Building Distributed System with Celery on Docker Swarm

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About Me

- Wei Lin
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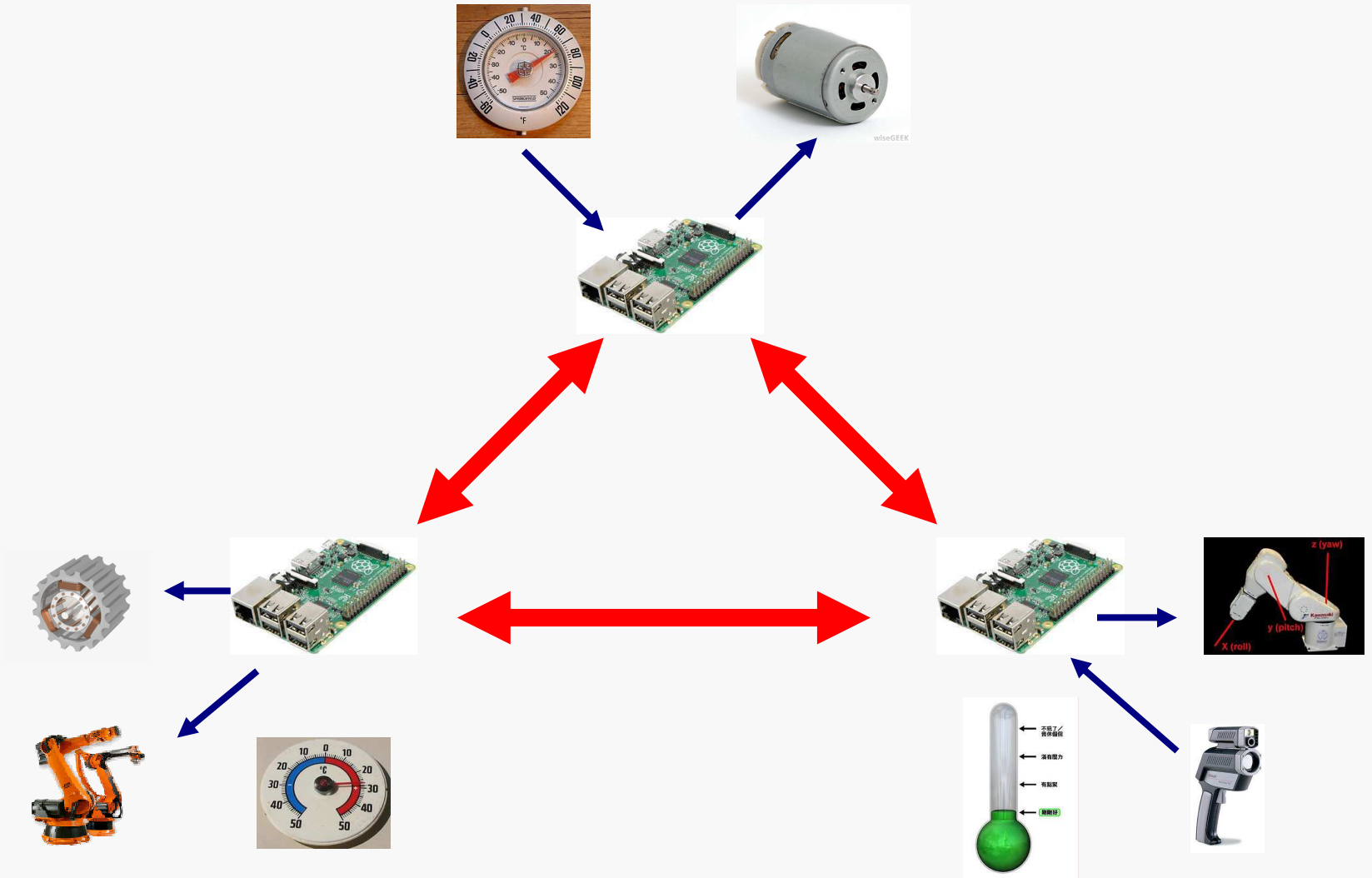
- Mostly worked in the fields of:
  - marketing
  - strategy-planning
  - project-management

- Materials of this talk:
  https://github.com/Wei1234c/PyCon-JP-2016-talk

Parallel computing

https://resin.io/blog/what-would-you-do-with-a-120-raspberry-pi-cluster/

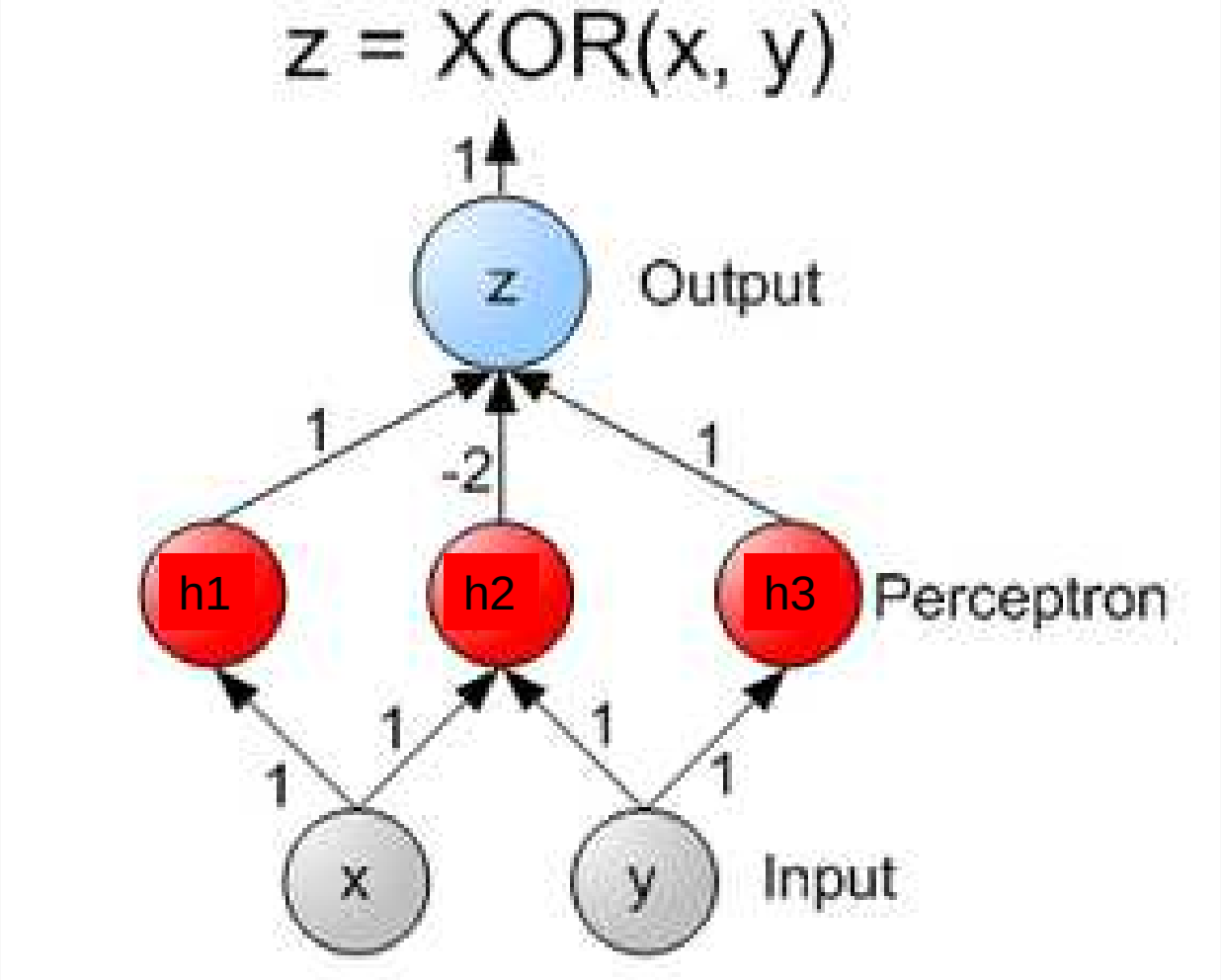
Distributed System



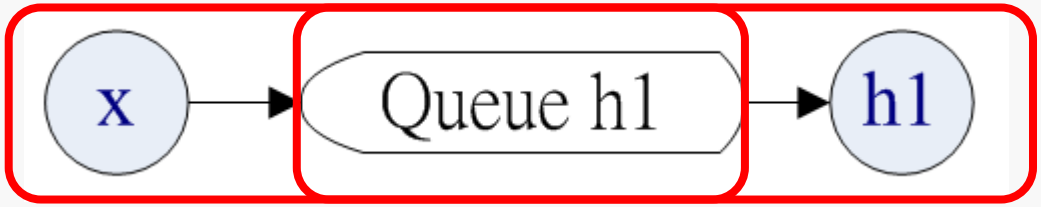
Distributed system

Distributed system (II)

Neural network

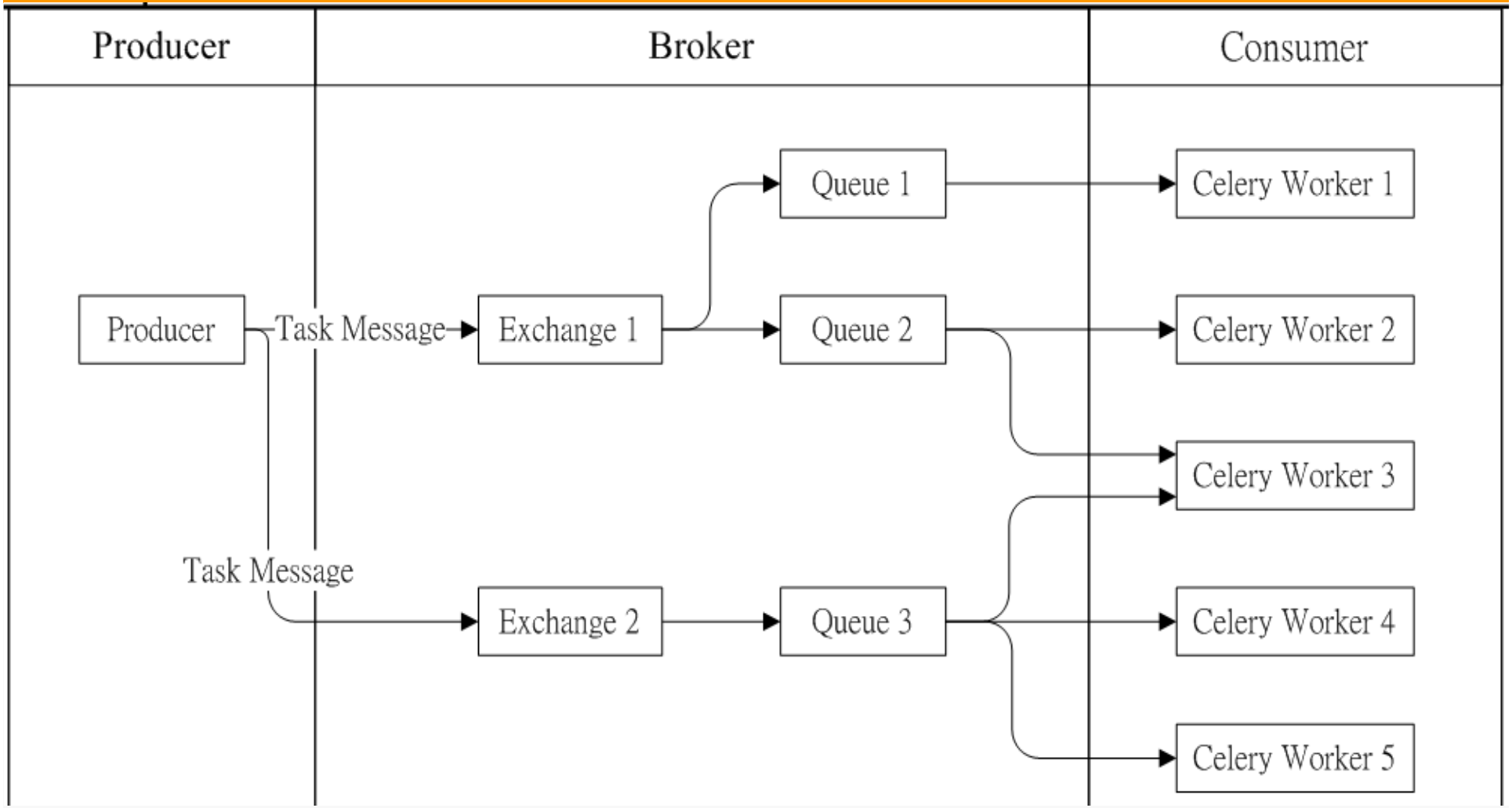


Communicate via Celery



Celery

Celery flowchart



Send message to a specific queue

Send message

http://docs.celeryproject.org/en/latest/userguide/calling.html

```
from celery import Celery

app = Celery()
app.config_from_object('celeryconfig')

@app.task
def kick(neuron_id):
    myName = getHostname()
    log('{0} is kicking {1}.'.format(neuron_id, myName))
    ...
```

kick.apply_async([‘neuron_x’])

kick.apply_async([‘neuron_x’], routing_key = ‘neuron_h1’)

Configuration file

```
#_____________________________Import Kombu classes_____________________________
from kombu import Exchange, Queue

#_____________________________CELERY_TIMEZONE & Misc._____________________________
CELERY_TIMEZONE = 'Asia/Taipei'
CELERYD_POOL_RESTARTS = True

#_____________________________BROKER_URL_____________________________
BROKER_URL = 'redis://192.168.0.114:6379/0'

#_____________________________CELERY_RESULT_BACKEND_____________________________
CELERY_RESULT_BACKEND = 'redis://192.168.0.114:6379/1'

#_____________________________CELERY_IMPORTS_____________________________
CELERY_IMPORTS = ('IoT.neuron',)

#_____________________________CELERY_QUEUES_____________________________
CELERY_QUEUES = (
    Queue('neuron_x', Exchange('celery', type = 'direct'), routing_key='neuron_x'),
    Queue('neuron_y', Exchange('celery', type = 'direct'), routing_key='neuron_y'),
    Queue('neuron_h1', Exchange('celery', type = 'direct'), routing_key='neuron_h1'),
    Queue('neuron_h2', Exchange('celery', type = 'direct'), routing_key='neuron_h2'),
    Queue('neuron_h3', Exchange('celery', type = 'direct'), routing_key='neuron_h3'),
    Queue('neuron_z', Exchange('celery', type = 'direct'), routing_key='neuron_z'),
)
```

Task Message Example

http://docs.celeryproject.org/en/latest/internals/protocol.html

```
{"id": "4cc7438e-afd4-4f8f-a2f3-f46567e7ca77",
 "task": "celery.task.kick",
 "args": ['neuron_x'],
 "kwargs": {},
 "retries": 0,
 "routing_key": "neuron_h1"}
```

Routing Tasks

http://docs.celeryproject.org/en/latest/userguide/routing.html

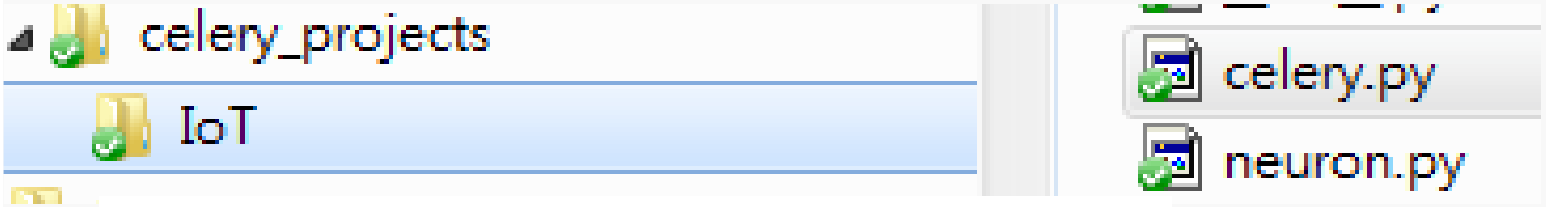
```
#_____________________________________CELERY_QUEUES_____________________________________
CELERY_QUEUES = (
    Queue('neuron_x', Exchange('celery', type = 'direct'), routing_key='neuron_x'),
    Queue('neuron_y', Exchange('celery', type = 'direct'), routing_key='neuron_y'),
    Queue('neuron_h1', Exchange('celery', type = 'direct'), routing_key='neuron_h1'),
    Queue('neuron_h2', Exchange('celery', type = 'direct'), routing_key='neuron_h2'),
    Queue('neuron_h3', Exchange('celery', type = 'direct'), routing_key='neuron_h3'),
    Queue('neuron_z', Exchange('celery', type = 'direct'), routing_key='neuron_z'),
)
```

Assign an unique worker for a specific queue

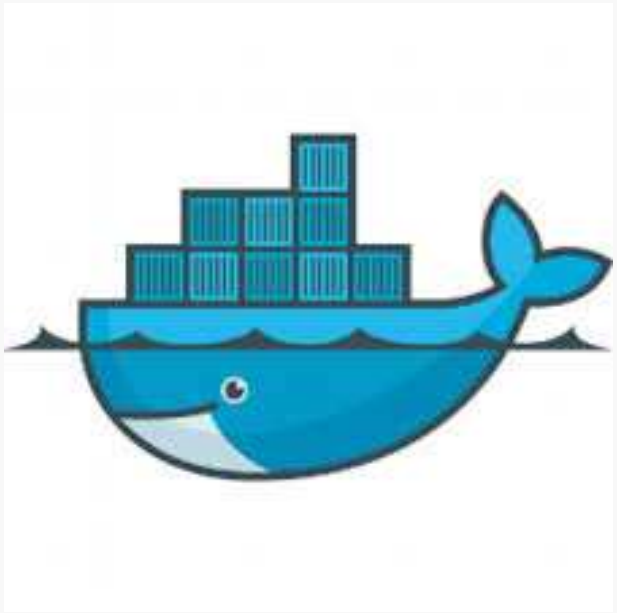
Starting the Worker

http://docs.celeryproject.org/en/latest/userguide/workers.html
https://github.com/celery/celery/issues/3065

```
$ celery -A IoT worker -n neuron_h1 \
  -Q neuron_h1 --concurrency=1
```



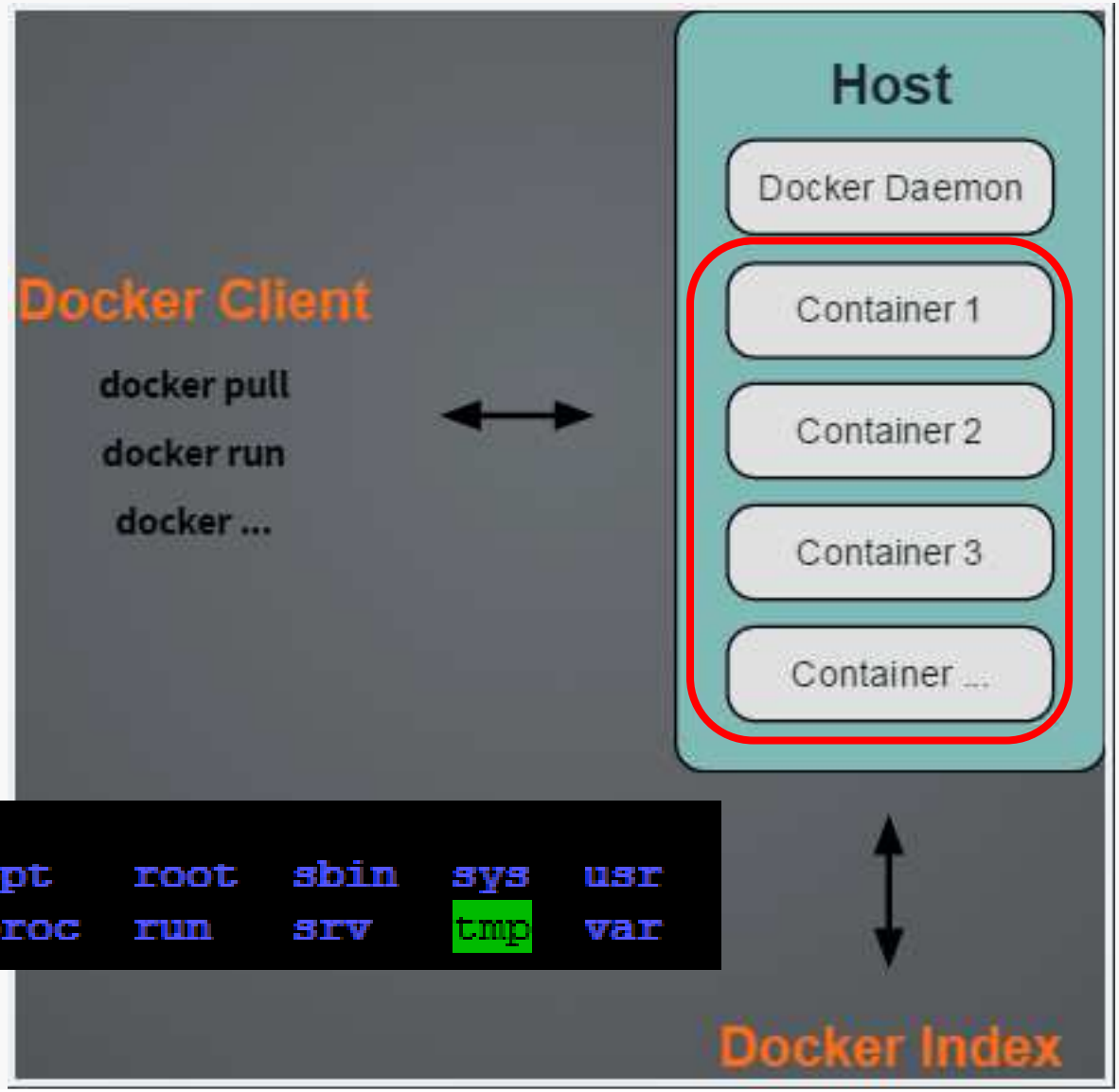

```
from celery import Celery
from kombu import Exchange, Queue

app = Celery()
app.config_from_object('celeryconfig')

if __name__ == '__main__':
    app.start()
```

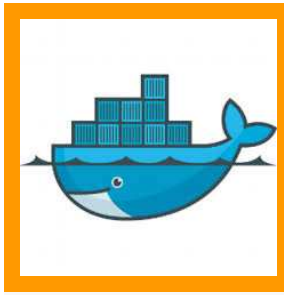


Docker

Host and containers

https://denibertovic.com/talks/supercharge-development-env-using-docker/#/10

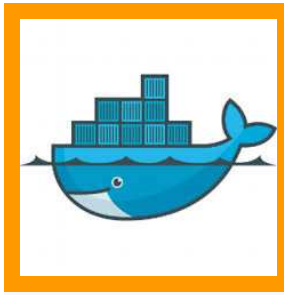




Run worker container

```
docker run -d --name=neuron_x --hostname=neuron_x \
--volume=/data/celery_projects:/celery_projects \
wei1234c/celery_armv7 \
/bin/sh -c \
"cd /celery_projects && \
celery -A IoT worker -n %h -Q neuron_x --concurrency=1"
```

```
docker run -d --name=neuron_y --hostname=neuron_y \
--volume=/data/celery_projects:/celery_projects \
wei1234c/celery_armv7 \
/bin/sh -c \
"cd /celery_projects && \
celery -A IoT worker -n %h -Q neuron_y --concurrency=1"
```

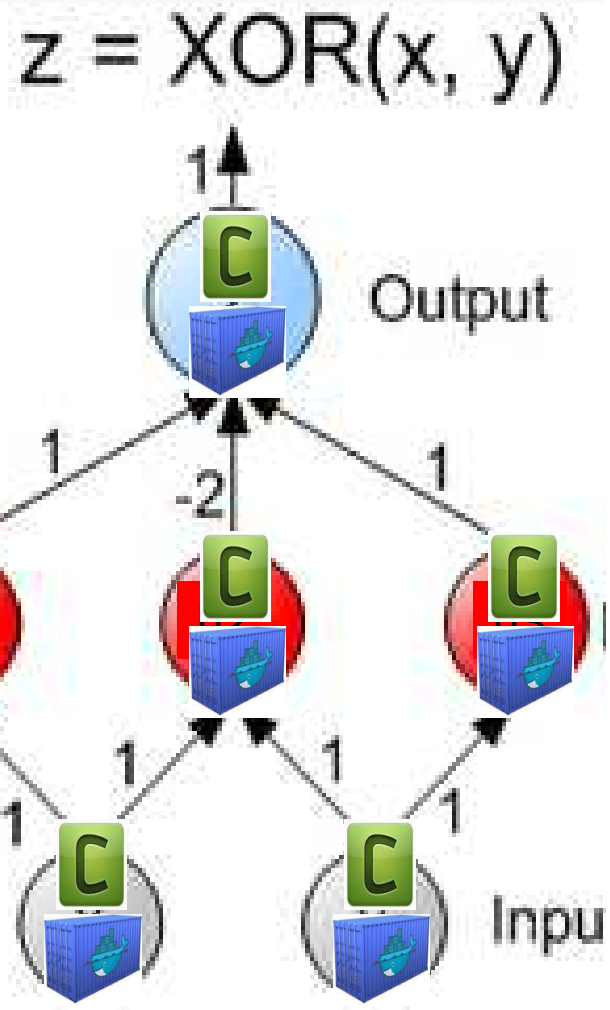


Deploy containers

Celery worker containers as neurons

kick.**apply_async**(routing_key = ‘neuron_h1’)

getData.**apply_async(**routing_key = ‘neuron_h1’) **.get()**



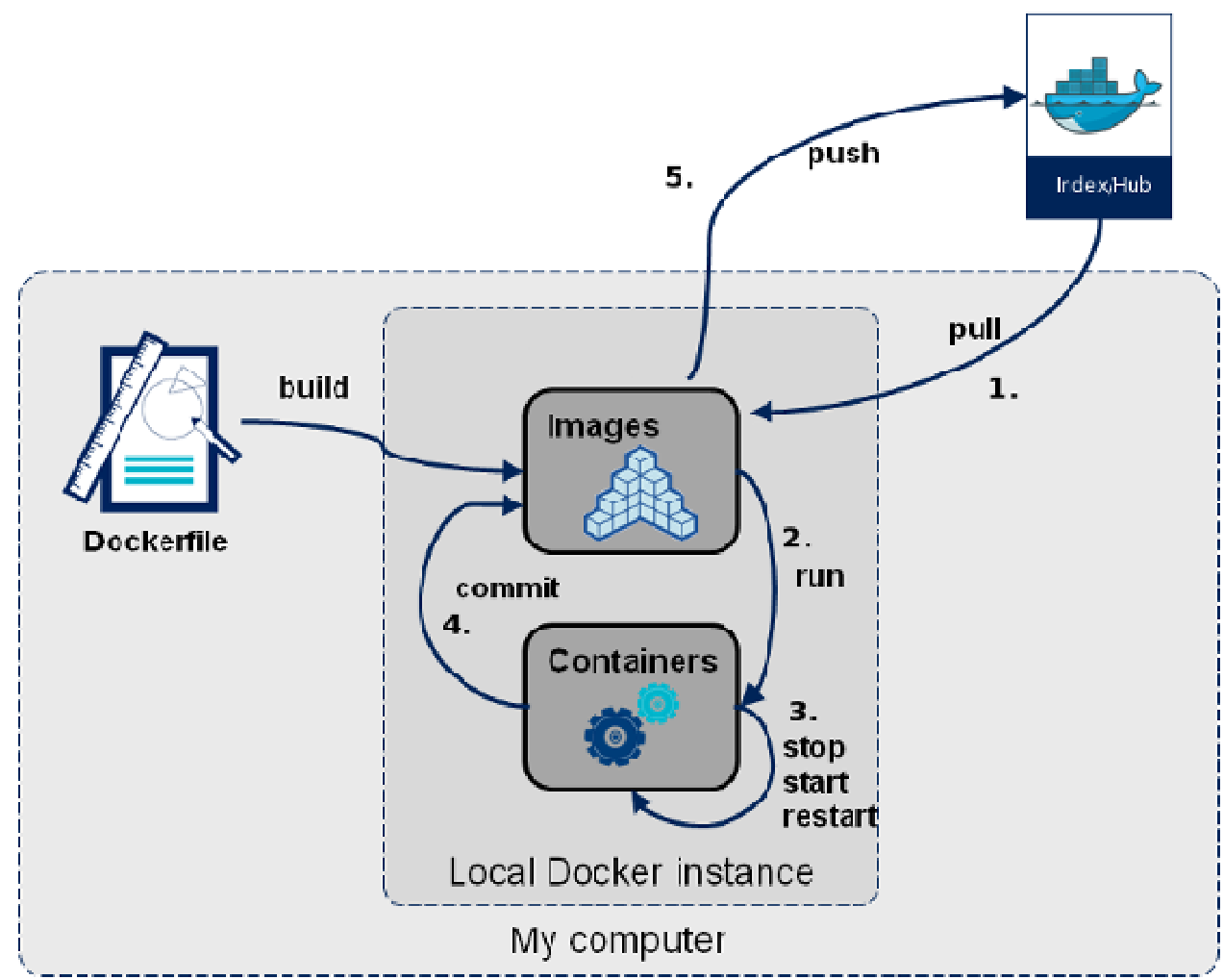
“Celery + Docker-Swarm”

So ?

I think…

Docker file/image/container

https://denibertovic.com/talks/supercharge-development-env-using-docker/#/11

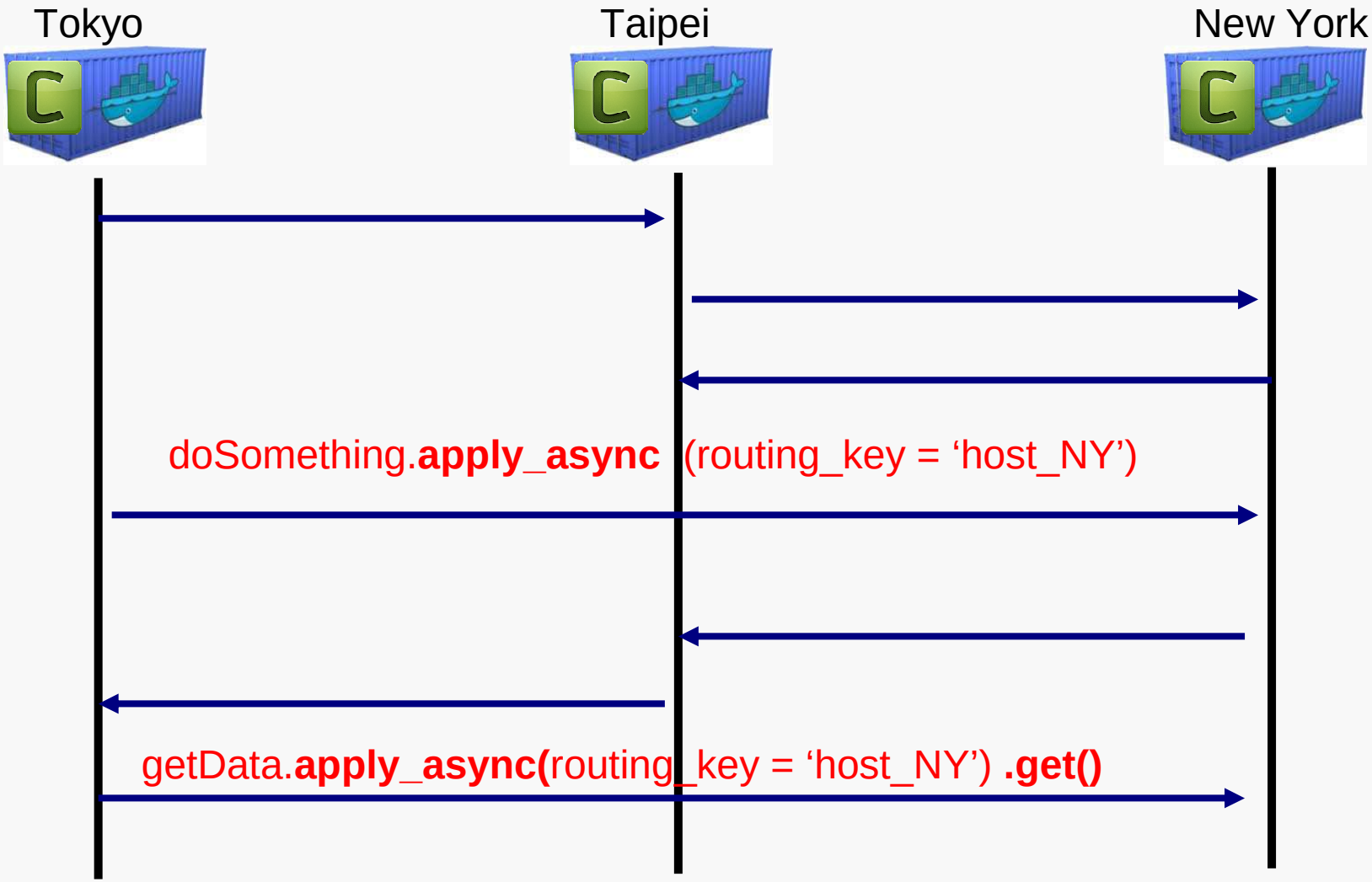


Think OO

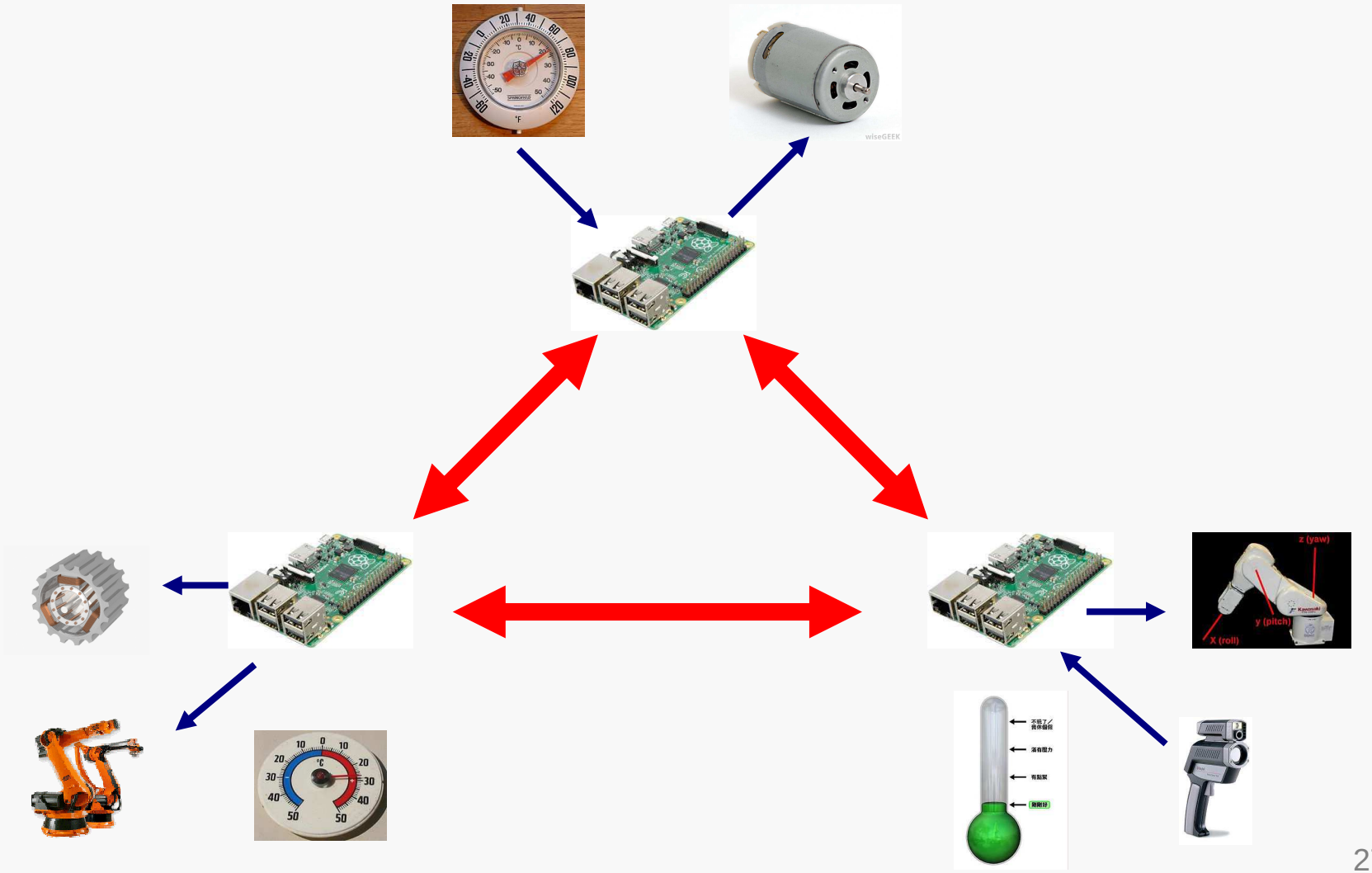
```
# Celery Worker Dockerfile
# 20151229

FROM wei1234c/python_armv7

MAINTAINER Wei Lin
ENV TERM linux
# Add user pi
RUN \
    useradd -G adm,sudo,users -s /bin/bash -m pi && \
    echo 'pi:raspberry' | chpasswd
# Install Celery
RUN \
   pip3 install -U redis celery flower sqlalchemy pymongo

WORKDIR /data
USER pi
EXPOSE 5555
CMD ["bash"]
```

- "From" to Inherit
- Dockerfile to Encapsulate
- Docker Image as Class
- Docker Container as Object

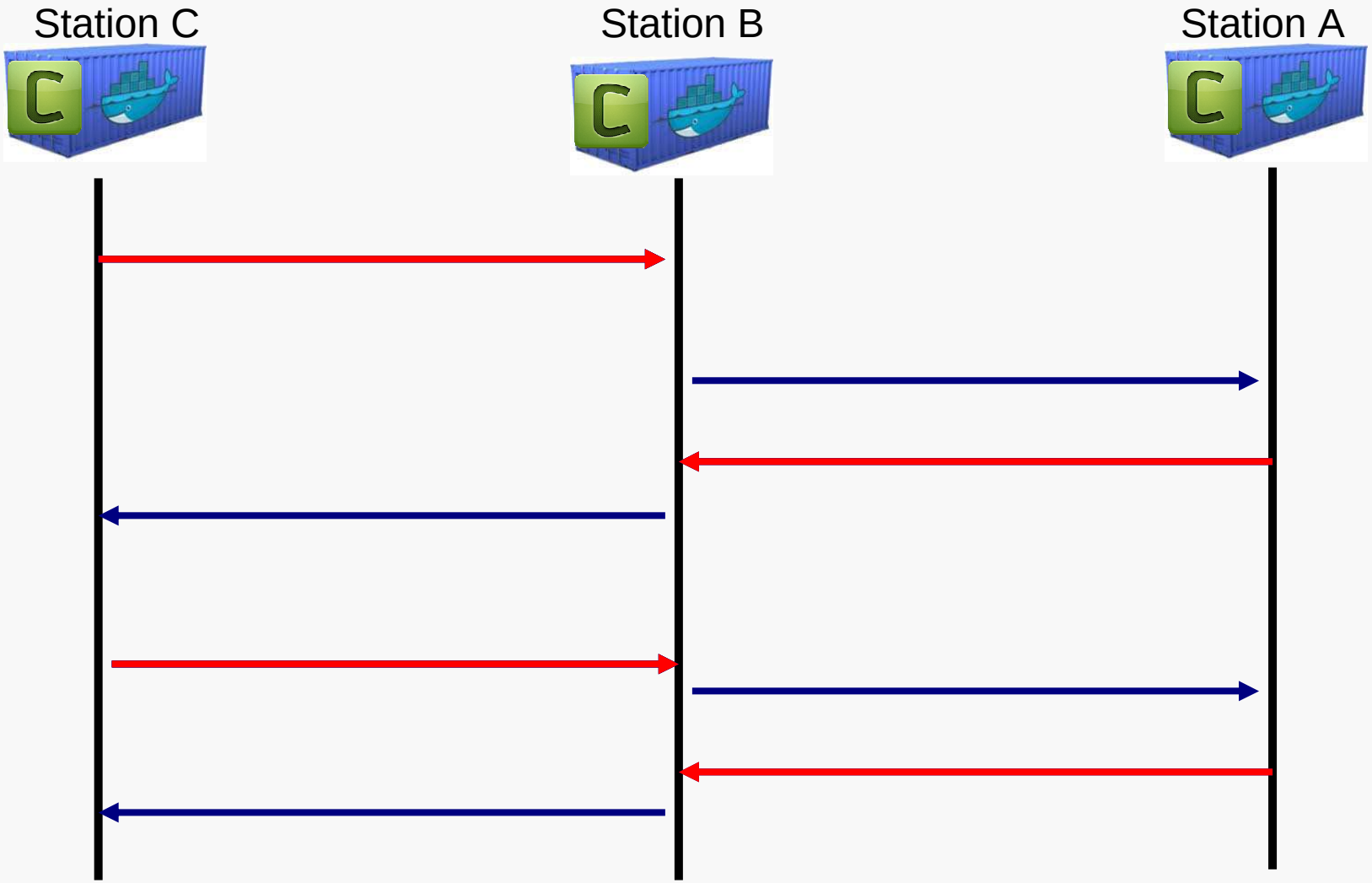
Docker Swarm & Celery

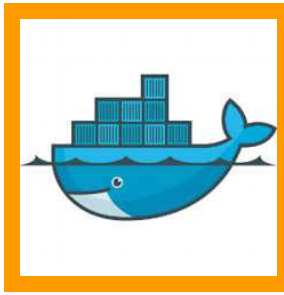


Distributed System



OOAD



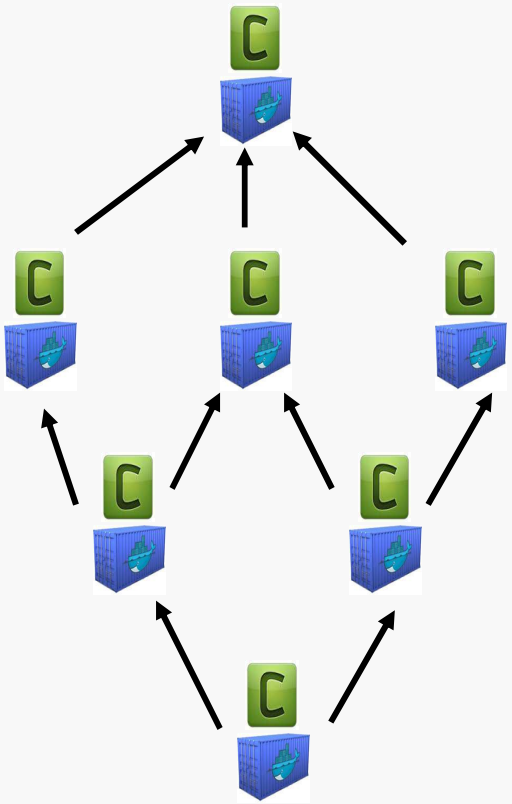


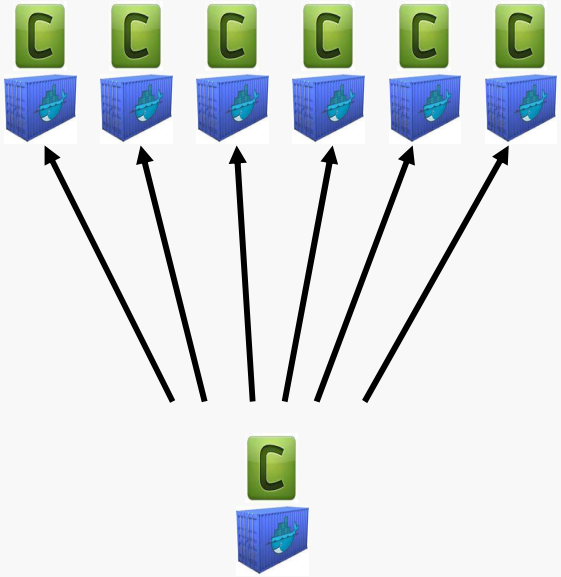
Bound services

Parallel computing

https://resin.io/blog/what-would-you-do-with-a-120-raspberry-pi-cluster/

parallel computing ⊆ distributed computing





How to do Parallel Computing

1. Run and deploy Docker containers across Docker Swarm cluster, with a Celery worker process running in each container.
2. When initiate worker processes, don’t assign “Queue” parameter, so ALL the workers will listen to the default queue in broker.
3. Sending bunch of messages to broker without setting routing_key parameter, the messages will be routed to the default queue.
4. In a parallel fashion, all workers will pick up messages from the default queue and do the tasks.

Deploy parallel computing

- Deploy containers over Docker Swarm
  - deploy containers
    - docker-compose up –d
    - docker-compose scale celery= n (for example)
- Send task messages to worker containers

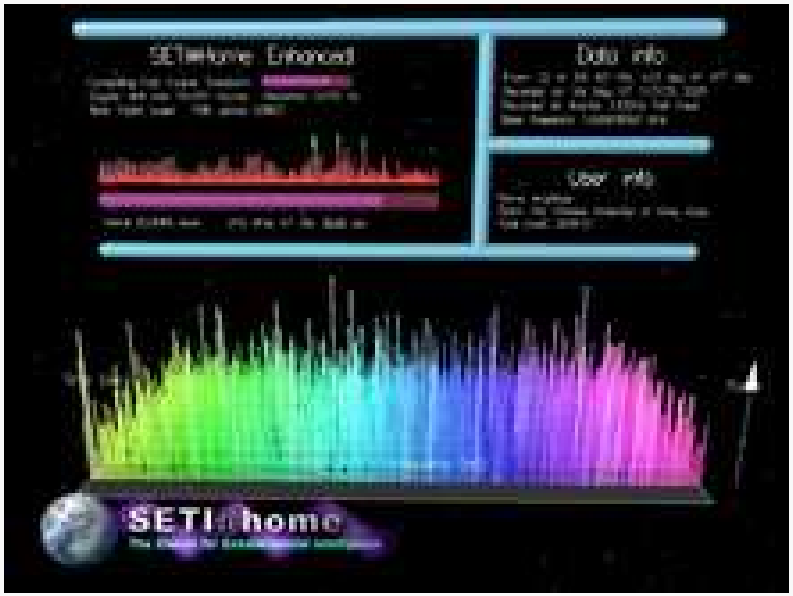
  results = [doSomething.**apply_async**([data]) **for data in dataset**]

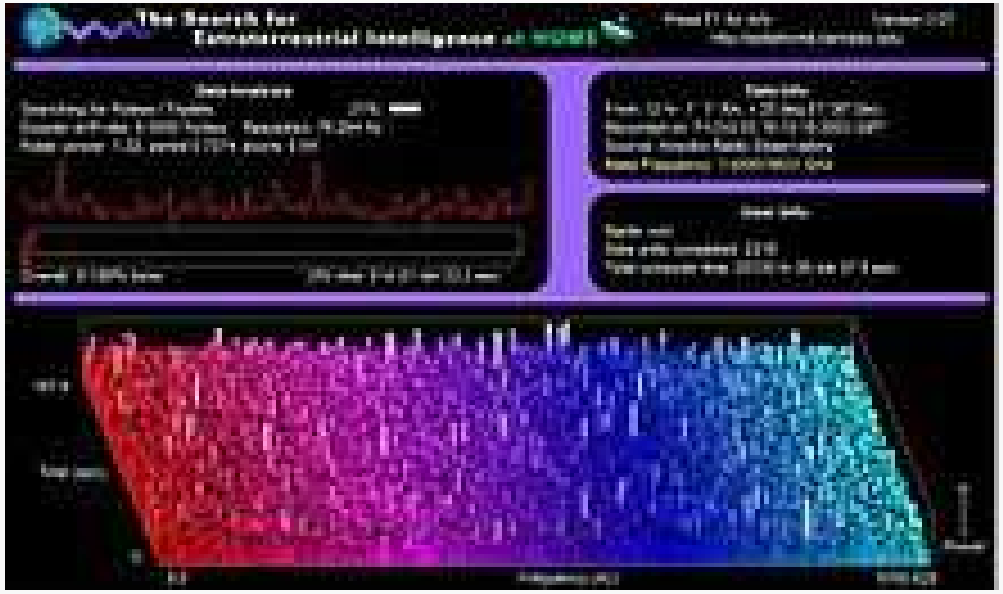
- But, Docker Swarm needs

  root password-less SSH

SETI@home

SETI HOME





One for all, All for one

https://github.com/Wei1234c/OneForAll_AllForOne/blob/master/celery_projects/OneForAll_AllForOne.md

- run a Docker image to join distributed parallel computing cluster, that’s all.

  docker run –d wei1234c/musketeer (for example)

Summary

- Easy to use
  - doSomething.**apply_async** ([xxx], routing_key = 'host_NY')
  - getData.**apply_async**(routing_key = 'host_NY') .**get**()
- Adventages of a distributed system
  - Decoupling, DI/IC (dependency injection / inversion of control)
  - Distributed = Shared
  - Load-Balancing
- Caution:
  - See ref: Distributed systems theory for the distributed systems engineer
- Take a look of Canvas in Celery
  - Chain
  - Group

Source Code

- Celery on Docker Swarm
  - using “Word Count” as an example of parallel computing.
  - https://github.com/Wei1234c/CeleryOnDockerSwarm/tree/master/celery_projects
- IoT as Brain
  - simulate an artificial neural-network of 6 neurons.
  - https://github.com/Wei1234c/IOTasBrain/tree/master/celery_projects
- One for all, all for one
  - follow the SETI@home paradigm.
  - on each machine, running a single Docker container to join the cluster.
  - https://github.com/Wei1234c/OneForAll_AllForOne/tree/master/celery_projects

References

References :

- **Distributed systems theory for the distributed systems engineer**
  - http://the-paper-trail.org/blog/distributed-systems-theory-for-the-distributed-systems-engineer/
- Celery user guide
  - http://docs.celeryproject.org/en/latest/userguide/
- Docker document
  - https://docs.docker.com/
- MQTT Message Type and Flows
  - http://blog.maxkit.com.tw/2014/02/mqttmessage-type-and-flows.html
- Celery on Docker Swarm
  - https://github.com/Wei1234c/PyCon-JP-2016-talk/blob/master/Celery%20on%20Docker%20Swarm%20-%20PyCon%20JP%202016.md
- IoT as Brain
  - https://github.com/Wei1234c/PyCon-JP-2016-talk/blob/master/IoT%20as%20Brain%20-%20PyCon%20JP%202016.md