TERMA

Naval & Communication Systems

Aerospace

Space

Air defense

Radar Systems

Manufacturing Division

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Radar Systems Division

Surface Movement Radar Sensor Systems

VTS & Coastal Surveillance

Ship Radar Systems

Airborne Surveillance Systems

Air Traffic Management

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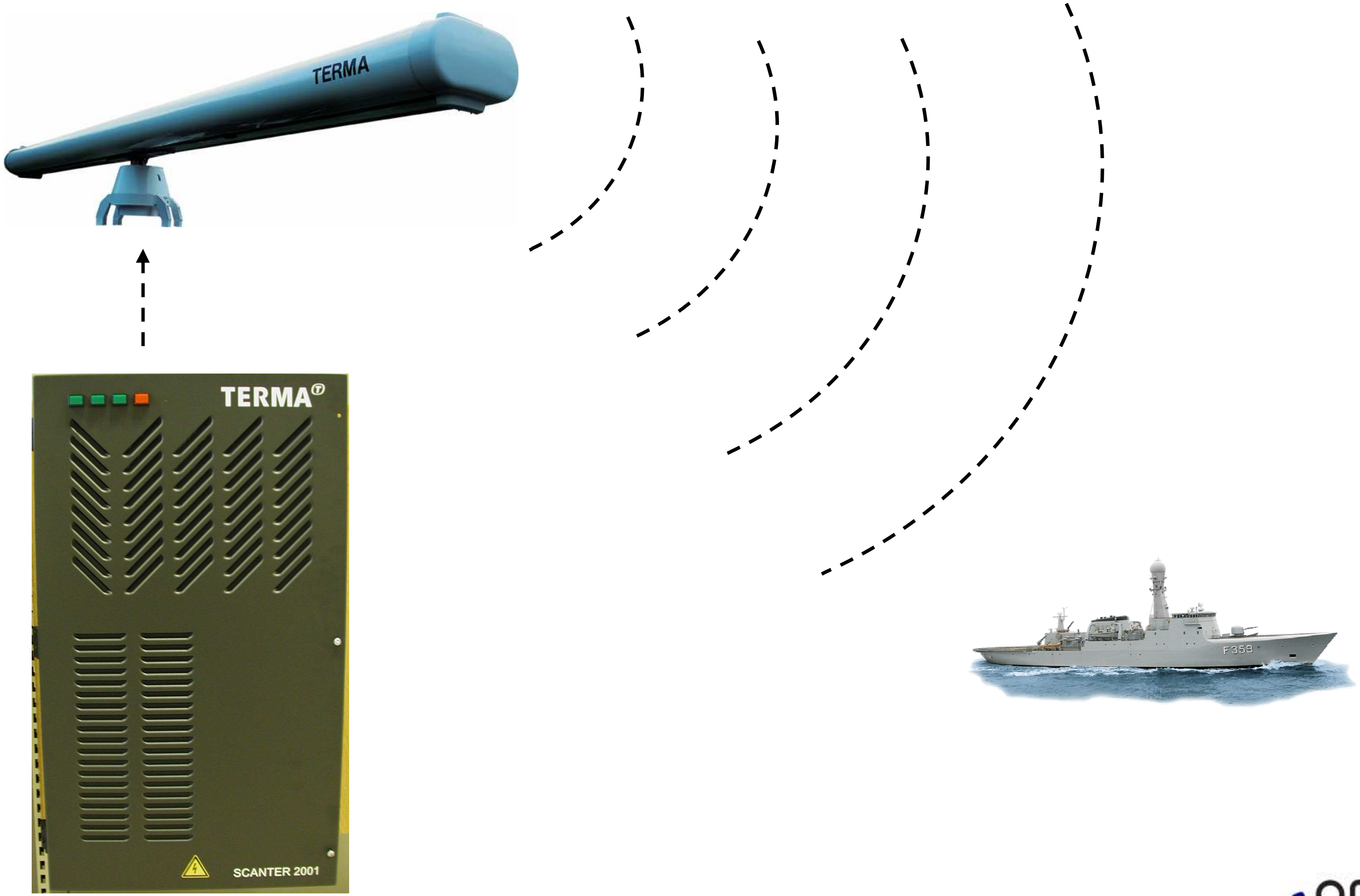
Radar Principles



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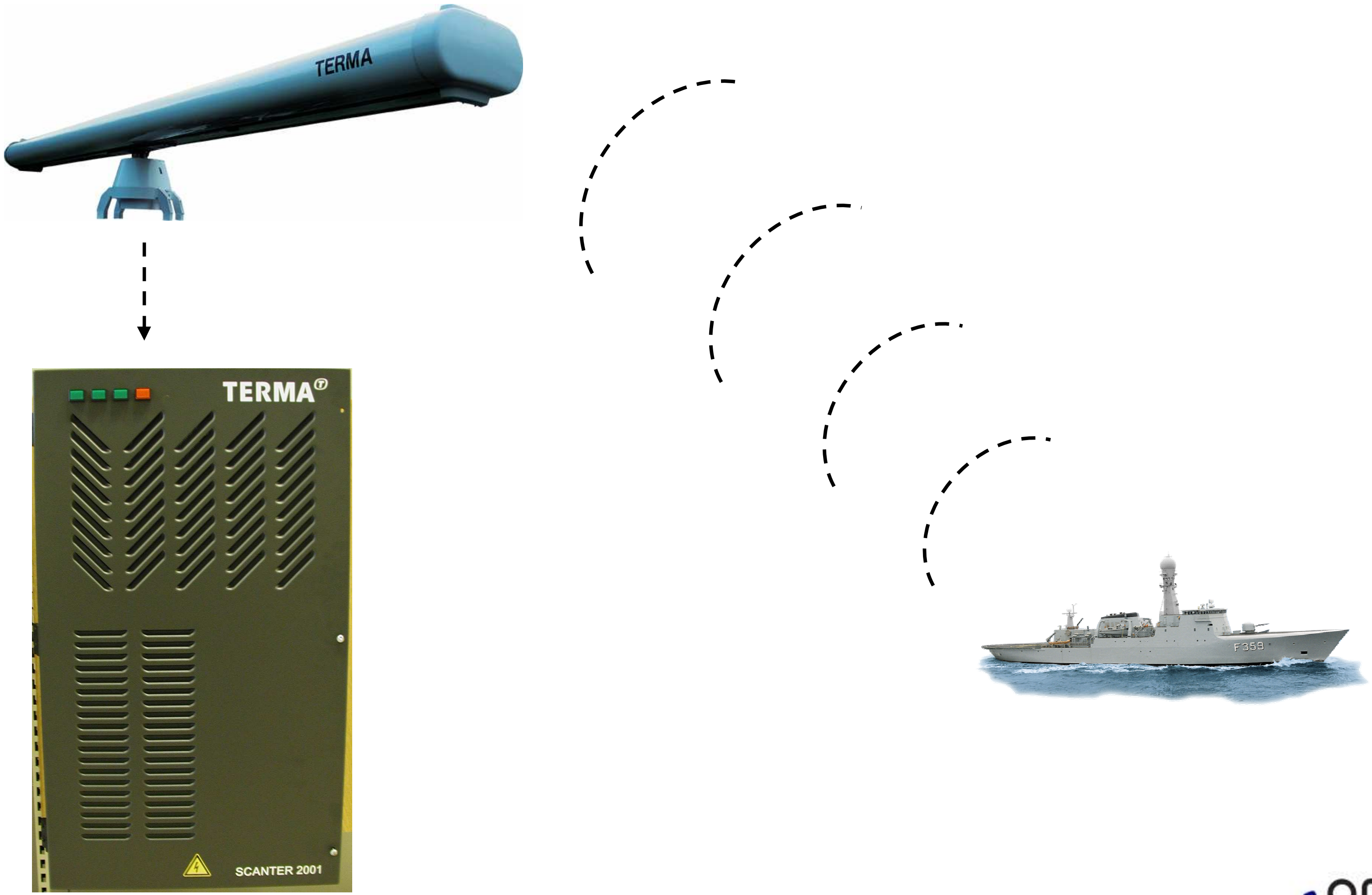
Radar Principles



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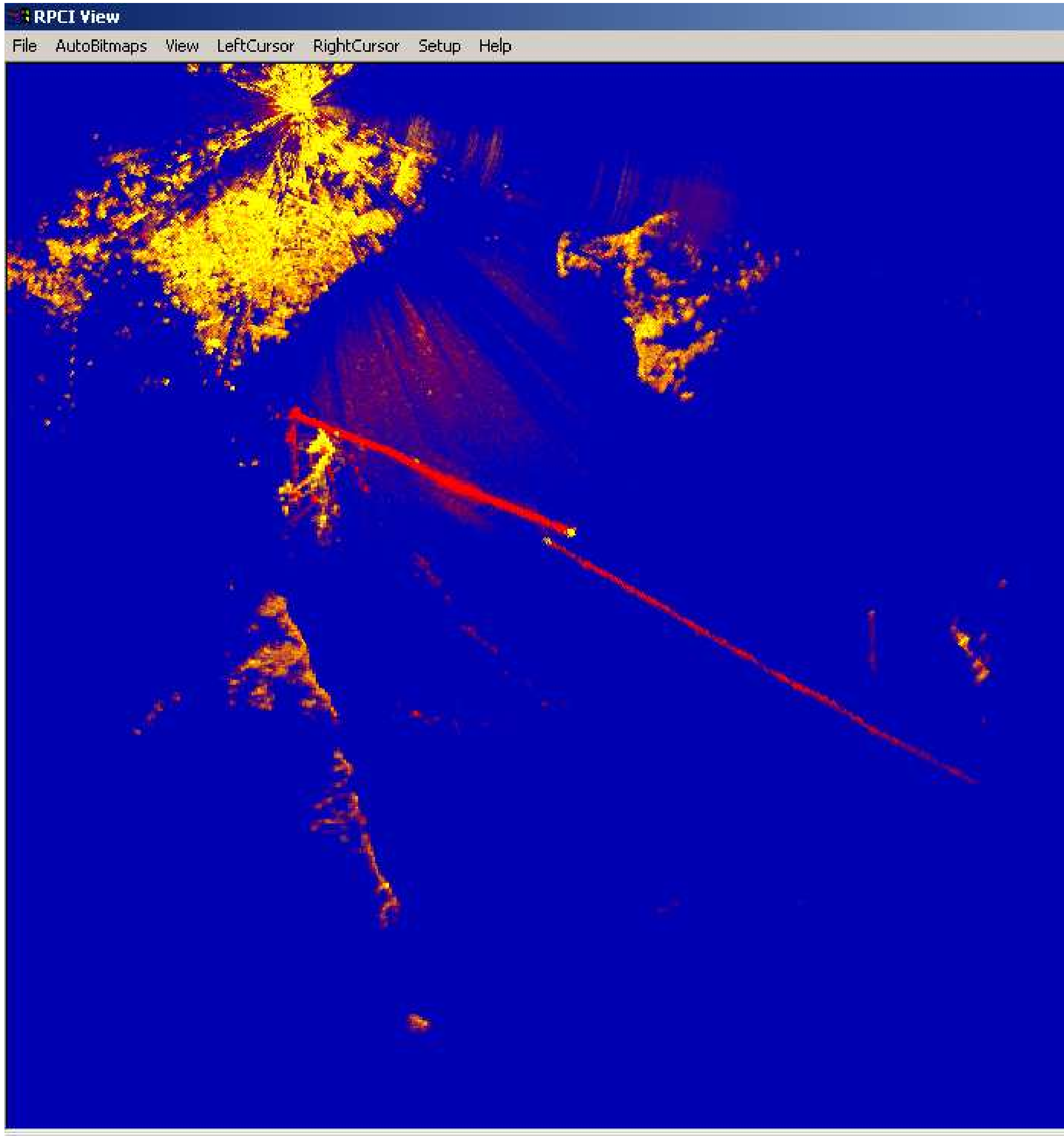
Difficulties

- Clutter
  - Rain
  - Sea
  - Ground / buildings
- Random noise
- Other radars



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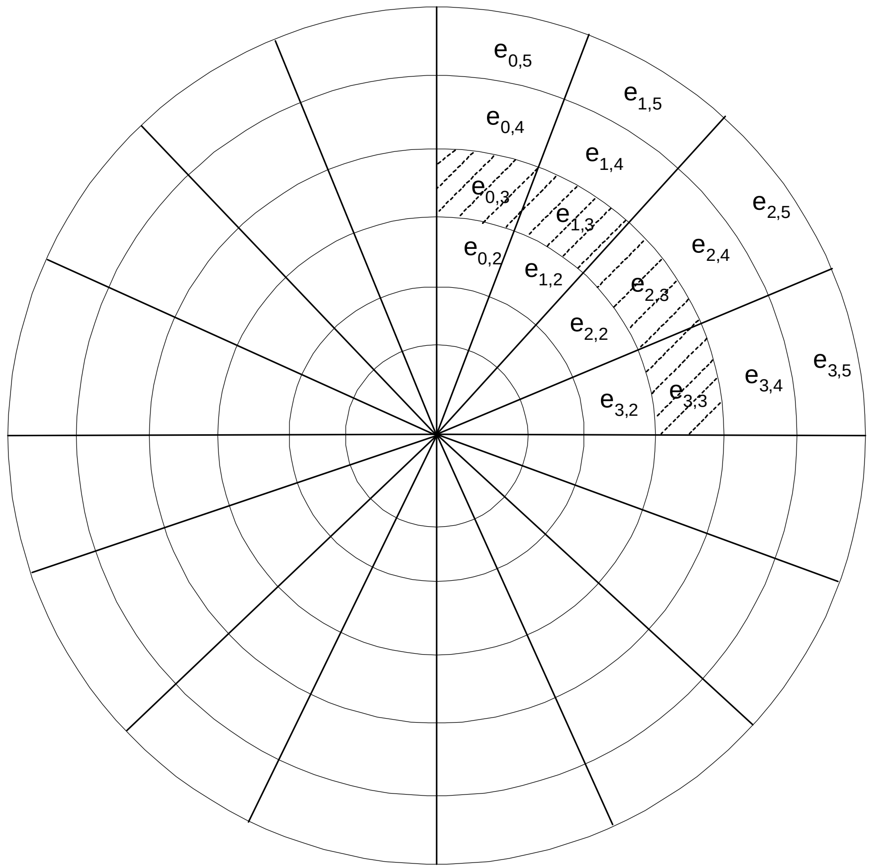
Sweep Integration

- Beam width of antenna, app. 0.4 deg



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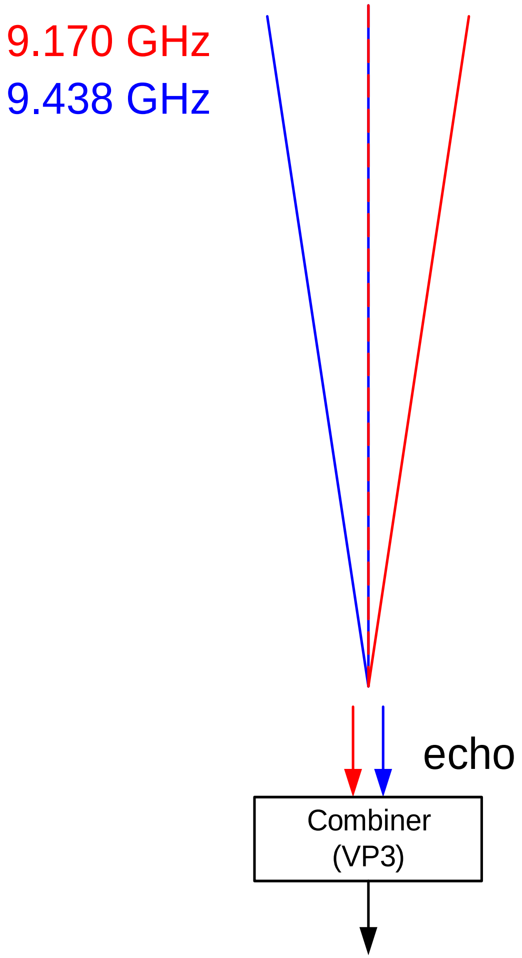
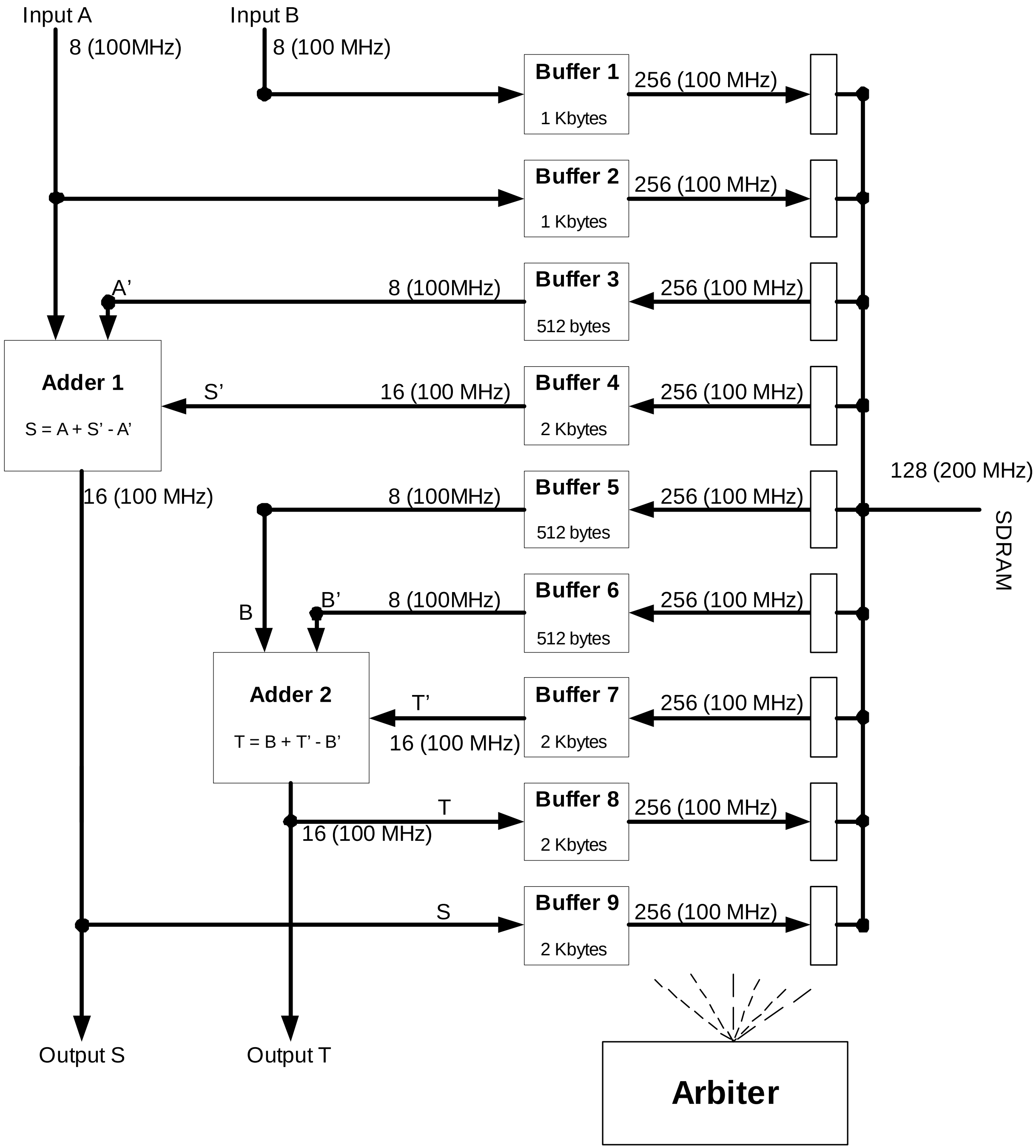
Frequency Diversity



- Increased power
- Time delay between echos (clutter change over time)
- Different frequencies



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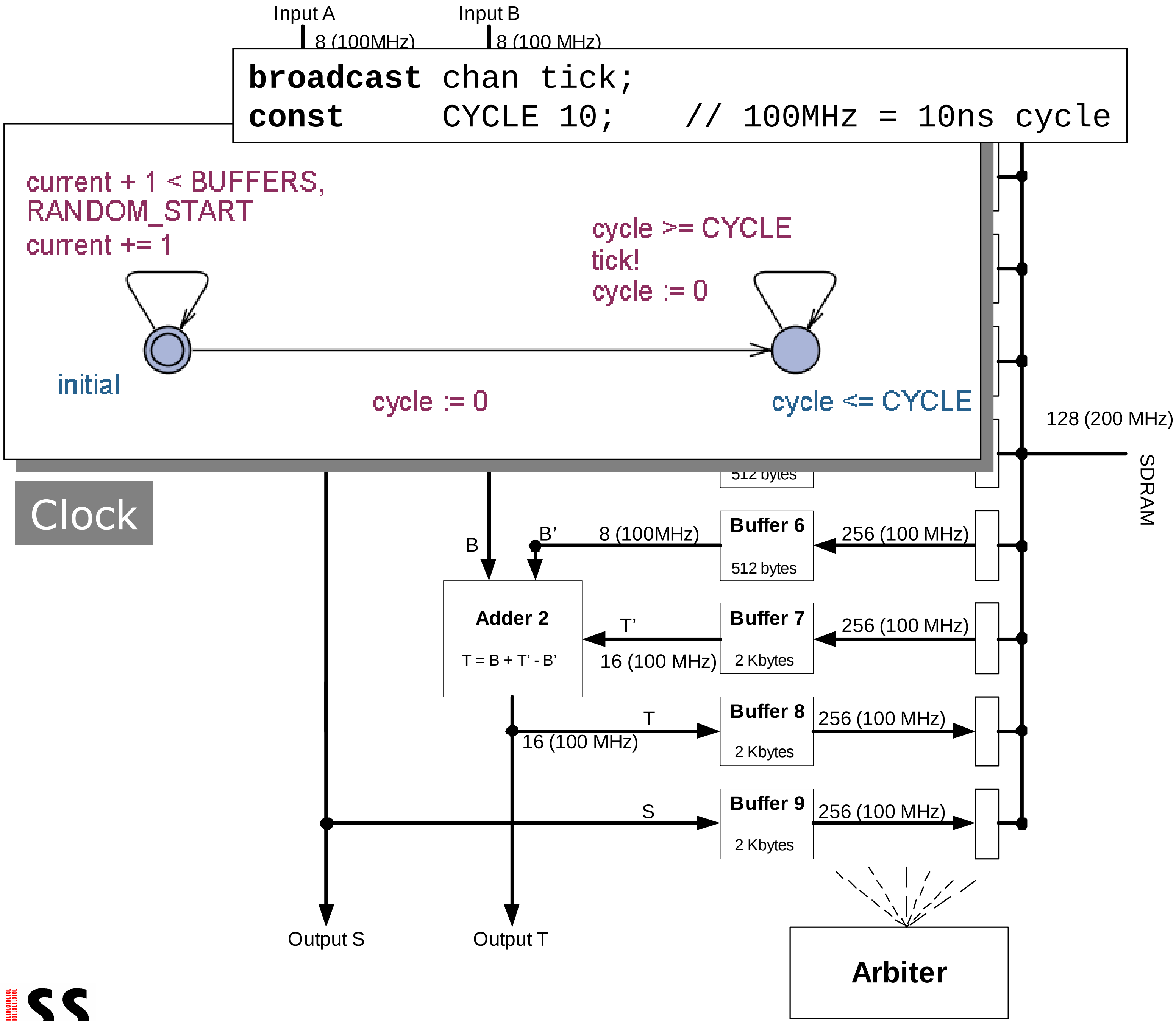
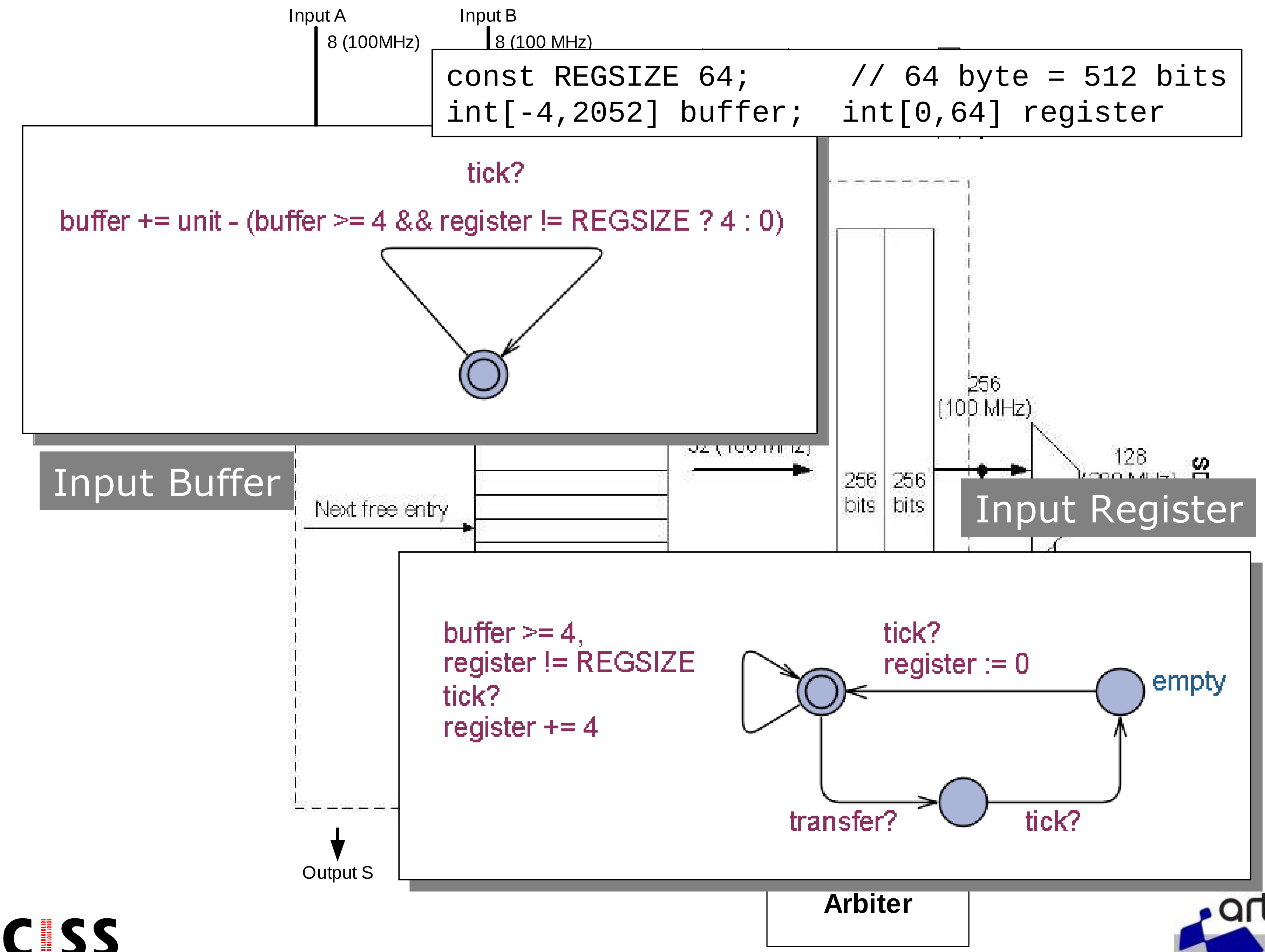
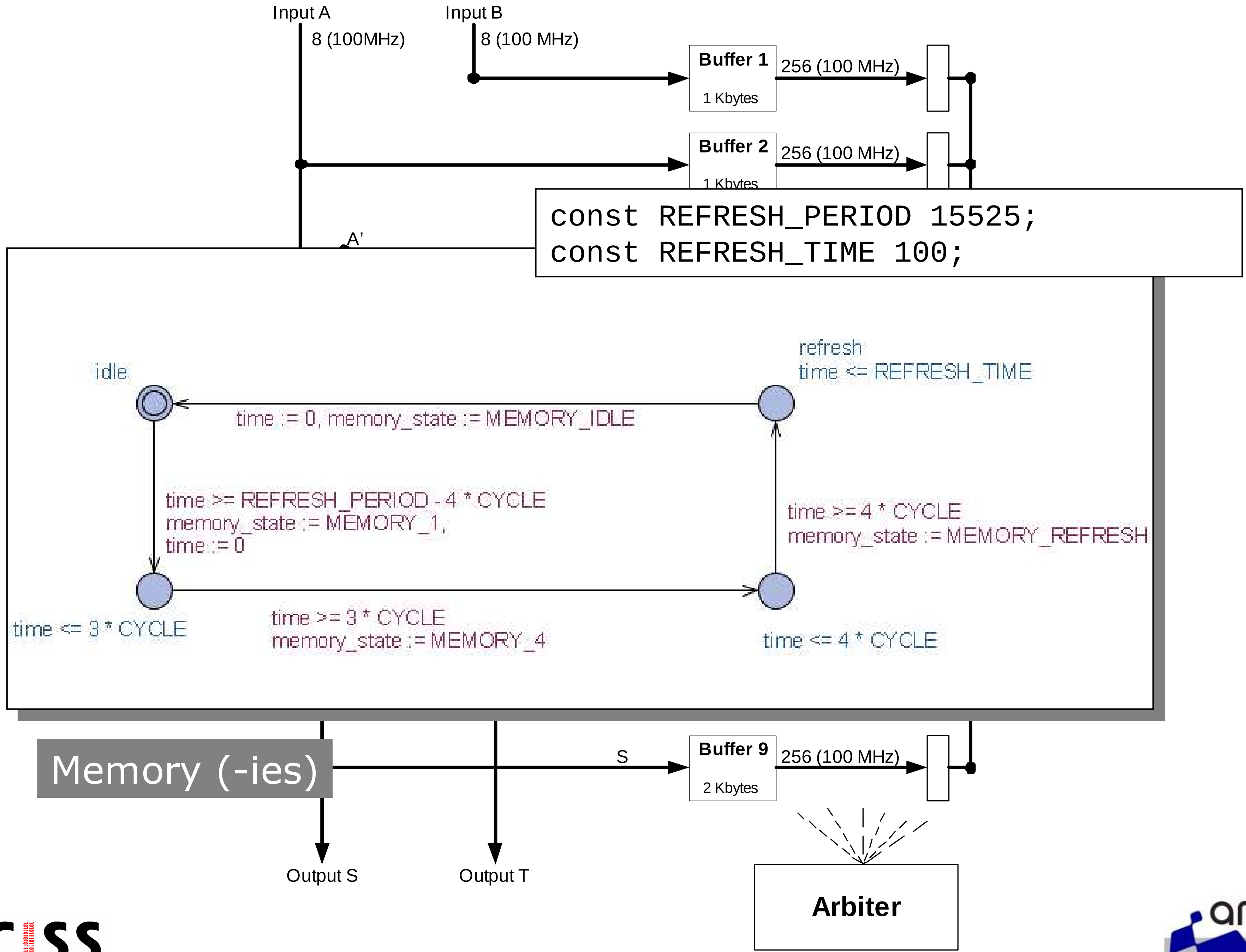
```
broadcast chan tick;
const     CYCLE 10;    // 100MHz = 10ns cycle
```




Input A
8 (100MHz)
Input B
8 (100 MHz)
const REGSIZE 64; // 64 byte = 512 bits
int[-4,2052] buffer; int[0,64] register
tick?
buffer += unit - (buffer >= 4 && register != REGSIZE ? 4 : 0)
Input Buffer
Next free entry
256 bits
256 bits
256
(100 MHz)
128
Input Register
buffer >= 4,
register != REGSIZE
tick?
register += 4
tick?
register := 0
empty
transfer?
tick?
Output S
Arbiter



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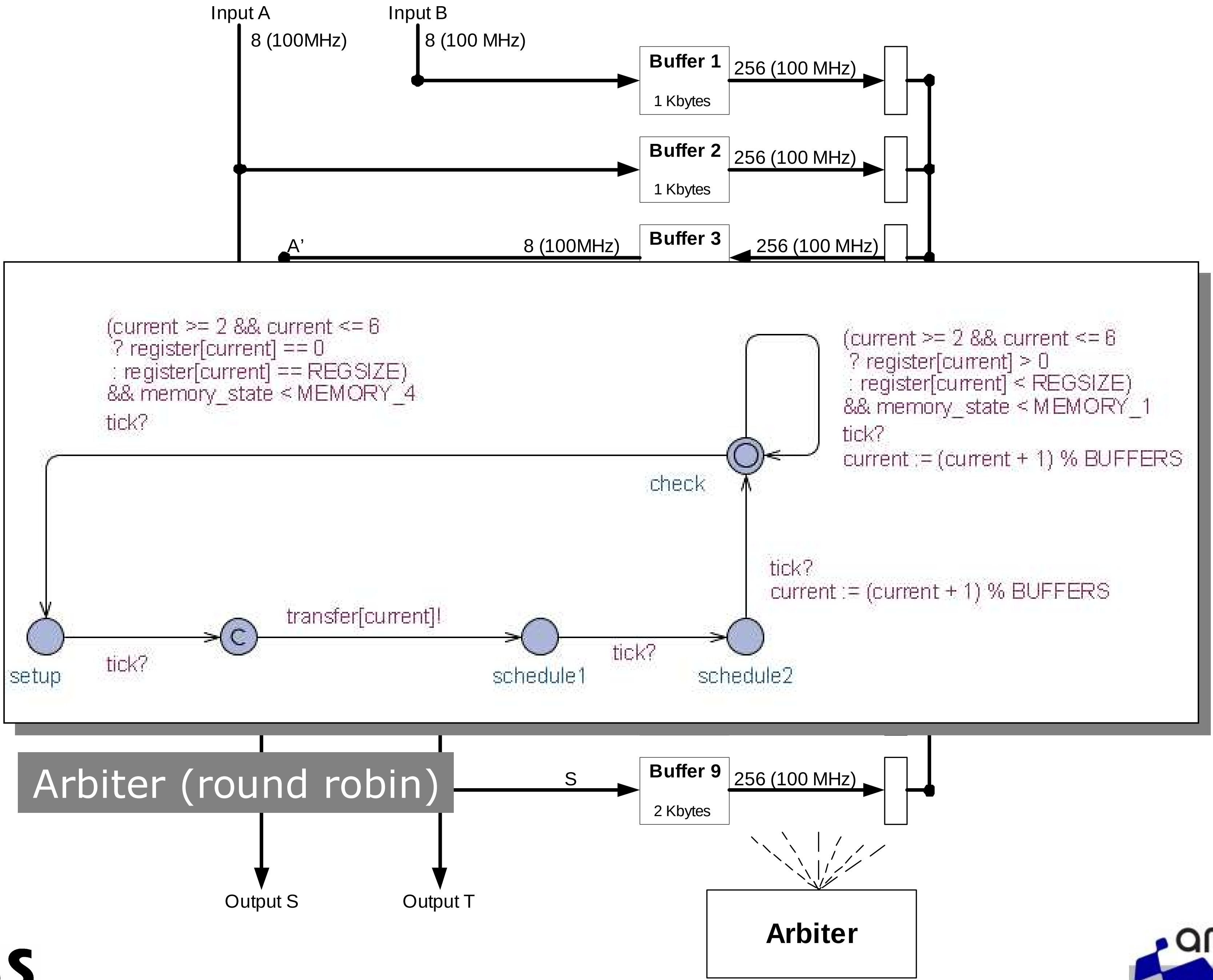
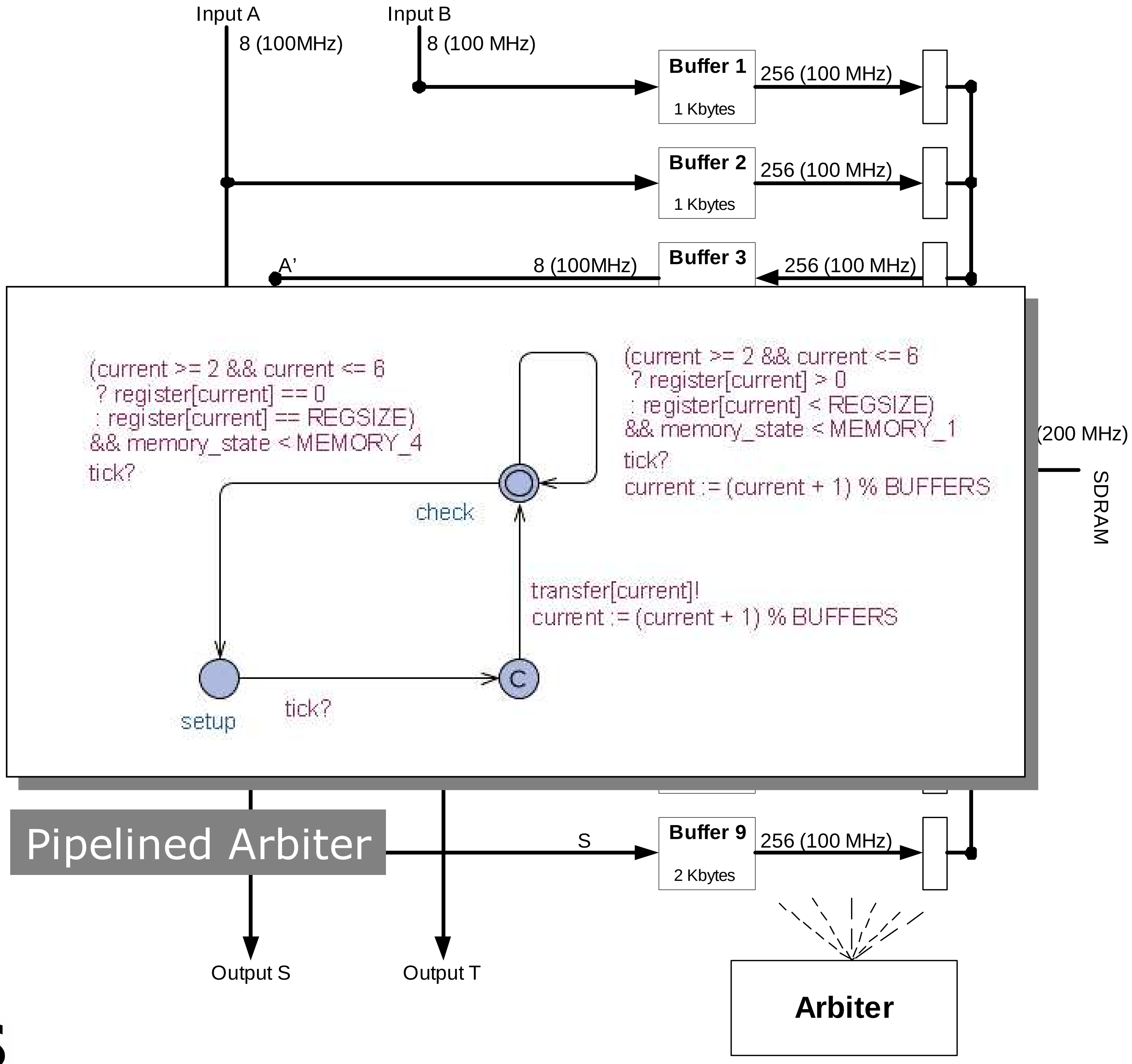

Input A
8 (100MHz)
Input B
8 (100 MHz)
Buffer 1
1 Kbytes
256 (100 MHz)
Buffer 2
1 Kbytes
256 (100 MHz)
A'
8 (100MHz)
Buffer 3
256 (100 MHz)
(current >= 2 && current <= 6
? register[current] == 0
: register[current] == REGSIZE)
&& memory_state < MEMORY_4
tick?
(current >= 2 && current <= 6
? register[current] > 0
: register[current] < REGSIZE)
&& memory_state < MEMORY_1
tick?
current := (current + 1) % BUFFERS
check
tick?
current := (current + 1) % BUFFERS
transfer[current]!
C
setup
tick?
schedule1
tick?
schedule2
Arbiter (round robin)
S
Buffer 9
2 Kbytes
256 (100 MHz)
Output S
Output T
Arbiter

Pipelined Arbiter



Conclusions

- Final UPPAAL model 21 timed automata and 20 integer variables.
- UPPAAL verifies (< 1 min) that the used “round-robin” scheduler is CORRECT in the sense that no buffer over-flows or under-flows.
- Synthesis of scheduler optimal in terms of minum buffer size (6 bytes) (Juhan Ernits / Gera Weiss)
- Manual translation of VHDL descriptions to UPPAAL -- c(sh)ould be automated.

Much more to come …

DaNES

Danish Network for Intelligent Embedded Systems

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Dynamic Voltage Scaling

ANALOG DEVICES

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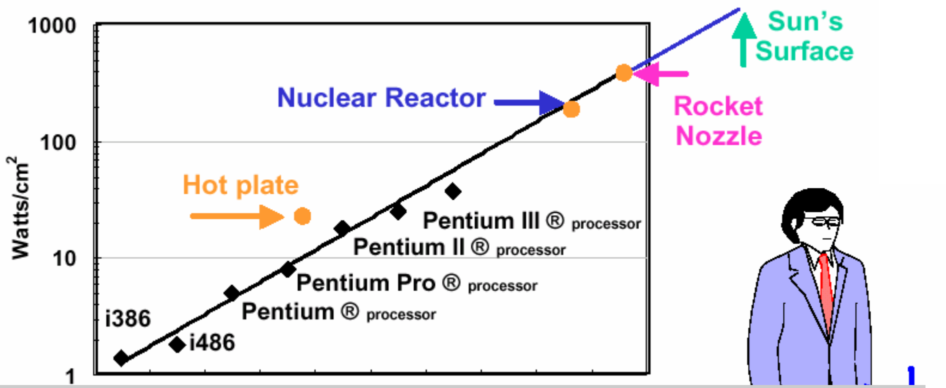
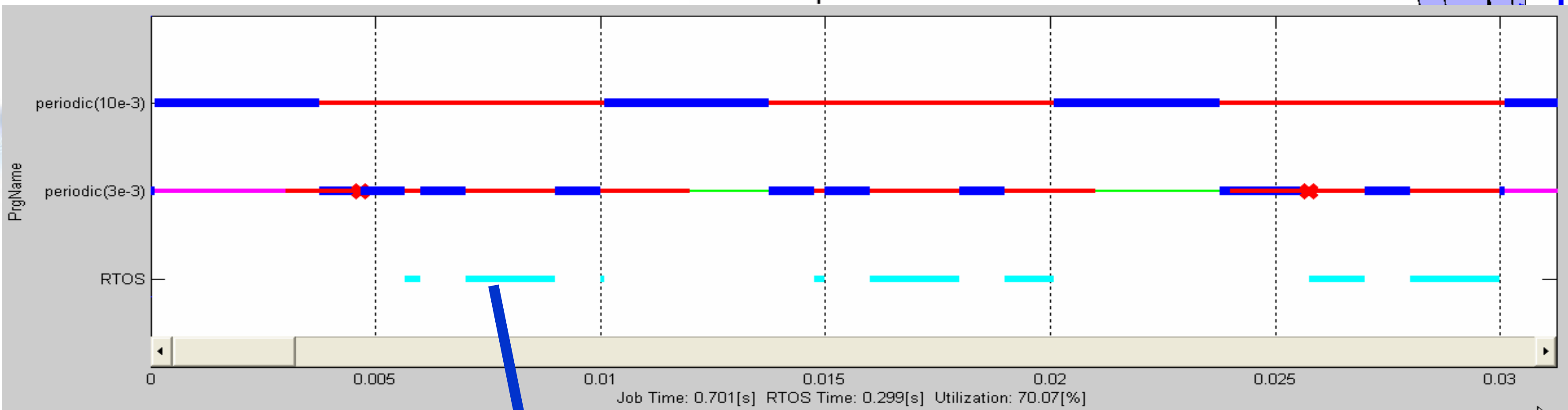
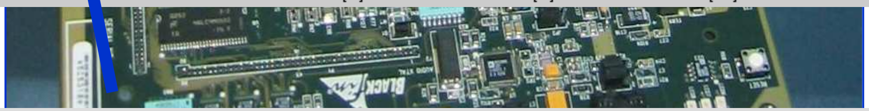
Power Management

Dynamic Voltage Scaling







Dynamically lower voltage supply (frequency) to utilize free CPU time

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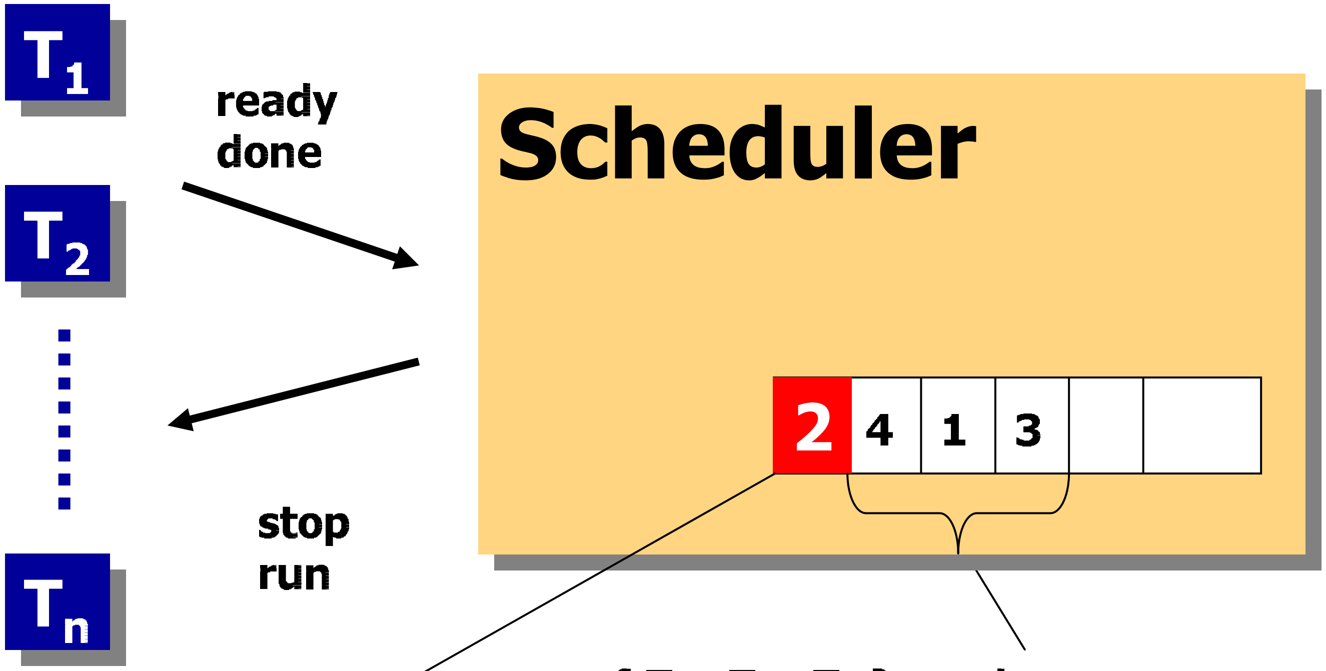
Task Scheduling

utilization of CPU

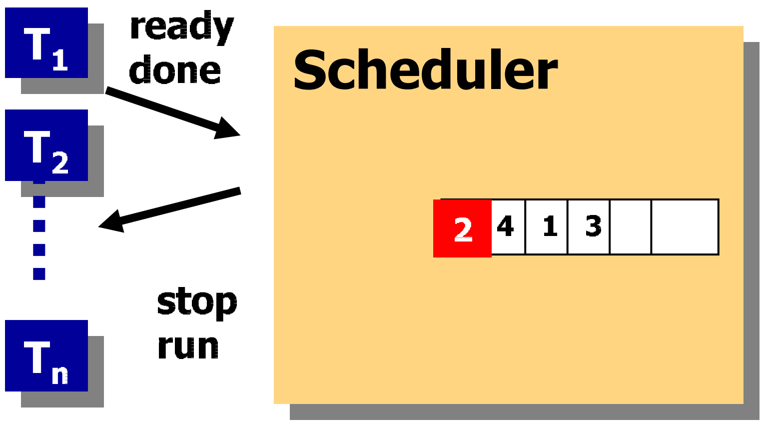
P(i), [E(i), L(i)], .. : period or earliest/latest arrival or .. for T_i
C(i): execution time for T_i
D(i): deadline for T_i

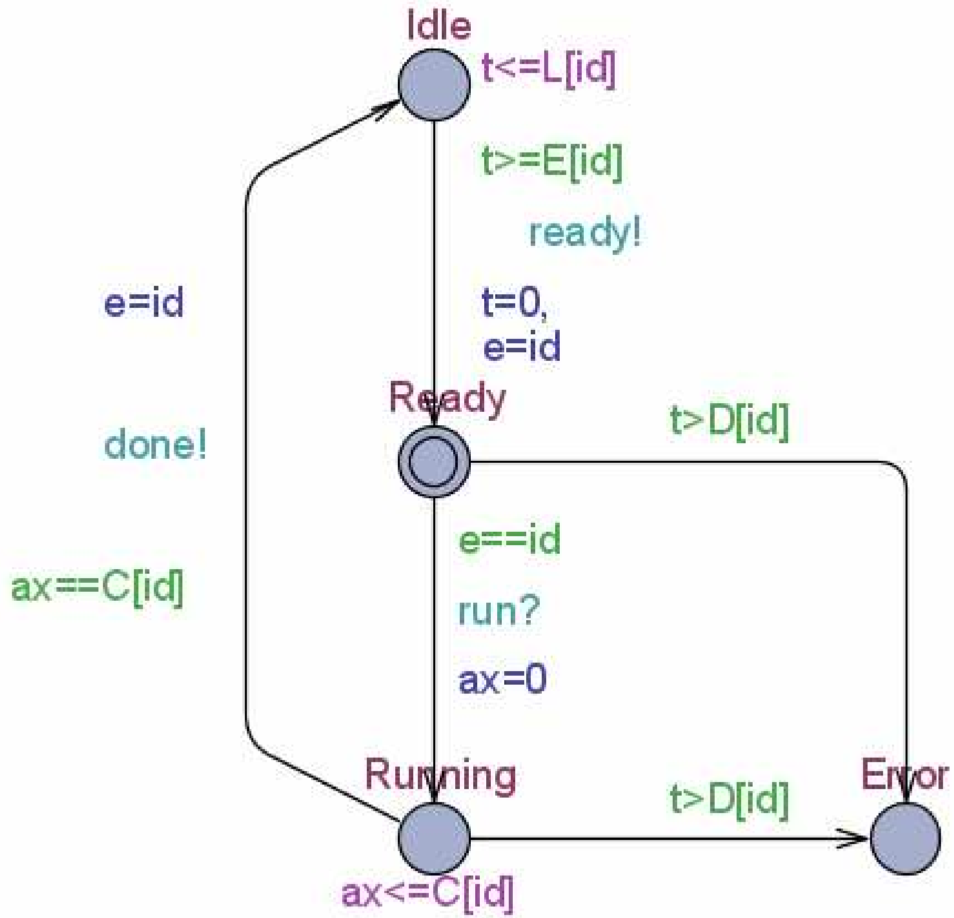


T_2 is running

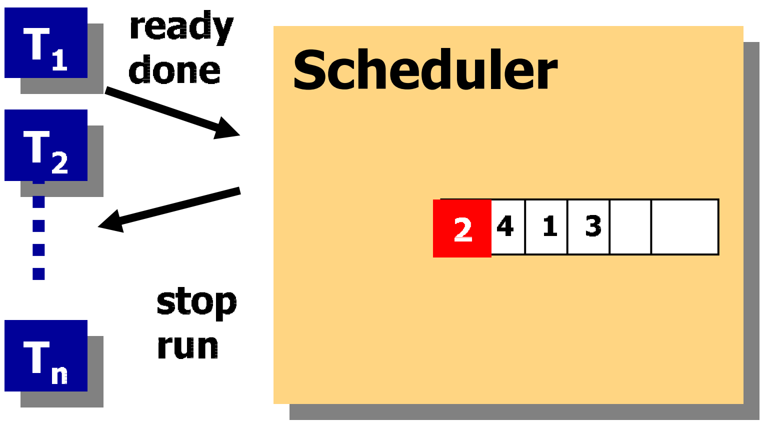
{ T_4 , T_1 , T_3 } ready
ordered according to some given priority:
(e.g. Fixed Priority, Earliest Deadline,..)

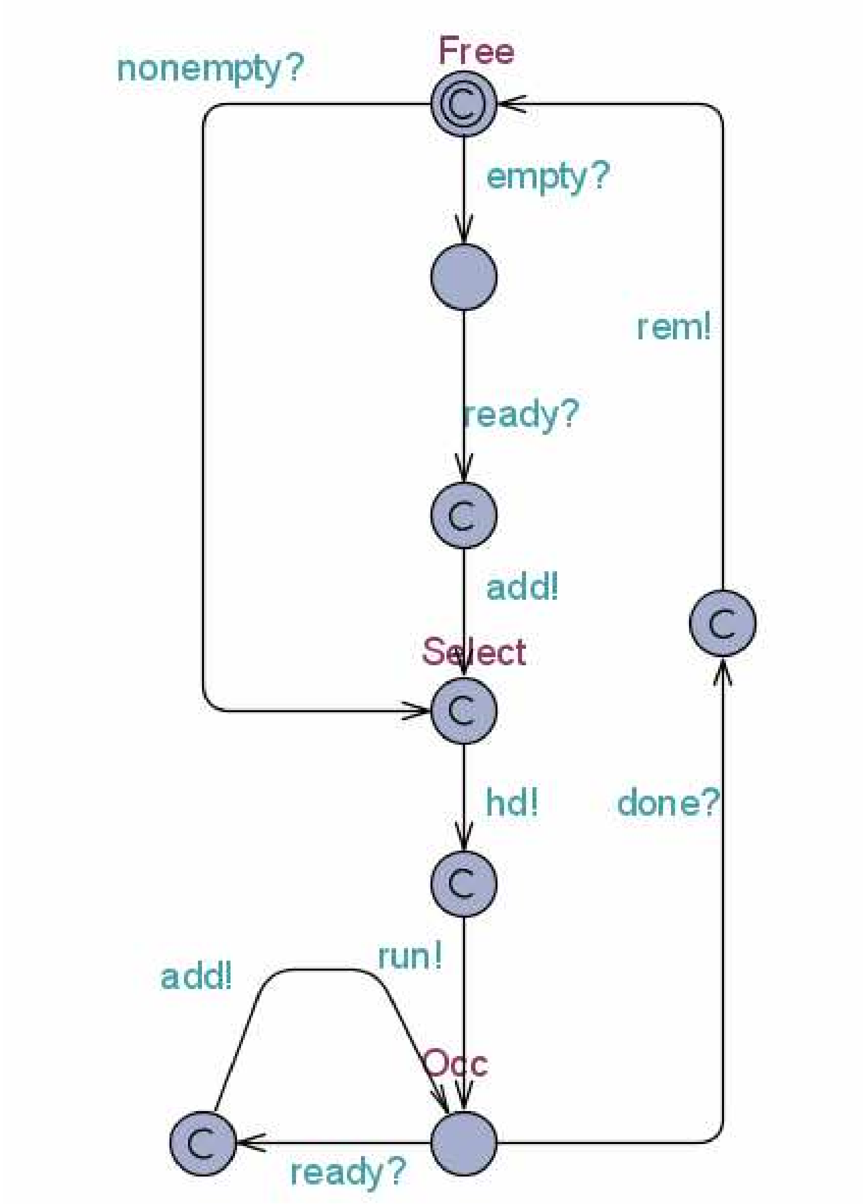
Modeling Task



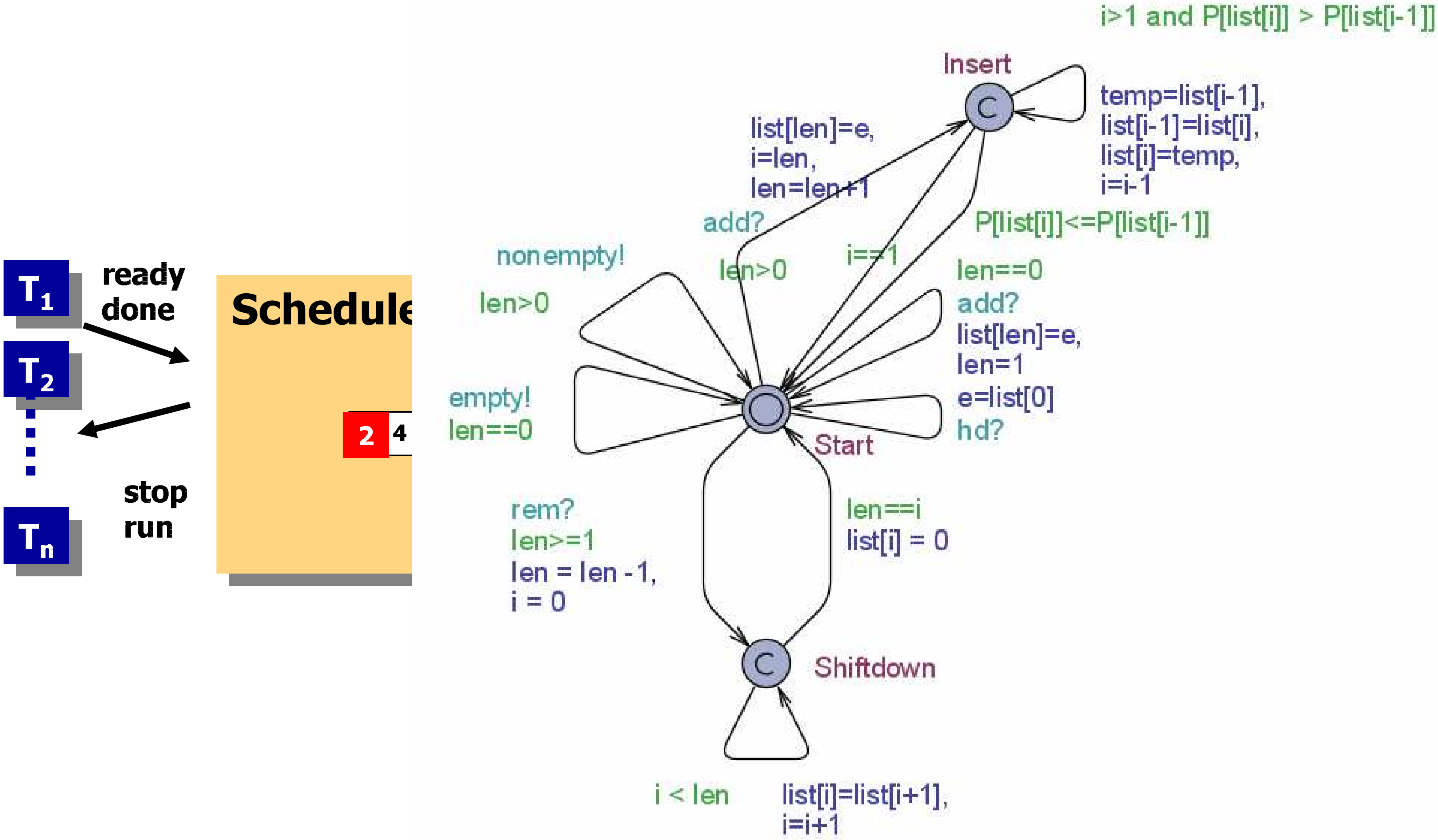


Modeling Scheduler



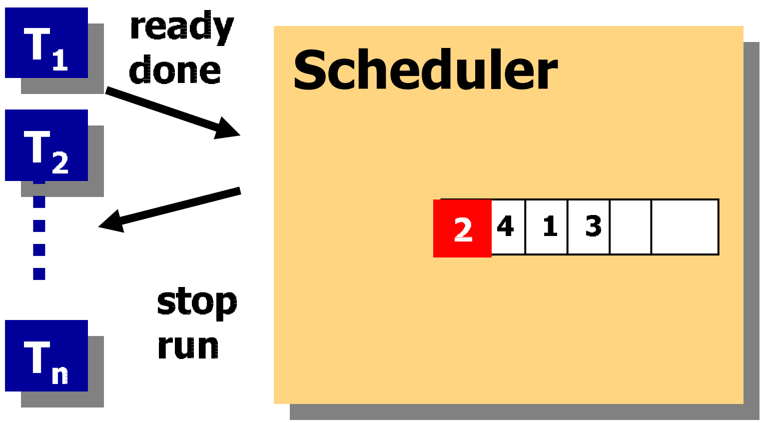


Modeling Queue



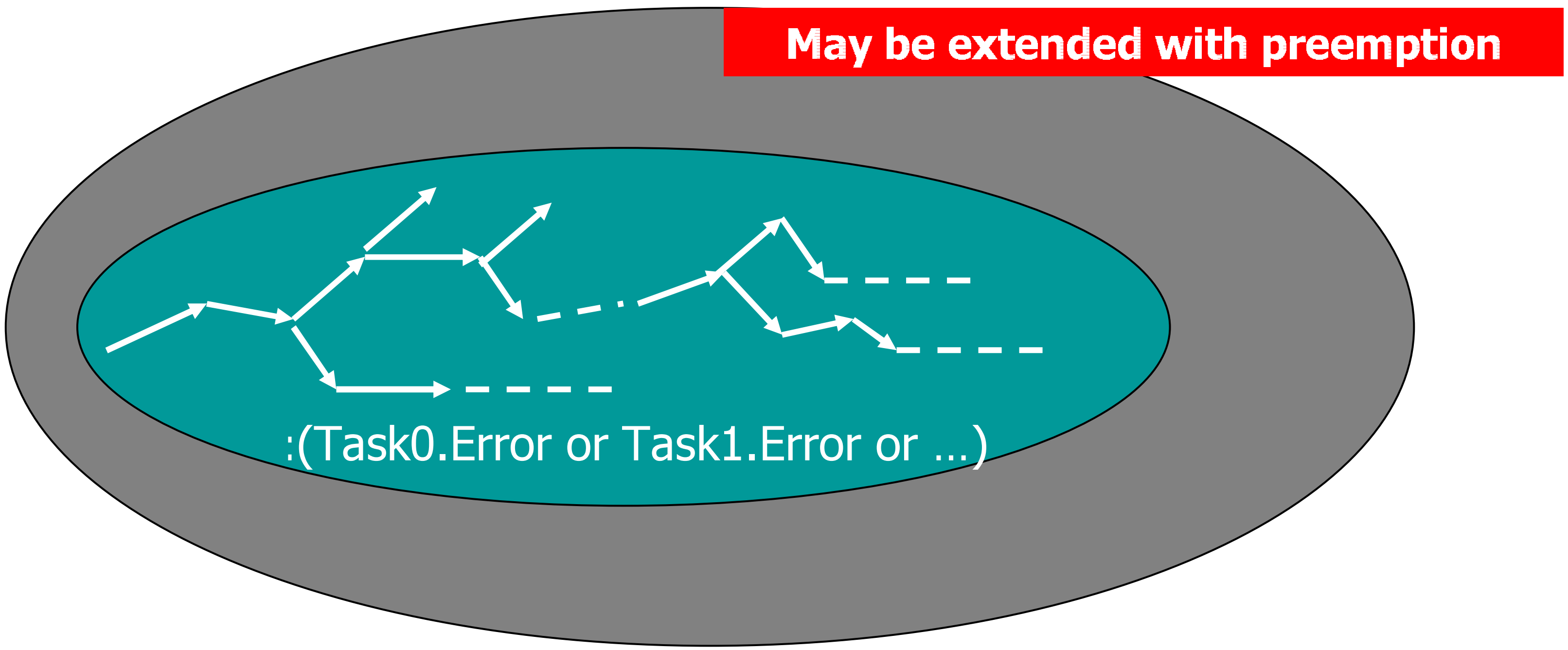
Modeling Queue

In UPPAAL 4.0
User Defined Function




```
void add(id_t element)
{
int i=len;
int temp=0;
if(len==0)
{       list[len]=e;
len=1;
}
   else
{       list[len]=e;
        i=len;
        len=len+1;
        while (i>1 && P[list[i]]> P[list[i-1]])
        {       temp=list[i-1];
                list[i-1]=list[i];
                list[i]=temp;
                i=i-1;
        }
}
}
```

Schedulability = Safety Property



A□ :(Task0.Error or Task1.Error or ...)

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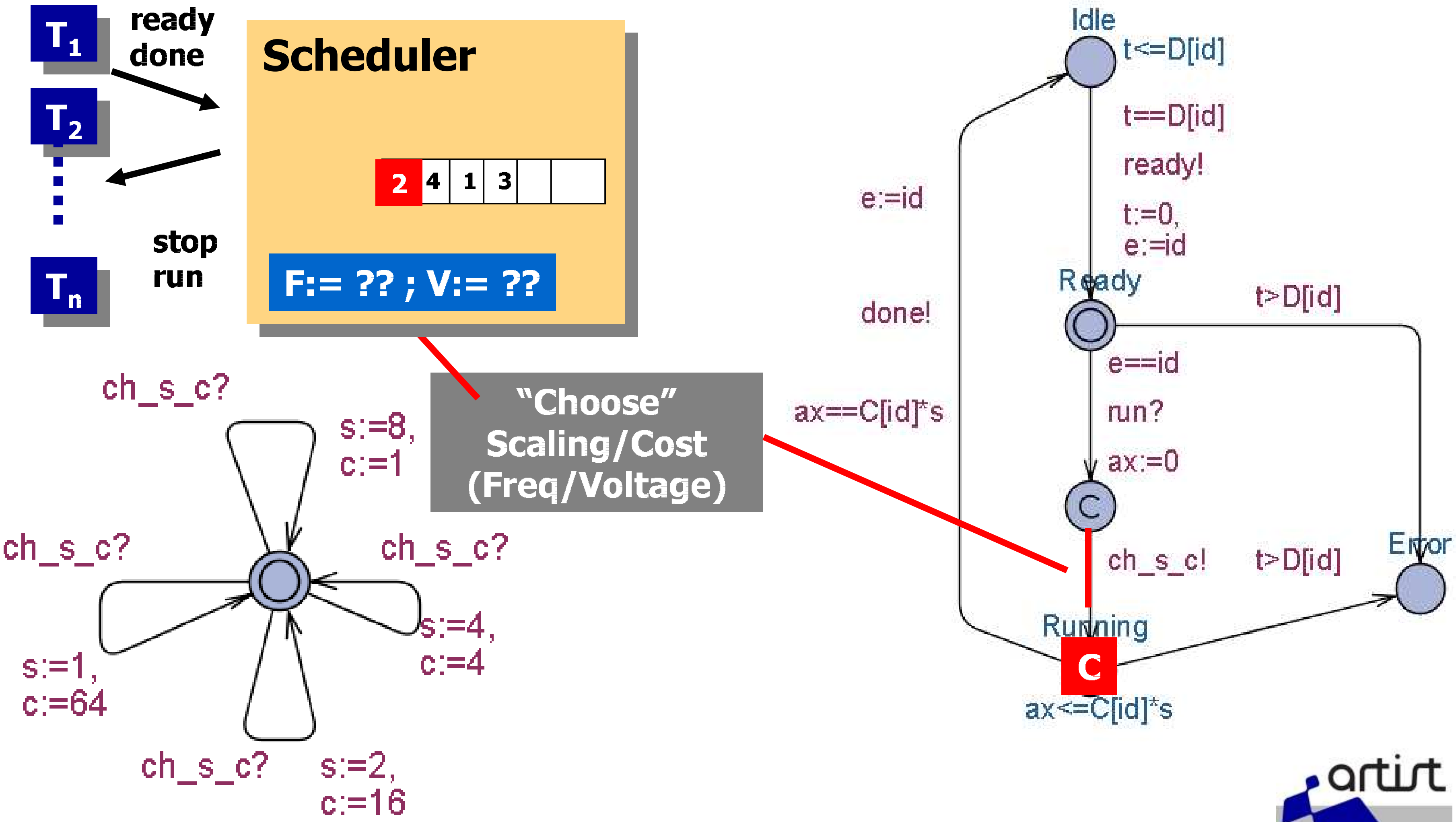
Energy Optimal Scheduling

Using Priced Timed Automata



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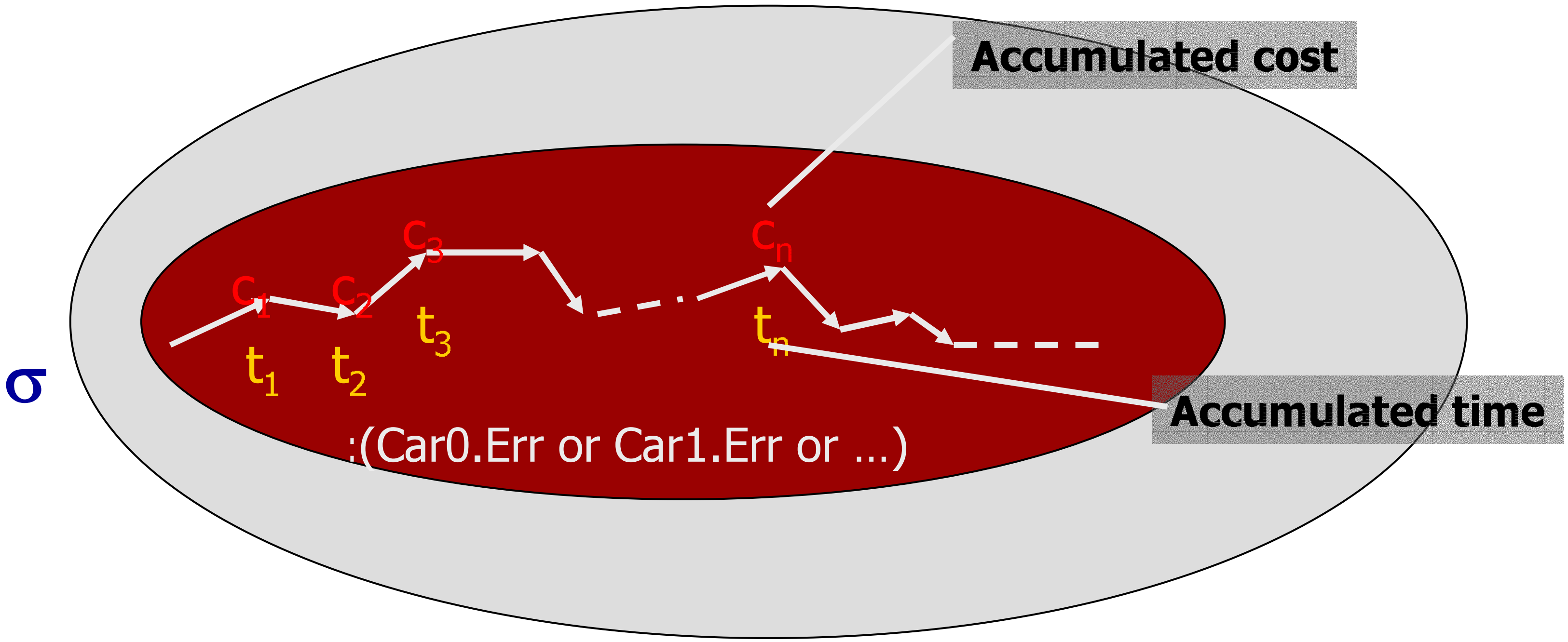
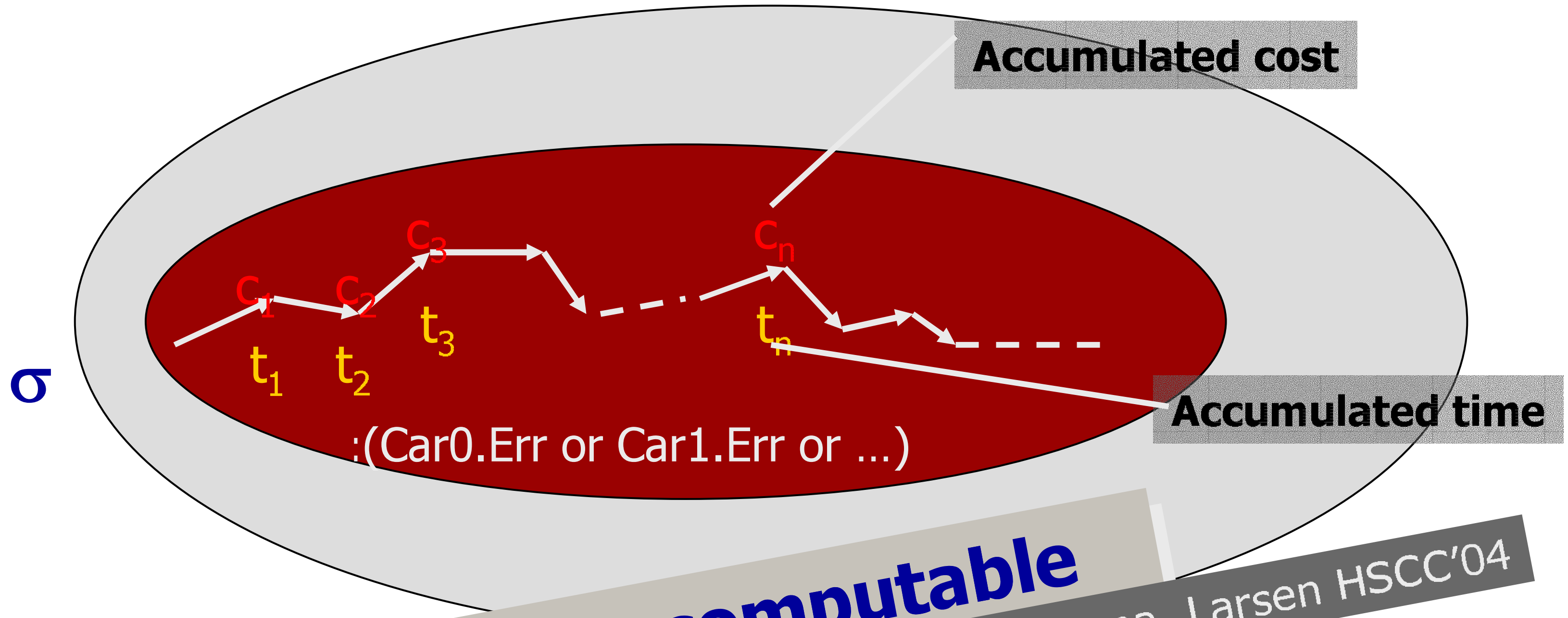
Cost *Optimal* Scheduling =
Optimal Infinite Path



Value of path σ: $val(\sigma) = \lim_{n\to\infty} c_n/t_n$

Optimal Schedule σ^*: $val(\sigma^*) = \inf_{\sigma} val(\sigma)$

Cost Optimal Scheduling = *Optimal Infinite Path*



THEOREM: σ* is computable

Bouyer, Brinksma, Larsen HSCC'04

... path σ: val(σ) = $\lim_{n!1} c_n/t_n$

Optimal Schedule σ*: val(σ*) = $\inf_\sigma$ val(σ)

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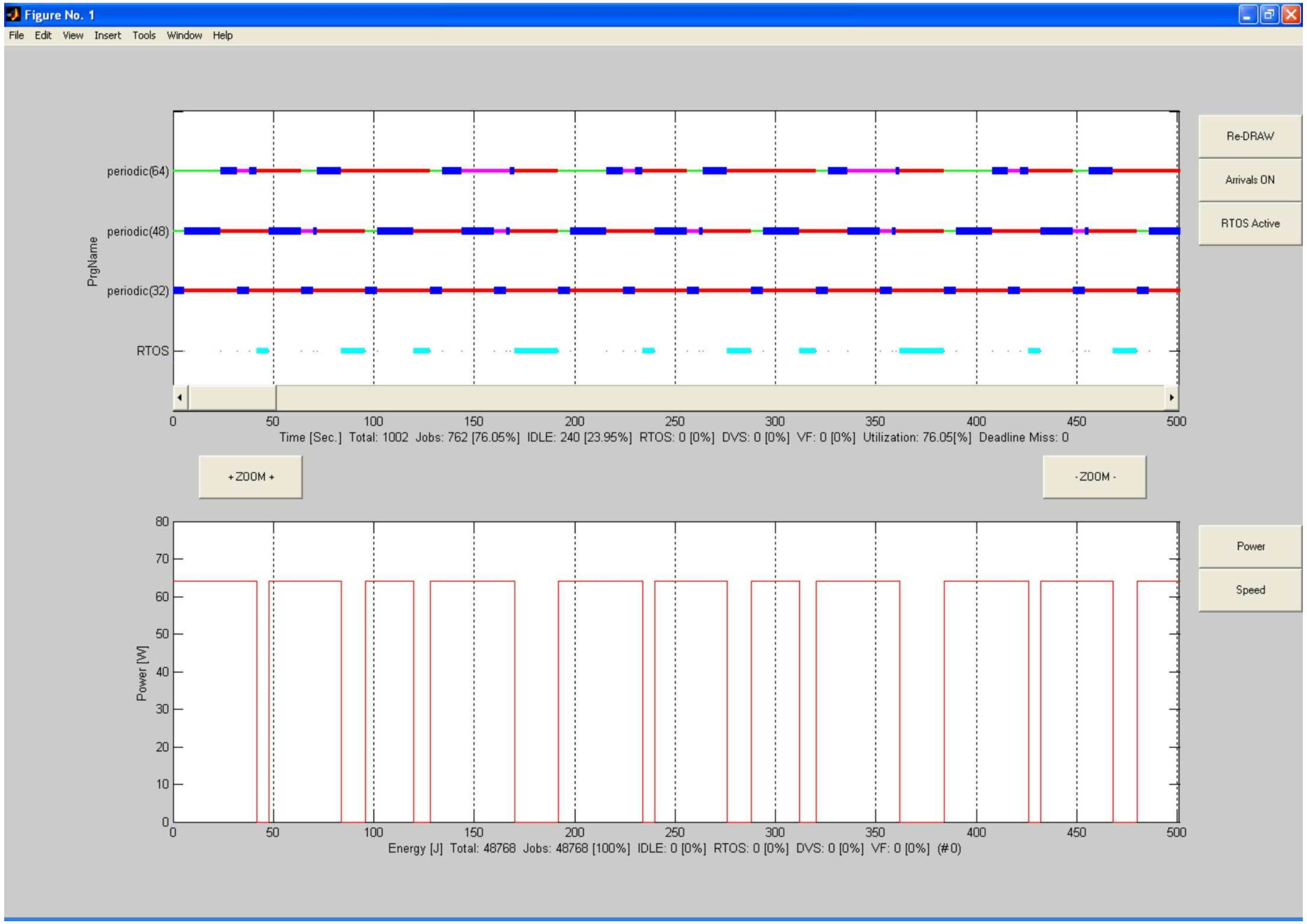
Preliminary Results



EDF w preemption no DVS: avr.: 48

P_1=D_1=32 C_1=6
P_2=D_2=48 C_2=18
P_3=D_3=64 C_3=12

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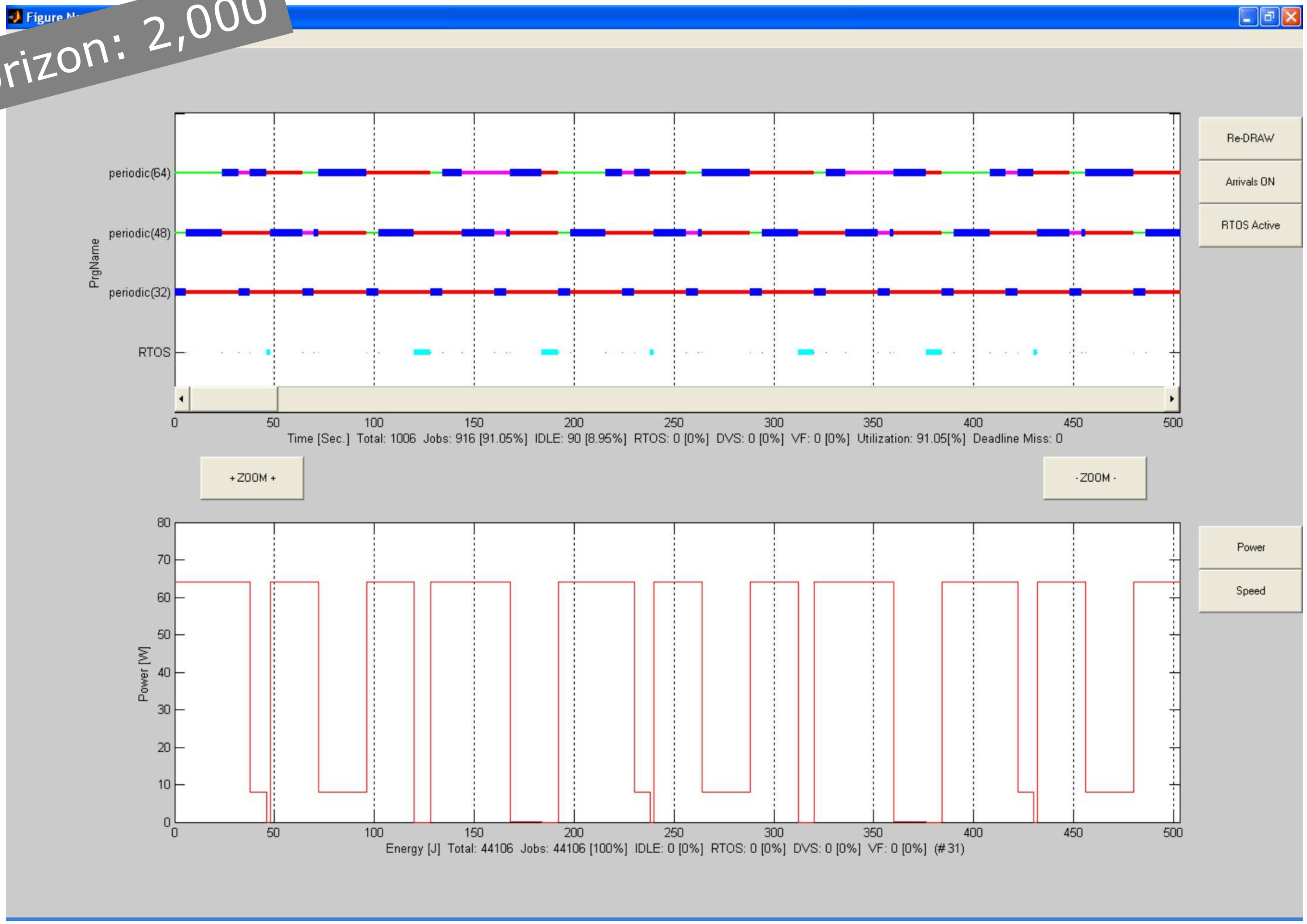
Preliminary Results

Cost horizon: 2,000



EDF w preemption w DVS: avr.: 43.37

$P_1=D_1=32$ $C_1=6$
$P_2=D_2=48$ $C_2=18$
$P_3=D_3=64$ $C_3=12$