machine Mach_PartProc_Trans_with_Events

refines Mach_PartProc_Trans **sees** Ctx_PartProc_with_Events

variables processes
processes_of_partition
partition_mode process_state periodtype_of_process

invariants
@inv_pertype_of_proc periodtype_of_process ∈ processes → **PROC_PERIOD_TYPE**
@inv_onlyone_runproc ∀*p1*,*p2*·(*p1*∈processes ∧ *p2*∈processes ∧ process_state(*p1*)=**PS_Running** ∧ process_state(*p2*)=**PS_Running** ⇒ *p1*=*p2*) *// card(process_state~[{PS_Running}]) ≤ 1 // at most one RUNNING proc in a single processor system*

events
event INITIALISATION **extends** INITIALISATION
then
@act11 periodtype_of_process ≔ ∅
end

event partition_schedule

```
    any part
    where
      @grd01 part∈PARTITIONS
      @grd02 partition_mode(part) = PM_NORMAL ∨ partition_mode(part) = PM_WARM_START ∨
partition_mode(part) = PM_COLD_START
  end

  event process_schedule extends process_schedule
  end

  event create_process extends create_process
    any ptype
    where
      @grd11 ptype∈PROC_PERIOD_TYPE
    then
      @act11 periodtype_of_process(proc) ≔ ptype
  end

  event set_partition_mode_to_idle extends partition_modetransition_to_idle
    then
      @act31 periodtype_of_process ≔ procs ⩤ periodtype_of_process
```

```
end

event set_partition_mode_to_normal extends partition_modetransition_to_normal
end

event set_partition_mode_to_coldstart extends partition_modetransition_to_coldstart
  then
    @act31 periodtype_of_process ≔ procs ⩤ periodtype_of_process
end

event set_partition_mode_to_warmstart extends partition_modetransition_to_warmstart
  then
    @act31 periodtype_of_process ≔ procs ⩤ periodtype_of_process
end

event coldstart_partition_fromidle
extends partition_modetransition_idle_to_coldstart
end

event warmstart_partition_fromidle
extends partition_modetransition_idle_to_warmstart
```

```
end

event suspend_self refines process_state_transition
  any part proc newstate
  where
    @grd01 part ∈ PARTITIONS
    @grd02 proc ∈ processes
    @grd03 newstate ∈ PROCESS_STATES
    @grd06 processes_of_partition(proc) = part
    @grd31 partition_mode(part) = PM_NORMAL
    @grd32 process_state(proc) = PS_Running
    @grd33 newstate = PS_Suspend
    @grd34 periodtype_of_process(proc) = APERIOD_PROC
  then
    @act11 process_state(proc) ≔ newstate
end

event suspend refines process_state_transition
  any part proc newstate
  where
    @grd01 part ∈ PARTITIONS
```

@grd02 *proc* ∈ processes
@grd03 *newstate* ∈ **PROCESS_STATES**
@grd06 processes_of_partition(*proc*) = *part*
@grd07 partition_mode(*part*) = **PM_NORMAL** ∨ partition_mode(*part*) = **PM_WARM_START** ∨ partition_mode(*part*) = **PM_COLD_START**
@grd31 partition_mode(*part*) = **PM_NORMAL** ⇒ (process_state(*proc*) = **PS_Ready** ∧ *newstate* = **PS_Suspend**)∨ (process_state(*proc*) = **PS_Waiting** ∧ *newstate* = **PS_WaitandSuspend**)
@grd32 (partition_mode(*part*) = **PM_COLD_START** ∨ partition_mode(*part*) = **PM_WARM_START**)⇒ (process_state(*proc*) = **PS_Waiting** ∧ *newstate* = **PS_WaitandSuspend**)
@grd34 periodtype_of_process(*proc*) = **APERIOD_PROC**

then

@act11 process_state(*proc*) ≔ *newstate*

end

event resume **refines** process_state_transition

any *part proc newstate*

where

@grd01 *part* ∈ **PARTITIONS**
@grd02 *proc* ∈ processes
@grd03 *newstate* ∈ **PROCESS_STATES**
@grd06 processes_of_partition(*proc*) = *part*

@grd07 partition_mode(*part*) = **PM_NORMAL** ∨ partition_mode(*part*) = **PM_WARM_START** ∨ partition_mode(*part*) = **PM_COLD_START**

@grd31 partition_mode(*part*) = **PM_NORMAL** ⇒ ((process_state(*proc*) = **PS_Suspend** ∧ *newstate* = **PS_Ready**) ∨ (process_state(*proc*) = **PS_WaitandSuspend** ∧ *newstate* = **PS_Waiting**))

@grd32 (partition_mode(*part*) = **PM_COLD_START** ∨ partition_mode(*part*) = **PM_WARM_START**)⇒ (process_state(*proc*) = **PS_WaitandSuspend** ∧ *newstate* = **PS_Waiting**)

@grd34 periodtype_of_process(*proc*) = **APERIOD_PROC**

then

@act11 process_state(*proc*) ≔ *newstate*

end

event stop_self **refines** process_state_transition

any *part proc newstate*

where

@grd01 *part* ∈ **PARTITIONS**

@grd02 *proc* ∈ processes

@grd03 *newstate* ∈ **PROCESS_STATES**

@grd06 processes_of_partition(*proc*) = *part*

@grd30 partition_mode(*part*) = **PM_NORMAL**

@grd31 process_state(*proc*) = **PS_Running** ∧ *newstate* = **PS_Dormant**

then

```
        @act11 process_state(proc) ≔ newstate
    end

    event stop refines process_state_transition
      any part proc newstate
      where
        @grd01 part ∈ PARTITIONS
        @grd02 proc ∈ processes
        @grd03 newstate ∈ PROCESS_STATES
        @grd06 processes_of_partition(proc) = part
        @grd07 partition_mode(part) = PM_NORMAL ∨ partition_mode(part) = PM_WARM_START ∨
partition_mode(part) = PM_COLD_START
        @grd31 partition_mode(part) = PM_NORMAL ⇒  ((process_state(proc) = PS_Ready ∨ process_state(proc)
= PS_Waiting ∨ process_state(proc) = PS_Suspend ∨ process_state(proc) = PS_WaitandSuspend) ∧ newstate
= PS_Dormant)
        @grd32 (partition_mode(part) = PM_COLD_START ∨  partition_mode(part) = PM_WARM_START)⇒
((process_state(proc) = PS_Waiting ∨ process_state(proc) = PS_WaitandSuspend) ∧ newstate = PS_Dormant)
      then
        @act11 process_state(proc) ≔ newstate
    end
```

```
event start refines process_state_transition
  any part proc newstate
  where
    @grd01 part ∈ PARTITIONS
    @grd02 proc ∈ processes
    @grd03 newstate ∈ PROCESS_STATES
    @grd06 processes_of_partition(proc) = part
    @grd07 partition_mode(part) = PM_NORMAL ∨ partition_mode(part) = PM_WARM_START ∨
partition_mode(part) = PM_COLD_START
    @grd31 partition_mode(part) = PM_NORMAL ⇒  (process_state(proc) = PS_Dormant ∧
          ((periodtype_of_process(proc) = APERIOD_PROC ⇒ newstate = PS_Ready) ∧
(periodtype_of_process(proc) = PERIOD_PROC ⇒ newstate = PS_Waiting)))
    @grd32 (partition_mode(part) = PM_COLD_START ∨  partition_mode(part) = PM_WARM_START)⇒
(process_state(proc) = PS_Dormant ∧ newstate = PS_Waiting)
  then
    @act11 process_state(proc) ≔ newstate
end

event delayed_start refines process_state_transition
  any part proc newstate
  where
```

@grd01 *part* ∈ **PARTITIONS**

@grd02 *proc* ∈ processes

@grd03 *newstate* ∈ **PROCESS_STATES**

@grd06 processes_of_partition(*proc*) = *part*

@grd07 partition_mode(*part*) = **PM_NORMAL** ∨ partition_mode(*part*) = **PM_WARM_START** ∨ partition_mode(*part*) = **PM_COLD_START**

@grd31 partition_mode(*part*) = **PM_NORMAL** ⇒ (process_state(*proc*) = **PS_Dormant** ∧ *newstate* = **PS_Waiting**)

@grd32 (partition_mode(*part*) = **PM_COLD_START** ∨ partition_mode(*part*) = **PM_WARM_START**)⇒ (process_state(*proc*) = **PS_Dormant** ∧ *newstate* = **PS_Waiting**)

then

@act11 process_state(*proc*) ≔ *newstate*

end

event timed_wait **refines** process_state_transition

any *part proc newstate*

where

@grd01 *part* ∈ **PARTITIONS**

@grd02 *proc* ∈ processes

@grd03 *newstate* ∈ **PROCESS_STATES**

@grd06 processes_of_partition(*proc*) = *part*

```
    @grd31 partition_mode(part) = PM_NORMAL
    @grd32 process_state(proc) = PS_Running ∧ (newstate = PS_Ready ∨ newstate = PS_Waiting)
  then
    @act11 process_state(proc) ≔ newstate
end

event period_wait refines process_state_transition
  any part proc newstate
  where
    @grd01 part ∈ PARTITIONS
    @grd02 proc ∈ processes
    @grd03 newstate ∈ PROCESS_STATES
    @grd06 processes_of_partition(proc) = part
    @grd31 partition_mode(part) = PM_NORMAL
    @grd32 process_state(proc) = PS_Running ∧ newstate = PS_Waiting
  then
    @act11 process_state(proc) ≔ newstate
end

event process_finished refines process_state_transition
  any part proc newstate
```

```
    where
      @grd01 part ∈ PARTITIONS
      @grd02 proc ∈ processes
      @grd03 newstate ∈ PROCESS_STATES
      @grd06 processes_of_partition(proc) = part
      @grd31 partition_mode(part) = PM_NORMAL
      @grd32 process_state(proc) = PS_Running ∧ (newstate = PS_Dormant ∨ newstate = PS_Waiting)
    then
      @act11 process_state(proc) ≔ newstate
  end

  event time_out refines process_state_transition
    any part proc newstate
    where
      @grd01 part ∈ PARTITIONS
      @grd02 proc ∈ processes
      @grd03 newstate ∈ PROCESS_STATES
      @grd06 processes_of_partition(proc) = part
      @grd31 partition_mode(part) = PM_NORMAL
      @grd32 process_state(proc) = PS_Waiting ∨ process_state(proc) = PS_Suspend ∨ process_state(proc) =
PS_WaitandSuspend
```

```
    @grd33 process_state(proc) = PS_Waiting ∨ process_state(proc) = PS_Suspend ⇒ newstate = PS_Ready
    @grd34 process_state(proc) = PS_WaitandSuspend ⇒ newstate = PS_Suspend
  then
    @act11 process_state(proc) ≔ newstate
end

event req_busy_resource refines process_state_transition
  any part proc newstate
  where
    @grd01 part ∈ PARTITIONS
    @grd02 proc ∈ processes
    @grd03 newstate ∈ PROCESS_STATES
    @grd06 processes_of_partition(proc) = part
    @grd31 partition_mode(part) = PM_NORMAL
    @grd32 process_state(proc) = PS_Running
    @grd34 newstate = PS_Waiting
  then
    @act11 process_state(proc) ≔ newstate
end

event resource_become_available refines process_state_transition
```

```
  any part proc newstate
  where
    @grd01 part ∈ PARTITIONS
    @grd02 proc ∈ processes
    @grd03 newstate ∈ PROCESS_STATES
    @grd06 processes_of_partition(proc) = part
    @grd31 partition_mode(part) = PM_NORMAL
    @grd32 process_state(proc) = PS_Waiting ∨ process_state(proc) = PS_WaitandSuspend
    @grd33 process_state(proc) = PS_Waiting ⇒ newstate = PS_Ready
    @grd34 process_state(proc) = PS_WaitandSuspend ⇒ newstate = PS_Suspend
  then
    @act11 process_state(proc) ≔ newstate
end

event resource_become_available2 refines process_state_transition2
  any part procs newstates
  where
    @grd01 part ∈ PARTITIONS
    @grd02 procs ⊆ processes
    @grd03 newstates ∈ procs → PROCESS_STATES
    @grd06 procs ⊆ processes_of_partition~[{part}]
```

@grd31 partition_mode(*part*) = **PM_NORMAL**

@grd32 ∀*proc*·(*proc*∈*procs* ⇒ process_state(*proc*) = **PS_Waiting** ∨ process_state(*proc*) = **PS_WaitandSuspend**)

@grd33 ∀*proc*·(*proc*∈*procs* ∧ process_state(*proc*) = **PS_Waiting** ⇒ *newstates*(*proc*) = **PS_Ready**)

@grd34 ∀*proc*·(*proc*∈*procs* ∧ process_state(*proc*) = **PS_WaitandSuspend** ⇒ *newstates*(*proc*) = **PS_Suspend**)

then

@act11 process_state ≔ process_state *newstates*

end

event periodicproc_reach_releasepoint

refines process_state_transition

any *part proc newstate*

where

@grd01 *part* ∈ **PARTITIONS**

@grd02 *proc* ∈ processes

@grd03 *newstate* ∈ **PROCESS_STATES**

@grd04 processes_of_partition(*proc*) = *part*

@grd05 partition_mode(*part*) = **PM_NORMAL**

@grd06 periodtype_of_process(*proc*) = **APERIOD_PROC**

@grd07 process_state(*proc*) = **PS_Waiting**

```
        @grd08 newstate = PS_Ready
      then
        @act01 process_state(proc) ≔ newstate
    end
end
```