Examples of CERN ICT Technologies

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Software

- Open Source
  - INDICO
  - INVENIO
  - KiCad
  - ROOT
  - GEANT4
  - quasar
  - CernVM-FS
  - C2MON
- Other
  - FLUKA
  - KRYOLIZE
  - Robotics software

INDICO

Description:

Collaboration tool, event organization, archival, etc. Web-based, multi-platform, conference lifecycle and agenda management system. Integration with videoconference services.

Web site:

http://indico.github.io/ (see video clip)
http://indico-software.org

Strong points:

- Web-based, fully flexible platform
- Suitable for entire event lifecycle, from pre- to post- conference management
- Multi-platform compatibility (Windows, Mac, Linux)
- Flexible plugins system to integrate the software seamlessly to the corporate/institutional environment

Applications:

- Event Management; full life-cycle
- Corporate and institutional event data management and archiving
- Professional collaboration hub

IP status: GPL v.3

Examples: Over 200 installations that we know worldwide. One company providing support services.

INVENIO

Description:

Integrated digital library and repository system. Software suite for building and managing an autonomous digital library systems.

Web site:

http://invenio-software.org/

Strong points:

- Navigable collection tree. Documents organized in collections
- Powerful search engine. Combined metadata, full text & citation search
- Flexible metadata – Std format (MARC)
- Handling articles, books, theses, photos, videos, museum objects and more

Applications:

- Digital library server
- Institutional document repository
- Multimedia document archive
- Administrative document management
- Long term preservation functionality under development

Limitations:

- Complexity
- Large document repositories (>10K records)

IP status: GPL v.2

Examples: Very wide use in the scientific world. TIND – CERN spinoff. Support services: https://tind.io/. Cloud service too. Repository and functions can be used as a powerful backbone for other systems, eg BlogForEver project.

KiCad

Description:

Electronic Design Automation tool for the creation of professional schematics and printed circuit boards up to 32 copper layers with additional technical layers. KiCad runs on Windows, Linux and Apple OS X and is released under open-source licence. KiCad is a mature EDA software tool under continuous development.

Web site:

http://www.kicad-pcb.org

Strong points:

- dynamic and growing user community contributing regularly
- Rich set of open-source libraries including 3D Models
- Three step approach in PCB design via independent interconnected modules.
- All KiCad files are in ASCII. Facilitates manual manipulation and scripting. No vendor lock in.
- Extensive documentation
- Supported by Uni of Grenoble, CERN, SoftPLC, Raspberry Pi Foundation, Arduino LCC, GleSYS etc

Applications:

- PCB design
- Educational tool to teach electronics

Limitations:

- Stable version 4.0.0 published in Nov 2015. Today 4.0.5 (18/12/2016) Growing community of users.
- Under continuous development

IP status: GPL v.3

Examples: Opportunities in PCB design combined with the Open hardware repository where open designs can be found. http://www.ohwr.org/

ROOT

Description:

General purpose framework to analyse very large amounts of data in a extremely efficient way. Data is defined as objects. Direct access to attributes of data objects. Very powerful visualization tools including histograms in any number of dimensions, curve fitting, parallel coordinates etc. Easy to set up an analysis system that can query data interactively or in batch mode.

Web site:

https://root.cern.ch

Strong points:

- query databases in parallel on clusters of workstations or many-core machines
- Very fast response. Can handle very large amounts of data
- Machine learning integrated environment for the processing and parallel evaluation of sophisticated multivariate classification techniques. https://root.cern.ch/tmva
- Many external libraries available. Open system easily extendable

Applications:

- Data Analysis in various fields. Examples are: Scientific, Finance, Medicine, etc

Limitations:

- Complexity
- Homogeneous data

IP status: LGPL

Examples:

ROOT is being used in may industries, from auto crash testing, insurance fraud detection, financial analysis (hedge fund) etc. Any big data application.

Offer data analytics services to a specific industry sector.

GEANT4

Description:

Geant4 is a toolkit for simulating the passage of particles through matter. Geant4 covers all relevant physics processes, electromagnetic, hadronic, decay, optical, for long and short lived particles, for energy range spanning from tens of eV to TeV scale. The transport of low energy neutrons down to thermal energies can also be handled. Monte Carlo simulation software.

Web site: https://cern.ch/geant4

Strong points:

- query databases in parallel on clusters of workstations or many-core machines
- Very fast response. Can handle very large amounts of data
- Many external libraries available. Open system easily extendable
- Fully OO, Runs on Linux, Mac, Windows (32/64) and parallel architectures.

Applications:

- Medical, e.g. Radiotherapy
- Space & Radiation, eg. Electronics radiation damage assesment. Cosmic rays
- Dosimetry, Biological damage studies
- Radiation shielding

Limitations:

- Complexity

IP status: OS based on the EGEE licence (permissive)

Examples: Tomographic emission (GATE), DNA damage assessment (G4DNA), Radiation treatment (G4NAMU)

quasar

Description:

Quasar is a generic software framework that reduces the cost of developing and maintaining OPC-UA servers. OPC Unified Architecture (OPC-UA) is an industrial standard, widely used to provide an interface between software and hardware in a safe, reliable, manufacturer and platform independent manner. OPC specifies the communication of real-time data between control devices from different manufacturers.

At CERN, OPC-UA servers are often used to provide the link between control systems software and a range of hardware from commercial vendors and developed internally.

The concept of standards based connectivity is key in the “Internet of Things” paradigm. IoT device manufacturers and increasingly adopting OPC-UA since interoperability is key to their paradigm.

Web site: https://github.com/quasar-team/quasar

Strong points:

- Widely used standard in research and in industry.
- An OPC-UA server for a device opens up that device to interaction with any software compliant with the standard
- Greatly simplifies writing OPC-UA servers. Allows optimization by specific manufactures.
- Licensing model allows for commercial servers to be produced with the software.

Applications:

- Any field where hardware is driven by OPC-UA compliant software for example OPC technology for applications in building automation (HVAC, BAS), discrete manufacturing, process control etc
- IoT devices applications

Limitations:

- OPC-UA compliance

IP status: LGPL v3.0

Related links

http://icalepcs.synchrotron.org.au/papers/web3o02.pdf
http://iopscience.iop.org/article/10.1088/1742-6596/664/8/082039/pdf

CernVM-FS

Description:

It is a web-based, global, and versioning file system optimized for software distribution. The file system content is installed on a central web server from where it can be mirrored and cached by other web servers and web proxies. File system clients download data and meta-data on demand and cache them locally. Data integrity and authenticity is ensured by cryptographic hashes and digital signatures. CernVM-FS is used, among others, by the LHC experiments for the distribution of 100 million files and directories of LHC experiment software onto tens of thousands of nodes distributed worldwide.

Web site: http://cernvm.cern.ch

Strong points:

- Various Linux distributions (x86, AMD64, ARM) & Mac OS X (client) supported
- Global-scale open source file system optimized for software distribution.
- Data transport via standard HTTP protocol.
- Data integrity secured by cryptographic hashes and digital signatures.
- File system level versioning.
- Transparent data compression/decompression and file chunking.
- Capability to hot patch the file system client.
- Capability to work in offline mode providing that all required files are cached.

Applications:

- Large-scale distributed computing, big data processing. Volunteer computing services for companies, monetization of sleeping resources etc

IP status: BSD Licence

Examples:

Docker containers. Volunteer computing projects. Security application etc

C2MON

Description:

C2Mon is the CERN Control and Monitoring Platform, a SCADA system used to monitor complex CERN infrastructure, such as HVAC, Access, Safety etc. It is based on more than 10 years of experience with the previous Technical Infrastructure Monitoring systems at CERN. It is a Java application which handles a very large number of alarms in an intelligent way via a sophisticated filtering mechanism in order to provide meaningful dashboards and alarms to human operators so that they can take appropriate action.

Web site: http://c2mon.web.cern.ch

Strong points:

- Sophisticated filtering & alarm mechanism resulting from years of CERN experience
- Many different dashboards providing sophisticated monitoring capabilities (>200 synoptic views)
- Easy to integrate additional systems that need to be monitored and create new monitoring views
- Full Java application using Oracle as a repository but can use HSQL or MySQL

Applications:

- Any large and complex control & monitoring environment. From factory to healthcare

IP status: Open source, LGPL v3.0

Examples:

Health care, large industrial installations.

FLUKA

Description:

FLUKA (Fluctuating Cascade) is a general purpose tool for calculations of particle transport and interactions with matter.

FLUKA is a MonteCarlo simulation software that can simulate with high accuracy the interaction and propagation in matter of about 60 different particles, from 1 keV to thousands of TeV, neutrinos, muons of any energy, hadrons of energies up to 20 TeV and all the corresponding antiparticles.

FLUKA can handle even very complex geometries. It has been designed to track correctly also charged particles (even in the presence of magnetic or electric fields). It is also possible to describe a complex geometry in terms of "voxels" (tiny parallelepipeds forming a 3-dimensional space) especially useful when translating a CT scan of a human body into a dosimetry phantom.

Web site: http://www.fluka.org

Strong points:

- Sound and modern physical models. High level of reliability. Predictability where no experimental data are directly available
- A friendly user interface, FLAIR, is available, as well as a 3D visualisation too.
- Continuous development & improvement of models. User support is provided through the web site and a dedicated mailing list
- Courses for beginners and for advanced users are regularly organised

Limitations: Linux only but can be used on Mac & Windows via a VM

Applications:

- Medical applications (radiotherapy), shielding to target design for accelerator applications, calorimetry, activation, dosimetry, detector design, Accelerator Driven Systems, cosmic rays, neutrino physics, etc

IP status: CERN & INFN proprietary licence

Examples:

Particle therapy treatment plans, design of medical (particle therapy) hw, shielding applications, nuclear industry simulation consultancy services, etc.

KRYOLIZE

Description:

Kryolize is a software tool for sizing the minimum discharge area of a safety protection device, against overpressure. Based on international (ISO), European (EN) and American (API) standards, Kryolize allows calculation and sizing of safety valves for cryogenic systems and is a novel tool that assists engineers with a uniform approach in the sizing of safety valves for cryogenics applications.

Web site: https://hse.cern/content/kryolize

Strong points:

- Results backed by experimental data
- Easy to use, friendly user interface, reporting facilities
- Implements latest standards

Limitations: Dynamic sizing not yet included

Applications:

- Cryogenics, Cryogenic safety

IP status: CERN proprietary licence

Examples:

Valve sizing fo cryogenic installations

Robotics Software

Description:

The CERN Robotics Software consists of a complete software suite necessary to manage safely the autonomous movement and all the necessary functionality in order to allow a modular robotics platform to perform sophisticated tasks which are defined as part of a specific mission. In addition to the core and peripheral functionality the software suite includes drivers necessary to integrate a variety of commercially available sensors and robotic arms, to the hardware platform.

Strong points:

- Modular software that can be combined to support various configurations
- Tested in the CERN acceleration complex. Example TIM (Train Inspection Monorail)

Applications:

- Vast application area for all repetitive and dangerous tasks in hostile environments (radiation). Inspection, monitoring, remote handling, civil defence applications, etc

IP status: CERN proprietary licence

Examples:

Mobile robotics platforms

Thank you for your attention.

Questions ?

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