United States Environmental Protection Agency

# Building the LCA data pipeline - Automating product system creation

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# Disclaimer

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# WP-2757 Summary

- **Task 1 - LCA Data Pipeline**
- Task 2 - Impact assessment
  - Eutrophication
  - LCIA formatter tool
- Task 3 - USEEIO/DIO

# The LCA Data Pipeline

- Pipeline: To rapidly standardize and stream data for LCA with full metadata/data quality/provenance

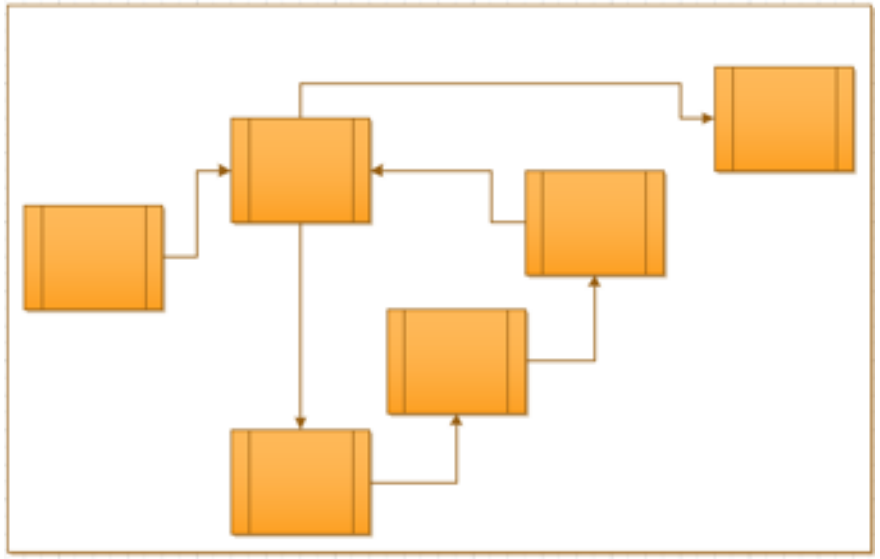
- Major challenge: LCA data is highly structured and must all be harmonized to work together. No common process nomenclature is used.

# Federal LCA Commons

FEDERAL LCA COMMONS

- Developing common standards for LCA data
- The beneficiaries in addition to DOD and the LCA practitioner community

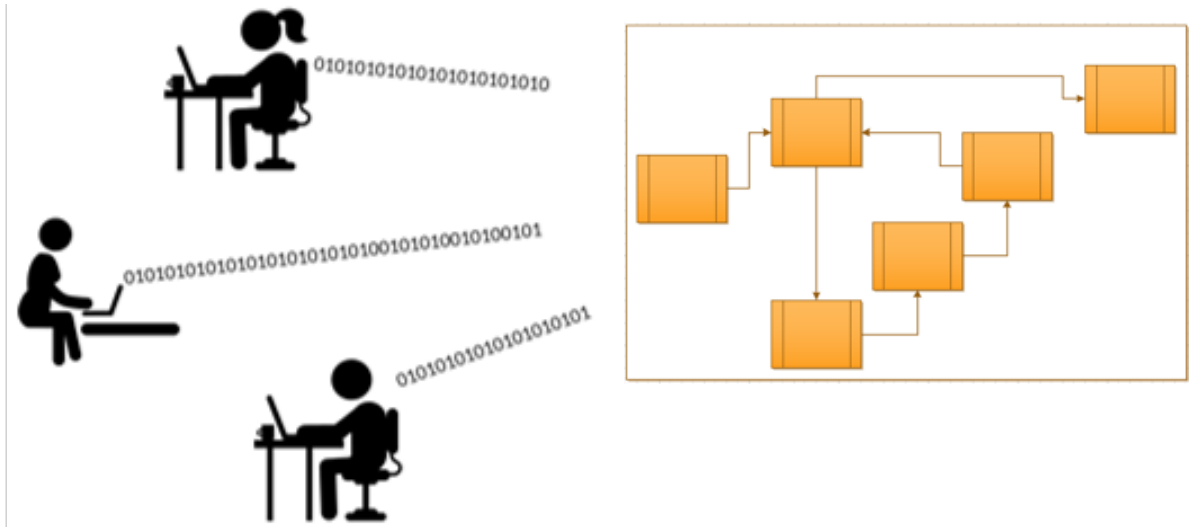
# Product system models



*The key to automating assembly is finding background processes that provide the input to the foreground process, then establishing these linkages*

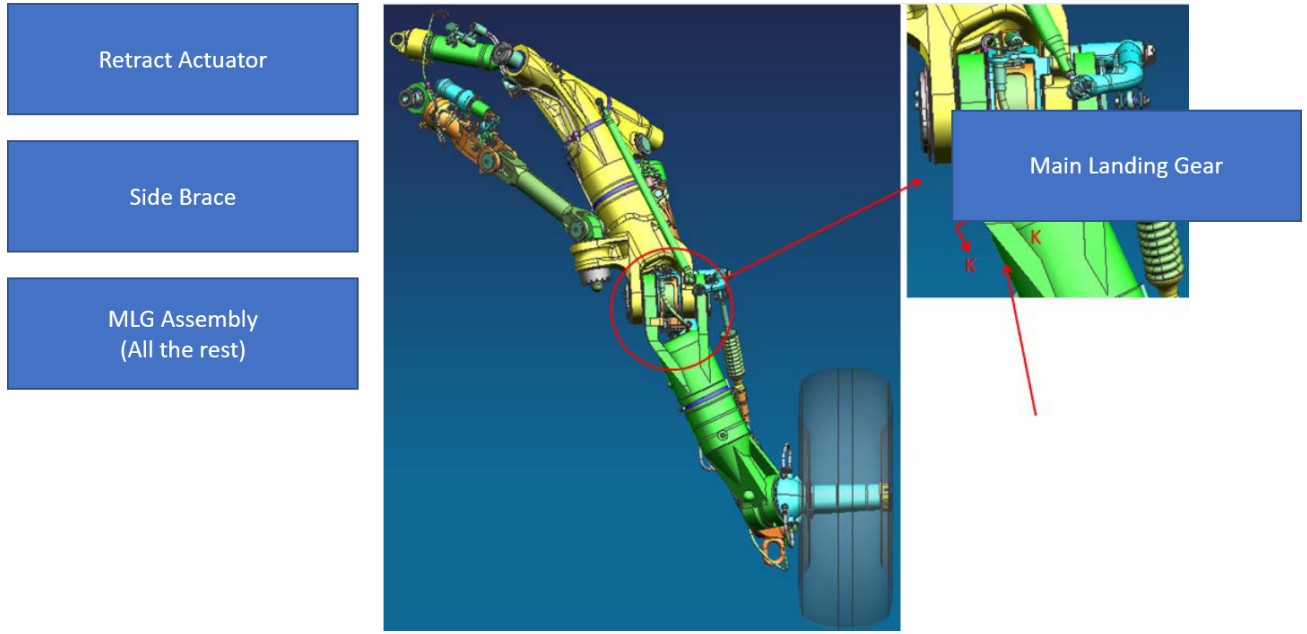
- PSM : A system of interconnected unit processes representing an entire supply chain.
- Foreground vs. Background

# Approach: Prototype challenge




- Onboard 3 top LCA software developers
- Present objectives, requirements, and time constraints
- Create prototypes that meet these requirements

# Model system: F-18 landing gear



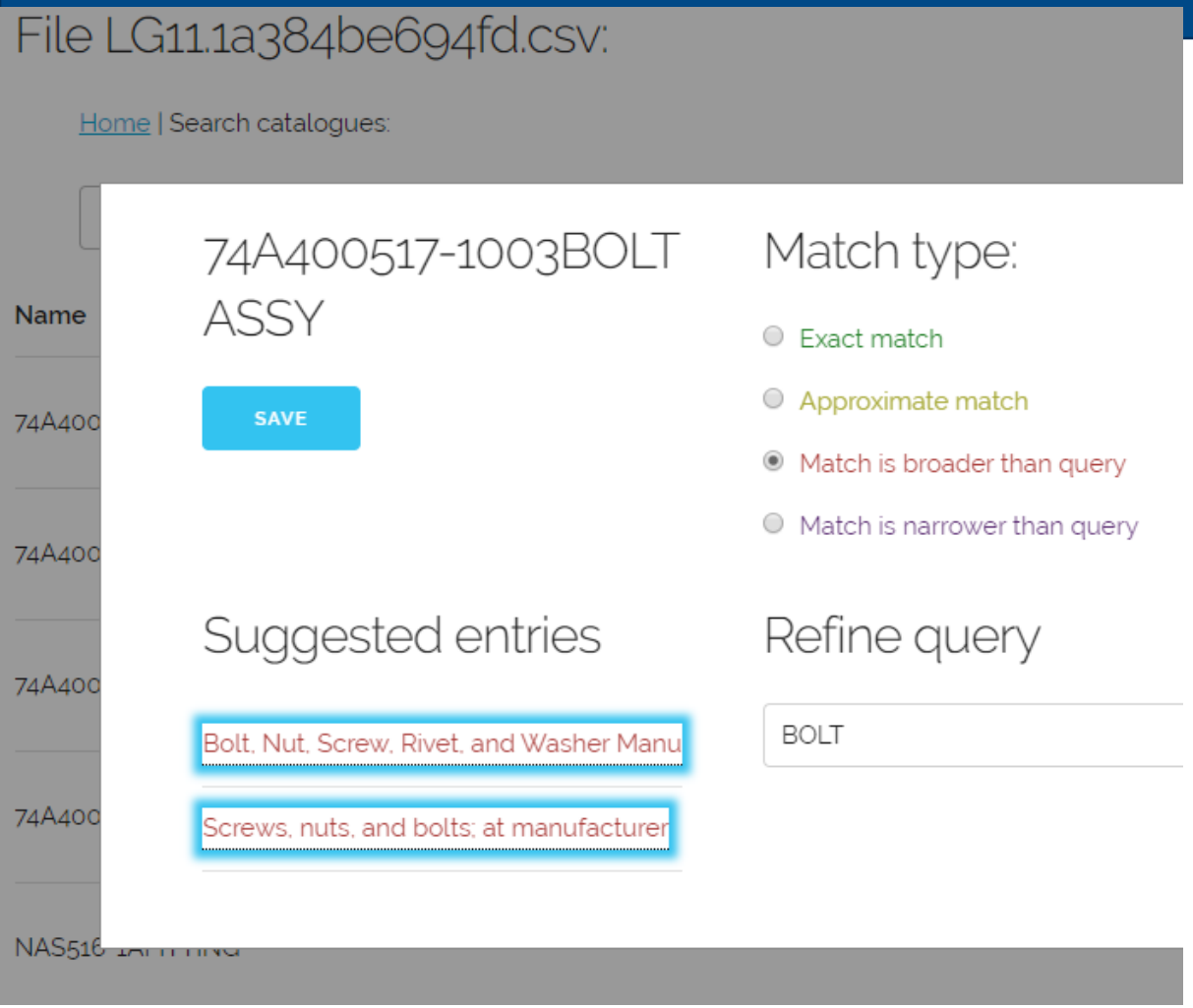

- Provided with a standard bill of materials (BOM) that included assemblies, subassemblies, part numbers, part descriptions

# Bill of Materials Example

| Level | Part Number | PT | QNA | Part Name | Next Assembly |
|---|---|---|---|---|---|
| 0 | **ANON_777789** | 1 | 002 | **ANON_777789 Sub-assembly** | |
| 1 | 74A400803-2001 | 1 | 001 | PLATE, IDENT | **ANON_777789** |
| 1 | 74A400804-2001 | 1 | 001 | TUBE, TRANSFER | **ANON_777789** |
| 1 | 74A400806-2001 | 1 | 001 | PISTON, RETRACT | **ANON_777789** |
| 1 | 74A400807-2001 | 1 | 001 | SPACER, PLATE | **ANON_777789** |
| 1 | 74A400808-2001 | 1 | 001 | CYLINDER, RETRACT | **ANON_777789** |
| 1 | 74A400809-2001 | 1 | 001 | PLATE, LOCKING | **ANON_777789** |
| 1 | **ANON_504842** | 1 | 001 | **ANON_504842 Sub-assembly** | **ANON_777789** |
| 2 | 74A400811-2001 | 1 | 001 | HEAD | **ANON_504842** |
| 2 | M83461/1-010 | 4 | 002 | PACKING | **ANON_504842** |
| 2 | MS14101-12 | 4 | 001 | BEARING | **ANON_504842** |
| 2 | 7M1244C4 | 5 | 002 | ADAPTER | **ANON_504842** |
| 2 | AS3125-04 | 6 | 002 | PLUG | **ANON_504842** |
| 2 | AS3126-04 | 6 | 002 | PIN | **ANON_504842** |
| 1 | **ANON_625299** | 1 | 001 | **ANON_625299 Sub-assembly** | **ANON_777789** |
| 2 | 74A400821-2003 | 1 | 001 | ROD | **ANON_625299** |
| 2 | MS14103-12 | 4 | 001 | BEARING | **ANON_625299** |
| 1 | **ANON_698156** | 1 | 001 | **ANON_698156 Sub-assembly** | **ANON_777789** |
| 2 | 74B400819-201 | DP | 002 | RING, PISTON | **ANON_698156** |
| 2 | 74B400819-203 | DP | 001 | RING, EXPANDER | **ANON_698156** |
| 1 | 74B410058-105 | 1 | 001 | SCRAPER | **ANON_777789** |

Nested BOM

# Prototype: perdu

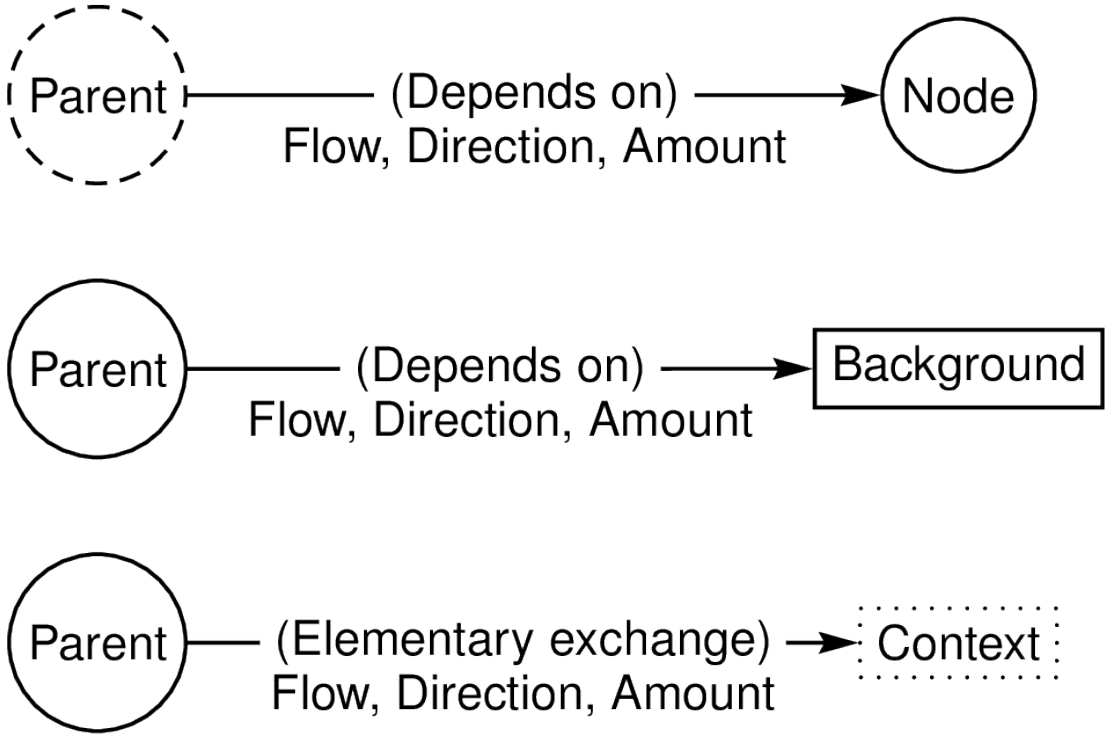



- Python library and web application for matching against standard industry and product classifiers

- Preloaded with GS1, NAICS, and USEEIO model classifications

- Uses semantic matching

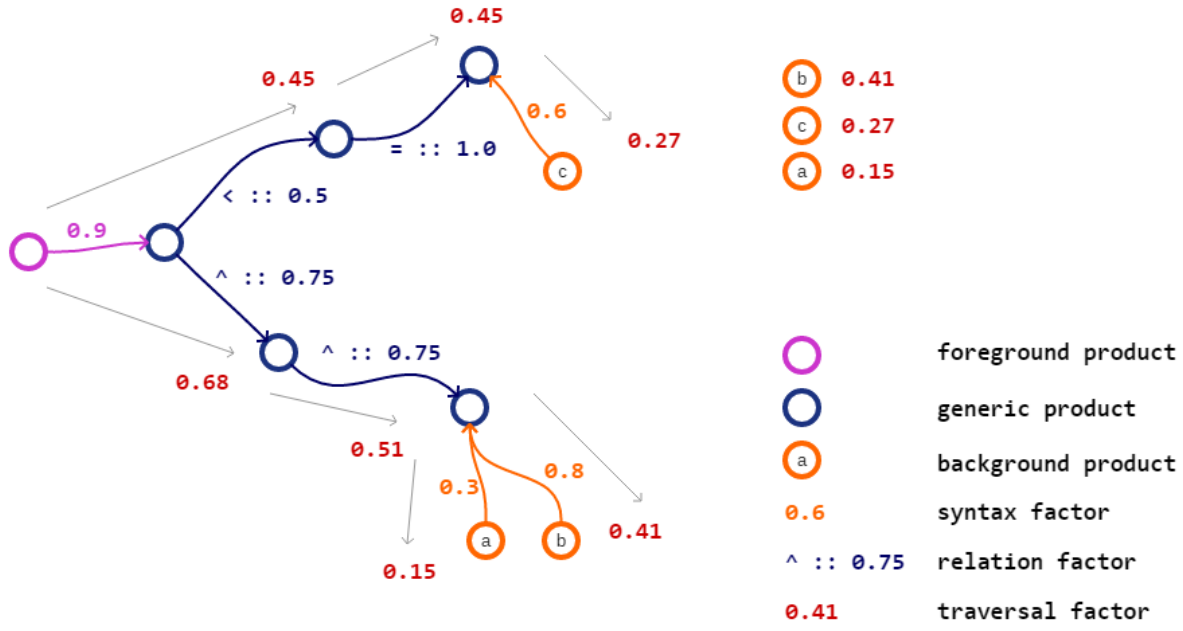
# Prototype: PSM-antelope




- An implementation of antelope using PS disclosure framework

- Works with various LCI datasets like USLCI, ELCD, and USEEIO

# Prototype: pslink




- Mines components databases (e.g. Part Target) and generates semantic networks for PSMs

-Creates quantitative relationships between quantity and masses

- Provides measures of linkage integrity

# Summary of prototypes

| Prototype | Primary Dependencies | Name or Classification Search? | Supervised or Unsupervised Linking? | Creates Bridge Processes? | Match Statistics? | Datasources Linked | Product System Statistics? | Output formats |
|---|---|---|---|---|---|---|---|---|
| perdu | RDFLib, Whoosh | Both | Supervised | ±Y | N | USEEIO | N | CSV, TTL, JSON-LD |
| psm_antelope | lca-tools | Name | Supervised | N | N | USEEIO, USLCI, ELCD | Y | JSON, Excel* |
| pslink | olca-py | Name | Unsupervised | Y | N | Ecoinvent | Y | JSON-LD |

# Initial results

- BOMs can be used to generate connections and create Fed Commons-compliant LCI

- ~ 40% of landing gear parts linked to upstream

- Prototypes demonstrate automated linkages with multiple data sources

# Next steps

- Testing with more standard gate-to-gate life cycle inventory data
- Testing with alternative BOM
- More complete evaluation

# Avenues for integrating into the DOD/Commons ecosystems

1. Original data – BOMs

2. Existing data - Linkages to reference models and structuring

# Take-Aways

- Automation of linkage was demonstrated to be possible
- Data have to be very well-described for unsupervised classification
- Product classification can be very valuable
  - Requires use on data
  - Need more resolution in classification systems
- Semantic matching and match statistics excellent

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- SERDP/ESTCP Special Project WP-2757
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