Content

- Introduction
- Example models
  - timeshared
  - multiteller
  - jobshop
  - supplychain
- Problems implementing the examples
  - Handling of concurrent events
  - Separation of entities from a queue
  - Storing entities
  - Time measurements across several blocks
  - Statistical analysis
- Conclusions

Introduction

**Discrete systems**

- many different modeling paradigms
- graphical methods
  - abstract (Petri nets, state graphs)
  - medium level of abstraction (entities running through components)
  - concrete (material flow applications, e.g. PlantSimulation)
- medium level widely used
  - sufficiently abstract to be universally applicable
  - concrete enough to be comprehensible by users
  - process based (active components, e.g. Arena) or transaction based (active entities, e.g. SimEvents)

**Closer look at transaction based modeling**

- no well-established set of basic features and components (cf. SimEvents 4.4 → 5.0)
- open issues
  - shortcomings of current implementations
  - missing concepts or components
  - reasonable set of components
- strategy
  - implement many different applications
  - concrete: SimEvents 4.4 (Mathworks)
**Time-shared computer model**
- from Law's textbook
- several terminals send jobs of varying computing time demands
- processed in time slices using a round-robin scheduler

![Diagram of time-shared computer model]

**Multiteller**

**Multiteller bank with jockeying**
- from Law's textbook
- bank with several teller queues
- customers are allowed to change to a shorter queue (jockeying)

![Diagram of multiteller bank with jockeying]
**Job-shop model**
- from Law's textbook
- factory with five workstations
- variable kinds of jobs with different paths through the stations

![Job-type 1 diagram](image)

**Supply chain model**
- from Argesim benchmark C14
- supply chain with factories, distributors and wholesalers
- wholesalers order different products from distributors
- distributors use special strategies to comply with the demand

![Supply chain diagram](image)
Handling of concurrent events

Who defines the order of concurrent events?
- often: a global event queue
- in TBM: events are defined by blocks → order not well-defined

Example testNullserver

- leads to error message
- undefined, what comes first at Set Attribute: new entity or new attribute value

Solutions
- ignore message → entities leave at the wrong port!
- null server after Get Attribute → model works

Old problem
- BUFFER command of GPSS

Handling of concurrent events

Null server - no universal solution
- its output may be blocked → null server stores entity
- no problem, if an (unlimited) queue follows

Careful with null server between queue and server
- example timeshared/CPU

- server busy → next entity sits in the null server
- has to be taken into account, e.g. for computation of queue length!

Null server workaround conceptually wrong
- its purpose is not related to storage → easily forgotten
- creates unexpected problems
Separation of entities from a queue

Several applications, e.g.
- leaving a queue after a maximal waiting time (reneging)
- changing to shorter queue (jockeying)

In SimEvents
- reneging is implemented
- jockeying is not

Shuffle queue
- jockey event leads to cyclic walk of queue entities
- last one gets separated

Separation of entities from a queue

Clone queue
- incoming entities are duplicated and routed to a FIFO and a LIFO queue
- jockey event → entity is taken from the LIFO queue
- bookkeeping device destroys clones, whose partner has already left

Result
- complex timing problems → cumbersome and error prone
- one needs generic solution
- maybe similar to user chains in GPSS
Storing entities

Storage component for supplychain example
- input for product entities (with type and amount)
- input for order entities (with type and amount)
- output for product entities
- signal output for inventory vector
- parameter for initial stock

Possible storage components in SimEvents
- N-server: how to get an entity of given type?
- resources: fixed amount!
- queues: one necessary for every product type!
- do it yourself with Simulink

Implementation of inventory

Result
- works - but not really a "storage"
- design of a generic storage component?
- special queue with internal advancement (user chains)?
Time measurements across several blocks

Total waiting time in several queues
- in SimEvents: only time between two points
- solution: accumulation of several waiting times in an attribute

New timer components for Start/Pause/Continue/Read

- submodel PauseCTimer

Time measurement across several queues
- problem with null server when accumulating between queue and server

Workaroud
- measure $t_{Q+S}$ and $t_S$
- accumulate behind server (= before next queue) $t_Q = t_{Q+S} - t_S$

Statistical analysis

Decentral concept of TBM
- $\rightarrow$ no central collection instance
- block statistical data often not sufficient

Workaroud
- collect data in entities
- final statistics component at the end of the entity path

Statistics components

Computing time averages
- using continuous time domain

- atomic subsystems with $1/z$ block as accumulator

If necessary
- create report using Matlab
Conclusions

Some basic problems of TBM/SimEvents
- timing of concurrent events
  - null server is the wrong solution!
- implementation of alternative queueing policies
  - a new (or old) abstraction is needed
- storing and retrieving of entities
  - again: a basic concept is missing
- gathering and processing of statistical data
  - a few supplementing blocks would be handy

Proposal: new Argesim benchmark with
- modeling of jockeying queues
- statistical data over several queues
- additional complication: many queues

SimEvents 5
- complete redesign of the library
- based on a unifying theoretical description (but not DEVS)
- migration from SimEvents 4 difficult!
- is it better? We'll see ...

Conclusions

For the advancement of TBM we need
- fundamental abstractions
- theoretical analysis
- stable designs

Or else we have
- tricky workarounds
- no real understanding of our models
- redesign every other year