OneM2M

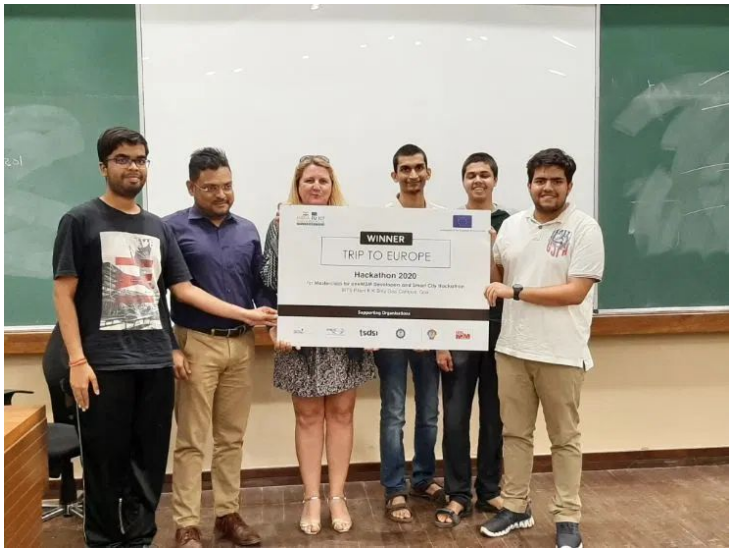
Spring 2020, IIIT-H

India-EU Collaboration

- Promote India and EU ties to produce ICT standards
- OneM2M standards developed for standard IoT framework

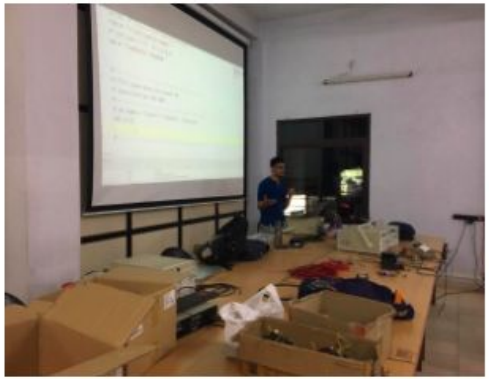
Activities under the collaboration

1. **Hackathons**
   IIIT students won 2 of the 4 hackathons



Activities under the collaboration

2. **Labs sessions**



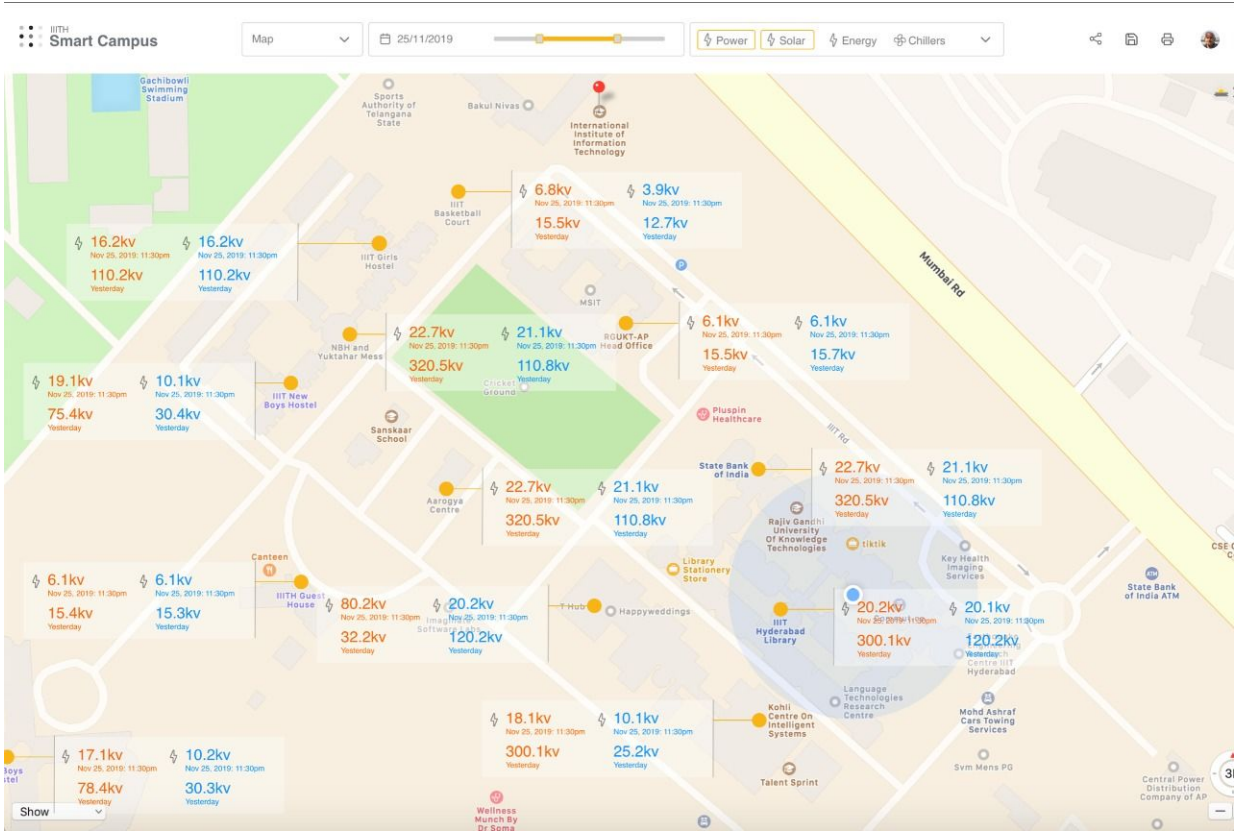
Activities under the collaboration

3. **Smart Campus**

   Deployed multiple IoT devices across the IIIT-H campus

Activities under the collaboration

4. **Smart Campus**



Today’s topics

1. Case study : Existing IoT Solutions
2. The OSI model
3. General look at interoperability
4. Introduction to OneM2M
5. Why OneM2M
6. Ontology (or Nomenclature)
7. Using OneM2M
8. Open Source opportunities

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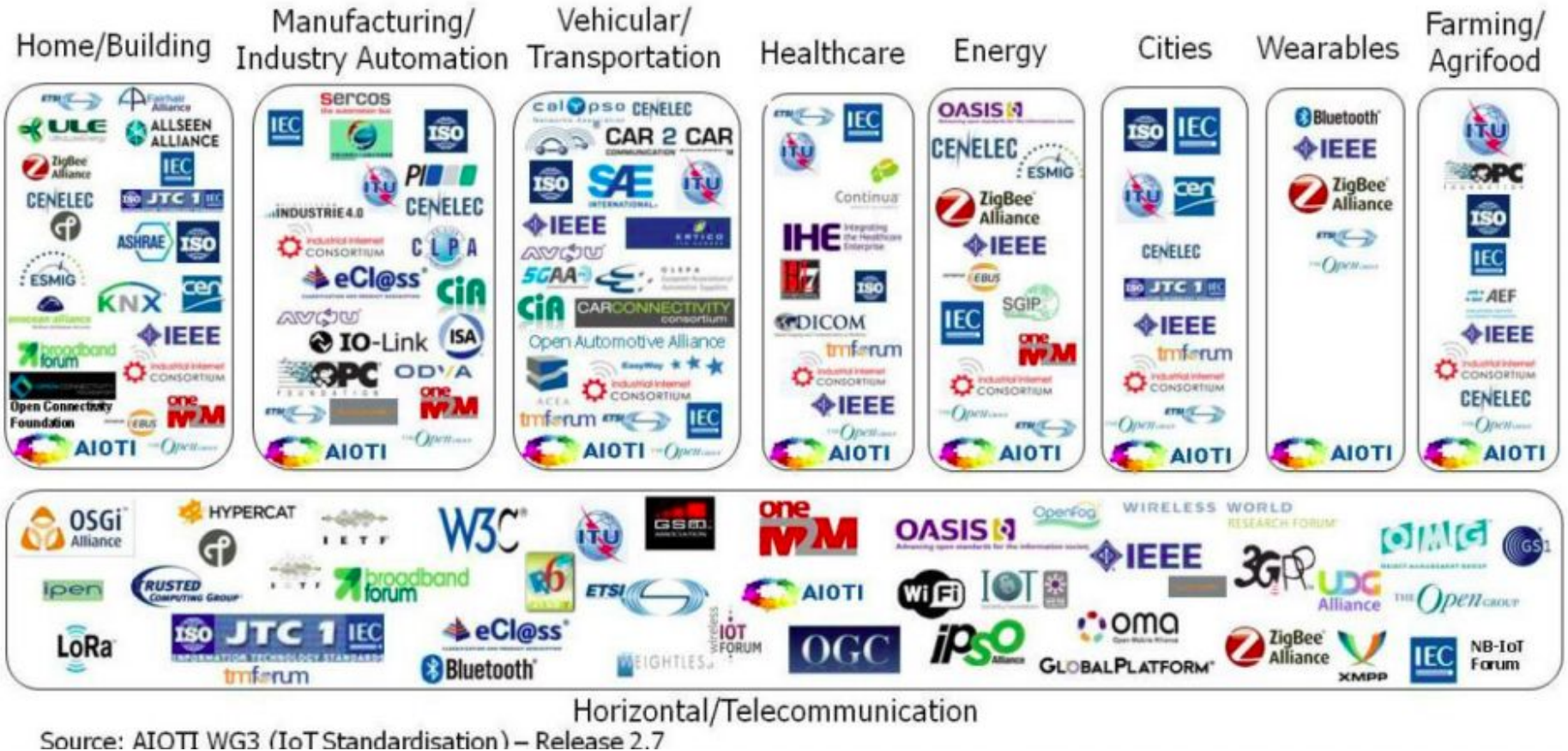
A simple case

Source : http://www.onem2m.org/images/app_dev_guide/tr-0057/sillos.png

- Highly fragmented market with limited vendor-specific applications
- Re-inventing the wheel : Same services developed again and again
- Each silo contains its own technologies without interoperability


Home/Building
Manufacturing/ Industry Automation
Vehicular/ Transportation
Healthcare
Energy
Cities
Wearables
Farming/ Agrifood
Horizontal/Telecommunication
Source: AIOTI WG3 (IoT Standardisation) – Release 2.7

Source

The challenges

1. Interoperability
2. Scalability
3. Device management

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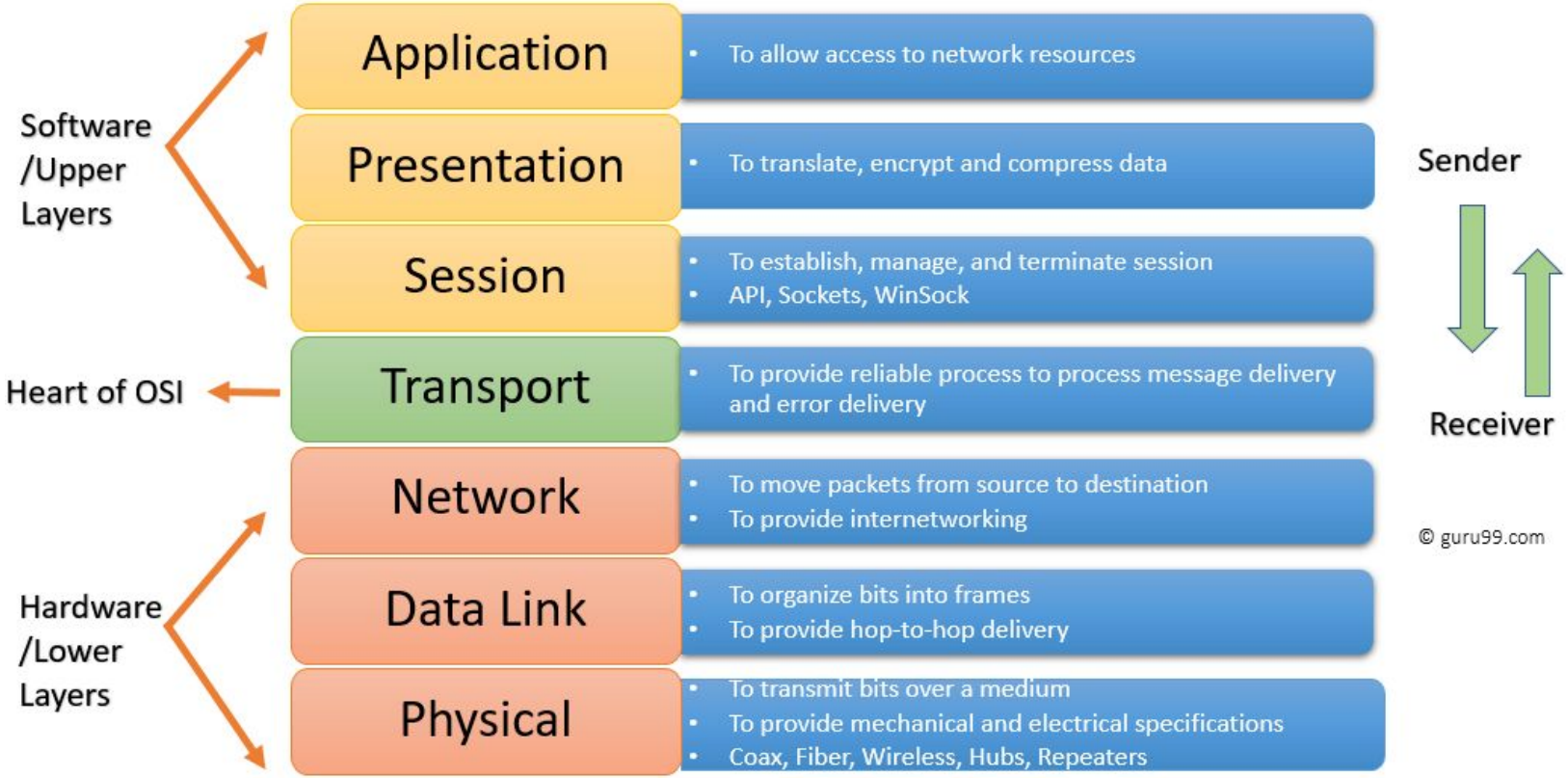
OSI model

APSTNDP



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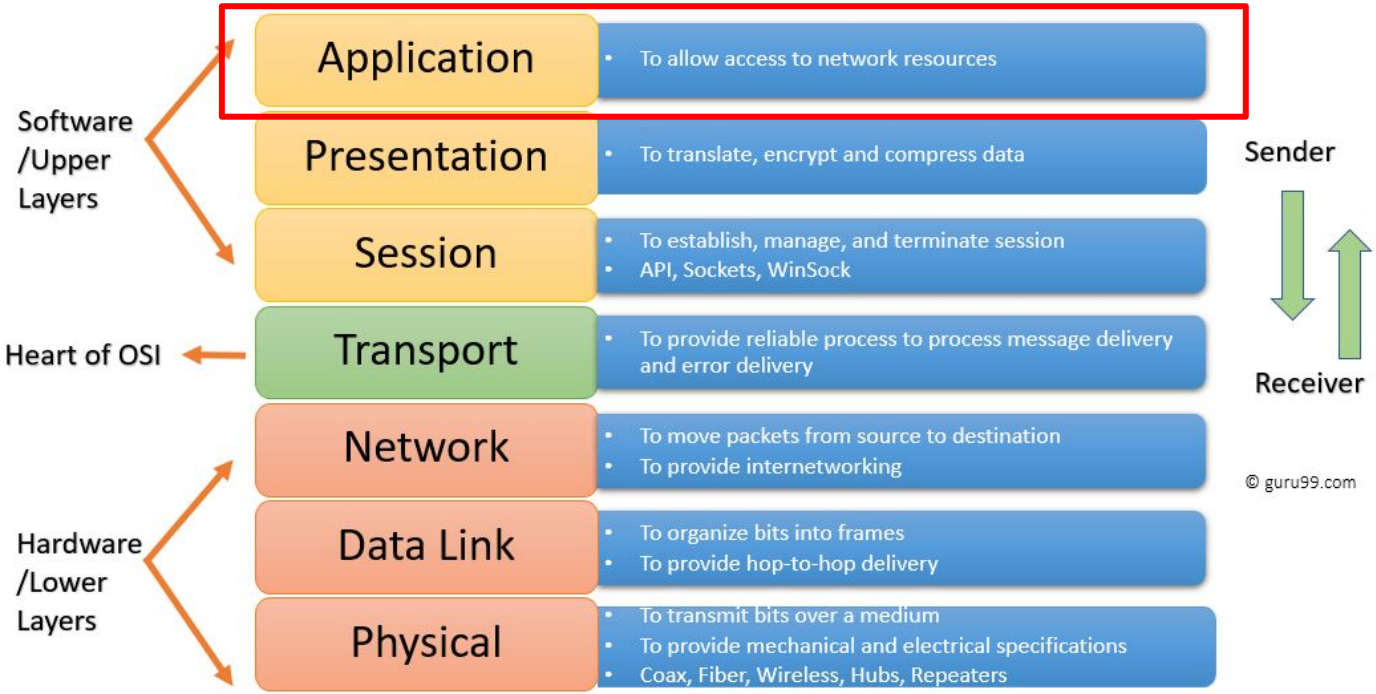
OSI model

NOTE:
This is a loose interpretation of OSI model and interoperability for understanding.



Semantic interoperability

- Standardization of *application layer*
- Formal definition of W3C "*Enabling different agents, services, and applications to exchange information, data and knowledge in a meaningful way, on and off the Web*"
- In short, various applications should be able to understand the meaning or semantics of the data being shared
- Eg: Units of measurement, compatible data structures

OSI model

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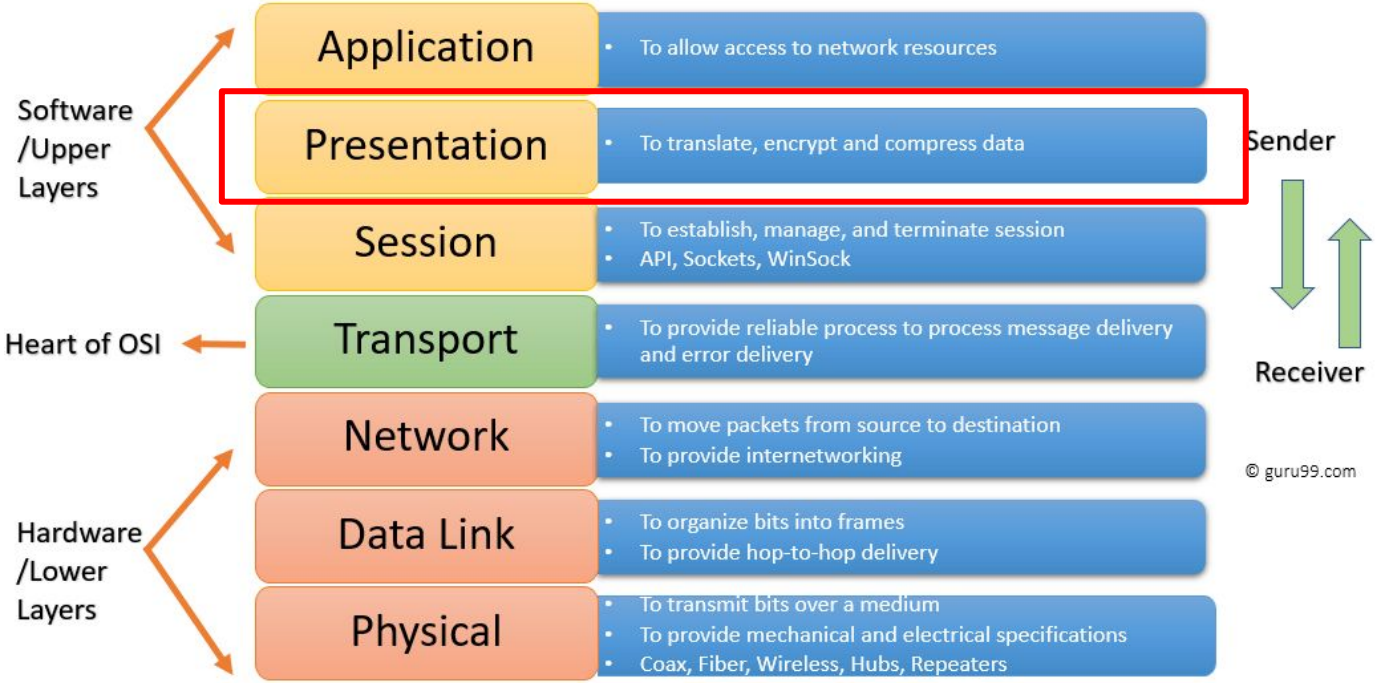

Syntactic interoperability

- Standardization of *Presentation layer*
- Standardized rules encrypt the data in the same way.
- In short, various applications should be able to decrypt and translate the data in the same way
- Eg: Using different encryption techniques doesn't allow understanding of data

OSI model

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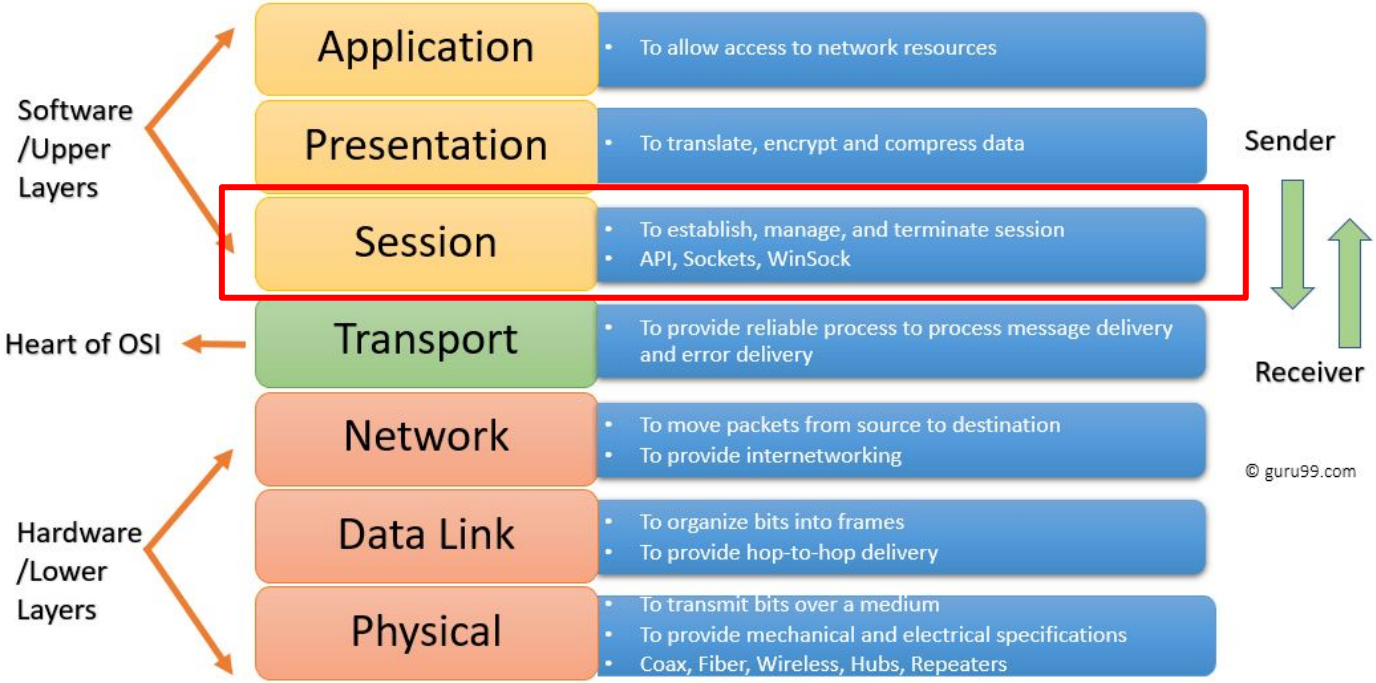

Platform interoperability

- Standardization of *Session layer*
- Rules on how to manage data.
- Eg: APIs of various verticals are different. With standardisation, it enables developers with ease of access to data and develop applications rather than spend time understanding the APIs of each vertical

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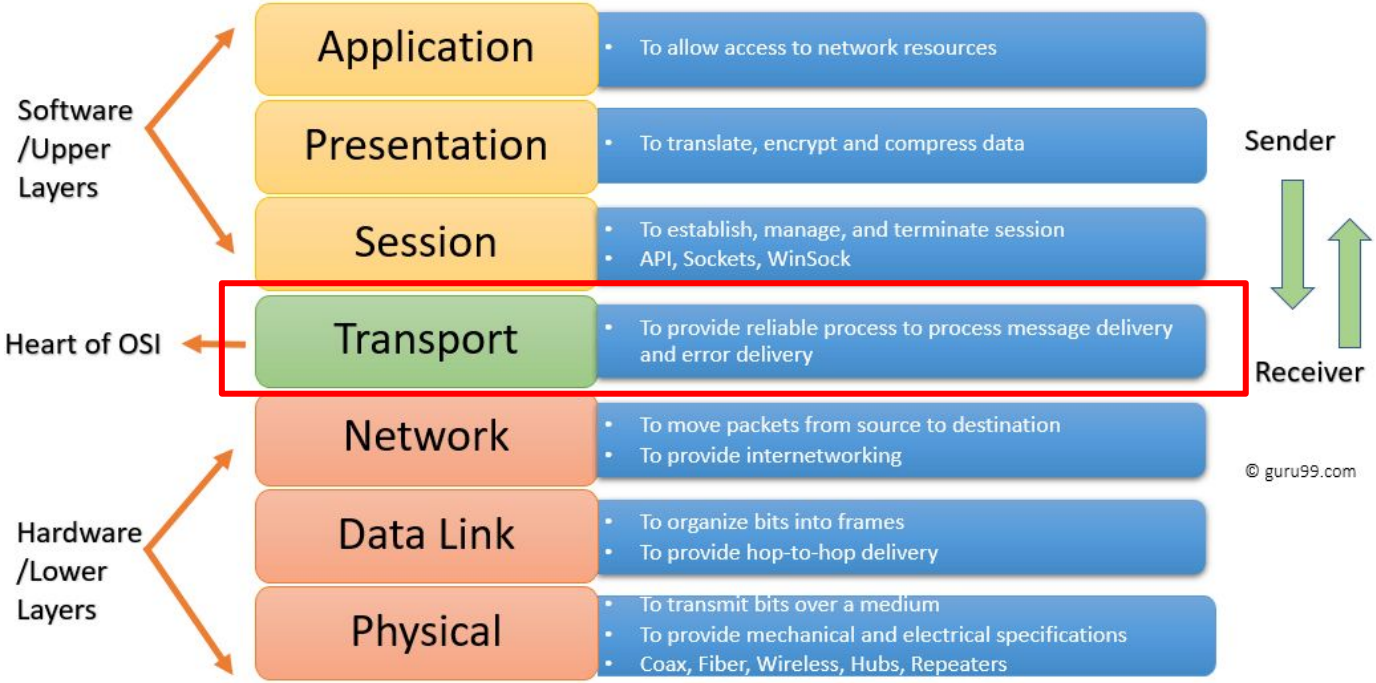

Transport interoperability

- Standardization of *Transport layer*
- OneM2M started with focus to standardize this layer
- In short, a horizontal layer to enable communications between various hardware and software solutions
- Will look into detail later

OSI model

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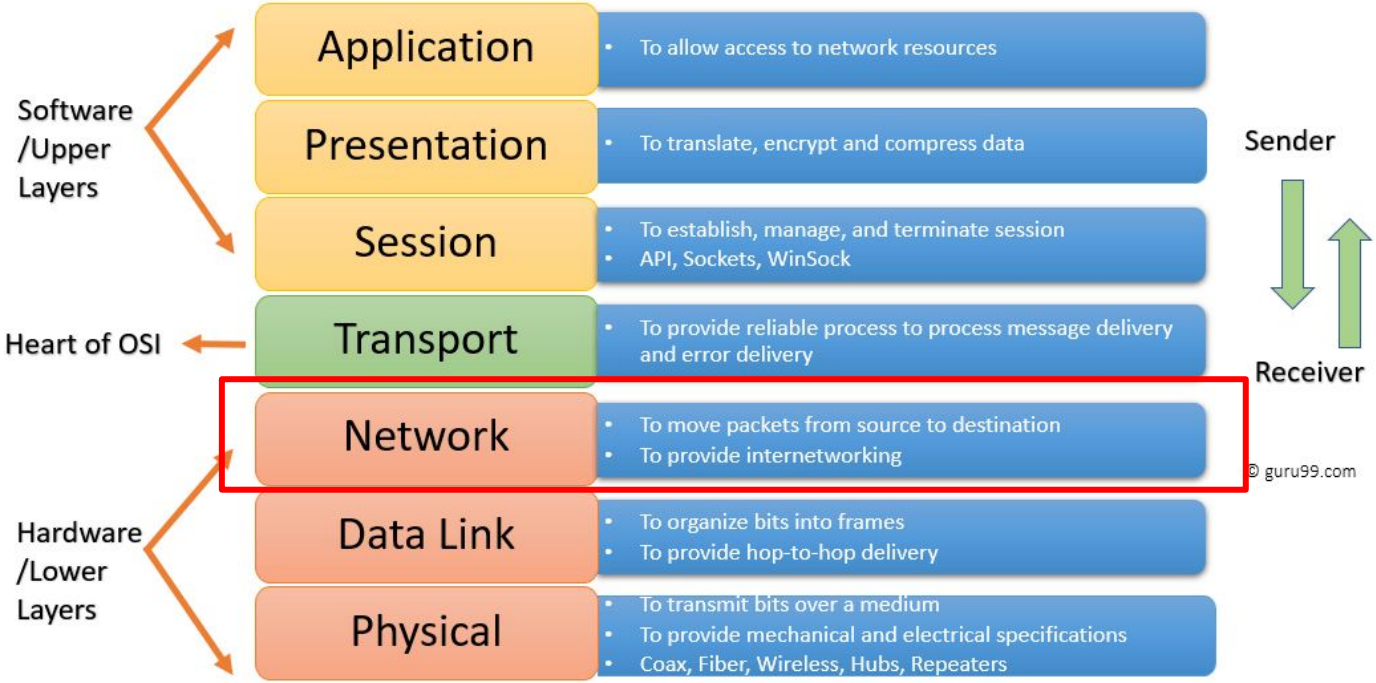

Network interoperability

- Standardization of *Network layer*
- Ability for data to travel across various kinds of networks
- Eg: Data transfer from Zigbee to bluetooth networks

OSI model

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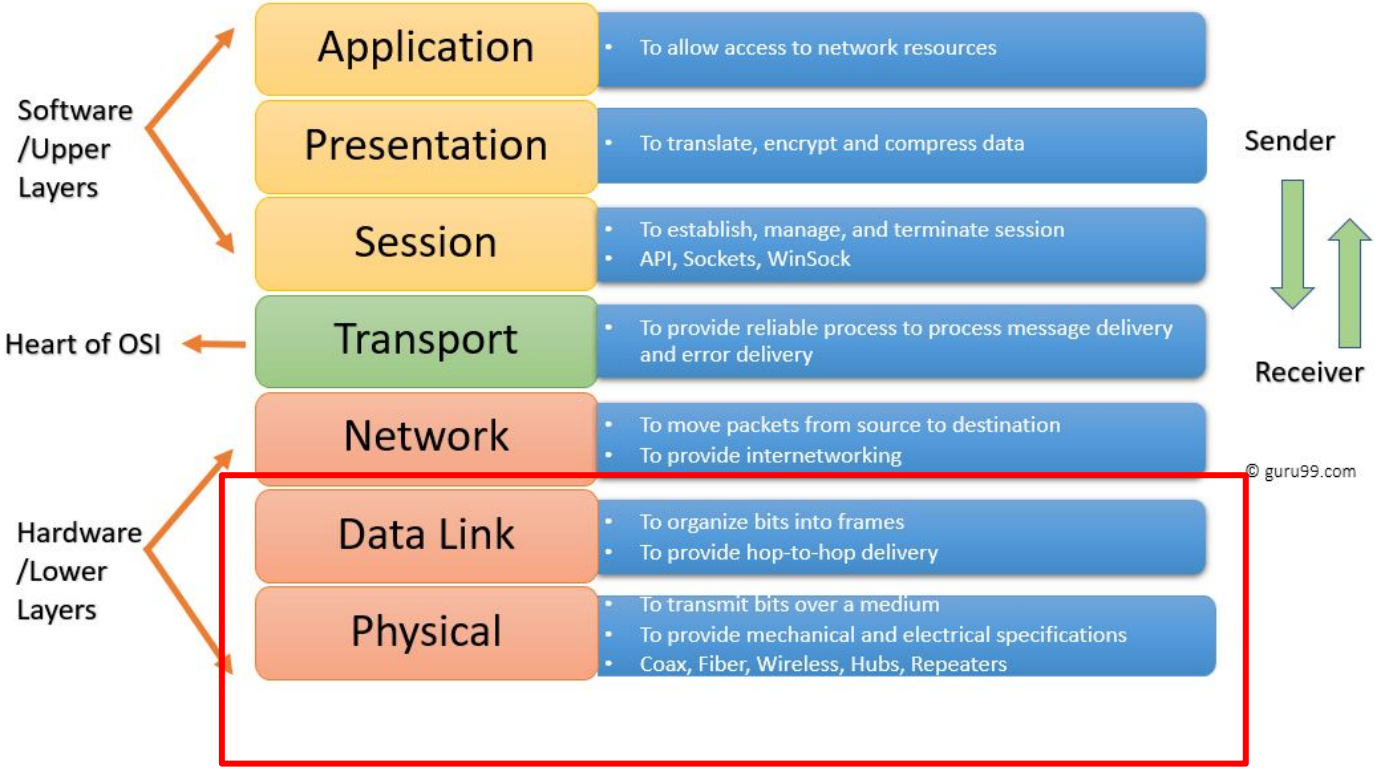
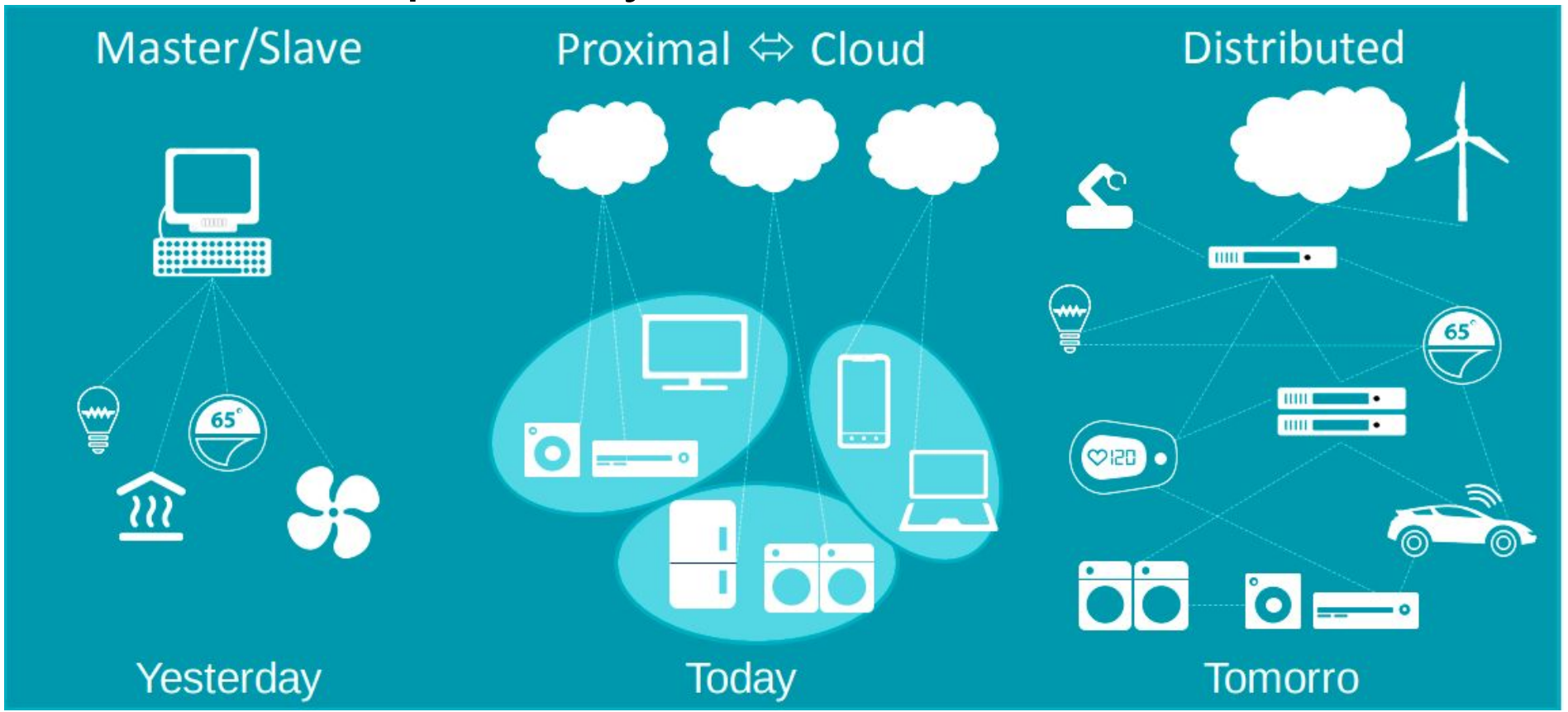
This is a loose interpretation of OSI model and interoperability for understanding.



Device interoperability

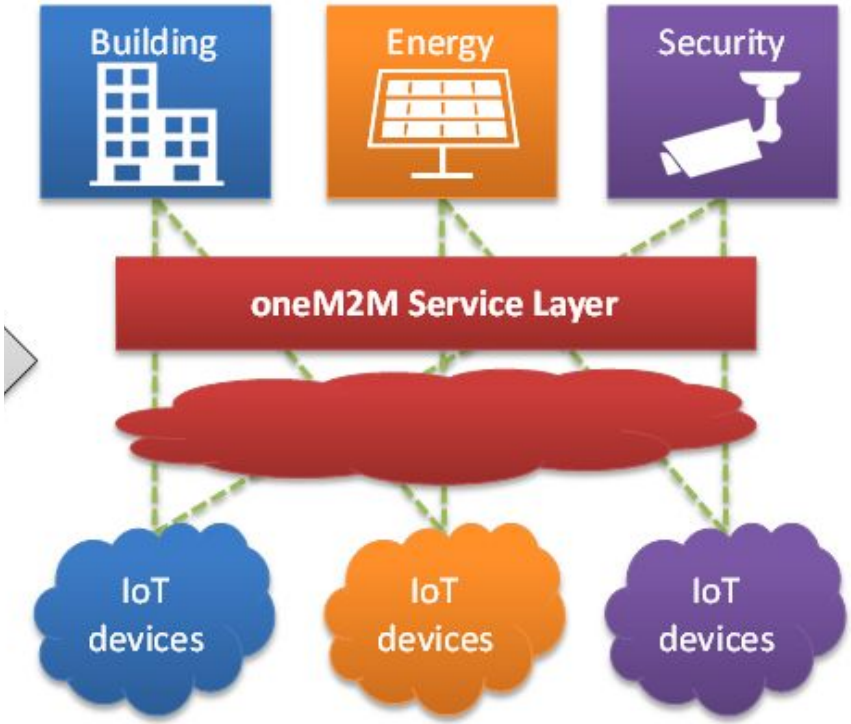
- Standardization of *Data link and Physical layer*
- Enables Cross-vendor support for devices/hardware platforms
- Eg: Using sensors and boards from various manufacturers. Servers able to accept data from various sources and route them accordingly

Aim of interoperability



Source

With oneM2M



Source : http://www.onem2m.org/images/app_dev_guide/tr-0057/sillos.png

- End-to-end platform : common service capabilities layer
- Interoperability at the level of data and control exchanges via uniform APIs
- Seamless interaction between heterogeneous applications and devices

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What is oneM2M

- Global standardization for M2M and IoT
- Provides a software framework by creating a **horizontal** layer across domains.
- This service layer is located between applications and hardware infrastructure
- Enables reusability
- Members consist of various standard bodies, ICTs and companies.
- Work was initiated in 2008

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Need for standardization

- To provide scalability and flexibility
- Improves functionality-cost-quality trade off
- Set of APIs communicating with the service layer reduces:
  - Time-to-market
  - Development and on-boarding costs
  - Management of devices and applications

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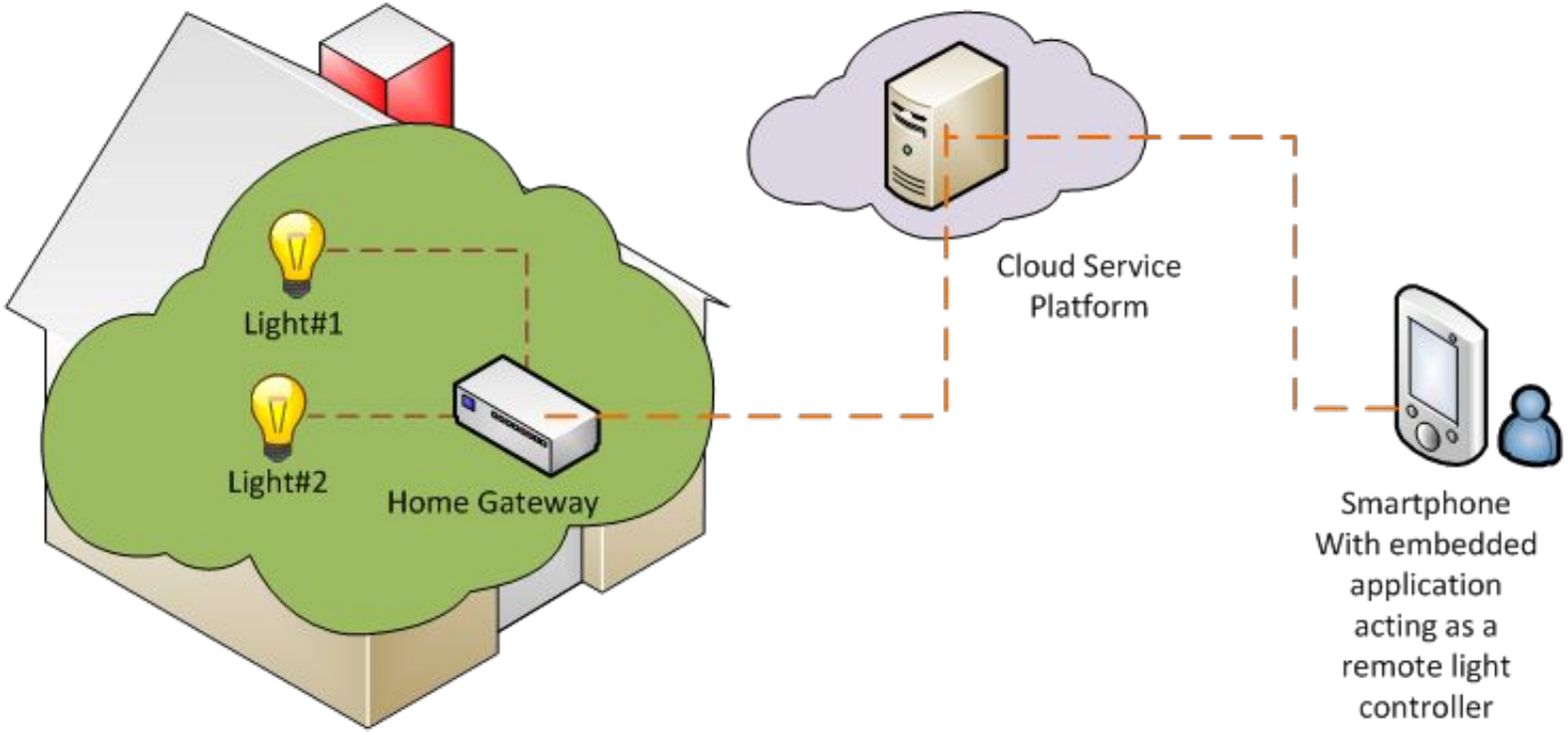
Ontology

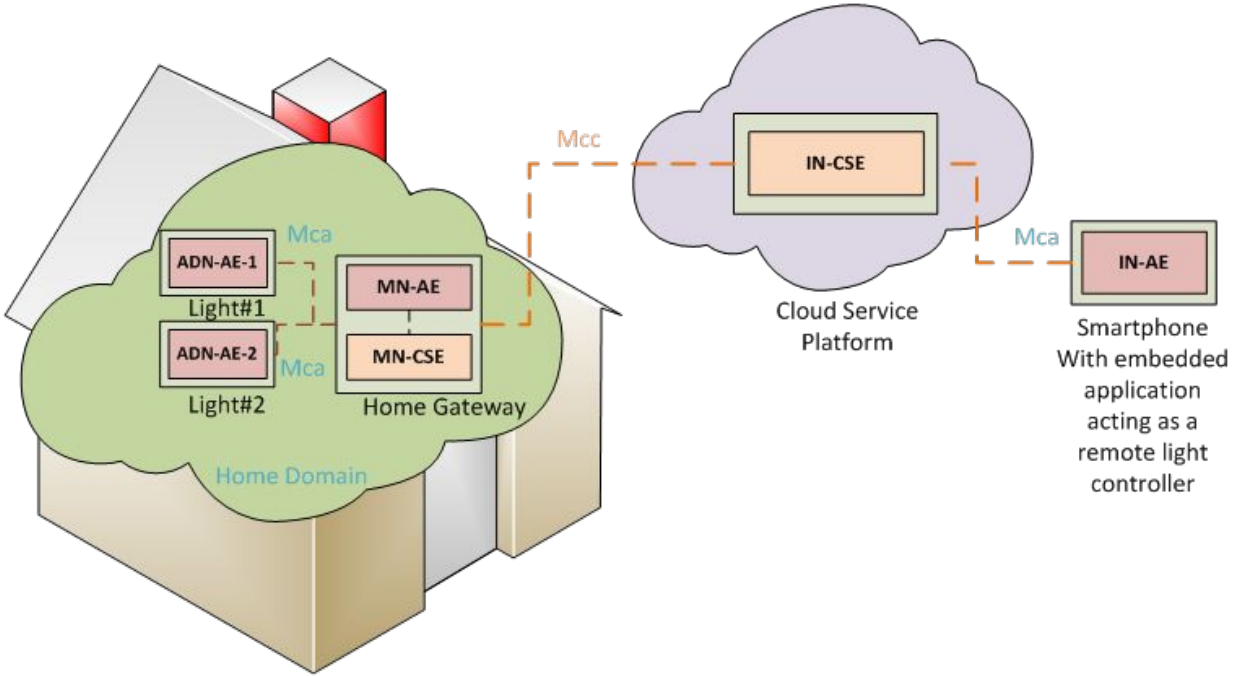


http://www.onem2m.org/images/app_dev_guide/UseCase.png

IN : Infrastructure Node
MN : Middle Node

CSE : Common service entity
AE : Application Entity

ADN : Application Device Node



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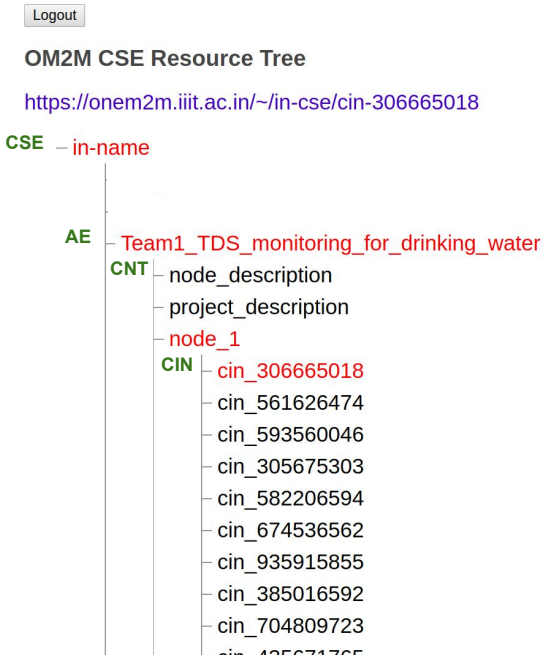
For the purpose of this demo...

Build the header and payload using Python libraries on my local system.

- Registering AE
- Creating Container
- Create content instances
- Retrieve data



OM2M Connecting things

Attribute	Value
rn	cin_306665018
ty	4
ri	/in-cse/cin-306665018
pi	/in-cse/cnt-808290327
ct	20191017T182755
lt	20191017T182755
st	0
cnf	text/plain:0
cs	13
con	test_instance

Protocols to communicate with OneM2M

- **HTTP**
- MQTT
- CoAP

HTTP Messages

The hardware reads the sensor data and encapsulates a HTTP message by forming the *header* and the *payload.*

- Header:
  - Consists of meta information, credentials, etc…
- Payload:
  - Actual data and other relevant parameters
  - Can specify payload in either XML or **JSON** format
- This is then sent to the IoT server using appropriate HTTP methods.

HTTP Request can be made from any device

Condition : Hardware should have a TCP/IP stack

- A plain arduino UNO or Mega doesn’t have TCP/IP stack
  (should use a WiFi shield)
- RaspberryPi, BeagleBone, etc.. have the TCP/IP stack.
- Considering the power consumption and footprint, ESP has been a good choice
  (ESP32, ESP8266, NodeMCU)

For the purpose of this demo...

- **Registering AE**
- Create Container
- Create content instances
- Retrieve data

Registering AE

Things to note:

- Run once per AE
- Type:2 (specifies we are creating an AE)
- rn : resource name (name of the AE)
- lbl : labels (used to filter)
- Header + payload = HTTP message
- Then execute a HTTP POST method (sends the HTTP message to the server)

```
def register_ae(uri_cse, ae_name, labels="", fmt_ex="json"):
    """
        Method description:
        Registers an application entity(AE) to the OneM2M framework/tree
        under the specified CSE

        Parameters:
        uri_cse : [str] URI of parent CSE
        ae_name : [str] name of the AE
        labels : [str] labels for the AE
        fmt_ex : [str] payload format
    """

    headers = {
        'X-M2M-Origin': 'admin:admin',
        'Content-type': 'application/{};ty=2'.format(fmt_ex)}

    payload = {
        "m2m:ae": {
            "rn": "{}".format(ae_name),
            "api": "tap",
            "rr": "true",
            "lbl": labels
        }
    }

    response = requests.post(uri_cse, json=payload, headers=headers)
    print('Return code : {}'.format(response.status_code))
    print('Return Content : {}'.format(response.text))
```

For the purpose of this demo...

- Registering AE
- **Creating Container**
- Create content instances
- Retrieve data

Creating Container

Things to note:

- Run once per CNT
- Type:3 (specifies we are creating an CNT)
- rn : resource name (name of the CNT)
- mni : Maximum number of Instances
- Header + payload = HTTP message
- Then execute a HTTP POST method (sends the HTTP message to the server)

```
def create_cnt(uri_ae, cnt_name="", fmt_ex="json"):
    """
        Method description:
        Creates a container(CON) in the OneM2M framework/tree
        under the specified AE

        Parameters:
        uri_ae : [str] URI for the parent AE
        cnt_name : [str] name of the container (DESCRIPTOR/DATA)
        fmt_ex : [str] payload format
    """

    headers = {
        'X-M2M-Origin': 'admin:admin',
        'Content-type': 'application/{};ty=3'.format(fmt_ex)}

    payload = {
        "m2m:cnt": {
            "rn": "{}".format(cnt_name),
            "mni": -1
        }
    }

    response = requests.post(uri_ae, json=payload, headers=headers)
    print('Return code : {}'.format(response.status_code))
    print('Return Content : {}'.format(response.text))
```

For the purpose of this demo...

- Registering AE
- Creating Container
- **Create content instances**
- Retrieve data

Creating Content instances

Things to note:

- Type:4 (specifies we are creating an CIN)
- con : content (sensor/actuator state)
- Header + payload = HTTP message
- Then execute a HTTP POST method (sends the HTTP message to the server)

```
def create_data_cin(uri_cnt, value, fmt_ex="json"):
    """
        Method description:
        Creates a data content instance(data_CIN) in the OneM2M framework/tree
        under the specified DATA CON

        Parameters:
        uri_cnt : [str] URI for the parent DATA CON
        fmt_ex : [str] payload format (json/XML)
    """

    headers = {
        'X-M2M-Origin': 'admin:admin',
        'Content-type': 'application/{};ty=4'.format(fmt_ex)}

    payload = {
        "m2m:cin": {
            "con": "{}".format(value)
        }
    }

    response = requests.post(uri_cnt, json=payload, headers=headers)
    print('Return code : {}'.format(response.status_code))
    print('Return Content : {}'.format(response.text))
```

For the purpose of this demo...

- Registering AE
- Creating Container
- Create content instances
- **Retrieve data**

Retrieve

- Using the GET method by specifying the URI of the resource

Things to note:

- Type: not necessary to specify
- No payload
- Just Header = HTTP message
- Then execute a HTTP GET method (get the data that we want)
- Append “/la” to the URI to get the latest content instance from the specified container

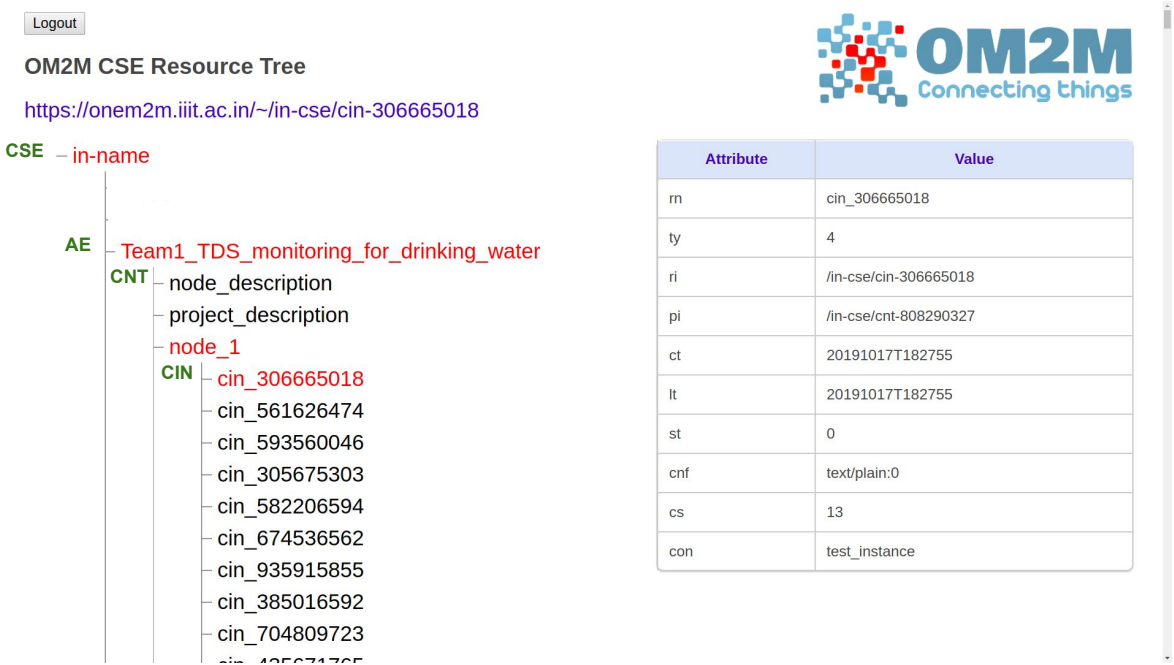
```
def get_data(uri, format="json"):
    """
        Method description:
        Gets data from the specified container(data_CIN)
        in the OneM2M framework/tree

        Parameters:
        uri : [str] URI for the parent DATA CON appended by "la" or "ol"
        fmt_ex : [str] payload format (json/XML)
    """
    headers = {
        'X-M2M-Origin': 'admin:admin',
        'Content-type': 'application/json'}

    response = requests.get(uri, headers=headers)
    print('Return code : {}'.format(response.status_code))
    print('Return Content : {}'.format(response.text))
    _resp = json.loads(response.text)
    return response.status_code, _resp["m2m:cin"]["con"]
```

OneM2M Resource tree

CSE : Common service entity
AE : Application entity
CNT : Container
CIN : Container Instance



- ae: Application Entity(Sensor/actuators)
- cnt: Container(For holding various kinds of data under the same AE)
- cin: Content Instance(For holding various instances of the same data type)
- sub: Subscription
- rn: Resource Name
- ty: Type
- ri: Resource ID
- pi: Parent Id
- Acpi: Access Control Policies IDs
- uril: URI List
- ct: Creation Time
- et: Expiration Time
- lt: Last Modified Time
- lbl: Label
- cnf: Content Format
- con: Content
- mni: Maximum Number of Instance
- api: Application Id
- poa: Point of Access
- rr: Request Reachability
- sur: Subscription URI

To summarize

- IoT devices need to make HTTP requests to communicate with the OneM2M resource tree:
  - To send data, we use the POST method using HTTP request
  - To get data, we use the GET method
  - There are other methods like UPDATE and DELETE

- HTTP Requests can be made from any kind of device given it has TCP/IP hardware stack.
  - Arduino boards with wifi shields
  - ESP32, ESP8266
  - Raspberry Pi

Advanced Features

- Grouping
- Filtering
- Subscription
- Security and permissions

- Can pass various parameters for attaining flavours of functionality
  - Eg: Get data after a particular date, get data between 2 time intervals, etc..

Kinds of URI

- Direct URI
- Indirect URI
- Other kinds can be found in the OneM2M documentation

Open Source Contribution

- Make presentations on Technical sheets
- Develop Python/C++ codes for advanced features
- Developing IIIT’s implementation of OneM2M

Github repo https://github.com/suraj2596/OneM2M-IIIT-H

References

- http://www.onem2m.org/getting-started/onem2m-overview/introduction/service-layer
- http://www.onem2m.org/technical/published-drafts/release-3
- http://www.onem2m.org/developer-guides
- Om2m.org