Energy and Performance-Aware Task Scheduling in a Mobile Cloud Computing Environment Algorithm Implementation

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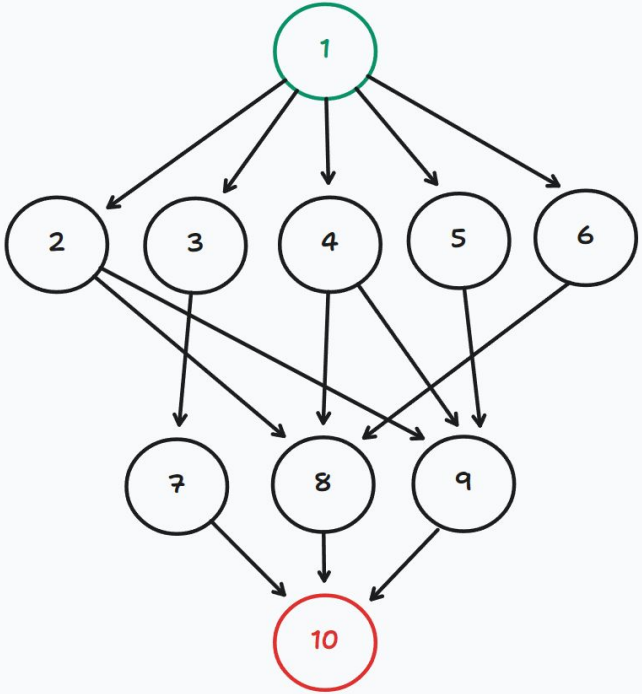
Test 1- Graph and Execution Time Table



Node ID	Core1	Core2	Core3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	7	4	2

Ws_time	Cloud_time	Wr_time
3	1	1

Test 1- Initial Scheduling Results with Energy Calculation

```
INITIAL TIME: 18
INITIAL ENERGY: 100.5
Node ID: 1, Assignment: Core 3, Local Start Time: 0, Local Finish Time: 5
Node ID: 2, Assignment: Cloud, Cloud Start Time: 8, Cloud Finish Time: 9, WS Start Time: 5, WS Finish Time: 8, WR Start Time: 9, WR Finish Time: 10
Node ID: 3, Assignment: Core 3, Local Start Time: 5, Local Finish Time: 9
Node ID: 4, Assignment: Core 1, Local Start Time: 5, Local Finish Time: 12
Node ID: 5, Assignment: Core 3, Local Start Time: 9, Local Finish Time: 11
Node ID: 6, Assignment: Core 2, Local Start Time: 5, Local Finish Time: 11
Node ID: 7, Assignment: Core 3, Local Start Time: 11, Local Finish Time: 14
Node ID: 8, Assignment: Core 2, Local Start Time: 12, Local Finish Time: 16
Node ID: 9, Assignment: Core 3, Local Start Time: 14, Local Finish Time: 16
Node ID: 10, Assignment: Core 3, Local Start Time: 16, Local Finish Time: 18
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5

Energy = Power * time

Core 1 Count = 1 (Node 4)

Core 2 Count = 2 (Nodes 6,8)

Core 3 Count = 6 (Nodes 1,3,5,7,9,10)

Cloud Count = 1 (Node 2)

E1 = 7*1 = 7

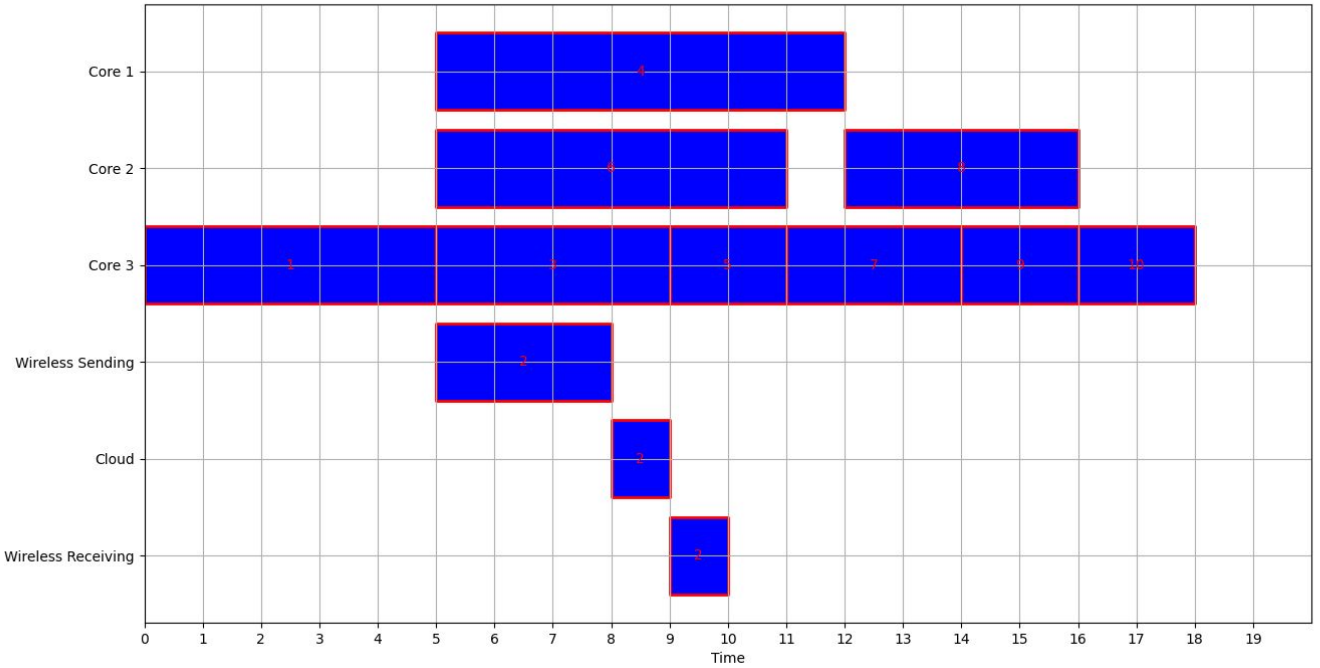
E2 = 6*2 + 4*2 = 20

E3 = 5*4 + 4*4 + 2*4 + 3*4 + 4*2 +2*4 = 72

ECloud = 1*3*0.5 (Node 2)

E_total = E1+E2+E3+ECloud = 100.5

Test 1- Initial Scheduling Results Plot



Test 1- Final Scheduling Results with Energy Calculation

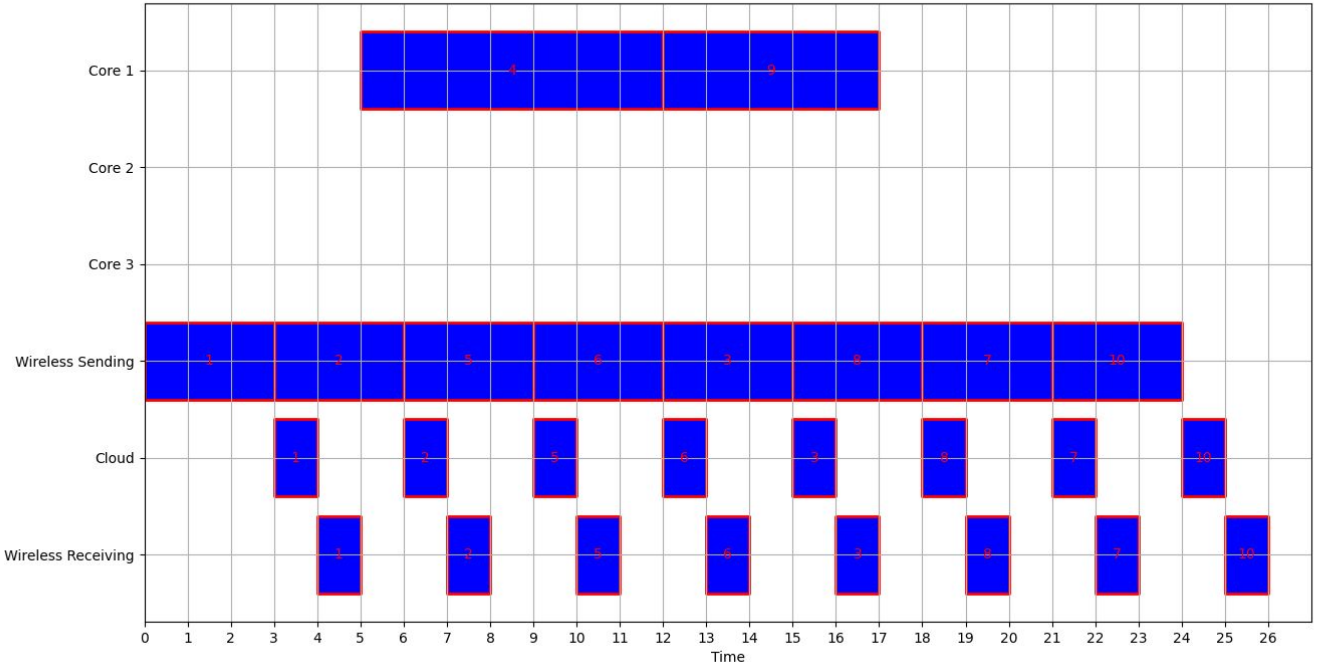
```
RESCHEDULING FINISHED

Node ID: 1, Assignment: Cloud, Cloud Start Time: 3, Cloud Finish Time: 4, WS Start Time: 0, WS Finish Time: 3, WR Start Time: 4, WR Finish Time: 5
Node ID: 2, Assignment: Cloud, Cloud Start Time: 6, Cloud Finish Time: 7, WS Start Time: 3, WS Finish Time: 6, WR Start Time: 7, WR Finish Time: 8
Node ID: 3, Assignment: Cloud, Cloud Start Time: 15, Cloud Finish Time: 16, WS Start Time: 12, WS Finish Time: 15, WR Start Time: 16, WR Finish Time: 17
Node ID: 4, Assignment: Core 1, Local Start Time: 5, Local Finish Time: 12
Node ID: 5, Assignment: Cloud, Cloud Start Time: 9, Cloud Finish Time: 10, WS Start Time: 6, WS Finish Time: 9, WR Start Time: 10, WR Finish Time: 11
Node ID: 6, Assignment: Cloud, Cloud Start Time: 12, Cloud Finish Time: 13, WS Start Time: 9, WS Finish Time: 12, WR Start Time: 13, WR Finish Time: 14
Node ID: 7, Assignment: Cloud, Cloud Start Time: 21, Cloud Finish Time: 22, WS Start Time: 18, WS Finish Time: 21, WR Start Time: 22, WR Finish Time: 23
Node ID: 8, Assignment: Cloud, Cloud Start Time: 18, Cloud Finish Time: 19, WS Start Time: 15, WS Finish Time: 18, WR Start Time: 19, WR Finish Time: 20
Node ID: 9, Assignment: Core 1, Local Start Time: 12, Local Finish Time: 17
Node ID: 10, Assignment: Cloud, Cloud Start Time: 24, Cloud Finish Time: 25, WS Start Time: 21, WS Finish Time: 24, WR Start Time: 25, WR Finish Time: 26

Time to run on machine: 24 milliseconds
final sequence:
[4 9 ]
[]
[]
[1 2 5 6 3 8 7 10 ]

INITIAL TIME: 18
INITIAL ENERGY: 100.5

FINAL TIME: 26
FINAL ENERGY: 24
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

Core 1 Count = 2 (Node 4,9)
Core 2 Count = 0
Core 3 Count = 0
Cloud Count = 8 (Node 1,2,5,6,3,8,7,10)

E1 = 7*1 + 5*1 = 12
E2 = 0
E3 = 0
ECloud = 8*3*0.5
E_total = E1+E2+E3+ECloud = 24

Test 1- Final Scheduling Results Plot



Comparison between test 1 and example test in the paper

- Initial task scheduling is identical
- Final task scheduling varies only in the placement of task 9 (In my test it occurs on core 1 immediately after the completion of 4
- Test 1 results: T_total = 26 E_total = 24
- Paper results : T_total = 26 E_total = 27
- The issue appears to arise only in phase 2 of scheduling (outer loop) not initial scheduling
- The issue most likely comes down to simply how the nodes are sorted. There are often ties in eff_ratio values and the first max value is the one selected for migration. A slightly different ordering of the node list could easily lead to minor changes in rescheduling that propagate and alter the overall final scheduling

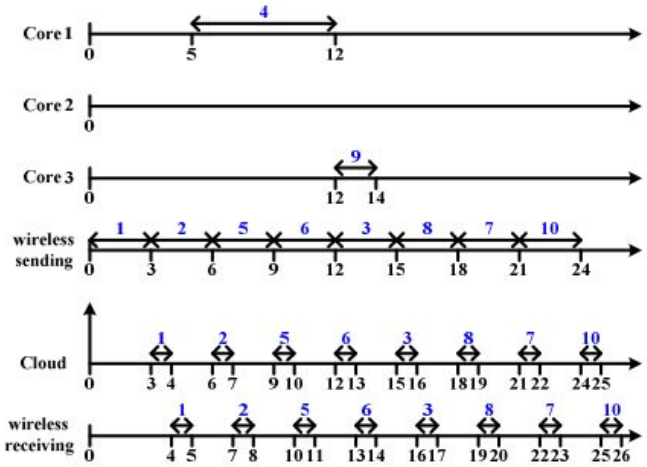
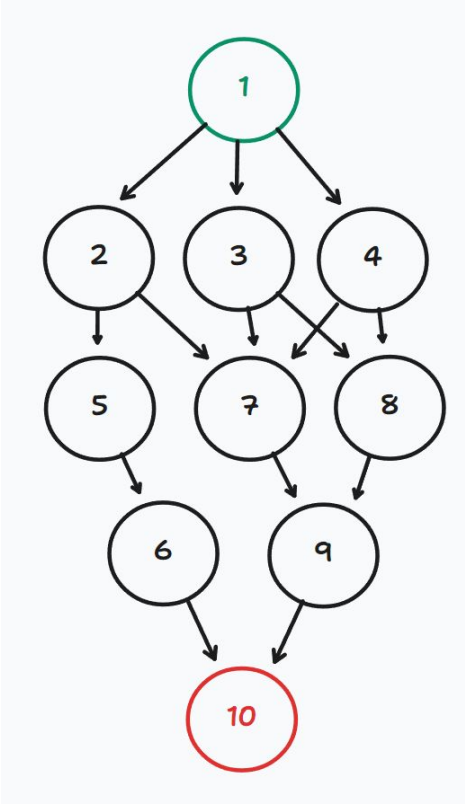


Figure 4. Task scheduling result by the MCC task scheduling algorithm.

Test 2- Graph and Execution Time Table



Node ID	Core1	Core2	Core3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	7	4	2

Ws_time	Cloud_time	Wr_time
3	1	1

Test 2- Initial Scheduling Results with Energy Calculation

```
INITIAL TIME: 19
INITIAL ENERGY: 95
Node ID: 1, Assignment: Core 3, Local Start Time: 0, Local Finish Time: 5
Node ID: 2, Assignment: Core 3, Local Start Time: 5, Local Finish Time: 10
Node ID: 3, Assignment: Cloud, Cloud Start Time: 8, Cloud Finish Time: 9, WS Start Time: 5, WS Finish Time: 8, WR Start Time: 9, WR Finish Time: 10
Node ID: 4, Assignment: Core 2, Local Start Time: 5, Local Finish Time: 10
Node ID: 5, Assignment: Core 3, Local Start Time: 10, Local Finish Time: 12
Node ID: 6, Assignment: Cloud, Cloud Start Time: 15, Cloud Finish Time: 16, WS Start Time: 12, WS Finish Time: 15, WR Start Time: 16, WR Finish Time: 17
Node ID: 7, Assignment: Core 2, Local Start Time: 10, Local Finish Time: 15
Node ID: 8, Assignment: Core 3, Local Start Time: 12, Local Finish Time: 14
Node ID: 9, Assignment: Core 3, Local Start Time: 15, Local Finish Time: 17
Node ID: 10, Assignment: Core 3, Local Start Time: 17, Local Finish Time: 19
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5

Energy = Power * time

Core 1 Count = 0

Core 2 Count = 2 (Nodes 4,7)

Core 3 Count = 6 (Nodes 1,2,5,8,9,10)

Cloud Count = 2 (Node 3,6)

E1 = 0

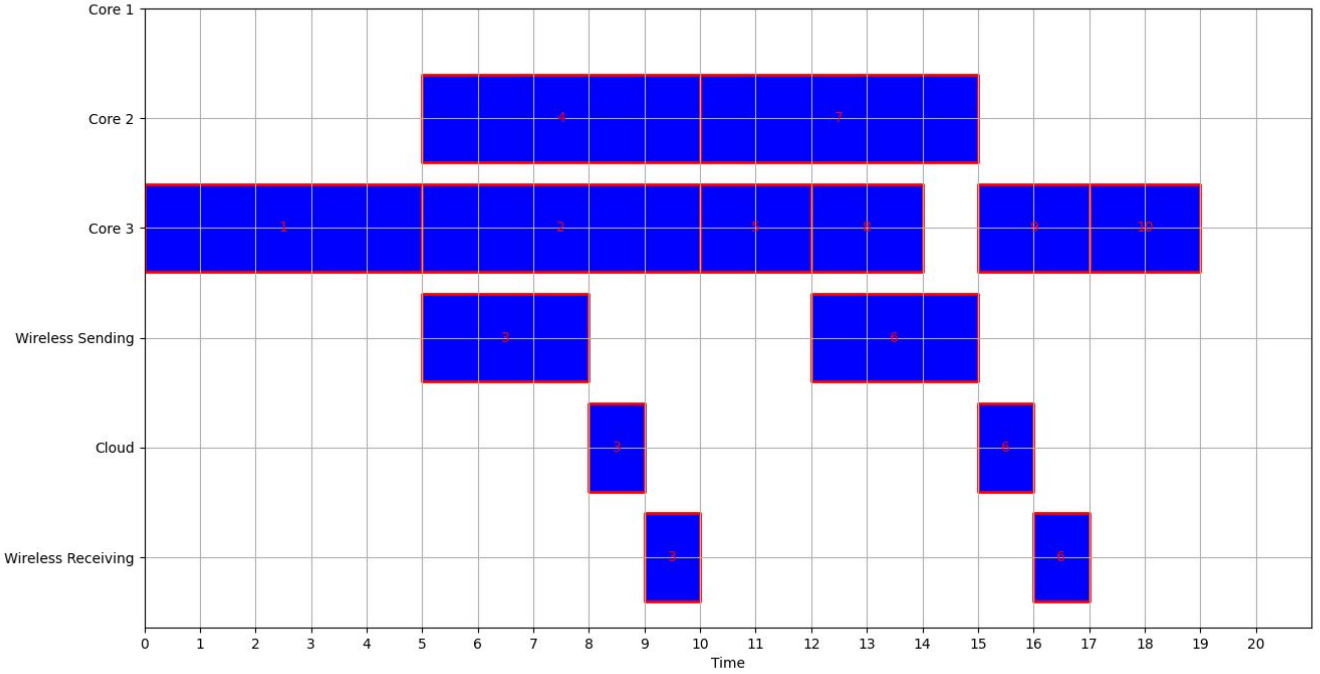
E2 = 5*2 + 5*2 = 20

E3 = 5*4 + 5*4 + 2*4 + 2* 4+ 2*4 + 2*4 = 72

ECloud = 2*3*0.5 = 3

E_total = E1+E2+E3+ECloud = 95

Test 2- Initial Scheduling Results Plot



Test 2- Final Scheduling Results with Energy Calculation

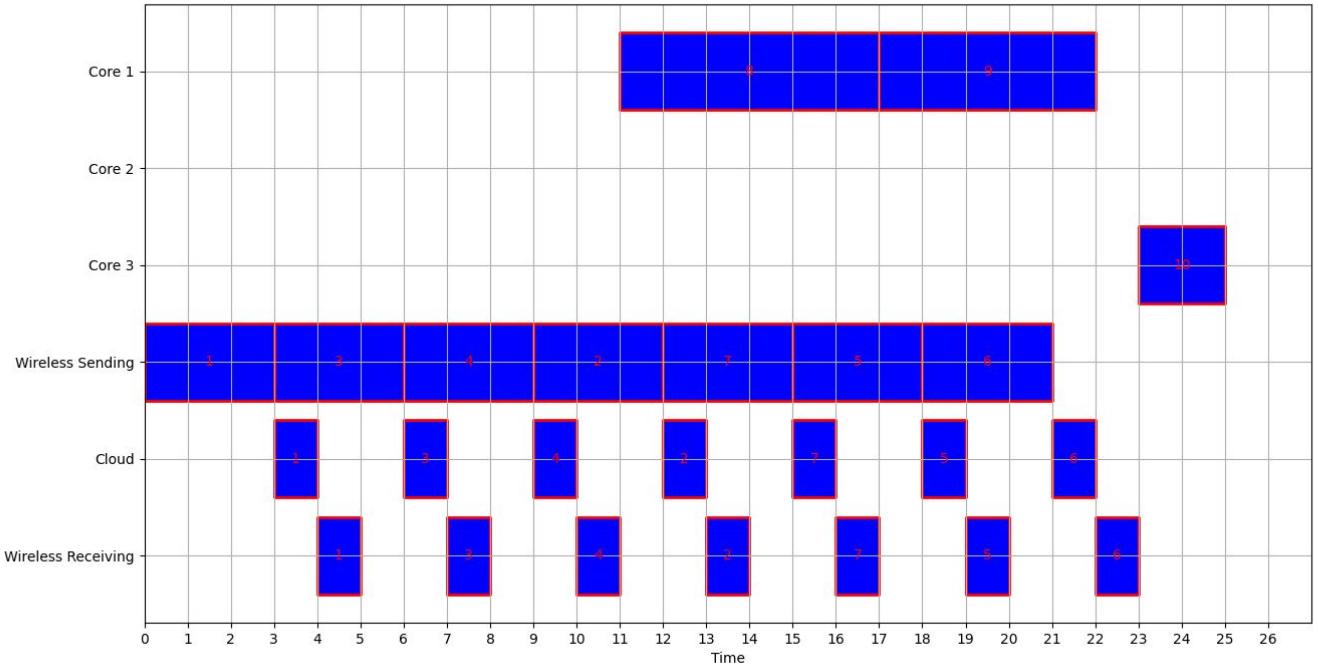
```
RESCHEDULING FINISHED

Node ID: 1, Assignment: Cloud, Cloud Start Time: 3, Cloud Finish Time: 4, WS Start Time: 0, WS Finish Time: 3, WR Start Time: 4, WR Finish Time: 5
Node ID: 2, Assignment: Cloud, Cloud Start Time: 12, Cloud Finish Time: 13, WS Start Time: 9, WS Finish Time: 12, WR Start Time: 13, WR Finish Time: 14
Node ID: 3, Assignment: Cloud, Cloud Start Time: 6, Cloud Finish Time: 7, WS Start Time: 3, WS Finish Time: 6, WR Start Time: 7, WR Finish Time: 8
Node ID: 4, Assignment: Cloud, Cloud Start Time: 9, Cloud Finish Time: 10, WS Start Time: 6, WS Finish Time: 9, WR Start Time: 10, WR Finish Time: 11
Node ID: 5, Assignment: Cloud, Cloud Start Time: 18, Cloud Finish Time: 19, WS Start Time: 15, WS Finish Time: 18, WR Start Time: 19, WR Finish Time: 20
Node ID: 6, Assignment: Cloud, Cloud Start Time: 21, Cloud Finish Time: 22, WS Start Time: 18, WS Finish Time: 21, WR Start Time: 22, WR Finish Time: 23
Node ID: 7, Assignment: Cloud, Cloud Start Time: 15, Cloud Finish Time: 16, WS Start Time: 12, WS Finish Time: 15, WR Start Time: 16, WR Finish Time: 17
Node ID: 8, Assignment: Core 1, Local Start Time: 11, Local Finish Time: 17
Node ID: 9, Assignment: Core 1, Local Start Time: 17, Local Finish Time: 22
Node ID: 10, Assignment: Core 3, Local Start Time: 23, Local Finish Time: 25

Time to run on machine: 23 milliseconds
final sequence:
[8 9 ]
[]
[10 ]
[1 3 4 2 7 5 6 ]

INITIAL TIME: 19
INITIAL ENERGY: 95

FINAL TIME: 25
FINAL ENERGY: 29.5
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

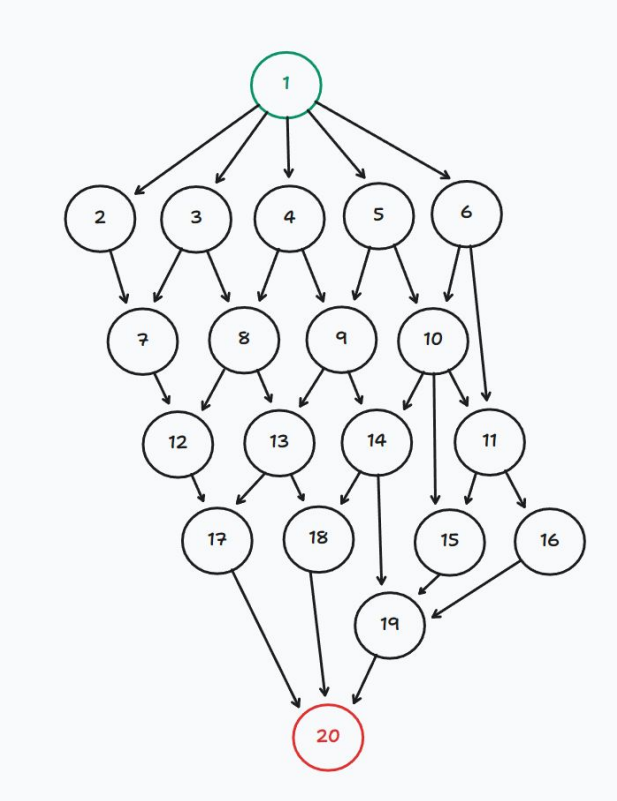
Core 1 Count = 2 (Node 8,9)
Core 2 Count = 0
Core 3 Count = 1 (Node 10)
Cloud Count = 7 (Node 1,2,3,4,5,6,7)

E1 = 6*1 + 5*1 = 11
E2 = 0
E3 = 2*4 = 8
ECloud = 7*3*0.5 = 10.5
E_total = E1+E2+E3+ECloud = 29.5

Test 2- Final Scheduling Results Plot



Test 3- Graph and Execution Time Table



Node ID	Core1	Core2	Core3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	7	4	2
11	12	3	3
12	12	8	4
13	11	3	2
14	12	11	4
15	13	4	2
16	9	7	3
17	9	3	3
18	13	9	2
19	10	5	3
20	12	5	4

Ws_time	Cloud_time	Wr_time
3	1	1

Test 3- Initial Scheduling Results with Energy Calculation

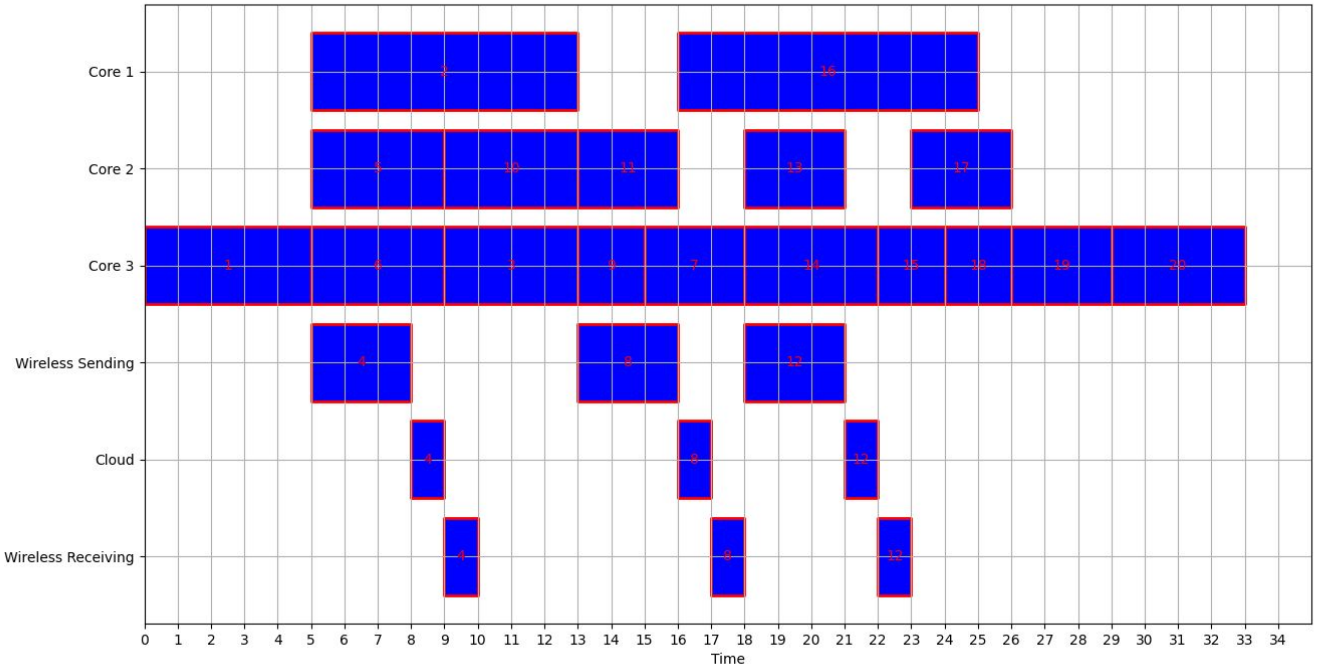
```
INITIAL TIME: 33
INITIAL ENERGY: 187.5
Node ID: 1, Assignment: Core 3, Local Start Time: 0, Local Finish Time: 5
Node ID: 2, Assignment: Core 1, Local Start Time: 5, Local Finish Time: 13
Node ID: 3, Assignment: Core 3, Local Start Time: 9, Local Finish Time: 13
Node ID: 4, Assignment: Cloud, Cloud Start Time: 8, Cloud Finish Time: 9, WS Start Time: 5, WS Finish Time: 8, WR Start Time: 9, WR Finish Time: 10
Node ID: 5, Assignment: Core 2, Local Start Time: 5, Local Finish Time: 9
Node ID: 6, Assignment: Core 3, Local Start Time: 5, Local Finish Time: 9
Node ID: 7, Assignment: Core 3, Local Start Time: 15, Local Finish Time: 18
Node ID: 8, Assignment: Cloud, Cloud Start Time: 16, Cloud Finish Time: 17, WS Start Time: 13, WS Finish Time: 16, WR Start Time: 17, WR Finish Time: 18
Node ID: 9, Assignment: Core 3, Local Start Time: 13, Local Finish Time: 15
Node ID: 10, Assignment: Core 2, Local Start Time: 9, Local Finish Time: 13
Node ID: 11, Assignment: Core 2, Local Start Time: 13, Local Finish Time: 16
Node ID: 12, Assignment: Cloud, Cloud Start Time: 21, Cloud Finish Time: 22, WS Start Time: 18, WS Finish Time: 21, WR Start Time: 22, WR Finish Time: 23
Node ID: 13, Assignment: Core 2, Local Start Time: 18, Local Finish Time: 21
Node ID: 14, Assignment: Core 3, Local Start Time: 18, Local Finish Time: 22
Node ID: 15, Assignment: Core 3, Local Start Time: 22, Local Finish Time: 24
Node ID: 16, Assignment: Core 1, Local Start Time: 16, Local Finish Time: 25
Node ID: 17, Assignment: Core 2, Local Start Time: 23, Local Finish Time: 26
Node ID: 18, Assignment: Core 3, Local Start Time: 24, Local Finish Time: 26
Node ID: 19, Assignment: Core 3, Local Start Time: 26, Local Finish Time: 29
Node ID: 20, Assignment: Core 3, Local Start Time: 29, Local Finish Time: 33
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

Core 1 Count = 2 (Node 2,16)
Core 2 Count = 5 (Node 5,10,11,13,17)
Core 3 Count = 10 (Node 1,6,3,7,9,14,15,18,19,20)
Cloud Count = 3 (Node 4,8,12)

E1 = 8*1 + 9*1 = 17
E2 = 4*2 + 4*2 + 3*2 + 3*2 + 3*2 = 34
E3 = 4(5+4+4+3+2+4+2+2+3+4) = 132
ECloud = 3*3*0.5 = 4.5
E_total = E1+E2+E3+ECloud = 187

Test 3- Initial Scheduling Results Plot



Test 3- Final Scheduling Results with Energy Calculation

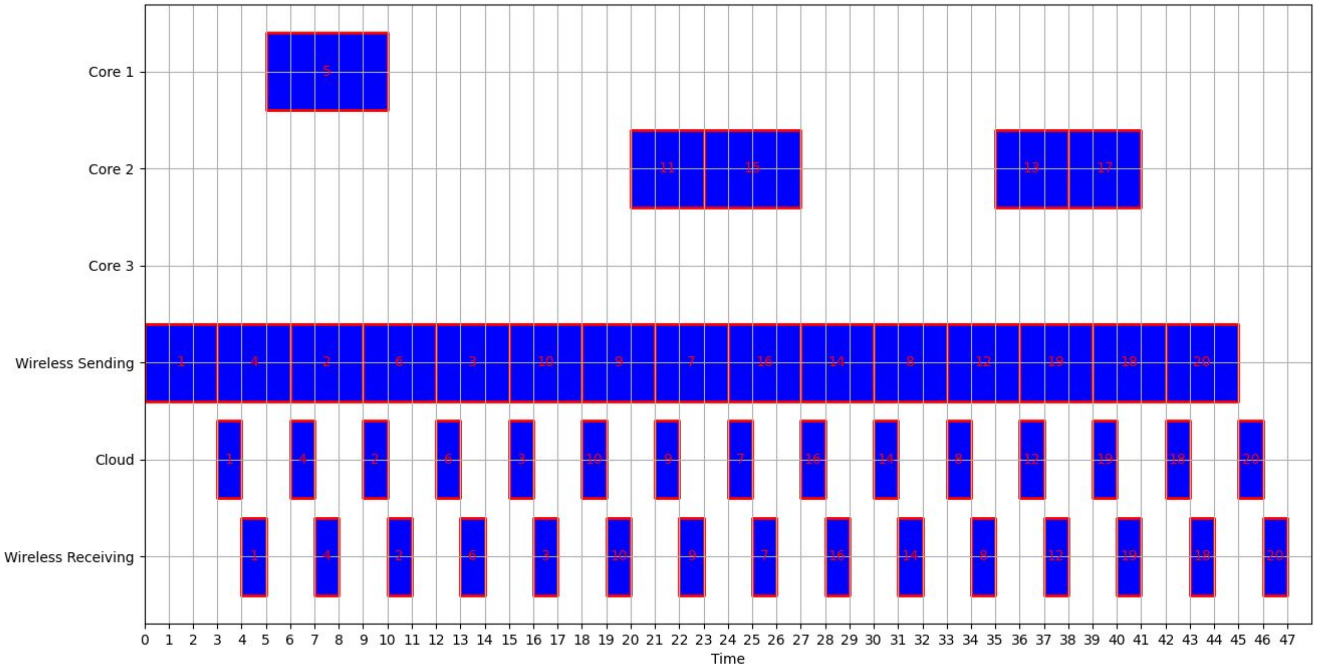
```
Node ID: 1, Assignment: Cloud, Cloud Start Time: 3, Cloud Finish Time: 4, WS Start Time: 0, WS Finish Time: 3, WR Start Time: 4, WR Finish Time: 5
Node ID: 2, Assignment: Cloud, Cloud Start Time: 9, Cloud Finish Time: 10, WS Start Time: 6, WS Finish Time: 9, WR Start Time: 10, WR Finish Time: 11
Node ID: 3, Assignment: Cloud, Cloud Start Time: 15, Cloud Finish Time: 16, WS Start Time: 12, WS Finish Time: 15, WR Start Time: 16, WR Finish Time: 17
Node ID: 4, Assignment: Cloud, Cloud Start Time: 6, Cloud Finish Time: 7, WS Start Time: 3, WS Finish Time: 6, WR Start Time: 7, WR Finish Time: 8
Node ID: 5, Assignment: Core 1, Local Start Time: 5, Local Finish Time: 10
Node ID: 6, Assignment: Cloud, Cloud Start Time: 12, Cloud Finish Time: 13, WS Start Time: 9, WS Finish Time: 12, WR Start Time: 13, WR Finish Time: 14
Node ID: 7, Assignment: Cloud, Cloud Start Time: 24, Cloud Finish Time: 25, WS Start Time: 21, WS Finish Time: 24, WR Start Time: 25, WR Finish Time: 26
Node ID: 8, Assignment: Cloud, Cloud Start Time: 33, Cloud Finish Time: 34, WS Start Time: 30, WS Finish Time: 33, WR Start Time: 34, WR Finish Time: 35
Node ID: 9, Assignment: Cloud, Cloud Start Time: 21, Cloud Finish Time: 22, WS Start Time: 18, WS Finish Time: 21, WR Start Time: 22, WR Finish Time: 23
Node ID: 10, Assignment: Cloud, Cloud Start Time: 18, Cloud Finish Time: 19, WS Start Time: 15, WS Finish Time: 18, WR Start Time: 19, WR Finish Time: 20
Node ID: 11, Assignment: Core 2, Local Start Time: 20, Local Finish Time: 23
Node ID: 12, Assignment: Cloud, Cloud Start Time: 36, Cloud Finish Time: 37, WS Start Time: 33, WS Finish Time: 36, WR Start Time: 37, WR Finish Time: 38
Node ID: 13, Assignment: Core 2, Local Start Time: 35, Local Finish Time: 38
Node ID: 14, Assignment: Cloud, Cloud Start Time: 30, Cloud Finish Time: 31, WS Start Time: 27, WS Finish Time: 30, WR Start Time: 31, WR Finish Time: 32
Node ID: 15, Assignment: Core 2, Local Start Time: 23, Local Finish Time: 27
Node ID: 16, Assignment: Cloud, Cloud Start Time: 27, Cloud Finish Time: 28, WS Start Time: 24, WS Finish Time: 27, WR Start Time: 28, WR Finish Time: 29
Node ID: 17, Assignment: Core 2, Local Start Time: 38, Local Finish Time: 41
Node ID: 18, Assignment: Cloud, Cloud Start Time: 42, Cloud Finish Time: 43, WS Start Time: 39, WS Finish Time: 42, WR Start Time: 43, WR Finish Time: 44
Node ID: 19, Assignment: Cloud, Cloud Start Time: 39, Cloud Finish Time: 40, WS Start Time: 36, WS Finish Time: 39, WR Start Time: 40, WR Finish Time: 41
Node ID: 20, Assignment: Cloud, Cloud Start Time: 45, Cloud Finish Time: 46, WS Start Time: 42, WS Finish Time: 45, WR Start Time: 46, WR Finish Time: 47

Time to run on machine: 150 milliseconds
final sequence:
[5 ]
[11 15 13 17 ]
[]
[1 4 2 6 3 10 9 7 16 14 8 12 19 18 20 ]

INITIAL TIME: 33
INITIAL ENERGY: 187.5

FINAL TIME: 47
FINAL ENERGY: 53.5
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

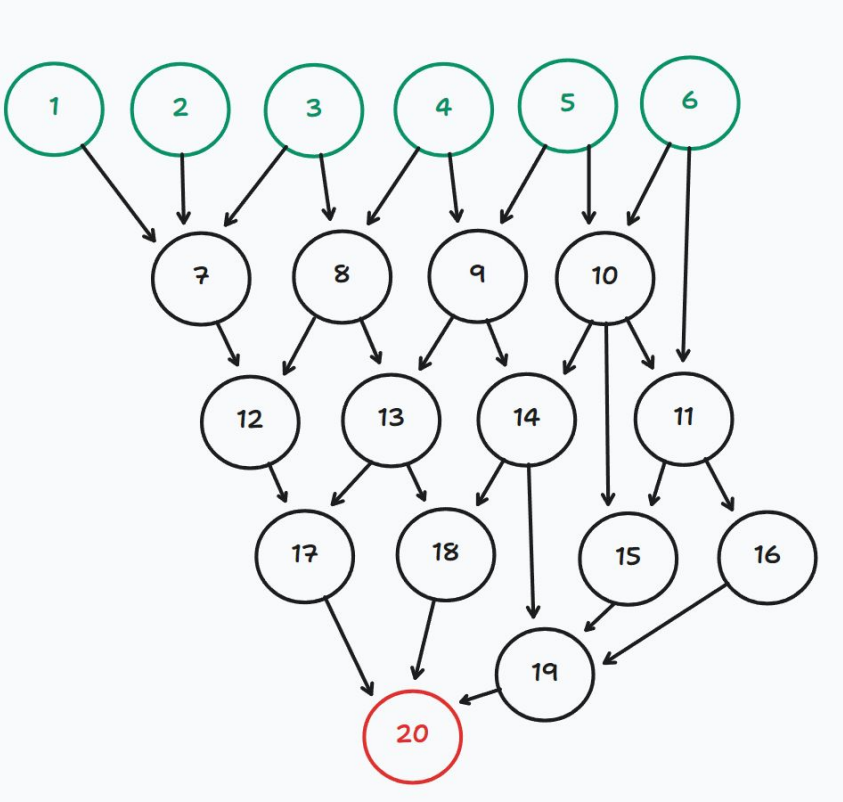
Core 1 Count = 1 (Node 5)
Core 2 Count = 4 (Node 11,13,15,17)
Core 3 Count = 0
Cloud Count = 15 (Node 1,2,3,4,6,7,8,9,10,12,14,16,18,19,20)

E1 = 5*1 = 5
E2 = 2(3+3+4+3) = 26
E3 = 0
ECloud = 15*3*0.5 = 22.5
E_total = E1+E2+E3+ECloud = 53.5

Test 3- Final Scheduling Results Plot



Test 4- Graph and Execution Time Table



Node ID	Core1	Core2	Core3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	7	4	2
11	12	3	3
12	12	8	4
13	11	3	2
14	12	11	4
15	13	4	2
16	9	7	3
17	9	3	3
18	13	9	2
19	10	5	3
20	12	5	4

Ws_time	Cloud_time	Wr_time
3	1	1

Test 4- Initial Scheduling Results with Energy Calculation

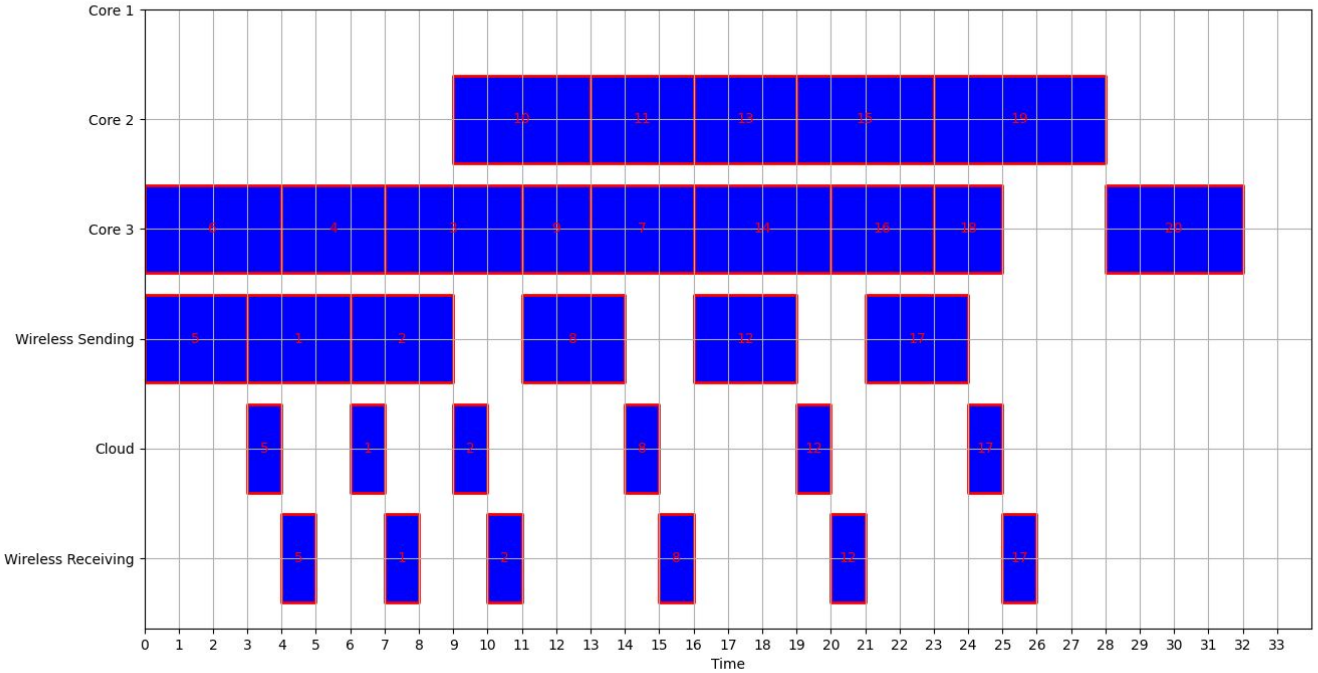
```
INITIAL TIME: 32
INITIAL ENERGY: 163
Node ID: 1, Assignment: Cloud, Cloud Start Time: 6, Cloud Finish Time: 7, WS Start Time: 3, WS Finish Time: 6, WR Start Time: 7, WR Finish Time: 8
Node ID: 2, Assignment: Cloud, Cloud Start Time: 9, Cloud Finish Time: 10, WS Start Time: 6, WS Finish Time: 9, WR Start Time: 10, WR Finish Time: 11
Node ID: 3, Assignment: Core 3, Local Start Time: 7, Local Finish Time: 11
Node ID: 4, Assignment: Core 3, Local Start Time: 4, Local Finish Time: 7
Node ID: 5, Assignment: Cloud, Cloud Start Time: 3, Cloud Finish Time: 4, WS Start Time: 0, WS Finish Time: 3, WR Start Time: 4, WR Finish Time: 5
Node ID: 6, Assignment: Core 3, Local Start Time: 0, Local Finish Time: 4
Node ID: 7, Assignment: Core 3, Local Start Time: 13, Local Finish Time: 16
Node ID: 8, Assignment: Cloud, Cloud Start Time: 14, Cloud Finish Time: 15, WS Start Time: 11, WS Finish Time: 14, WR Start Time: 15, WR Finish Time: 16
Node ID: 9, Assignment: Core 3, Local Start Time: 11, Local Finish Time: 13
Node ID: 10, Assignment: Core 2, Local Start Time: 9, Local Finish Time: 13
Node ID: 11, Assignment: Core 2, Local Start Time: 13, Local Finish Time: 16
Node ID: 12, Assignment: Cloud, Cloud Start Time: 19, Cloud Finish Time: 20, WS Start Time: 16, WS Finish Time: 19, WR Start Time: 20, WR Finish Time: 21
Node ID: 13, Assignment: Core 2, Local Start Time: 16, Local Finish Time: 19
Node ID: 14, Assignment: Core 3, Local Start Time: 16, Local Finish Time: 20
Node ID: 15, Assignment: Core 2, Local Start Time: 19, Local Finish Time: 23
Node ID: 16, Assignment: Core 3, Local Start Time: 20, Local Finish Time: 23
Node ID: 17, Assignment: Cloud, Cloud Start Time: 24, Cloud Finish Time: 25, WS Start Time: 21, WS Finish Time: 24, WR Start Time: 25, WR Finish Time: 26
Node ID: 18, Assignment: Core 3, Local Start Time: 23, Local Finish Time: 25
Node ID: 19, Assignment: Core 2, Local Start Time: 23, Local Finish Time: 28
Node ID: 20, Assignment: Core 3, Local Start Time: 28, Local Finish Time: 32
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

Core 1 Count = 0
Core 2 Count = 5 (Node 10,11,13,15,19)
Core 3 Count = 9 (Node 3,4,6,7,9,14,16,18,20)
Cloud Count = 6 *Node 1,2,5,8,12,17)

E1 = 0
E2 = 2(4+3+3+4+5) = 44
E3 = 4(4+3+4+3+2+4+3+2+4) = 116
ECloud = 6*3*0.5
E_total = E1+E2+E3+ECloud = 163

Test 4- Initial Scheduling Results Plot



Test 4- Final Scheduling Results with Energy Calculation

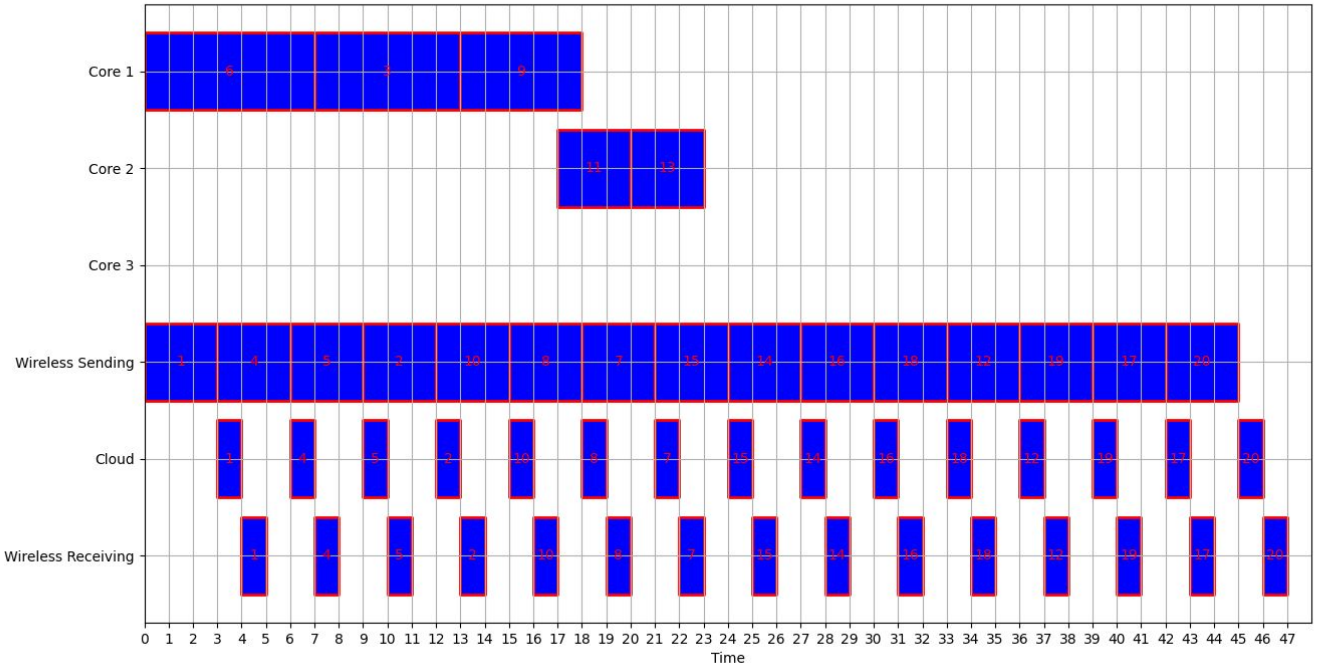
```
Node ID: 1, Assignment: Cloud, Cloud Start Time: 3, Cloud Finish Time: 4, WS Start Time: 0, WS Finish Time: 3, WR Start Time: 4, WR Finish Time: 5
Node ID: 2, Assignment: Cloud, Cloud Start Time: 12, Cloud Finish Time: 13, WS Start Time: 9, WS Finish Time: 12, WR Start Time: 13, WR Finish Time: 14
Node ID: 3, Assignment: Core 1, Local Start Time: 7, Local Finish Time: 13
Node ID: 4, Assignment: Cloud, Cloud Start Time: 6, Cloud Finish Time: 7, WS Start Time: 3, WS Finish Time: 6, WR Start Time: 7, WR Finish Time: 8
Node ID: 5, Assignment: Cloud, Cloud Start Time: 9, Cloud Finish Time: 10, WS Start Time: 6, WS Finish Time: 9, WR Start Time: 10, WR Finish Time: 11
Node ID: 6, Assignment: Core 1, Local Start Time: 0, Local Finish Time: 7
Node ID: 7, Assignment: Cloud, Cloud Start Time: 21, Cloud Finish Time: 22, WS Start Time: 18, WS Finish Time: 21, WR Start Time: 22, WR Finish Time: 23
Node ID: 8, Assignment: Cloud, Cloud Start Time: 18, Cloud Finish Time: 19, WS Start Time: 15, WS Finish Time: 18, WR Start Time: 19, WR Finish Time: 20
Node ID: 9, Assignment: Core 1, Local Start Time: 13, Local Finish Time: 18
Node ID: 10, Assignment: Cloud, Cloud Start Time: 15, Cloud Finish Time: 16, WS Start Time: 12, WS Finish Time: 15, WR Start Time: 16, WR Finish Time: 17
Node ID: 11, Assignment: Core 2, Local Start Time: 17, Local Finish Time: 20
Node ID: 12, Assignment: Cloud, Cloud Start Time: 36, Cloud Finish Time: 37, WS Start Time: 33, WS Finish Time: 36, WR Start Time: 37, WR Finish Time: 38
Node ID: 13, Assignment: Core 2, Local Start Time: 20, Local Finish Time: 23
Node ID: 14, Assignment: Cloud, Cloud Start Time: 27, Cloud Finish Time: 28, WS Start Time: 24, WS Finish Time: 27, WR Start Time: 28, WR Finish Time: 29
Node ID: 15, Assignment: Cloud, Cloud Start Time: 24, Cloud Finish Time: 25, WS Start Time: 21, WS Finish Time: 24, WR Start Time: 25, WR Finish Time: 26
Node ID: 16, Assignment: Cloud, Cloud Start Time: 30, Cloud Finish Time: 31, WS Start Time: 27, WS Finish Time: 30, WR Start Time: 31, WR Finish Time: 32
Node ID: 17, Assignment: Cloud, Cloud Start Time: 42, Cloud Finish Time: 43, WS Start Time: 39, WS Finish Time: 42, WR Start Time: 43, WR Finish Time: 44
Node ID: 18, Assignment: Cloud, Cloud Start Time: 33, Cloud Finish Time: 34, WS Start Time: 30, WS Finish Time: 33, WR Start Time: 34, WR Finish Time: 35
Node ID: 19, Assignment: Cloud, Cloud Start Time: 39, Cloud Finish Time: 40, WS Start Time: 36, WS Finish Time: 39, WR Start Time: 40, WR Finish Time: 41
Node ID: 20, Assignment: Cloud, Cloud Start Time: 45, Cloud Finish Time: 46, WS Start Time: 42, WS Finish Time: 45, WR Start Time: 46, WR Finish Time: 47

Time to run on machine: 147 milliseconds
final sequence:
[6 3 9 ]
[11 13 ]
[]
[4 5 1 2 10 8 7 15 14 16 18 12 19 17 20 ]

INITIAL TIME: 32
INITIAL ENERGY: 163

FINAL TIME: 47
FINAL ENERGY: 52.5
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

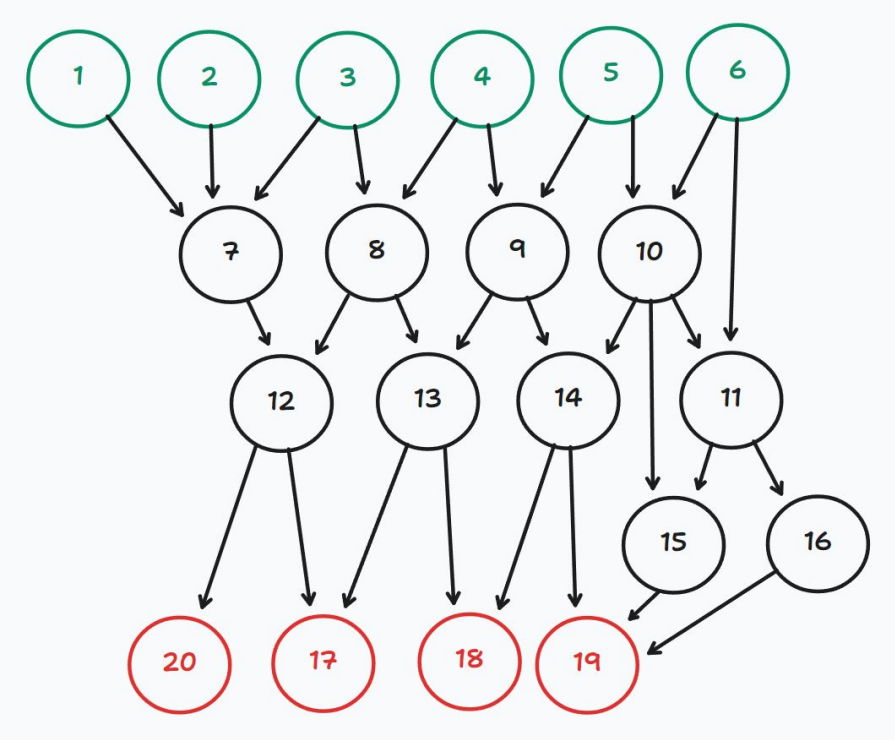
Core 1 Count = 3 (Node 3,6,9)
Core 2 Count = 2 (Node 11,13
Core 3 Count = 0
Cloud Count = 15 (Node 1,2,4,5,7,8,10,12,14,15,16,17,18,19,20)

E1 = 1(6+7+5) =18
E2 = 2(3+3)=12
E3 = 0
ECloud = 15*3*0.5 =22.5
E_total = E1+E2+E3+ECloud = 52.5

Test 4- Final Scheduling Results Plot



Test 5- Graph and Execution Time Table



Node ID	Core1	Core2	Core3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	7	4	2
11	12	3	3
12	12	8	4
13	11	3	2
14	12	11	4
15	13	4	2
16	9	7	3
17	9	3	3
18	13	9	2
19	10	5	3
20	12	5	4

Ws_time	Cloud_time	Wr_time
3	1	1

Test 5- Initial Scheduling Results with Energy Calculation

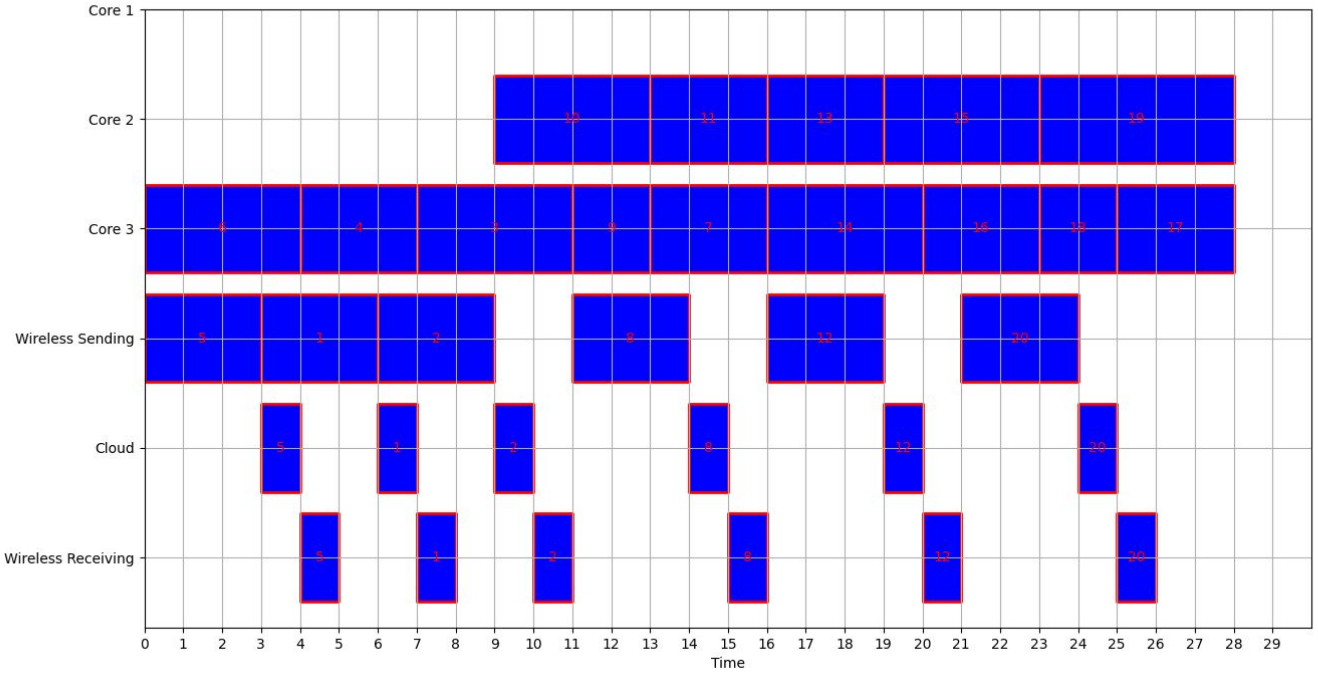
```
INITIAL TIME: 26
INITIAL ENERGY: 159
Node ID: 1, Assignment: Cloud, Cloud Start Time: 6, Cloud Finish Time: 7, WS Start Time: 3, WS Finish Time: 6, WR Start Time: 7, WR Finish Time: 8
Node ID: 2, Assignment: Cloud, Cloud Start Time: 9, Cloud Finish Time: 10, WS Start Time: 6, WS Finish Time: 9, WR Start Time: 10, WR Finish Time: 11
Node ID: 3, Assignment: Core 3, Local Start Time: 7, Local Finish Time: 11
Node ID: 4, Assignment: Core 3, Local Start Time: 4, Local Finish Time: 7
Node ID: 5, Assignment: Cloud, Cloud Start Time: 3, Cloud Finish Time: 4, WS Start Time: 0, WS Finish Time: 3, WR Start Time: 4, WR Finish Time: 5
Node ID: 6, Assignment: Core 3, Local Start Time: 0, Local Finish Time: 4
Node ID: 7, Assignment: Core 3, Local Start Time: 13, Local Finish Time: 16
Node ID: 8, Assignment: Cloud, Cloud Start Time: 14, Cloud Finish Time: 15, WS Start Time: 11, WS Finish Time: 14, WR Start Time: 15, WR Finish Time: 16
Node ID: 9, Assignment: Core 3, Local Start Time: 11, Local Finish Time: 13
Node ID: 10, Assignment: Core 2, Local Start Time: 9, Local Finish Time: 13
Node ID: 11, Assignment: Core 2, Local Start Time: 13, Local Finish Time: 16
Node ID: 12, Assignment: Cloud, Cloud Start Time: 19, Cloud Finish Time: 20, WS Start Time: 16, WS Finish Time: 19, WR Start Time: 20, WR Finish Time: 21
Node ID: 13, Assignment: Core 2, Local Start Time: 16, Local Finish Time: 19
Node ID: 14, Assignment: Core 3, Local Start Time: 16, Local Finish Time: 20
Node ID: 15, Assignment: Core 2, Local Start Time: 19, Local Finish Time: 23
Node ID: 16, Assignment: Core 3, Local Start Time: 20, Local Finish Time: 23
Node ID: 17, Assignment: Core 3, Local Start Time: 25, Local Finish Time: 28
Node ID: 18, Assignment: Core 3, Local Start Time: 23, Local Finish Time: 25
Node ID: 19, Assignment: Core 2, Local Start Time: 23, Local Finish Time: 28
Node ID: 20, Assignment: Cloud, Cloud Start Time: 24, Cloud Finish Time: 25, WS Start Time: 21, WS Finish Time: 24, WR Start Time: 25, WR Finish Time: 26
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

Core 1 Count = 0
Core 2 Count = 5 (Node 10,11,13,15,19)
Core 3 Count = 9 (Node 3,4,6,7,9,14,16,17,18)
Cloud Count = 6 (Node 1,2,5,8,12,20)

E1 = 0
E2 = 2(4+3+3+4+5) = 38
E3 = 4(4+3+4+3+2+4+3+3+2) = 112
ECloud = 6*3*0.5 =9
E_total = E1+E2+E3+ECloud = 24

Test 5- Initial Scheduling Results Plot



Test 5- Final Scheduling Results with Energy Calculation

```
Node ID: 1, Assignment: Cloud, Cloud Start Time: 3, Cloud Finish Time: 4, WS Start Time: 0, WS Finish Time: 3, WR Start Time: 4, WR Finish Time: 5
Node ID: 2, Assignment: Cloud, Cloud Start Time: 9, Cloud Finish Time: 10, WS Start Time: 6, WS Finish Time: 9, WR Start Time: 10, WR Finish Time: 11
Node ID: 3, Assignment: Cloud, Cloud Start Time: 12, Cloud Finish Time: 13, WS Start Time: 9, WS Finish Time: 12, WR Start Time: 13, WR Finish Time: 14
Node ID: 4, Assignment: Core 1, Local Start Time: 0, Local Finish Time: 7
Node ID: 5, Assignment: Cloud, Cloud Start Time: 6, Cloud Finish Time: 7, WS Start Time: 3, WS Finish Time: 6, WR Start Time: 7, WR Finish Time: 8
Node ID: 6, Assignment: Core 1, Local Start Time: 7, Local Finish Time: 14
Node ID: 7, Assignment: Core 3, Local Start Time: 14, Local Finish Time: 17
Node ID: 8, Assignment: Cloud, Cloud Start Time: 15, Cloud Finish Time: 16, WS Start Time: 12, WS Finish Time: 15, WR Start Time: 16, WR Finish Time: 17
Node ID: 9, Assignment: Core 1, Local Start Time: 21, Local Finish Time: 26
Node ID: 10, Assignment: Core 1, Local Start Time: 14, Local Finish Time: 21
Node ID: 11, Assignment: Core 2, Local Start Time: 21, Local Finish Time: 24
Node ID: 12, Assignment: Cloud, Cloud Start Time: 20, Cloud Finish Time: 21, WS Start Time: 17, WS Finish Time: 20, WR Start Time: 21, WR Finish Time: 22
Node ID: 13, Assignment: Core 2, Local Start Time: 26, Local Finish Time: 29
Node ID: 14, Assignment: Core 1, Local Start Time: 26, Local Finish Time: 38
Node ID: 15, Assignment: Cloud, Cloud Start Time: 27, Cloud Finish Time: 28, WS Start Time: 24, WS Finish Time: 27, WR Start Time: 28, WR Finish Time: 29
Node ID: 16, Assignment: Cloud, Cloud Start Time: 30, Cloud Finish Time: 31, WS Start Time: 27, WS Finish Time: 30, WR Start Time: 31, WR Finish Time: 32
Node ID: 17, Assignment: Cloud, Cloud Start Time: 44, Cloud Finish Time: 45, WS Start Time: 41, WS Finish Time: 44, WR Start Time: 45, WR Finish Time: 46
Node ID: 18, Assignment: Cloud, Cloud Start Time: 41, Cloud Finish Time: 42, WS Start Time: 38, WS Finish Time: 41, WR Start Time: 42, WR Finish Time: 43
Node ID: 19, Assignment: Cloud, Cloud Start Time: 47, Cloud Finish Time: 48, WS Start Time: 44, WS Finish Time: 47, WR Start Time: 48, WR Finish Time: 49
Node ID: 20, Assignment: Cloud, Cloud Start Time: 23, Cloud Finish Time: 24, WS Start Time: 20, WS Finish Time: 23, WR Start Time: 24, WR Finish Time: 25

Time to run on machine: 102 milliseconds
final sequence:
[4 6 10 9 14 ]
[11 13 ]
[7 ]
[5 1 2 3 8 12 20 15 16 18 17 19 ]

INITIAL TIME: 26
INITIAL ENERGY: 159

FINAL TIME: 25
FINAL ENERGY: 80
```

Power for each device: Core1 =1, Core2 = 2, Core3 = 4, Cloud =0.5
Energy = Power * time

Core 1 Count = 5 (Node 4,6,9,10,14)
Core 2 Count = 2 (Node 11,13)
Core 3 Count = 1 (Node 7)
Cloud Count = 12 (Node 1,2,3,5,8,12,15,16,17,18,19,20)

E1 = 1(7+7+5+7+12) = 38
E2 = 2(3+3)= 12
E3 = 4(3)= 12
ECloud = 12*3*0.5= 18
E_total = E1+E2+E3+ECloud = 80

Test 5- Final Scheduling Results Plot