Open Hardware for Technology Transfer

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BE-CO Hardware and Timing section
CERN, Geneva, Switzerland

CERN BE-KT Day
Outline

1. Open Hardware
   - Open Hardware Intro
   - Open Hardware Repository
   - CERN Open Hardware Licence

2. Case studies
   - Case studies – SPEC & ADC
   - Experience with Industry

3. Conclusions
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3 Conclusions
CERN Open products are real products
Seven CERN designs commercialised by four companies

Erik van der Bij
Open Hardware for Technology Transfer
Why we use Open Hardware

Design re-use
When it’s Open, people are more likely to re-use it: feedback.

Dissemination of knowledge
One of CERN’s key missions!

Healthier relationship with companies
No vendor-locked situations. Companies selected solely on the basis of technical excellence, good support and price.

Spend money where you or your funding agencies want
Opens the door to smaller companies with local support.
## Dispelling the commercial vs open myth

<table>
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<th>Open</th>
<th>Commercial</th>
<th>Non-commercial</th>
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<td>Winning combination. Best of both worlds.</td>
<td>Whole support burden falls on developers. Not scalable.</td>
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<td>Vendor lock-in.</td>
<td>Dedicated non-reusable projects.</td>
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CERN FMC projects in OHWR.org – some examples

### FMC Carriers
- VME64x (BE/BI & BE/CO), VXS (BE/RF)
- PCIe (BE/CO), PXIe (EN/ICE & BE/CO), AMC (PH/ESE)

### FMC Mezzanines
- ADC sampling speed: 100 MSPS
- TDC and Fine delay: 1 ns resolution
- Digital I/O: 5 channels

### Stimulates collaboration between CERN groups
- VME64x: BE/BI & BE/CO
- TDC: TE/ABT, TE/CRG & BE/CO
FMC mezzanine: 5-channel 1ns TDC. Produced and sold in The Netherlands
Joint development by TE/ABT, TE/CRG & BE/CO
SVEC - Simple VME FMC Carrier
Produced and sold in Germany
FMC mezzanine: 4-channel Fine Delay
Produced and sold in Spain
CERN Open Hardware License – ohwr.org/cernohl

Provides a solid legal basis

- Developed by Knowledge and Technology Transfer Group at CERN
- Open Software licences not usable (GNU, GPL, ...)
- Defines conditions of using and modifying licenced material

Practical: makes it easier to work with others

- Upfront clear that anything you give will be available to everyone
- Makes it clear that anyone can use it for free
CERN Open Hardware License – ohwr.org/cernohl

Same principles as Open Software
- Anyone can see the source (design documentation)
- Anyone is free to study, modify and share
- Any modification and distribution under same licence
- Persistence makes everyone profit from improvements

Hardware production
- When produce: licensee is invited to inform the licensor
Case study – SPEC: Simple PCI Express FMC carrier
Made in Spain, The Netherlands & Poland
**Case study – SPEC**

**Development**
- Used a small Polish **company** to help with the design
- Review and quality documentation by CERN

**Make it a testable product**
- Developed go/no-go test suite

**First series of 70 boards (production, guarantee)**
- Solid specification, IPC norms for PCB fab and assembly
- Price Enquiry to 7 **companies** having already **PCIe products**. First delivery in March 2012. Now 3 produce!
- CERN helped company to get quality right
Case study – SPEC

Users, incomplete list

- B-train system (CERN TE/MSC)
- CLIC Interlock System study (CERN TE-MPE)
- ATLAS Pixel IBL readout concept prototyping
- CNGS
- GEM detector readout (Creotech, PL)
- FAIR accelerator timing network (GSI)
- LHAASO telescope (Tsinghua University, China)
- Metrology Institutes for Time transfer (NL, UK, ...)
- Industry (isolated high-voltage measurement station, NL)

Case study – 100 MSPS 14-bit 4-channel ADC
Made in The Netherlands
Case study – 100 MSPS 14-bit 4-channel ADC

Design

- Design by CERN student
- A small specialist company designed the front-end
- Reviews at CERN
- Design process well documented (mails, documents)

CERN Price Enquiry for 40 boards (production, guarantee)

- Price Enquiry to five companies *that produce ADC boards*
- Useful design feedback (schematics and PCB layout) from company. Delivered in April 2012.
- Company adapted the design for 2 new products
Case study – 100 MSPS 14-bit 4-channel ADC

Potential users

- BPM Linac4 (CERN BE/BI)
- Frame grabber for BSRT emittance meter (CERN BE/BI)
- PSB pick-ups (CERN BE/BI)
- Septum. Booster Trajectory Measurement (CERN TE/ABT)
- OASIS general purpose (CERN BE/CO)
- Italian Hadron Therapy Centre, BPM system (CNAO)
- Culham Centre for Fusion Energy (CCFE)
- ESS: European Spallations Source
- Advanced Photon Source (Argonne National Laboratory)
- Radio Telescope (Oregan State University)
- Industry: high-voltage measurement station
Experience with Industry
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Companies used (usually paid for)
- 15 European companies

Types of work
- Hardware: development, production
- Software: VHDL firmware, drivers
- Usually small projects (<2 months work), speeds up projects, gets in specialist knowledge
- Small companies can play a large role
- Production: follows CERN purchasing rules (competition)
Experience with Industry

Examples of re-use of work

- Two companies modified SPEC carrier design.
  - larger FPGA (for software radio), PXIe bus version
- A company modified ADC100M design.
  - other input filter, high-voltage front-end
- A company re-used nanoFIP code for renovating trains.

Generates interaction

- Companies work together – building an ecosystem:
  - One sells a carrier, others sell mezzanines
  - One sells a WR switch, others sell WR nodes
- Once company makes its own designs available on OHR.
- Could negotiate component pricing for all partners.
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Open Hardware has many advantages.
- Anyone can help in developments and make improvements.
- Allows to work differently with industry (design work, smaller companies).
- Not tied to a single company for production and support.

CERN Open Hardware Licence provides a legal basis.
OHWR.org site is practical for engineers and users.

**Seven of CERN’s designs are already commercialized.**
- Companies receive new clients.
- Companies get knowledge of CERN (design, production).
- Companies use CERN designs to make new products.
- The scalable model attracts users to CERN technology.
CERN Open products are real products
CERN’s use of the Open Hardware paradigm generates technology transfer and stimulates innovation.