CYCLUS

A Next Generation Fuel Cycle Simulator

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Abstract

- Determining if and how to transition to advanced nuclear fuel cycles will require an alignment of the technical imperatives with the socio-political imperatives.
- Fuel cycle simulators provide indications of future mass flows and facility deployments under different technology choices.
- Many socio-economic impacts can be derived from these primary results to inform fuel cycle assessment.
- Previous fuel cycle simulators have either been:
  - Too simple for credibility with technical audiences
  - Too complex for use by non-technical audiences
- *CYCLUS* aims to bridge this gap with alternative user interfaces based on a common flexible simulation engine
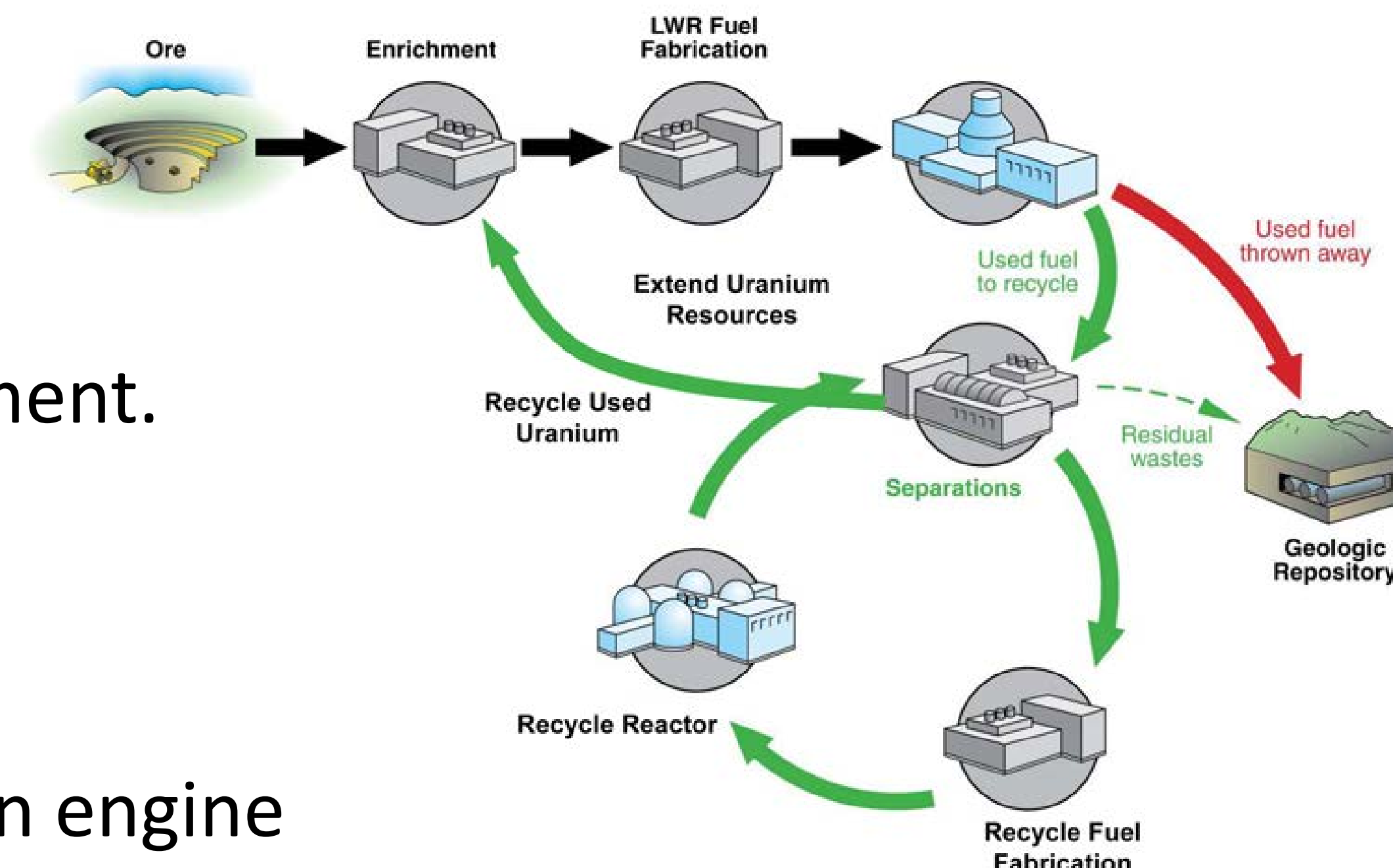
Platform

Agent-Based Approach

- Encapsulate physics and interaction behavior in each *Facility*
- Each facility operated by an *Institution* in a geo-political *Region*

Dynamic Resource Exchange

- Constant deployment gives changing material flow paths
- Material substitution complicates matching of supply/demand
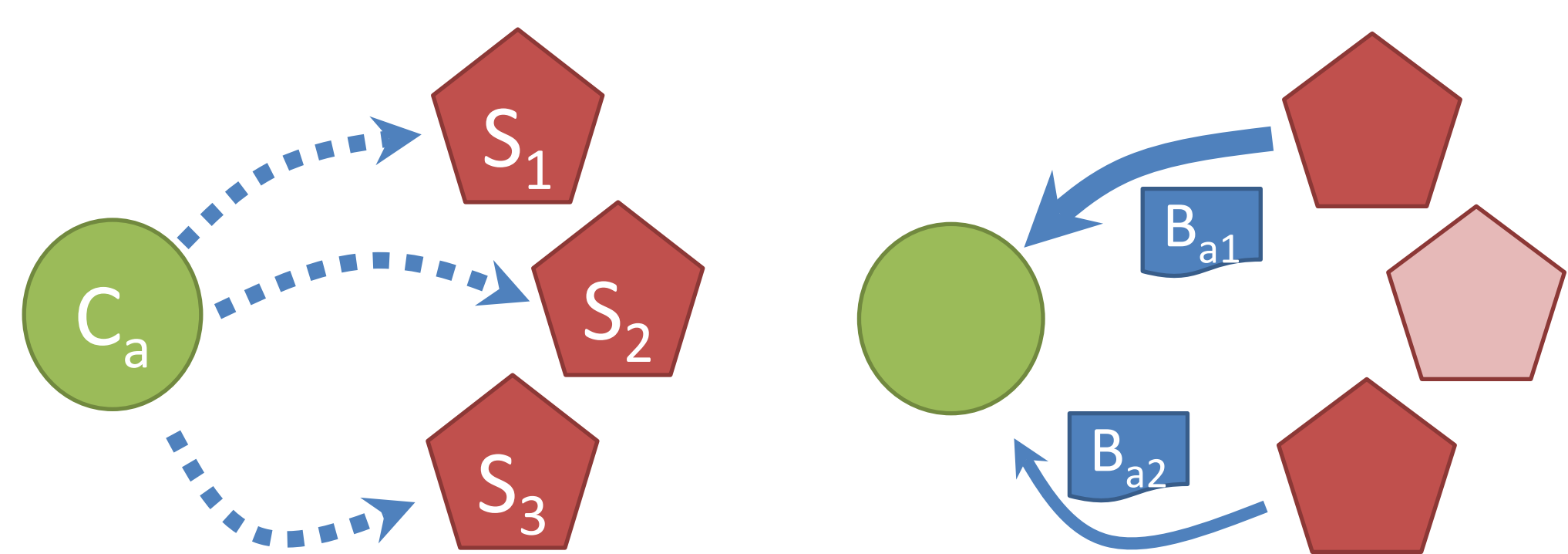
1. Request for bids
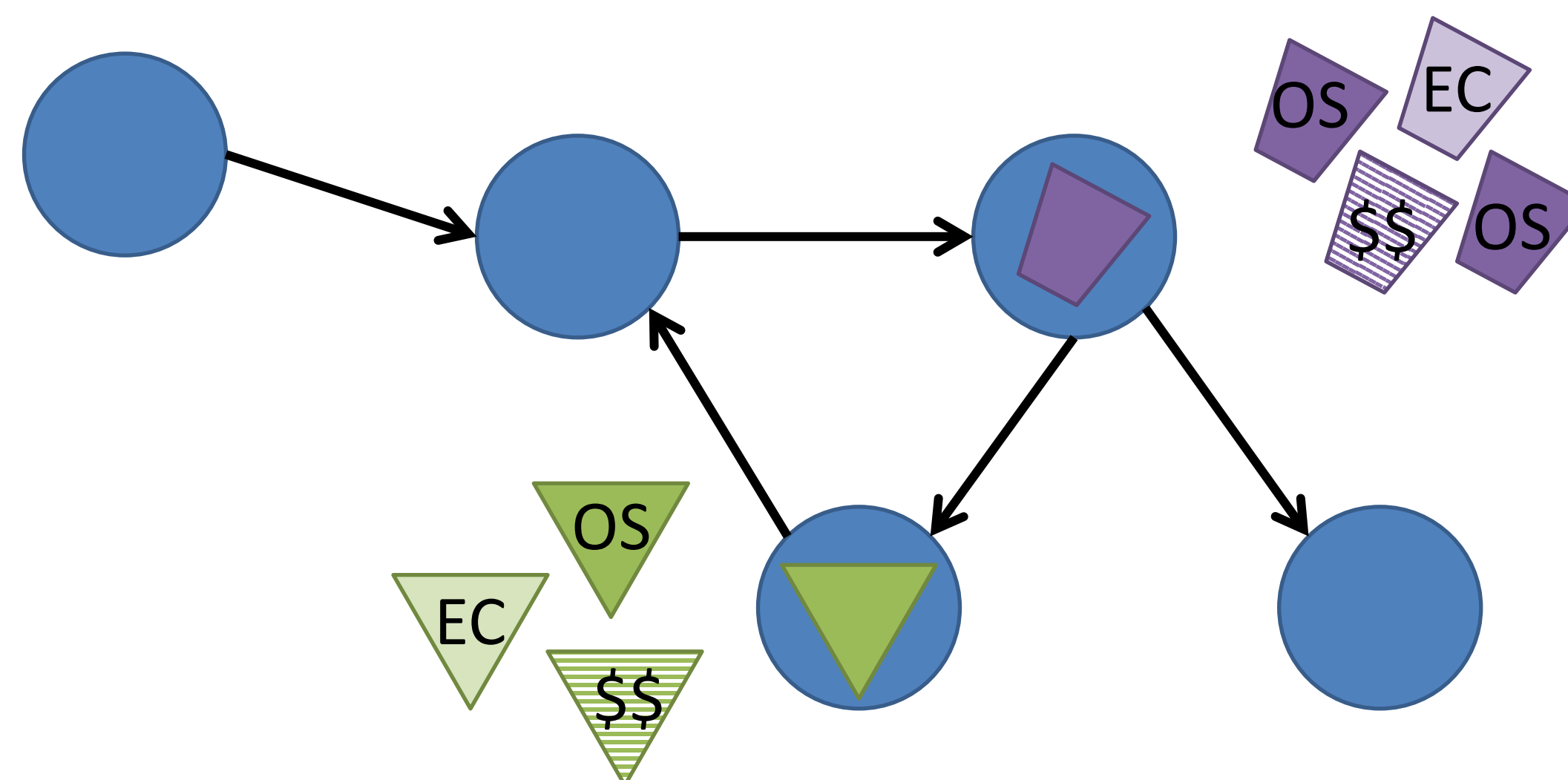
2. Response to request for bids

$$\max_{x,n} \sum \alpha_{xn}$$
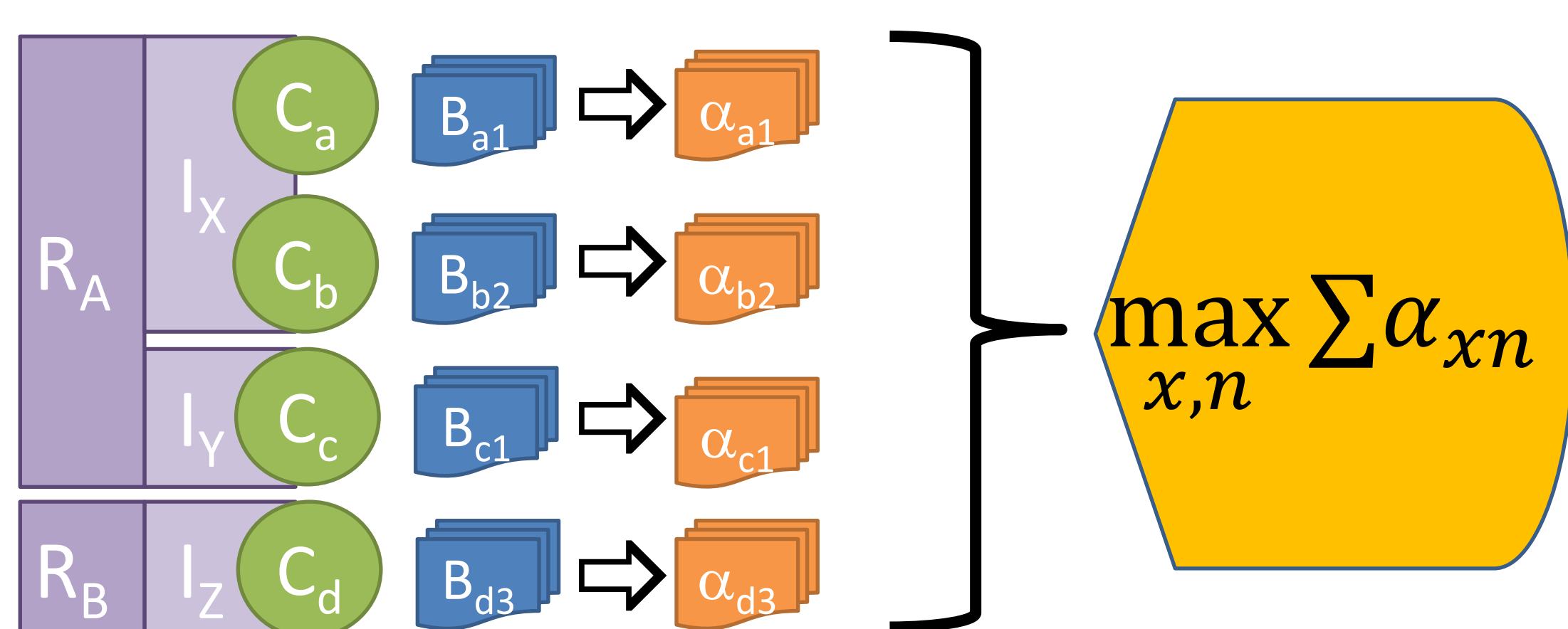
3. Preference adjustment

4. Market resolution

Discrete Material Tracking

- Enable analysis based on tracking history of individual material objects: e.g. transportation, forensics

Ecosystem

Run-Time Plug-ins

- Diverse set of developers can implement agents with specific behaviors
  - Varying physics model complexity
  - Varying interaction behavior
- Easily swap and compare different agent behaviors

Flexibility in distribution

- Developers can choose distribution limits including export controlled (EC), commercial ($$), or open source (OS)

Open source

- *CYCLUS* platform distributed freely with no license restrictions
- Community-based development process using modern software engineering practices

User Interaction

Communication Research

- Understand user interests
- Designed to answer relevant questions
- Results presented in context relevant to users
- Study effectiveness of visualization options

Simulation Builder

- Drag-and-drop interface
- Freedom to be creative with fuel cycle design
- Different modes for different user types
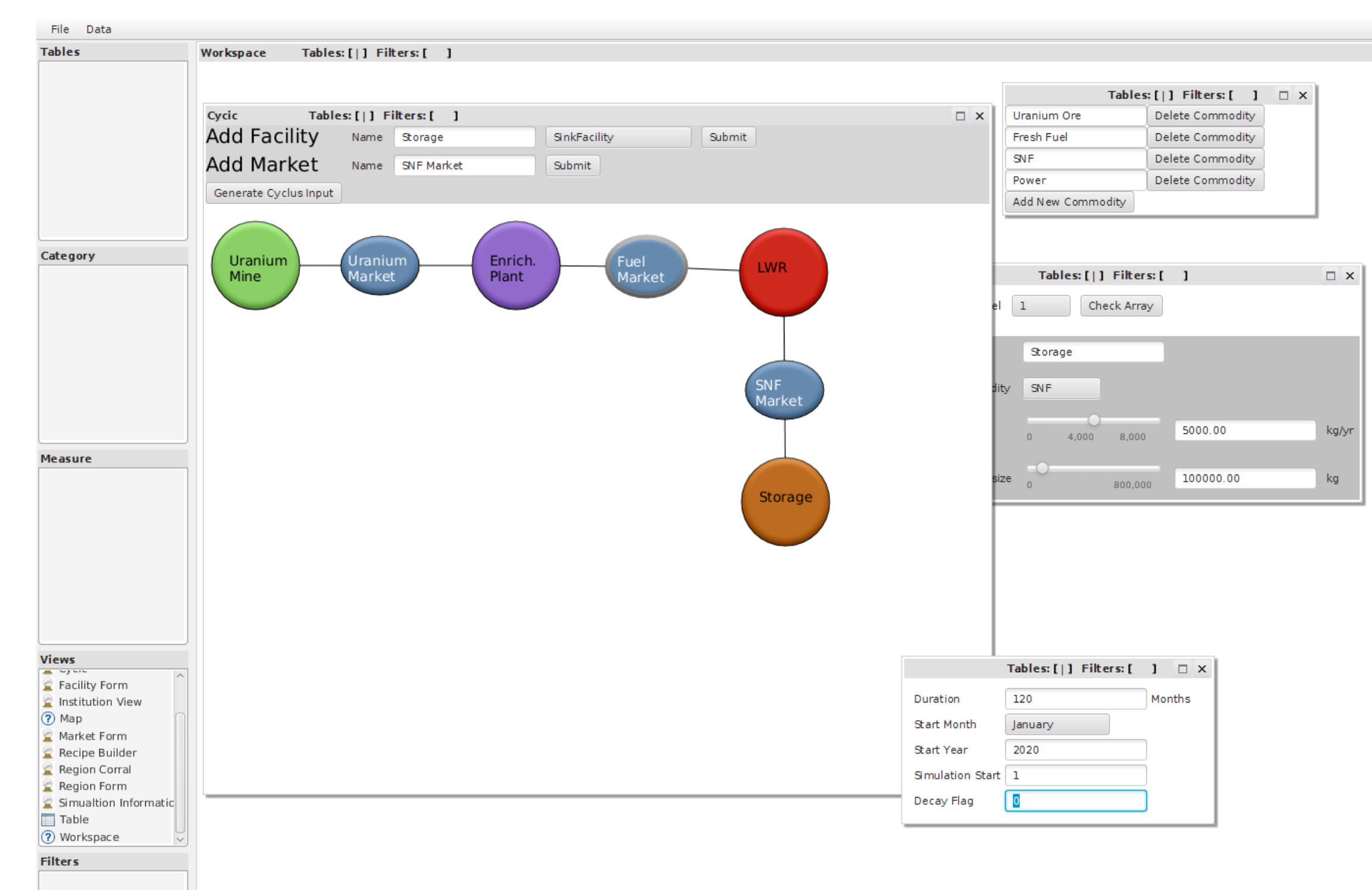
Data Analysis Environment

- Explore data dynamically, filtering by:
  - Region, Institution Facility type, Isotope, *etc.*
- Visualization mode matched to combination of data type and user needs.