



IWES 2018

Third Italian Workshop on Embedded Systems

Siena – 13-14 September 2018

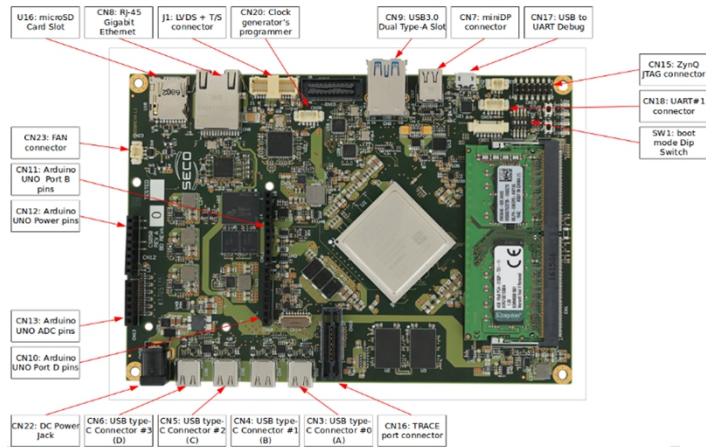
Embedded System Research @UNISI

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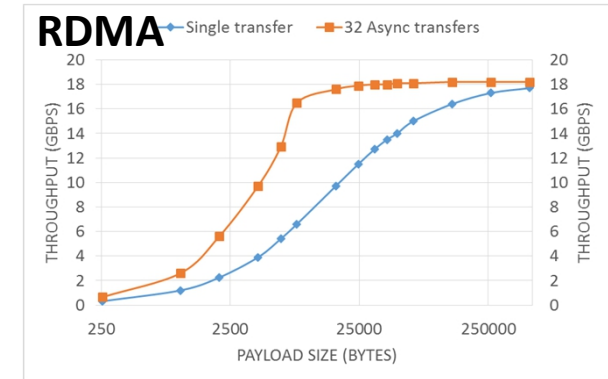
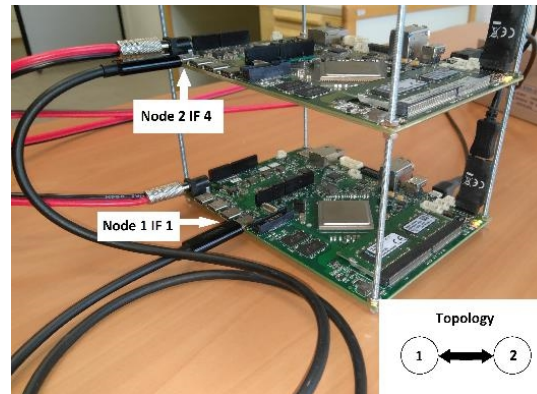
<http://www.dii.unisi.it/~giorgi>

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Bidirectional links



• UNIQUE FEATURES

- SCALABILITY via USB-C cable: building clusters up to 255 boards
- 4 channels on USB-C cable @ 18Gbps (custom protocol)
- PROGRAMMABILITY via OpenMP: TRANSPARENT FPGA acceleration + CLUSTER distribution
- ARDUINO-UNO socket on board for easy interfacing with the physical world
- 250MHz Trace port – Lauterbach compatible
- Open-source software stack + BSP: <https://git.axiom-project.eu/> (10⁶+ Lines of Code!)

http://www.axiom-project.eu/AXIOM_BOARD_GUIDE.pdf

✓ **DELIVERED March 2018**

Other projects

- ▶ TERAFLUX: (**UNISI=1.3Meuro**) 2010-14 <http://teraflux.eu>
- ▶ **ERA: (UNISI=0.4Meuro)** Embedded Reconfigurable Architectures 2010-13
- ▶ SARC: Scalable Architectures (UNISI=0.12Keuro) 2005-2010
- ▶ HiPEAC: High Perf. Embedded Arch+Comp. (UNISI=0.06Keuro) 2004-2018
- ▶ NCA (FIRB): Non-conventional Architectures (UNISI=0.04Keuro) 2001-2004
- ▶ PHOTONICA: Integrated photonics in CMPs (UNISI=0.14Keuro) 2010-2014
- ▶ INASSE: Industry 4.0 As a Service (UNISI=0.15Keuro) 2018-2020

Research Group @ UNISI

- ▶ 1 Assoc. prof.: Roberto Giorgi (G) + 1 Aggreg. prof.: Sandro Bartolini (B) + 1 Full Prof. Antonio Rizzo (R):
 - Currently 3 PhD Students, 2 Postdocs
 - HR Throughput: 2 Full-Prof., 2 Junior Researchers, 9 Postdocs, 10+ PhD students, 20+ students and collaborators ---- during the last 8 years
- ▶ Courses (G=Giorgi,B=Bartolini,R=Rizzo):
 - (G) Bachelor (L1): **Computer Architecture** (6 credits) -3rd year (Italian)
 - (G) Master (L2): **High Performance Computer Architecture** (9 credits) – 1st and 2nd year(English)
 - (B) Master (L2): **Design of Applications Systems and Services** (9 credits) – 2nd year (English)
 - (R) Bachelor (L1): **Interaction Design**(6 credits) -2rd year (Italian)
 - (R) Master (L2): **Cognitive Science and Tecnology** (6 credits) – 1st year (Italian)

LAB RESOURCES

▶ Lab Resources

- 64-core (x86) CC-NUMA w/1024GiB RAM
- 48-core+256GiB, about 15 simulation servers (8-core+32GiB)
- 12 different FPGA boards ranging from Virtex-6 to Zynq Ultrascale+ (6-core 64 bits)
- Xeon Phi, Maxeler Dataflow computer, GPUs, 50+ embedded boards, (20+ workstations)
- Various server machines (Xeon, i7) with up to 128GiB and some hosting high-end Nvidia GPUs: dual 1080ti, 1080, 970
- Intel development suite
- UDOO Lab: 4 kickstarter projects w/SECO

2014,UDOO



\$641,614

2015,UDOO-NEO



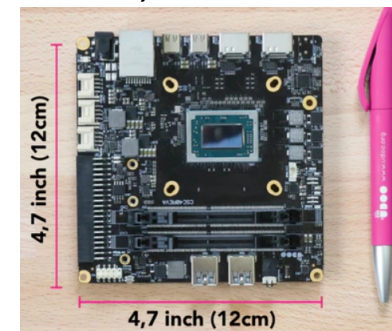
\$268,415

2017,UDOO-X86



\$800,211

2018,UDOO-BOLT



\$635,769

Cooperation with Laboratorio Nazionale Embedded Systems and Smart Manufacturing (LN-ESSM) CINI

- ▶ CINI lab LN-ESSM (in progress) director prof. Antonino Mazzeo
- ▶ UNISI competences
 - (Giorgi, Bartolini) Programmable Hardware, Processors, Co-processors and Microcontrollers
 - (Giorgi) Hardware/software projects ecosystems
 - (Giorgi) Smart Cyber-Physical Systems architectures
 - (Giorgi, Rizzo) Smart Systems Integration and Internet of Things Applications
 - (Rizzo) Human Machine Interface
 - (Bartolini) Efficient programmability of heterogeneous multi-/many-core systems with single source code
 - (Bartolini) Hardware and software for security, trust, block-chain
 - (Bartolini) HW/SW architectures for computer vision
 - (Bartolini) Energy Management, power efficiency and approximate computing in embedded nodes

Scalable Embedded Systems – A new concept?

- ▶ 1 board → ~10s, 2 board(USB-C connected)→ ~7s (no optimizations)
- ▶ SAME board type, SAME software, NO programming efforts, still EMBEDDED



Future Directions

- ▶ FPGA/GPU-based Software/Hardware for AI Applications
- ▶ Computers for Intelligent Unmanned Systems
- ▶ Smart Vision and Security