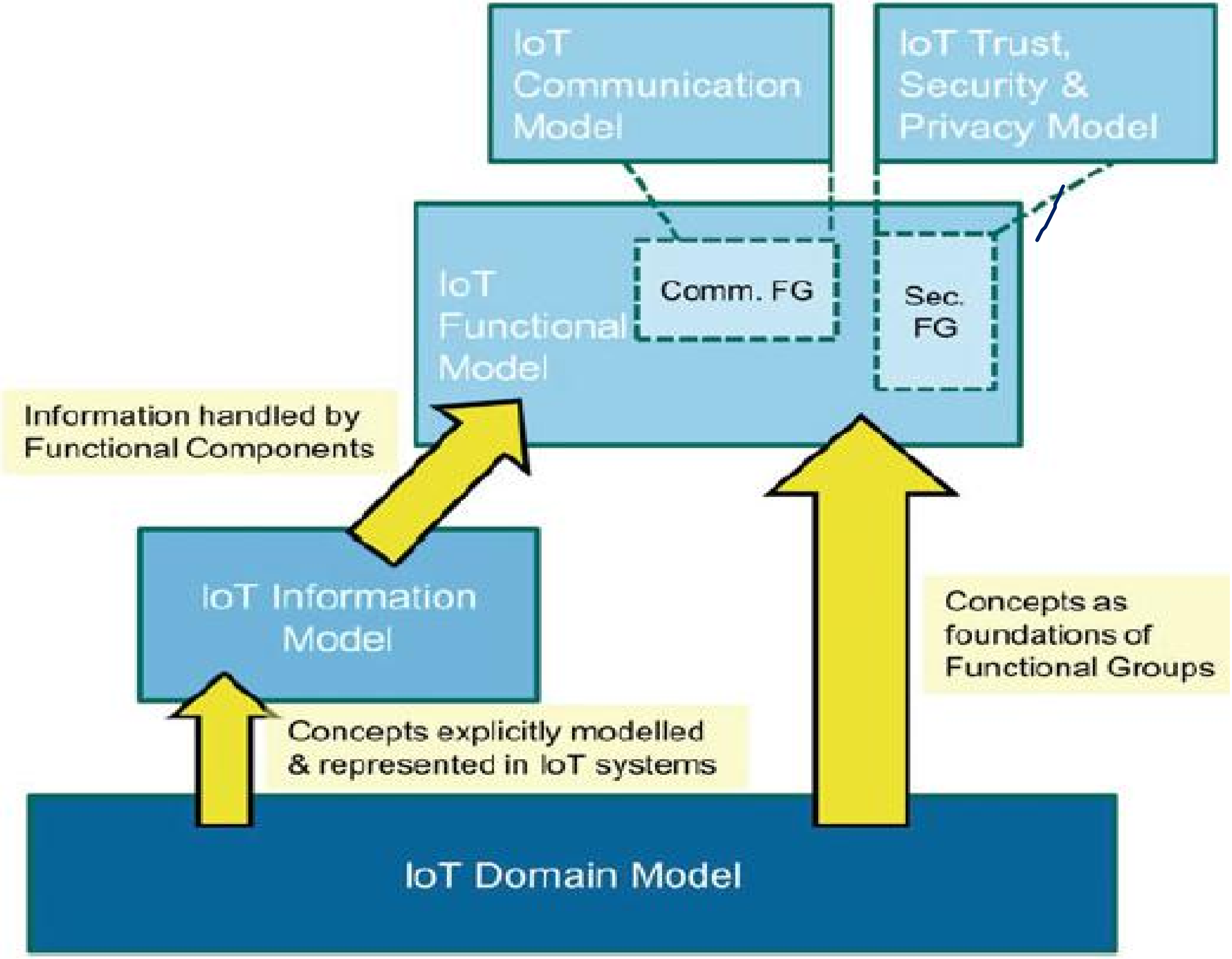
Module 1

Models Applied in IoT solutions

reference Arch model

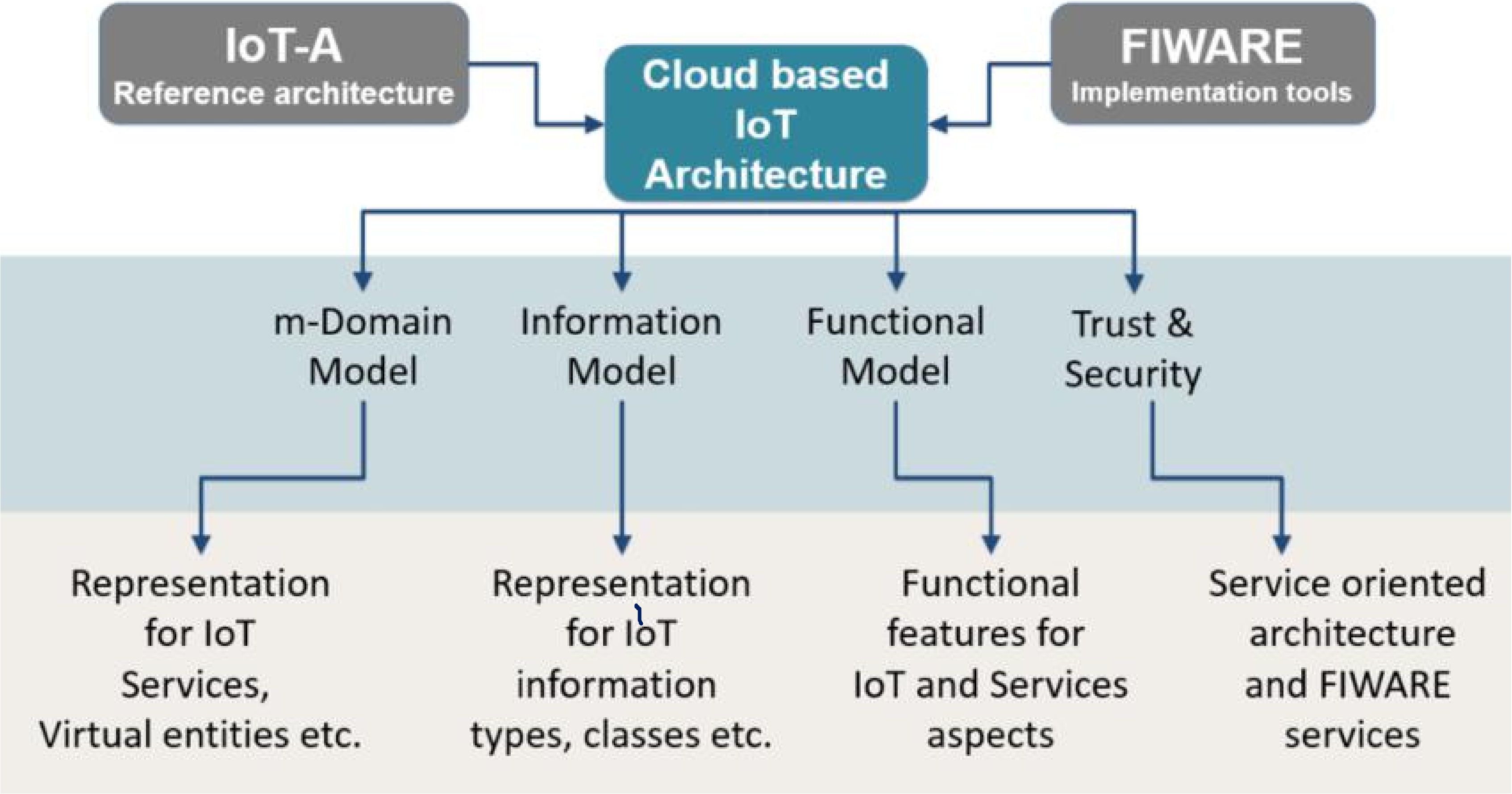
Reference Model


IoT Communication Model
IoT Trust, Security & Privacy Model
IoT Functional Model
Comm. FG
Sec. FG
Information handled by Functional Components
IoT Information Model
Concepts explicitly modelled & represented in IoT systems
Concepts as foundations of Functional Groups
IoT Domain Model

The IoT Reference Model aims at establishing a common grounding and a common language for IoT architectures and IoT systems.

A reference model describes the domain using a number of sub-models

IoT Architecture


IoT-A
Reference architecture
Cloud based IoT Architecture
FIWARE
Implementation tools
m-Domain Model
Information Model
Functional Model
Trust & Security
Representation for IoT Services, Virtual entities etc.
Representation for IoT information types, classes etc.
Functional features for IoT and Services aspects
Service oriented architecture and FIWARE services

Reference model

Domain model: captures the main concepts or entities in the domain

adds descriptions about the relationship between the concepts.

- These concepts and relationships serve the basis for the development of an information model because a working system needs to capture and process information about its main entities and their interactions
- information model contains concepts and entities of its own
- These two needs to be described in a separate model, the functional model.

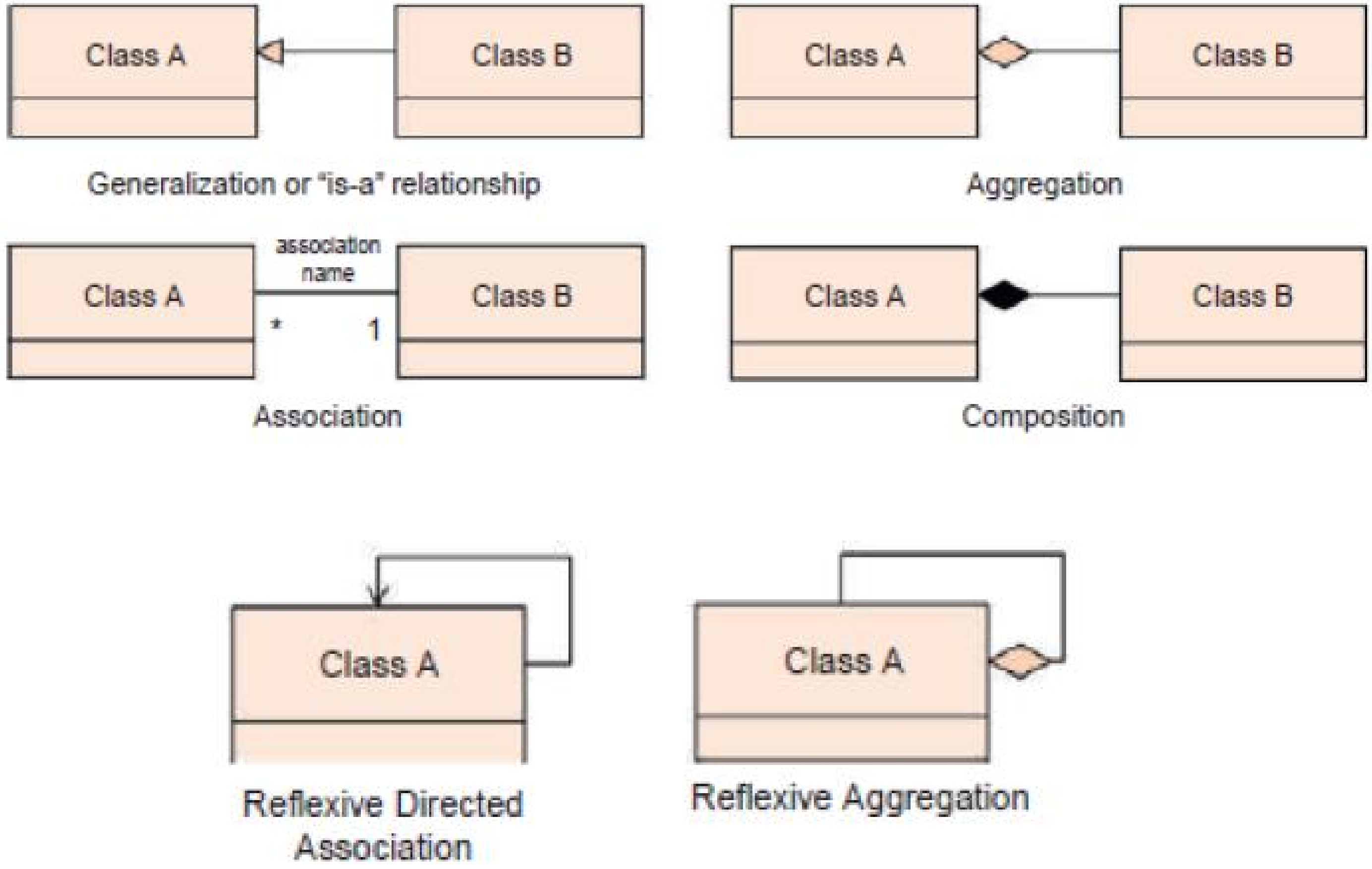
Reference model

- The foundation of the IoT Reference Model is the **IoT Domain Model**, which introduces the main concepts of the IoT like Devices, IoT Services and Virtual Entities (VE), and it also introduces relations between these concepts.
- Based on IoT Domain Model, the IoT Information Model has been developed. It defines the structure (e.g. relations, attributes) of IoT related information in an IoT system on a conceptual level.
- The IoT Functional Model identifies groups of functionalities. A number of these Functionality Groups (FG) build on each other
- The IoT Communication Model introduces concepts for handling the complexity of communication. Communication has one FG in the IoT Functional Model.

Domain model

- Describe Concepts in particular area.
- Defines the basic attributes of concepts like name, identifier also defines relationship between concepts.
- Exchange of data between domains.
- Common understanding of target domain.
- The concept of IoT domain model is represented by class diagrams.
- Class diagram-static diagram, used for modelling object oriented system.
- Collection of classes, interfaces, collaboration, constraints.
- Class-represent main elements, interactions, and applications to be programmed. Contains name, attributes, operations.

Domain model-class diagram



Domain model-class diagram

Generalization: Class A is a general case of Class B or Class B is special case or specialization of Class A. Generalization is also called an “is-a” relationship

Aggregation: class B represents a part of the whole Class A, or in other words, an object of Class A “contains” or “has-a” object of Class B.

Composition: object of Class B is part of an object of Class A (composition), when the object of Class A disappears, the object of Class B also disappears.

Association : objects of Class B have the necessary attributes to know that they relate to objects of Class A. objects of Class A can exist without having references to objects of Class B.

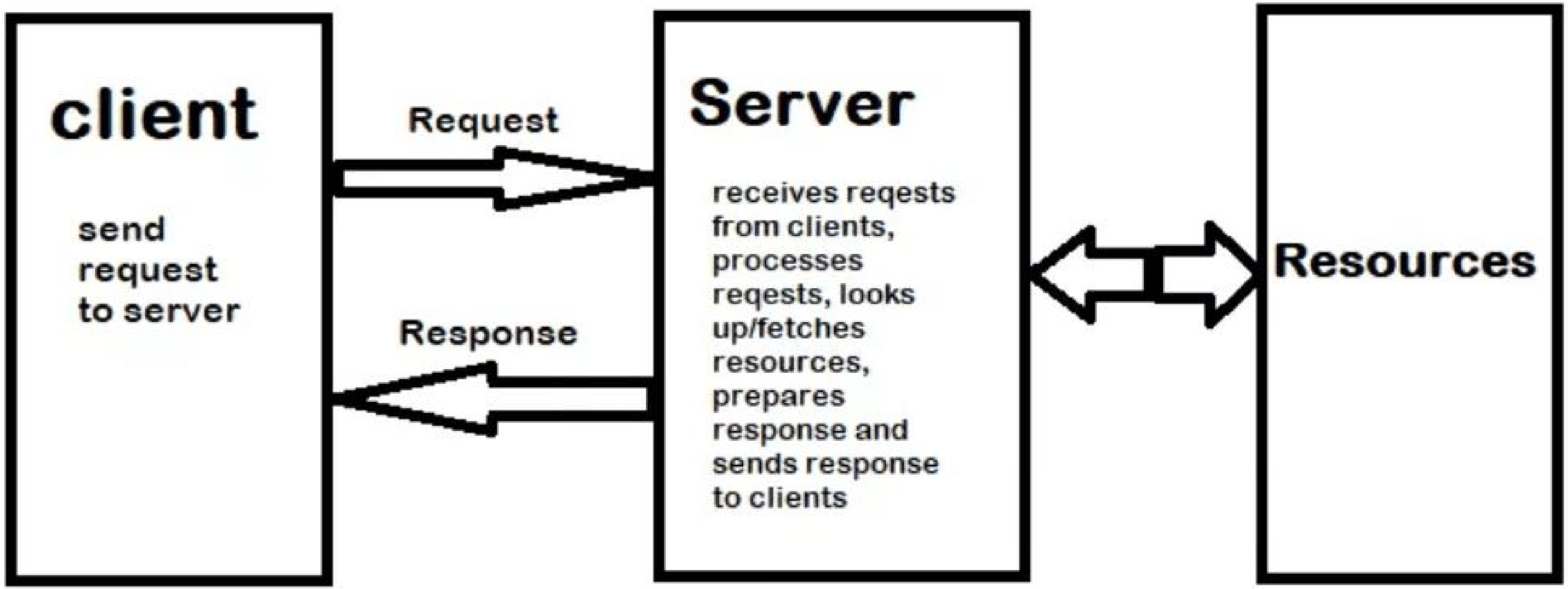
Reflexive Aggregation: Objects of a class contain objects of the same class.

Reflexive Directed Association: object of this class is associated with objects of the same class with the specific named association.

Communication model

- Identification of the endpoints of interactions, traffic patterns, technologies used for enabling such interactions.
- The potential communicating endpoints or entities are the Users, Resources, and Devices from the IoT Domain Model.
- Users include Human Users and Active Digital Artifacts
- Devices with a Human_Machine Interface mediate the interactions between a Human User and the physical world.
- The User-to-Service and Service-to-Service communication is typically based on Internet protocols.
- Devices may be so constrained that they cannot host the Services, while the Resources could be hosted or not depending on the Device capabilities

Communication model



client

send
request
to server

Request

Response

Server

receives reqests
from clients,
processes
reqests, looks
up/fetches
resources,
prepares
response and
sends response
to clients

Resources

Request-Response Communication Model

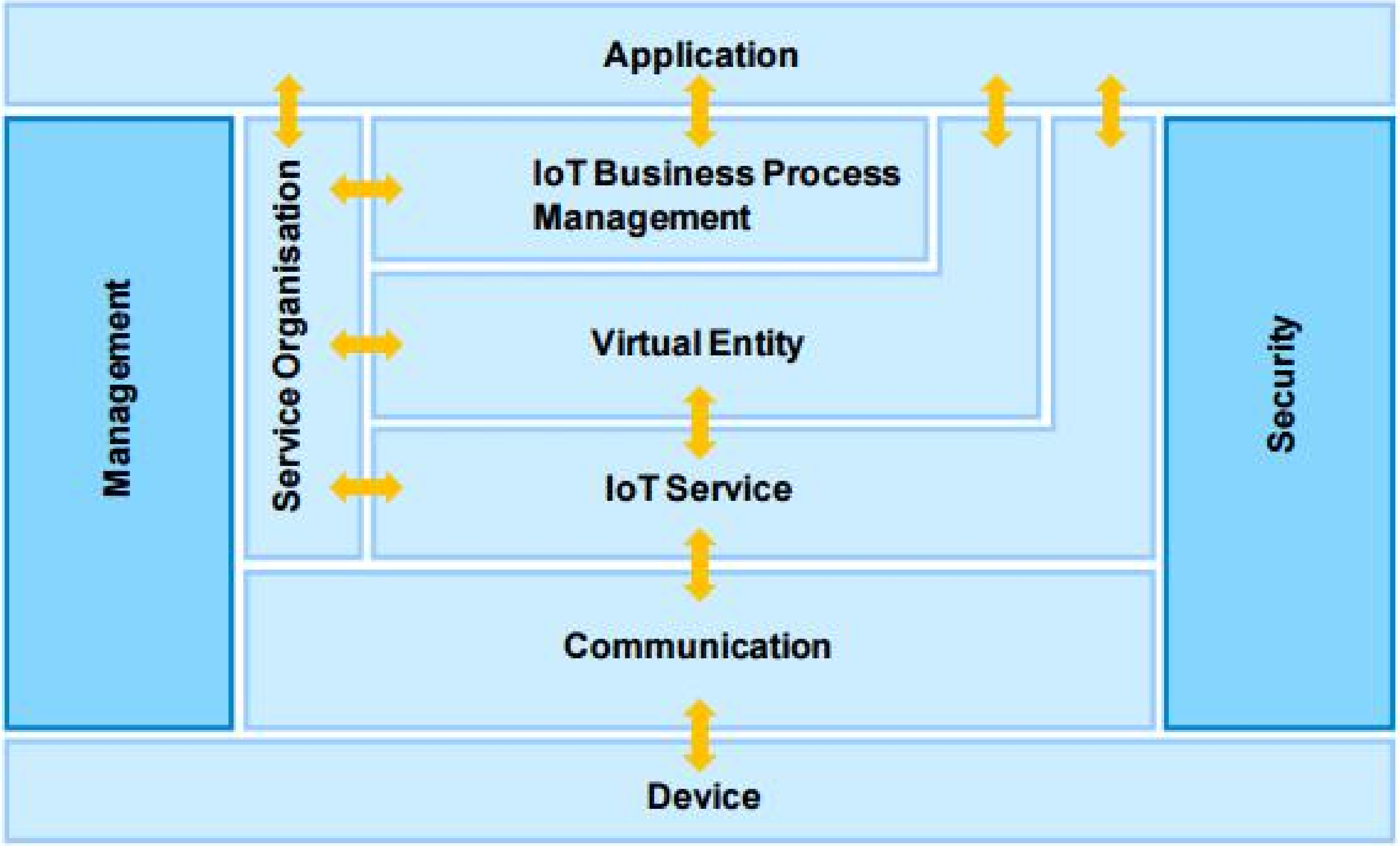
Communication model

- Client sends the request for data to the server and the server responds according to the request. when a server receives a request it fetches the data, retrieves the resources and prepares the response, and then sends the data back to the client.
- The request-response model server send the response of equivalent on the request of the client. in this model, HTTP works as a request-response protocol between a client and server.

Functional model

- IoT system consist number of functional blocks: Devices, services, communication, security
- capability for sensing, actuation, identification, communication, and management.
- These functional blocks consist of devices that provide monitoring control functions, handle communication between host and server, manage the transfer of data, secure the system using authentication and other functions, and interface to control and monitor various terms.

Functional model



Functional model

- Describe the Functional Groups (FG) and their interaction with the ARM.

Functional View of a Reference Architecture describes the functional components of an FG, interfaces, and interactions between the components.

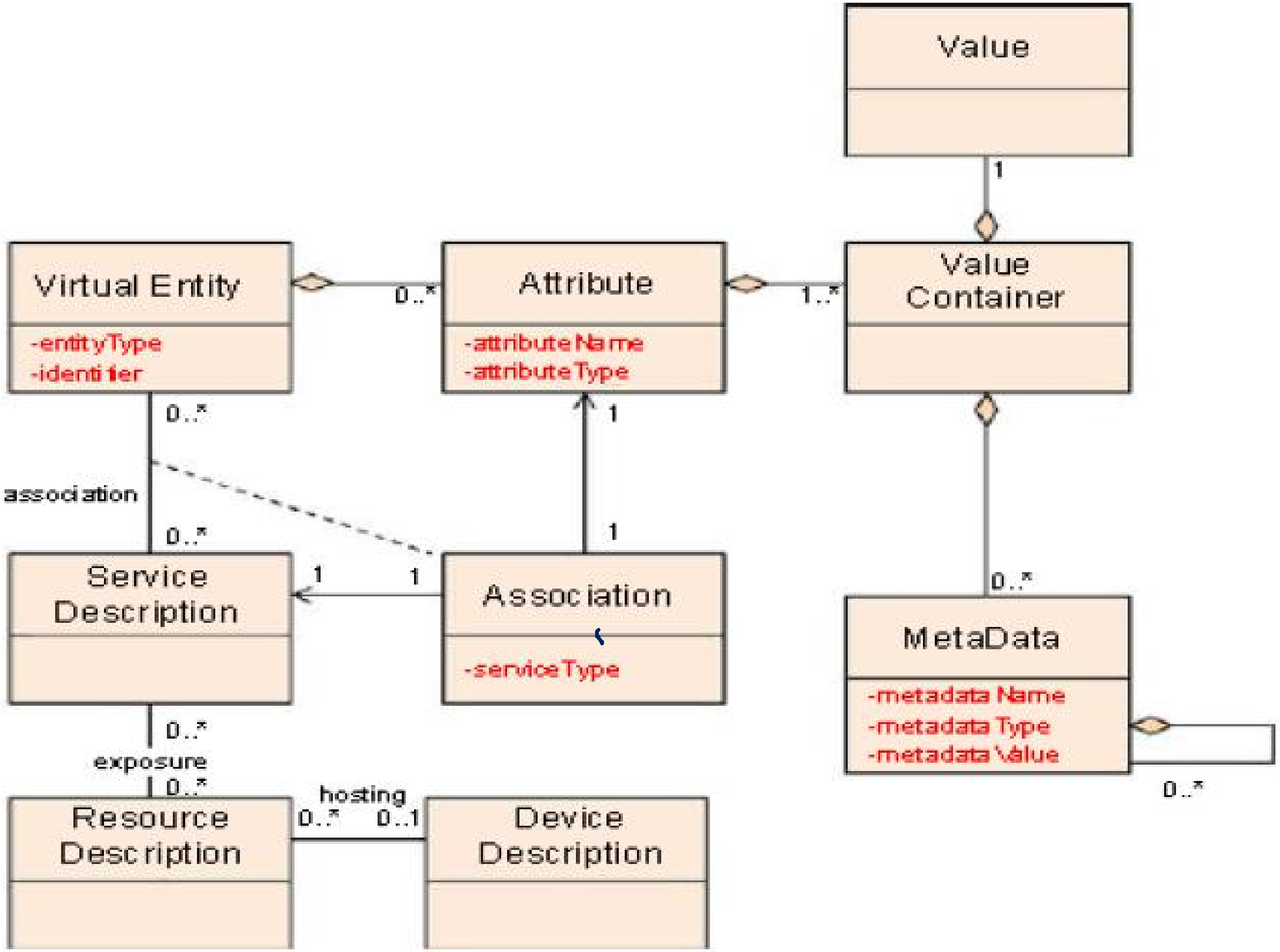
- The Application, Virtual Entity, IoT Service, and Device FGs are generated by starting from the User.
- Virtual Entity, Resource, Service, and Device classes from the IoT Domain Model.
- To compose simple IoT services and to integrate these services with existing Information and Communications Technology (ICT) infrastructure, is the main driver behind the introduction of the Service Organization and IoT Process Management FGs respectively.
- FGs need to be supported by management and security functionality captured by the corresponding FGs.

Information model

- Enrichment of data (raw values without relevant or usable context) with the right context.
- Captures the details of a Virtual Entity centric model.
- A virtual entity is **a custom entity** that has fields containing data from an external data source. Virtual entities appear in your app to users as regular entity records, but contain data that is sourced from an external database.

- Association: information about the specific association between a Virtual Entity and a related Service.
- On a high-level, the IoT Information Model maintains the necessary information about Virtual Entities and their properties or attributes.

Information model



Information model

- These properties/attributes can be static or dynamic and enter into the system in various forms, e.g. by manual data entry or reading a sensor attached to the Virtual Entity.

- high-level IoT information model, we omit the attributes that are not updated by an IoT Device (sensor, tag) or the attributes that do not affect any IoT Device (actuator, tag), with the exception of essential attributes such as names and identifiers.

- Associated services: Resources and Devices as seen from the IoT Domain Model.

- Attribute: semantic type of the value

- Attribute class also contains a complex attribute
- container includes complex attributes of the class Value and the class MetaData.
- Meta data: attributes with the self-descriptive names

TSP model

- ❑Trust, Security and Privacy (TSP) are important in typical IoT use-case scenarios.
- ❑The relevant functionalities and their interdependencies and interactions are introduced in the IoT TSP Model.
- ❑As in the case of communication, security constitutes one FG in the Functional Model.