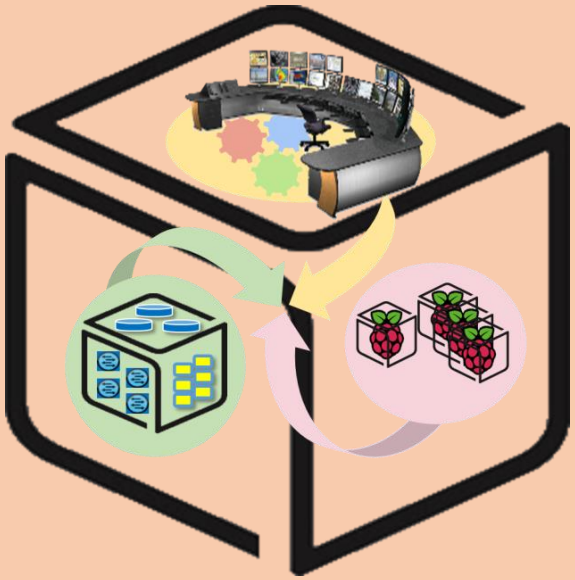
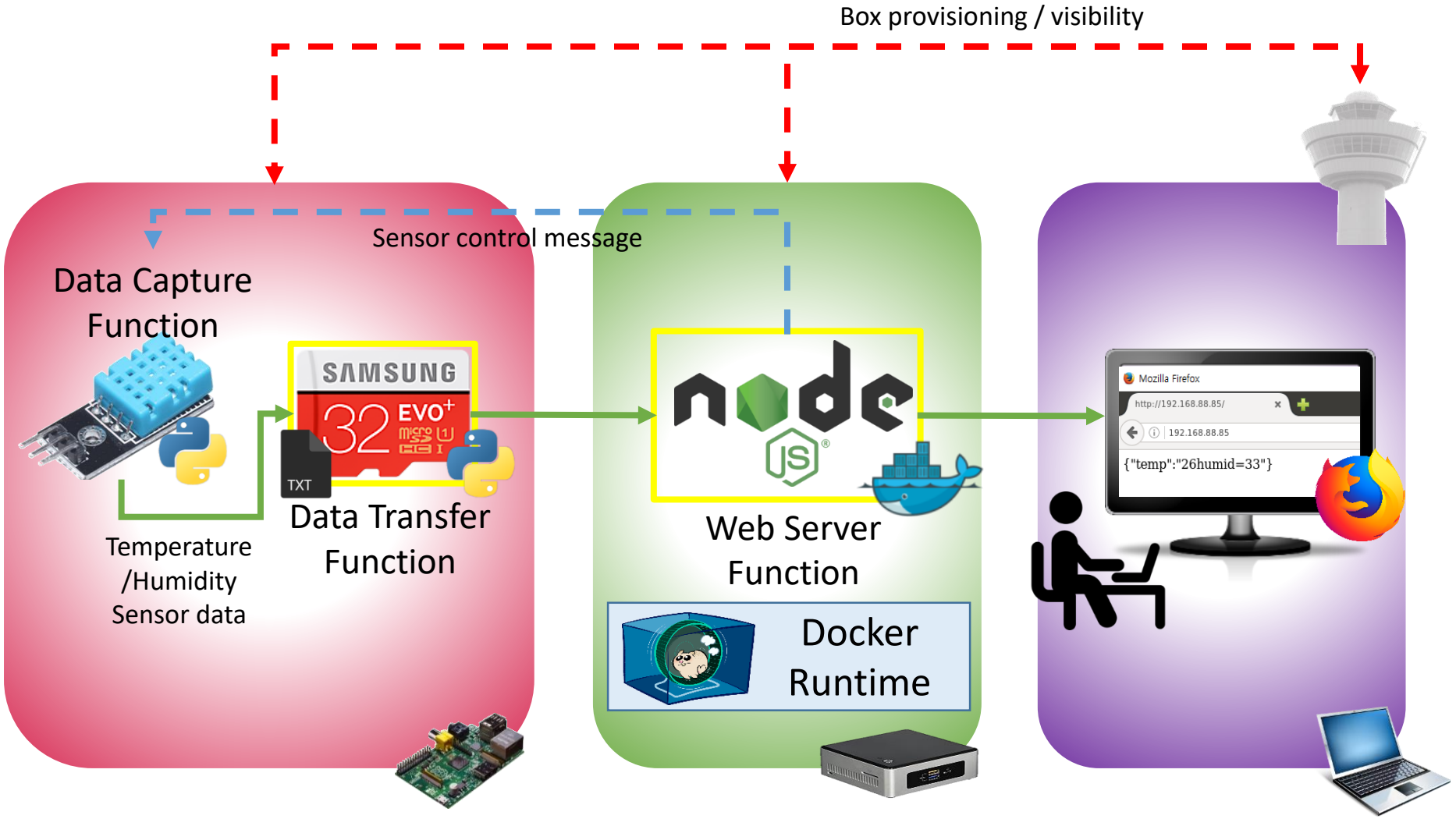
Computer Systems For AI-inspired Cloud Theory & Lab.

Lab #4: IoT



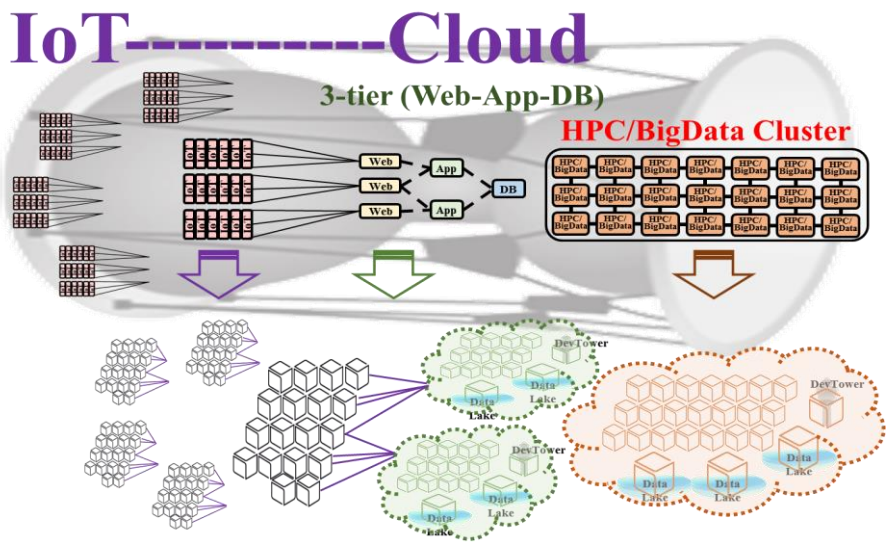
https://github.com/SmartX-Labs/SmartX-Mini-MOOC

IoT Lab: Concept



Theory

SmartX IoT-Cloud Services with Micoservices-based SaaS Applications



p(Baremetal)
+ **c**(Container)
+ **v**(VM)

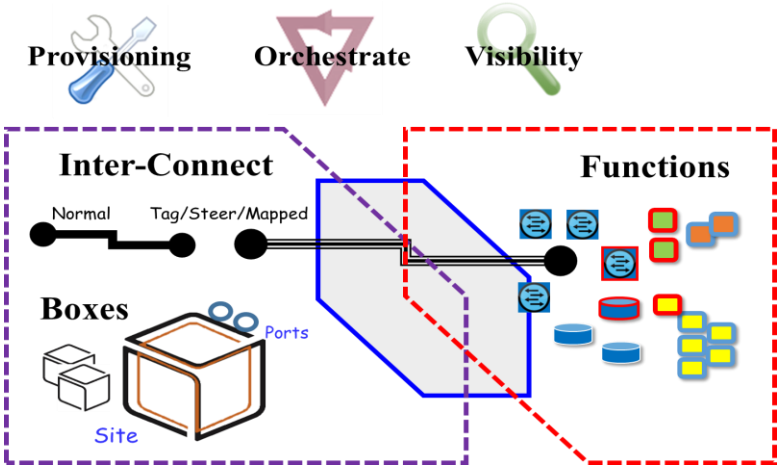
Process containers

SHIFTER

application containers

(Monster containers)

Machine containers

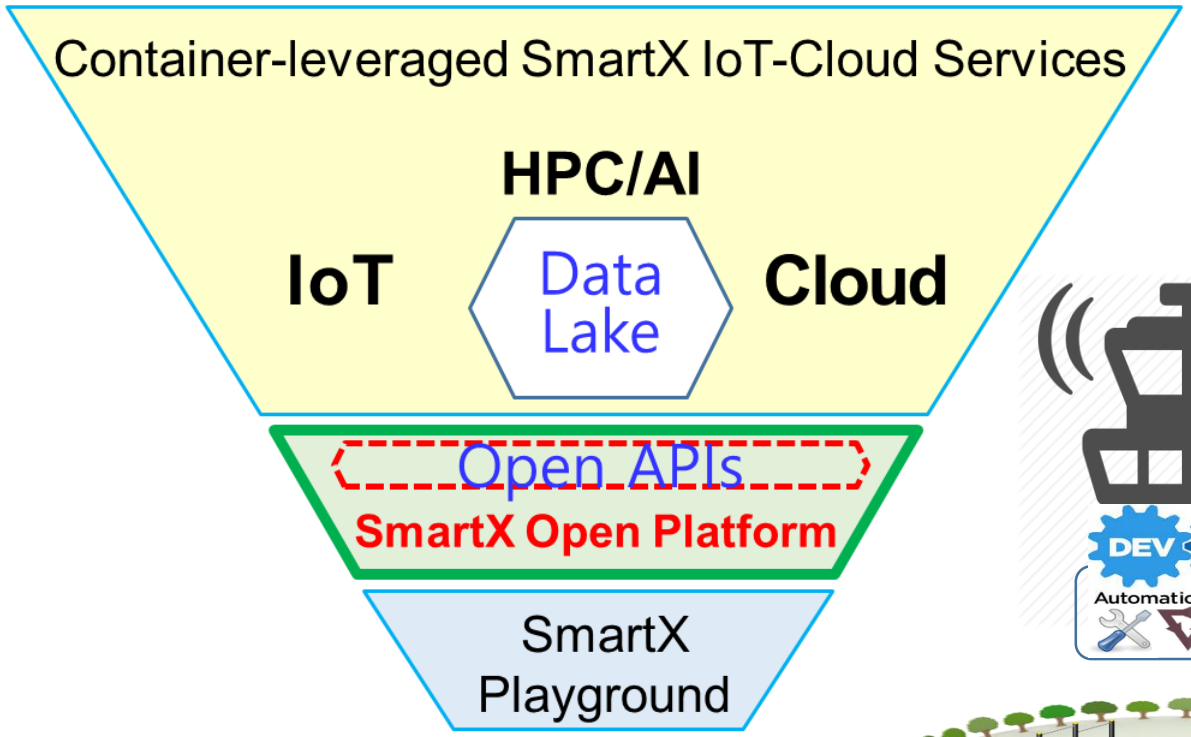


KVM

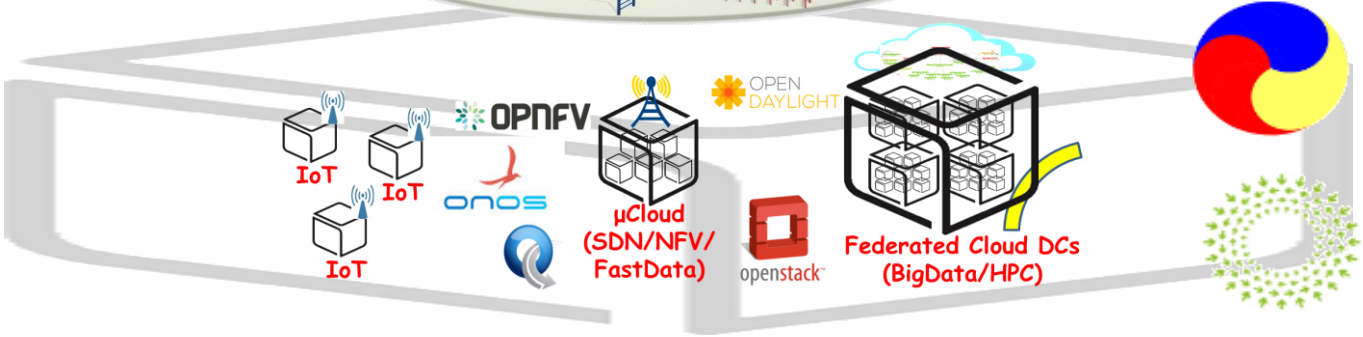
VM hypervisors

Open-Source-leveraged **Playgrounds**

(IoT-SDN/NFV-Cloud (HPC/BigData) Ready)



SmartX Open Playgrounds

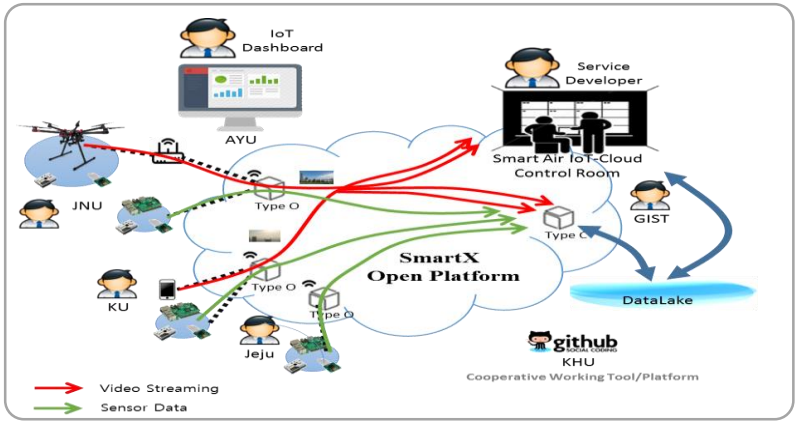


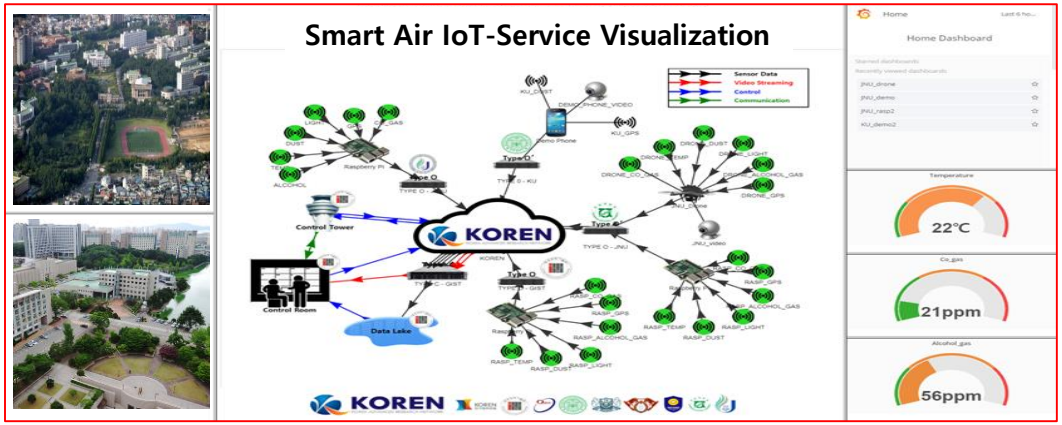
Smart Air IoT-Cloud Services over SmartX Open Platform

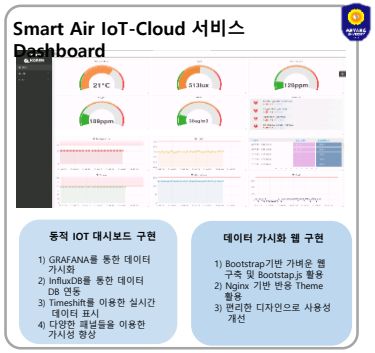
KOREN 연구협력포럼

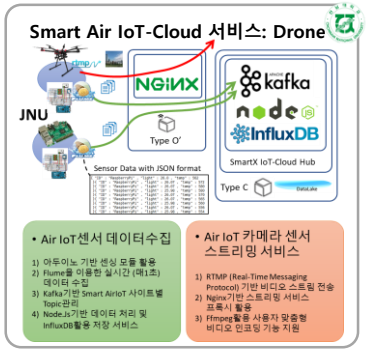
KOREN SmartX Platform을 활용한 선택된 산업인터넷 도메인에 대한 서비스 실증:

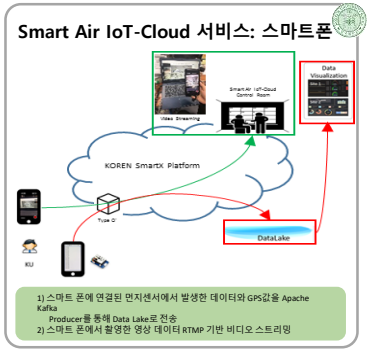
컨테이너 기반 Smart Air IoT-Cloud 서비스

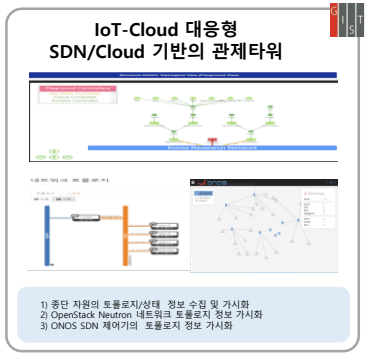






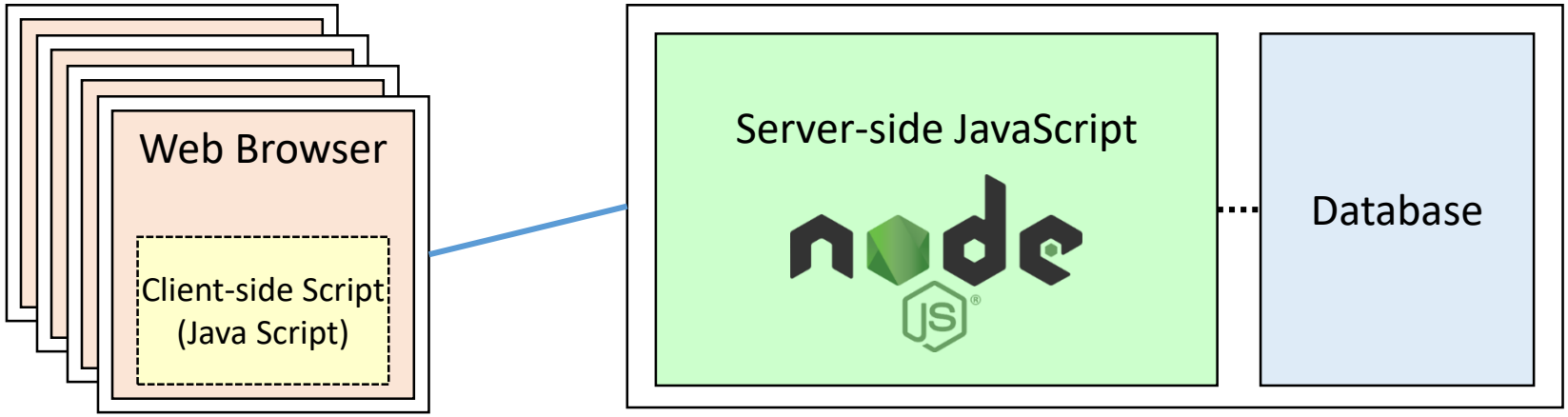


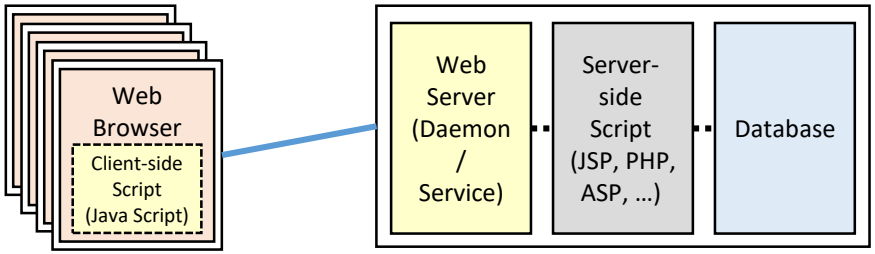




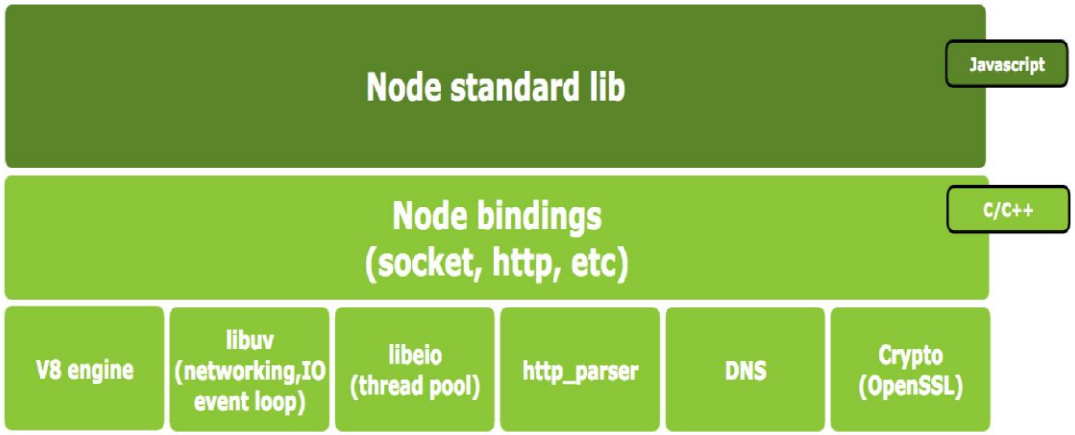
KOREN 연구협력포럼 | GIST | OSIA (사)개방형컴퓨터통신연구회 Open Standards and Internet Association | NIA 한국정보화진흥원 | KOREN KOREA ADVANCED RESEARCH NETWORK

Node.js Web Server Programming

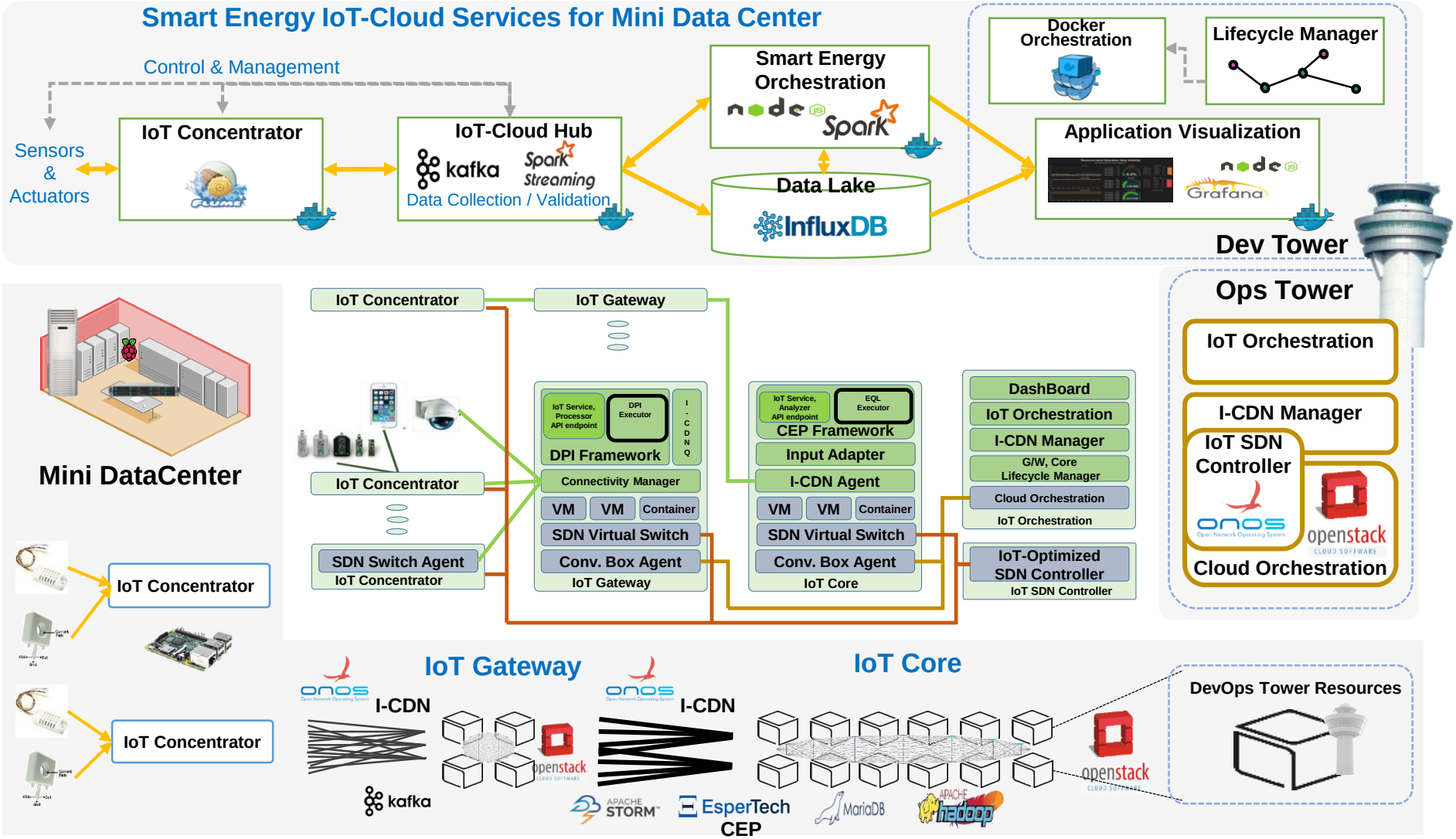




- Node.js Pros: Server-side JavaScript → High productivity; Single thread, non-block I/O → light-weight and agile; no direct I/O → no process blocking
- Node.js Cons: Single thread → Complicated multi-process management for multi-core CPU efficiency; Overlapped event callback → callback hell; Memory management overhead due to Garbage Collection



SmartX IoT-Cloud Services for Smart Energy Domain



Practice

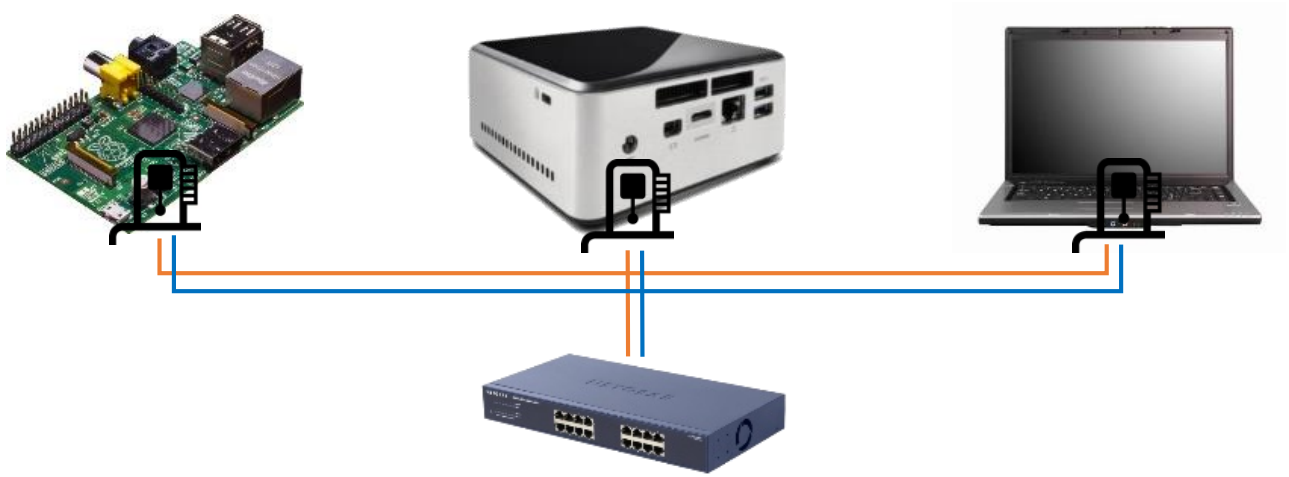
#0 Lab Preparation (1/2)

Wired connection

NAME: Raspberry Pi Model B (Pi)
CPU: ARM Cortex A7 @900MHz
CORE: 4
Memory: 1GB
SD Card: 32GB

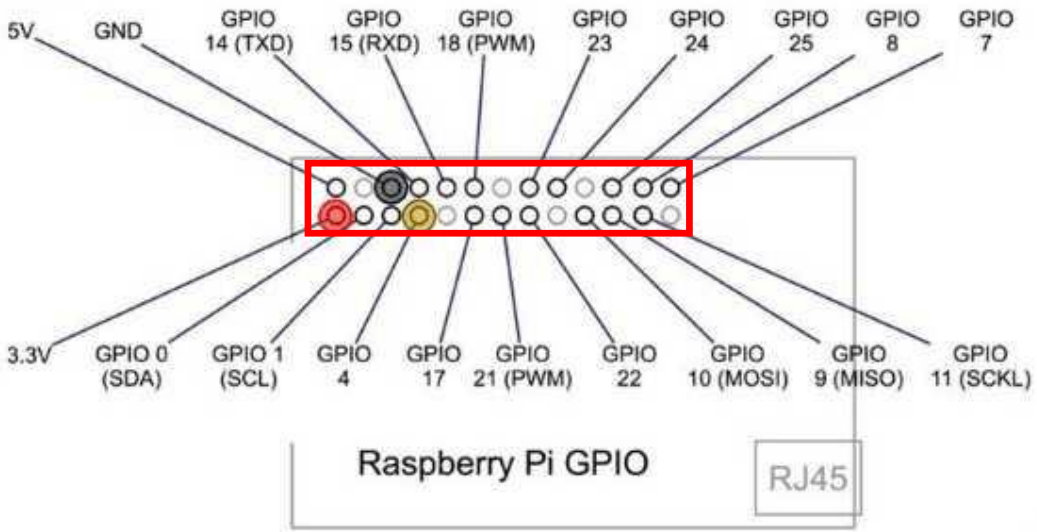
NAME: NUC5i5MYHE (NUC PC)
CPU: i5-5300U @2.30GHz
CORE: 4
Memory: 16GB DDR3
HDD: 94GB

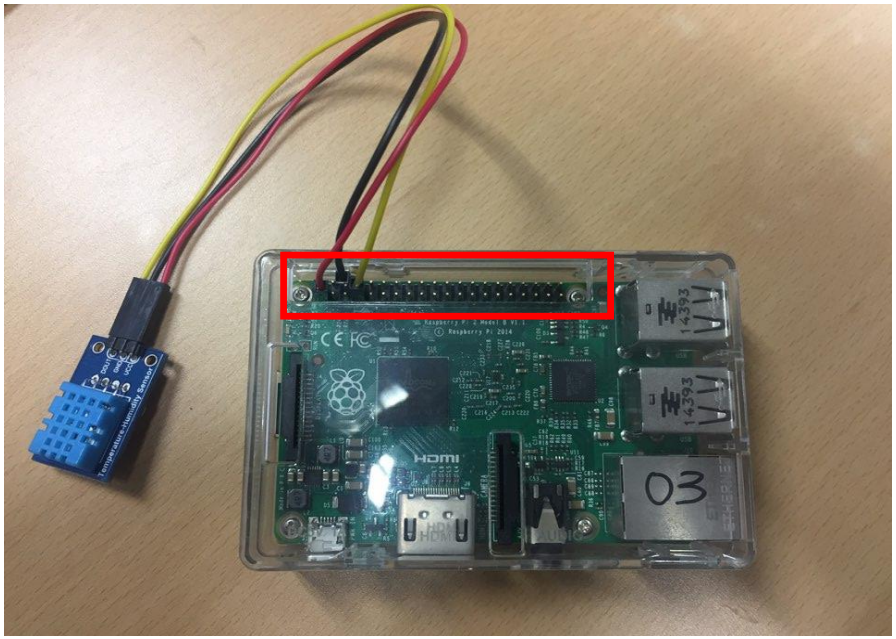
NAME: NT900X3A
CPU: i5-2537U @1.40GHz
CORE: 2
Memory: 4GB DDR3
HDD: 128GB



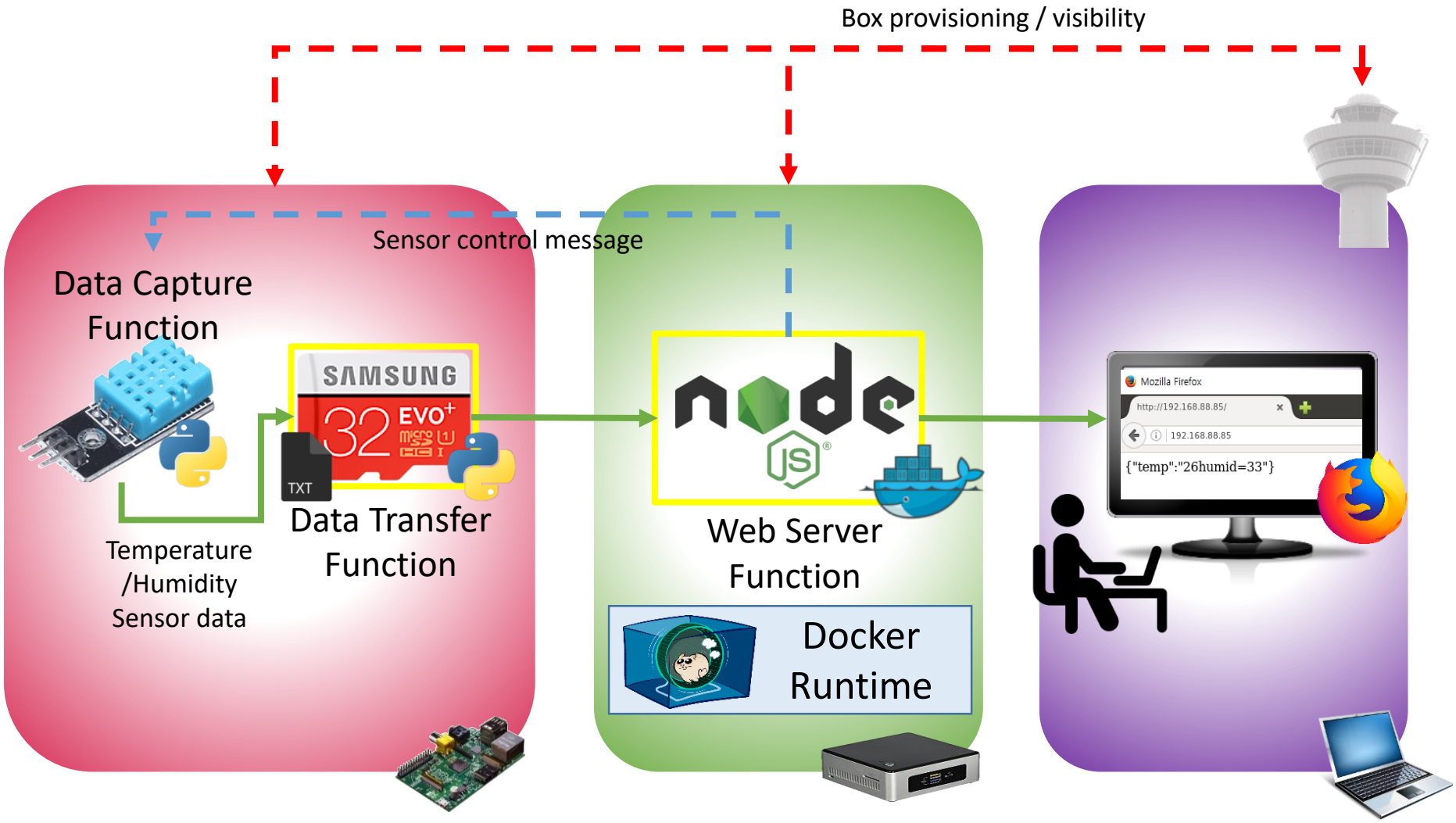
NAME: netgear prosafe 16 port gigabit switch(Switch)
Network Ports: 16 auto-sensing 10/100/1000 Mbps Ethernet ports

#0 Lab Preparation (2/2)





IoT Lab: Concept



#1-1 Docker Container for Node.js Web Server: Run Container

- Run a Docker Container
  $ sudo docker run –it ––net=host ––name=webserver lshyeung/smartx_webserver

- On container
  $ apt-get update
  $ apt-get install vim

```
root@5daf51f2abb0:/# ifconfig
eth0      Link encap:Ethernet  HWaddr 02:42:ac:11:00:05
          inet addr:172.17.0.5  Bcast:0.0.0.0  Mask:255.255.0.0
          inet6 addr: fe80::42:acff:fe11:5/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:4635 errors:0 dropped:0 overruns:0 frame:0
          TX packets:3305 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:12293854 (12.2 MB)  TX bytes:223481 (223.4 KB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

#1–2 Docker Container for Node.js Web Server: Server code

- Open Server code and change NUC IP

  $ vi /SmartX-mini/IoT-labs/webserver.js

```
var net = require('net');
var http = require('http');
var url = require('url');
var fs = require('fs');
var temp;

var server = net.createServer();

server.on('connection', function (socket) {
        socket.write("capture start! \r\n");
        //socket.pipe(socket);
        server.close(function(){
                console.log("tcp server closed.");
                console.log("IoT Temperature, Humidity service web server started");
                server.unref();
        });
});
server.listen(1337, '<NUC IP>');
http.createServer (function (request, response) {
        var query = url.parse(request.url, true).query;
        response.writeHead(200, { 'content-Type': 'text/html'});
        console.log(JSON.stringify(query));
        if (JSON.stringify(query).length > 13)
        {
                fs.writeFile('temp.txt', JSON.stringify(query), 'utf8', function (error){
                console.log('write');
        });
                                        }
        fs.readFile('temp.txt', 'utf8', function (error, data){
                console.log(data);
                temp = data;
        });

        response.end(temp);
}).listen(80,function (){});
```

#1–3 Docker Container for Node.js Web Server: Execute Server

- Execute webapp.js

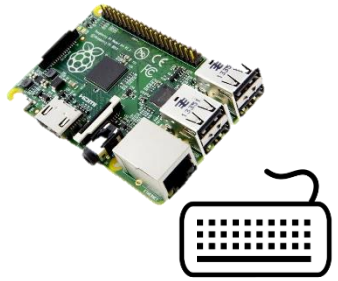
  $ cd SmartX-mini/IoT-labs

  $ nodejs webserver.js

- Open browser and go to

  http://{IP_of_your_NUC}

#2–1 Temperature / Humidity Sensor test on Raspberry PI: Install package



- Download package from github

  $ git clone https://github.com/adafruit/Adafruit_python_DHT.git

- Install package

  $ cd Adafruite_python_DHT

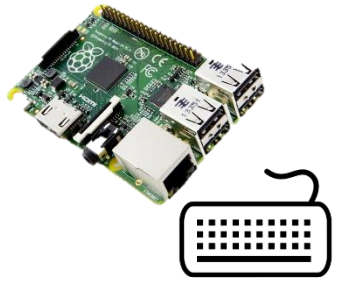
  $ apt-get update

  $ apt-get install python-pip

  $ python -m pip install -upgrade pip setuptools wheel

  $ sudo python setup.py install

#2–2 Temperature / Humidity Sensor test on Raspberry PI: Sensor test



- Move to example directory

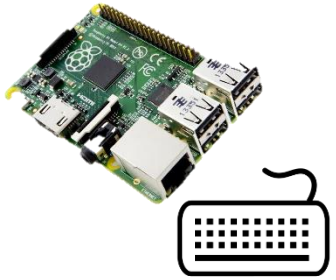
  $ cd ~/Adafruit_python_DHT/examples

- Execute test code

  $ sudo ./AdafruitDHT.py 11 4

```
HypriotOS: root@pi03 in ~/Adafruit_Python_DHT/examples on master
$ ./AdafruitDHT.py 11 4
Temp=22.0*  Humidity=20.0%
```

#3–1 Sensor Data Capture and Transfer: Sensor Data capture code

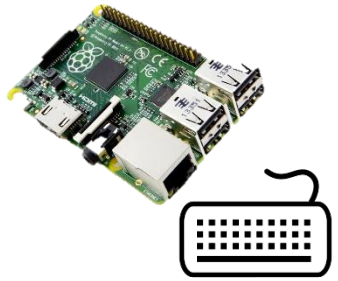


- Install dependencies at RPi
  - $ sudo apt-get update
  - $ sudo apt-get install libpython2.7-dev python-numpy
  - $ sudo apt-get install mercurial

- Open Sensor Data Capture code and Change IP Address
  - $ vi ~/SmartX-mini/IoT-Labs/RPI_capture.py

```
import Adafruit_DHT as dht
import urllib2
from time import sleep
import socket

sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
sock.connect(('<NUC IP>',1337))
s = sock.recv(5441)

sock.close()

if s:
        h,t = dht.read_retry(dht.DHT11,4)
        print ('Temp={0:0.1f}*C Humidity={1:0.1f}%').format(t, h)
        f=open("/root/data.txt",'w')
        data =str(t) + " " + str(h)
        f.write(data)
        f.close
sleep(1)
```

#3–2 Sensor Data Capture and Transfer: Sensor Data transfer code

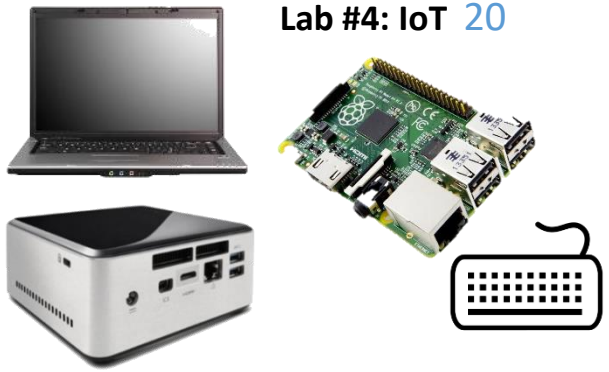


- Open Sensor Data Capture code and Change IP Address

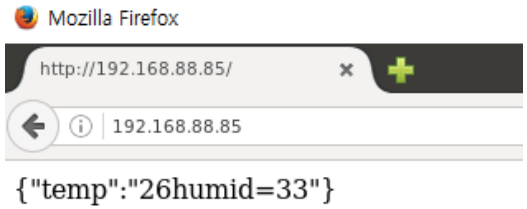
  $ vi ~/SmartX-mini/IoT-Labs/RPI_transfer.py

```
import Adafruit_DHT as dht
import urllib2
from time import sleep

def transfer():
        f=open("/root/data.txt",'r')
        line = f.readline()
        words = line.split(" ")
        print(words)
        urllib2.urlopen("http://<NUC IP>?temp="+words[0]+"humid="+words[1]).close
        f.close()

transfer()
```

#4 Execute IoT Web service



- At the Docker container in NUC (Webserver)
  - $ cd ~/SmartX-mini/IoT-labs
  - $ nodejs webserver.js
- At the Laptop (Tower)
  - Open Web browser and go to http://<IP_of_NUC>
- At the Rpi (Sensor Data Capture and Transfer)
  - $ cd ~/SmartX-mini/IoT-labs
  - $ chmod +x process.sh
  - $ sudo ./process.sh



Review

Lab Summary

With IoT Lab, you have experimented

1. An example-based realization of **container-based IoT-Cloud services** that can sense and actuate distributed IoT devices (i.e., Boxes).

2. For the cloud side, the required **Web-app server** realization is supported by utilizing **Node.js programming**.

Thank You for Your Attention
Any Questions?

mini@smartx.kr