UUW1624006

INTERNET OF THINGS

Program Studi Informatika
Fakultas Sains dan Matematika
Universitas Diponegoro

IDENTITAS MATA KULIAH

KODE	UUW1624006
NAMA	Internet of Things
BEBAN	2 SKS
PENGAMPU	1. Dr. Indra Waspada, S.T., M.T.I. 2. Satriawan Rasyid Purnama S.Kom., M.Cs. 3. Henri Tantyoko S.Kom., M.Kom.

CAPAIAN PEMBELAJARAN

CPL-07: Mampu menerapkan konsep sistem dan pengembangan perangkat lunak untuk menghasilkan solusi atas permasalahan kompleks di berbagai bidang dengan mempertimbangkan aspek keamanan.
CPMK: Mampu menerapkan konsep sistem untuk merancang solusi atas permasalahan kompleks.

CAPAIAN PEMBELAJARAN

Sub CPMK:

1. mampu menjelaskan kembali (C2) pengertian Internet of Things (IoT) dan hubungannya di dalam masyarakat
2. mampu menjelaskan kembali (C2) aplikasi Internet of Things (IoT) dalam berbagai benda/perangkat/ obyek IPTEKS yang berhubungan dengan data collection dan platform sosial, ekonomi, dan politik
3. mampu menjelaskan (C2) aspek tata kelola dan kesempatan bisnis dalam internet of things (IoT)
4. mampu melakukan pencarian data dan tools marketing serta mengimplementasikannya (C3) pada contoh aplikasi Internet of things
5. mampu menjelaskan (C2) aspek kecerdasan buatan yang digunakan dalam memahami pola pasar dan pola dari pemakaian alat dalam Internet of Things (IoT)
6. mampu menjelaskan (C2) konsep dasar cyber security sederhana dalam IoT
7. mampu menjelaskan (C2) arsitektur dan organisasi Internet of Things
8. mampu mengaplikasikan (C3) Internet of Things untuk kewirausahaan berbasis e-commerce
9. mampu mempraktekkan (C3) penggunaan aplikasi berbasis IoT
10. mampu mengimplementasikan (C3) teknologi IoT dalam projek multi disiplin ilmu

DESKRIPSI MATA KULIAH

Mata kuliah internet of things (IoT) berisi materi dasar tentang penggunaan internet dari dimensi masyarakat yang bisa dibenamkan pada benda/perangkat/objek IPTEKS (Ilmu Pengetahuan, Teknologi, dan Seni) di sekitar. Pada hasil akhir kuliah diharapkan mahasiswa terampil dalam mengaplikasikan internet of things (IoT) secara santun, praktis dan komprehensif.

TOPIK PERTEMUAN

1. [Was] IoT sebagai Enabler Industri 4.0
2. [Was] Pemrograman IoT
3. [Was] Proyek 1: Kontrol Led
4. [Ras] Monitoring nilai
5. [Ras] Pengumpulan data
6. [Ras] Proyek 2: Monitoring dan DataLogger Suhu
7. [Ras] Keamanan Data
8. UTS (tertulis)

9. [Ras] Sistem IoT dua arah
10. [Hen] Sistem IoT dengan Multi sensor
11. [Hen] Proyek 3: Kontrol dan Monitoring multi sensor
12. [Hen] Kecerdasan buatan
13. [Hen] Proyek 4: Sistem klasifikasi
14. [Hen] SotA penelitian IoT (*Release Tugas Besar)
15. [Hen] Etika IoT
16. UAS (*Tugas Besar)

Dosen Pengampu:

- [Was] = Dr. Indra Waspada
- [Ras] = Satriawan Rasyid Purnama, M.Cs
- [Hen] = Henri Tantyoko, M.Kom

Catatan:

- Perangkat keras IoT menggunakan Perangkat Virtual
- Output proyek (1-4): Prototype, Slide, dan dipresentasikan
- Output Tugas Besar: Draft proposal Gemastik, Slide, Prototype, presentasi

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Referensi:

1. Bahga & Madisetti. 2015. Internet of Things – A Hands-on Approach. Universities Press. India [pdf]
2. Greengard. 2021. The Internet of Things. The MIT Press. London, England. [pdf]
3. Gondosubroto. 2024. Internet of Things from Scratch. Packt Publishing. Birmingham. [epub]
4. Sanjaya. 2025. Eksperimen Virtual Internet of Things ESP32. Bolabot. Bandung. [hard]

PENILAIAN

1. Aktivitas Partisipatif ±10
2. Hasil Proyek ±40: Proyek 1, 2, 3, 4 (kelompok)
3. Tugas ±10 (individu)
4. Kuis ±10 (individu)
5. Ujian Tengah Semester (UTS) ±15
6. Ujian Akhir Semester (UAS) ±15 : Tugas Besar

KESEPAKATAN KULIAH

1. RPS dan kontrak kuliah tersedia di kulon
2. Materi tersedia di kulon (PPT dan/atau Video)
3. Pengumpulan surat izin / sakit di akhir menjelang UTS/UAS
4. Pelaporan belum berhasil presensi di kulon (max setengah dari waktu kuliah)
5. Survey setelah kelas (max hari itu di 23.59)
6. Di akhir sesi ada perhitungan mahasiswa yang hadir yang dicocokkan dengan presensi siap
7. Nilai **Aktivitas Partisipatif** diambil dari komponen berikut :
   - presensi kehadiran
   - mengisi survey
   - mengajukan diri dalam menyelesaikan persoalan di kelas
8. Kesepakatan ini berlaku mulai pertemuan ke-2

01

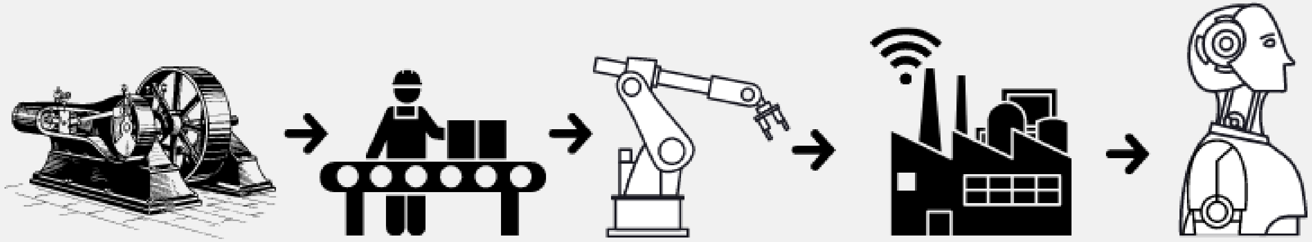
IoT sebagai Enabler Industri 4.0

Revolusi Industri 4.0

- Revolusi industri dapat dipahami sebagai **transformasi fundamental** dalam metode manusia memanfaatkan sumber daya untuk menghasilkan barang dan jasa pada berbagai sektor ekonomi.
- Perubahan ini tidak hanya **mengakselerasi efisiensi produksi**, tetapi juga menimbulkan **implikasi luas** terhadap struktur perekonomian, dinamika politik, serta tatanan sosial-budaya.
- Misalnya, penerapan **mesin uap** pada abad ke-18 tidak hanya meningkatkan kapasitas produksi tekstil, tetapi juga memicu urbanisasi besar-besaran serta perubahan pola hubungan kerja antara pemilik modal dan pekerja.

Industrial

REVOLUTIONS

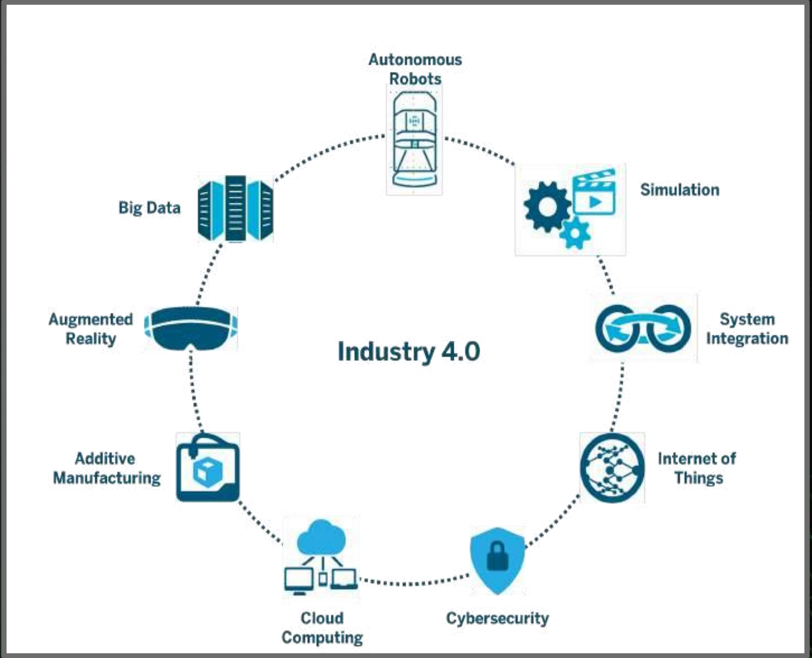


Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0	Industry 5.0
mechanization, water and steam powers	mass production, electric power, assembly line	computers, automated production, electronics	cyber-physical systems, IoT, networking, machine learning	human-robot collaboration, cognitive systems, customization
1800	1900	2000	2010	2020

https://youtu.be/b9mJrzdlfR8?si=nr1MDkBdA0frokEr

Peran IoT dalam Industri 4.0

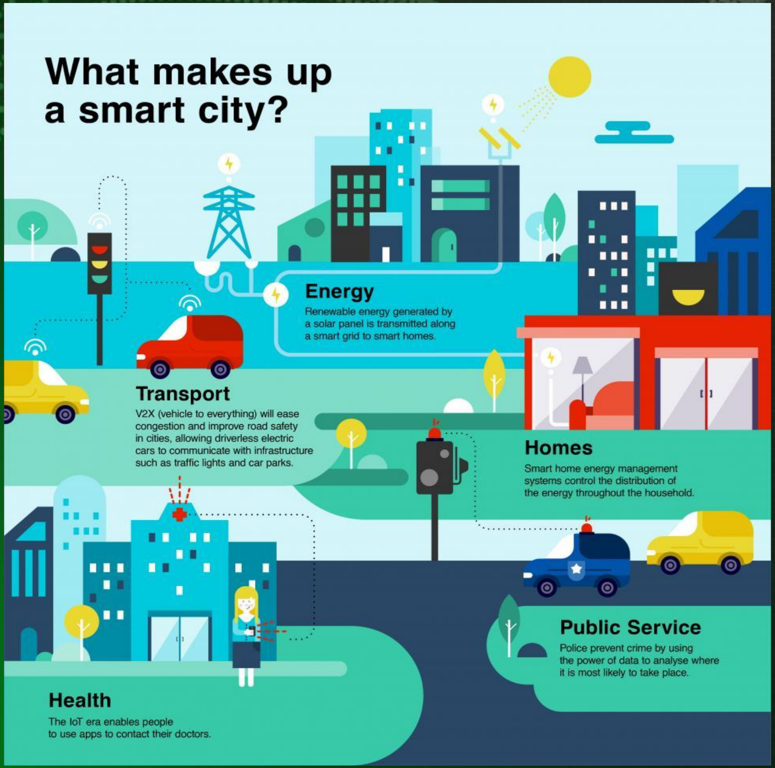
- Konektivitas dan Integrasi Sistem
  IoT memungkinkan mesin, sensor, dan perangkat saling terhubung
- Optimasi Proses Produksi
  data dari mesin dan robot otonom dapat dimonitor terus-menerus sehingga mendukung *simulation* untuk perencanaan produksi
- Pengambilan Keputusan Berbasis Data
  menghasilkan *big data* yang dapat dianalisis untuk meningkatkan produktivitas, memprediksi kerusakan mesin, dan menurunkan biaya operasional.
- Kolaborasi dengan Teknologi Lain
  penghubung utama antara *cloud computing*, *cybersecurity*, dan *augmented reality*



Tantangan IoT

- Keamanan menjadi tantangan utama karena banyaknya perangkat IoT yang rentan terhadap serangan siber.
- Interoperabilitas menjadi masalah karena perangkat IoT menggunakan berbagai standar komunikasi yang berbeda.
- Konsumsi daya pada perangkat IoT harus dioptimalkan agar perangkat dapat beroperasi dalam jangka panjang.
- Skalabilitas jaringan menjadi tantangan karena semakin banyak perangkat yang terhubung memerlukan infrastruktur yang lebih kuat.

Contoh Implementasi IoT



Implementasi IoT pada **Smart City**

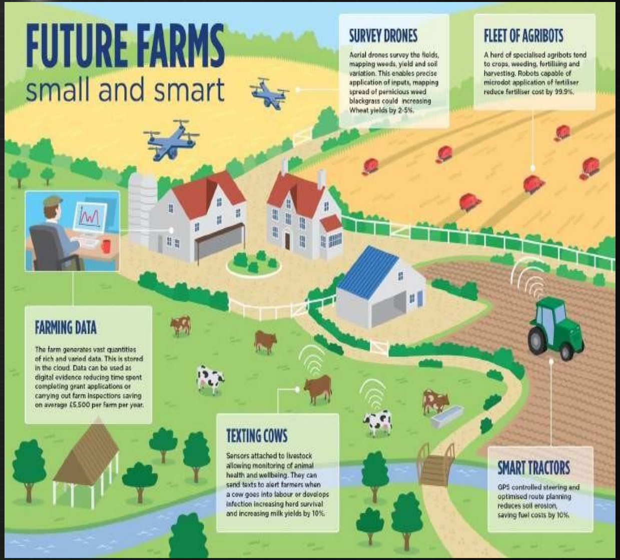
Mencakup sektor :

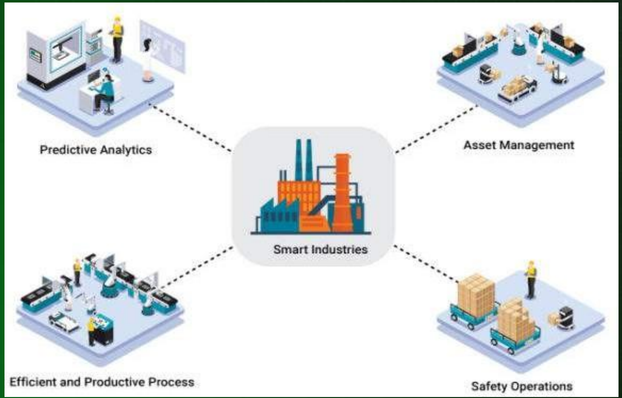
- Industri
- Keamanan
- Retail
- Sosial
- Kesehatan
- Tempat tinggal
- Energi
- Mobilitas

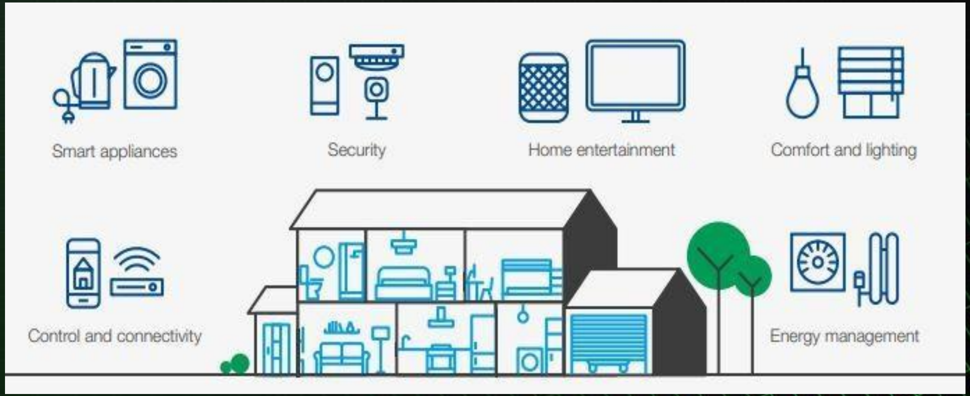
https://youtu.be/Q3ur8wzzhBU?si=qdHsZg8rC4TtHaK2

Contoh Implementasi IoT

- Smart Farming
- Smart Industries
- Smart Homes







Key Aspects of IoT

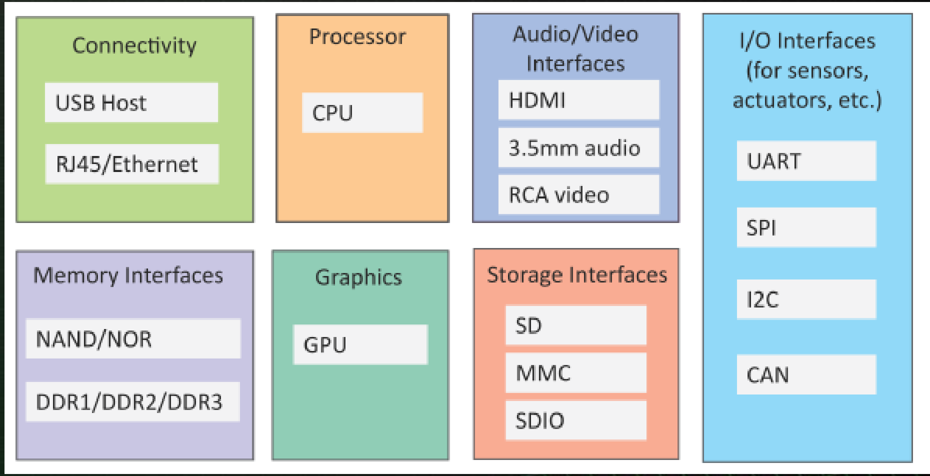
- Data Security
  - Protecting data from cyber threats (encryption, authentication, access control).
  - Ensuring user privacy and system integrity.
- Governance
  - Standardizing IoT protocols and regulatory compliance.
  - Risk management and legal accountability.
- Ethics
  - Transparent and responsible use of data.
  - Preventing algorithmic bias and technology misuse.
- Business Opportunities
  - Innovation in data-driven services (smart city, smart industry, e-commerce).
  - Operational efficiency & new business models through IoT + AI + Cloud.

Definition of Internet of Things (IoT)

- A dynamic global network infrastructure with **self-configuring capabilities** based on **standard and interoperable communication protocols** where physical and virtual "things" have identities, physical attributes and virtual personalities, use **intelligent interfaces**, are **seamlessly integrated** into the information network, and often communicate data associated with users and their environments.
- Dynamic & Self-Adapting; Self-Configuring; Interoperable Communication Protocols; Unique Identity; Integrated into Information Network

Generic Block Diagram of an IoT Device

- An IoT device may consist of several interfaces for connections to other devices, both wired and wireless.
  - I/O interfaces for **sensors**
  - Interfaces for **internet** connectivity
  - **Memory** and **storage** interfaces
  - **Audio/video** interfaces



IoT **Protocols**

Link Layer

802.3 – Ethernet,

802.11 – WiFi,

802.16 – WiMax

802.15.4 – LR-WPAN, 2G/3G/4G

Network/Internet Layer

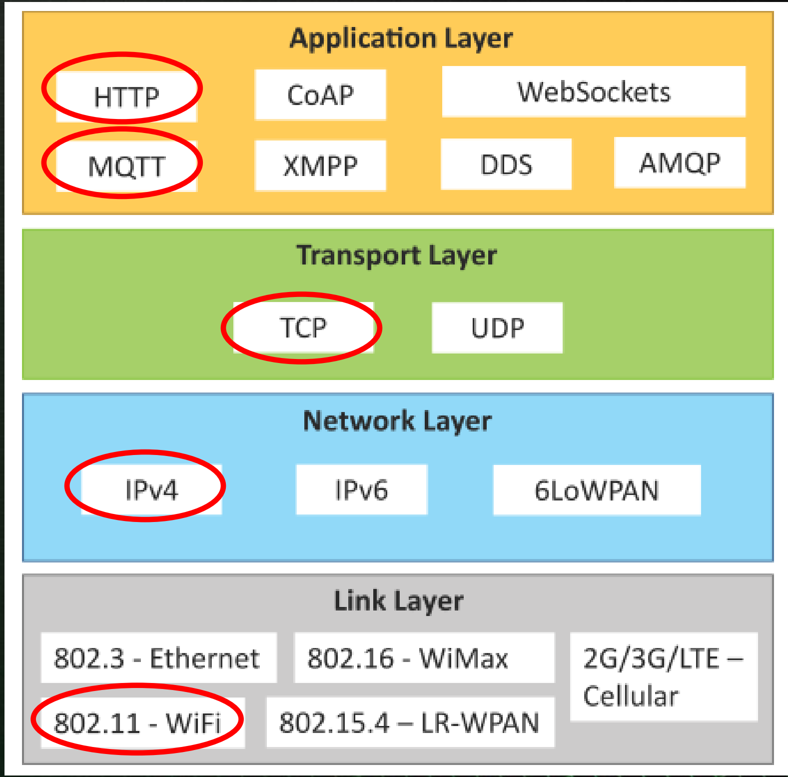
IPv4, IPv6, 6LoWPAN

Transport Layer

TCP, UDP

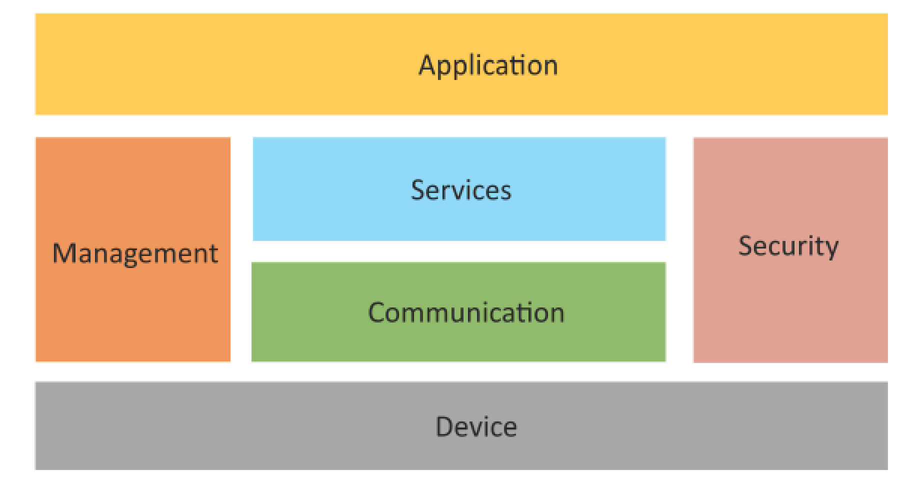
Application Layer

HTTP, CoAP, WebSocket, **MQTT**, XMPP, DDS, AMQP



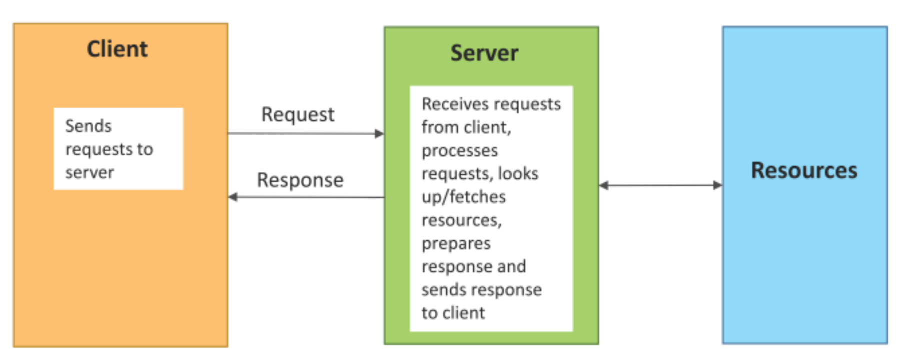
Logical Design of IoT

- Logical design of an IoT system refers to an abstract representation of the entities and processes without going into the low-level specifics of the implementation.
- An IoT system comprises a number of **functional blocks** that provide the system the capabilities for **identification**, **sensing**, **actuation**, **communication** and **management**.



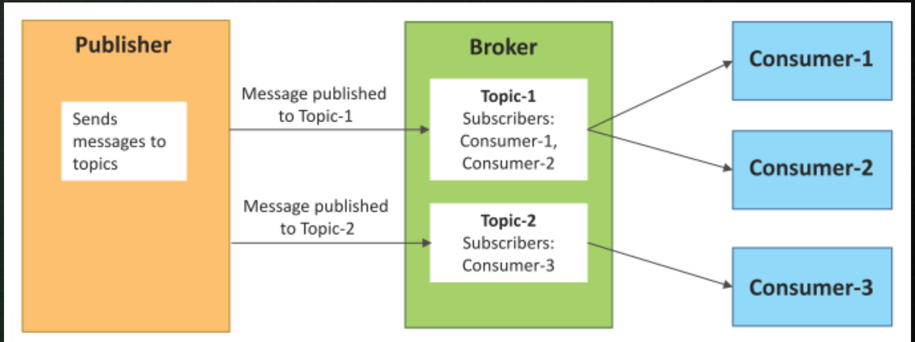
Request-Response Communication **Model**

- Request–Response is a communication model in which the **client sends requests** to the server and the **server responds** to the requests.
- When the server receives a request, it decides how to respond, fetches the data, retrieves resource representations, prepares the response and then sends the response to the client.



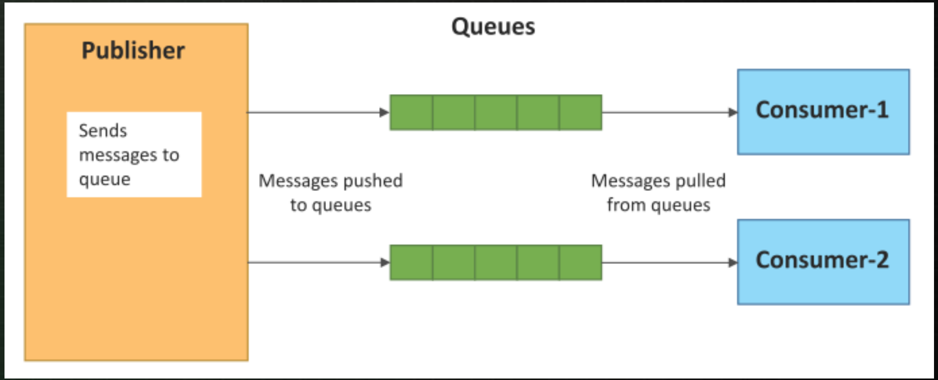
Publish-Subscribe Communication Model

- Publish–Subscribe is a communication model that involves publishers, brokers and consumers.
- **Publishers** are the source of data. Publishers send the data to the topics which are managed by the broker. Publishers are not aware of the consumers.
- **Consumers** subscribe to the topics which are managed by the broker.
- When the **broker** receives data for a **topic** from the publisher, it sends the data to all the subscribed consumers.



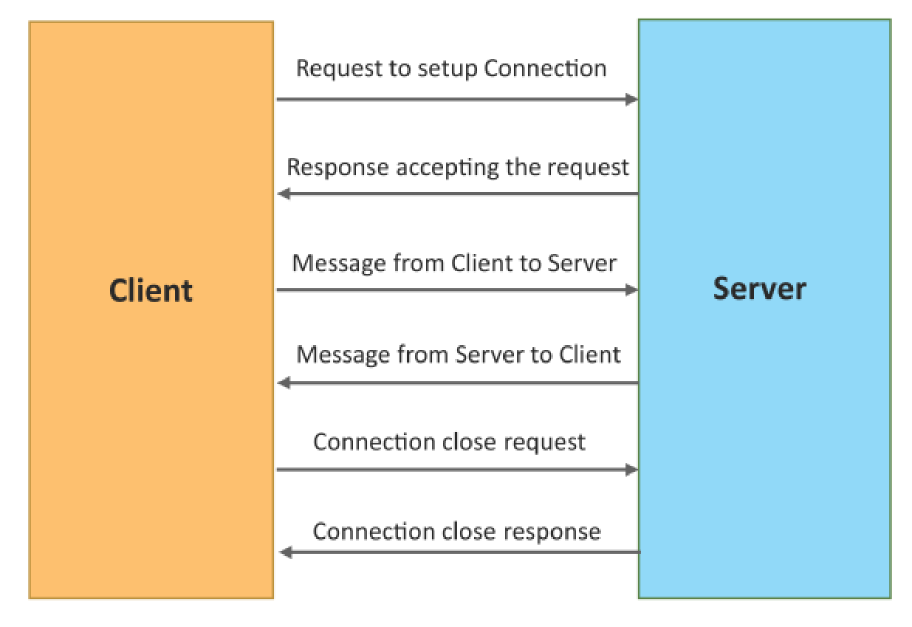
Push-Pull Communication **Model**

- Push–Pull is a communication model in which the data **producers push** the data **to queues** and the **consumers pull** the data from the queues. Producers do not need to be aware of the consumers.
- Queues help in decoupling the messaging between the producers and consumers.
- Queues also act as a **buffer** which helps in situations when there is a mismatch between the rate at which the producers push data and the rate at which the consumers pull data.



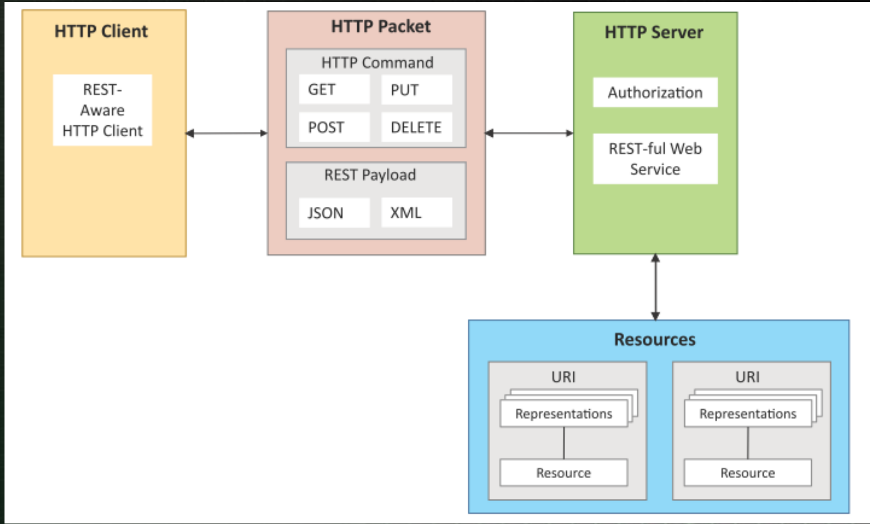
Exclusive Pair Communication Model

- Exclusive Pair is a bidirectional, fully duplex communication model that uses a **persistent connection** between the client and the server.
- Once the connection is set up it, remains open until the client sends a request to close the connection.
- Client and server can send messages to each other after connection setup.



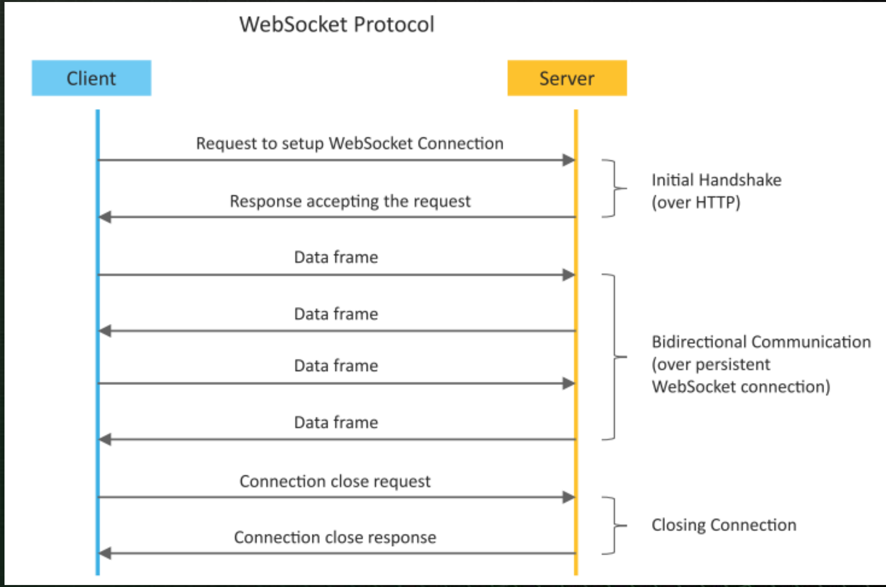
Communication **APIs: REST-based**

- Representational State Transfer (REST) is a set of architectural principles by which you can design **web services** and **web APIs** that focus on a system's resources and how resource states are addressed and transferred.
- REST APIs follow the **request–response communication model**.
- REST architectural constraints apply to the components, connectors and data elements within a distributed hypermedia system.



Communication **APIs : WebSocket-based**

- WebSocket APIs allow **bi-directional, full duplex** communication between clients and servers.
- WebSocket APIs follow the **exclusive pair communication model**.



IoT Levels and Deployment Templates

An IoT system comprises the following components:

Device: An IoT device allows identification, remote sensing, actuating and remote monitoring capabilities.

Resource: Resources are software components on the IoT device for accessing, processing and storing sensor information, or for controlling actuators connected to the device. Resources also include the software components that enable network access for the device.

Controller Service: Controller service is a native service that runs on the device and interacts with the web services. Controller service sends data from the device to the web service and receives commands from the application (via web services) for controlling the device.

IoT Levels and Deployment Templates (2)

Database: Database can be either local or in the cloud and stores the data generated by the IoT device.

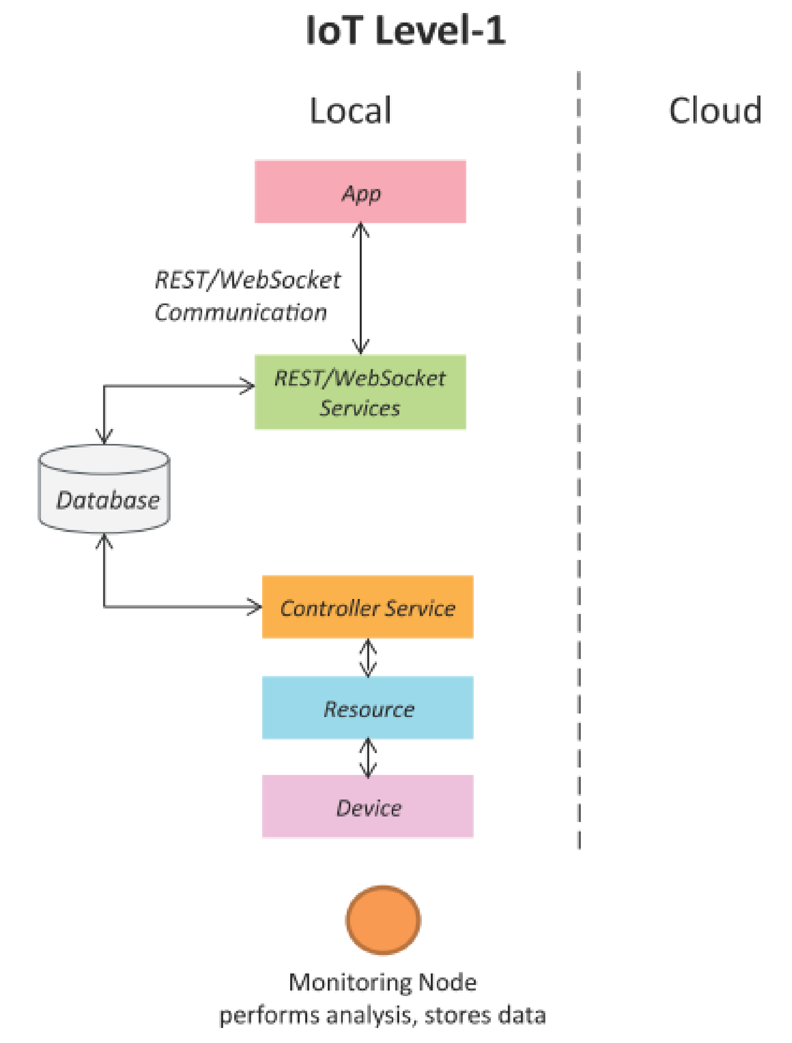
Web Service: Web services serve as a link between the IoT device, application, database and analysis components. Web service can be implemented using HTTP and REST principles (REST service) or using the WebSocket protocol (WebSocket service).

Analysis Component: This is responsible for analyzing the IoT data and generating results in a form that is easy for the user to understand.

Application: IoT applications provide an interface that the users can use to control and monitor various aspects of the IoT system. Applications also allow users to view the system status and the processed data.

IoT Level-1

- A level-1 IoT system has a **single node/device** that performs **sensing** and/or **actuation**, stores data, performs analysis and hosts the application.
- Level-1 IoT systems are suitable for modelling low-cost and low-complexity solutions where the data involved is not big and the analysis requirements are not computationally intensive.

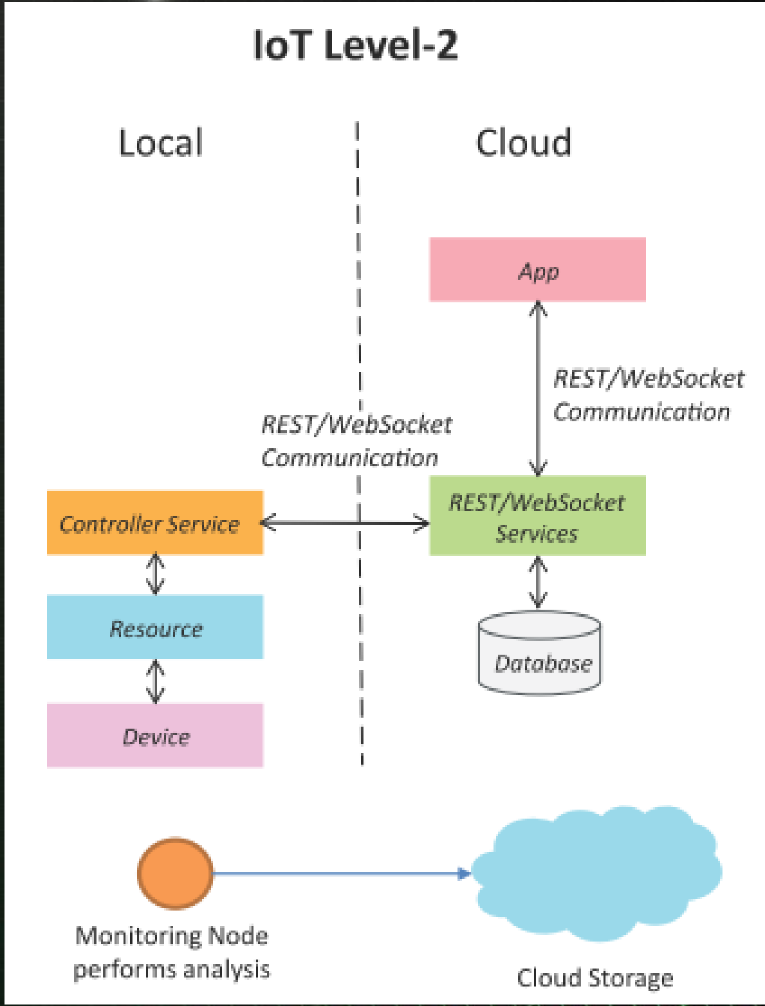


IoT Level-2

A level-2 IoT system has a **single node** that performs sensing and/or actuation and local analysis.

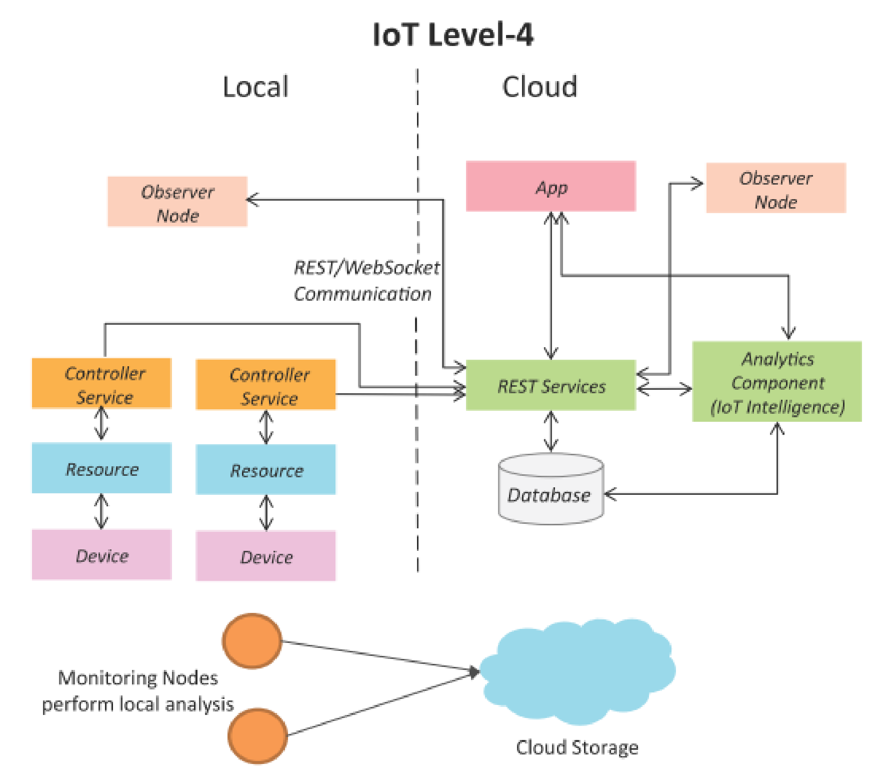
Data is stored in the **cloud** and the application is usually cloud-based.

Level-2 IoT systems are suitable for solutions where the **data involved is big**; however, the primary analysis requirement is not computationally intensive and can be done locally.



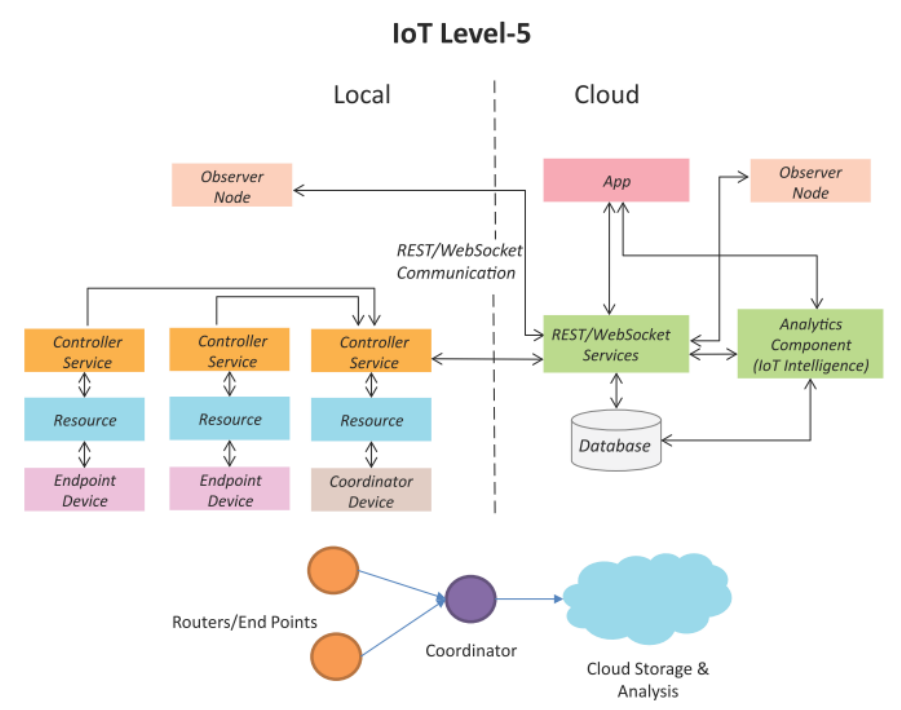
IoT Level-4

- A level-4 IoT system has **multiple nodes** that perform local analysis. Data is stored in the **cloud** and the application is cloud-based.
- Level-4 contains local and cloud-based **observer nodes** which can subscribe to and receive information collected in the cloud from IoT devices.
- Level-4 IoT systems are suitable for solutions where multiple nodes are required, the data involved is big and the analysis requirements are **computationally intensive**.



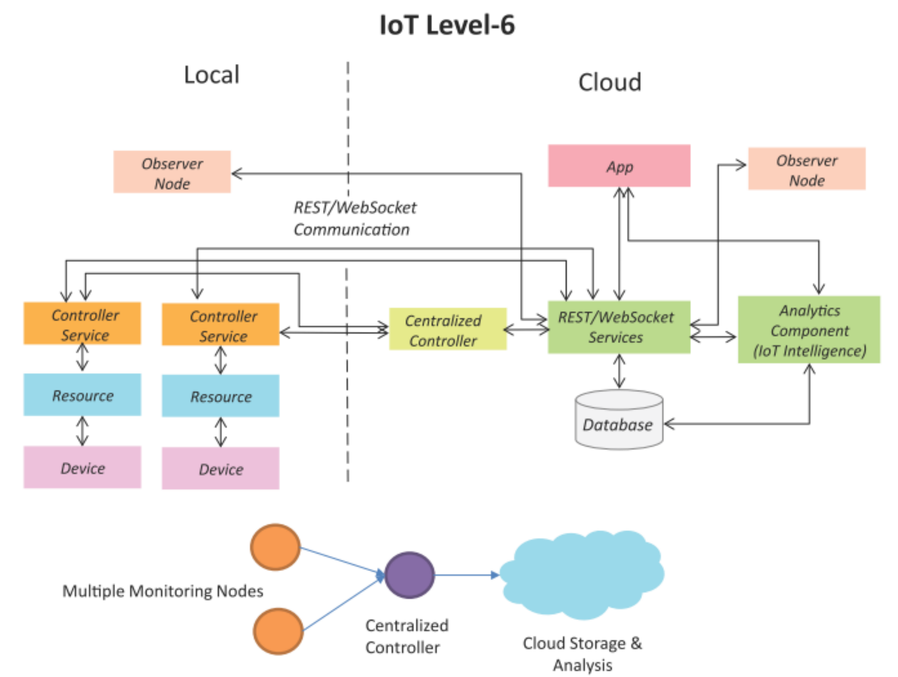
IoT Level-5

- A level-5 IoT system has **multiple end nodes** and **one coordinator node**.
- The end nodes perform sensing and/or actuation.
- The coordinator node collects data from the end nodes and sends it to the cloud.
- Data is stored and analyzed in the cloud and the application is cloud-based.
- Level-5 IoT systems are suitable for solutions based on **wireless sensor networks**, in which the data involved is big and the analysis requirements are computationally intensive.



IoT Level-6

- A level-6 IoT system has **multiple independent end nodes** that perform sensing and/or actuation and send data to the cloud.
- Data is stored in the cloud and the application is cloud-based.
- The analytics component analyzes the data and stores the results in the cloud database.
- The results are visualized with the cloud-based application.
- The **centralized controller** is **aware of the status of all the end nodes** and sends control commands to the nodes.



Kesimpulan

- IoT sebagai Enabler Industri 4.0 mendukung otomatisasi, konektivitas, integrasi sistem, dan pengambilan keputusan berbasis data.
- Peran Strategis IoT efisiensi produksi, prediksi kerusakan, penurunan biaya, integrasi dengan AI, cloud, dan keamanan siber.
- Aplikasi Nyata smart city, smart farming, smart home, smart industries, kesehatan, energi, transportasi, dan retail.
- Aspek Penting keamanan data, tata kelola, etika, dan peluang bisnis
- Arsitektur & Protokol IoT melibatkan sensor, perangkat, jaringan, cloud, aplikasi; protokol umum: HTTP, MQTT, CoAP, WebSocket.
- Model Komunikasi: request–response, publish–subscribe, exclusive pair, REST, dan WebSocket.
- Level Implementasi IoT mulai dari sistem sederhana (Level-1) hingga kompleks berbasis cloud & multi-node (Level-6).

Next Week…

WOKWi

World's most advanced ESP32 simulator

Discord Community LinkedIn Group Pricing

Simulate with Wokwi Online

Arduino (Uno, Mega, Nano)

ESP32

MQTT

Getting started

MQTT Specification

Software

Use Cases

FAQ

MQTT: The Standard for IoT Messaging

MQTT is an OASIS standard messaging protocol for the Internet of Things (IoT). It is designed as an extremely lightweight publish/subscribe messaging transport that is ideal for connecting remote devices with a small code footprint and minimal network bandwidth. MQTT today is used in a wide variety of industries, such as automotive, manufacturing, telecommunications, oil and gas, etc.

Getting started with MQTT

Standard 5mm LED.

Pin names

Name	Description
A	Anode (positive pin)
C	Cathode (negative pin)

Result	Attrs
	{ "value": "1" }
	{ "value": "220" }
	{ "value": "10000000" }

tkinter — Python interface to Tcl/Tk

Source code: Lib/tkinter/__init__.py

The `tkinter` package ("Tk interface") is the standard Python interface to the Tcl/Tk GUI toolkit. Both Tk and `tkinter` are available on most Unix platforms, including macOS, as well as on Windows systems.

Terimakasih