Model-Example

IoT-Domain model

- Description of concepts belonging to a particular area of interest. Defines the basic attributes of these objects, such as name and identifier.
- Defines relationships between objects, for instance "**sensor**(Device) monitors room(Physical Entity)".
- Purpose - generate a common understanding of the target domain.
- UML - graphically illustrate the model.
- Abstraction: For example, in the IoT domain, the device concept will likely stay around, while the types of devices used will change over time or vary depending on the application context. Similarly, there are many technologies to identify objects – **RFID, bar codes, image recognition** etc. But which of these will still be in use? and which is the best suited technology for a particular application? For these and related reasons, the domain model does not include particular technologies, but rather abstractions.

IoT-Domain model

- Scenario requirement - User needs to interact (remote) with a Physical Entity.
- Physical environment- interactions directly.

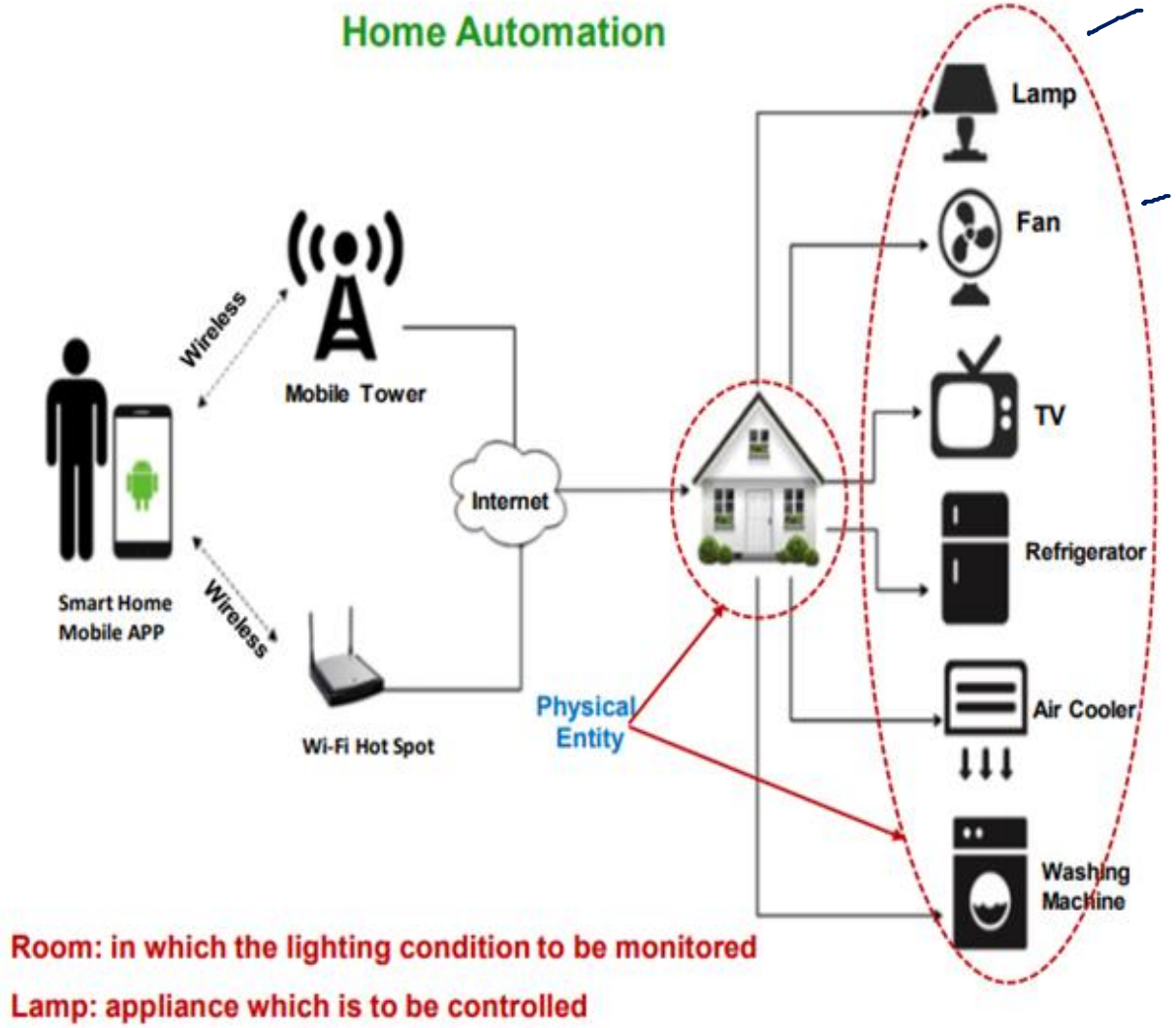
- IoT environment- interaction is indirect or mediated, i.e., by calling a service that will either give information about the Physical Entity.
- A Human User access a service through a service client, i.e., some software with an accessible user interface.
- Interaction - characterized by the goal of the user.
- The concepts include:

1. Physical entity, 2. Virtual entity, 3. Device, 4. Resource, 5. Service.

1. Physical Entity (PE)

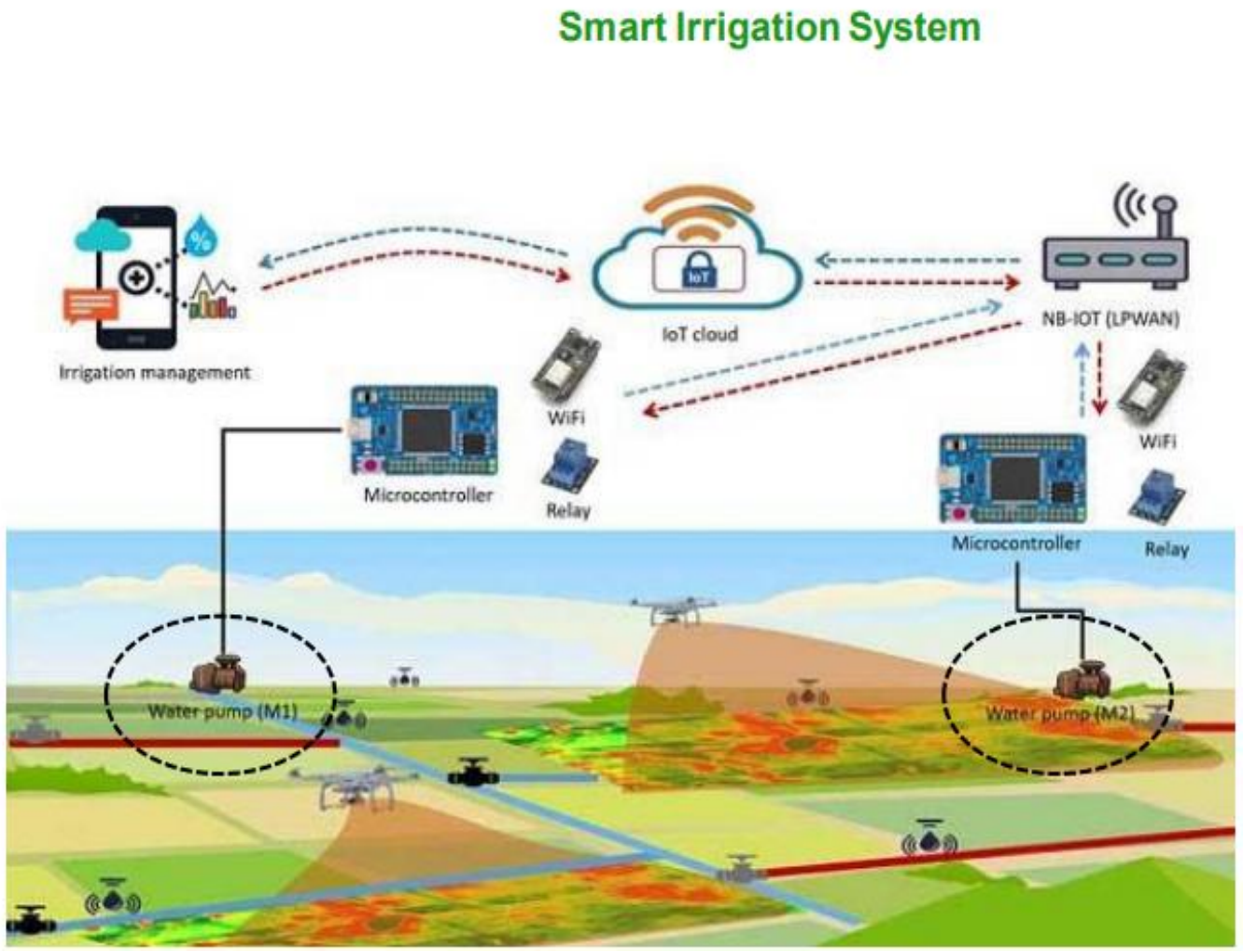
- Identifiable part of the physical environment which is of interest to the user for the completion of his goal.

- Example: Physical Entities can be any object or environment; from humans/animals to cars; from store/ logistic chain items to computers; from electronic appliances to closed/open environments.



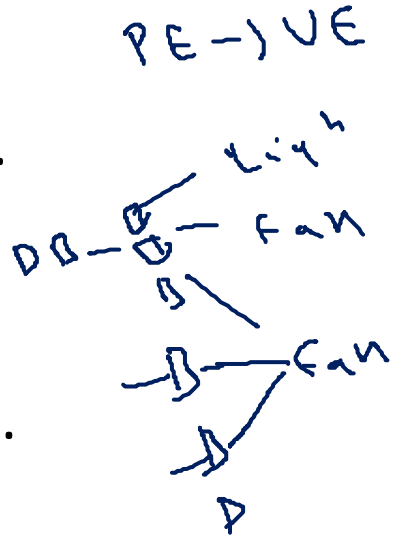
1. Physical Entity (PE)

- Physical entities of Irrigation System Soil (moisture content is to be monitored) Motor (to be controlled)



2. Virtual Entity (VE)

- Physical Entities are represented in the digital world by Virtual Entity.
- Representations: 3D models, data-base entries, social-network account.
- Fundamental properties: 1. VEs are associated to single PE.
  2. VEs are updated upon any change in the PE.

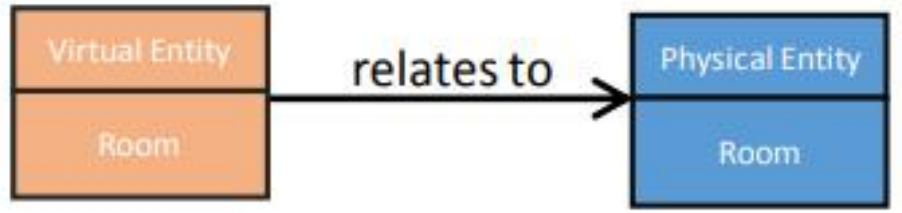


- One PE for each VE, also possible that the same PE can be associated to several VEs. Each VE must have only one ID.
- Examples: Active Digital Artefacts - running software applications, agents or Services that may access other services or Resources.
- Passive Digital Artefacts - data-base entries, other digital representations of PE.

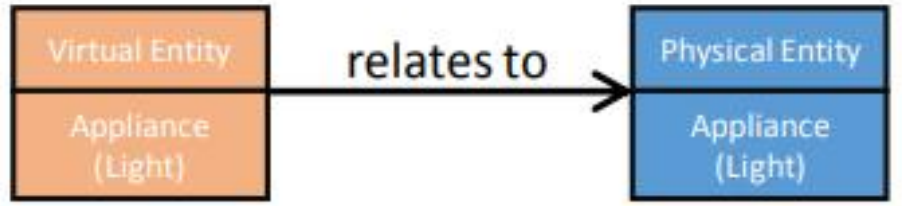
2. Virtual Entity (VE)

- **Example:** Consider the Home Automation with two PEs i.e. Room and Light. Though the single Physical Entity can be associated to several Virtual Entities in this example it is assumed that each Physical Entity has one virtual entity i.e. Virtual Entity of Room and Virtual Entity of Light.

- Relationship between Virtual Entity and Physical Entity is depicted as per UML Class Diagram using the "Class Diagram Relationship Association"



→ **Association:** Describes the static or physical connection between objects



3. Device

- Medium for interactions between PEs and VEs.
- Devices are either attached to PEs or placed near PEs.
- Three basic types of devices required for IoT. Gather information about PEs - sensors, perform actuation upon PEs-actuators, identify PEs-tags.
- Interface between the digital and the physical worlds, i.e. a link between the VEs and PEs.
- Purpose: monitoring, sensing, processing, computation, storage.
- Devices must be able to operate both in the physical and digital world.

3. Device

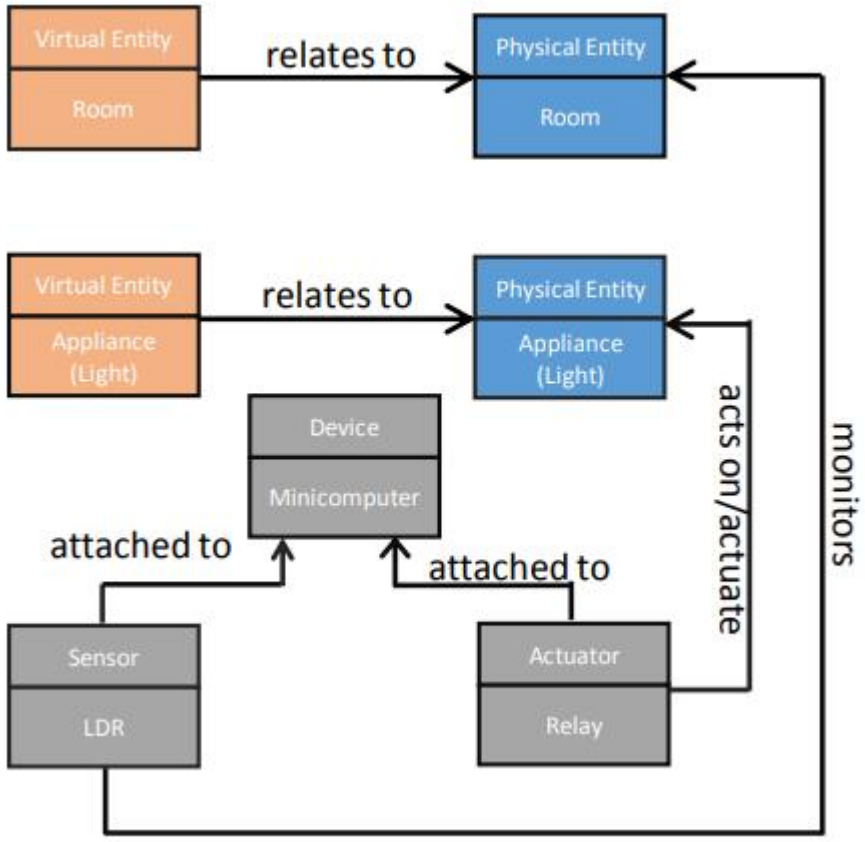
- Aggregation of several Devices of different types. Along with basic devices

(sensors, tags, and actuators) the devices may be a computer, microcontroller, etc.

Home Automation:

sensor and actuator are considered along with single board minicomputer.

Sensors and actuators are interfaced with the computer.

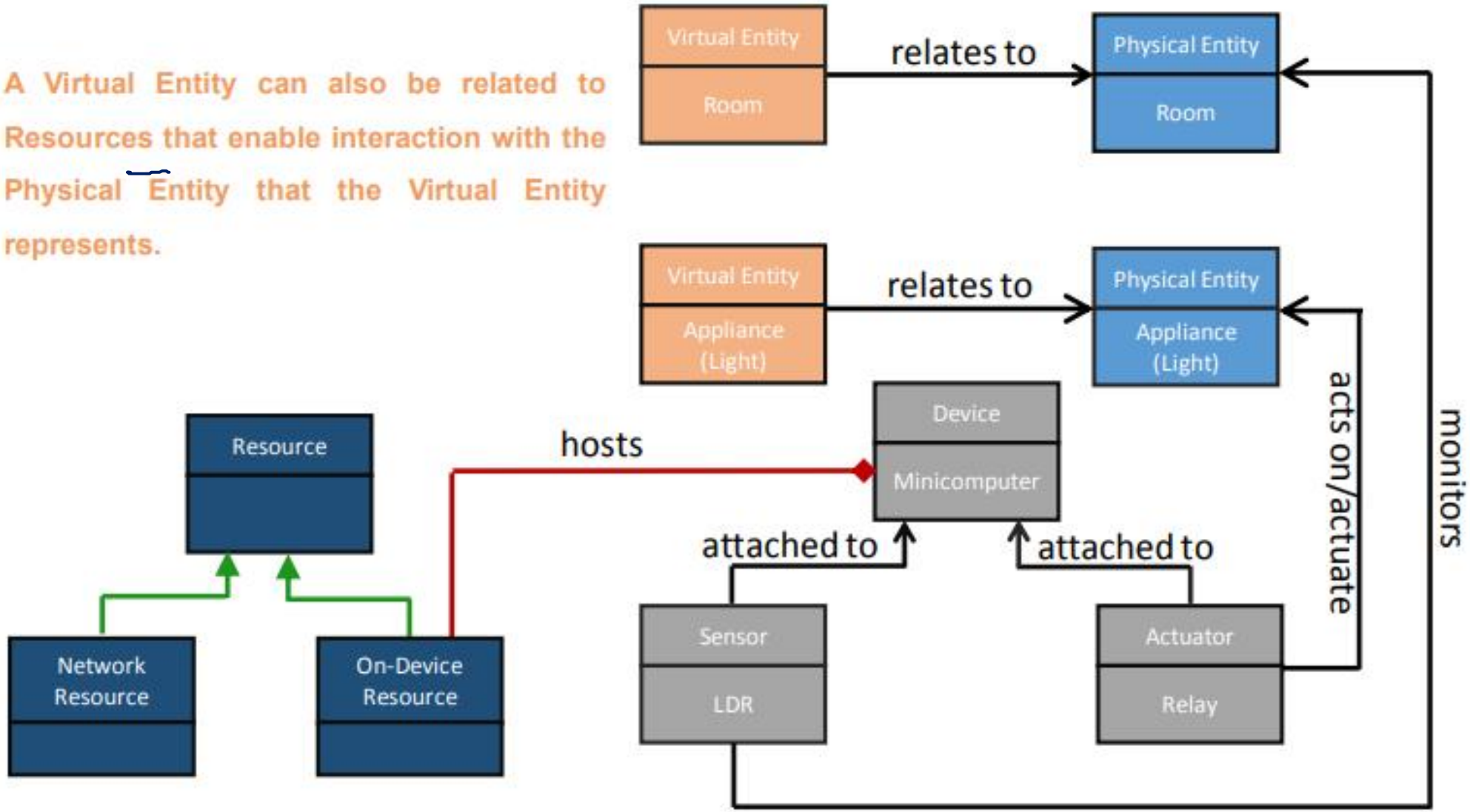


4. Resource- Network resources

- Back-end or cloud-based data bases.
- Run on a dedicated server in the network or in the “cloud”, they do not rely on special hardware that allows a direct connection to the physical world.
- Process data, for instance they take sensor information as input and produce aggregated or more high-level information as output.
- Storage Resources can store information from Resources and provide information about PEs.
- Users can also update the information in a storage Resource, since not all known information about an entity can be provided by Devices.

4. Resources

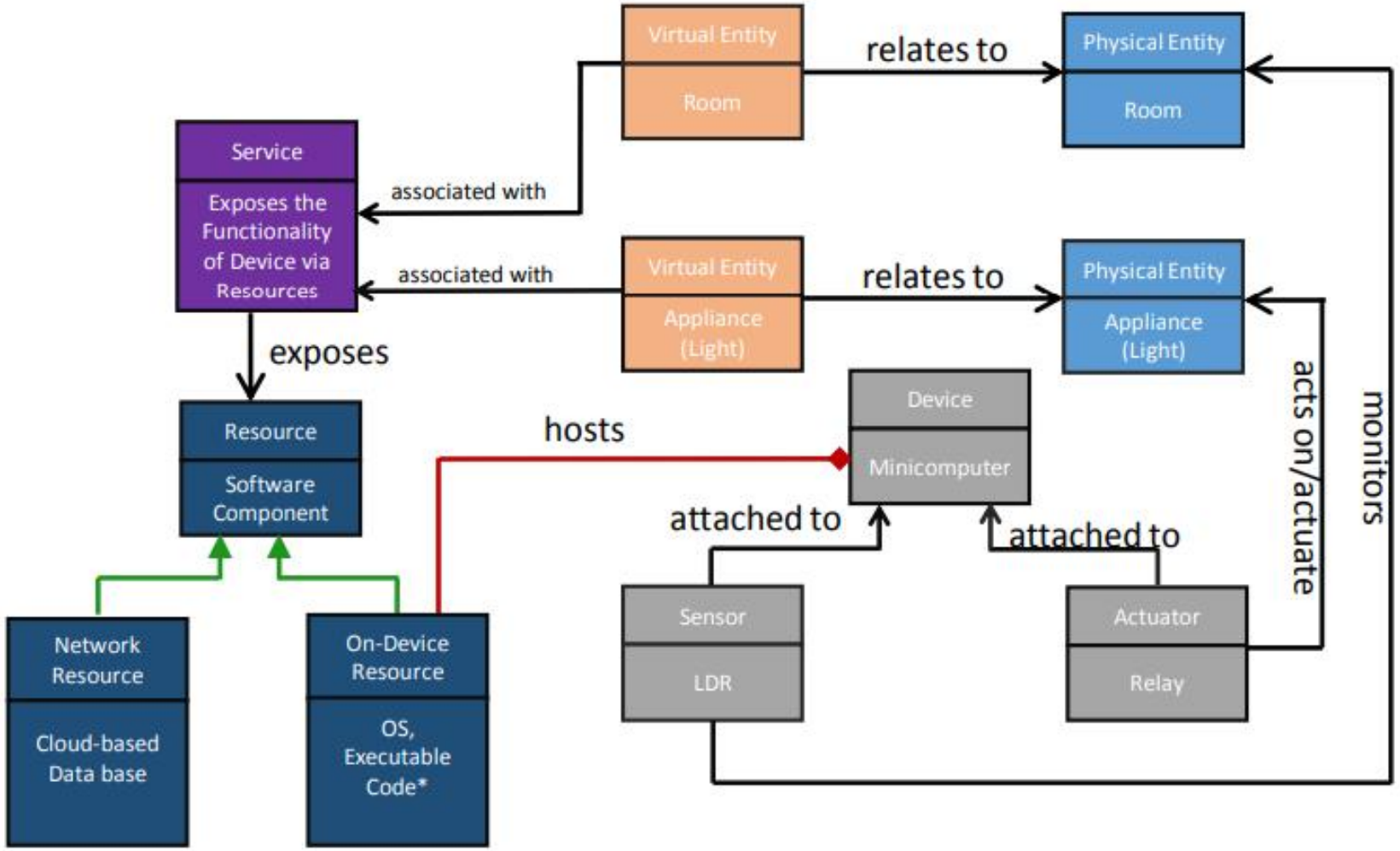
A Virtual Entity can also be related to Resources that enable interaction with the Physical Entity that the Virtual Entity represents.



5. Service

- Provides a standardized interface, offering all necessary functionalities for interacting with PEs and related processes. Interaction with the Service is done via the network.
- Services expose the functionality of a Device through its hosted Resources.
- Service makes a Resource accessible and hence the relations between Resources and VEs are modelled as associations between VEs and services.
- Resource-level: Expose the functionality of a Device by accessing its hosted Resources.
- VE-level: access to information on a Virtual Entity level, Services for accessing attributes.

5. Service



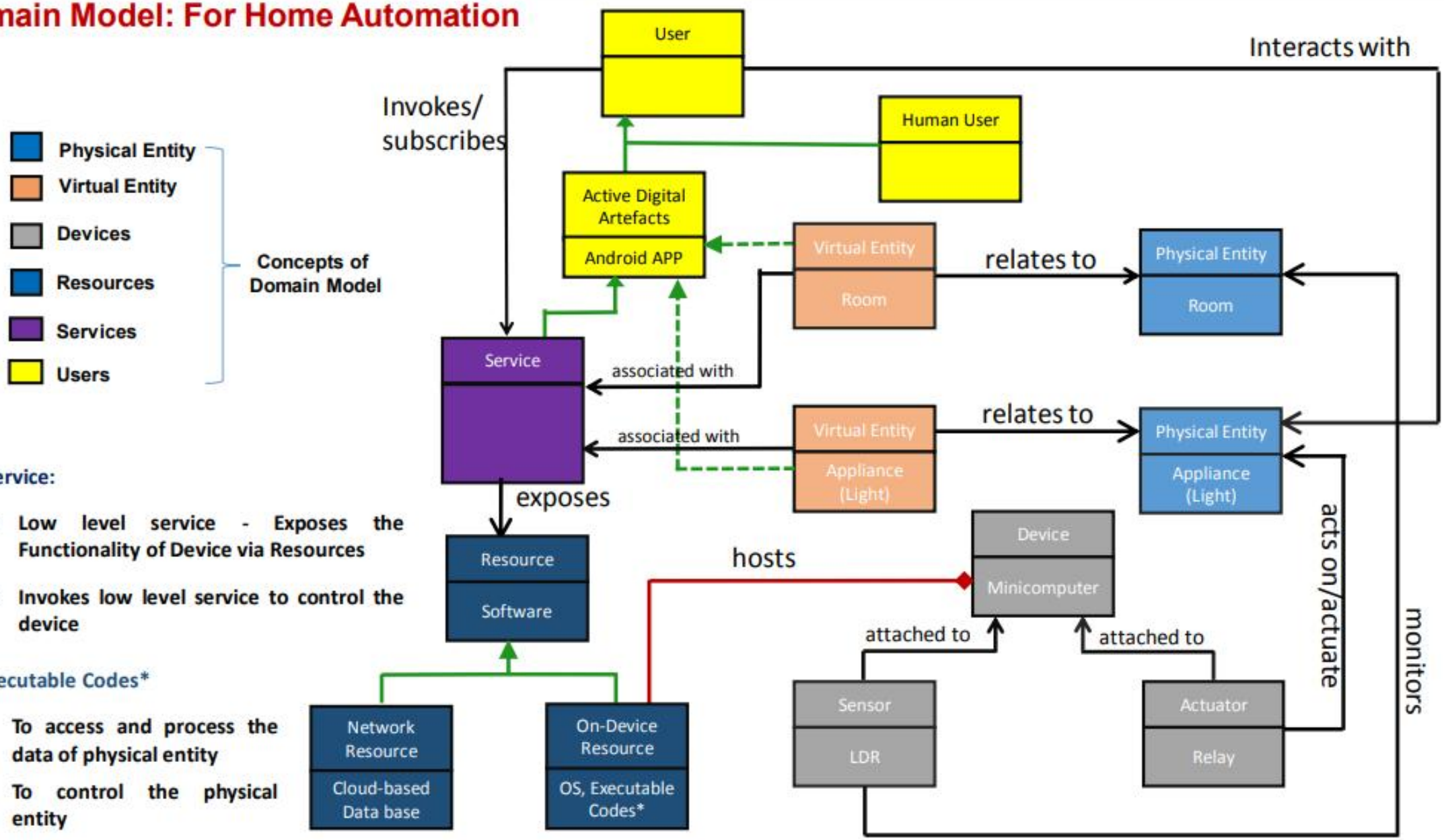
Service:

- Low level service - Exposes the Functionality of Device via Resources
- Invokes low level service to control the device

Executable Codes*

- To access and process the data of physical entity
- To control the physical entity

Domain Model: For Home Automation



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