Message Passing

- Abstract notions representing physical communication possibilities
- Many different names: Message queues, pipes, mailboxes, ...

Primitives

- **send** *msg* **to** *dest* **receive** *msg* [**from** *source*]

Issues

- Direct or indirect naming
- Synchronization (buffering)
- Blocking of operations
- Selective communication
- Message types and encodings

Communication Sequential Processes (CSP)

- Language proposal by C.A.R. Hoare 1978
- Idea: A few simple concepts for concurrent programming
  - No shared variables
  - Synchronous communication
  - Selection
- Later developed into *Theoretical CSP* notation
- Realized in the *Occam* language
- Seminal for many theories of concurrency, esp. *process algebras*

CSP constructs

Dijkstra's Guarded Commands

- **if** $b_1 \rightarrow S_1$ [] $b_2 \rightarrow S_2$ [] ... [] $b_n \rightarrow S_n$ **fi**

Synchronous Communication

	process A	**process** B	
	$\vdots$	$\vdots$	
Output	$B!e$	$A?x$	Input
	$\vdots$	$\vdots$	

Selective Communication

process A
$\vdots$
$C!e_1$
$\vdots$

process B
$\vdots$
$C!e_2$
$\vdots$

process C
$\vdots$
if $A?x \rightarrow S_1$
[] $B?y \rightarrow S_2$
fi
$\vdots$

The Erlang Language

History

- Developed by Ericsson during 1980'ies
- Open Source version of compiler/libraries in 2000
- Used especially for telephone switches

Erlang Characteristics

- Functional language with concurrency
- Asyncronous (buffered) communication
- Distributes readily
- Small contex switch times
- **Not** hard real-time
- Runs on top of (RT-)OS