Use of a continuous integration and deployment software to automate nuclear data V&V

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Cross Section Evaluation Working Group (CSEWG)
2/3 of BNL’s NCSP Nuclear Data tasks are now fully automated

- ✔ Perform data verification of new NCSP evaluations and store them on GForge server (Q1, Q2, Q3, Q4)
- ✔ Perform QA of new NCSP covariance data (Q2, Q4)
- ☐ Update Atlas of Neutron Resonances (Q4)

Our scheme is so useful, NNDC seeking to automate many other tasks with same system

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Benefits of automation are clear

- No waiting for assistance from processing code experts
- Extensive testing with minimum effort
  - Number of new commits verified
    - 1 deuteron-incident evaluation
    - 5 decay evaluations
    - 111 neutron-incident evaluations
- High-quality evaluations due to extensive and frequent testing
- Timely feedback on every change enables easier ID and correction of deficiencies

Expected Result
- Expedited submission of evaluations for CSEWG review
- Faster release of new evaluated data libraries
Why did we do it?

What’s the Problem?

- Data verification and data validation (V&V) is tedious, so evaluators usually “forget”
- Not all evaluators know how to run the commonly used V&V codes
- Evaluators may have different versions (read: different bugs) of the same V&V code thereby producing different results

What’s the solution?

- A highly automated, modular V&V system publicly accessible to evaluators

Automated Data Verification and Assurance for Nuclear Calculations Enhancement (ADVANCE)
Outline

- Motivation
- Benefits of ADVANCE
- The ADVANCE ND/QA System
  ADVANCE System Architecture
  ADVANCE Process Flow
- Future Directions
ADVANCE: The ENDF Continuous Integration System

ENDF/B Development

The development version of the Evaluated Nuclear Data File (ENDF/B)

Latest Updates:
- sublib_release_notes: neutrons
  Report sublib_release_notes on neutrons generated. The result was a SUCCESS
  2013-04-30 16:57:59.661872

- sublib_html: neutrons
  Report sublib_html on neutrons generated. The result was a SUCCESS
  2013-04-30 16:52:01.501892

- sublib_release_notes: neutrons
  Report sublib_release_notes on neutrons generated. The result was a SUCCESS
  2013-04-30 15:41:29.748913

Neutrons sublibraries:

- Neutrons Sublibrary
- Neutron-Induced Fission Yields Sublibrary
- Standards Sublibrary
- Thermal Neutron Scattering Sublibrary
Neutrons Sublibrary

ENDF/B Development Library

- General Information:
  - ENDF sublib designator: 10
- Revision Number: 611M
- Last Modified Revision: 532:611M
- Build Status:
  - Build status: ERROR
  - Build time: 2013-04-30 16:52:01.394282
- Listfile: neutrons.list
- Release Notes: neutrons-releaseNotes.pdf
- GForge Links:
  - Browse SVN
  - Browse sublibrary tracker

Periodic Table

Material List

Brookhaven Science Associates

NATIONAL LABORATORY
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<th>Status</th>
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<th># Errors</th>
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* Lanthanides (Lanthanoids) | 57 La | 58 Ce | 59 Pr | 60 Nd | 61 Pm | 62 Sm | 63 Eu | 64 Gd | 65 Tb | 66 Dy | 67 Ho | 68 Er | 69 Tm | 70 Yb | 71 Lu |
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Neutrons Sublibrary

- **General Information:**
  - ENDF MAT designator: 9437
  - Evaluated by Young, Chadwick, MacFarlane, Derrien (LANL), SEP06
  - Natural abundance: 0.0 +/- 0.0 %
  - Check out Wikipedia's entry for plutonium

- **Revision Number:** 611M
- **Last Modified Revision:** 532:611M
- **Build Status:**
  - Build status: **ERROR** (Submit tracker item)
  - Build time: 2013-04-30 06:17:38.108808

- **GForge Links:**
  - Browse SVN
  - View current revision
  - Download current revision

---

### Summary of all tests on this evaluation.

Use checking code button to show/hide errors.

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<th># Failures</th>
<th># Errors</th>
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Comparison between cross section data in this ENDF file and data retrieved from EXFOR

Aggregate channels:

Regular channels:

ADVANCE Version 0.7 (svn rev: 669 )
Codes used in ADVANCE version 0.7

- NNDC checking codes
  - STAN
  - STANEF
  - CHECKR
  - FIZCON
  - PSYCHE

- PREPRO
  - LINEAR
  - RECENT
  - SIGMA1

- NJOY2012 (upgraded from NJOY99)
  - grouping, heating, checking
  - ACE file

- Fudge-4.0 (upgraded from Fudge-2.0)
  - checking
  - cross section plotting
  - xml/html5 overview

- Other Codes
  - INTER: integral quantities
  - ACELST: ACE file overview
  - ENDF2HTM: ENDF overview
  - x4i: EXFOR data for plotting
Outline

★ Motivation
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★ The ADVANCE ND/QA System
★ ADVANCE System Architecture
★ ADVANCE Process Flow
★ Future Directions
• GForge Server as the versioning system (Subversion).
• Each commit to ENDF repository triggers data verification
• Results automatically posted on NNDC Web server
The ADVANCE ND/QA System (continued)

Why ControlTier?

- Robust and reliable
- Cost-free: Good for NNDC’s tight budget
- Open-source: Can change system code
- Platform independent: 100% Java
- Most complete platform:
  - Continuous integration + continuous deployment
- Highly scalable: Add servers + clients as needed
ADVANCE Process Flow
Data Verification

Code Dependencies

- A code may depend on output of another code. Thus, a code may not begin processing until the immediate preceding code completes.
- If new commit does not modify input file to a code, then the code and its dependent codes are not executed.
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Rest of FY13 plans (in addition to ENDF upkeep)

- More reports:
  - Plots of integral quantities (MACS, RI, Cf spectrum ave.)
  - Better energy balance report
  - Covariance QA report

- Full library tarballs (ACE, gnd, gendf)

- More processing codes:
  - PREPRO/sigma1, sixpack
  - CALENDVF
  - Fudge improvements
  - NJOY improvements

- Database of errors:
  - Processing code error mining
  - Regressions

- Notifications
  - RSS Feed
  - Emails

- Help pages

- Unit tests/docs

- About ADVANCE pages

- An ADVANCE paper

- Prepare for benchmarking?

Tuesday, May 28, 13
Next logical step: automate simulation of critical assemblies and other benchmarks

- Criticality benchmarks are already the core of our data testing regimen
- Many other tests check things of importance to NCSP
  - Reaction rates in irradiated foils target individual reactions
  - SINBAD shielding benchmarks can be used to benchmark decay/activation data

Current testing is human-driven and ad-hoc:
- We often test outdated libraries (ENDF/B-V??)
- We rerun same tests (do we need to run JEZEBEL again?)
- We often don’t run tests because of lack of resources: models, codes computing and/or manpower
Automated benchmarking is one of NCSP’s 5 year goals

Opportunities

- `cnp_test_suite release`
- Transport code and test suite donations
  - `COG release`
  - COG suite release
  - `MCNP6 release`
  - Mosteller suite of 119 tests
  - BNL 1D Sn tests
- NNDC cluster upgrade: cluster size to double to 184 Intel Xeon nodes
- ADVANCE master node upgrade

Challenges

- NNDC webserver upgrade: may force adoption of web content management system instead of static web pages for reports
- ControlTier project ended: in long term must switch control system to either RunDeck or BuildBot or similar

We would like to develop a meaningful requirements documentation
Gathering requirements for next major release of ADVANCE

- More processing codes: AMPX
- Local (NNDC) benchmarking
  - Using MCNP6, ANISN, TWOTRAN and COG
- Hooks for remote benchmarking
  - LLNL CNP group collaboration
- Try/accept functionality
  (try an evaluation before committing to GForge)
- Better notifications
- CMS for better report management
- Comments subsystem
- Better functionality for CI/CD for non-data projects
  (e.g. EMPIRE)
- Open source release

What else?
Acknowledgments

Many thanks to C. Mattoon (LLNL), B. Beck (LLNL), N. Summers (LLNL) and M.-A. Descalle (LLNL) for the advice and valuable assistance they provided especially at the early stage of the ADVANCE project and for providing us with LLNL’s cnp_test_suite package.

D. Heinrichs and C. Lee for preparing COG for general release.