CENTRE FOR ENERGY RESEARCH HUNGARIAN ACADEMY OF SCIENCES

Modelling fuel cycle events and advancing time in SITON v2.0

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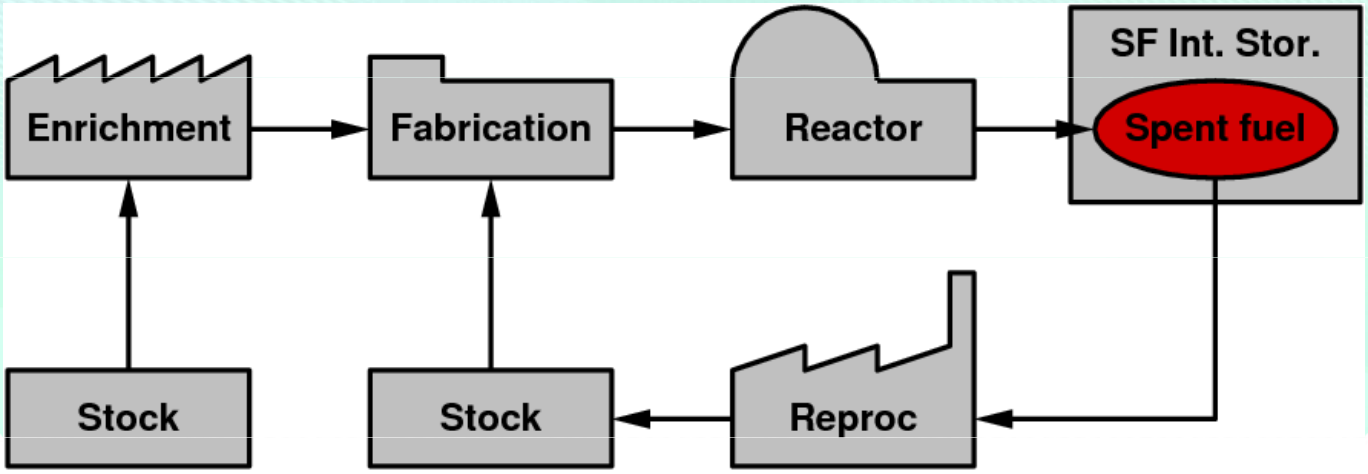
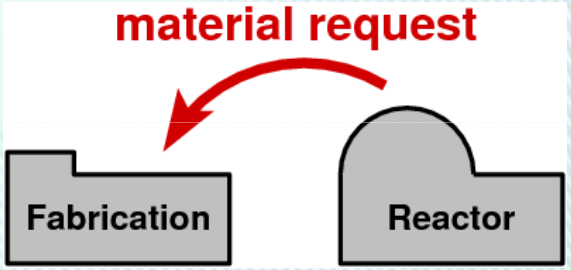
Main features of SITON v2.0

- SITON is a dynamic, discrete facilities, discrete materials and also discrete events fuel cycle simulation code
- Contains all facility types that are important from the point of view of natural uranium utilisation and waste management
- Irradiated fuel composition is determined via burnup tables or a FITXS-based burnup module
- Tracks 52 nuclides: 25 FPs, 27 actinides

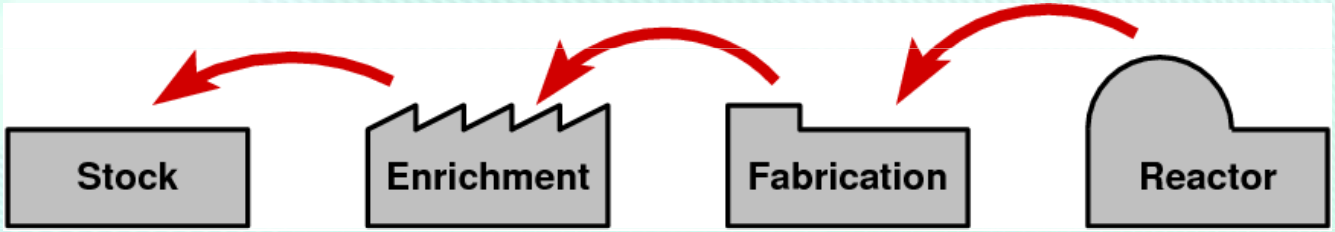


Let's focus on the front-end of the fuel cycle

During the simulation at t= $\mathbf{t_{NOW}}$



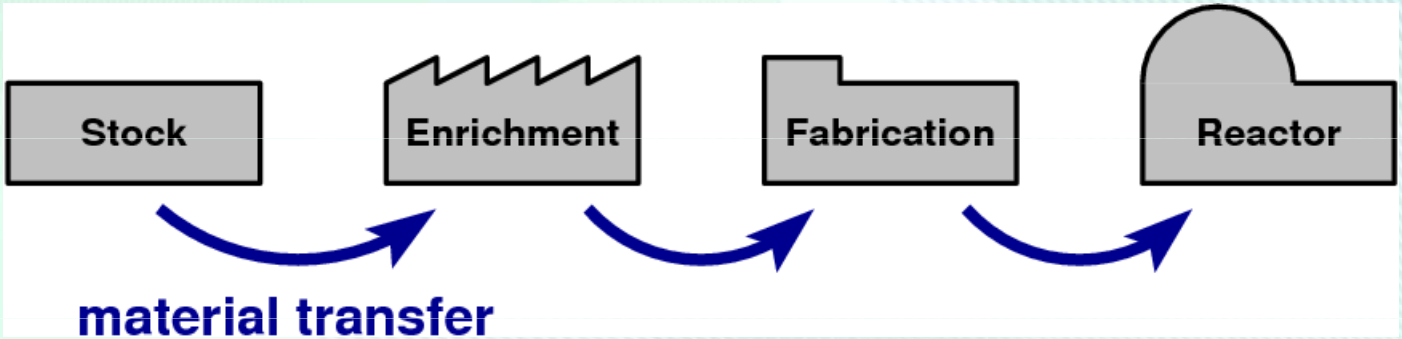
Usually the material request triggers other requests:



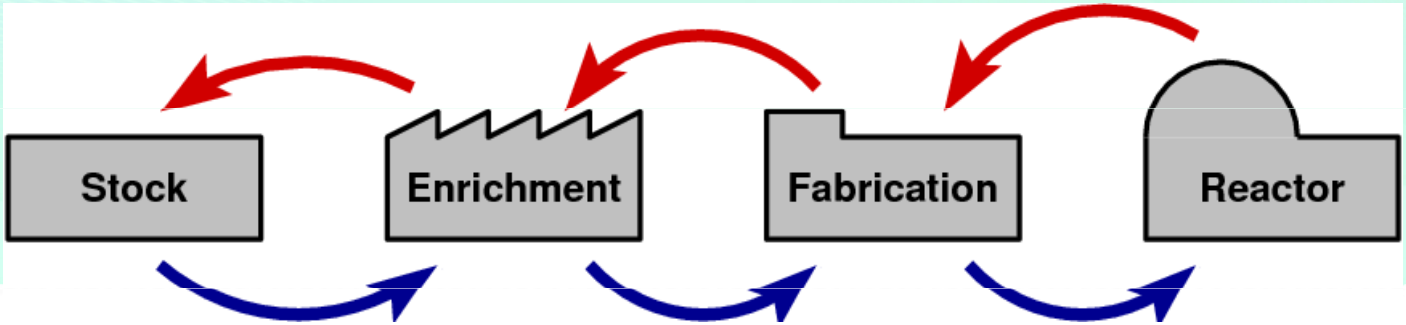
There is a chain of requests and information flows backwards, i.e. downstream in the front-end.

The result of the chain of requests

The chain of requests induce transfer of material upstream in the front-end.

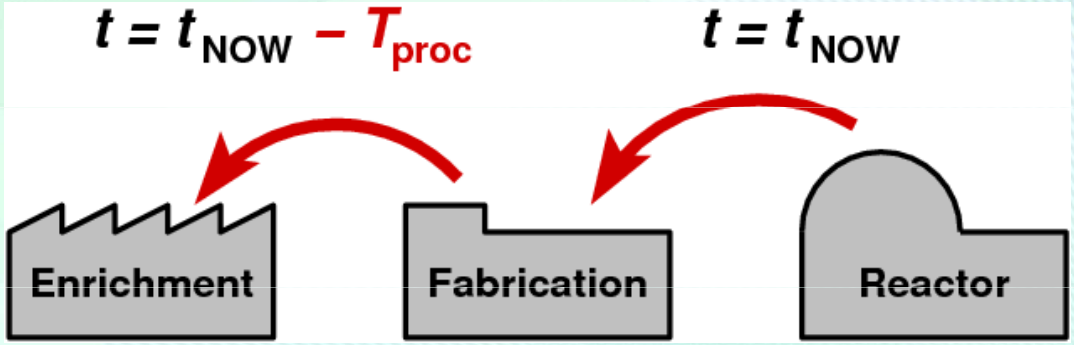


As a summary: at t= $\mathbf{t_{NOW}}$ ***both*** information and material is transferred between the facilities.



If plants have lag times…

However, if plants have lag time (or processing time) a request in the present will trigger a request in the past.

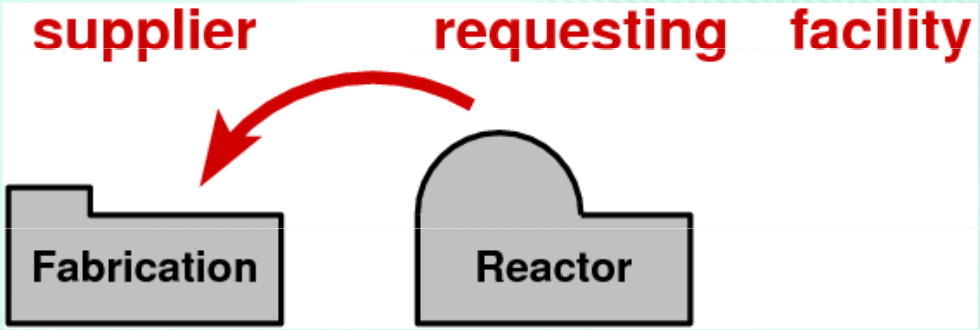


Idea: decoupling the handling of requests and fulfilling of requests, i.e.: material transfer.

Planning: a pre-simulation step in which requests of facilities are surveyed and triggered requests are tracked.

Concept of event

In order to be able to describe material requests the concept of event was introduced. All parameters of an event are stored on an event card.



Event Card

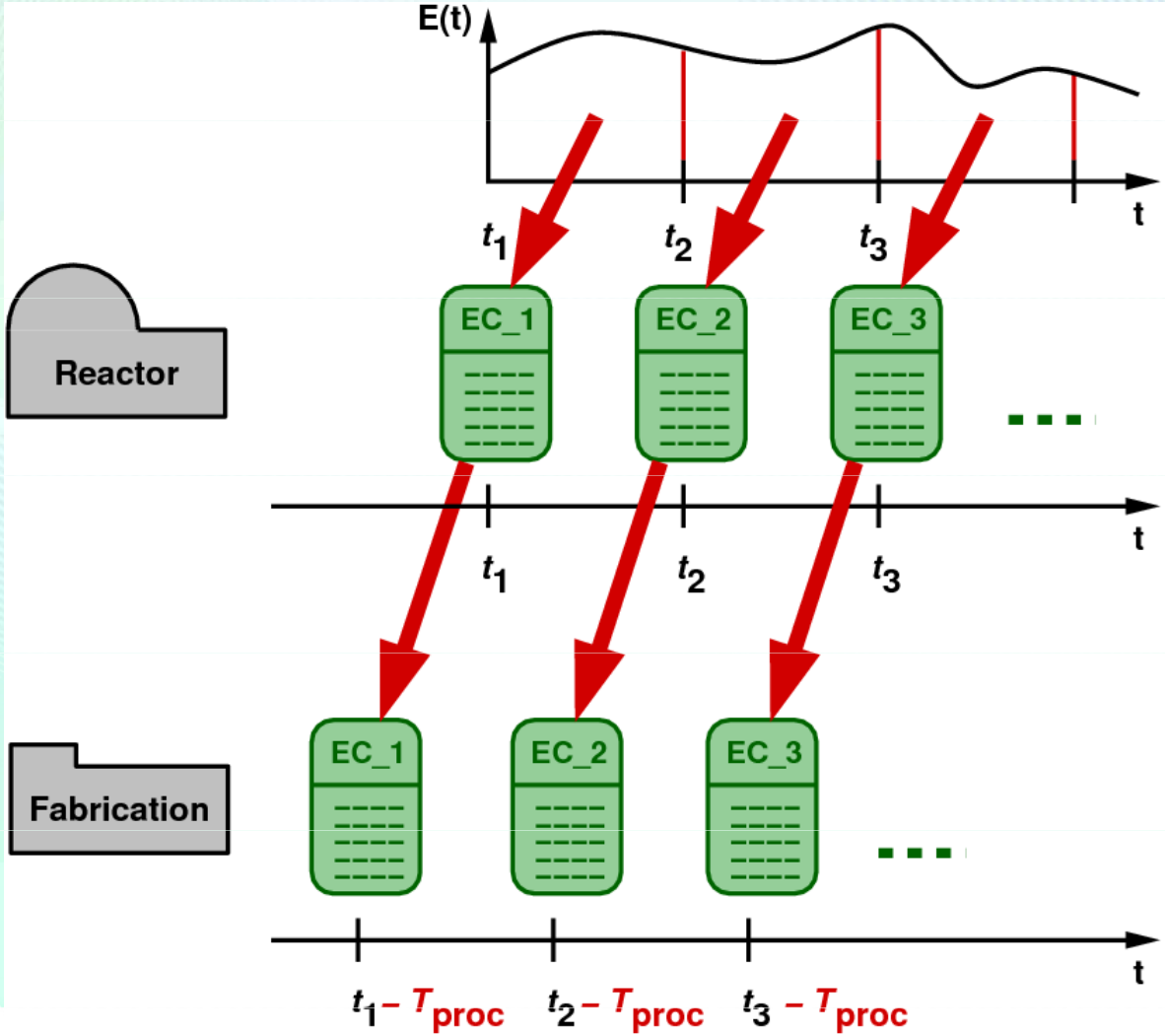
- supplier facility
- requesting facil.
- date
- mass
- what: mat. / fuel
- mat. / fuel ID
- target reactor
- cycle number

Planning: tracking chain of requests

Reactor creates its event cards according to its energy demand.

Fabrication plant derives its event cards from those of the reactor.

And so on…



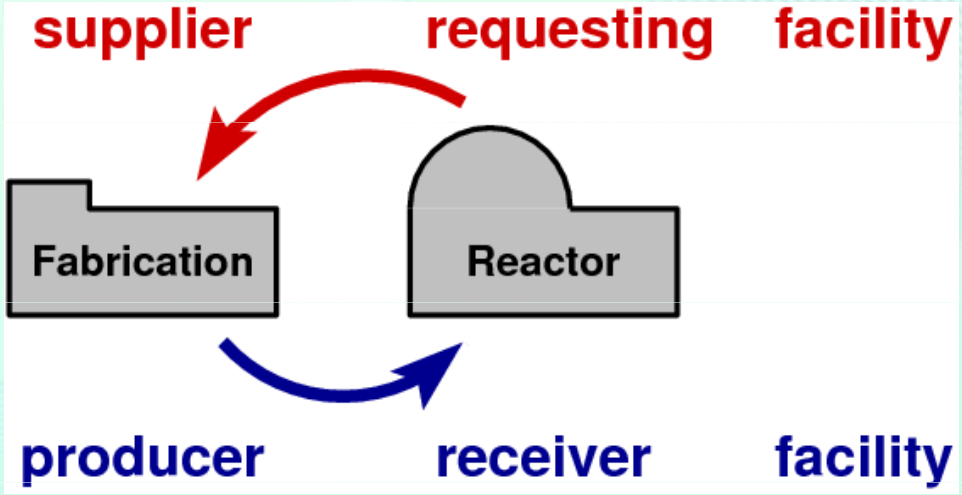
Planning: some details

The fresh fuel can be fabricated from several materials. However their **mass fraction in the fuel is fixed**. Therefore the fabrication plant will create as many event cards as many components the fuel has.

At the end of the planning event cards of each facility are collected and merged in an ordered manner into a big list of events: **event list of the simulation**.

Events during the simulation

The event list of the simulation is used to drive the simulation since event cards also describe the material transfer between two facilities.



Event Card

- producer facility
- receiver facility
- date
- mass
- what: mat. / fuel
- mat. / fuel ID
- target reactor
- cycle number

Summary: advantages

• Event cards describe both material requests and transfers: uniform handling of what happens in the fuel cycle.
• Decoupling survey of events and tracking of triggered events from the simulation: events happen at the proper time.
• Date on event cards is used to advance time: variable length time step, there is no need for a simulation clock.

Summary: limitations

Things that turn out only during the simulation cannot be treated:

- lack of material in a stock *
- shortage in the capacity of a plant *
- isotopic composition of material in a stock, e.g. Pu.

This would influence mass fractions the fresh fuel is fabricated from to ensure criticality. However, currently mass fractions of the materials in the fresh fuel is fixed.

Have we reached the limits of the planning-simulation approach?