البنيان المثالي لتطبيقات إنترنت الأشياء والروبوت

تقديم: علاء بادخن

العطاء الرقمي

Attaa Digital

البنيان المثالي للحلول

- التعمق والتوسع والخبرة في المجال
- الاهتمام بالتفاصيل مع مراعاة الصورة الكاملة
- قدرة التواصل مع الجهات ذات العلاقة (تقنياً و ادارياً)
- تطبيق التقنيات بشكل الامثل مع جانب ابتكاري
- المساهمة في كل عناصر المشروع الى التسليم
- الاشراف و مناصرة الحل بصفة الخبير المختص بالمشروع

برج الملك سلمان جدة

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

في هذه الورشة

الصورة الكاملة
والتطبيقات

نقطة الوصل
والتكامل

حلول وبنيان
الانظمة الروبوتية

حلول وبنيان
انترنت الاشياء

IoT Architecture Overview

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Basic IoT Architecture

Application Layer

Data Processing Layer

Networking Layer

Sensors and Actuators Layer

Basic IoT Architecture

Application Layer
- Data Vis & Analytics
- Infra Management
- End-User Experience

Data Processing Layer
- Server CPU
- Server GPU
- Server Storage
- Server OS/Net/Domain/FW

Networking Layer
- RF Comm. Protocols
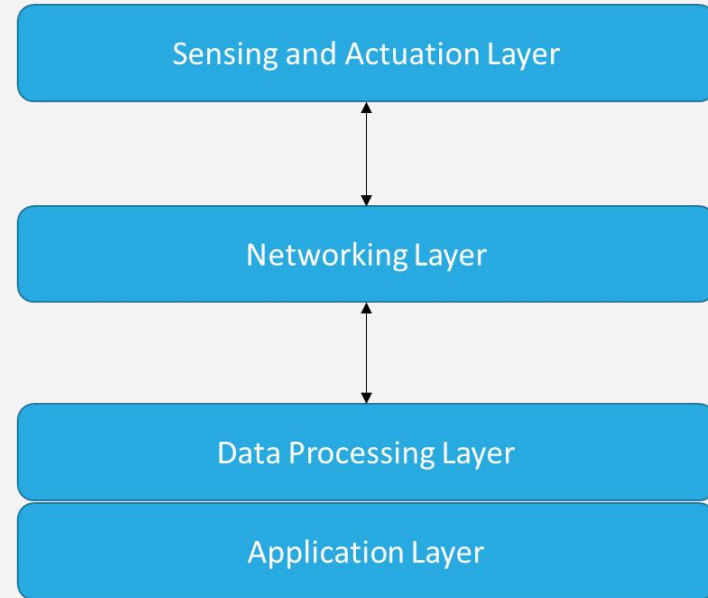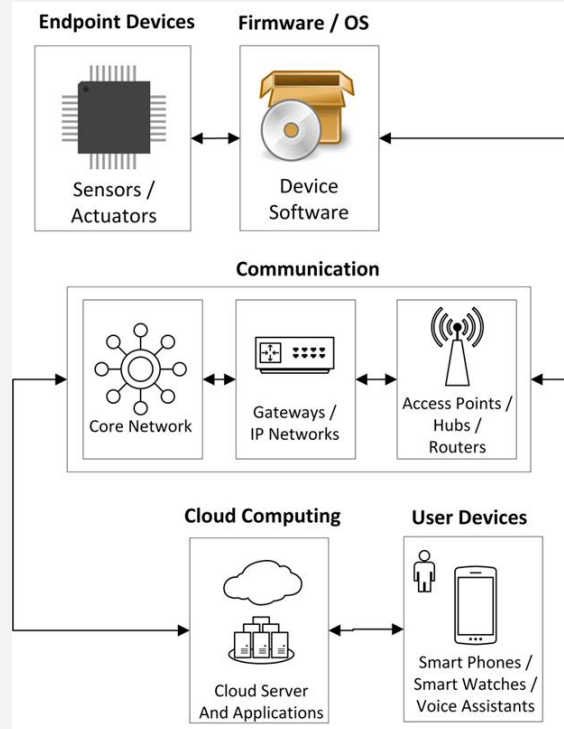- **Application Protocol**
- LAN/PAN/WAN
- **DC & HW Internet**

Sensors and Actuators Layer
- Sensor/Actuator
- MCU/SBC
- Embedded Software
- Hardware Packaging

What is an IoT Full-Stack?

IoT Full-Stack Ecosystem

Endpoint Devices   **Firmware / OS**

Sensors / Actuators   Device Software

Communication

Core Network   Gateways / IP Networks   Access Points / Hubs / Routers

Cloud Computing   **User Devices**

Cloud Server And Applications   Smart Phones / Smart Watches / Voice Assistants

Sensing and Actuation Layer

Networking Layer

Data Processing Layer

Application Layer

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IoT Full-Stack Ecosystem

CLOUD | Data Centres — **Thousands**

FOG | Nodes — **Millions**

EDGE | Devices — **Billions**

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Public vs "Own" Cloud

Depending on Public Clouds

Pros

◉ Universality / Integrable
◉ Pay as you use (On Demand)
◉ Software / Storage / Compute As A Service
◉ Directly Web Hosting

Cons

◉ Cloud Vendor Dependent
◉ Not Accepted by some Customer Policies
◉ Stick with Available Cloud features

Building Your Own Cloud

Pros

◉ Your Own Propriety Software / Flexible addons
◉ Self- Upgradable / Vendor Agnostic
◉ Develop only needed components
◉ Manage your own ISP and Network Plans
◉ Sell on-Premise Licenses to Customers or
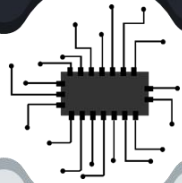◉ Become a Software aaS provider

Cons

◉ Usually has a Larger Capex
◉ Need to maintain Infrastructure by self

IoT Architecture Components

IoT Architecture Components

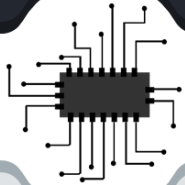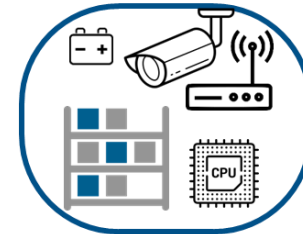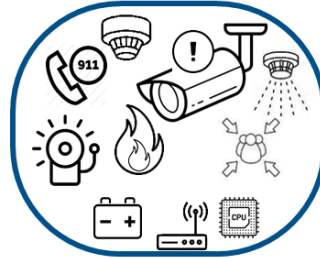| IoT Hardware	Comm. and Networks	Clouds and Servers	Databases	APIs	End-User

• Sensors/ Actuators
• PCB
• CPU
   • As MCU
   • As SBC
• Firmware
• Daemon Software
• [Edge Computing]
	• Wireless Communication Protocol
	• Access Points
	• Gateways
	• [Fog Computing]
	• Cloud Networking
		• Bare Metal Server
		• Virtual Machines
		• Operating Systems
		• Storage
		• DNS and Hosting
		• Websites
		• [Cloud Computing]
		• [Public Clouds]
			• SQL Servers
			• NoSQL Servers
			• Data Logs
			• Image Logs
			• Database Backups
				• IoT Node API
				• End Users API
				• Website API
				• Scripting Using
				   • JS
				   • Python
				   • Others
					• Web App Dev
					• Android/iOS App Dev

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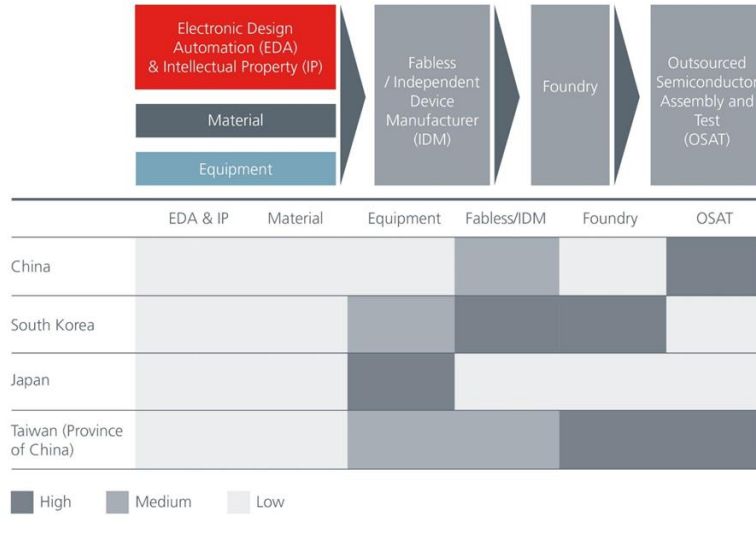
IoT Hardware

- Sensors/ Actuators
- PCB
- CPU
  - As MCU
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- Daemon Software
- [Edge Computing]
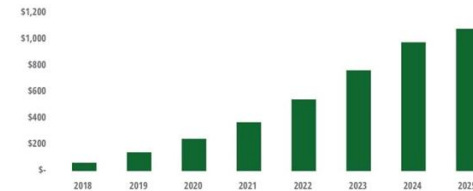
IoT Architecture Components

Own The Supply Chain

	EDA & IP	Material	Equipment	Fabless/IDM	Foundry	OSAT
China						
South Korea						
Japan						
Taiwan (Province of China)						

High / Medium / Low

Electronic Design Automation (EDA) & Intellectual Property (IP)
Material
Equipment
→ Fabless / Independent Device Manufacturer (IDM)
→ Foundry
→ Outsourced Semiconductor Assembly and Test (OSAT)

Source: Rise of the "Big 4". The semiconductor industry in Asia Pacific. Deloitte.

Begin By Owning The IP

siFive — FOUNDING
RISC-V
Google — FOUNDING
NVIDIA
intel
EAST CHINA NORMAL UNIVERSITY
Western Digital — FOUNDING

FIGURE 1
RISC-V revenue is on track for exponential growth
Total RISC-V market revenue, 2018–2025 (US$ millions)

$1,200
$1,000
$800
$600
$400
$200
$-
2018 2019 2020 2021 2022 2023 2024 2025

Source: Omdia, RISC-V Processors Report, 2019.

Deloitte Insights | deloitte.com/insights

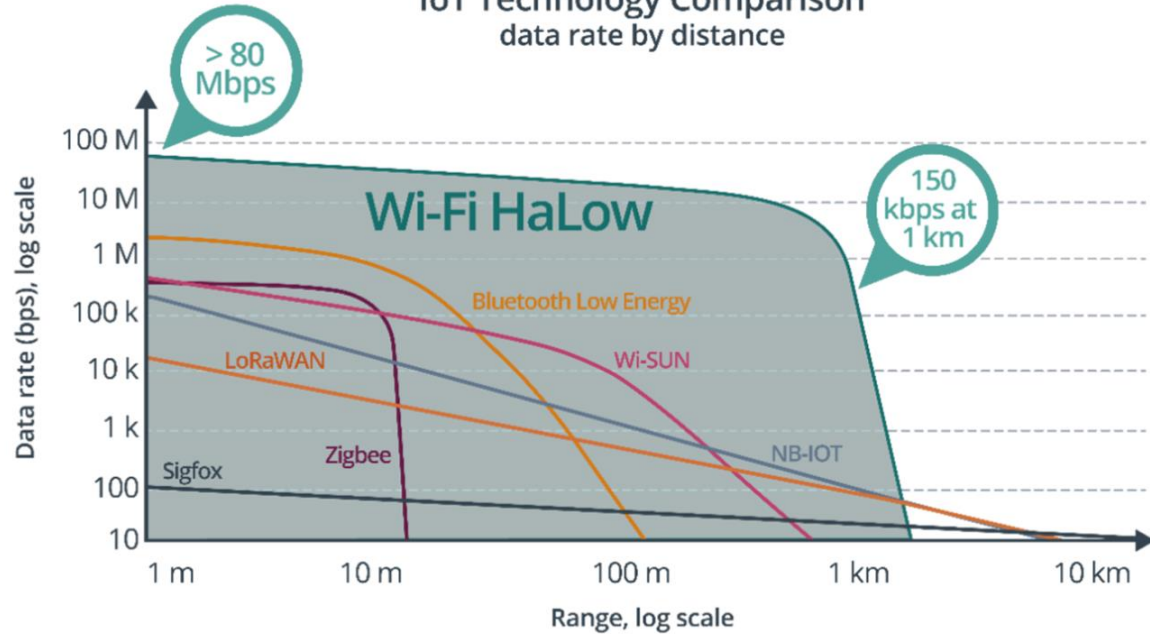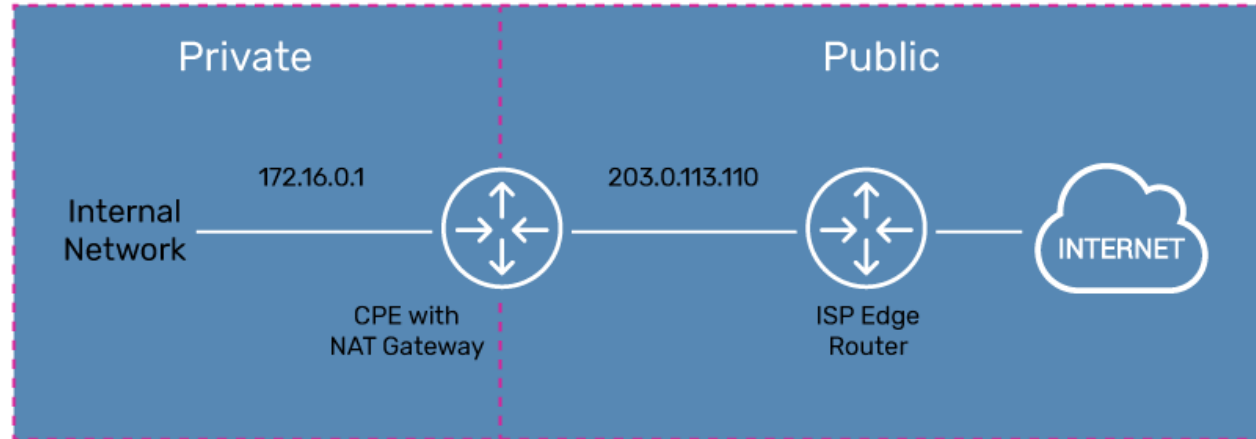علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

IoT Architecture Components

Comm. and Networks

- Wireless Communication Protocol
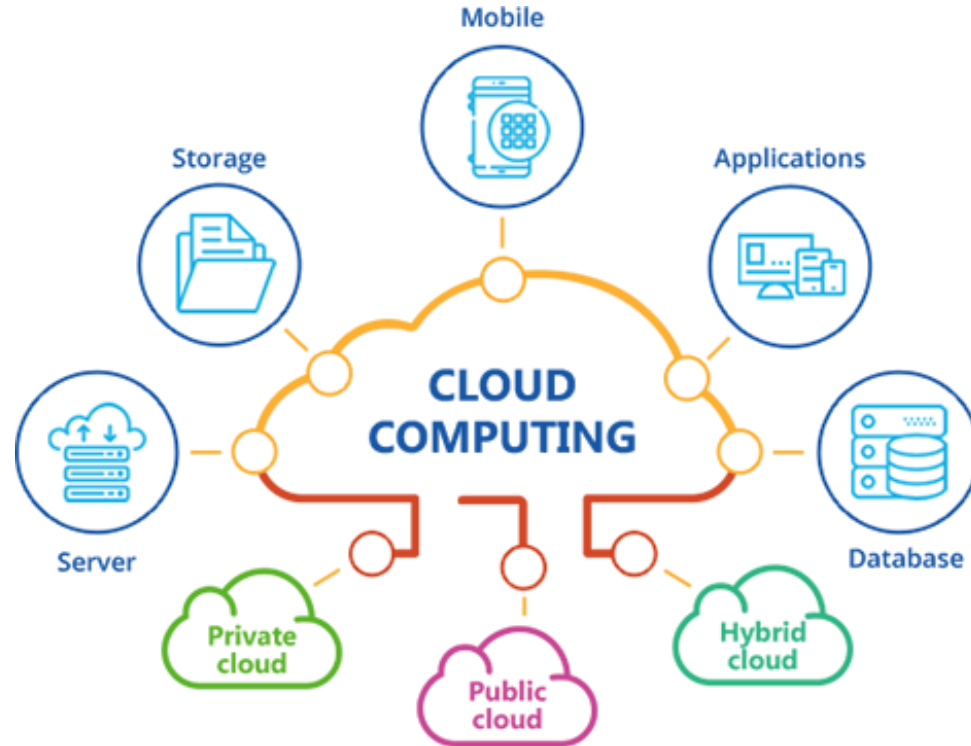- Access Points
- Gateways
- [Fog Computing]
- Cloud Networking

Wi-Fi ALLIANCE™

IEEE Advancing Technology for Humanity

LoRaWAN

WLAN	Technologies that offer greater reach than WPAN and shorter than LPWAN (Standard Wi-Fi 802.11 a/b/g/n/ac, Mesh, etc.).
LPWAN	Technologies that offer an extended range up to several kilometers with limited throughput (e.g., LoRaWAN, Sigfox, NB-IoT, Wi-Fi HaLowTM)
WPAN	Technologies that provide connectivity up to tens of meters (e.g., ZigBee, Bluetooth Low Energy).

Cost comparison | Wi-Fi HaLow versus short and long range IoT

	Wi-Fi HaLow	LoRaWAN	Sigfox	NB-IoT	Bluetooth 5.0	Z-Wave	Zigbee
Operator contract	No	Yes	Yes	Yes	No	No	No
Licensed spectrum	License-exempt	License-exempt	License-exempt	licensed	License-exempt	License-exempt	License-exempt
Interoperability	IEEE / Wi-Fi Alliance	Proprietary	Proprietary	3GPP	Bluetooth SIG	Proprietary	IEEE / Zigbee Alliance
Native IP support	Yes	None	None	Yes (limited)	None	None	None

IoT Technology Comparison
data rate by distance

> 80 Mbps

150 kbps at 1 km

Wi-Fi HaLow

Bluetooth Low Energy

LoRaWAN

Wi-SUN

Zigbee

NB-IOT

Sigfox

Data rate (bps), log scale

Range, log scale

Comm. and Networks

- Wireless Communication Protocol
- Access Points
- Gateways
- [Fog Computing]
- Cloud Networking

IoT Architecture Components

Comm. and Networks

- Wireless Communication Protocol
- Access Points
- Gateways
- [Fog Computing]
- Cloud Networking

Private — Public

Internal Network — 172.16.0.1 — CPE with NAT Gateway — 203.0.113.110 — ISP Edge Router — INTERNET

What is Carrier-grade NAT (CGN/CGNAT)? | Glossary | A10 Networks

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Clouds and Servers

- Bare Metal Server
- Virtual Machines
- Operating Systems
- Storage
- DNS and Hosting
- Websites
- [Cloud Computing]
- [Public Clouds]

Mobile

Storage

Applications

CLOUD COMPUTING

Server

Database

Private cloud

Public cloud

Hybrid cloud

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

Databases

- SQL Servers
- NoSQL Servers
- Data Logs
- Image Logs
- Database Backups

Relational
Tend to be larger, monolithic

Non-relational
Newer field, lots of players

The Types of Modern Databases - DZone Database

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

IoT Architecture Components

APIs

- IoT Node API
- End Users API
- Website API
- Scripting Using
  - JS
  - Python
  - Others

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت
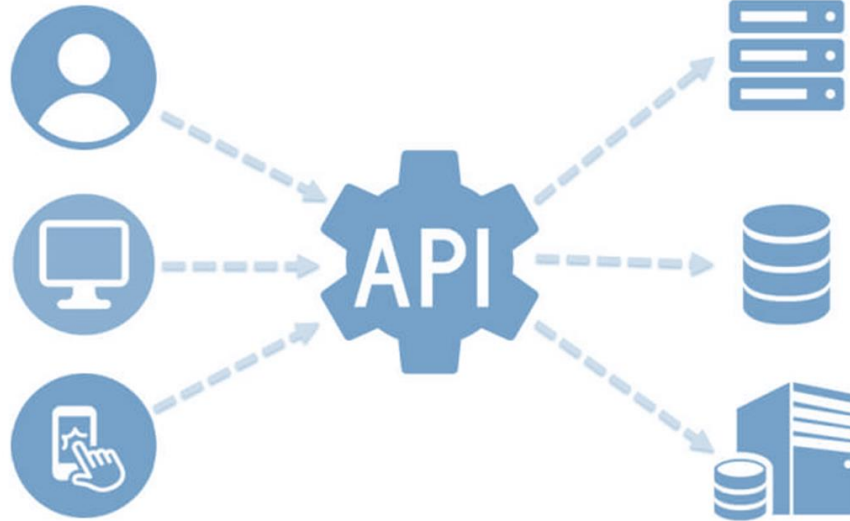
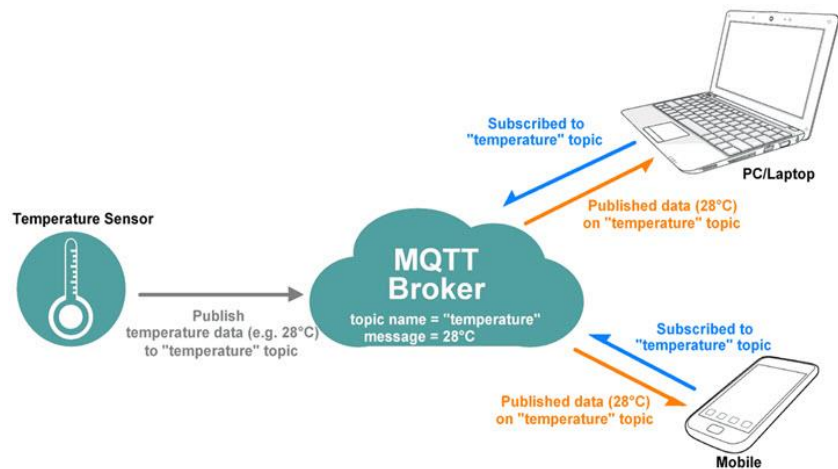# Types of IoT Architecture

- An application layer protocol

- Client-Server Comm.

- HTTP Verbs/Standards

- Limited protocol

- Light architecture

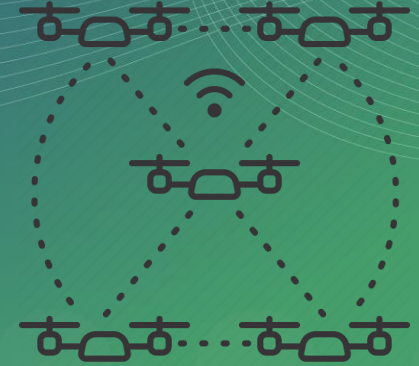**REST API Model**

Mobile/web/
desktop client

GET, POST, PUT, DELETE

JSON data

REST API

Server

- An application layer protocol

- Edge-to-edge comm.

- Client-to-edge comm.

- Modular protocol

- Expandable architecture

Temperature Sensor

Publish temperature data (e.g. 28°C) to "temperature" topic

MQTT Broker
topic name = "temperature"
message = 28°C

Subscribed to "temperature" topic

Published data (28°C) on "temperature" topic

PC/Laptop

Subscribed to "temperature" topic

Published data (28°C) on "temperature" topic

Mobile

Instant Messaging Protocol - MQTT - SoByte

Robotics Systems Architectures

The most important milestones in the history of robotics
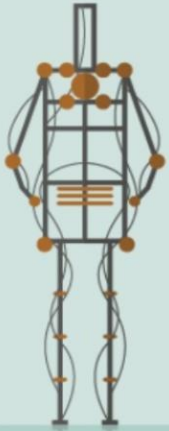
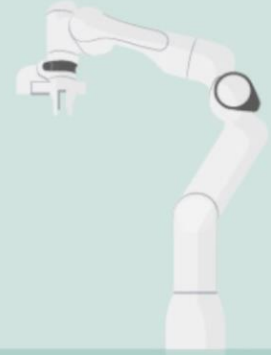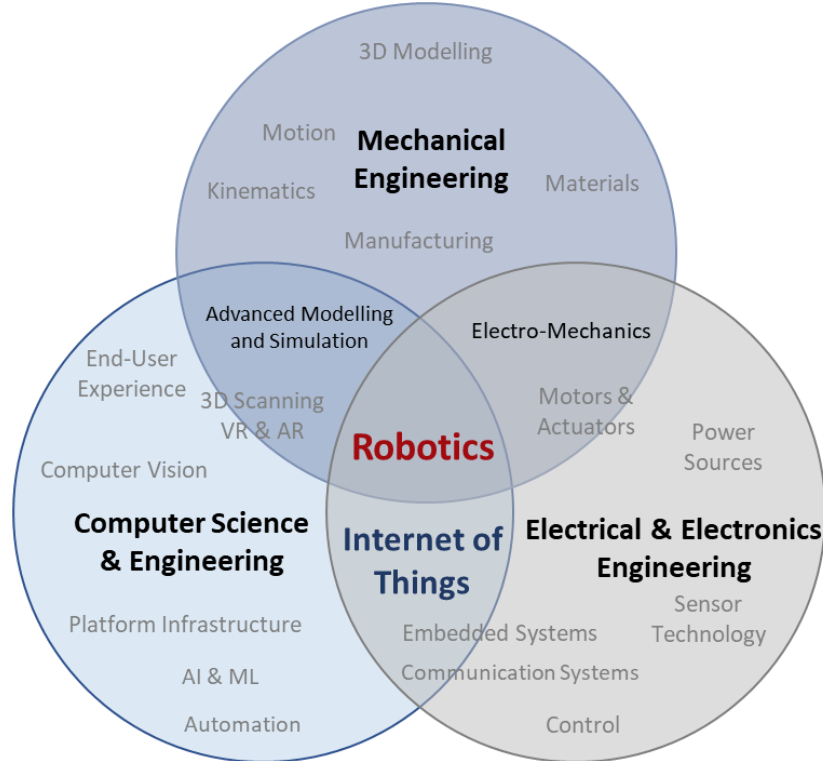| 1495	1937/38	1961	1991	2017
Leonardo Da Vinci	„Elektro" by Westinghouse	„Unimate" by Devol/Engelberger @ GM	„P1" by Honda	„Panda" by Franka Emika

Robotics Technology

Robotics is an interdisciplinary sector of science and engineering dedicated to the design, construction and use of mechanical robots. Our guide will give you a concrete grasp of robotics, including different types of robots and how they're being applied across industries.

IoT & Robotics Shared DNA

3D Modelling

Motion

Mechanical Engineering

Kinematics

Materials

Manufacturing

Advanced Modelling and Simulation

Electro-Mechanics

End-User Experience

3D Scanning VR & AR

Motors & Actuators

Power Sources

Computer Vision

Robotics

Computer Science & Engineering

Internet of Things

Electrical & Electronics Engineering

Platform Infrastructure

Embedded Systems

Sensor Technology

AI & ML

Communication Systems

Automation

Control

Sharing DNA in:
- **Electrical**
- **Electronics**
- **Computers**
- **Software**

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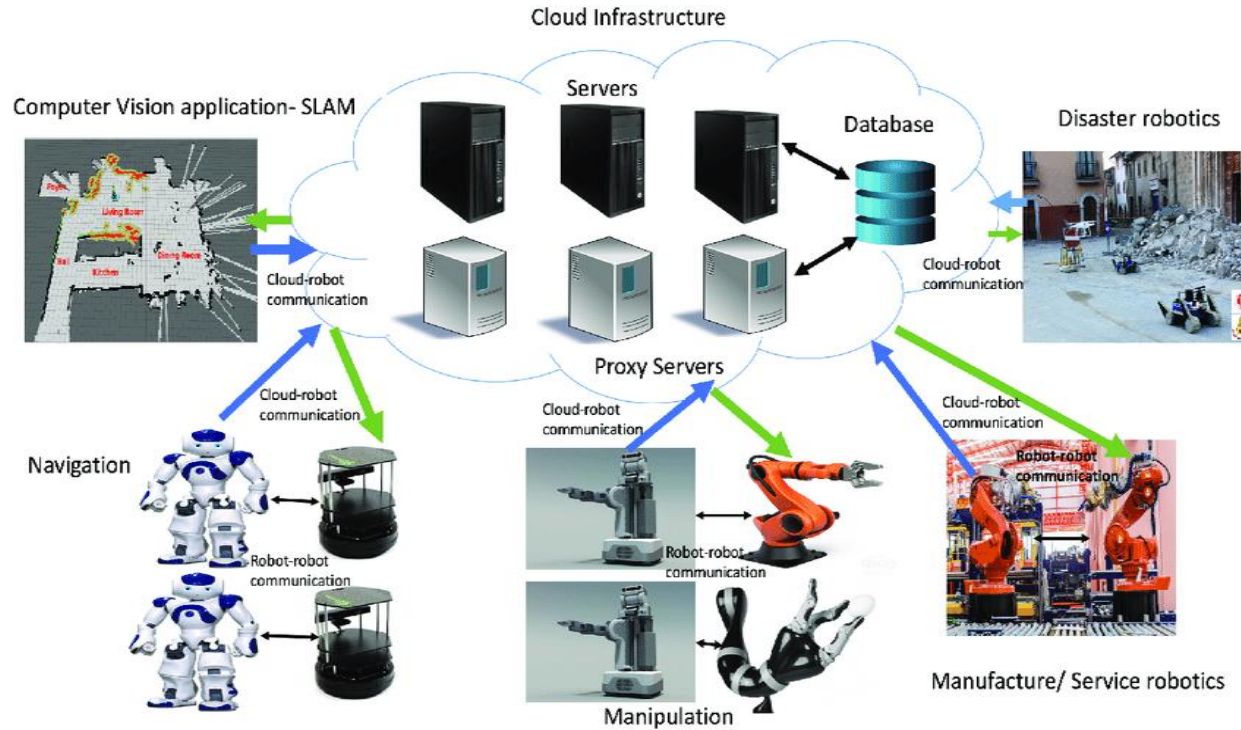
High-level overview of cloud robotics system architecture and applications. | Download Scientific Diagram (researchgate.net)

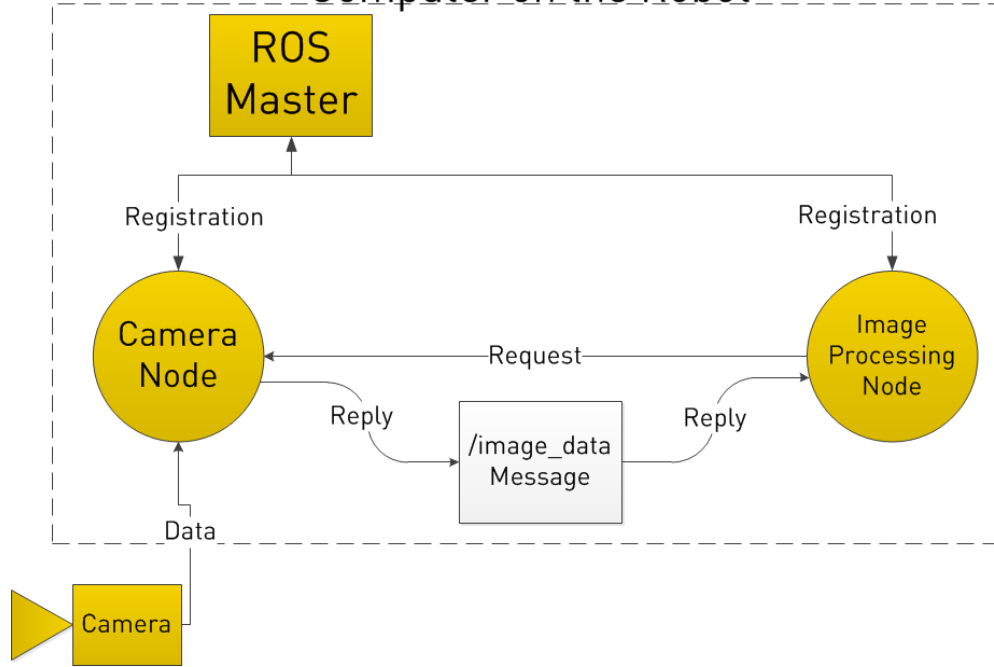علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

Computer on the Robot

ROS Master

Registration

Registration

Camera Node

Request

Image Processing Node

Reply

Reply

/image_data Message

Data

Camera

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Robotic Process Automation (ROS)

Communication | Visualization | Perception

Motion Planning | | Robot Control

ROS
Robot Operating System
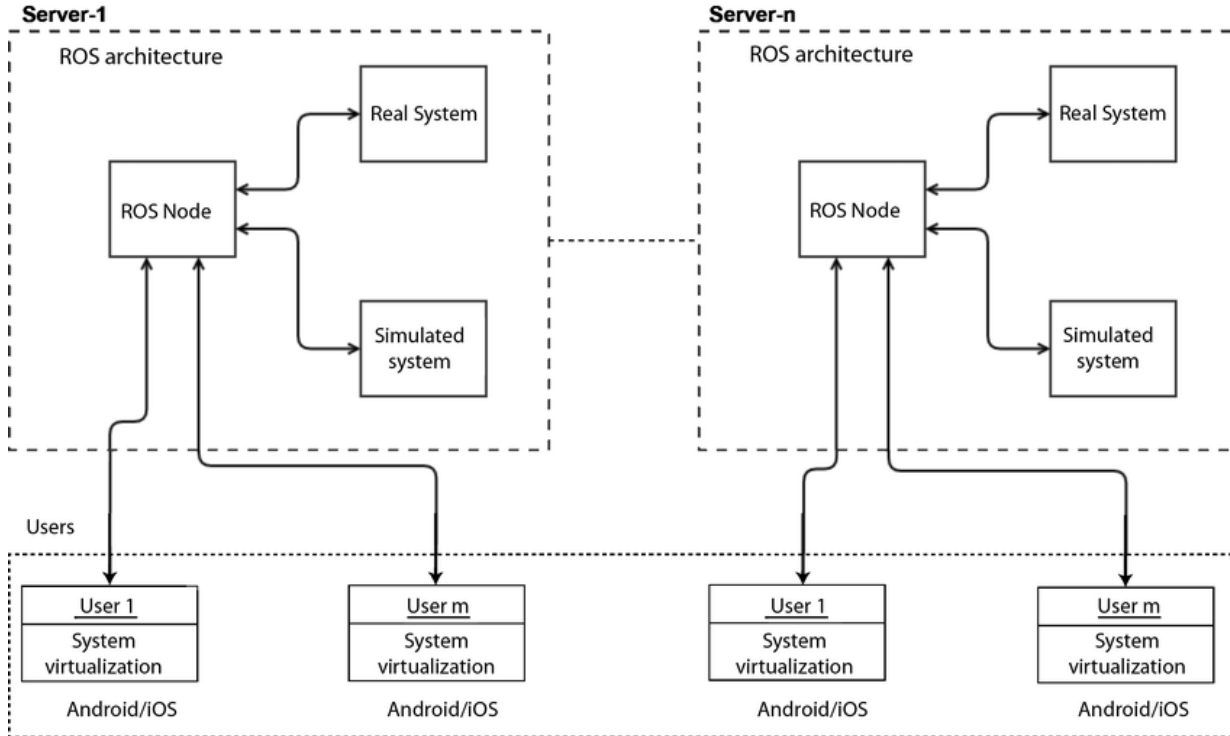
Computer Vision | | Hardware Drivers

Simulation | Data Logging | Machine Learning

[Robot Operating System 2 (ROS 2) Architecture | by Huseyin Kutluca | Software Architecture Foundations | Medium](#)

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Robotic Process Automation (ROS)

[(PDF) Virtualization of Robotic Hands Using Mobile Devices † (researchgate.net)](researchgate.net)

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

نقطة الوصل والتكامل

قيمة وهدف
للتكامل

رفع الكفاءة التشغيلية لأي
تطبيق

1

أتمتة المراقبة و العمليات - نتائج
وتفاعل بشكل لحظي وتلقائي

3

استدامة الحلول لتناسب
التطبيقات المستقبلية

4

التأمين الكامل لسلاسل الامداد
للمنتجات

2

علاء باحخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

Cooperative Interoperability

Robotics Command

Cobots Robotics — ROS

M2M IoT

IoT Command

Conveyer Robot

Manipulator Robot

Mobile Robot

Sensor Nodes
- Weather Sensors
- HVAC
- Storage Shelves Sensors

Actuation Nodes
- Lighting
- Door Access
- Fire Alarm

Complex Nodes
- Smart CCTV
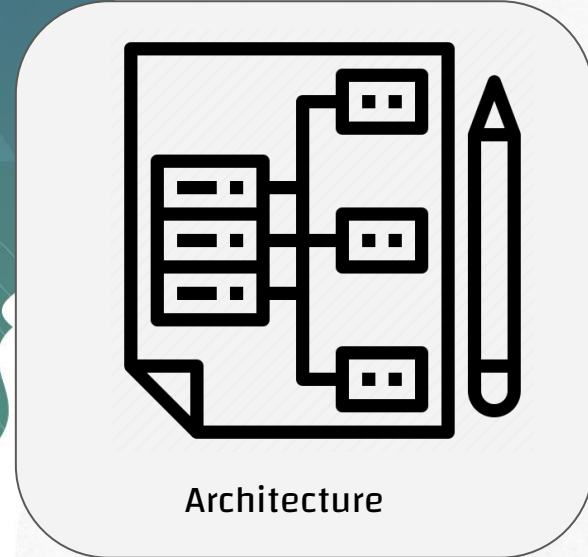- Quality Control
- Energy Management

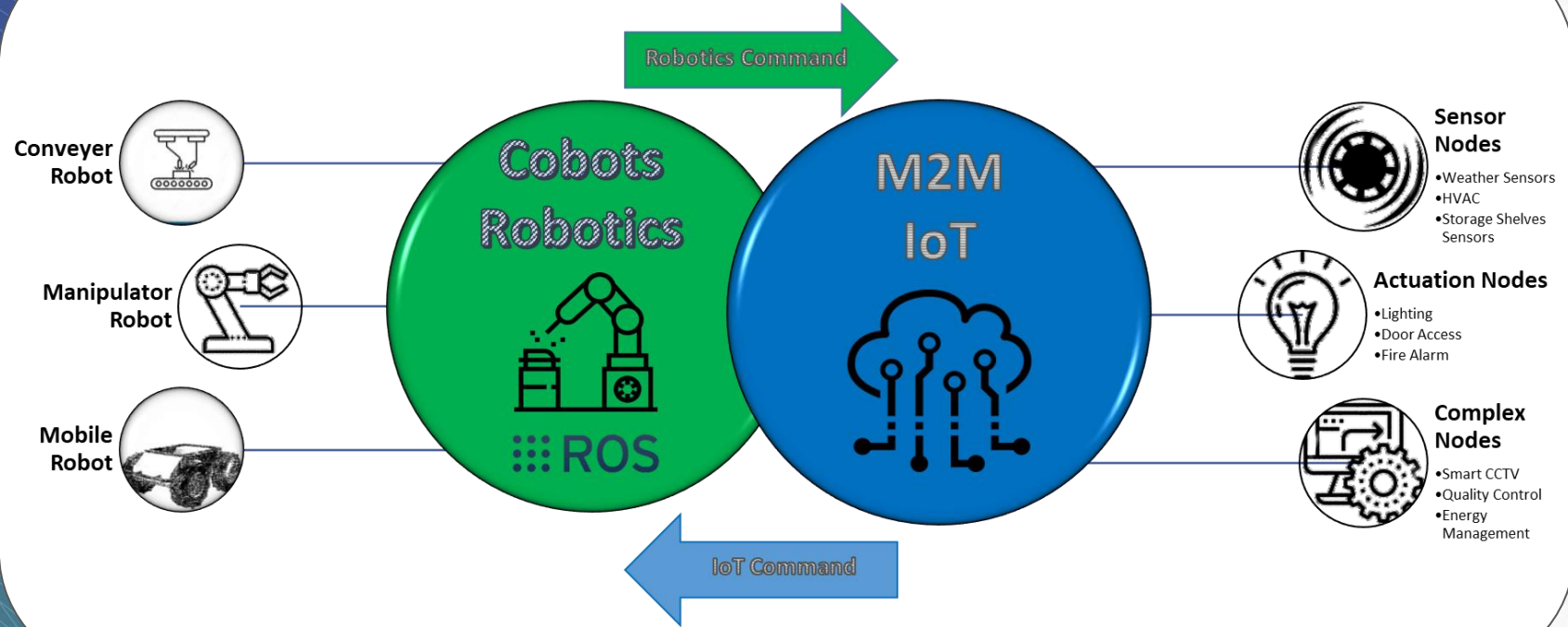علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت
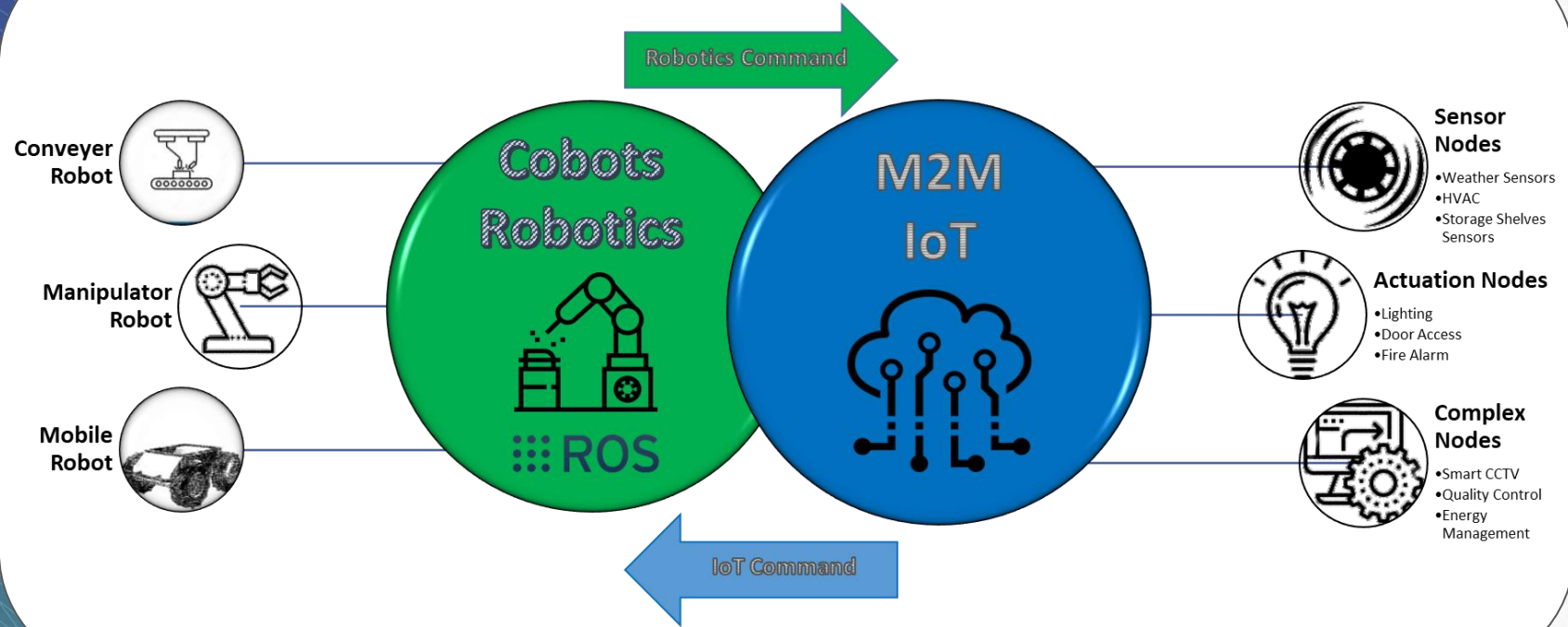
Afanasyev, Ilya, et al. "Towards the internet of robotic things: Analysis, architecture, components and challenges." 2019 12th International Conference on Developments in eSystems Engineering (DeSE). IEEE, 2019.

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

How Its Done?

Communication + Architecture

علاء بادخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت

Cooperative Interoperability

Robotics Command →

Conveyer Robot

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M2M IoT

← IoT Command

Sensor Nodes
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علاء باحخن – البنيان المثالي لتطبيقات إنترنت الاشياء والروبوت
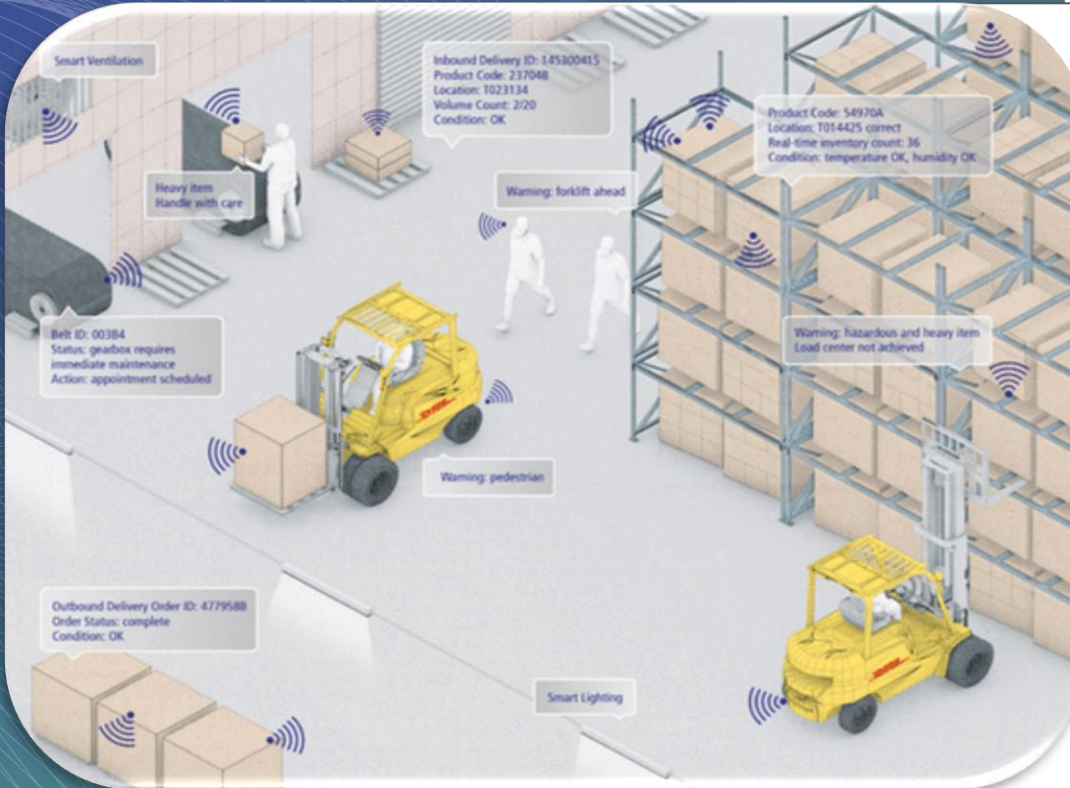
A REST-based industrial web of things' framework for smart warehousing | Request PDF (researchgate.net)

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الصورة الكاملة

How Its Made:
(Sneak Peek)

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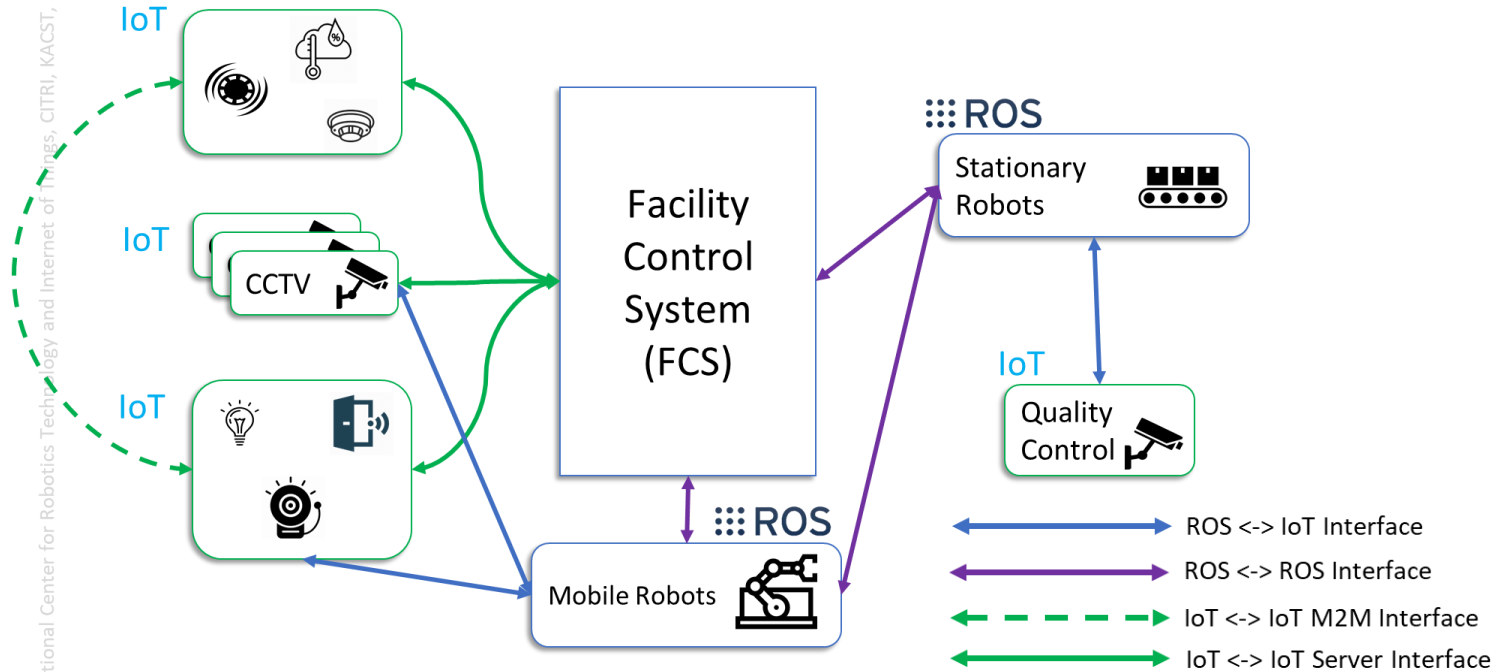
شكراً لكم

Thank you :)

Always appreciate your thoughts
and questions...

Always available at:
- albadokhon@gmail.com
- https://www.linkedin.com/in/ab-iot/

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