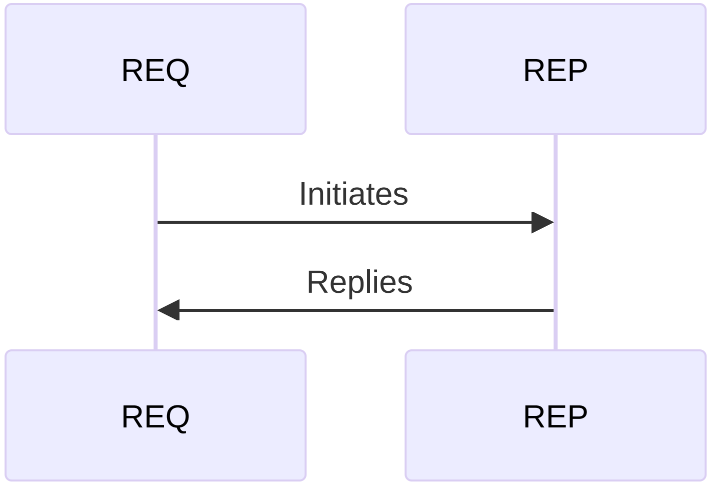
Master Thesis

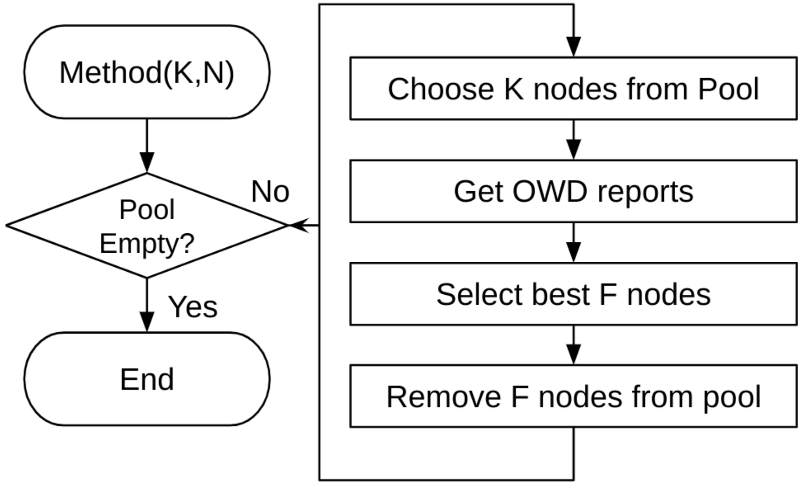
ZMQ Sockets

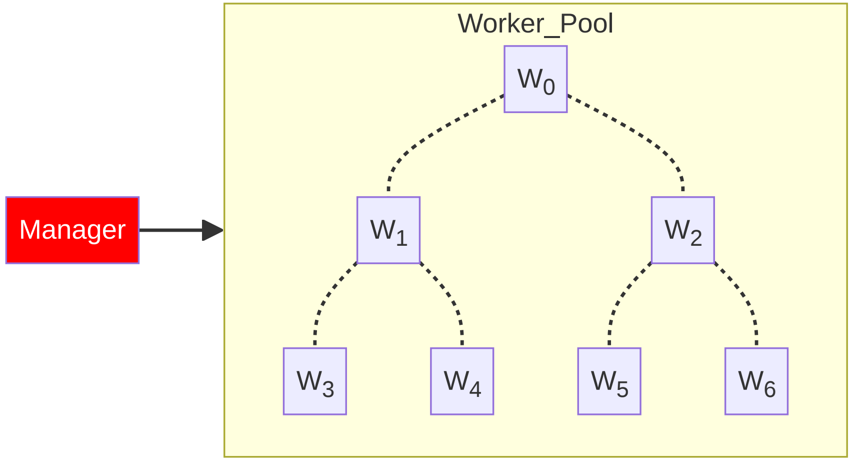
- ZMQ_REQ/ZMQ_REP
  - Send/Receiver order has to be respected
  - Reply remembers only last received address
- Other Sockets:
  - Push/Pull
  - Pub/Sub
  - Pair/Pair
  - Router/Dealer



Testbench and Heuristic

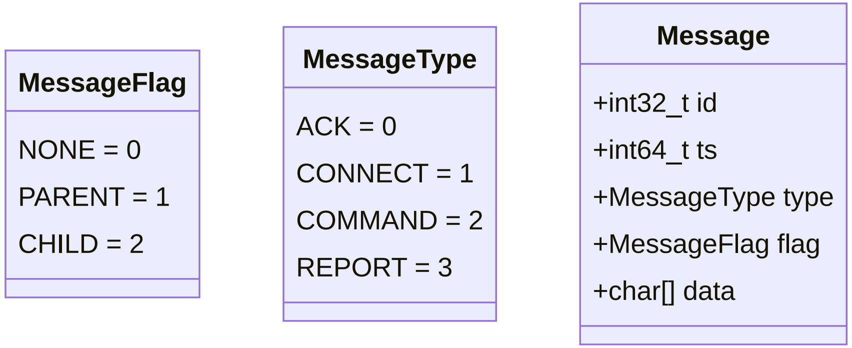
1. Allocate **N** VMs.
2. Run Jasper on Vanilla Setup
    1. Terminate
    2. Store Results
3. Apply Proposed Heuristic

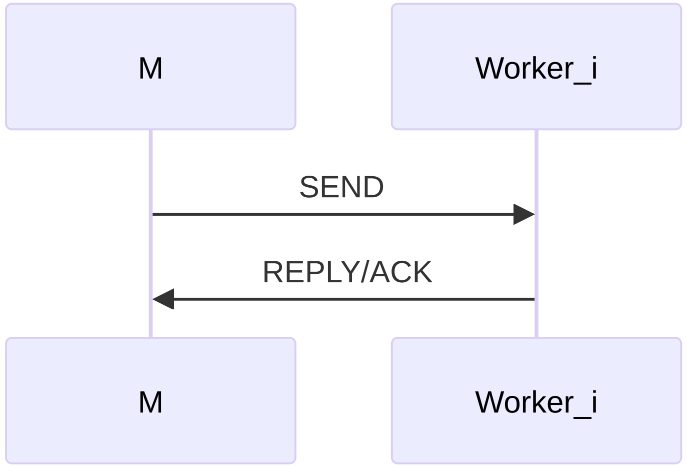




Manager x Worker: Communication

- ZMQ Sockets
- Pairwise send and reply initiated by Manager
- Manager: ZMQ_REQ
- Worker: ZMQ_REP

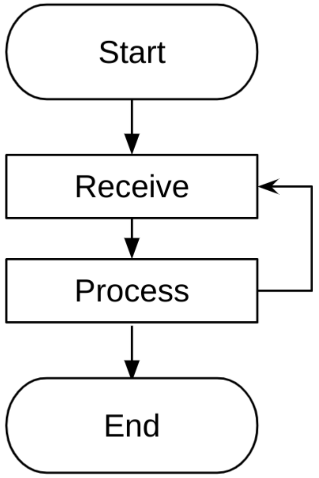




Worker State Machine

- Workers are reply sockets
- Bind and block on `recv()`
- Process message based on type

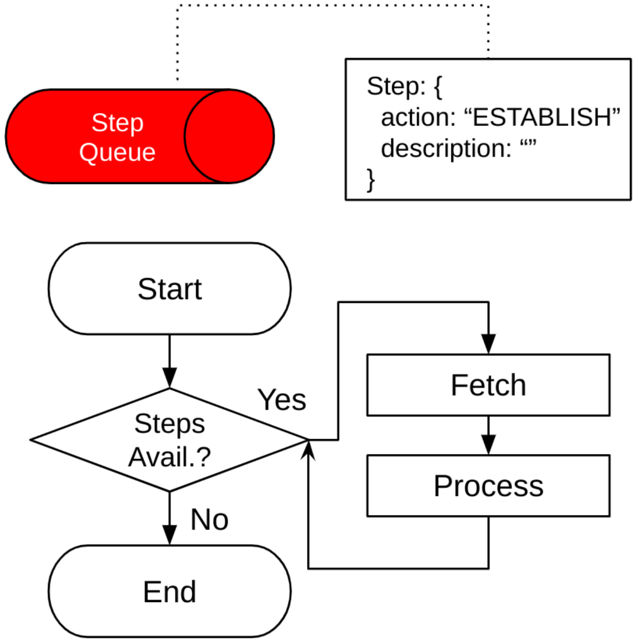
```
while(True):
    m = self.recv_message()
    match m.type:
        case CONNECT: self.connectACK(m)
        case COMMAND: self.commandACK(m)
        case REPORT:  self.reportACK(m)
        case _:       raise RuntimeError()
```



Manager State Machine

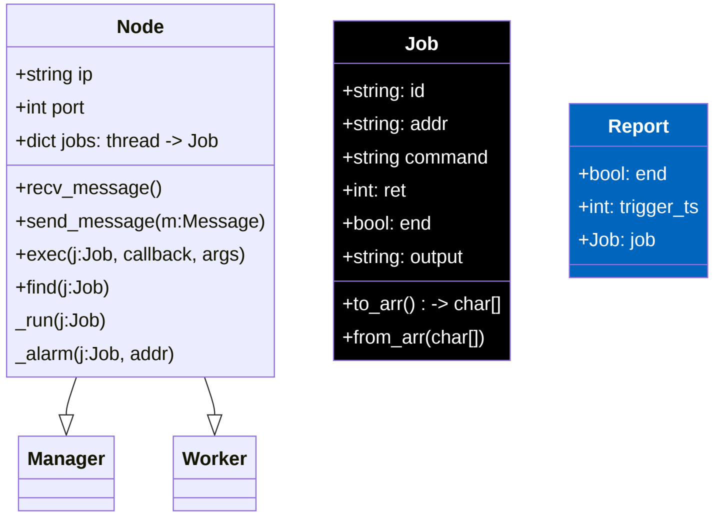
- Manager actively sends requests to workers
- Fetches steps from `step_queue`
- Process steps based on action type

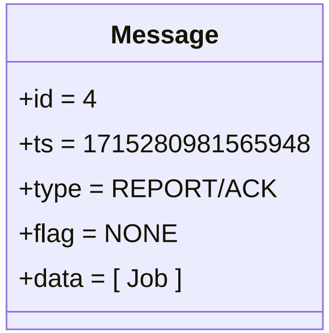
```
while(True):
    step = self.pop_step()
    if not step: break
        match step["action"]:
            case "CONNECT": self.establish()
            case "ROOT":    self.root()
            case "REPORT":  self.report()
            case _:         raise RuntimeError()
```

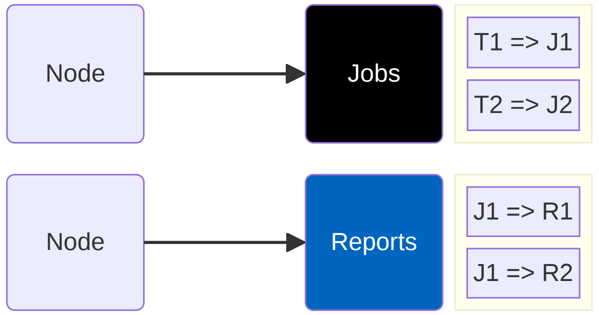


Manager x Worker: Jobs

- Manager and Workers inherit Node Class
- Nodes own jobs, mapped via a dictionary of threads
- `exec_job(j:Job)`:
  - Runs `j.command` in separate thread
  - stores thread handler in dict
  - thread ultimately modifies the overloaded Job



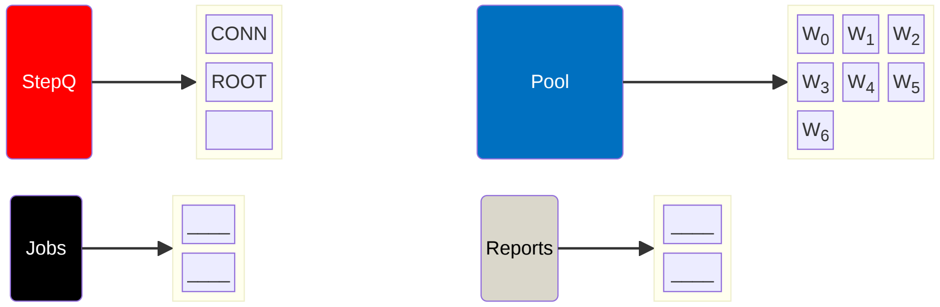


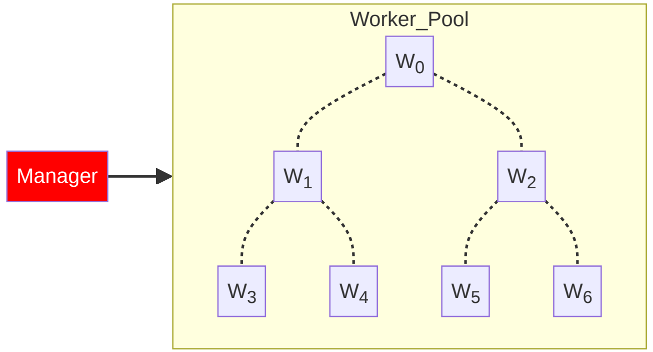


Manager x Worker: Workflow [i = 0]

- Manager reads in YAML *script*
- Populates step queue
- Fetches first step

```yaml
name: DEFAULT
hyperparameter: 0.5
rate: 10
duration: 10
addrs:
  - "localhost:9091"
  - "localhost:9092"
  - "localhost:9093"
  - "localhost:9094"
  - "localhost:9095"
  - "localhost:9096"
steps:
  - action: "CONNECT"
    description: "Establish connection workers."
    data: 0
  - action: "ROOT"
    description: "Choose root among worker nodes."
    data: 0
```

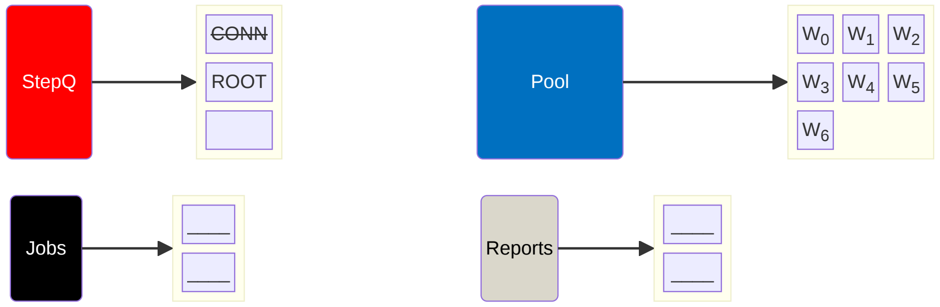


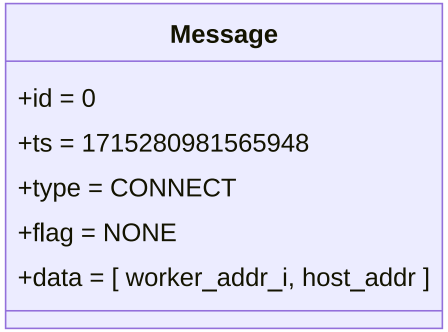


Manager x Worker: Workflow [i = 1]

- ACTION: CONNECT

1. Loops through all workers
    1. Establishes connection
    2. `Send()` CONNECT Messages
    3. `Recv()` ACK Messages
    4. Disconnects





Message

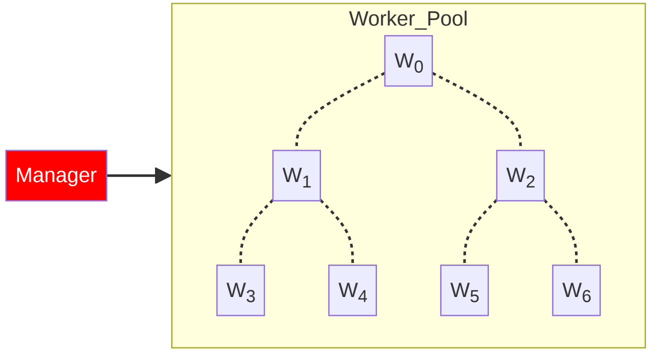
+id = 0

+ts = 1715280981565948

+type = CONNECT

+flag = NONE

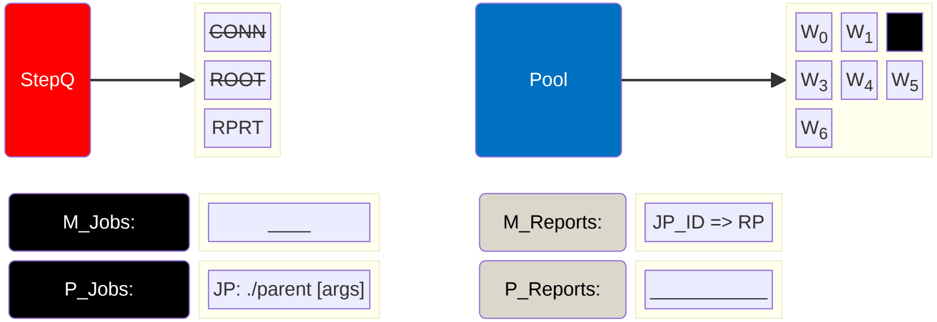
+data = [worker_addr_i, host_addr]

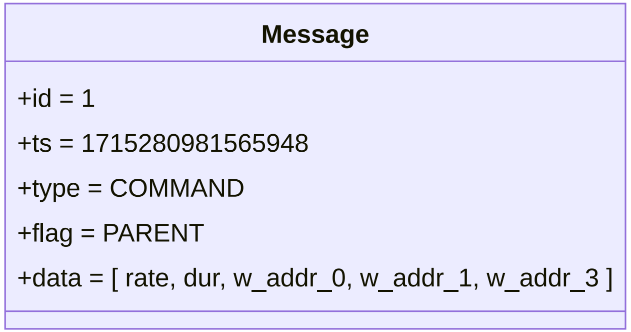


Manager x Worker: Workflow [i = 2]

- ACTION: ROOT

1. Select root from pool *(idx=2)*
2. Commands root to be *Parent*
3. Creates/Pushes: `Step=REPORT`
4. Creates/Pushes: `Report`





Message

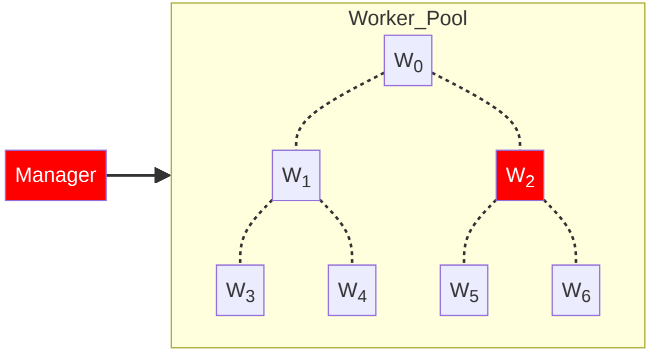
+id = 1

+ts = 1715280981565948

+type = COMMAND

+flag = PARENT

+data = [rate, dur, w_addr_0, w_addr_1, w_addr_3]



Manager x Worker: Workflow [i = 2.1]

- ACTION: ROOT

1. Connects to workers/children
2. Commands worker to be *Child*
    1. Starts Job: `./child <args`
3. Starts Job: `./parent <args`

Message

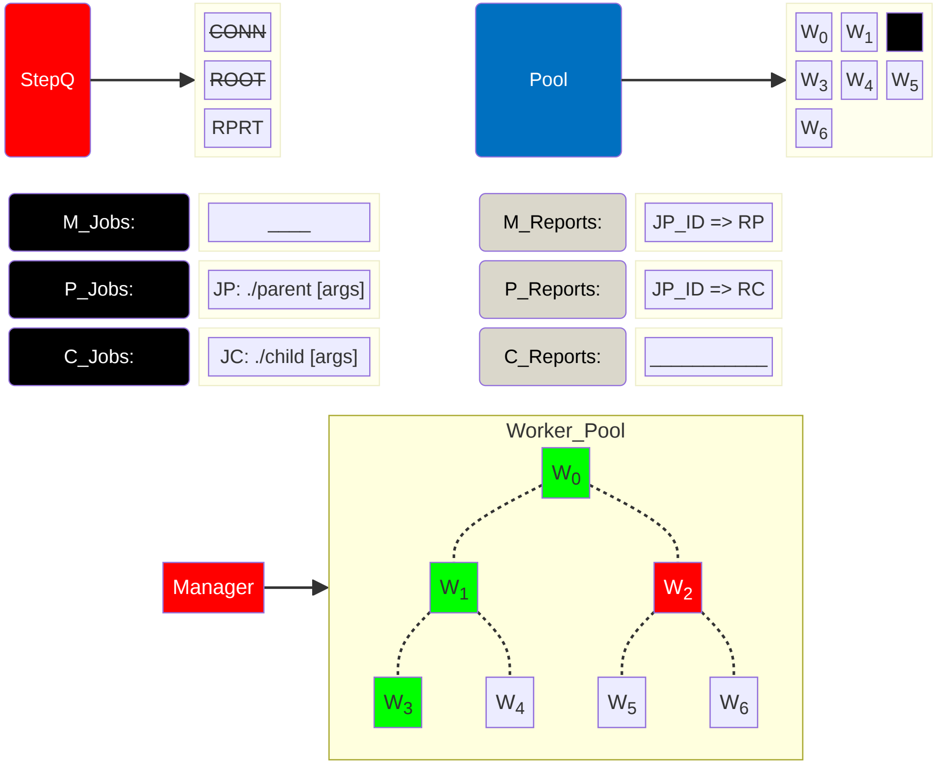
+id = 1

+ts = 1715280981565948

+type = COMMAND

+flag = CHILD

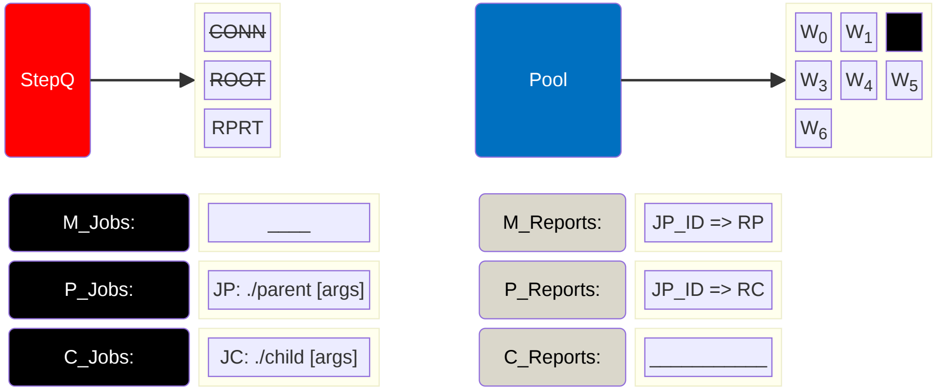
+data = [child_addr_i, host_addr]

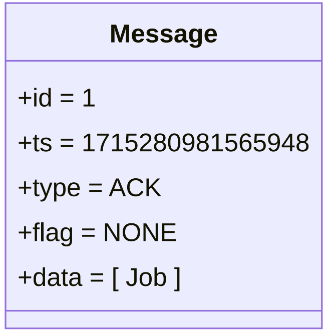


Manager x Worker: Workflow [i = 2.2]

- ACTION: ROOT

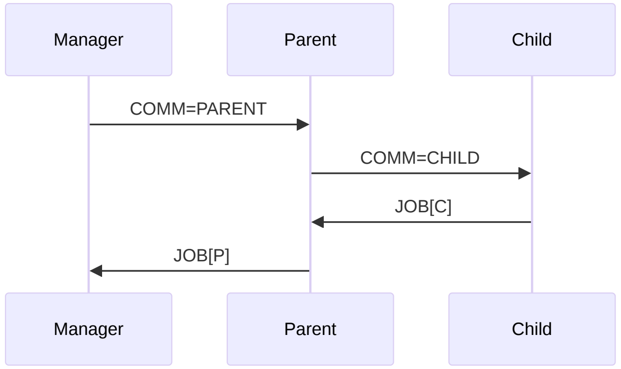
1. Manager: Tells root to be *Parent*
2. Parent:
    1. Creates required Parent Job
    2. Contacts Children, Get Child Job Structs
    3. Creates/Appends Reports
    4. Execs and Replies with Parent Job
3. Creates/Appends Report





Message

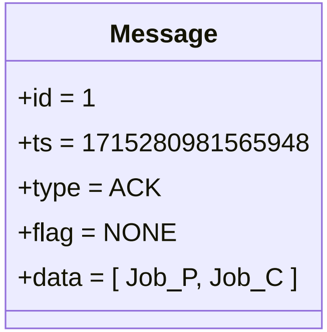
+id = 1
+ts = 1715280981565948
+type = ACK
+flag = NONE
+data = [Job]



Manager x Worker: Workflow [i = 3.0]

- ACTION: REPORT

1. Pops next report
2. Sleeps until trigger timestamp
3. Send pending job to owner (Report)
   1. Parent has received reports on children
   2. Parent has also finished its job
   3. Parent sends back all job results



Message

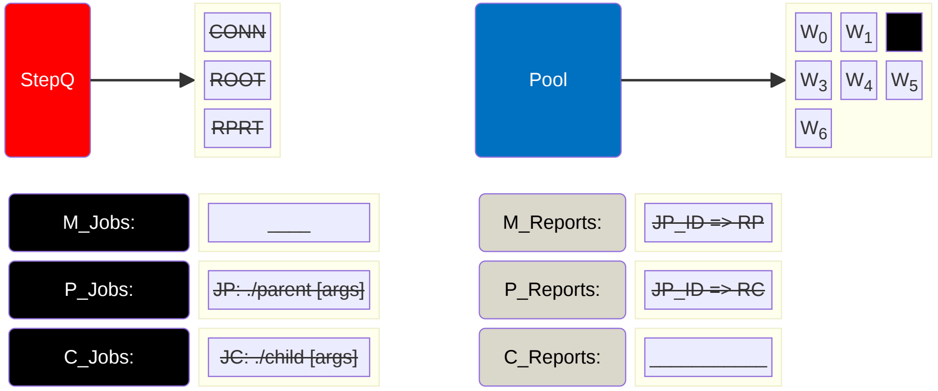
+id = 1

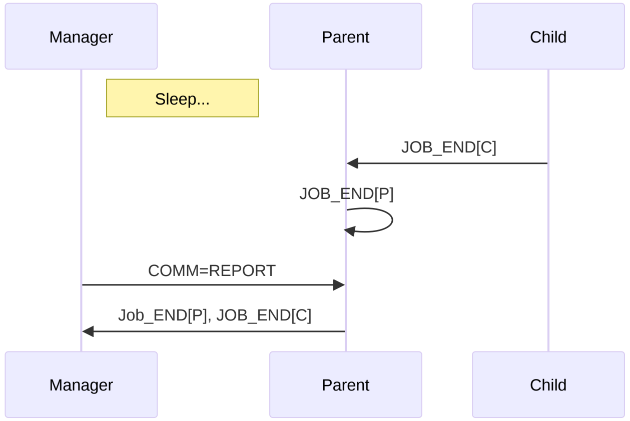
+ts = 1715280981565948

+type = ACK

+flag = NONE

+data = [Job_P, Job_C]


StepQ
~~CONN~~
~~ROOT~~
~~RPRT~~
Pool
W_0
W_1
W_3
W_4
W_5
W_6
M_Jobs:
____
P_Jobs:
~~JP: ./parent [args]~~
C_Jobs:
~~JC: ./child [args]~~
M_Reports:
~~JP_ID => RP~~
P_Reports:
~~JP_ID => RC~~
C_Reports:
____


Manager
Parent
Child
Sleep...
JOB_END[C]
JOB_END[P]
COMM=REPORT
Job_END[P], JOB_END[C]
Manager
Parent
Child