
ILP-based
Scheduler

1

Results

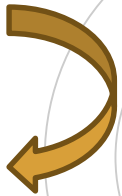
- Task Graph 1
- Task Graph 2
- Task Graph 3
- Task Graph 4
- Task Graph 5

1

- For each task graph
  - Task Graph Description
  - Example - 1 (Tmax only)
    - Intlinprog scheduling
    - Cplexmilp scheduling
  - Example - 2 (Tmax only)
    - Intlinprog scheduling
    - Cplexmilp scheduling

Communication Time differs!

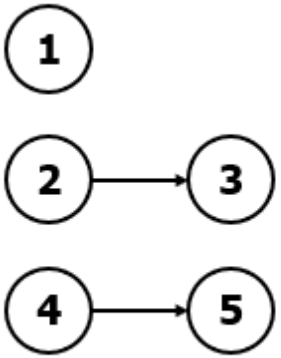
  - Example – 1” (Tmax + Energy)
    - Intlinprog scheduling
    - Cplexmilp scheduling
  - Example – 2” (Tmax + Energy)
    - Intlinprog scheduling
    - Cplexmilp scheduling



Communication Time and Power differs!

Task Graph 1

- CTG 1



- CTG 1 Description

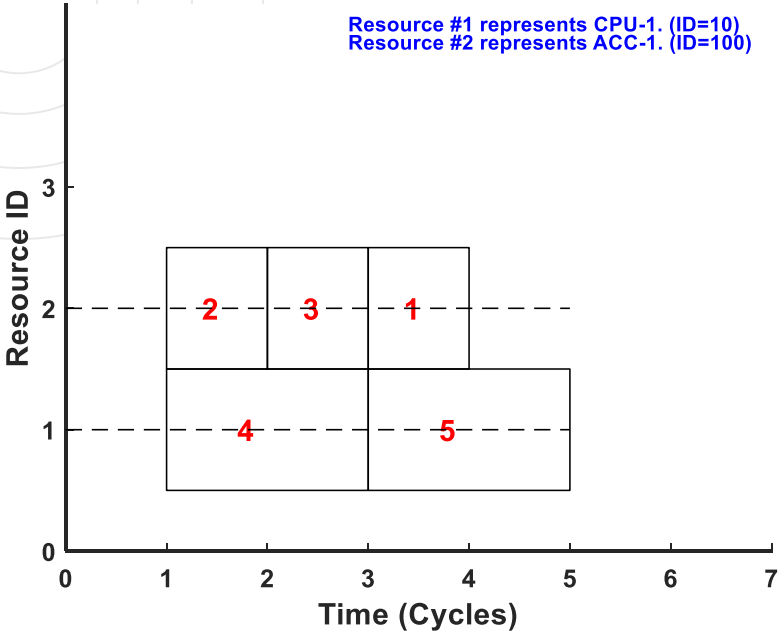
```
add_new_tasks 5
task_1 1
task_1 earliest_start 0 deadline 9
task_2 2
task_2 earliest_start 0 deadline 9
task_3 3 2
task_3 earliest_start 0 deadline 9
task_4 4
task_4 earliest_start 0 deadline 9
task_5 5 4
task_5 earliest_start 0 deadline 9
```

- Resource Description

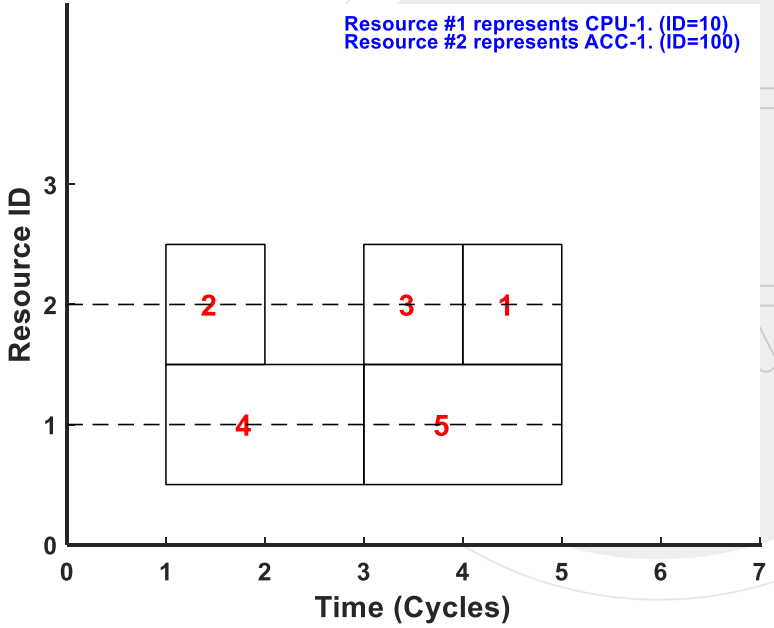
```
add_new_resource ACCa_0 0 5
task_1 10 5
task_2 10 4
task_3 10 3
task_4 10 2
task_5 10 1

add_new_resource CPUa_1 1 2
task_4 20 4
task_5 20 2
```

Task Graph 1 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 0 for same type*
  - *-- 2 cycles for different type*



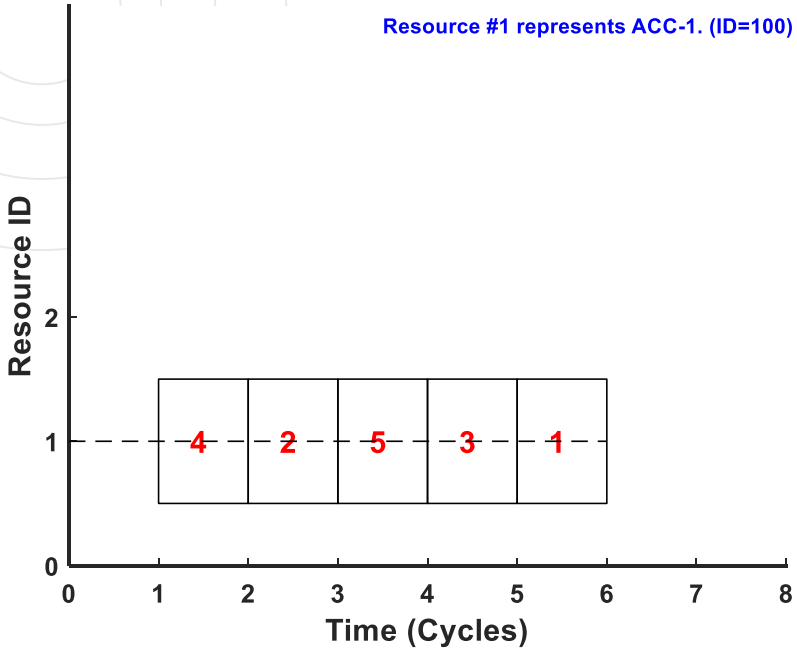
Intlinprog: 4 cycles



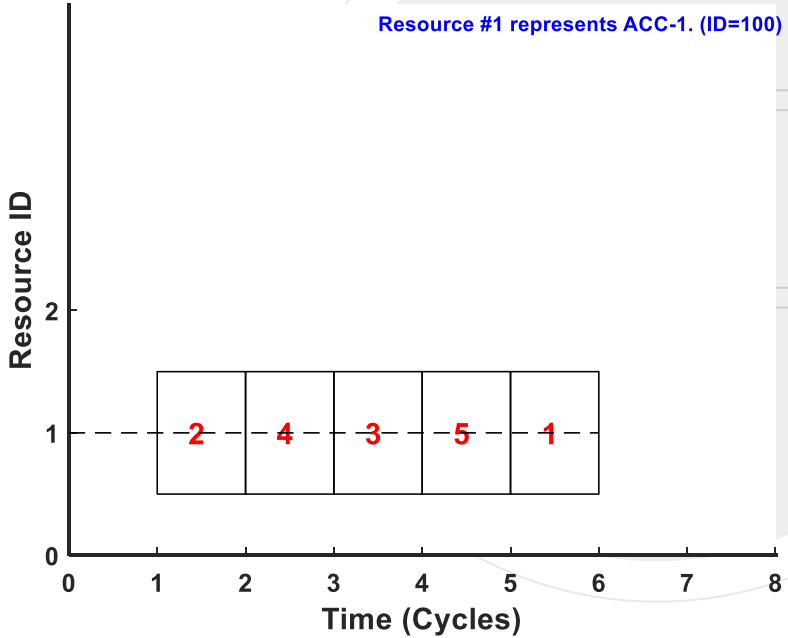
cplexmilp: 4 cycles

Task Graph 1 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 1 for same type*
  - *-- 2 cycles for different type*



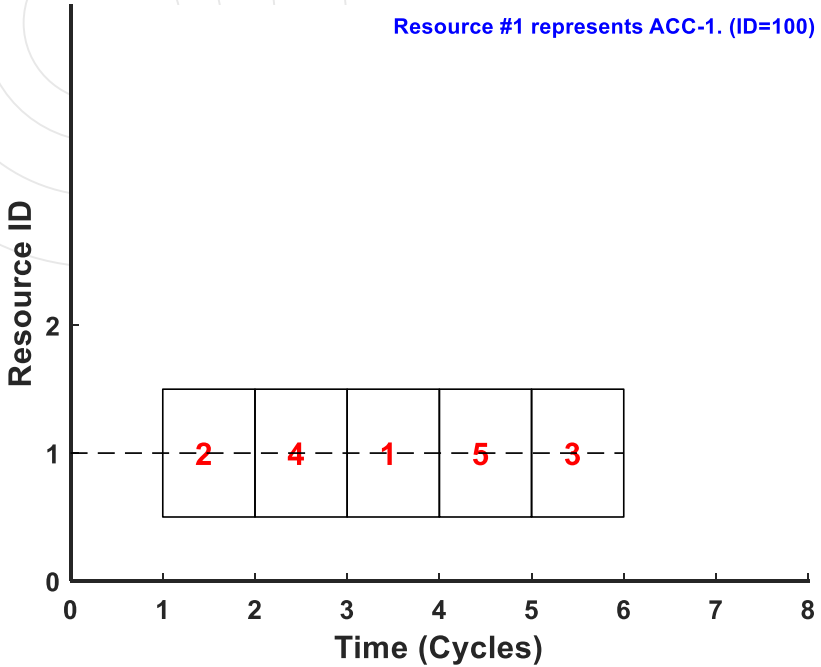
Intlinprog: 5 cycles



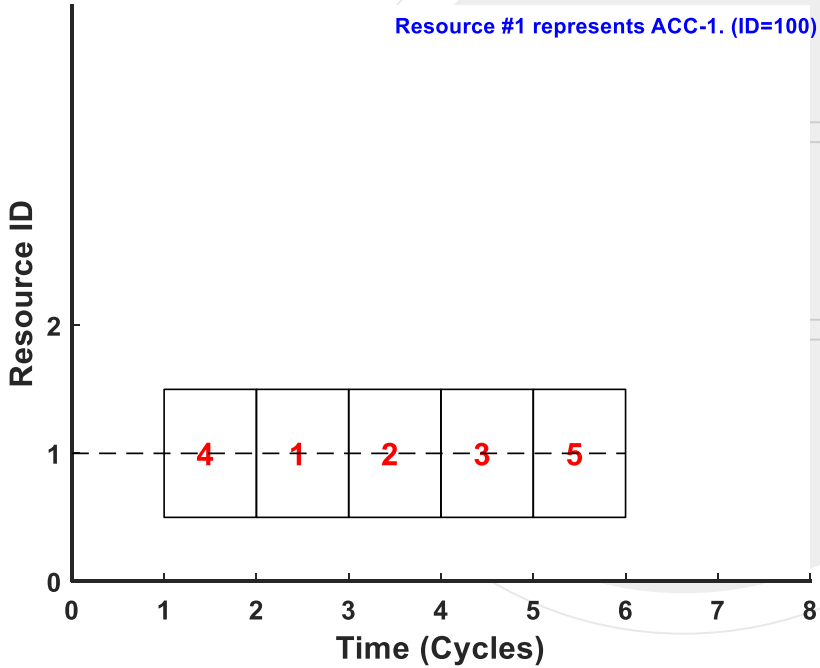
cplexmilp: 5 cycles

Task Graph 1 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 0 for same type*
  - *-- 2 for different type*



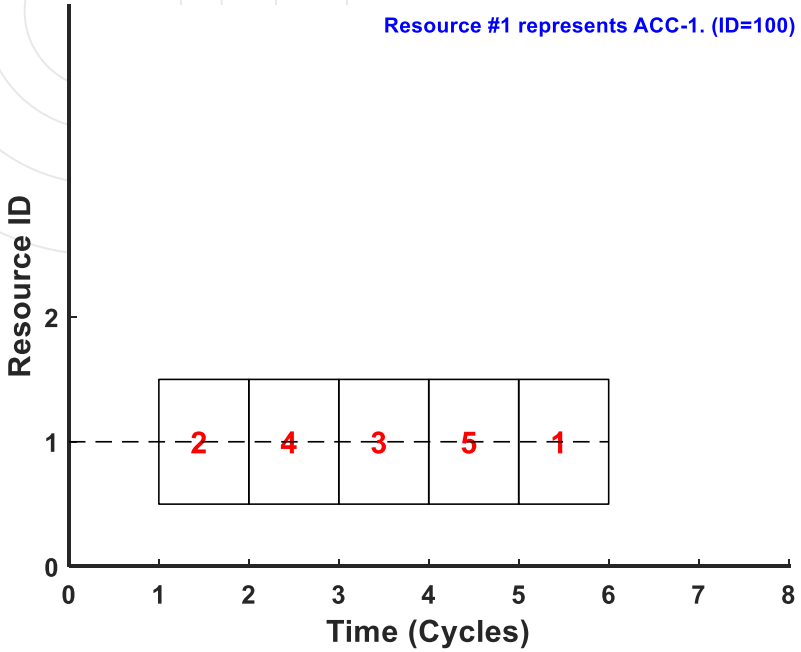
Intlinprog: 5 cycles, 15 units energy



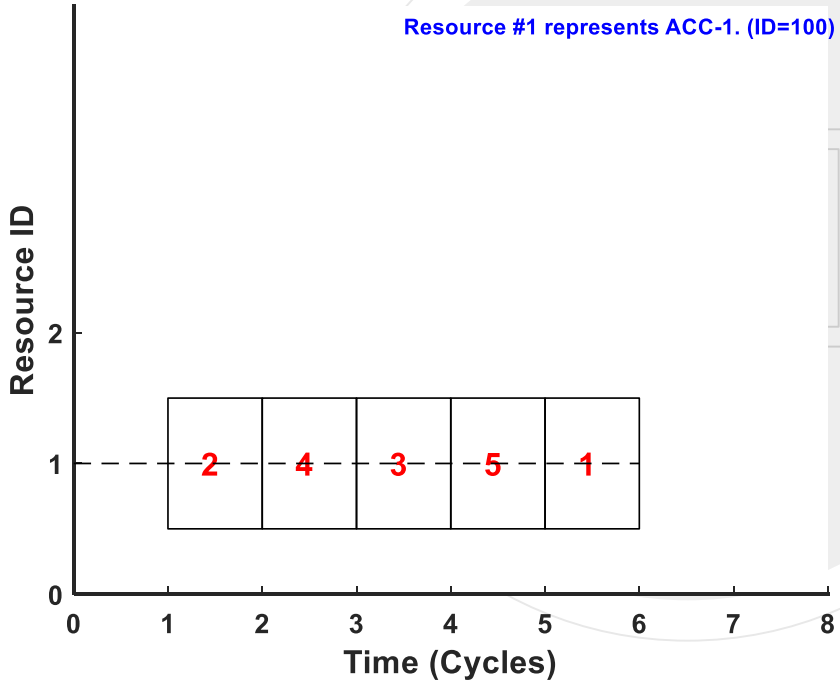
Cplexmilp: 5 cycles, 15 units energy

Task Graph 1 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 1 for same type*
  - *-- 2 for different type*



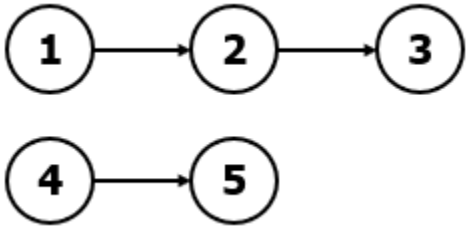
Intlinprog: 5 cycles, 17 units energy



Cplexmilp: 5 cycles, 17 units energy

Task Graph 2

- CTG 2



- CTG 2 Description

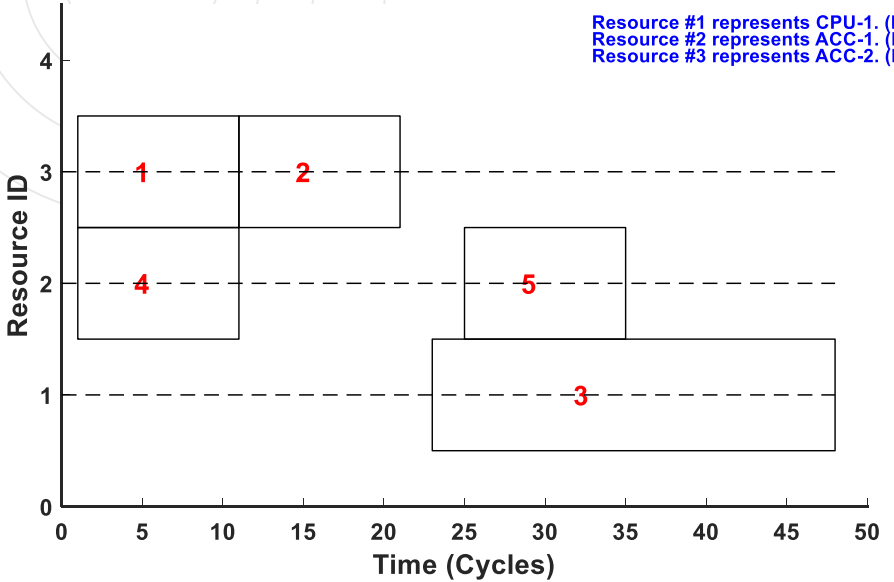
```
add_new_tasks 5
task_1 1
task_1 earliest_start 0 deadline 100
task_2 2 1
task_2 earliest_start 0 deadline 100
task_3 3 2
task_3 earliest_start 0 deadline 100
task_4 4
task_4 earliest_start 0 deadline 100
task_5 5 4
task_5 earliest_start 0 deadline 100
```

- Resource Description

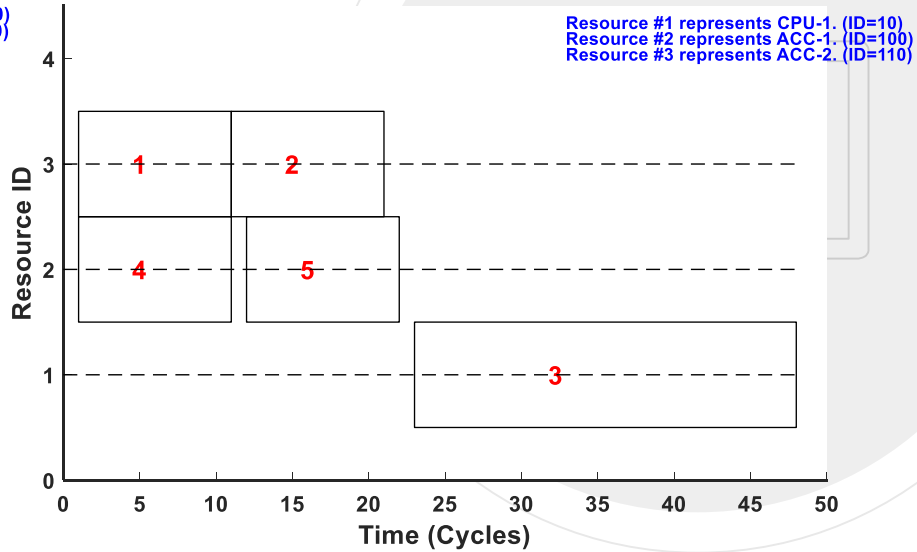
```
add_new_resource CPUa_0 0 5
task_1 30 10
task_2 32 10
task_3 25 10
task_4 20 10
task_5 20 10

add_new_resource ACCa_1 1 2
task_4 10 20
task_5 10 20

add_new_resource ACCb_1 1 2
task_1 10 10
task_2 10 10
```

Task Graph 2 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 0 for same type*
  - *-- 2 cycles for different type*



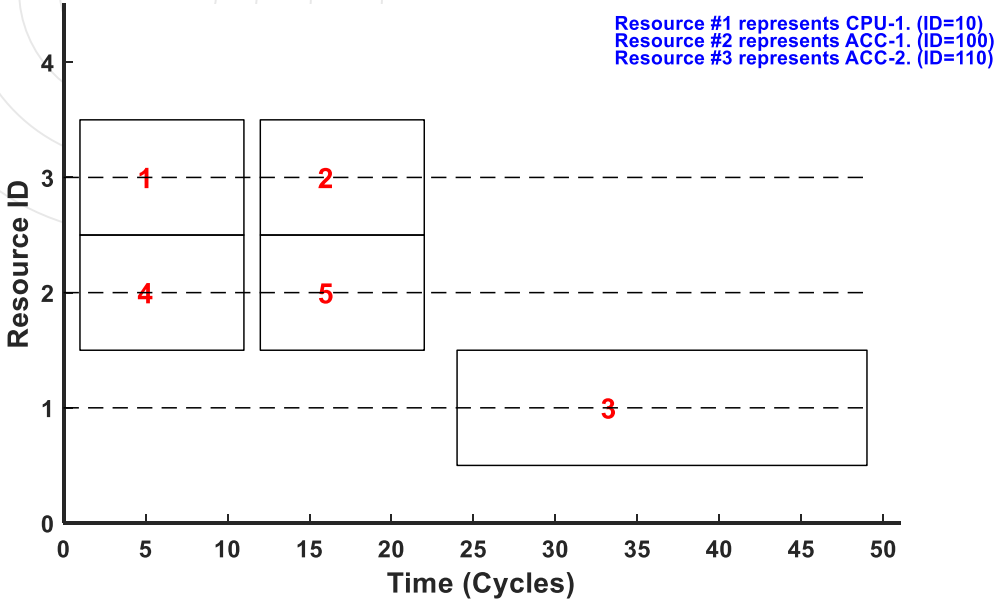
Intlinprog: 47 cycles



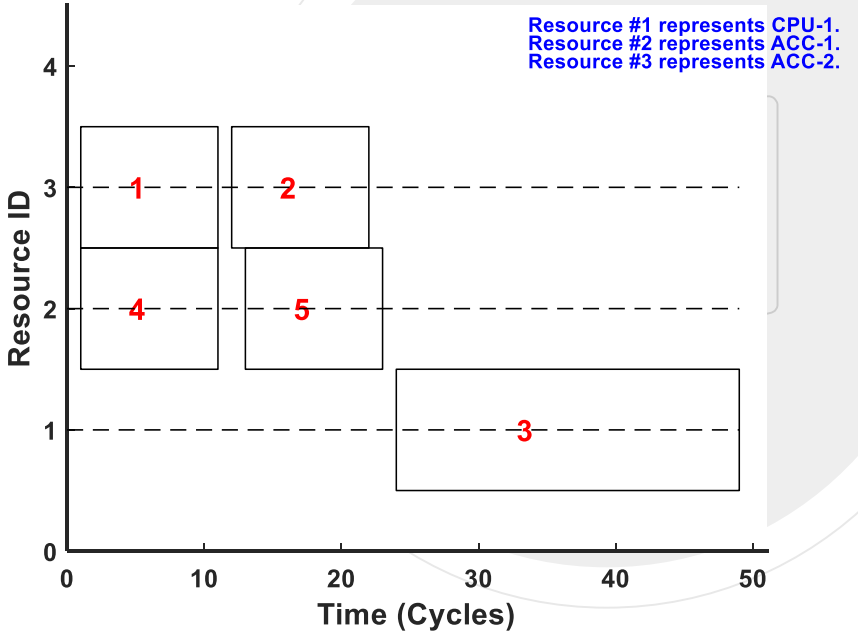
cplexmilp: 47 cycles

Task Graph 2 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 1 for same type*
  - *-- 2 cycles for different type*



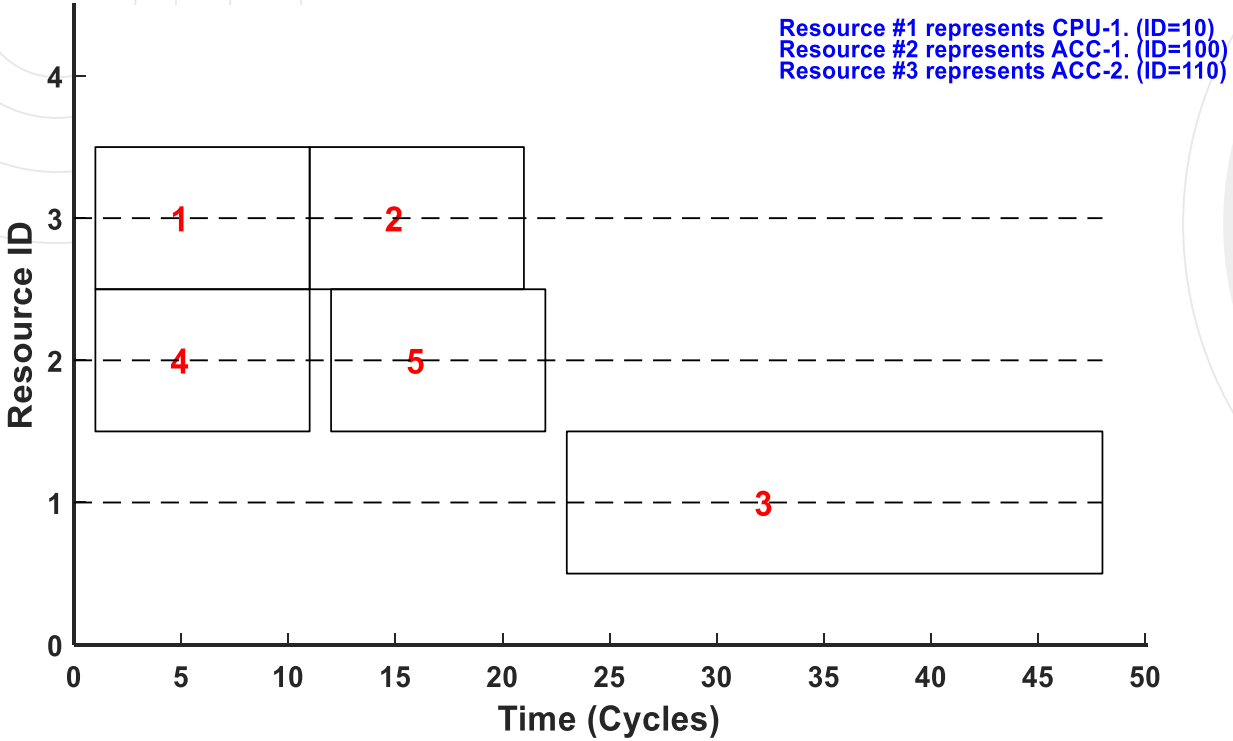
Intlinprog: 48 cycles



cplexmilp: 48 cycles

Task Graph 2 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 0 for same type*
  - *-- 2 for different type*



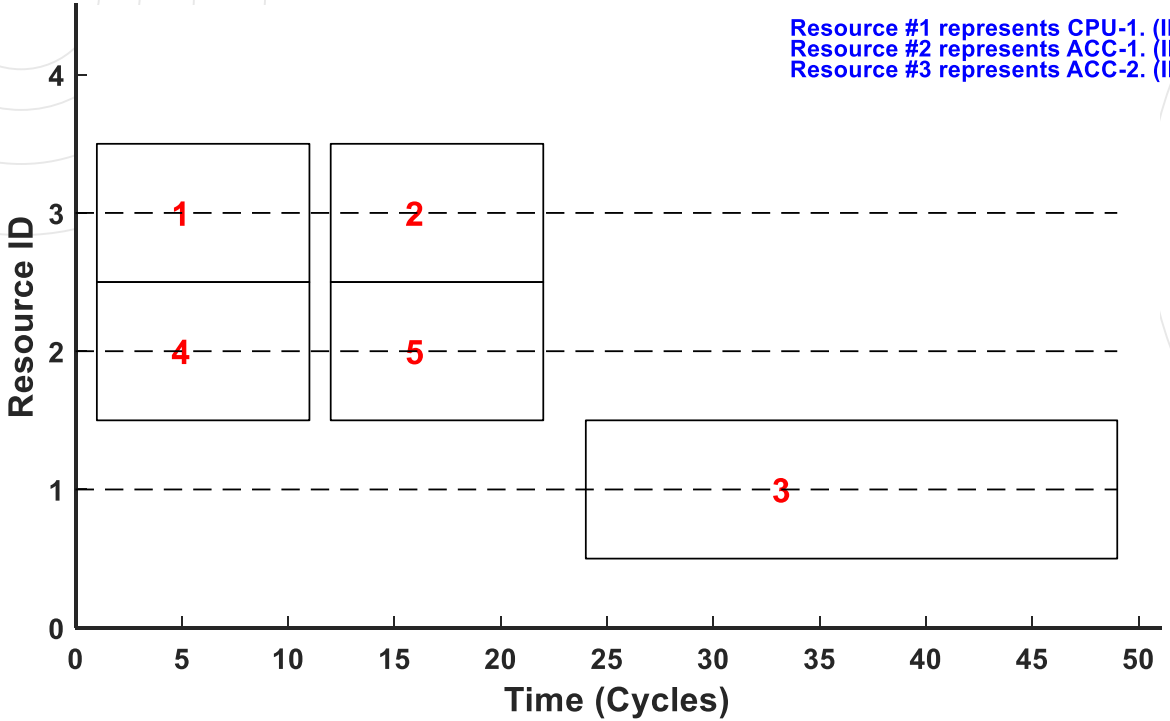
Cplexmilp:

47 cycles,

854 units energy

Task Graph 2 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 1 for same type*
  - *-- 2 for different type*



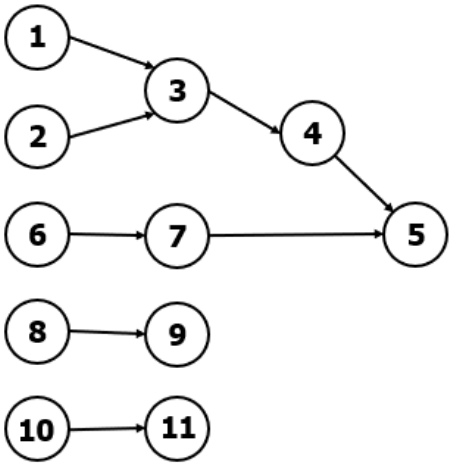
Cplexmilp:

48 cycles,

856 units energy

Task Graph 3

- CTG 3



- CTG 3 Description

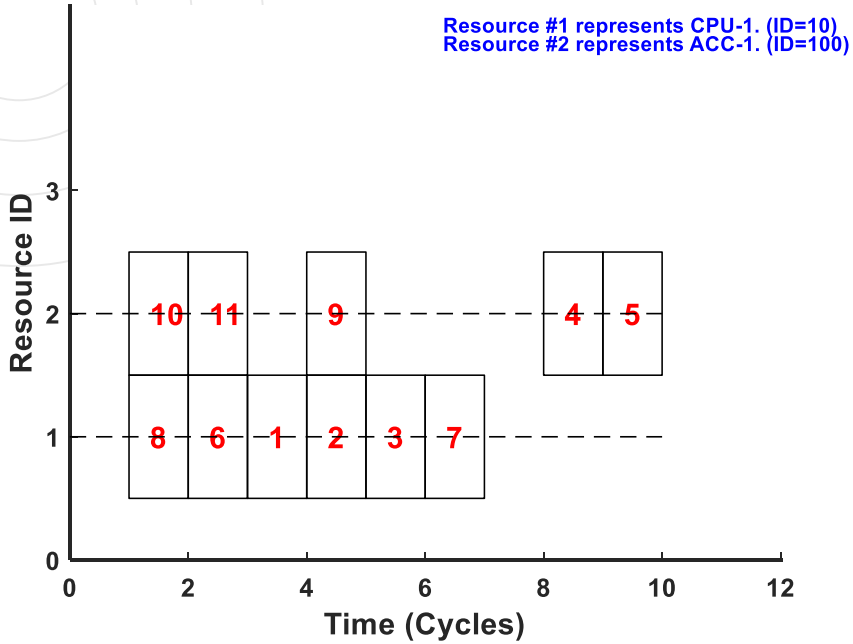
```
add_new_tasks 11
task_1 1
task_1 earliest_start 0 deadline 13
task_2 2
task_2 earliest_start 0 deadline 13
task_3 3 1 2
task_3 earliest_start 0 deadline 14
task_4 4 3
task_4 earliest_start 0 deadline 14
task_5 5 4 7
task_5 earliest_start 0 deadline 15
task_6 6
task_6 earliest_start 0 deadline 13
task_7 7 6
task_7 earliest_start 0 deadline 14
task_8 8
task_8 earliest_start 0 deadline 16
task_9 9 8
task_9 earliest_start 0 deadline 16
task_10 10
task_10 earliest_start 0 deadline 13
task_11 11 10
task_11 earliest_start 0 deadline 14
```

- Resource Description

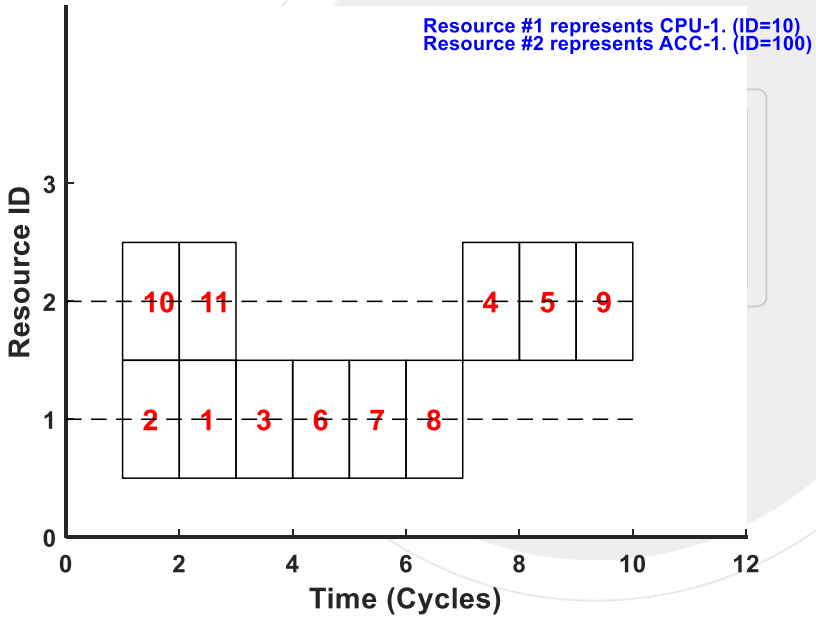
```
add_new_resource MULTIPLIER_0 0 6
task_1 10 15
task_2 10 15
task_3 10 15
task_6 10 15
task_7 10 15
task_8 10 15

add_new_resource ALU_1 1 5
task_4 10 10
task_5 10 10
task_9 10 10
task_10 10 10
task_11 10 10
```

Task Graph 3 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 0 for same type*
  - *-- 2 cycles for different type*



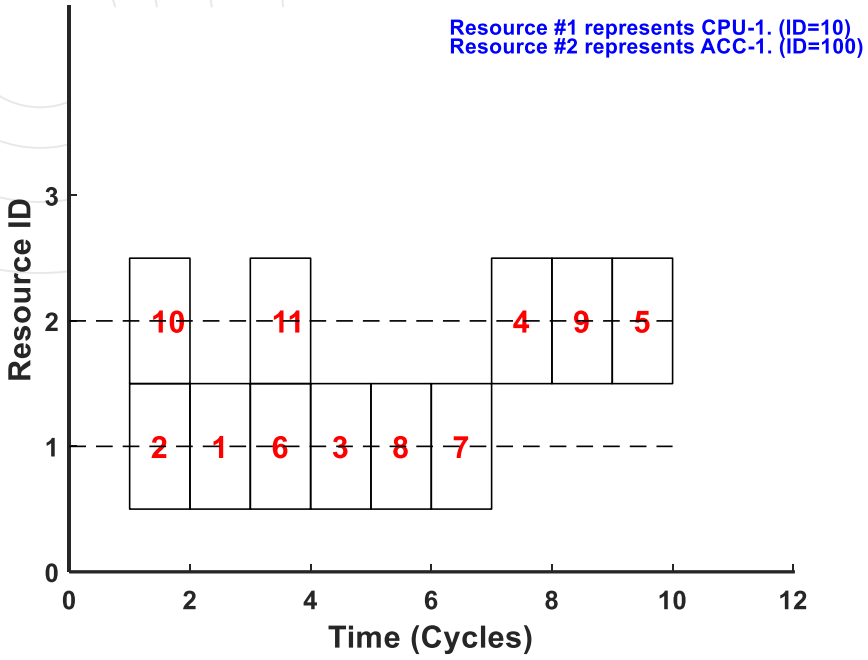
Intlinprog: 9 cycles



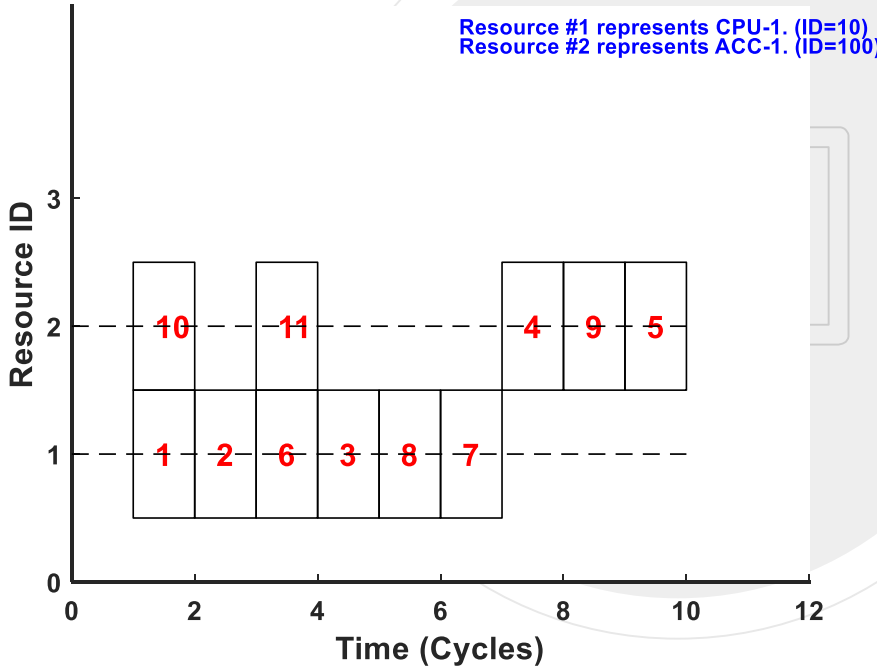
cplexmilp: 9 cycles

Task Graph 3 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 1 for same type*
  - *-- 2 cycles for different type*



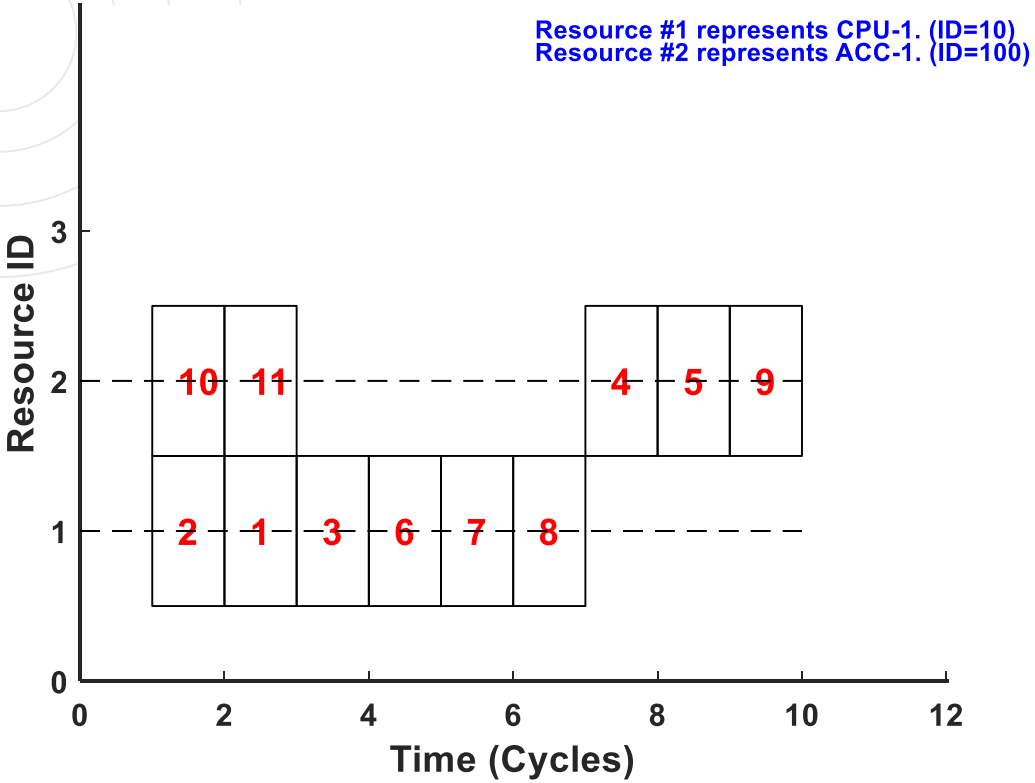
Intlinprog: 9 cycles



cplexmilp: 9 cycles

Task Graph 3 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 0 for same type*
  - *-- 2 for different type*



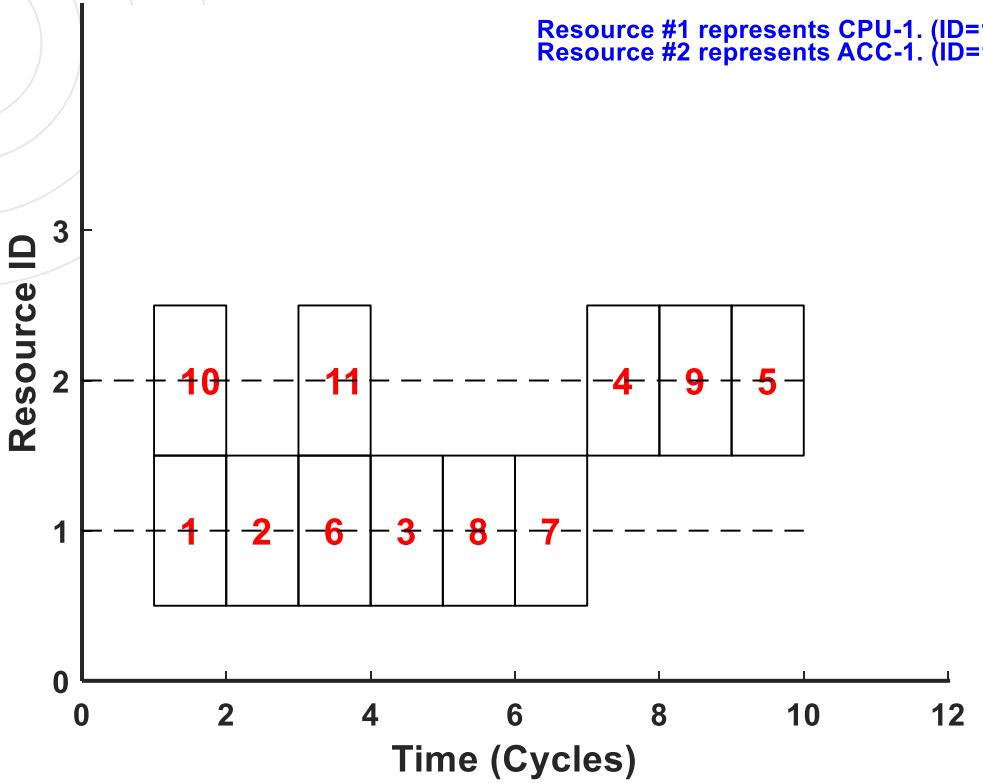
Cplexmilp:

9 cycles,

152 units energy

Task Graph 3 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 1 for same type*
  - *-- 2 for different type*



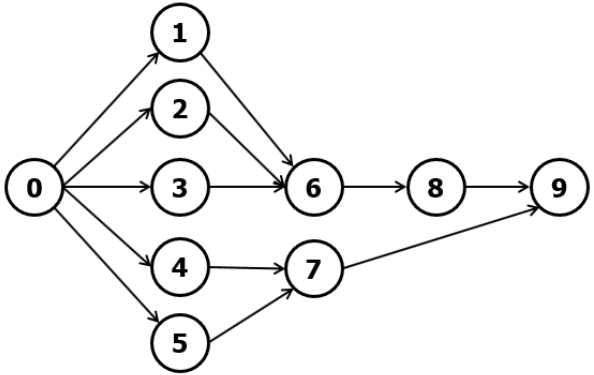
Cplexmilp:

9 cycles,

157 units energy

Task Graph 4

- CTG 4



- CTG 4 Description

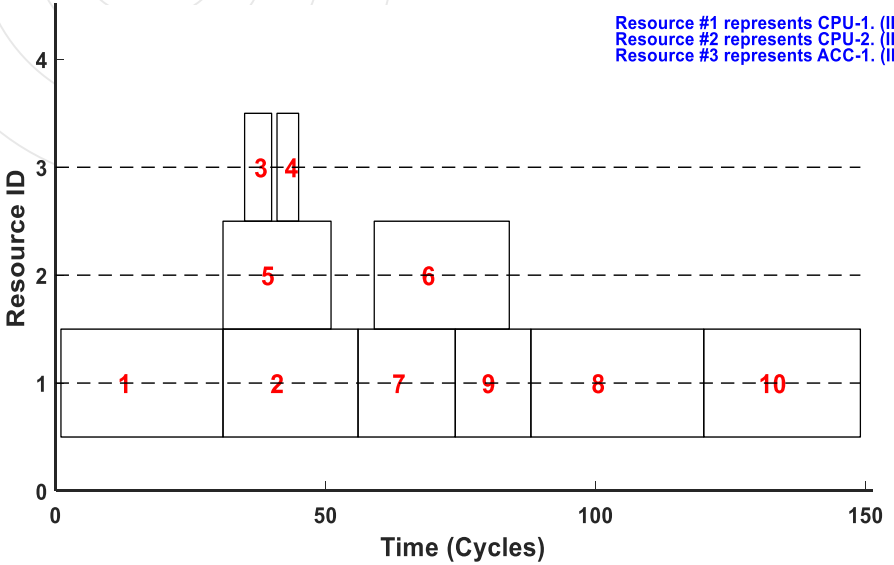
```
add_new_tasks 10
task_1 1
task_1 earliest_start 0 deadline 250
task_2 2 1
task_2 earliest_start 0 deadline 250
task_3 3 1
task_3 earliest_start 0 deadline 250
task_4 4 1
task_4 earliest_start 0 deadline 250
task_5 5 1
task_5 earliest_start 0 deadline 250
task_6 6 1
task_6 earliest_start 0 deadline 250
task_7 7 2 3 4
task_7 earliest_start 0 deadline 250
task_8 8 5 6
task_8 earliest_start 0 deadline 250
task_9 9 7
task_9 earliest_start 0 deadline 250
task_10 10 8 9
task_10 earliest_start 0 deadline 250
```

- Resource Description

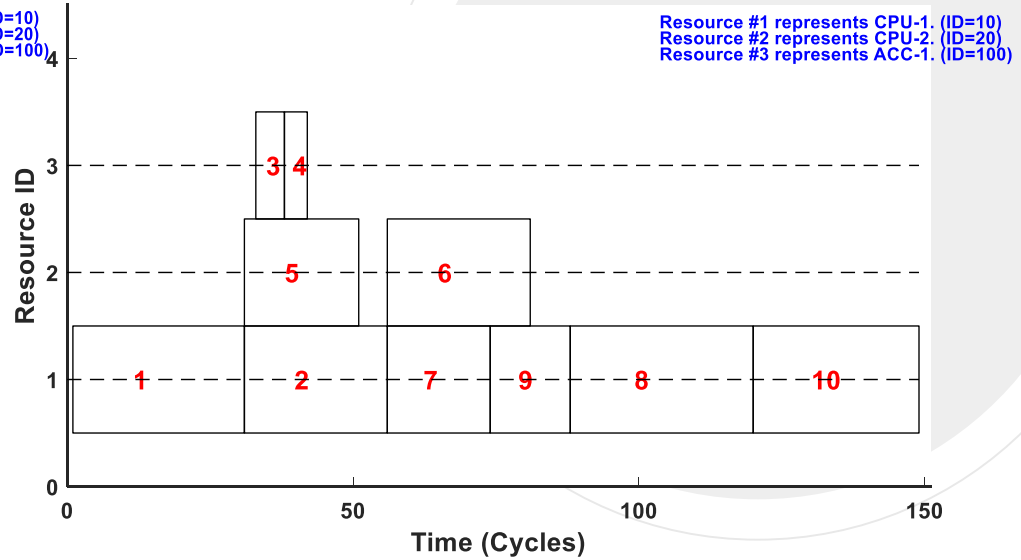
```
add_new_resource CPUa_0 0 10
task_1 30 22
task_2 25 23
task_3 23 24
task_4 16 20
task_5 20 18
task_6 25 17
task_7 18 20
task_8 32 29
task_9 14 15
task_10 29 18

add_new_resource ACCa_1 1 2
task_4 10 18
task_5 12 17

add_new_resource ACCb_1 1 2
task_2 5 4
task_3 4 5
```

Task Graph 4 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 0 for same type*
  - *-- 2 cycles for different type*



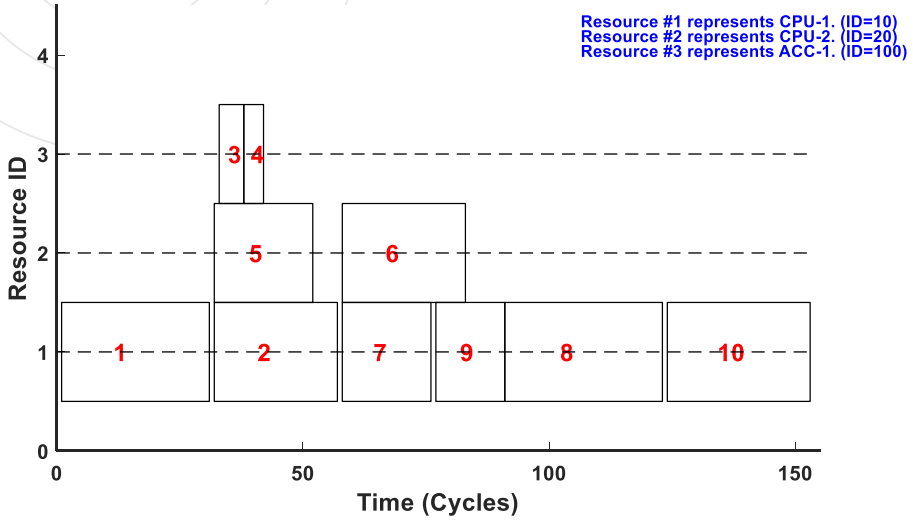
Intlinprog: 148 cycles



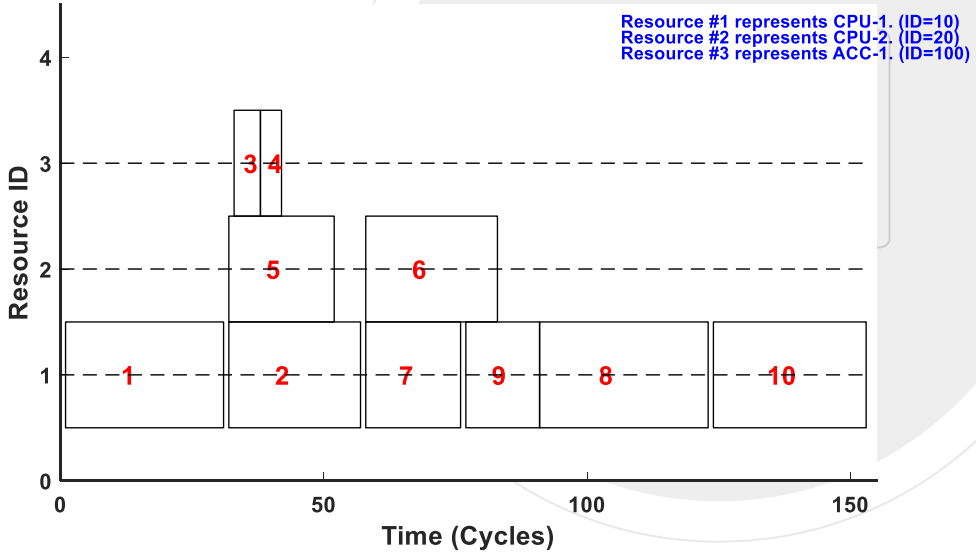
cplexmilp: 148 cycles

Task Graph 4 Scheduling (obj = tmax)

- **Communication Time:**
  - *-- 1 for same type*
  - *-- 2 cycles for different type*



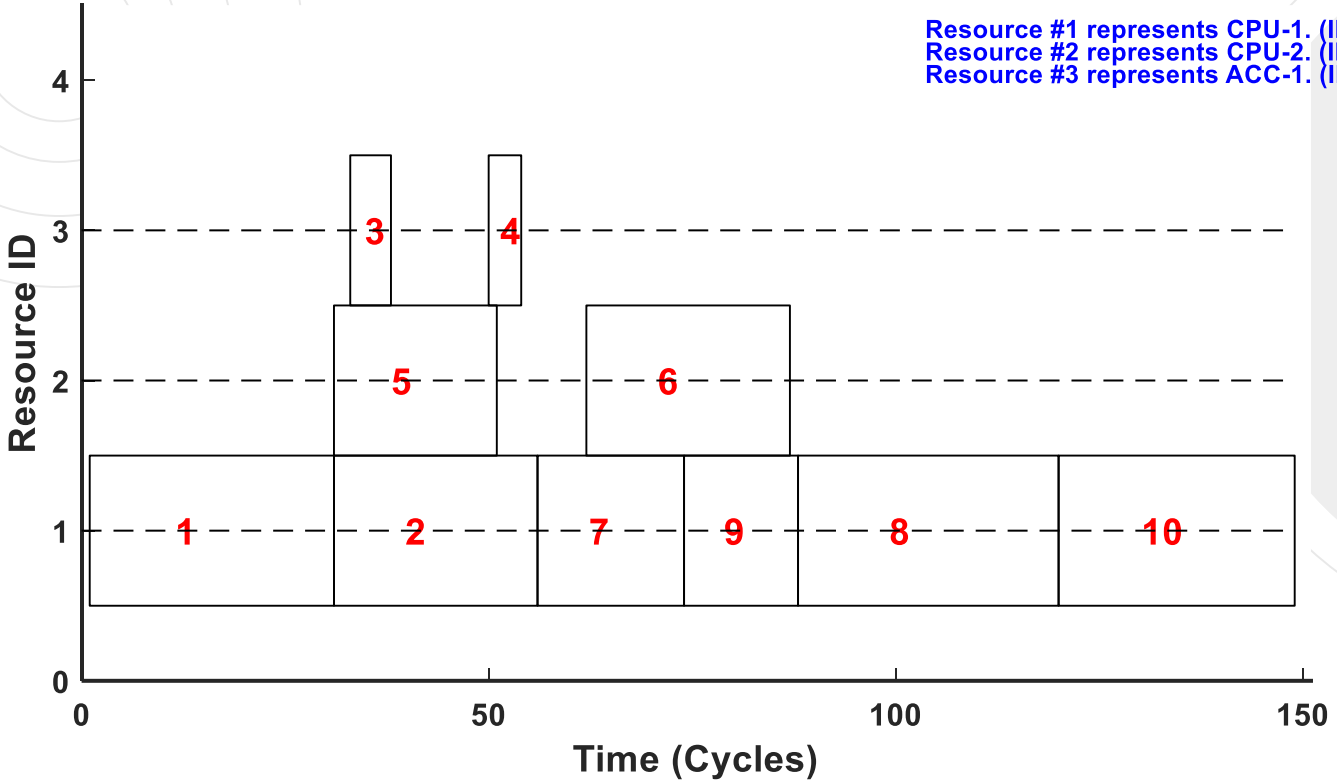
Intlinprog: 152 cycles



cplexmilp: 152 cycles

Task Graph 4 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 0 for same type*
  - *-- 2 for different type*



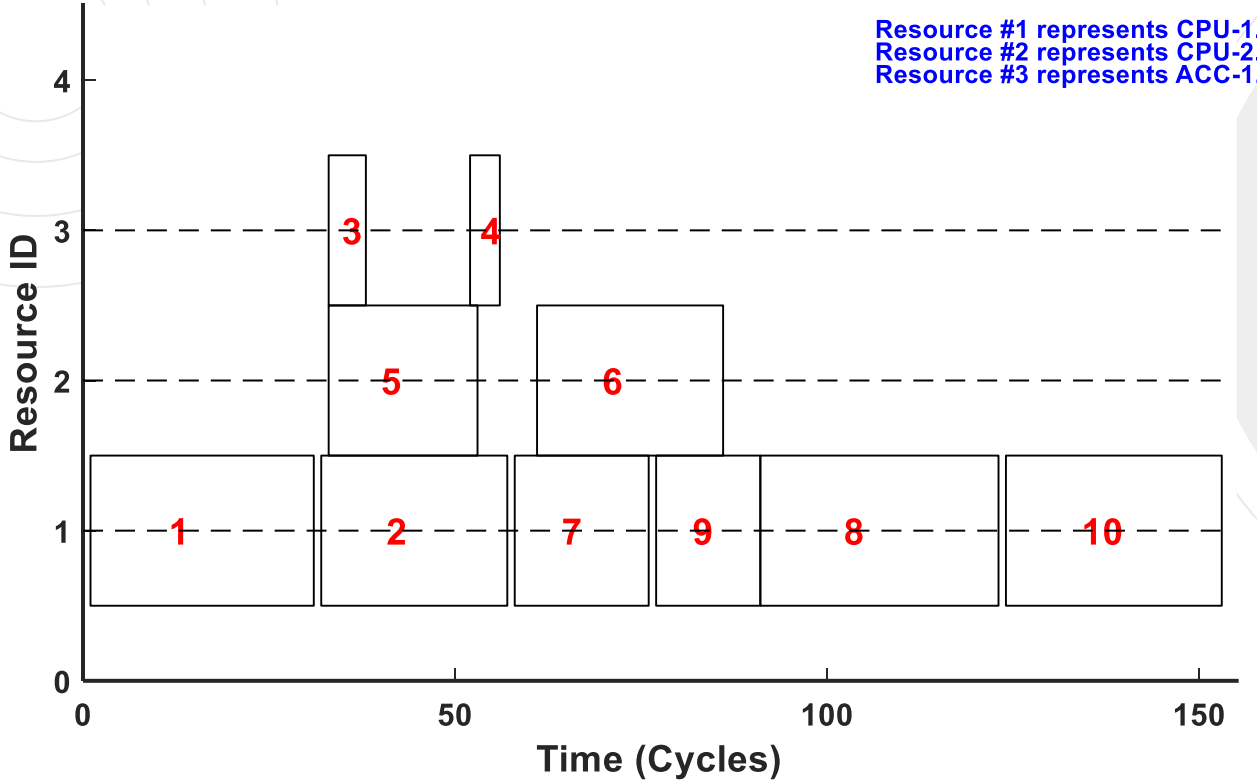
Cplexmilp:

148 cycles,

4100 units energy

Task Graph 4 Scheduling (obj = tmax + energy)

- Communication Power, Time:
  - *-- 1 for same type*
  - *-- 2 for different type*



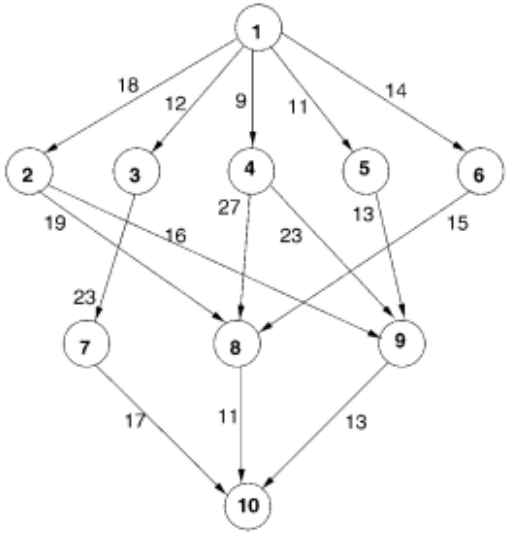
Cplexmilp:

152 cycles,

4110 units energy

Task Graph 5

- CTG 5



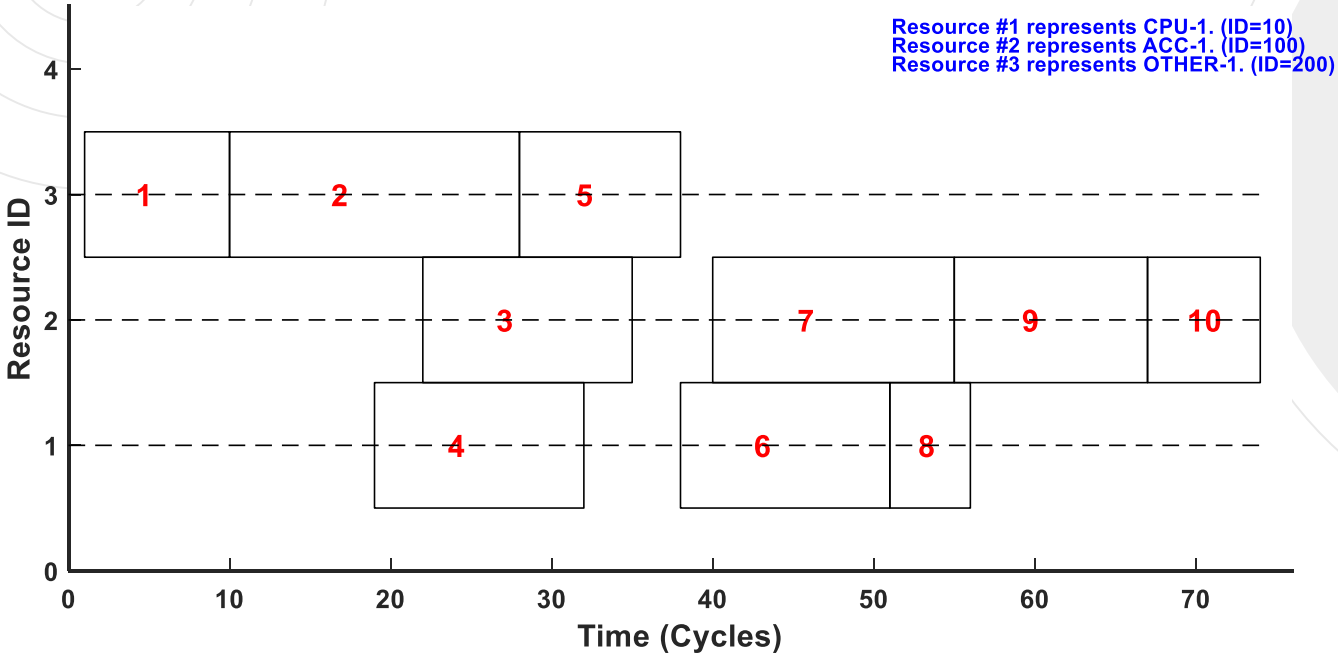
- CTG 5 Description

```
add_new_tasks 10
task_1 1
task_1 earliest_start 0 deadline 90
task_2 2 1
task_2 earliest_start 0 deadline 90
task_3 3 1
task_3 earliest_start 0 deadline 90
task_4 4 1
task_4 earliest_start 0 deadline 90
task_5 5 1
task_5 earliest_start 0 deadline 90
task_6 6 1
task_6 earliest_start 0 deadline 90
task_7 7 3
task_7 earliest_start 0 deadline 90
task_8 8 2 4 6
task_8 earliest_start 0 deadline 90
task_9 9 2 4 5
task_9 earliest_start 0 deadline 90
task_10 10 7 8 9
task_10 earliest_start 0 deadline 90
```

- Resource Description

```
add_new_resource CPUa_0 0 10
task_1 14 2
task_2 13 2
task_3 11 3
task_4 13 3
task_5 12 4
task_6 13 4
task_7 7 5
task_8 5 5
task_9 18 7
task_10 21 7

add_new_resource ACCa_1 1 10
task_1 16 4
task_2 19 4
task_3 13 3
task_4 8 3
task_5 13 2
task_6 16 2
task_7 15 1
task_8 11 1
task_9 12 3
task_10 7 3

add_new_resource OTHERa_1 1 10
task_1 9 12
task_2 18 12
task_3 19 11
task_4 17 11
task_5 10 5
task_6 9 5
task_7 11 7
task_8 14 7
task_9 20 9
task_10 16 9
```

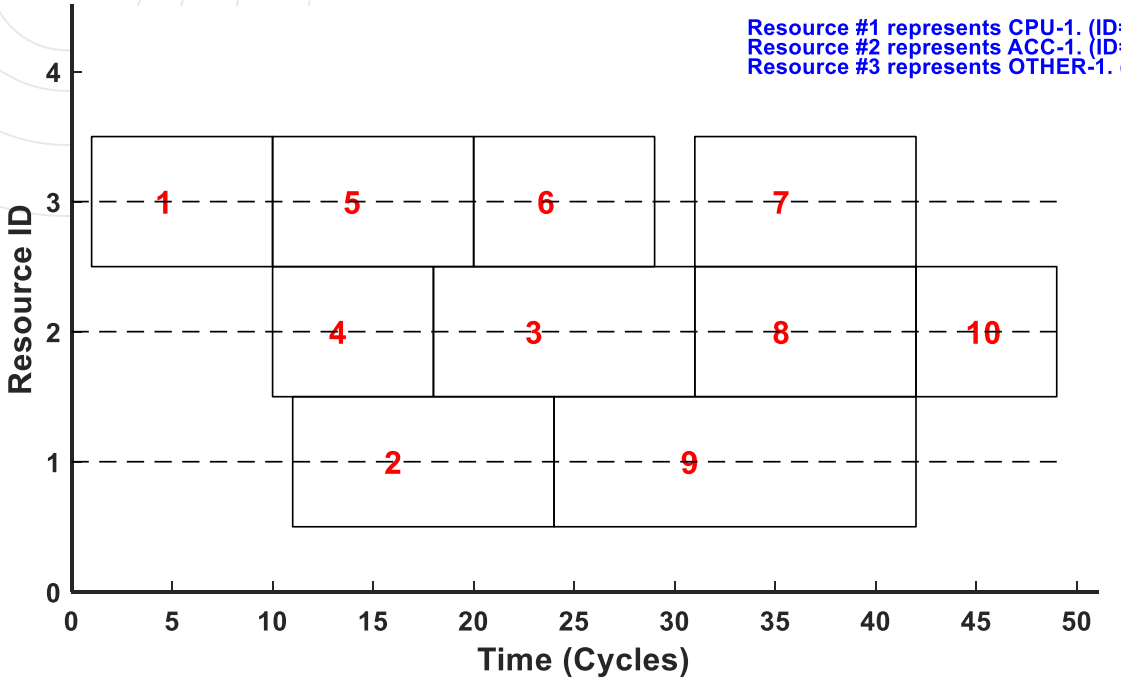
Task Graph 5 Scheduling (cplexmilp) (obj = tmax)



- ILP: 73 cycles
- HEFT: 80 cycles

Task Graph 5 Scheduling (cplexmilp) (obj = tmax)

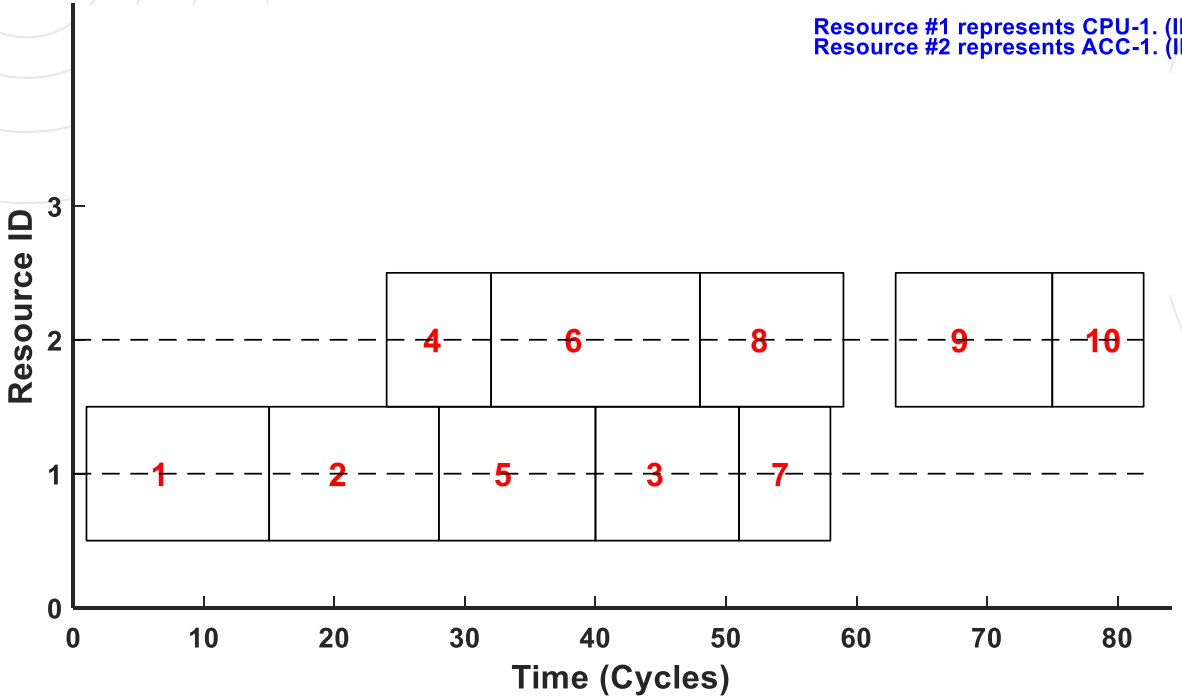
- Communication Time: 0!



- ILP: 48 cycles
- HEFT: ?? cycles

Task Graph 5 Scheduling (cplexmilp) (obj = tmax + energy)

- Communication Power:
  - *-- 0 for same type*
  - *-- 2 for different type*



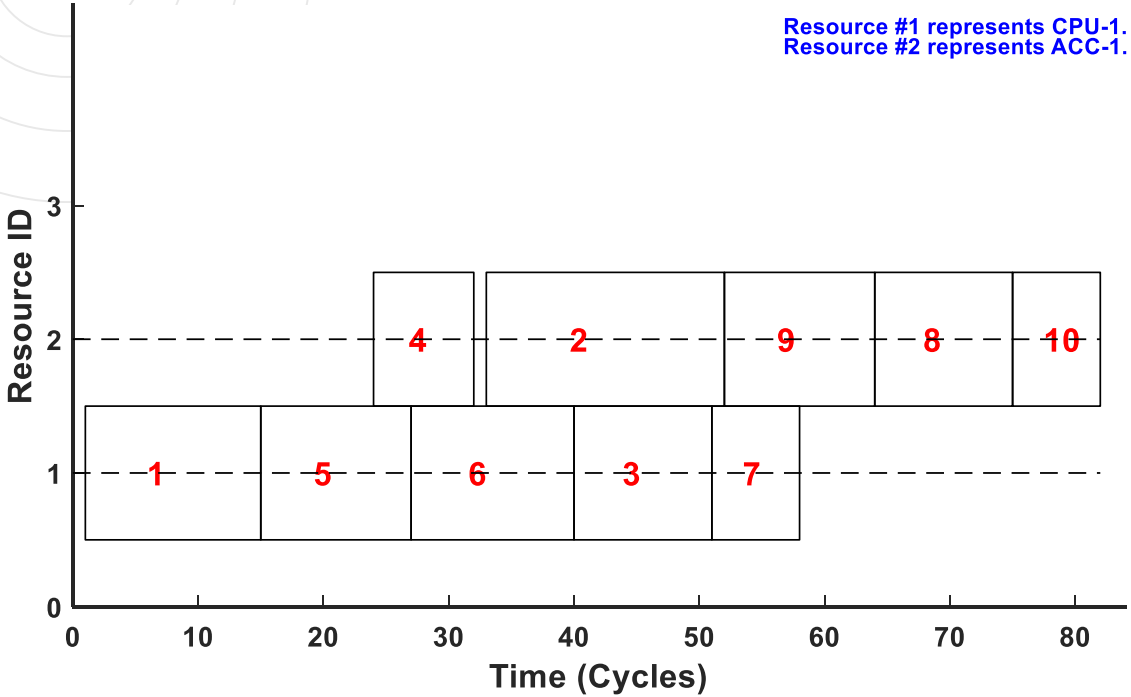
Cplexmilp:

81 cycles,

470 units energy

Task Graph 5 Scheduling (cplexmilp) (obj = tmax + energy)

- Communication Power:
  - *-- 0 for same type*
  - *-- 5 for different type*



Cplexmilp:

81 cycles,

724 units energy

Task Graph 5 Scheduling (cplexmilp) (obj = tmax + energy)

Performance Budget	Energy
< 73	NA
73	994
74	790
76	761
85	672
100	645