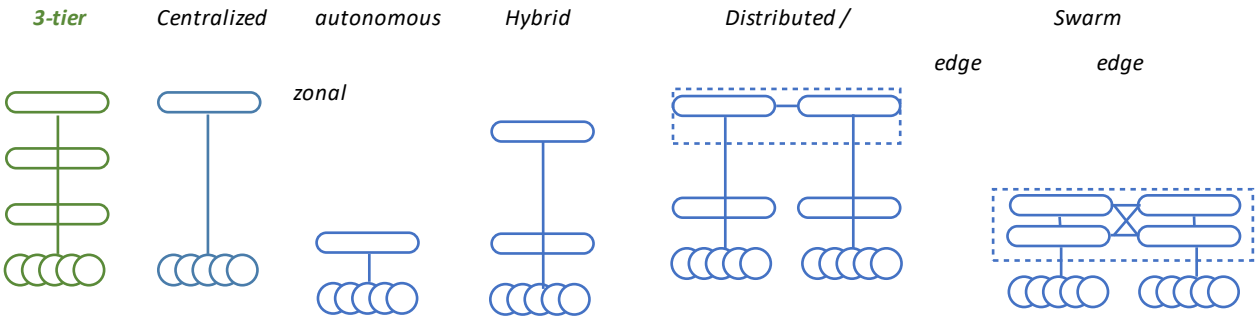
IIC Architecture - 3-tier pattern

Key question	Information, compute location
Alternatives	Autonomous edge, Hybrid, Swarm
Stakeholder	Service/Product designer

1. Problem

Information can be kept in the things at the edge, in a central location, distributed in all those places, replicated in diverse locations or can follow many creative schemes. In the same idea, applying logic on the information can be done at several places:



In those diagrams, rounds represent things which can be sensors, controllers. The rectangular objects represent levels/nodes of data handling and/or storage.

Distributed or Zonal pattern is a case where a number of systems collaborate to solve the problem. The presence of horizontal links intend to picture intra-level communication as opposed hierarchical communications nature of the 3-tier or centralized patterns.
The « geographic dispersion » can be between states in USA or between zones in a car (rear/left, rear/right, front/left, front/right, central1, central2).

The swarm pattern is a dynamic collection of collaborative nodes such as cars in a platoon.

Choosing one pattern can be either difficult or almost imposed by regulatory or operational constraints. Each pattern is described in a specific pattern document. Pattern description

2. Description

The 3-tier pattern places information and/or its handling on different layers or tiers, each participating to the decision making.

2.1. Solution

To reduce complexity in the design of an IoT solution, the solution architecture can be divided into several layers. This would increase the abstraction and thus, enables a discussion with relevant business stakeholders without revealing the solution's complexity.

2.2. Model

The three-tier architecture pattern comprises edge, platform and enterprise tiers. These tiers play specific roles in processing the data flows and control flows involved in usage activities.

They are connected by three networks.

The edge tier collects data from the edge nodes, using the proximity network. The architectural characteristics of this tier, including the breadth of distribution, location, governance scope and the nature of the proximity network, vary depending on the specific use cases.

The platform tier receives, processes and forwards control commands from the enterprise tier to the edge tier. It consolidates processes and analyzes data flows from the edge tier and other

tiers. It provides management functions for devices and assets. It also offers non-domain specific services such as data query and analytics.

The enterprise tier implements domain-specific applications, decision support systems and provides interfaces to end-users including operation specialists. The enterprise tier receives data flows from the edge and platform tier. It also issues control commands to the platform tier and edge tier.

The proximity network connects the sensors, actuators, devices, control systems and assets, collectively called edge nodes. It typically connects these edge nodes, as one or more clusters related to a gateway that bridges to other networks.

The access network enables connectivity for data and control flows between the edge and the platform tiers. It may be a corporate network, or an overlay private network over the public Internet or a 4G/5G network. Service network enables connectivity between the services in the platform tier and the enterprise tier, and the services within each tier. It may be an overlay private network over the public Internet or the Internet itself, allowing the enterprise grade of security between end-users and various services.

2.3. Stakeholder

This pattern is intended for the service or product designer that need to weigh efficiency, costs and possible regulatory constraints when choosing an overall system pattern such as the autonomous edge

3. Guidance

3.1. Advantages

The three-tier architecture pattern combines major components (e.g. platforms, management services, applications) that generally map to the functional domains (functional viewpoint). From the tier and domain perspective, the edge tier implements most of the control domain; the platform tier most of the information and operations domains; the enterprise tier most of the application and business domains. This mapping demonstrates a simple functional partitioning across tiers. In a real system, the functional mapping of IIoT system tiers depends greatly on the specifics of the system use cases and requirements. For example, some functions of the information domain may be implemented in or close to the edge tier, along with some application logic and rules to enable intelligent edge computing.

Another reason why implementation tiers do not generally have an exclusive mapping to a particular functional domain is that these tiers often provide services to each other to complete the end-to-end activities of the system. These services, for example, data analytics from the information functional domain, then become supportive of other functional domains in other tiers.

Similar operations domain services can be provided to the application domain components in the enterprise tier as well. Conversely, the operations domain components may use data services from the information domain component in order to get better intelligence from asset data, e.g. for diagnostics, prognostics and optimization on the assets.

As a result, components from all functional domains may leverage the same data and use analytic platforms and services to transform data into information for their specific purposes.

3.2. Disadvantages

Implementing tiers means deploying technology that can be under-utilized until the service/product reach a certain level of usage. As a result, it may be the most capital intensive pattern of its class.

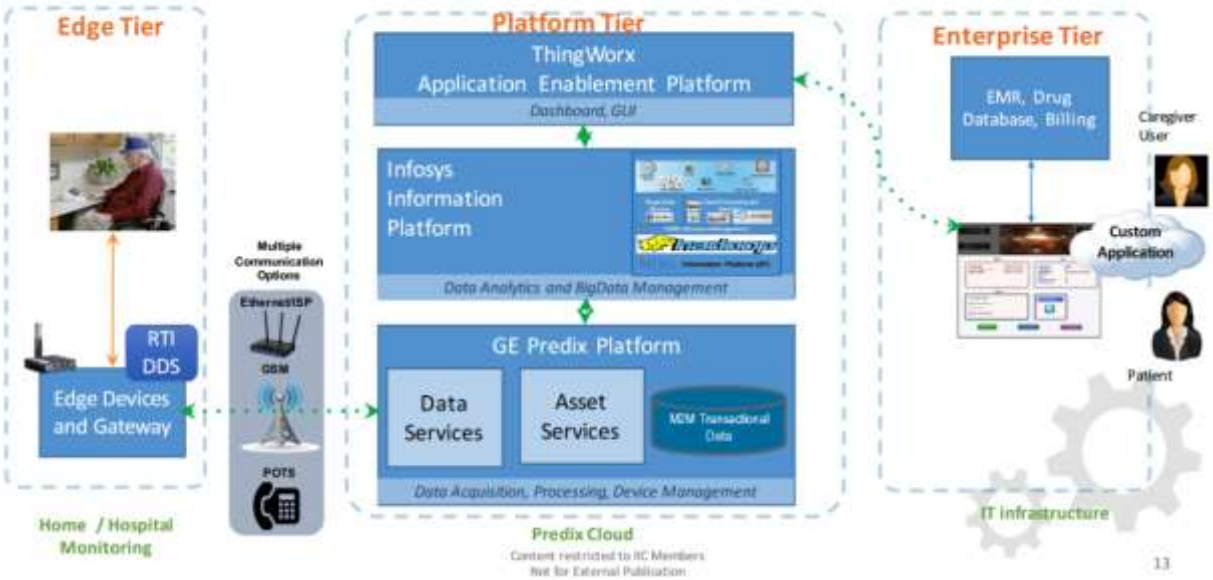
Technologies at each layer may be such that they require specific skill sets (mainframe, cloud or enterprise at the enterprise tier, clusters for the platform tier and servers for the edge tier).

3.3. Other considerations

Regulatory on data may be a hurdle where some data need to be contained in the same geography as the people associated to the data (health…).

4. Application notes

See more on applying the pattern in:



- Remote health monitoring / 3-tier pattern