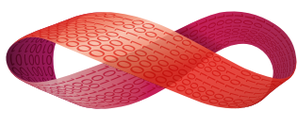
Heavy Industry Erlang

Erlang User Conference 2014, Stockholm



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PLC

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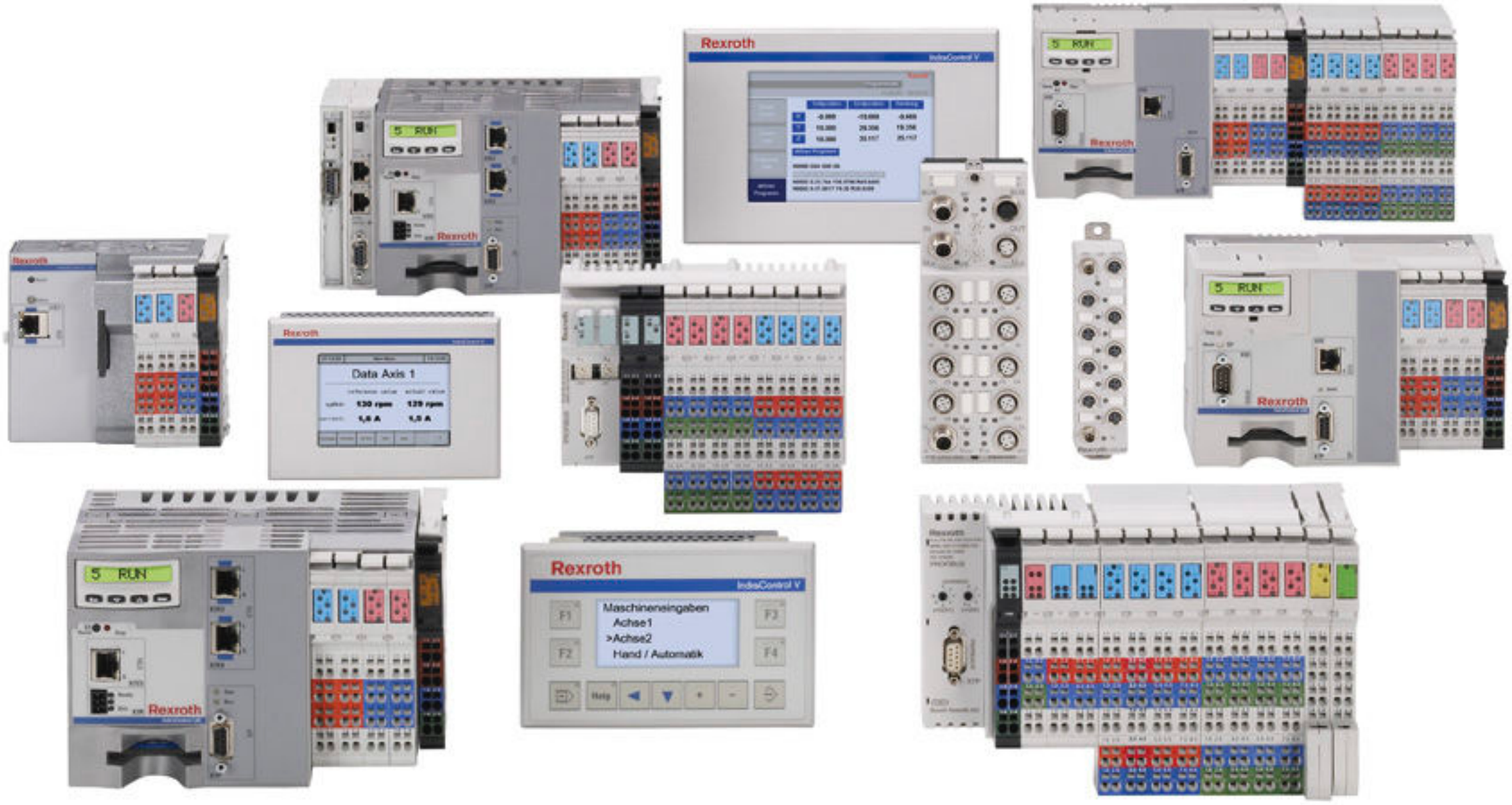
Standards

- IEC 61131 - classical PLCs
- IEC 61499 - distributed PLCs
- Some big companies have their own „Standards“



How to program?

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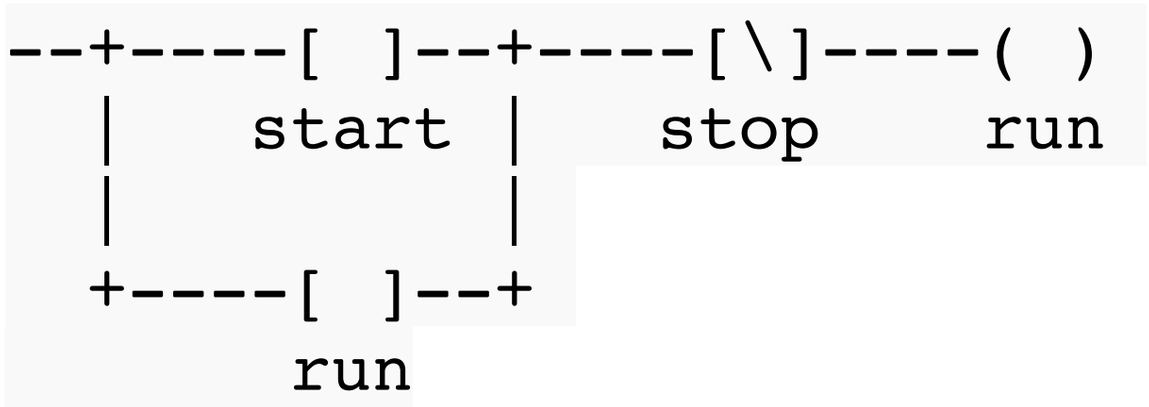
Ladder Diagram (LD) and Instruction List (IL)




```
LD A
ADD 5
ST C10. PV
LD %IX10
ST C10. CU
CAL C10
```

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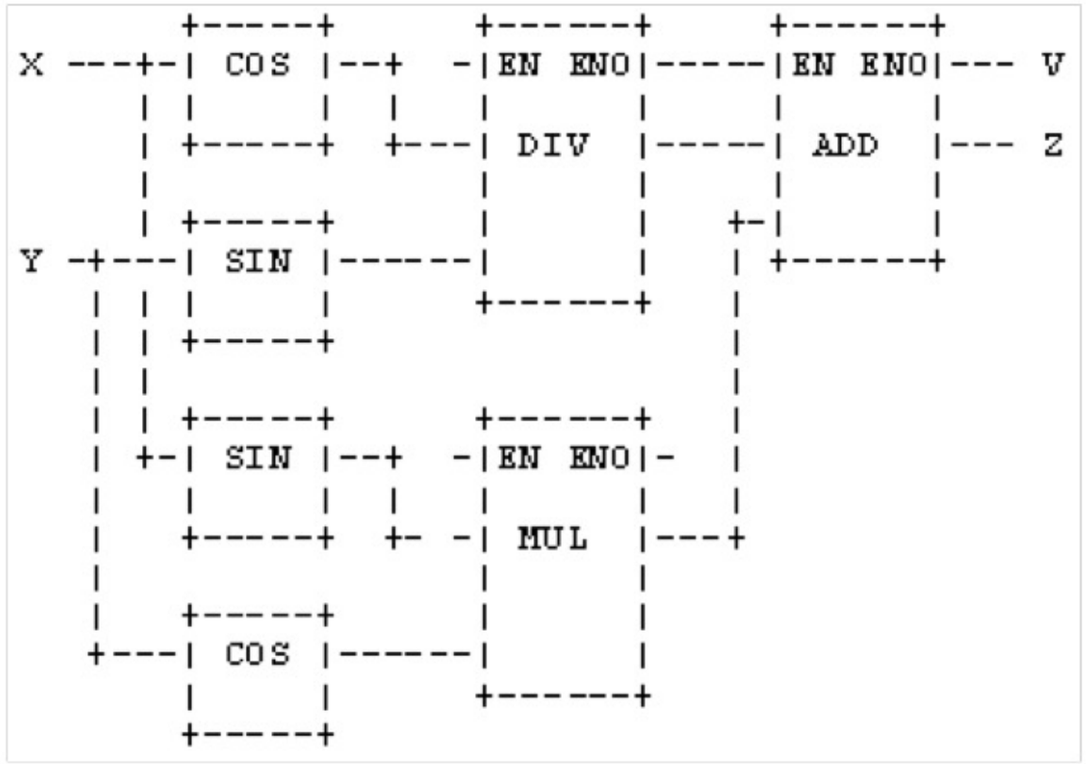
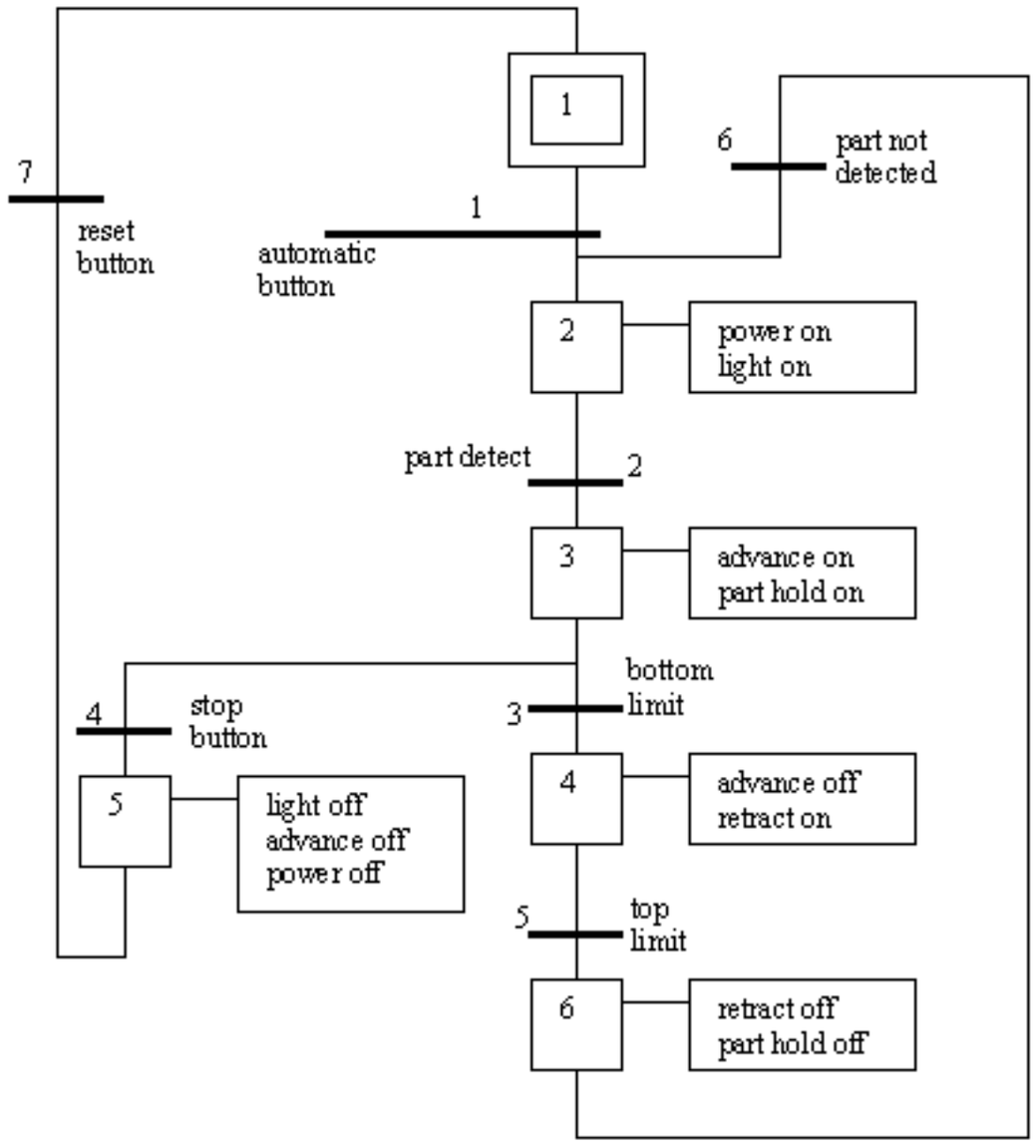
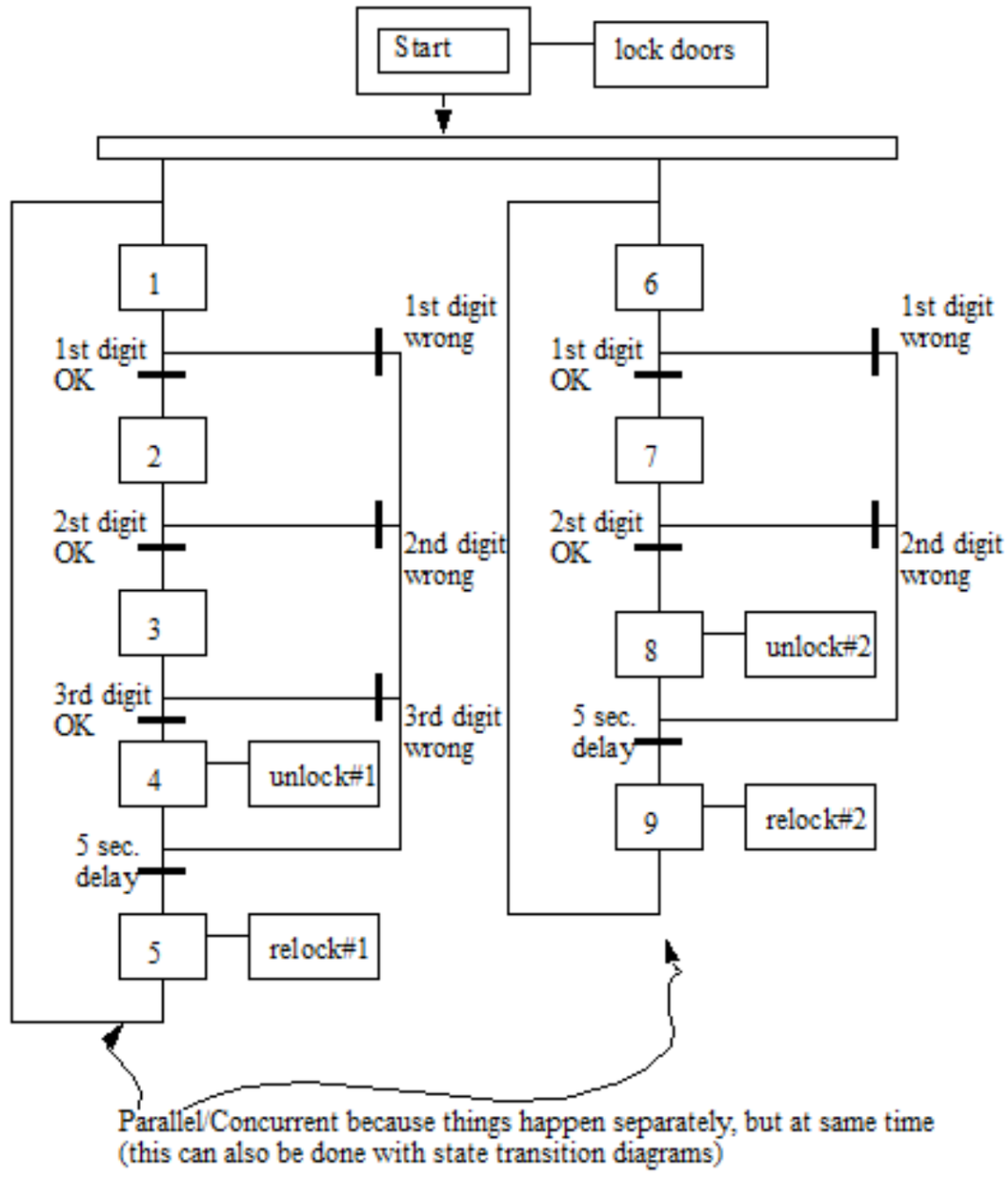
Structured Text (ST)
and Function-Blocks Diagram (FBD)

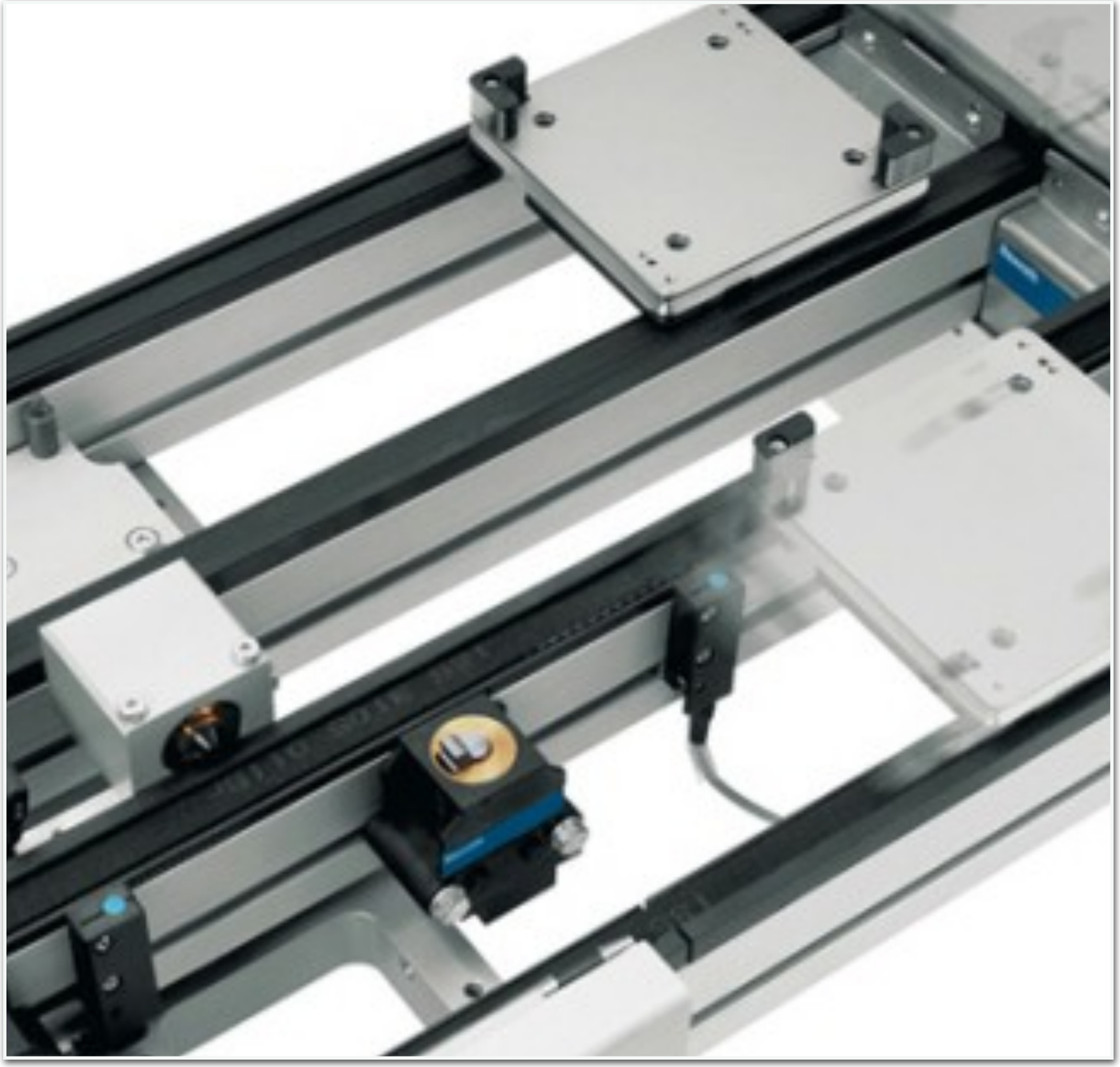


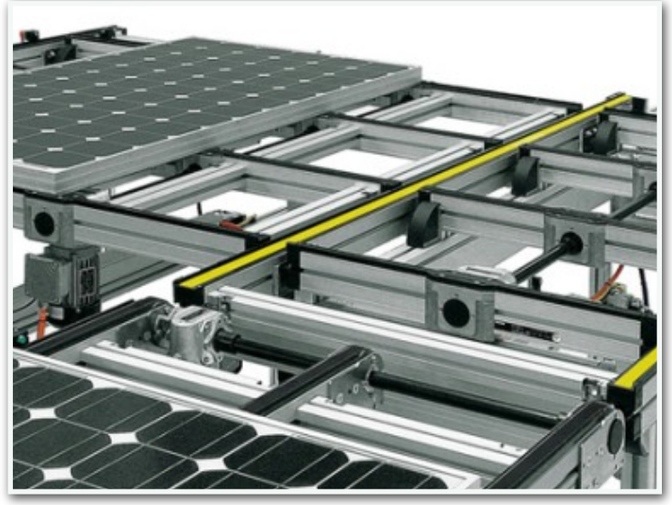

```
VAR
    X, Y, Z, RES1, RES2 : REAL;
    EN1, V : BOOL;
END_VAR
RES1 := DIV(IN1 := COS(X), IN2 := SIN(Y), ENO => EN1);
RES2 := MUL(SIN(X), COS(Y));
Z    := ADD(EN := EN1, IN1 := RES1, IN2 := RES2, ENO => V)
```

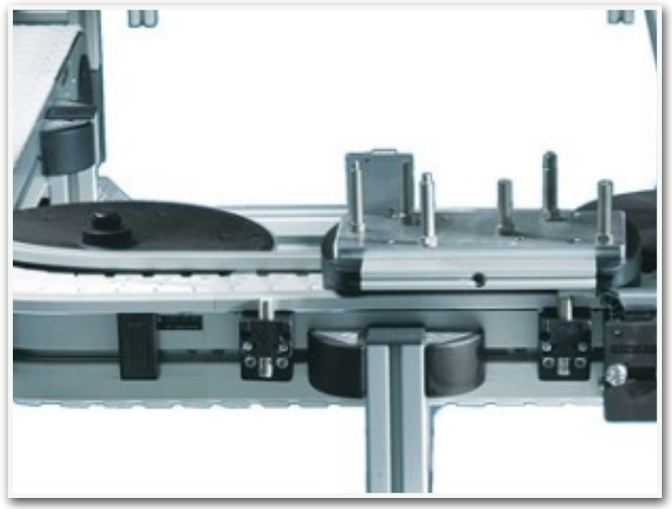
Sequence Function Chart











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Predecessor System written in C on RTEMS

- Boschrexroth ID40 RFID System

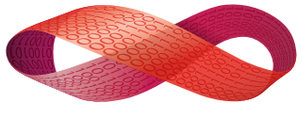
And some Objective-C

Application

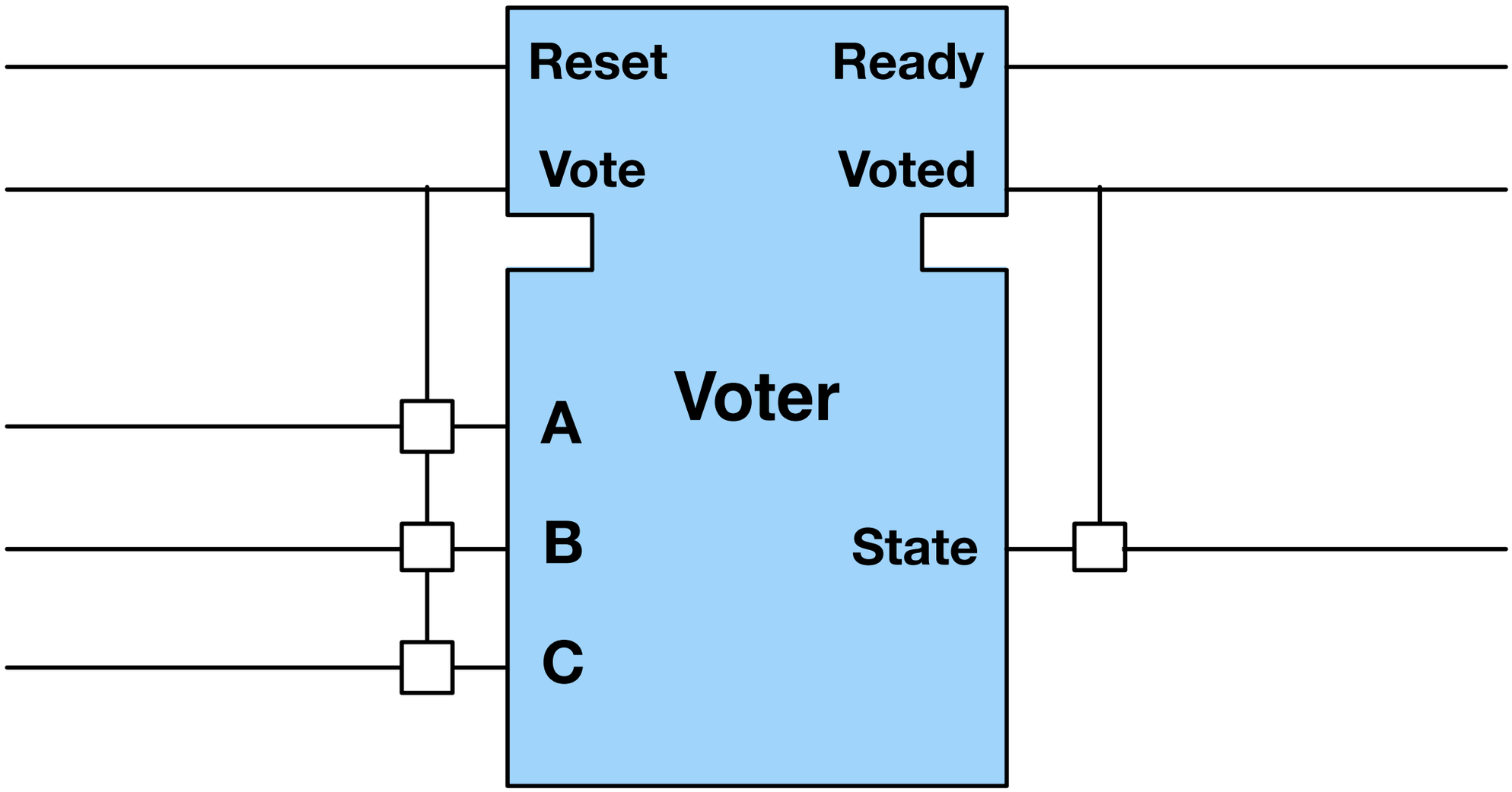
GEFÖRDERT VOM
Bundesministerium
für Bildung
und Forschung

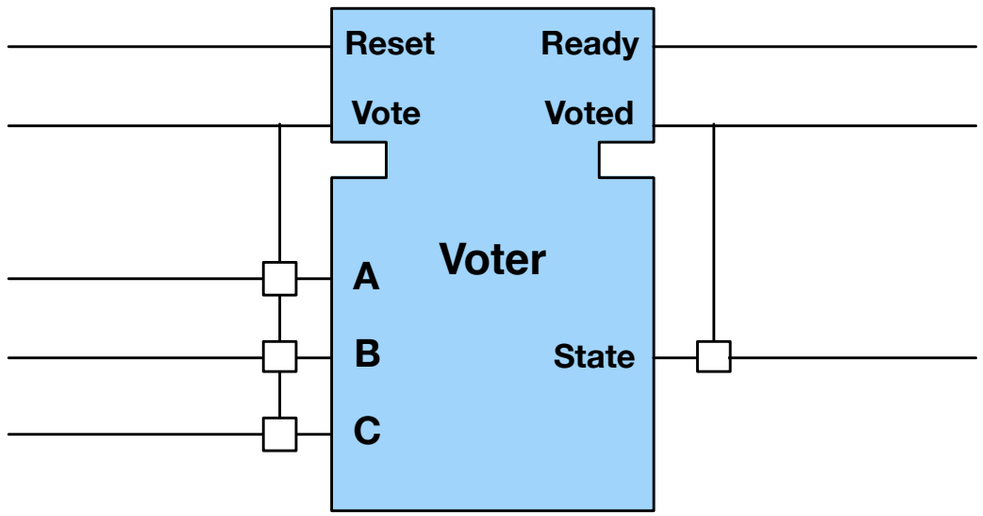
- Next Generation RFID System
- Industry 4.0, Smart Factory System
- Distributed data sharing and material routing in Erlang
- Programmability by PLC Programmers
- Research Project: Cyber-physical IT-Systems to handle the complexity of a new Generation of multi adaptive Factories

DLR
PT-SW des BMBF



Distributed PLC with IEC61499



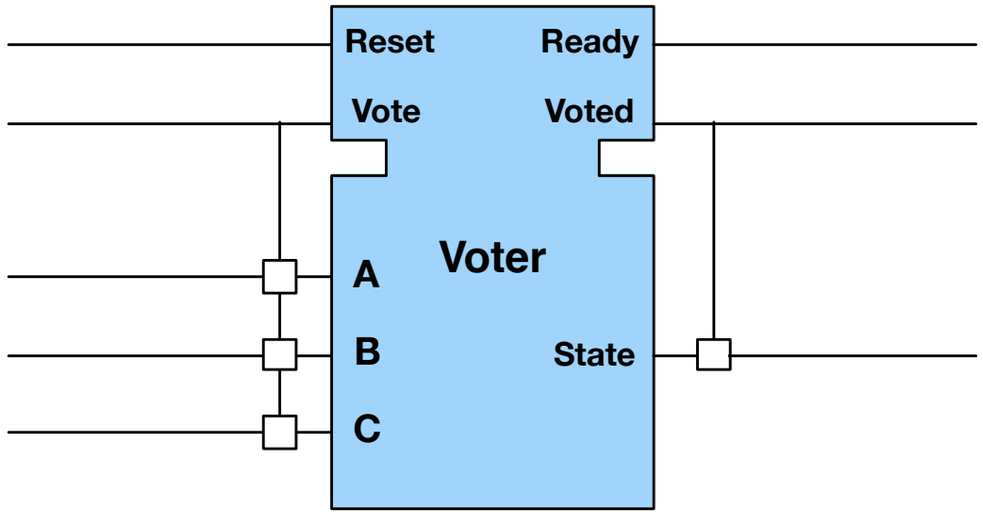



```
FUNCTION_BLOCK VOTER

EVENT_INPUT
    Reset;
    Vote WITH A, B, C;
END_EVENT

EVENT_OUTPUT
    Ready;
    Voted WITH State;
END_EVENT
```

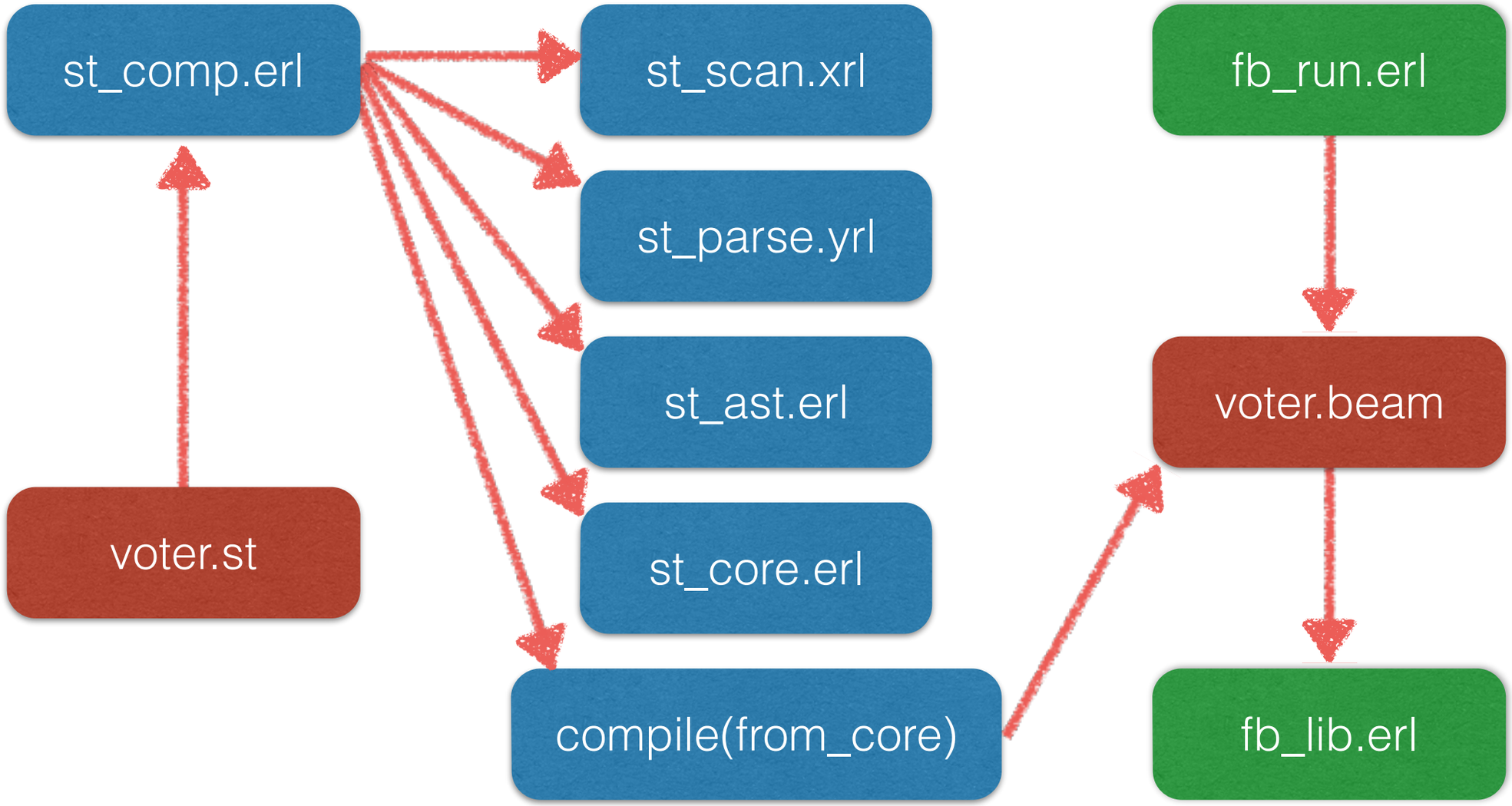
```
VAR_INPUT
    A : BOOL;
    B : BOOL;
    C : BOOL;
END_VAR
VAR_OUTPUT
    State : BOOL;
END_VAR
```



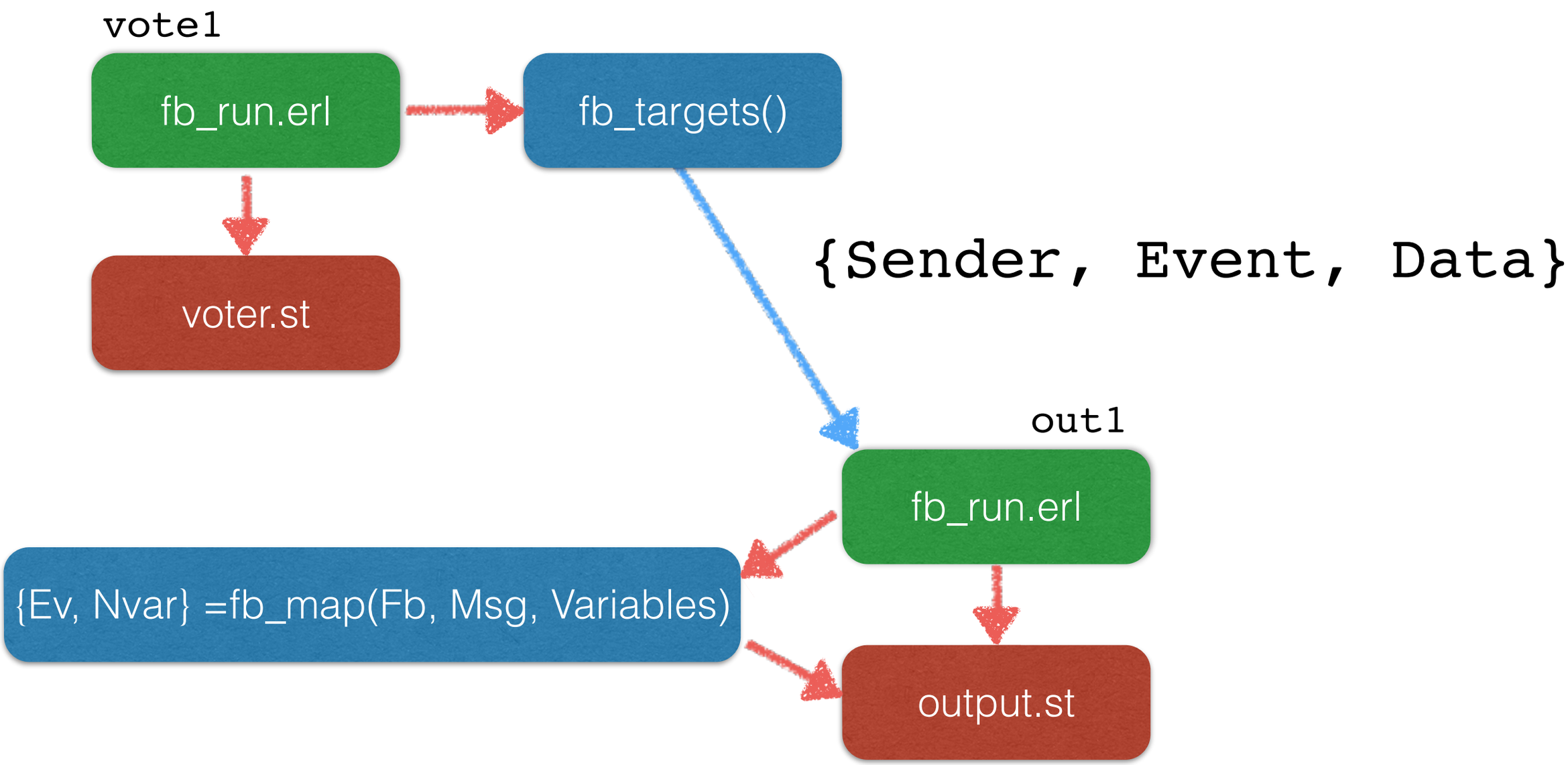

```
EC_STATES
    Ready : ResetAlg -> Ready;
    Voted : VoteAlg -> Voted;
END_STATES
EC_TRANSITIONS
    Ready TO Voted := Vote;
    Voted TO Voted := Vote;
    Voted TO Ready := Reset;
END_TRANSITIONS
```

```
ALGORITHM ResetAlg IN ST;
    State := 0;
END_ALGORITHM
ALGORITHM VoteAlg IN ST;
    IF State = 0 THEN
        State := (A AND B) OR (B AND C)
                 OR (A AND C);
    END_IF;
END_ALGORITHM
```

IEC61499 Compiler



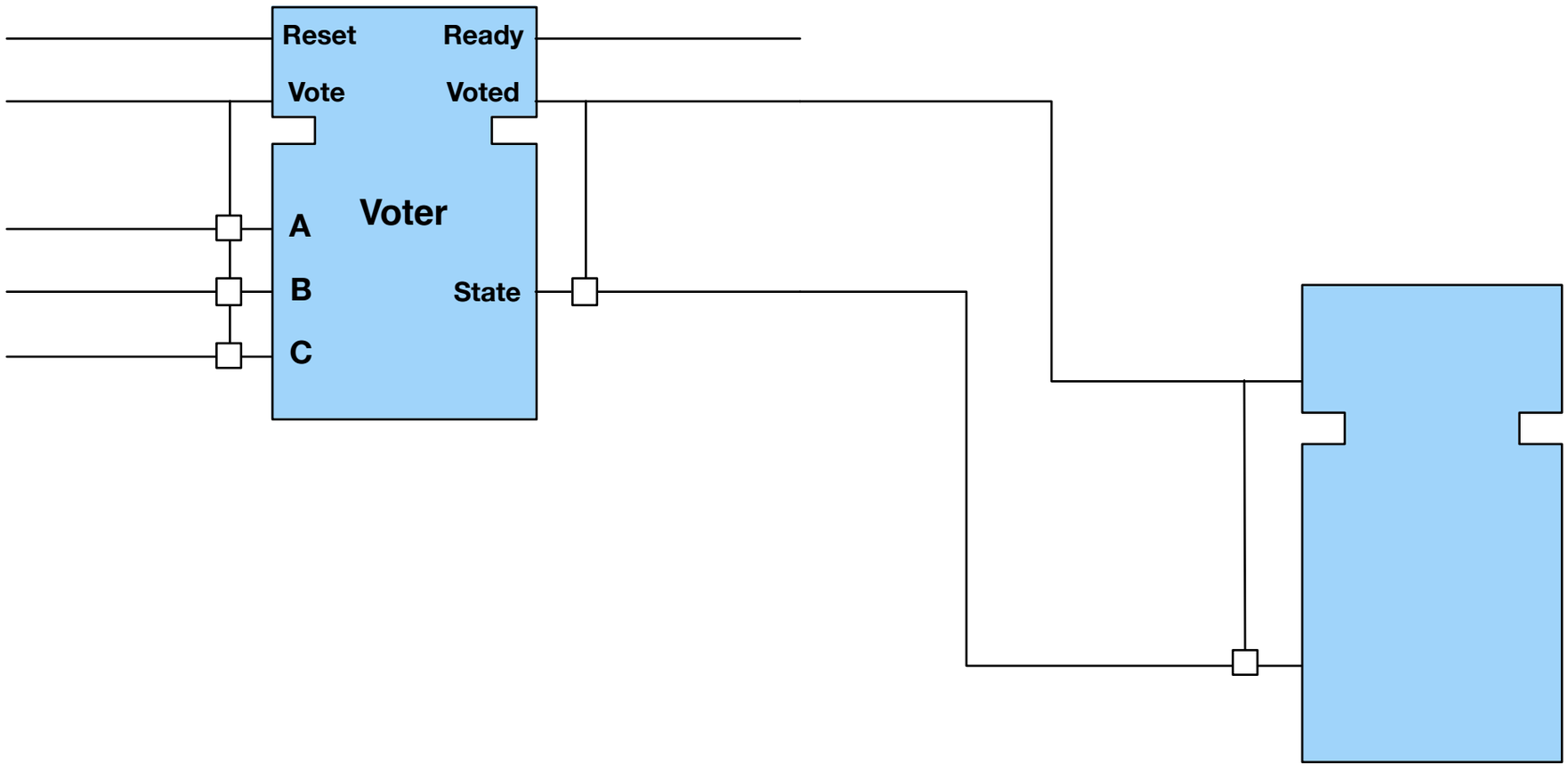
Mapping on Processes



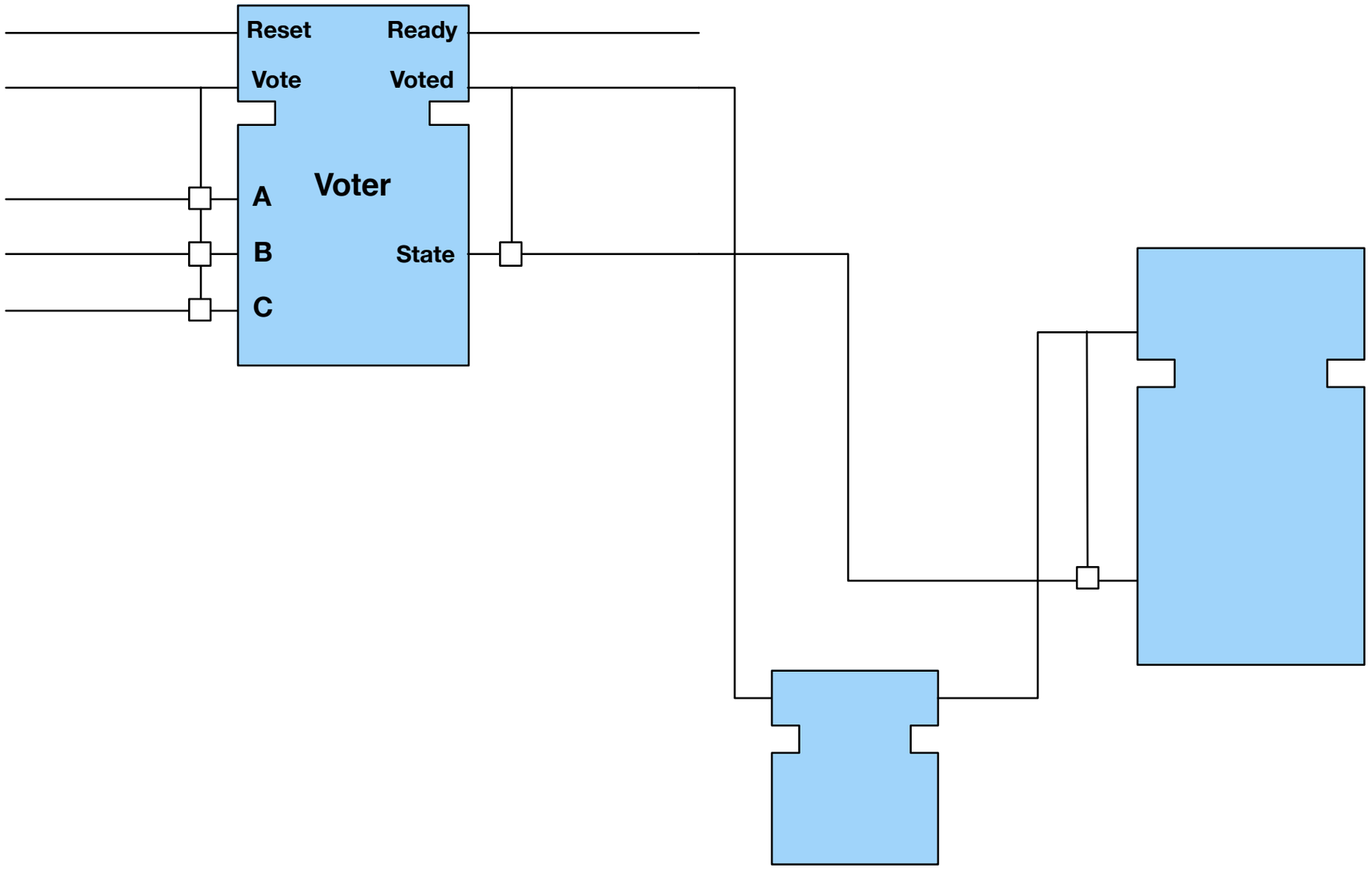
Core Erlang Tips

- `cerl:abstract/1`
- Use version of **`core_lint.erl`** with extra io calls uncommented
- `compile:forms(Core_ast, [from_core, `**`report`**`, verbose, `**`clint0`**`])`

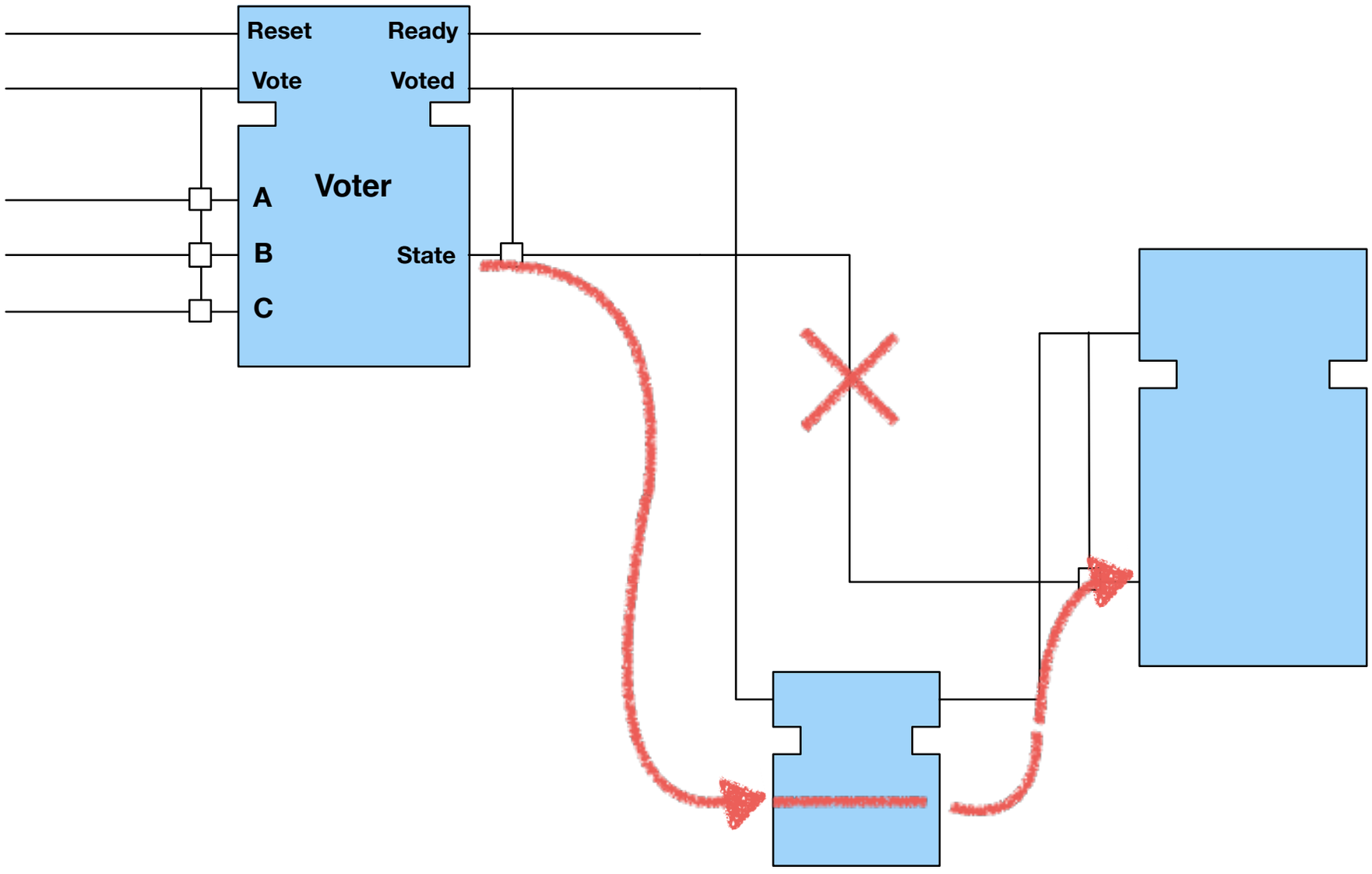
Event flows with Data



Events and Data diverge



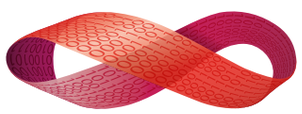
Mending Dataflow



Demo

RTEMS Realtime Operating System

- For Hard-Real-Time and/or Embedded Applications
- Small Resource Usage
  - ≥ 32KB RAM, ≥ 96KB ROM, ≥ 12 MHz Clock
- Reliable Realtime Behaviours with pluggable Schedulers
  - Context switch 10µs on 25MHz MC68360
- Posix API (among others)



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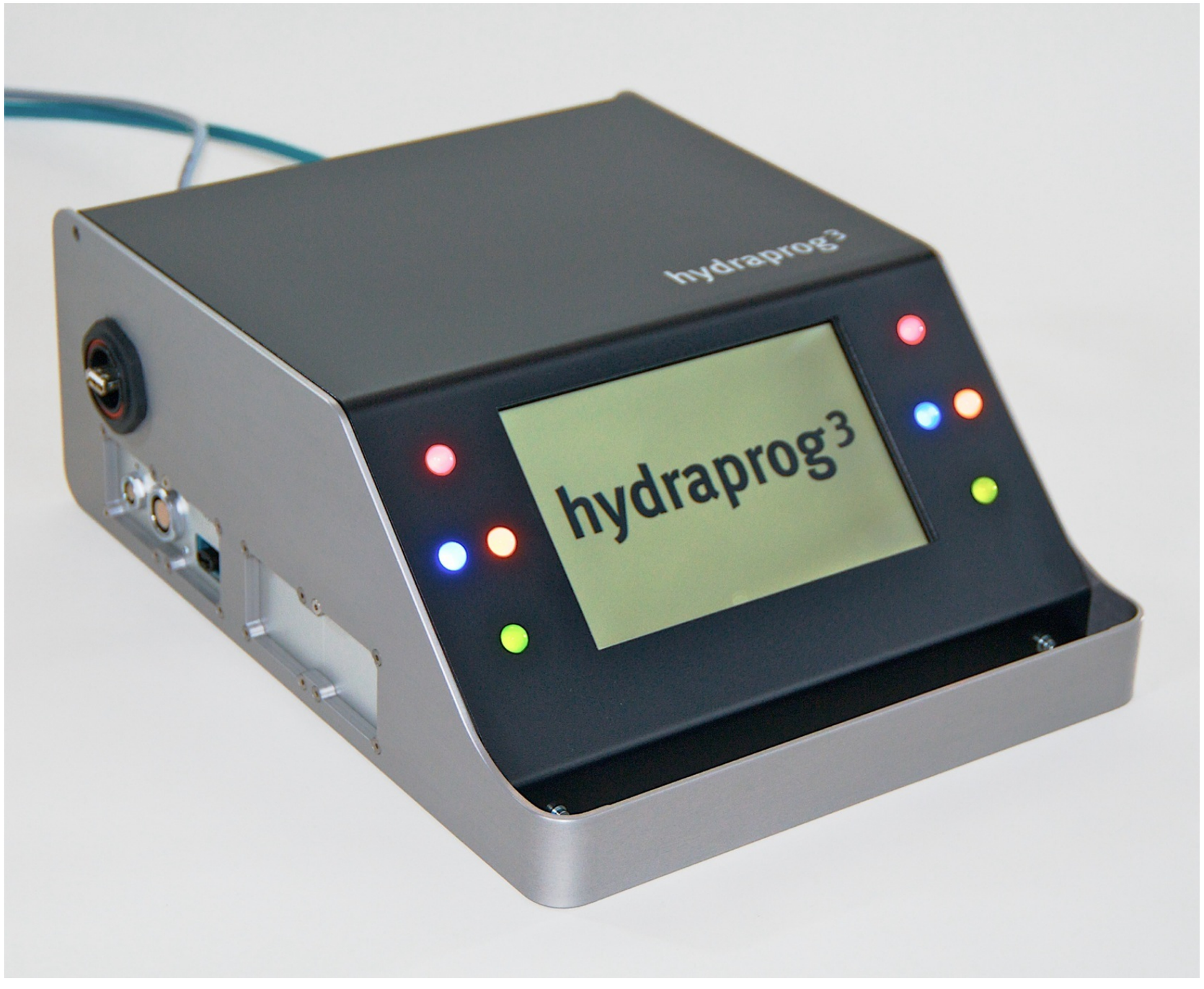
- Processes are actually Threads
- No virtual memory
- No memory protection
- Runs on basically all 32bit Architectures (and some 16bit)
- Can be ported to everything ≥ 32 Bit
- SMP Support
- http://www.rtems.org


hydraprog3
hydraprog3


hydraprog3


Hydraprog 3
Net 1
Net 2
Net 3
Main Pwr


X1
X2
HP3 GW-LCFM
X3

Mainboard
Mini ITX
Intel Atom
FreeBSD, Erlang

Gateways
custom
Freescale
MPC5517
RTEMS

Ethernet

USB

USB

Ethernet Switch / USB Hub

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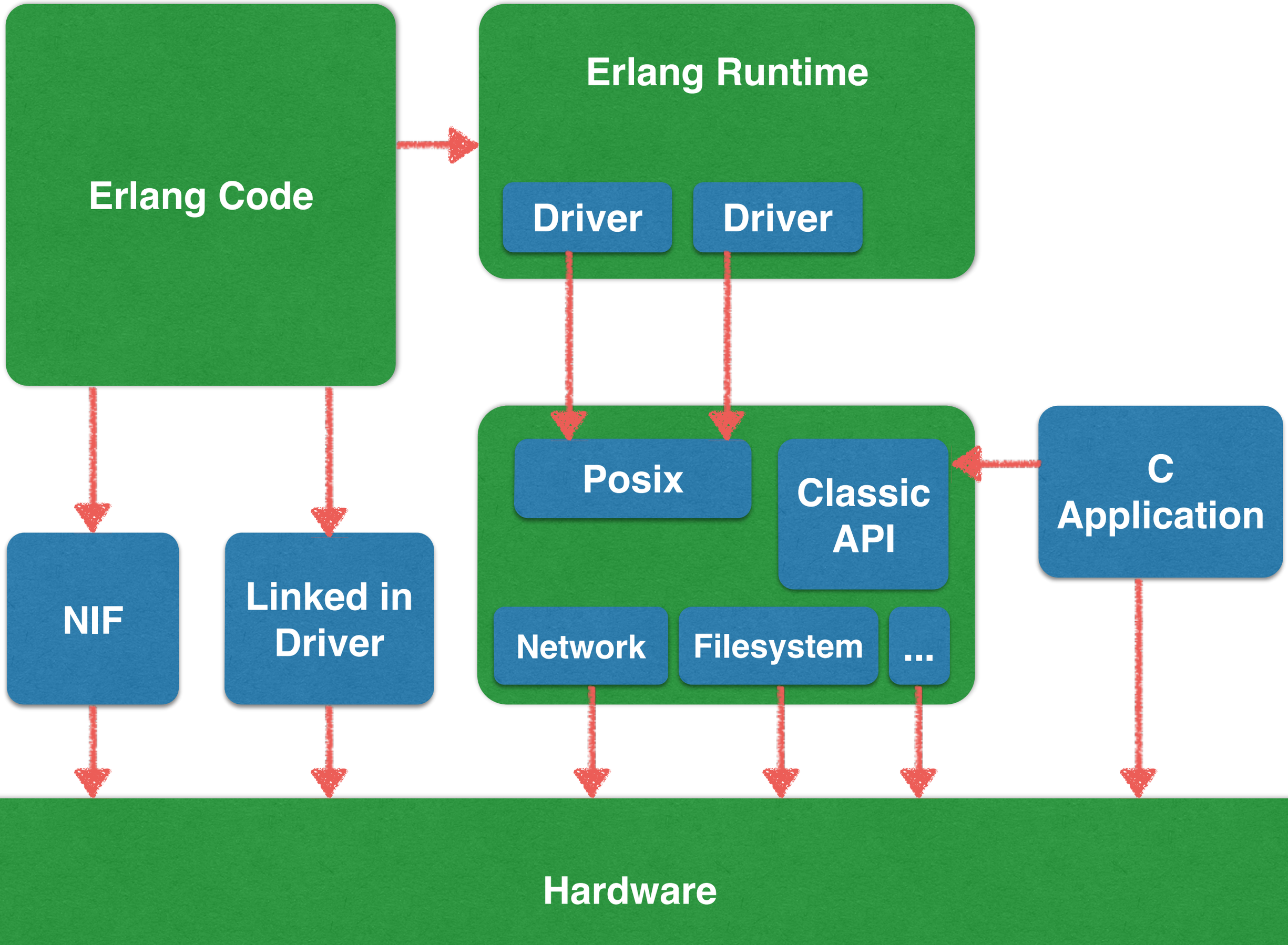
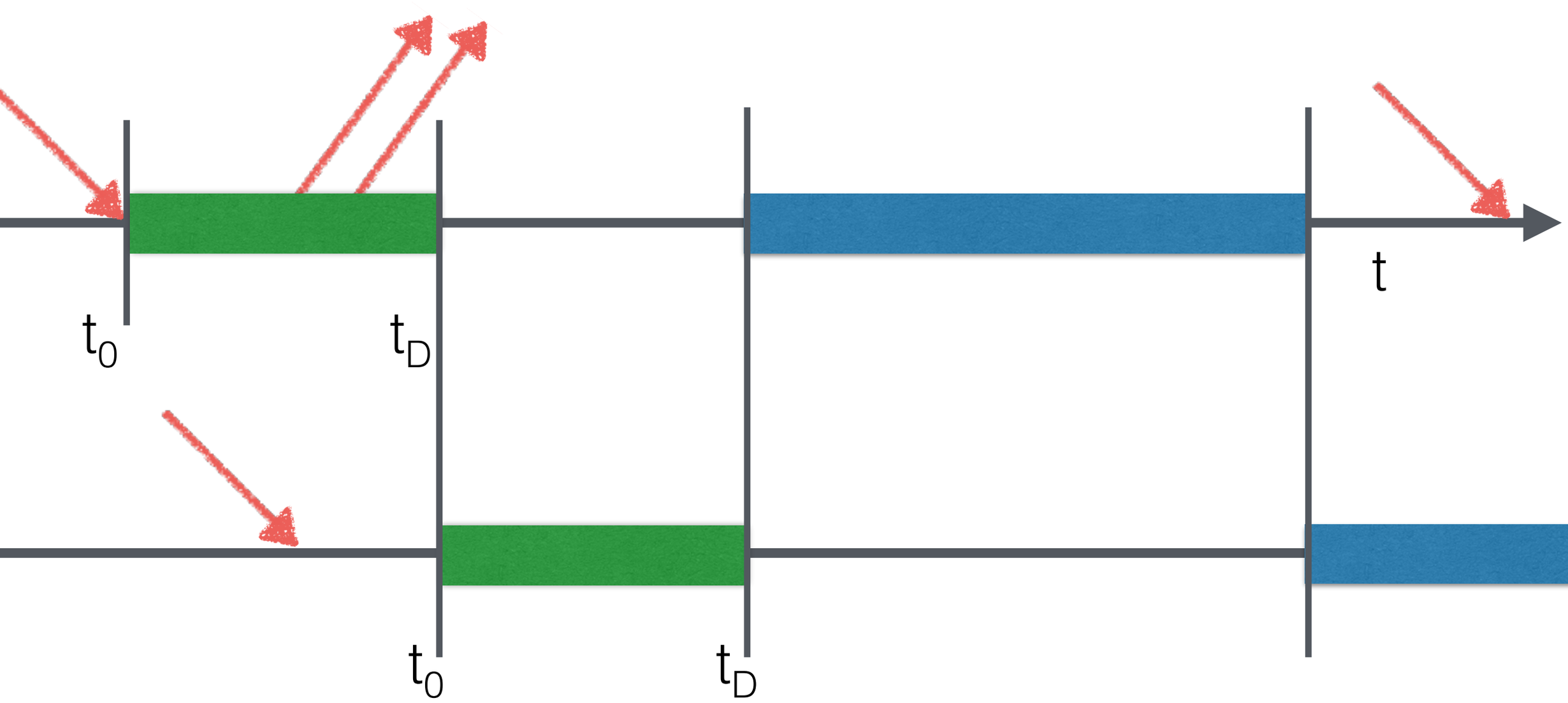
www.grisp.org


Erlang Code
Erlang Runtime
Driver
Driver
Posix
Classic API
C Application
Network
Filesystem
...
NIF
Linked in Driver
Hardware

Demo

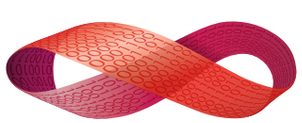
Hard Realtime Erlang Processes

Earliest Deadline First



Hard Realtime Erlang Processes

- Fixed two part Heaps
- Optional interruptible GC
- Crash on Deadline Miss or out of Heap
- Optional Auto-Restart
- Static analysis on Communication Graph



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Thanks to

- For funding the Erlang and RTEMS port IEC61499 compiler and being a great partner for innovations like this:

Rexroth
Bosch Group
The Drive & Control Company

- For great RTEMS support, nice hardware design and helping out with the RTEMS Intro slides

embedded brains GmbH®

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