Creating synthetic State declarations using Cyclus

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Introduction and Mission Relevance

**Mission:**
Improve data science techniques to process declarations to the IAEA
- Automate and improve efficiency of flagging inconsistencies

**Challenge:**
Real or realistic State Declarations not available to R&D community

**Objective:**
Produce synthetic State Declarations
- Safeguards community could use for developing new analytical algorithms
Technical Approach

- Is Cyclus the right tool?
- Can Cyclus adequately model the entire nuclear fuel cycle?

Built models of the fuel cycle with collaborators to determine applicability of Cyclus
Fictitious Case Study

• Five AP-1000-style reactors started up over a ~four year period
• No domestic enrichment
  • must export UF6 and import enriched material
Fresh fuel supplied to reactors

• Given production constraints (kg/day) and limits on imports, Cyclus model performs exactly as expected
Adapting Cyclus to safeguards

• Facilities have multiple material balance areas (MBA)
• Safeguards style data recorded per MBA for each facility
• can be tracked at facility or MBA level
Moving towards “realistic” material movement

Spruceland UF6 exported

Regular export

Material exported in realistic quantities (integer quantities of “1 truck worth”)

Constant request with random demand (Gaussian)

Realistic export with random demand (Gaussian)
MTV Impact

• Previous work developed out of internship at Los Alamos (thanks to consortium)
• Long-term collaboration with LANL
• Built network from MTV workshops and 2019 MTV fuel cycle facility modeling workshop at UW
  • Internship offers from labs

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Conclusion & Expected Impact

• Follow-up grant was funded
  • Cyclus modeling essential to project success

• Converting Cyclus simulation information into the recording and reporting procedures defined by the IAEA (Code 10)

• Adding new features to Cyclus

001:0I/NP/15#002:1/1#003:20142331#006:DanielJackson#010:I #015:20141201/20141231#207:NND-#307:NND1#309N#370:NN-B#40 7:3#411:RD#412:20141215#430:BQ1G#446:045C8#469:N#470:1#63 0:163257G#1306G#710:1498G#

Code 10 statement indicates a transfer of 163257 grams uncontained enriched U in oxide form with 1498 grams of plutonium from MBA NN-B to MBA NND1 on December 15, 2014.
Future developments to Cyclus

• Current cyclus agents are not “smart”
  • When a fresh fuel vault empties, it immediately requests more material
  • Contracts
• Transportation
  • Added shipment quantity
  • No time/distance handling yet
• Noise
  • Most cyclus agents are “perfect”
  • Material never lost or gained to the simulation

(diagram: Cyclus development team)
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