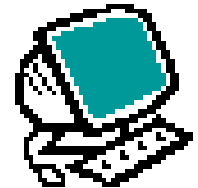


# SDL

Peter Marwedel  
Informatik 12  
TU Dortmund  
Germany

# SDL

Used here as a (prominent) example of a model of computation based on **asynchronous message passing communication**.



☞ appropriate also for distributed systems

<i>Communication/ Computation</i>	Shared memory	Message passing	
		blocking	Non-blocking
FSM	StateCharts		SDL

# SDL

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Language designed for specification of distributed systems.

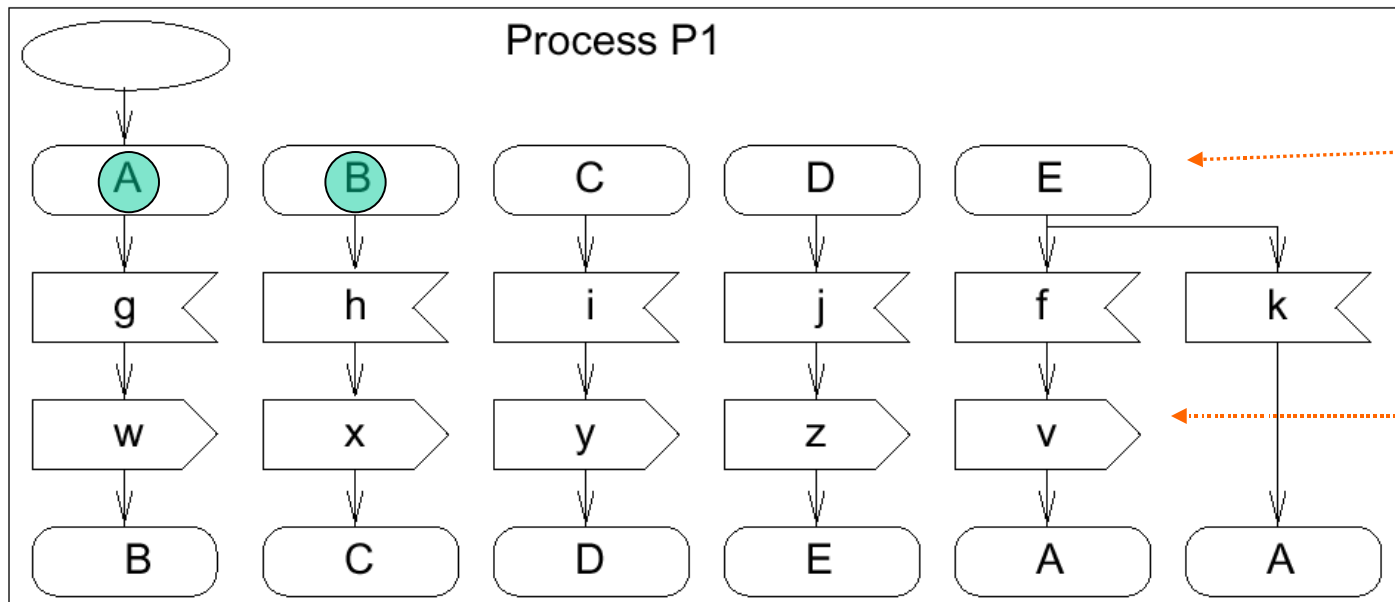
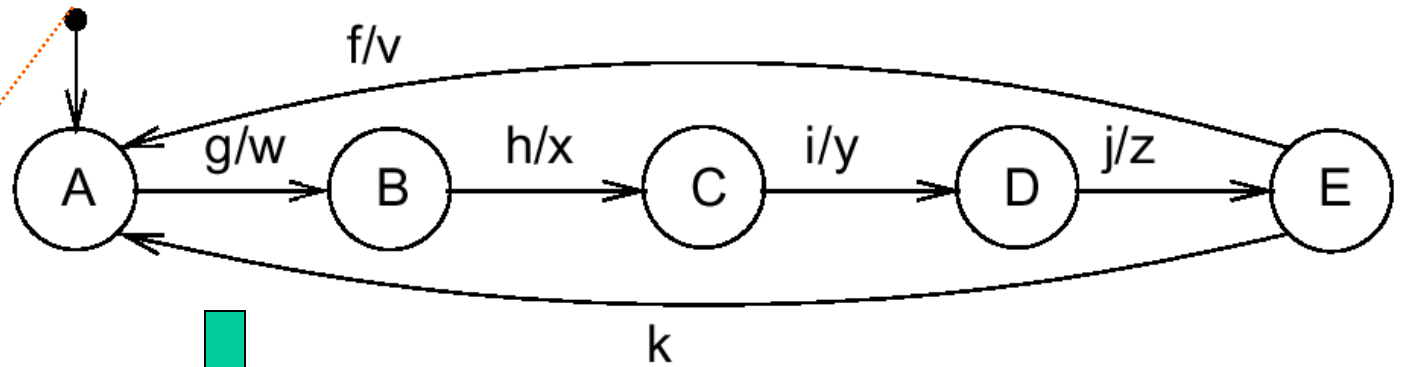
- Dates back to early 70s,
- Formal semantics defined in the late 80s,
- Defined by ITU (International Telecommunication Union): Z.100 recommendation in 1980  
Updates in 1984, 1988, 1992, 1996 and 1999

# SDL

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- Provides textual and graphical formats to please all users,
- Just like StateCharts, it is based on the CFSM model of computation; each FSM is called a **process**,
- However, it uses message passing instead of shared memory for communications,
- SDL supports operations on data.

# SDL-representation of FSMs/processes



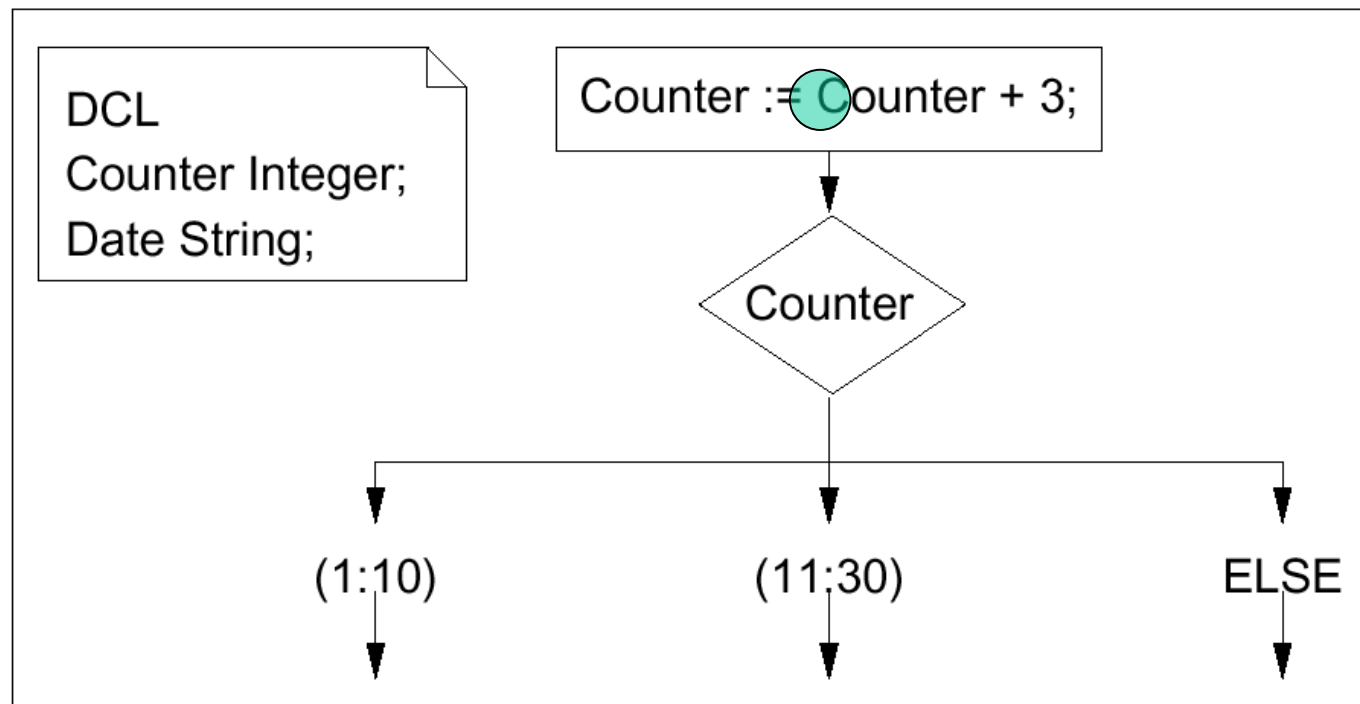
state

input

output

# Operations on data

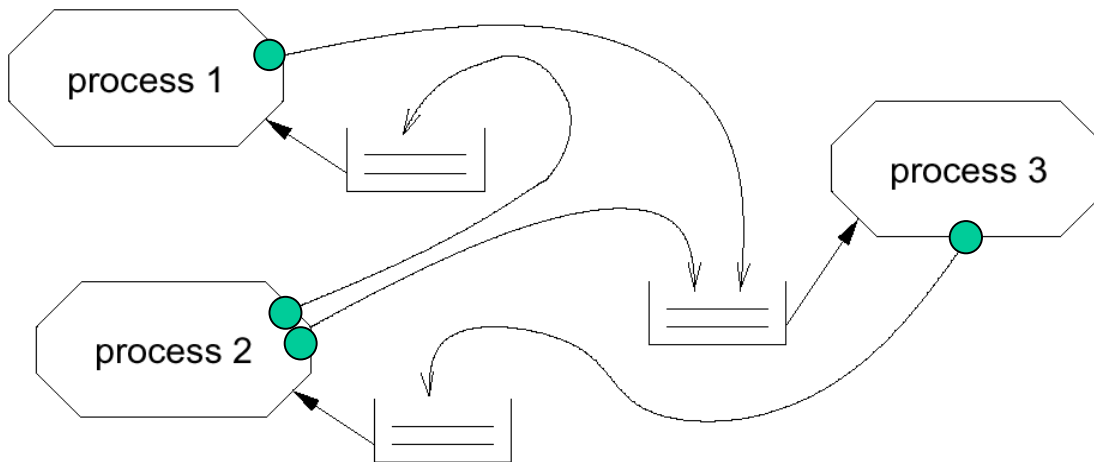
Variables can be declared locally for processes.  
Their type can be predefined or defined in SDL itself.  
SDL supports abstract data types (ADTs). Examples:



# Communication among SDL-FSMs

Communication between FSMs (or „processes“) is based on **message-passing**, assuming a **potentially indefinitely large FIFO-queue**.

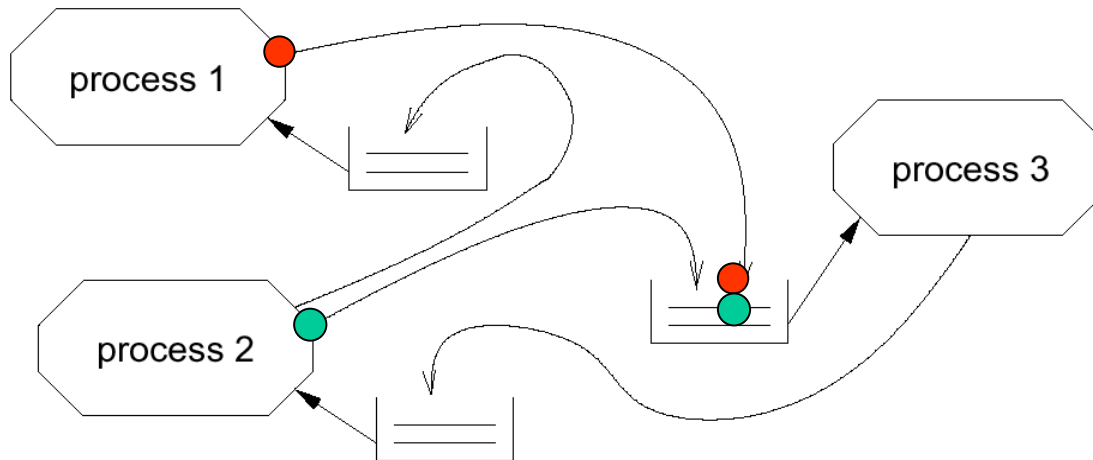
- Each process fetches next entry from FIFO,
- checks if input enables transition,
- if yes: transition takes place,
- if no: input is ignored (exception: SAVE-mechanism).



# Deterministic?

Let tokens be arriving at FIFO at the same time:

👉 Order in which they are stored, is unknown:



All orders are legal: 👉 simulators can show different behaviors for the same input, all of which are correct.

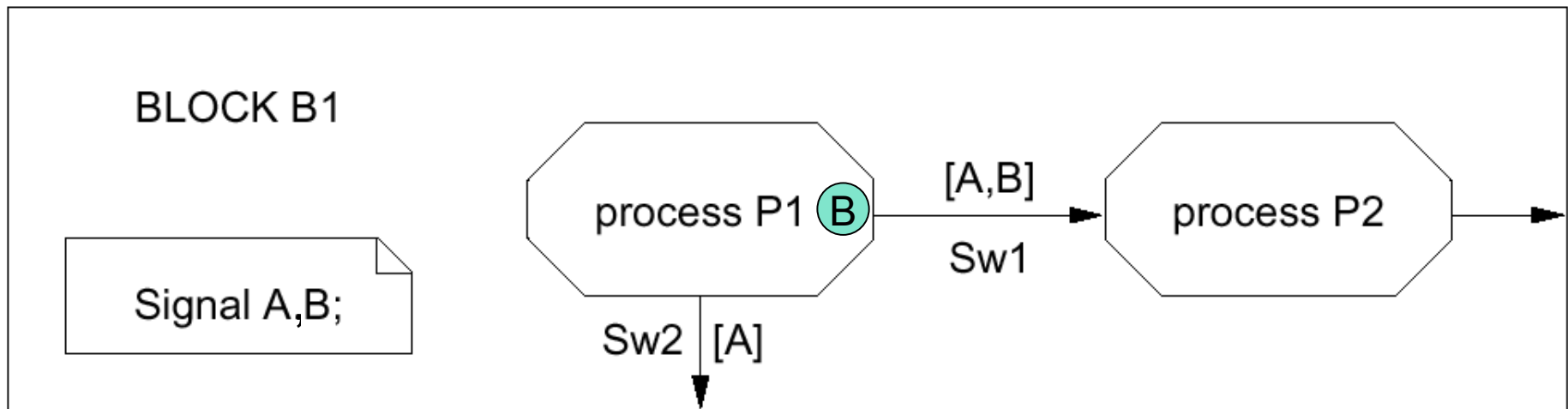


# Process interaction diagrams

Interaction between processes can be described in process interaction diagrams (special case of block diagrams).

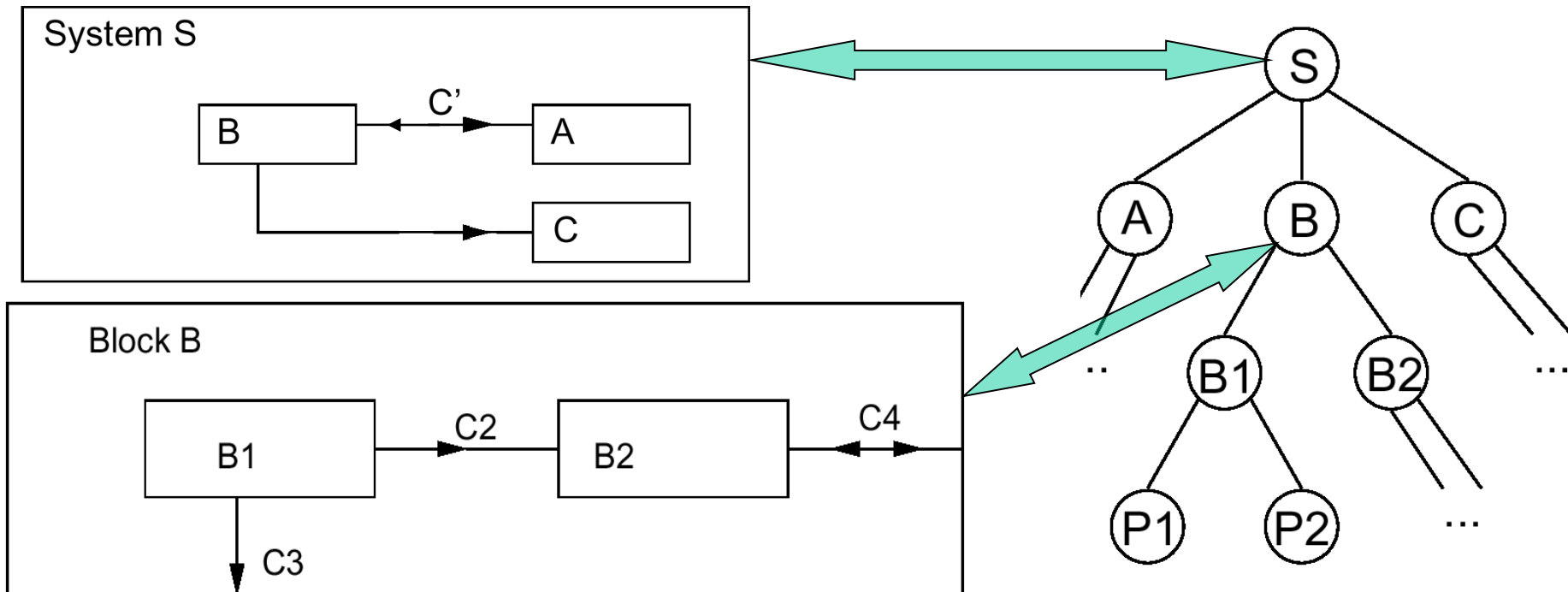
In addition to processes, these diagrams contain channels and declarations of local signals.

Example:



# Hierarchy in SDL

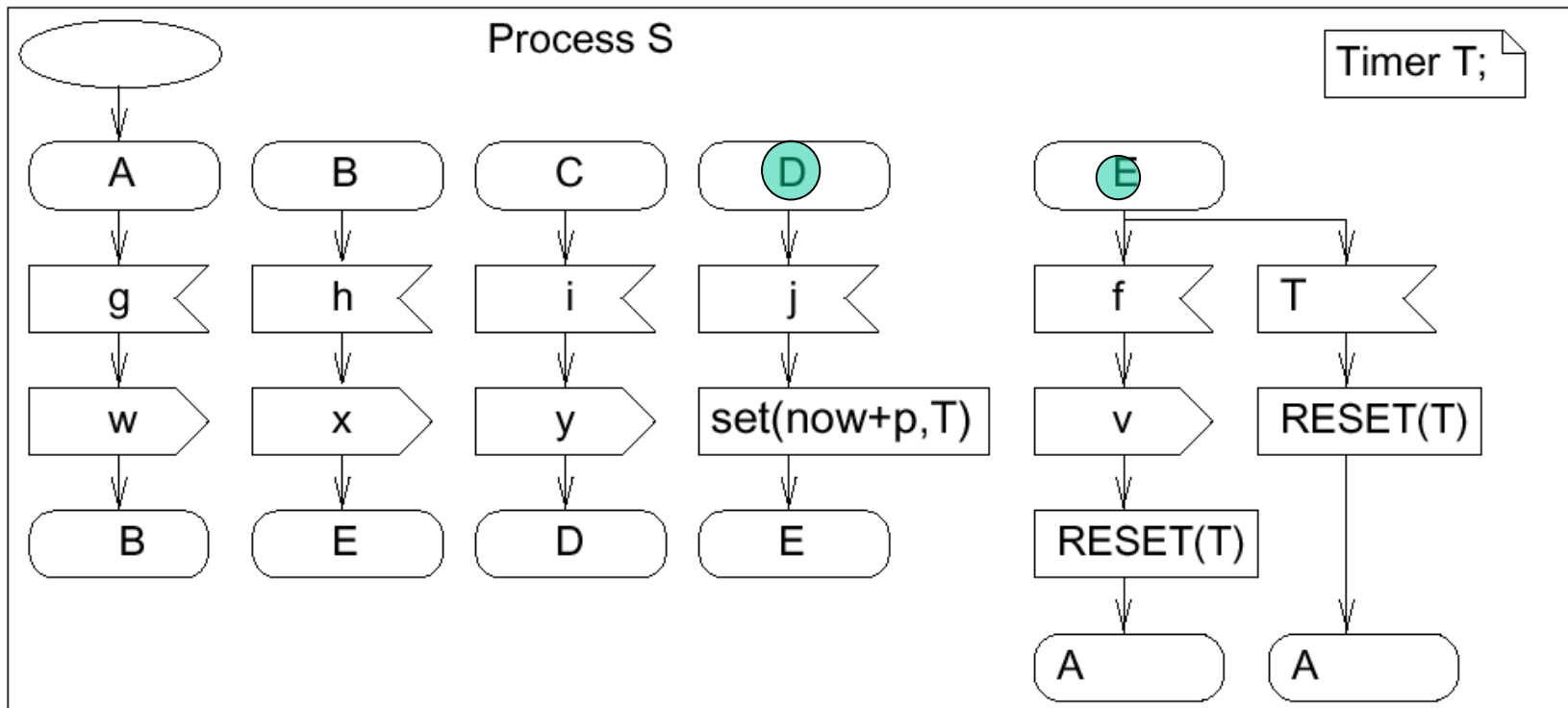
Process interaction diagrams can be included in **blocks**. The root block is called **system**.



Processes cannot contain other processes, unlike in StateCharts.

# Timers

Timers can be declared locally. Elapsed timers put signal into queue (not necessarily processed immediately).  
RESET removes timer (also from FIFO-queue).



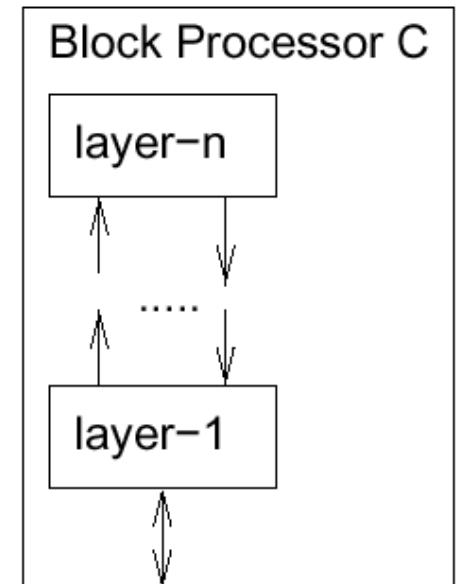
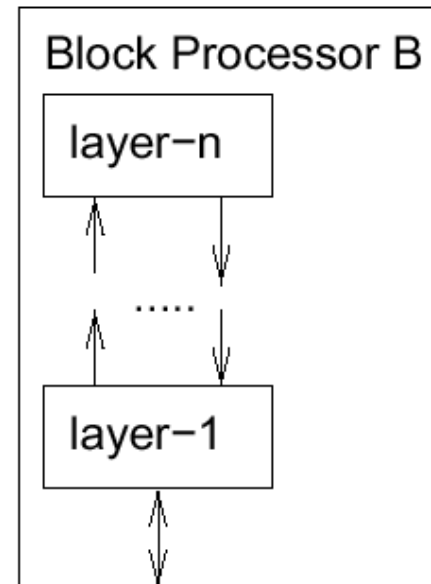
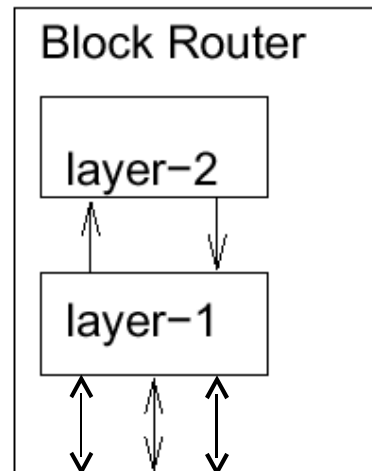
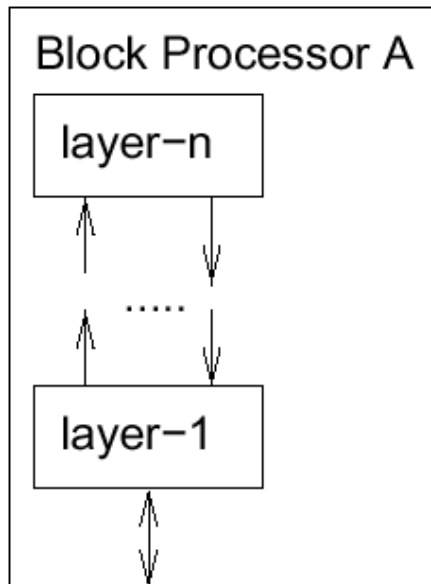
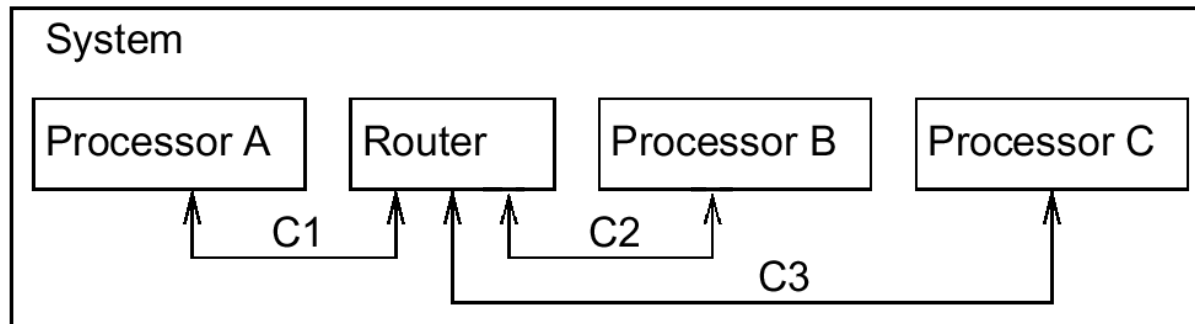
# Additional language elements

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SDL includes a number of additional language elements, like

- procedures
- creation and termination of processes
- advanced description of data
- More features added for SDL-2000 (not well accepted)

# Application: description of network protocols

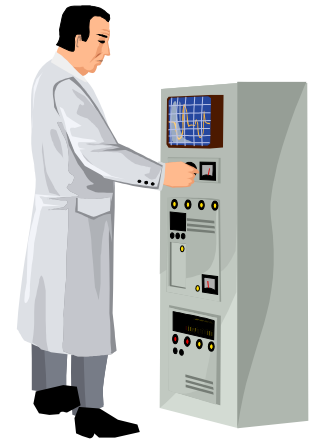


# Larger example: vending machine

Machine° selling pretzels, (potato) chips, cookies, and doughnuts:

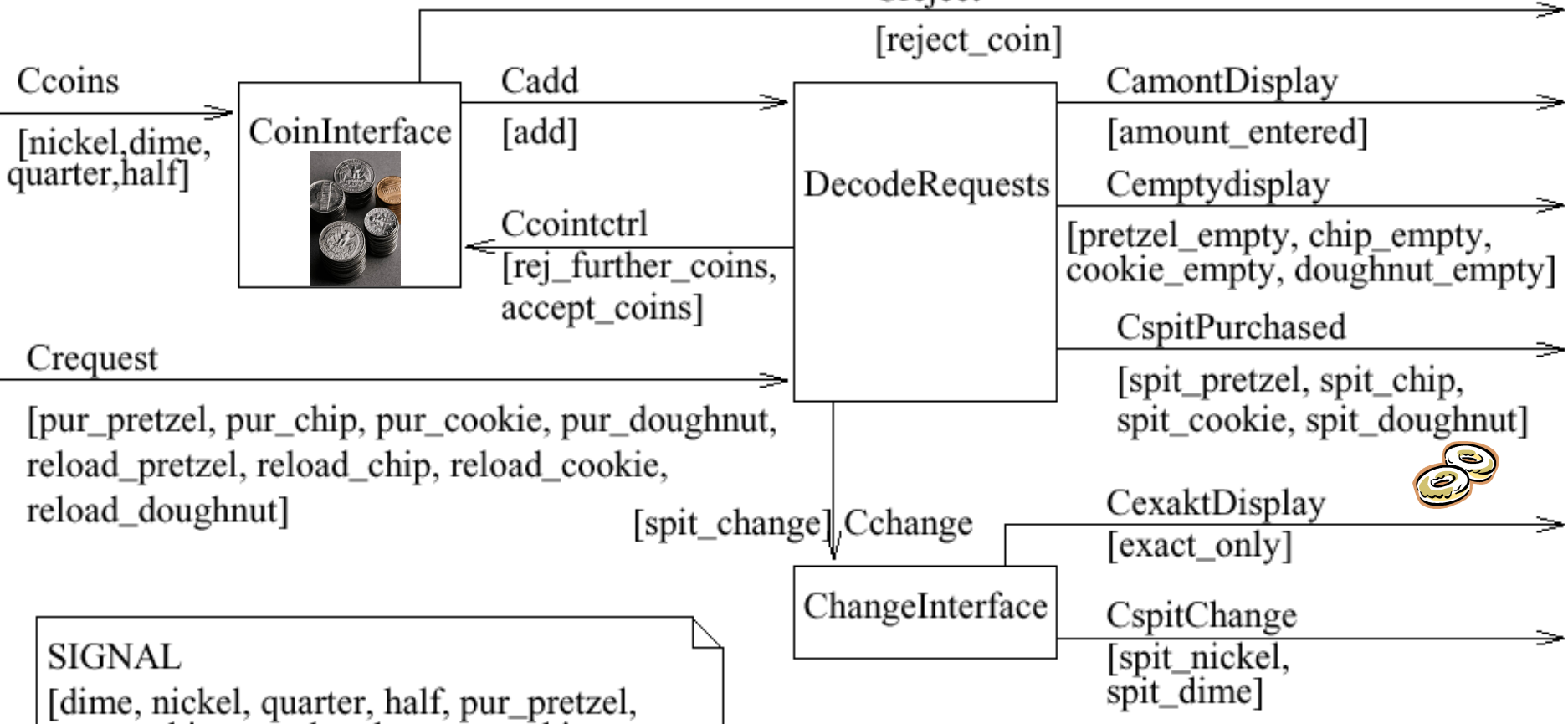
accepts nickels, dime, quarters, and half-dollar coins.

Not a distributed application.



° [J.M. Bergé, O. Levia, J. Roullard: High-Level System Modeling, Kluwer Academic Publishers, 1995]

# System VendingMachine

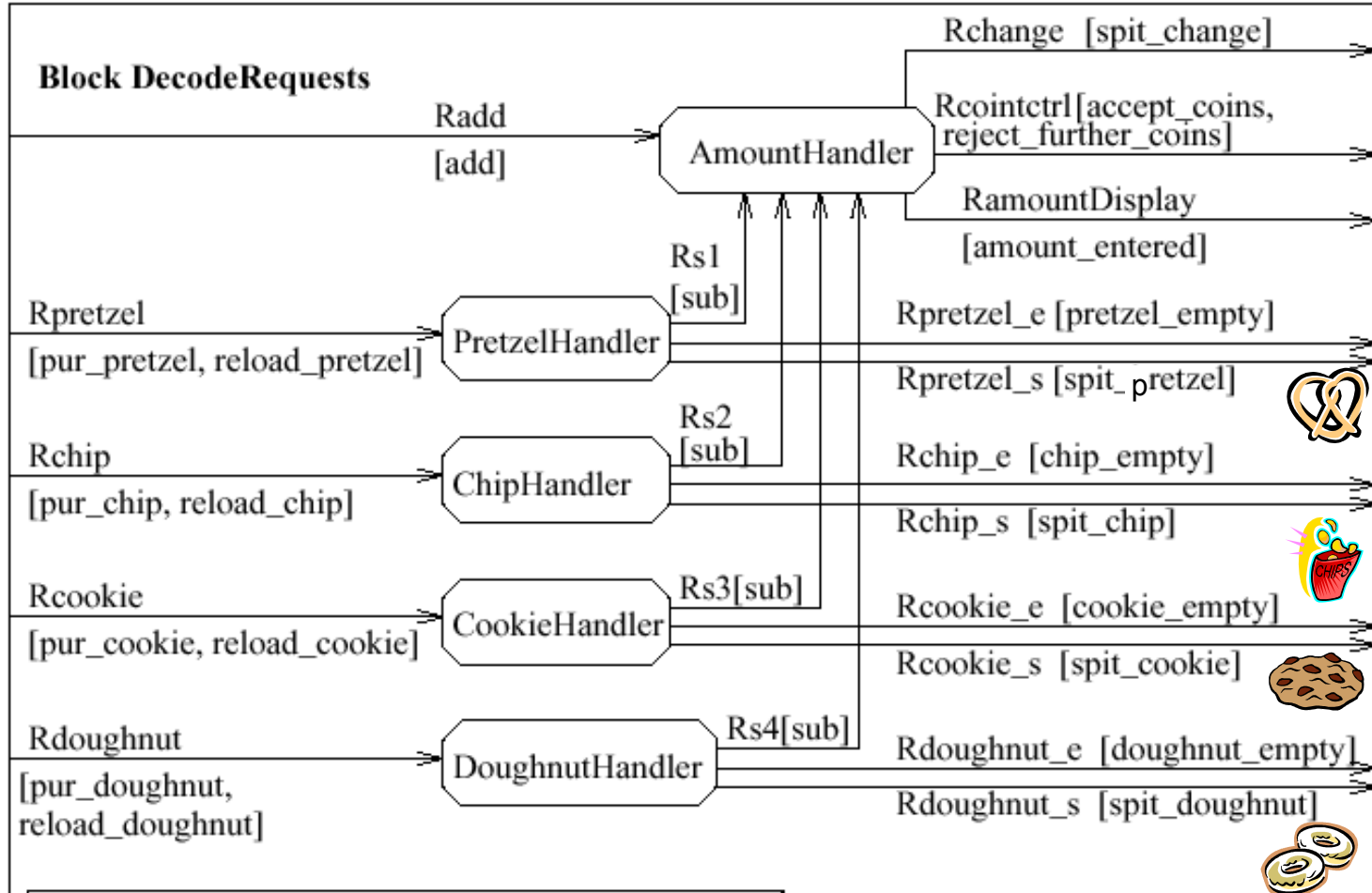


**SIGNAL**  
 [dime, nickel, quarter, half, pur\_pretzel, pur\_cookie, pur\_doughnut, pur\_chip, add(int), spit\_change(int), amount\_entered(int), reject\_further\_coins, exact\_only, accept\_coins, reject\_coins, spit\_dime, spit\_nickel, pretzel\_empty, spit\_pretzel, chip\_empty, spit\_chip, cookie\_empty, spit\_cookie, doughnut\_empty, spit\_doughnut, reload\_pretzel, reload\_chip, reload\_cookie, reload\_doughnut]

**SYNTYPE** items=INTEGER  
 CONSTANTS 0:7  
 ENDSYNTYPE items;

**SYNTYPE** int=INTEGER  
 CONSTANTS 0:127  
 ENDSYNTYPE int;

# Decode Requests



```

CONNECT Cadd AND Radd;
CONNECT Ccointrl AND Rcointrl;
CONNECT Cchange AND Rchange;
CONNECT CAmountDisplay AND RamountDisplay;
CONNECT Crequest AND Rpretzel,Rchip,Rcookie,
        Rdoughnut;
CONNECT CemptyDisplay AND Rpretzel_e,Rchip_e,
        Rcookie_e,Rdoughnut_e;
CONNECT CspitPurchased AND Rpretzel_s,
        Rchip_s,Rcookie_s,Rdoughnut_s;
    
```

```

SYNONYM PRETZEL int=50
SYNONYM PCHIP int=15;
SYNONYM PCOOKIE int=55;
SYNONYM PDOUGHNUT
        int=60;
SYNONYM PMAX int=60;
SYNONYM NITEMS items=7;
    
```

```
SIGNAL sub(int);
```

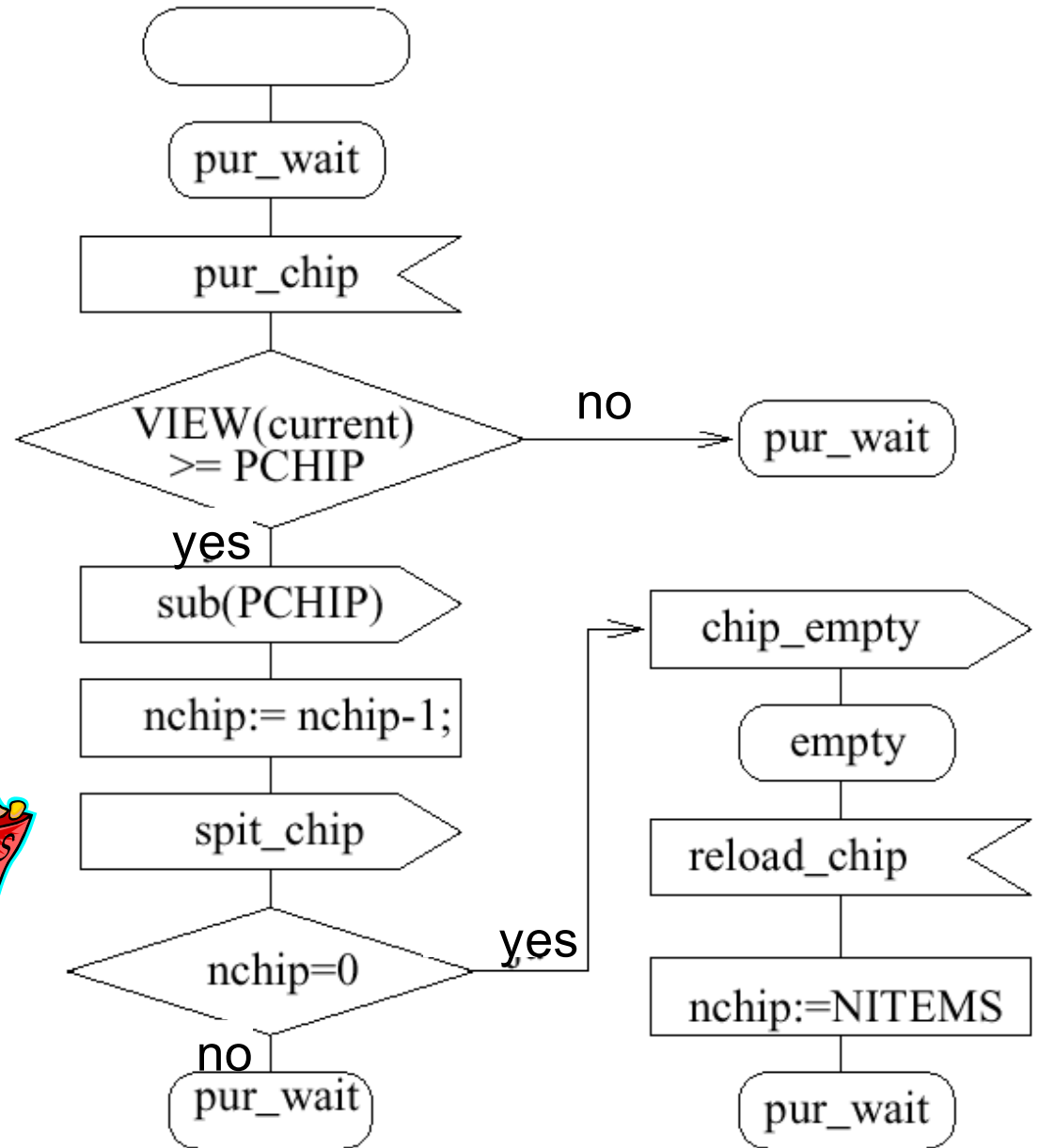


# ChipHandler

## Process ChipHandler

DCL nchip items:=NITEMS;

VIEWED current int;



# Evaluation

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- Excellent for distributed applications (used for ISDN),
- Commercial tools available from SINTEF, Telelogic, Cinderella ([//www.cinderella.dk](http://www.cinderella.dk)).
- Not necessarily deterministic  
(order, in which FSMs are reading input is unknown)  
☞ no synchronous language,
- Implementation requires bound for the maximum length of FIFOs; may be very difficult to compute,
- Timer concept adequate just for soft deadlines,
- Limited way of using hierarchies,
- Limited programming language support,
- No description of non-functional properties,
- Becoming less popular

# Summary

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## SDL

- MoC: finite state machine components  
+ non-blocking message passing communication
- Representation of processes
- Communication & block diagrams
- Timers and other language elements
- Example: Vending machine
- Evaluation