Software Architecture

Architecting for IOT & AI

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Contents

- Clarification on Assignments
- Quiz 2
- Makeup Exam Answers
- Architecting for IOT & AI

Assignment

A1 - Build an Architecture for an App

- The App should at minimum include the technologies Web, Mobile, IOT, cloud and analytics.
- Each team will select an application.
- The submitted architecture will be evaluated by the TA
- The team will be evaluated for their developed architecture

A2 – Research paper on real life architecture / latest trends etc

- Each team has to select a topic
- Final Paper should be submitted as per the agreed upon template and schedule

Refer to the template for Assignment #1

Assignment - 2 Sample

1. Performance - at least 3 popular applications
2. Scalability - at least 3 popular applications
3. Facebook - scalability
4. Agile and Architecture
5. Micro Services
6. Uber / Ola etc
7. Architecture For IOT
8. Architecture For Mobile
9. Architecture For Machine Learning
10. Architecture for Conferencing Platform
11. AWS Lambda
12. Architecture and NoSql DB
13. Architecting for cloud - trends
14. Compare cloud - Amazon / Azure / Google
15. YouTube / Netflix

Assignment - 2 Guidelines

innovate achieve lead

Guidelines

- **You are not building an architecture**
- **You are studying what is happening around**
- **You must read many papers / case studies**
- **You can do a Literature survey paper**
- **Key words**
  - Study
  - Analyze strengths / weakness
  - Compare
  - Trend - what is driving the trends

Guidelines for the paper

- **Intro**
- **Scope / objective**
- **Contents**
- **References**

Quiz 2

Like in Quiz 1, it will be 20 questions 30 minutes

Will open it from 10th April

From 10th April 7 PM (IST) to 16th April 11 PM (IST)

All topics that we have covered in the Contact Sessions

Architecting for IOT Applications

What are the characteristics of an IOT application

Amazon Fulfillment Center Video

IoT World Forum Reference Model

Levels

7 **Collaboration & Processes**
(Involving People & Business Processes)

6 **Application**
(Reporting, Analytics, Control)

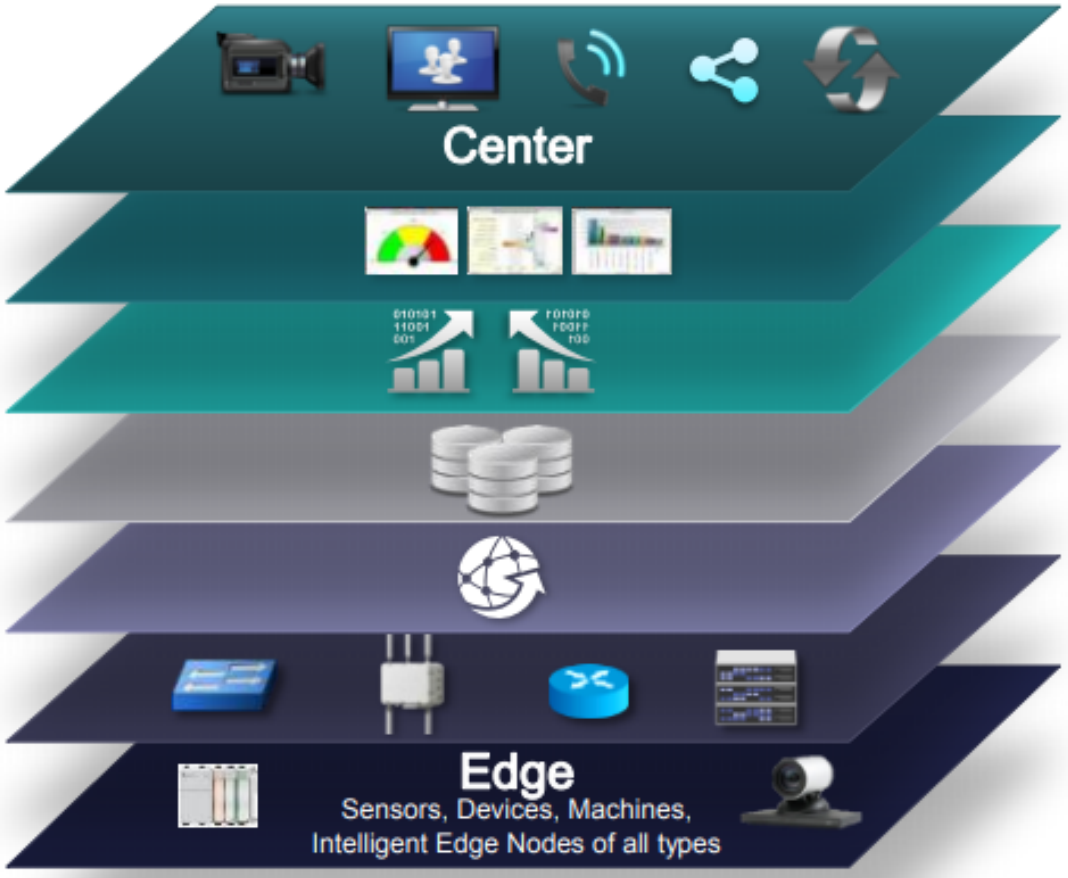
5 **Data Abstraction**
(Aggregation & Access)

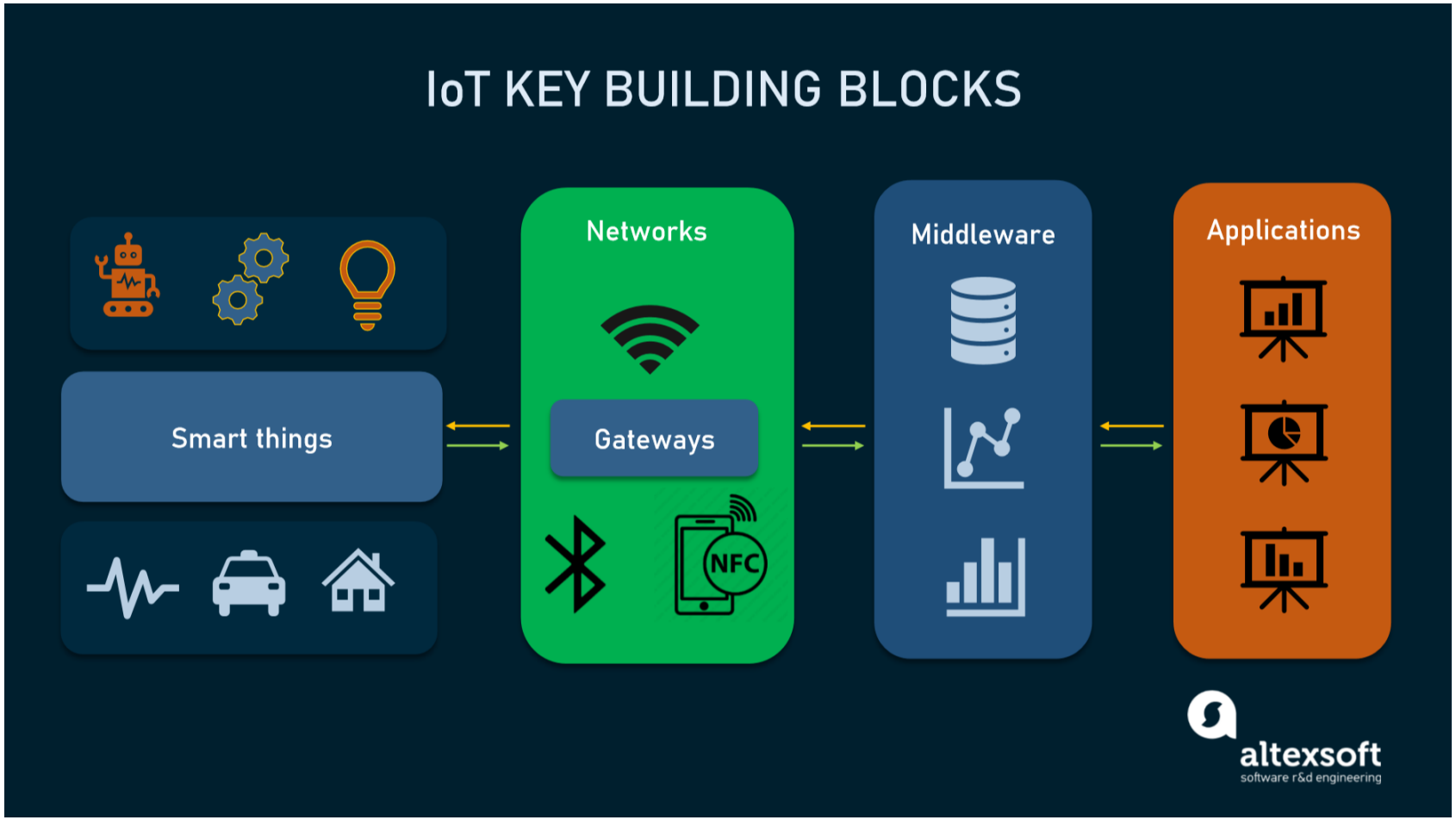
4 **Data Accumulation**
(Storage)

3 **Edge Computing**
(Data Element Analysis & Transformation)

2 **Connectivity**
(Communication & Processing Units)

1 **Physical Devices & Controllers**
(The "Things" in IoT)




IoT KEY BUILDING BLOCKS
Smart things
Networks
Gateways
NFC
Middleware
Applications
altexsoft
software r&d engineering

smart things;

networks and **gateways** enabling low-power devices (which is often the case in IoT) to enter the big Internet;

the **middleware or IoT platforms** providing data storage spaces and advanced computing engines along with analytical capabilities; and

applications, allowing end users to benefit from IoT and manipulate the physical world.

the **perception layer** hosting smart things;

the **connectivity or transport layer** transferring data from the physical layer to the cloud and vice versa via networks and gateways;

the **processing layer** employing IoT platforms to accumulate and manage all data streams; and

the **application layer** delivering solutions like analytics, reporting, and device control to end users.

the **edge or fog computing layer** performing data preprocessing close to the edge, where IoT things collect new information. Typically, edgy computing occurs on gateways;

the **business layer** where businesses make decisions based on the data; and

the **security layer** encompassing all other layers.

Perception Layer

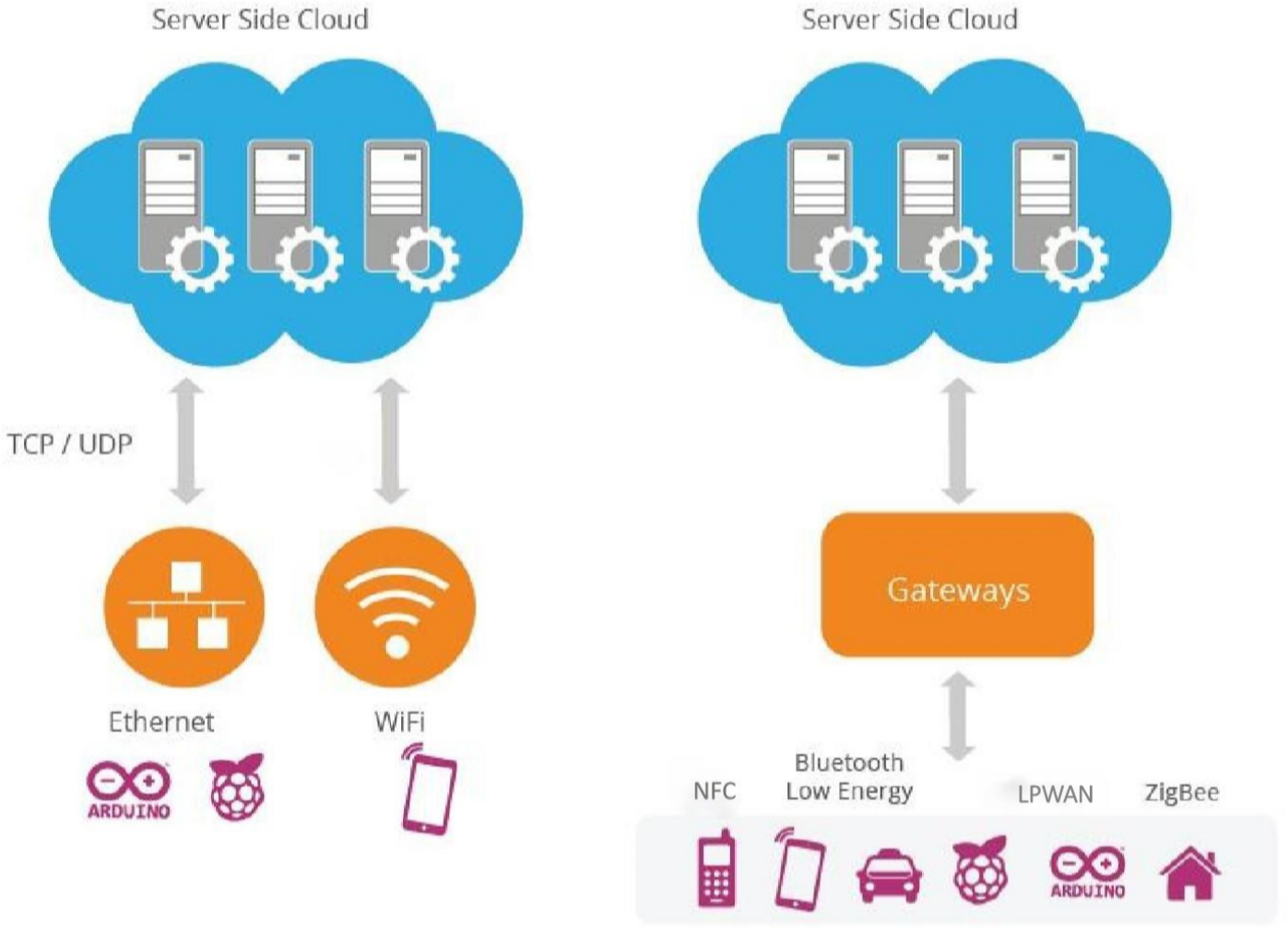
Sensors such as probes, gauges, meters, and others. They collect physical parameters like temperature or humidity, turn them into electrical signals, and send them to the IoT system. IoT sensors are typically small and consume little power.

Actuators, translating electrical signals from the IoT system into physical actions. Actuators are used in motor controllers, lasers, robotic arms.

Machines and devices connected to sensors and actuators or having them as integral parts.

It's important to note that the architecture puts no restriction on the scope of its components or their location. The edge-side layer can include just a few "things" physically placed in one room or myriads of sensors and devices distributed across the world.

Connectivity



Connectivity

Network	Connectivity	Pros and Cons	Popular use cases
Ethernet	Wired, short-range	☺ High speed ☺ Security ☹ Range limited to wire length ☹ Limited mobility	Stationary IoT: video cameras, game consoles, fixed equipment
WiFi	Wireless, short-range	☺ High speed ☺ Great compatibility ☹ Limited range ☹ High power consumption	Smart home, devices that can be easily recharged
NFC	Wireless, ultra-short-range	☺ Reliability ☺ Low power consumption ☹ Limited range ☹ Lack of availability	Payment systems, smart home
Bluetooth Low-Energy	Wireless, short-range	☺ High speed ☺ Low power consumption ☹ Limited range ☹ Low bandwidth	Small home devices, wearables, beacons

Connectivity

Network	Connectivity	Pros and Cons	Popular use cases
LPWAN	Wireless, long-range	☺ Long range ☺ Low power consumption ☹ Low bandwidth ☹ High latency	Smart home, smart city, smart agriculture (field monitoring)
ZigBee	Wireless, short-range	☺ Low power consumption ☺ Scalability ☹ Limited range ☹ Compliance issues	Home automation, healthcare and industrial sites
Cellular networks	Wireless, long-range	☺ Nearly global coverage ☺ High speed ☺ Reliability ☹ High cost ☹ High power consumption	Drones sending video and images

Connectivity - Protocols

Once parts of the IoT solution are networked, they still need messaging protocols to share data across devices and with the cloud. The most popular protocols used in the IoT ecosystems are:

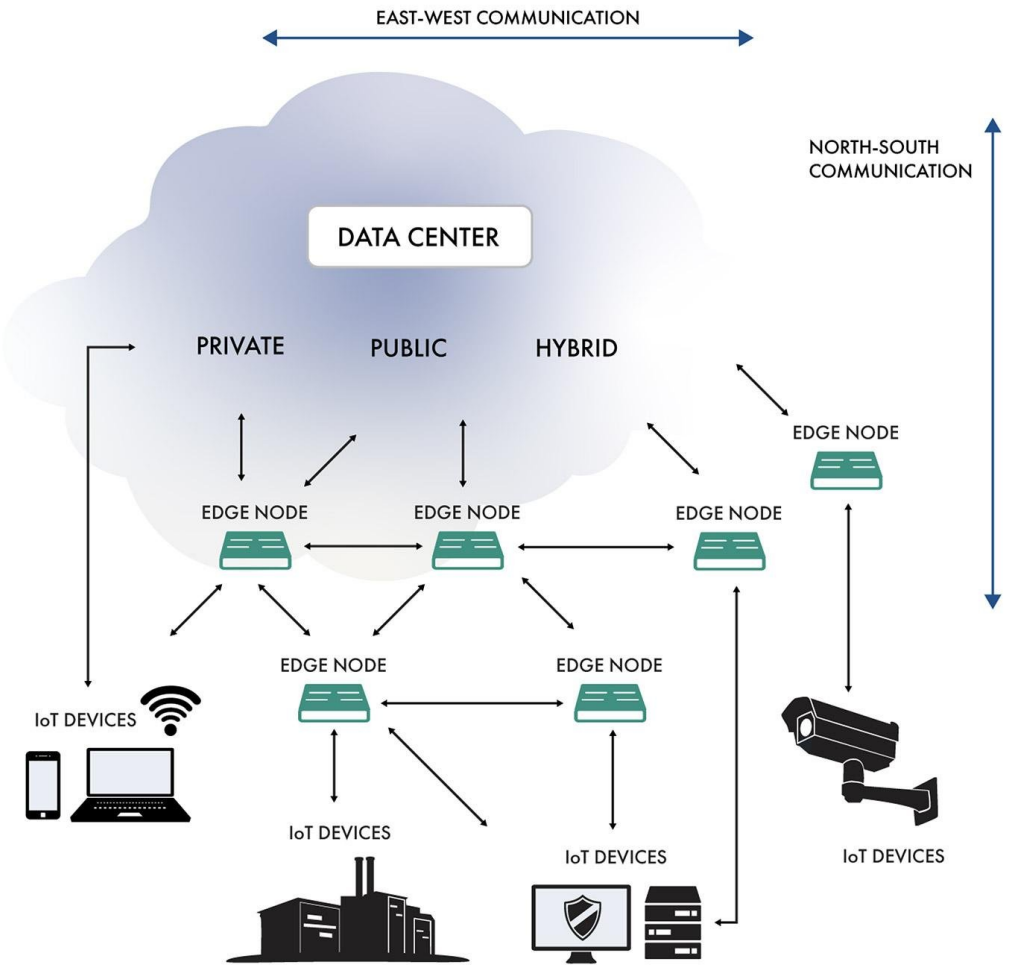
DDS (the Data Distribution Service) which directly connects IoT things to each other and to applications addressing the requirements of real-time systems;

AMQP (the Advanced Message Queuing Protocol) aiming at peer-to-peer data exchange between servers;

CoAP (the Constrained Application Protocol), a software protocol designed for *constrained devices* — end nodes limited in memory and power (for example, wireless sensors). It feels much like HTTP but uses fewer resources;

MQTT (the Message Queue Telemetry Transport), a lightweight messaging protocol built on top of TCP/IP stack for centralized data collection from low-powered devices.

Edge or fog computing layer: reducing system latency



Processing layer: making raw data useful

The processing layer accumulates, stores, and processes data that comes from the previous layer. All these tasks are commonly handled via IoT platforms and include two major stages.

Data accumulation stage

Data abstraction stage

Processing Layer: Data accumulation stage

The real-time data is captured via an API and put at rest to meet the requirements of non-real-time applications. The data accumulation component stage works as a transit hub between event-based data generation and query-based data consumption.

Among other things, the stage defines whether data is relevant to the business requirements and where it should be placed. It saves data to a wide range of storage solutions, from data lakes capable of holding unstructured data like images and video streams to event stores and telemetry databases. The total goal is to sort out a large amount of diverse data and store it in the most efficient way.

Processing Layer: Data abstraction stage

Here, data preparation is finalized so that consumer applications can use it to generate insights. The entire process involves the following steps:

combining data from different sources, both IoT and non-IoT, including ERM, ERP, and CRM systems;

reconciling multiple data formats; and

aggregating data in one place or making it accessible regardless of location through data virtualization.

Similarly, data collected at the application layer is reformatted here for sending to the physical level so that devices can “understand” it.

Together, the data accumulation and abstraction stages veil details of the hardware, enhancing the interoperability of smart devices. What’s more, they let software developers focus on solving particular business tasks — rather than on delving into the specifications of devices from different vendors.

Application, Business & Security

Application layer: addressing business requirements

- At this layer, information is analysed by software to give answers to key business questions.

Business layer: implementing data-driven solutions

Security layer: preventing data breaches

Architecting for IOT

Do not do from First Principles

Example of AWS

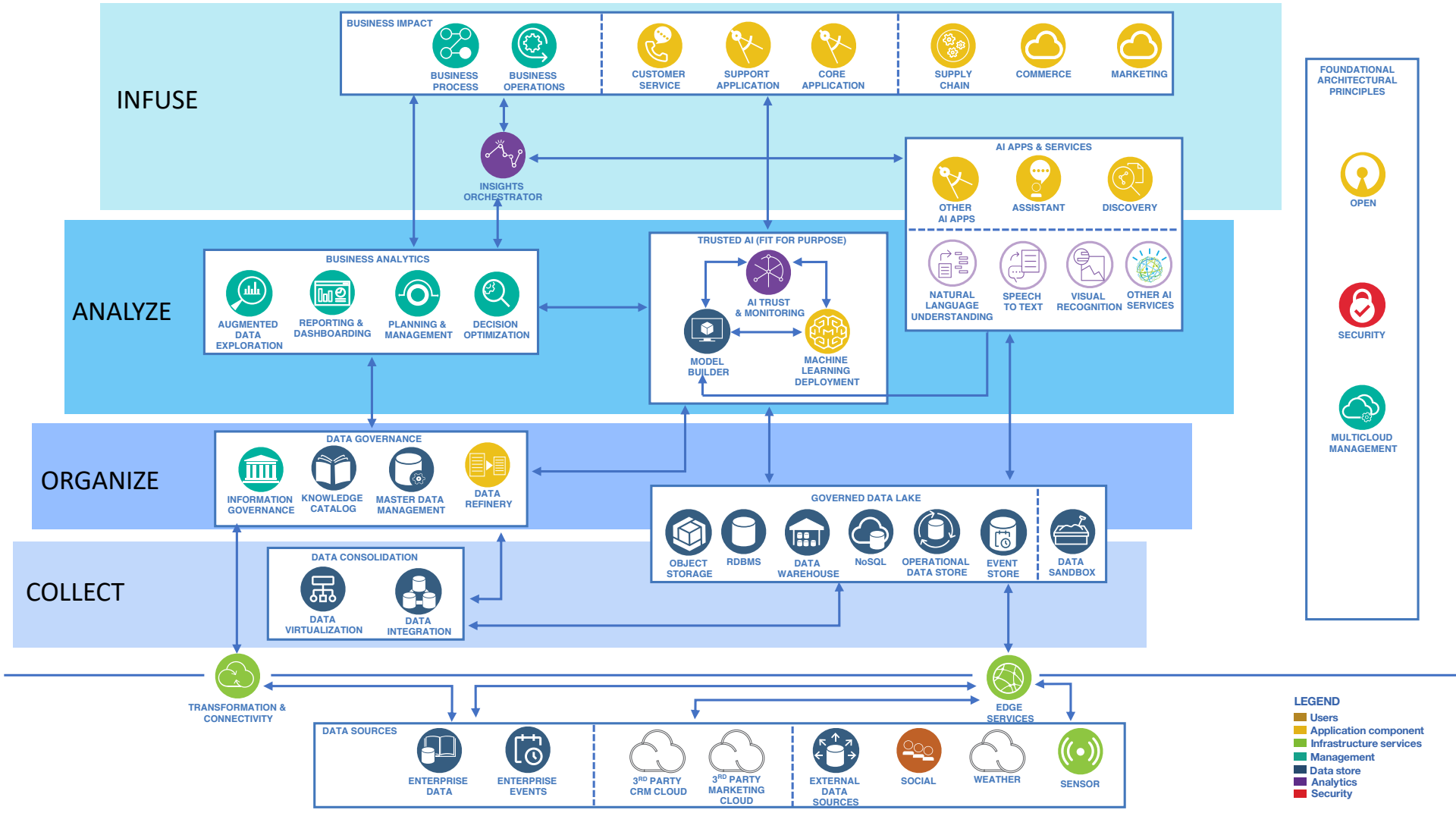
Example from Azure

Architecting for AI

Examples

Amazon Fulfillment Center

Google and Aravind Eye



- Collect data to make it easier to consume and access
- Organize data to create a trusted analytics foundation on data with business meaning
- Analyse to scale business insight with artificial intelligence everywhere
- Infuse to operationalize artificial intelligence with trust and transparency

Collect & Organize

Collect: Making data simple and accessible

Collect refers to how an enterprise can formally incorporate data into any analytic process. Properties of data include structured, semi-structured, or unstructured, proprietary or open, in the cloud or on premises, or any combination.

Organize: Trusted, governed analytics

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Ideally, the outcome is a body of data that is curated and that offers the highest value to an enterprise.

Data is discoverable, catalogued, profiled, categorized, classified, secured, and a source of truth and utility.

Analyze: Insights on demand

The analyze covers a span of techniques and capabilities, from basic reporting and business intelligence to deep learning. Through data, you can determine what happened, what is happening, and what might happen. You can compare against expectations and automate and optimize decisions.

Infuse: Operationalize artificial intelligence with trust and transparency

Infuse allows data to be used for automation and optimization, and as part of a causal loop of action and feedback. Data is exercised in a deployed model, used for developing insights and decision-making, beneficial to the organization, and applied by the enterprise.

Architecting AI Applications

From First Principles

Use services provided Amazon, Google, Azure