Software Process in Geant4

Gabriele Cosmo
CERN IT/API-SI
Gabriele.Cosmo@cern.ch

Outline

- Overview on Software Processes
- The area of application
- Life-cycle processes in Geant4
- Software Process Improvement
  - Future evolutions
- Conclusions

Definitions...

- Software Process
  - A set of interrelated activities, which transform inputs into outputs (*ISO 12207/8402*)
    - used by an organisation or project to plan, manage, execute, monitor, control and improve any software related activity
  - Life-cycle processes are structured in *dimensions*:
    - Primary processes
      - includes all major functions of software development
    - Supporting processes
      - for supporting other processes with a purpose
    - Organisational processes
      - for corporate level management and improvement

Process Architecture

Customer-Supplier

CUS.1 Acquisition
- CUS.1.1 Acquisition Preparation
- CUS.1.2 Supplier Selection
- CUS.1.3 Supplier Monitoring
- CUS.1.4 Customer Acceptance

CUS.2 Supply

CUS.3 Requirements Elicitation (*)

CUS.4 Operation
- CUS.4.1 Operational Use
- CUS.4.2 Customer Support (*)

Engineering

ENG.1 Development
- ENG.1.1 System Requirements A&D
- ENG.1.2 Software Requirements Analysis
- ENG.1.3 Software Design (*)
- ENG.1.4 Software Construction (*)
- ENG.1.5 Software Integration
- ENG.1.6 Software Testing
- ENG.1.7 System Integration & Testing (*)

ENG.2 System & Software Maintenance (*)

Support

SUP.1 Documentation (*)
SUP.2 Configuration Management (*)
SUP.3 Quality Assurance
SUP.4 Verification
SUP.5 Validation
SUP.6 Joint Reviews
SUP.7 Audit
SUP.8 Problem Resolution

Management

MAN.1 Management
MAN.2 Project Management
MAN.3 Quality Management
MAN.4 Risk Management

Organisation

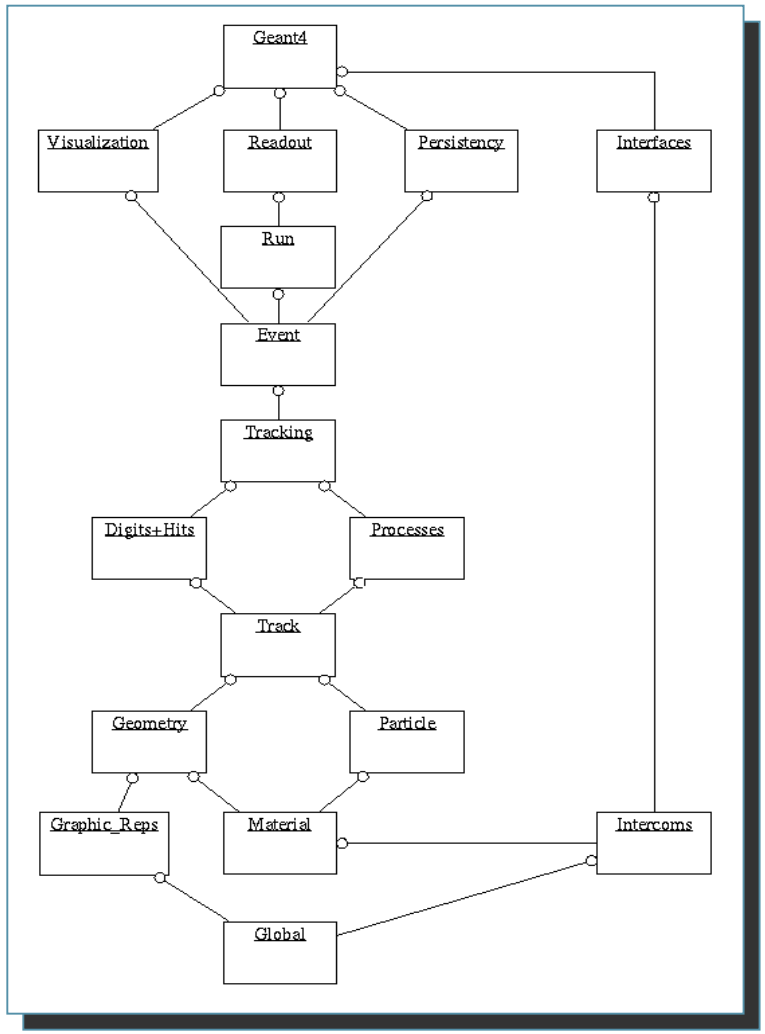
ORG.1 Organisational Alignment

ORG.2 Improvement
- ORG.2.1 Process Establishment
- ORG.2.2 Process Assessment
- ORG.2.3 Process Improvement (*)

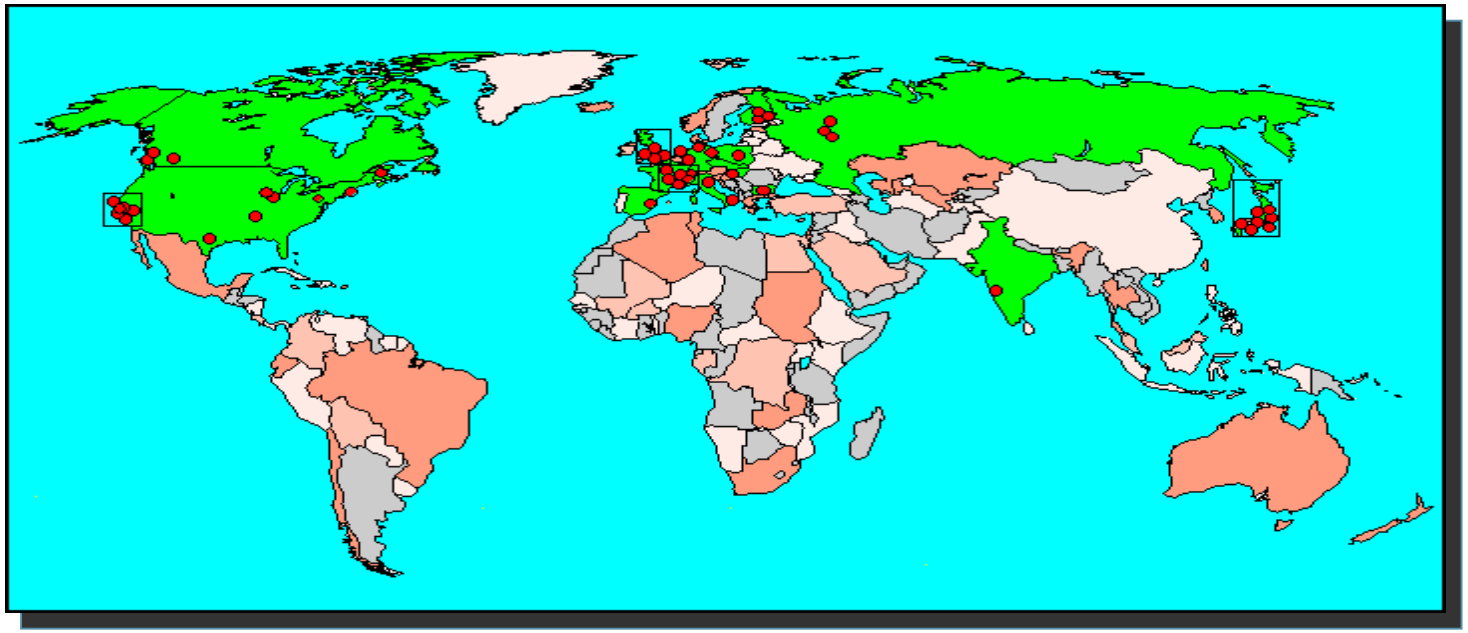
ORG.3 Human Resource Management
ORG.4 Infrastructure
ORG.5 Measurement
ORG.6 Reuse

The area of application: Geant4

- More than 1200 classes distributed in 17 Categories
  - software components in the Booch terminology
  - complex Categories organised in a hierarchical structure
- Decomposition to domain Categories derived from the design Category diagram
  - one development team associated to one Category domain



The area of application: Geant4



- Development teams distributed world-wide
  - domain decomposition <> geographical location of teams
  - centralized coordination of domain Categories
  - local coordination of each Working Group
    - assignment of responsibilities and support
  - distributed resources and funds in a *dynamic* environment
- Coordination for a coherent development
  - computing environment, methods and tools

Requirements Elicitation

- General User Requirements (UR) collected during the R&D phase of the project (RD44)
  - GEANT3 user community involved
  - URD generated according to the ESA PSS-05 software engineering standard
  - regular update and versioning of the URD along the development process
- Change-management based on *CVS*
  - general URD currently under revision
  - maintenance and tracking of specific detailed URDs under responsibility of WG coordinators
- New requirements approval: by the TSB
  - ongoing process improvement

Software Design

- Adoption of the *Booch* methodology for OOAD since the R&D project start
  - chosen after deep evaluation of the existing methodologies (‘94)
  - tailored to project specific needs
  - supported by CASE tools (*Rational-Rose*)
  - UML notation adopted for design documents
    - Category diagrams, Class diagrams, Scenario diagrams, Class specifications
    - ongoing process improvement
- Software development structured in *macro* and *micro* processes showed very effective
  - *iterative* & *incremental* approach (*spiral* model)
  - loose domain coupling led to efficient WG structure

Software Construction

- Software packaging reflects the domain decomposition in Categories
  - Packaging of Categories and sub-Categories in relation to definition of abstract and concrete interfaces (*frameworks*)
    - Provide a set of services in a *re-usable* way
    - Software *toolkit* approach
- Essential and flexible guidelines for coding
- Code filtering with specialised tools
  - *Code Wizard*
  - both in the global and unit context
    - tool accessible from Web

System Testing

- Activity deployed to a specialised team (STT)
  - based on defined procedures
    - *CVS* tagging policy
    - automated through Web tools and scripts
      - Bonsai, *LXR*, *Tinderbox*
      - ongoing process improvement
  - test applications used also for system integration
    - run & tested on every supported platform/compiler
    - ongoing process improvement
  - user example applications used for acceptance
- Category tags submitted to testing in sequence according to the dependency flow dictated by the design category diagram
- Close collaboration with the release manager

Bonsai version 1.3

CVS Tags

Tags to directory *geant4/* on all tags in canonical form since the last 2 'Global' tag:

This is **Bonsai**: a query interface to the CVS source repository

Modify Query (keeping query string)
Modify Query (relax query)
Mail everyone on this page **(9 people)**

When	Who	Directory	Tag	Status	Testarea	Sentence	Description
08/30/2001 11:00	gcosmo	geant4	geant4-03-02-ref-03	Internal	CVS		
08/30/2001 02:17	allison	geant4/ source/ visualization	vis-V03-02-14	Proposed	CVS		Coworks with config-V03-02-06. First developers release of HepRep graphics
08/30/2001 02:15	johna	geant4/ config	config-V03-02-06	Proposed	CVS		Coworks with vis-V03-02-14. For HepRep driver.
08/29/2001 23:29	asaim	geant4/ source/ intercoms	intercoms-V03-02-06	Selected	Test1		Corrections in G4UIbatch to ignore the blank line.
08/29/2001 20:53	pia	geant4/ source/ processes/ electromagnetic/ lowenergy	emlowen-V03-02-10	Proposed	CVS		Major revision: re-implementation of photon processes according to a major
08/29/2001 20:35	pia	geant4/ source/ processes/ electromagnetic/ lowenergy	emlowen-V03-02-09	Internal	CVS		
08/29/2001 18:57	pia	geant4/ source/ processes/ electromagnetic/ lowenergy	emlowen-V03-02-08	Internal	CVS		
08/29/2001 10:43	gcosmo	geant4/ source/ processes/ electromagnetic/ lowenergy	emlowen-V03-02-07	Accepted	CVS	OK.	Fixed std=>G4std.
08/29/2001 09:21	gcosmo	geant4/ source/ run	run-V03-02-02	Selected	Test1		- Add Set/GetApplyCuts methods in G4VUserPhysicsList.
08/28/2001 18:43	pia	geant4/ source/ processes/ electromagnetic/ lowenergy	emlowen-V03-02-06	Internal	CVS		
08/28/2001 15:09	gcosmo	geant4/ tests	tests-V03-02-00	Selected	Test1		Removed obsolete files in directories "results" and "tools"
08/28/2001 08:01	asaim	geant4/ source/ intercoms	intercoms-V03-02-05	Internal	CVS		G4UIbatch now displays (G4cerr) the error message.
08/28/2001 07:37	asaim	geant4/ source/ event	event-V03-02-05	Selected	Test1		Convert NULL to 0 in G4EventManager.cc.
08/27/2001 19:58	japost	geant4/ source/ processes/ transportation	transport-V03-02-01	Rejected	CVS	All tests/examples fail at run-time on HP-aCC:	Erases state information (in ChordFinder) from previous track at the first step
08/27/2001 19:54	japost	geant4/ source/ geometry/ magneticfield	field-V03-02-00	Rejected	CVS	All tests/examples fail at run-time on HP-aCC:	To ensure repeatability between tracks & events: added method to erase/reset the
08/27/2001 15:22	gcosmo	geant4/ source/ geometry/ solids/ CSG	geom-solids-csg-V03-02-00	Selected	Test1		G4Sphere.cc: bug fixed in G4Sphere::SurfaceNormal for the

Software Maintenance

- Adoption of standards
- Encapsulation of components
  - minimise coupling to reduce software complexity
  - regular monitoring of architectural dependencies
- Avoid system-dependent solutions in the source code as much as possible
  - centralise system configuration management
  - modular structure for architecture setups
- Avoid use of too “advanced” language features to maximise porting
- Traceability of updates
  - history files & regular tagging
  - disentangle development from bug-fixes

Customer Support

- Terms of the User Support are defined in the Memorandum of Understanding (MoU)
- Effort shared among WGs
  - contact persons defined for each WG
  - acting as experts in their specific domain
  - joint meetings with users and developers
- Problem Tracking System (*Bugzilla*) available to users
  - flexible design allowing easy customisation for Geant4
  - tokens automatically assigned to responsible persons
  - 300 reports submitted since tool in production
  - ongoing process improvement
- On-line documentation, training and FAQ on Web
- Source code and binaries available on Web and AFS
- *Hypernews* user forum available (hosted by SLAC)

Geant 4

Geant4 problem tracking system v0.1 is based on Bugzilla.

Query Page

If you do not select a choice in a category, the default is to report all problems!

Find a problem report that contains these words in the summary, description, file or URL:

Summary: [ ] Substring Regexp

Description: [ ] Substring Regexp Submit query

URL: [ ] Substring Regexp

File: [ ] Substring Regexp

Provide additional information for searching (if you want):

Changed in the last [ ] days.

Program:	Release:	Tag:	Component:
Geant4	Geant4 1.0 Geant4 1.1 Geant4 2.0 Geant4 3.0 Geant4 3.1	geant4-01-01 geant4-02-00 other sometag	analysis config digits+hits digits+hits/detector digits+hits/digits

Submit query

Status:	Resolution:	Platform:	OpSys:	Priority:	Severity:
NEW ASSIGNED REOPENED RESOLVED VERIFIED CLOSED	FIXED INVALID WONTFIX LATER REMIND DUPLICATE WORKSFORME	All DEC HP PC SGI Sun Other	All Windows NT AIX HP-UX IRIX Linux OSF/1	P1 P2 P3 P4 P5	critical major normal minor trivial enhancement

Submit query

Email: [ ] matching as substring Assigned To Reporter

Submit query

Documentation

- Six user manuals available on-line
  - Introduction to Geant4
  - Installation Guide
  - User's Guide for Application Developers
  - User's Guide for Toolkit Developers
  - Physics Reference Manual
  - Software Reference Manual
- User examples: novice, extended, advanced
- Training kit: three module-structured courses
- Design documents
- Defined policy for update

Configuration Management - releases

- Defined policy for *major* and *minor* releases
  - 4 major releases, 4 minor releases, 6 patches published since in production (December '98)
  - policy periodically revised and updated
- Development releases distributed monthly to collaborators and developers
  - additional development releases if necessary
- Close collaboration with System Testing Team
  - acceptance tests, part also of system tests, are also run independently by the release manager
- Prompt collaboration from developers required during the public release phase

Software Process Improvement (SPI)

- Understand, determine and establish applicable procedures to Software development and maintenance of the software
- Make SPI a Software Process *life-cycle driven*

  Primary life-cycle processes:
  - guarantee that the code quality will not degrade with time: SPI actions associated with a regular QA activity
  - assure that coupling will not increase with the growing complexity of the software

  Improve overall usability and robustness of applications: improve quality, maintainability and reliability of the code

  Assure continuity and integration of regular system testing within the normal Software development activity

Software Process Improvement (SPI)

- (Chosen) Domains of applicability in Geant4:
  - Q/A & Optimisation activity
    - applied to the software product in either global and component domain related context
  - Analysis & Design software cycle
    - identify the well established OOP procedure for development and maintenance – assessment based on ISO-15504
  - Testing
    - assure constant improvement and continuity to system testing
- Action for improvement identified
  - plan for SPI established
  - progressive implementation

Future evolutions

- Make SPI part of the software life-cycle
- Consider monitoring progress of the SPI program
  - regular check-points at *Category-Coordinator meetings*
    - regular update of status:
      - **http://cern.ch/geant4/milestones/software_process**
  - include activities addressing SPI in the Collaboration Workshops
- Iterate new assessments in future
  - extend assessment to uncovered (or partially covered) domains (testing, documentation, Software Management)
  - try improving Capability level

Conclusions

- Geant4, a challenging project for applying Software Processes
- Current strategy demonstrated to be effective and flexible
  - far from being perfect !
    - requires continuous monitoring and improvement
    - SPI must be life-cycle driven
  - organisational alignment