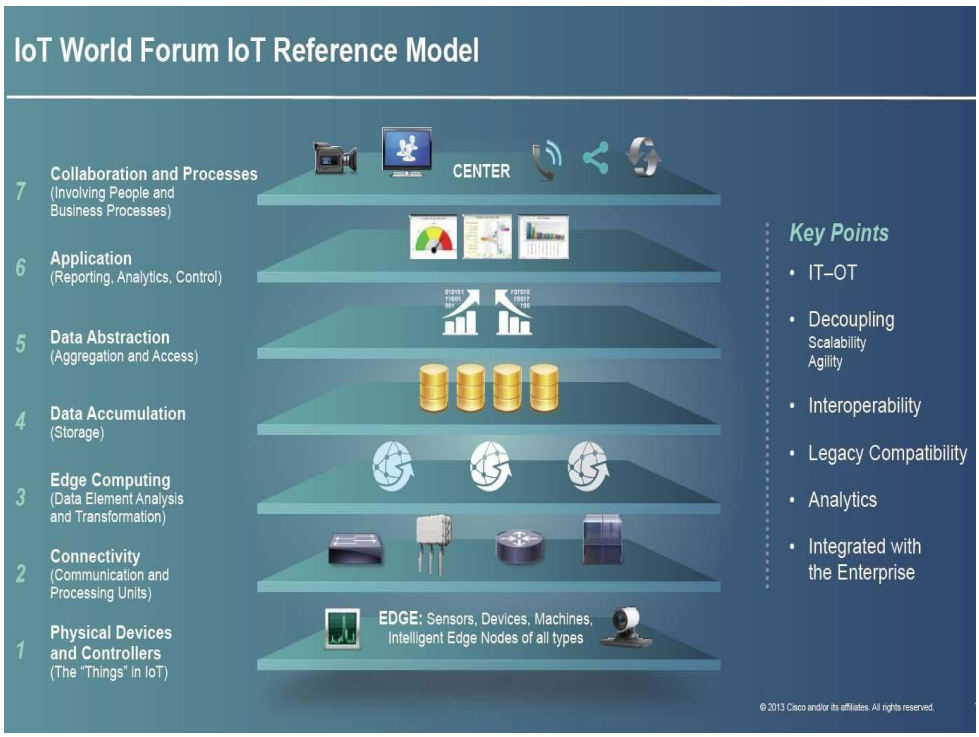
SCHEME AND SOLUTION: IOT & WSN: 18EC752

Sub:	IoT & WSN					Sub Code: 18EC752
Date:	22/10/2022	Duration:	90 Minutes	Max Marks:	50	Sem / Sec: 7

Answer any FIVE FULL Questions

1 What is IOT. Explain conceptual framework of IoT with necessary equations. [10] M



LAYER 1. Physical devices and controllers

- They are the **physical devices** , also called as "**THINGS**" in IOT .
- Basically they are **Embedded Devices**, Embedded hardware/software like Sensors/Actuators , RFID, Hardware (Arduino, Raspberry Pi, Intel Edison, Beagle Bone Black and Wireless SoC…).
- They are **ready to send and receive the information**.
- Devices are **unlimited, diverse and no rules about the size**, location etc…. For example..
- Devices are capable of **Analog to digital conversion** and vice versa.
- Devices are capable of **generating data and being queried**.

LAYER 2. Connectivity (Communication and processing units)

Processing Units:

□Contains **Routers and Gateways**

□Main task is to deliver the right information at right time and to right machine i.e. reliable transmission.

Communication:

□Includes **protocol handlers, message routers, message cache**

□It can be between smart device and network/ internet directly

□It can be through gateways then to network

□**Therefore main task involves switching and routing, enriching, transcoding, translation between protocols, security and self learning etc.**

Layer 3 [Edge Computing Or Fog Computing]

□Edge computing is an architecture that uses **edge devices** / **network edge** like **routers, gateways, switches**, multiplexers, integrated access devices to do some **preprocessing of data**.

□**Preprocessing** includes data aggregation, storage, data filtering, cleanup, analysis, transformation (formatting, decoding, distillation) , Threshold(alert), event generation etc.

Layer 4 [Data Accumulation and storage]

Data management is done at backend server/cloud or data base centres

Main roles of layer 4 are:

□**Convert data in motion to data at rest.**

□**Convert format from network packets to database relational tables.**

□**Convert Event based data to query based data (it bridges the gap between real time networking and non real time)**

□**The concept of BIG DATA is used at layer 4.**

Layer 5 Data Abstraction

Data abstraction is done at backend server/cloud or data base centres

Abstraction **means providing the essential and relevant information** of the data by hiding the irrelevant one.

Main roles are:

1) **Provide multiple storage systems** to accommodate data from different IOT devices.
2) **Reconciling multiple data format** from different sources.
3) **Combining data from multiple sources** and simplifying the application i.e consolidating the data into one place.
4) **Filtering, selecting, projecting and reformatting the data** to serve client application.
5) **Protecting the data** with appropriate authentication and authorization.

Layer 6 Application

- Layer 6 deals with reporting, analysis and control
- i.e. the data is analysed and then send to controlling device like actuator.

And then the data is passed to specific application like mobile application or webpage or to the business enterprise which require that data

2 What is M2M? What are the differences between IoT and M2M? [10] M

M2M communication

□M2M refers to the process of **communication of the physical devices or machines or smart devices with the other machines of same type without intervention of humans**.

□**Smart devices collect the data, monitor it, do some necessary computations, and perform communication to the remote devices using internet**

□It also uses servers or cloud end applications, services and processes.

□**M2M is used in many applications like home automation, industrial automation, smart cities, healthcare etc** .

□For-example using robots interacting with machines at home.

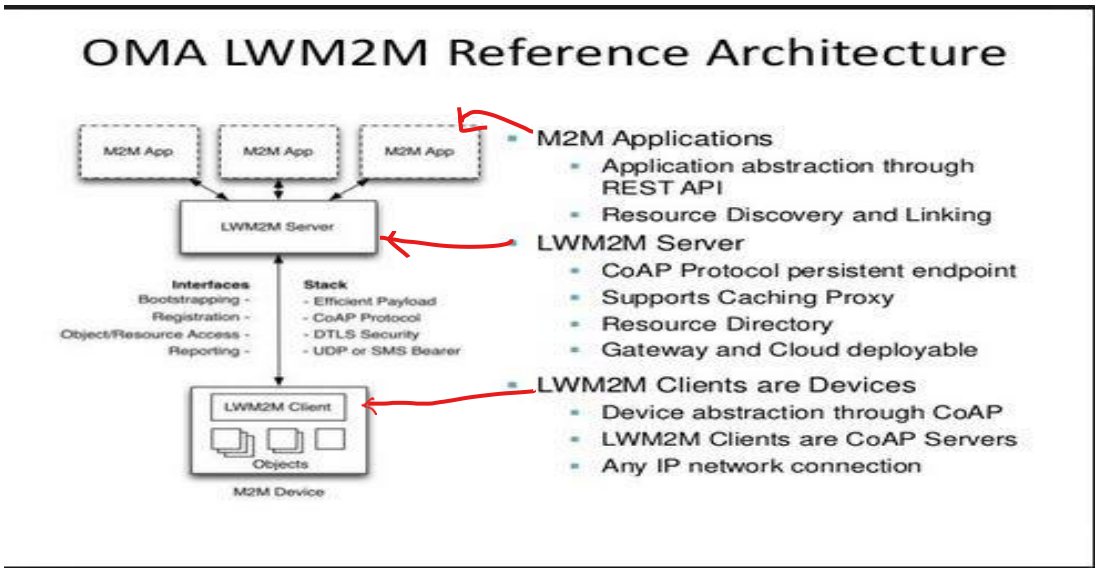
□IT is similar to SCADA (Supervisory control and data acquisition system)

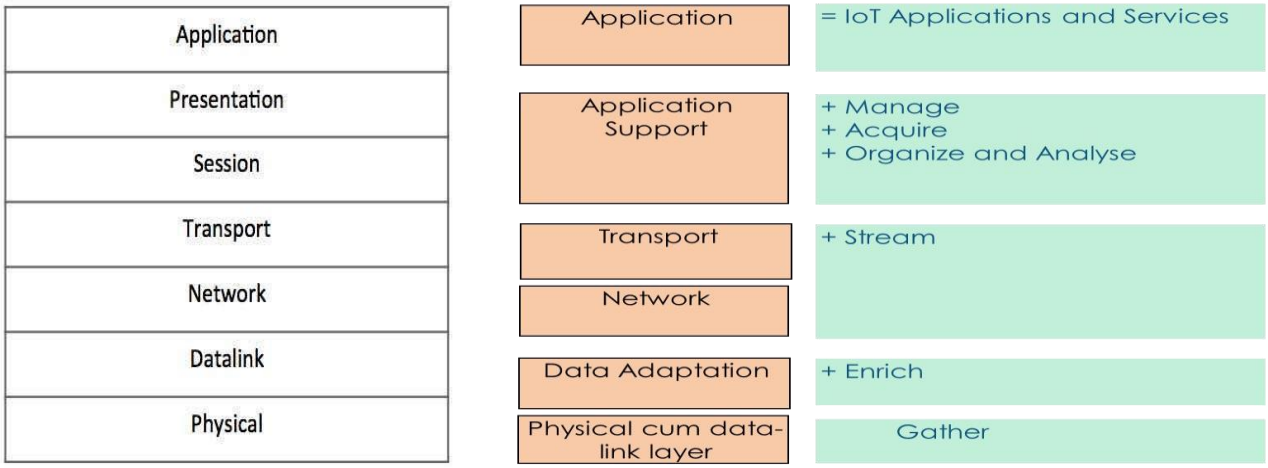
Difference between IoT and M2M

M2M	IOT
Abbreviation for machine to machine	Abbreviation for internet of things
It is about direct machine to machine communication	It is about sensor automation and internet platform
It support point to point communication	It support cloud based communication
Device not necessary relay on internet	Device necessary relay on internet
It mostly based on hardware	It based on both hardware and software
Machine normally communicates with single machine at a time	Many user can access at a time over internet
It uses either proprietary or non IP based protocols	It uses IP based protocols
Its for only B2B business type	Its for B2B and B2C business type
Limited number of devices can be connected at a time	More number of devices can be connected at a time
It does not support open API's	It supports open API's
It is less scalable	It is more scalable

3 What is LWM2M? Explain the web communication protocol LWM2M with necessary figure [10].

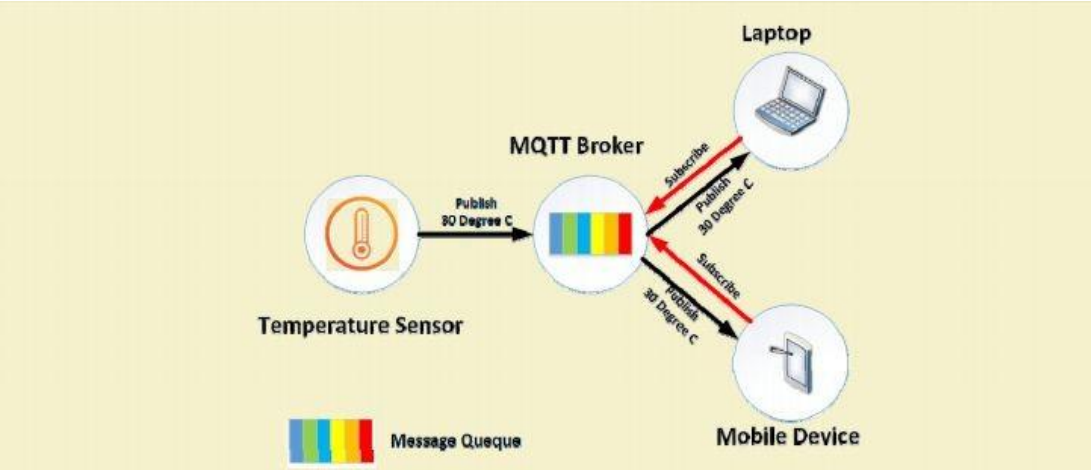
- ☐ Called as light weight Machine to machine protocol▪
  - The protocol is compact and have **small header.**
  - It can transfer 100s of bytes.
- ☐ LWM2M protocol is **specified by OMA (open mobile alliance) and uses CoAP** protocol for transmission of service and data in IOT for secure data transfer



4	Explain modified OSI Model for the IoT/M2M Systems with appropriate figures.[10] M Modified OSI model for the IOT/M2M Systems  ***Physical cum data link layer*** ❑ It is also called or object layer or device layer. ❑ The physical layer consists of the physical device called as 'Things' which can be sensors, actuators, RFID tags. ❑ These devices collects and **gather** the raw data from the environment, do some processing and have computational capabilities. ***Data Adaptation layer*** The main function of data adaptation layer is data enrichment. Gateway works at the data adaptation layer ***Network layer and transport layer*** • Both the layers deals with Data streaming i.e. transfer of data at a steady high-speed rate sufficient to support such applications as high-definition television (HDTV). The layer deals with the protocol translation, managing the traffic, interoperability tasks, bandwidth management. ***Application support layer/middleware layer*** • The layer deals with the service management layer or processing layer. It allows the IOT application programmer to work with heterogeneous objects without consideration to specific hardware. • The layer deals with the device management, device modeling, device configuration, security, data abstraction, analysis of data, managing data flow, data mining, big data processing analysis of information etc. ***Application layer/business layer:*** ☐ This layer is responsible for building the business model, making reports, graphs, flowcharts, ☐ This layer also supports decision making process based on big data analysis. □The various protocols which work at the App layer are HTTP/COAP, MQTT, AMQP etc
5	Explain message communication protocol MQTT with pub/sub model. Draw all the necessary figures. [10] M Message Queuing Telemetry Transport: • An **open source protocol for machine-to-machine (M2M)**/"Internet of Things" connectivity • **(Telemetry dictionary meaning is measuring and sending values or messages to far off places by**

radio or other mechanism)

- Created by IBM IN 1999, as a constrained environment protocol.
- Designed to **provide connectivity** (mostly embedded) **between applications** and middle-wares **(M2M/IOT objects)** on one side **and networks and communications (WEB Objects)** on the other side.



1) **Publisher:**

- They are the **light weight sensors also called as clients**
- These **clients first make connections to the Broker and then publish a message to the broker.**
- **The message include the topic**. The topic is the routing information for the broker.

2) **Broker:**

- Perform **store and forward** operation
- **Receives the topics** from **publishers**
- **Each client** that wants to receive messages **first subscribes to a certain topic** and then **the broker delivers all messages with the matching topic to the client**. *Therefore the clients don't have to know each other. They only communicate over the topic*.

3) **Subscribers:**

- They are the clients that require the information from publishers

6 Explain in brief about XMPP and give some applications of IOT. [10] M

XMPP (Extensible Messaging and Presence Protocol)

XMPP uses XML technology for real time communication includes instant messaging (used in multiuser chat) Presence Collaboration

- The protocol is *used in constrained environment* for messaging.
- It is also used for publish-subscribe systems, signaling for VoIP, video, file transfer, gaming etc.

X- Extensible:

XMPP is designed to be *extensible*, in has been designed to *grow and accommodate changes*.

M-Messaging:

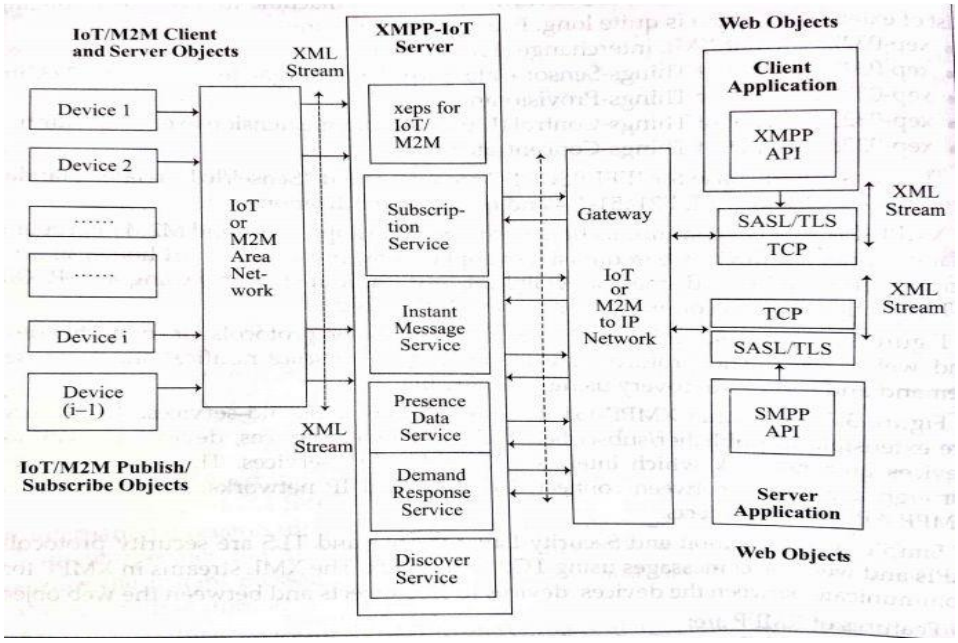
XMPP has been designed to send instant message.

P-Presence:

The presence indicator tells the server that you are online/offline/busy.

Protocol:

XMPP is a protocol; a set of standards to talk to each other. It is widely used across web but is unadvertised.



Applications of IoT:

Consumer Applications: The **Internet of Things** makes people's lives easier by monitoring and managing their lifestyles. There is a massive market for intelligent electronics, watches, television systems, health tracking, and virtual reality. In addition, IoT is leading the market with applications such as home security and personal asset tracking.

Healthcare: Wearable IoT devices provide a range of benefits to patients and healthcare providers alike. By extension, IoT enables healthcare professionals to monitor patients remotely. The devices can automatically collect patients' health vitals like blood pressure, heart rate, temperature, and more.

Insurance: IoT is altering traditional business models like insurance. It simplifies and accelerates the claim and underwriting process. Besides reducing costs, digital networking via IoT generates additional revenues. Cross-selling and more significant customer interaction become a strategic component for insurers.

Manufacturing: The **Internet of Things** creates a more technically-driven environment for manufacturing industries. It can automatically track development cycles, facilitate the production flow, and manage inventories.

Retail: IoT devices can collect vital data on a product's shopping lifecycle. Once this data is processed and analyzed, retail managers can make valuable decisions to improve retail operations and the customer experience.

Transportation: IoT applications integrate personal and commercial vehicles by improving communication and information distribution. Besides connecting consumers and goods, it offers benefits such as route optimization, automobile tracking, weather monitoring, distance coverage, and more.

7 What is cloud computing? Explain the cloud service model with the necessary figure. [10] M

Cloud Computing is:

- A collection of integrated and networked hardware, software, Internet infrastructure (called a platform) with a huge storage, computing capabilities.
- It provides hardware, software and networking services to clients on rent.
- These platforms hide the complexity and details of the underlying infrastructure from users and applications using API

Service Models

Cloud computing is not a single piece of technology, like a microchip or a cell phone. Rather, it's a system, primarily comprised of three services:

Service Models are the reference models on which the Cloud Computing is based. These can be categorized into three basic service models as listed below:

1. **Infrastructure as a Service (IaaS)**
2. **Platform as a Service (PaaS)**
3. **Software as a Service (SaaS)**

SaaS is a method for delivering software applications over the Internet, on rent (i.e. on demand) to the end users typically on a subscription basis.
There are several SaaS applications, some of them are listed below:

- Billing and Invoicing System
- Help Desk Applications
- Human Resource (HR) Solutions
- Customer Relationship Management (CRM) applications

PaaS is like delivering the software online, it supplies or rent a platform over some time for creating developing, testing, delivering and managing software applications like web or mobile apps, without worrying about setting up or managing the underlying infrastructure of servers, storage, network and databases needed for development

Google's App Engine, Force.com are examples of PaaS offering vendors

IaaS rents complete IT infrastructure to the user like—servers and virtual machines (VMs), storage, data center, networks, operating systems through IP-based connectivity as part of an on-demand service. Cloud paradigm also serves as a business model apart from technology.

8	Explain IoT cloud-based data collection, storage and computing services using Nimbits server. What are the advantages of cloud computing.

Cloud computing is the delivery of computing services —servers, storage, databases, networking, software, hardware, analytics and more—over the Internet ("the cloud").

Cloud delivers the computational functionality.

Companies offering these computing services are called cloud service providers and typically charge for cloud computing services based on usage, similar to how you are billed for water or electricity at home.

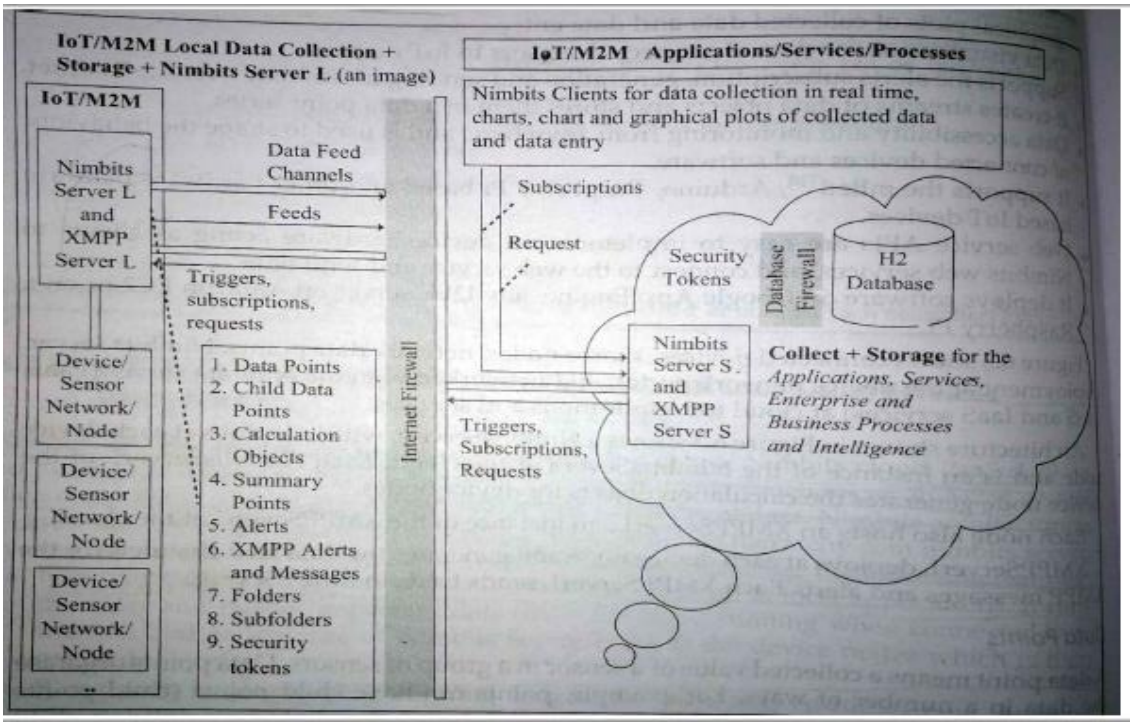
Nimbits server:

- Nimbits is a platform as a service (PaaS) used to develop software and hardware solutions that seamlessly connect to the cloud and each other.
- Nimbits server runs on powerful cloud platforms like Google App Engine to the smallest Raspberry Pi device.
- Nimbits server is a web portal and API designed to

- Provides time-stamping or geo-stamping on incoming data.
- Store and process that time and location stamped data over cloud (pushing the data over cloud and store them in a data point)
- Provide filtering to incoming data from noise, add important changes to it and then generate trigger events and alerts based on rules and then sending them in real time over internet.
- It provides rule engine for connecting sensors, persons and software to cloud.

Nimbits clients can plot charts and graphs of real time collected data over the internet.

- It supports many format like text, JSON or XML values into the cloud.
- It provides edge computing locally on devices and nodes**.**
- It supports multiprogramming languages, M2M communication and hardware platform of IoT devices like mbed, Arduino, raspberry Pi based etc.
- Nimbits data points can relay data between the software systems or hardware devices like Arduino, using cloud as backend.
- It provides data logging services, access and data monitoring from anywhere.


IoT/M2M Local Data Collection + Storage + Nimbits Server L (an image)
IoT/M2M
Nimbits Server L and XMPP Server L
Data Feed Channels
Feeds
Triggers, subscriptions, requests
Device/ Sensor Network/ Node
Device/ Sensor Network/ Node
Device/ Sensor Network/ Node
1. Data Points
2. Child Data Points
3. Calculation Objects
4. Summary Points
5. Alerts
6. XMPP Alerts and Messages
7. Folders
8. Subfolders
9. Security tokens
Internet Firewall
IoT/M2M Applications/Services/Processes
Nimbits Clients for data collection in real time, charts, chart and graphical plots of collected data and data entry
Subscriptions
Request
Security Tokens
Database Firewall
H2 Database
Nimbits Server S and XMPP Server S
Collect + Storage for the Applications, Services, Enterprise and Business Processes and Intelligence
Triggers, Subscriptions, Requests