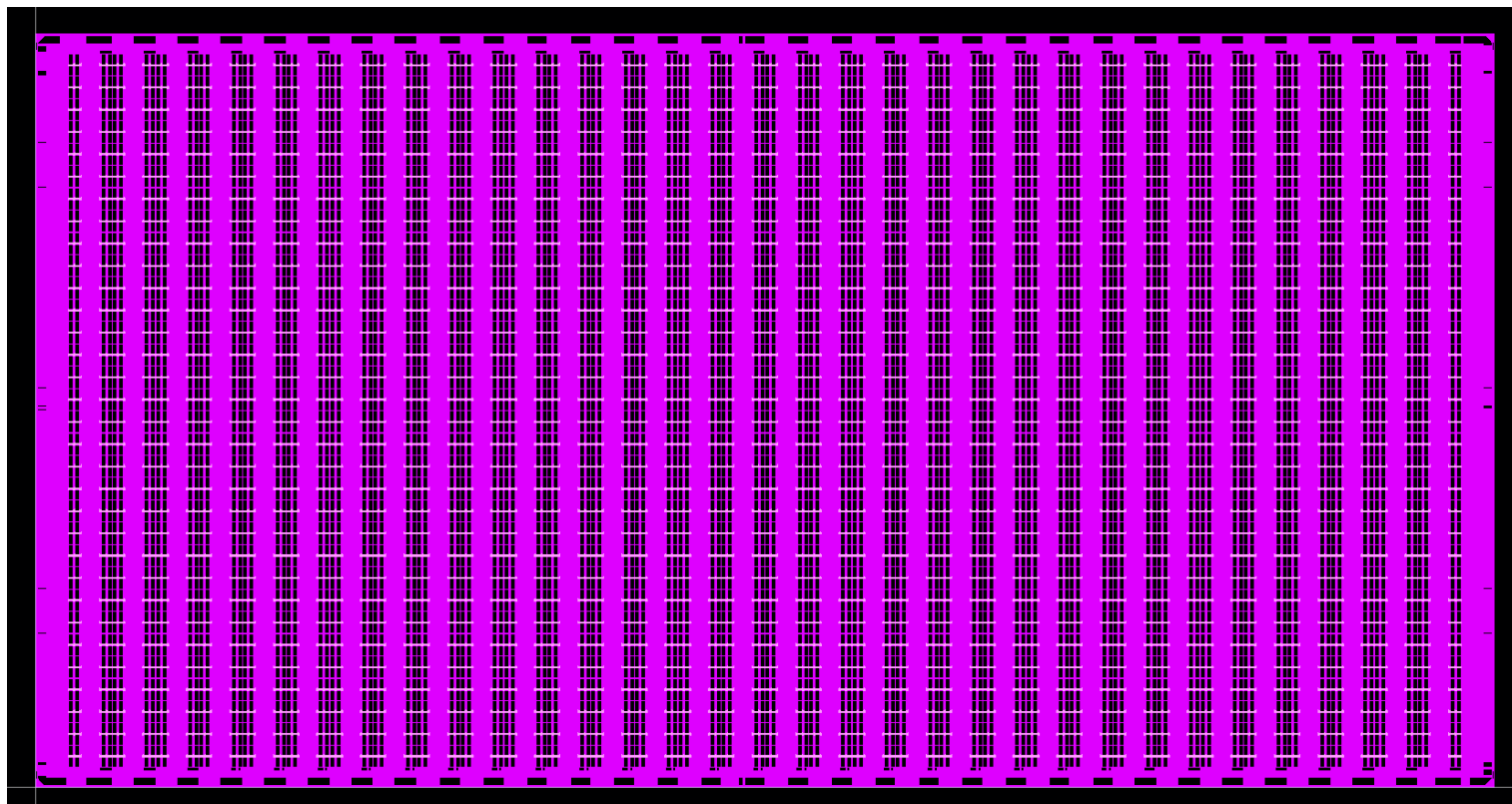
# Parallel



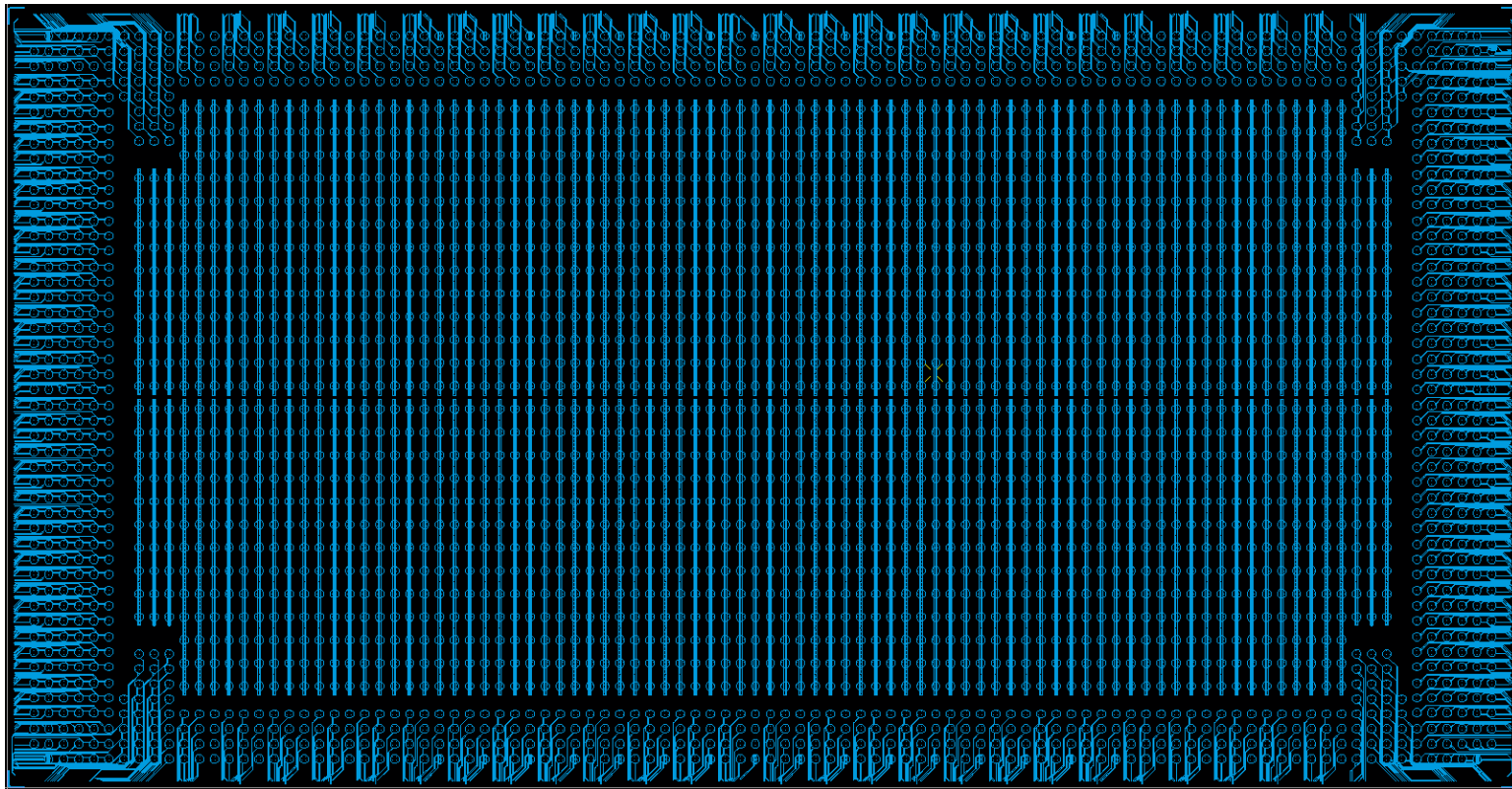
# Epiphany-V Introduction

- TSMC 16FF (CRAFT tapeout)
- 1024 64-bit RISC processors
- 64/32-bit IEEE floating point support
- 64 MB on-chip SRAM
- 1024 programmable I/O signals
- 117mm<sup>2</sup>, 4.5B transistors

# E5 Layout



# E5 Bumps



# Our I/O Challenges

- Needed massive IO to support 4 TFLOPS!
- Initial plan was 128 x 10Gbit SERDES lanes
- ...but cost made monolithic integration impossible
- Fallback was 1024 1.8V CMOS pins running at @ 150MHz...

**Rule**

**Value**

8

# Opportunity

**Rule**

**Value**

Chip wire pitch

0.08um

2.5D wire pitch

4um

Wirebond pitch

30um

2.5D Bump pitch

45um

Flip-chip pitch

170um

BGA pitch (advanced)

400um

Ethernet connector

~10,000um



# A Strawman Chip-to-Chip Interface

- Make 50um bumps are available to all customers
- Drive parallel interfaces (clk, frame, wait, data[N-1:0])
- Reference RTL: [github.com/parallella/oh](https://github.com/parallella/oh)
- CMOS signaling using thin oxide transistors (0.8V)
- Energy Target: 0.2pJ / bit
- Density Target: 2Tbit / mm<sup>2</sup>

# Standards Recommendations

- Open access
- Open license
- Free from royalty/patent issues
- At least one free physical implementation
- Keep it simple
- Open collaboration (optional)