



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35

An Autonomous Institution

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Chennai



DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT213- IoT SYSTEM ARCHITECTURE

II ECE / IV SEMESTER

UNIT 5 – IOT APPLICATIONS

TOPIC 3 –Architectures for IoRT

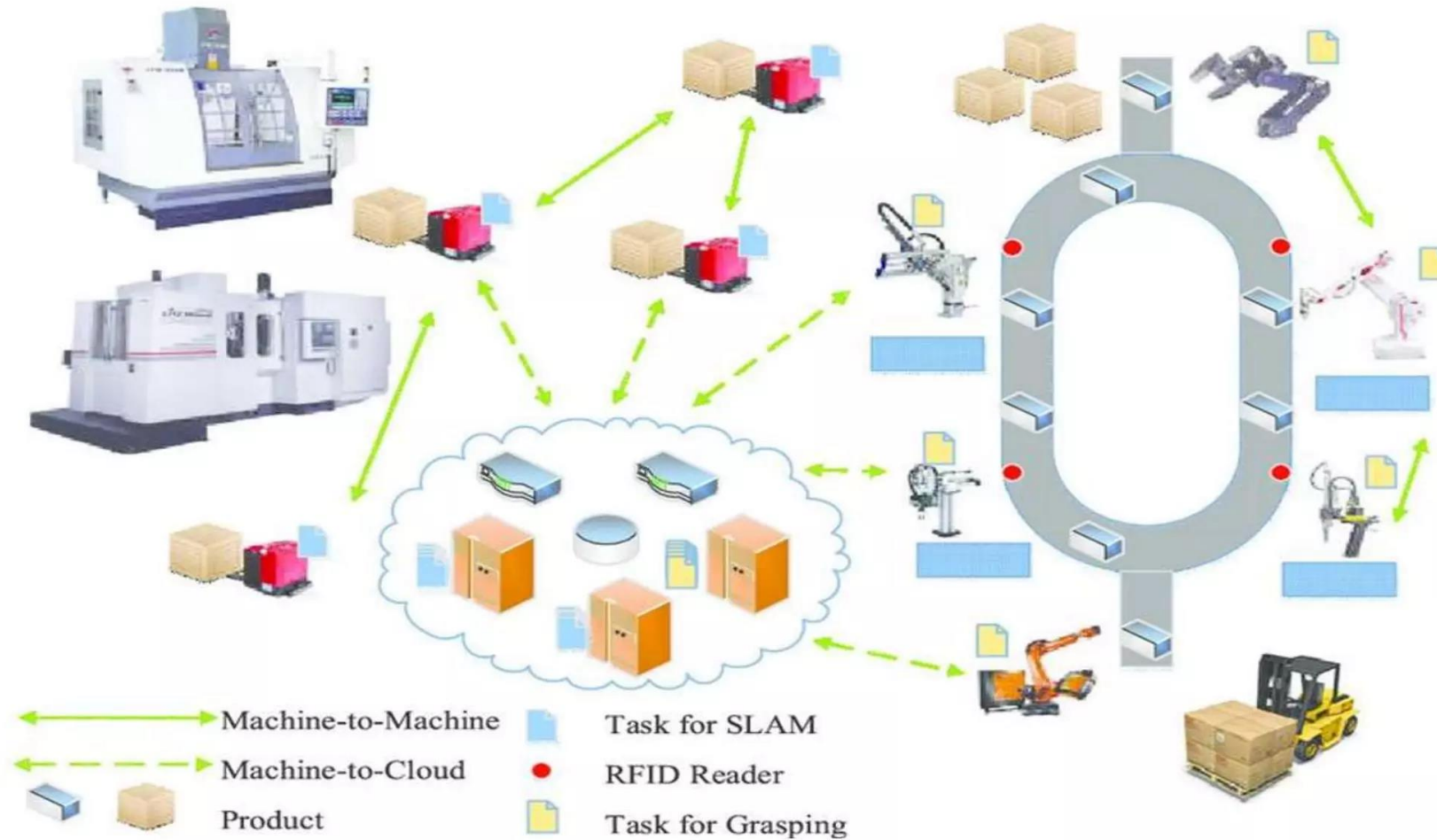


Internet of Robotic Things

- It is a mix of diverse technologies like Cloud Computing, Artificial Intelligence (AI), Machine Learning and Internet of Things (IoT).
- The term 'Internet of robotic things' itself was coined in a report of ABI research to denote a concept where sensor data from a variety of sources are fused, processed using local and distributed intelligence and used to control and manipulate objects in the physical world.



Internet of Robotic Things





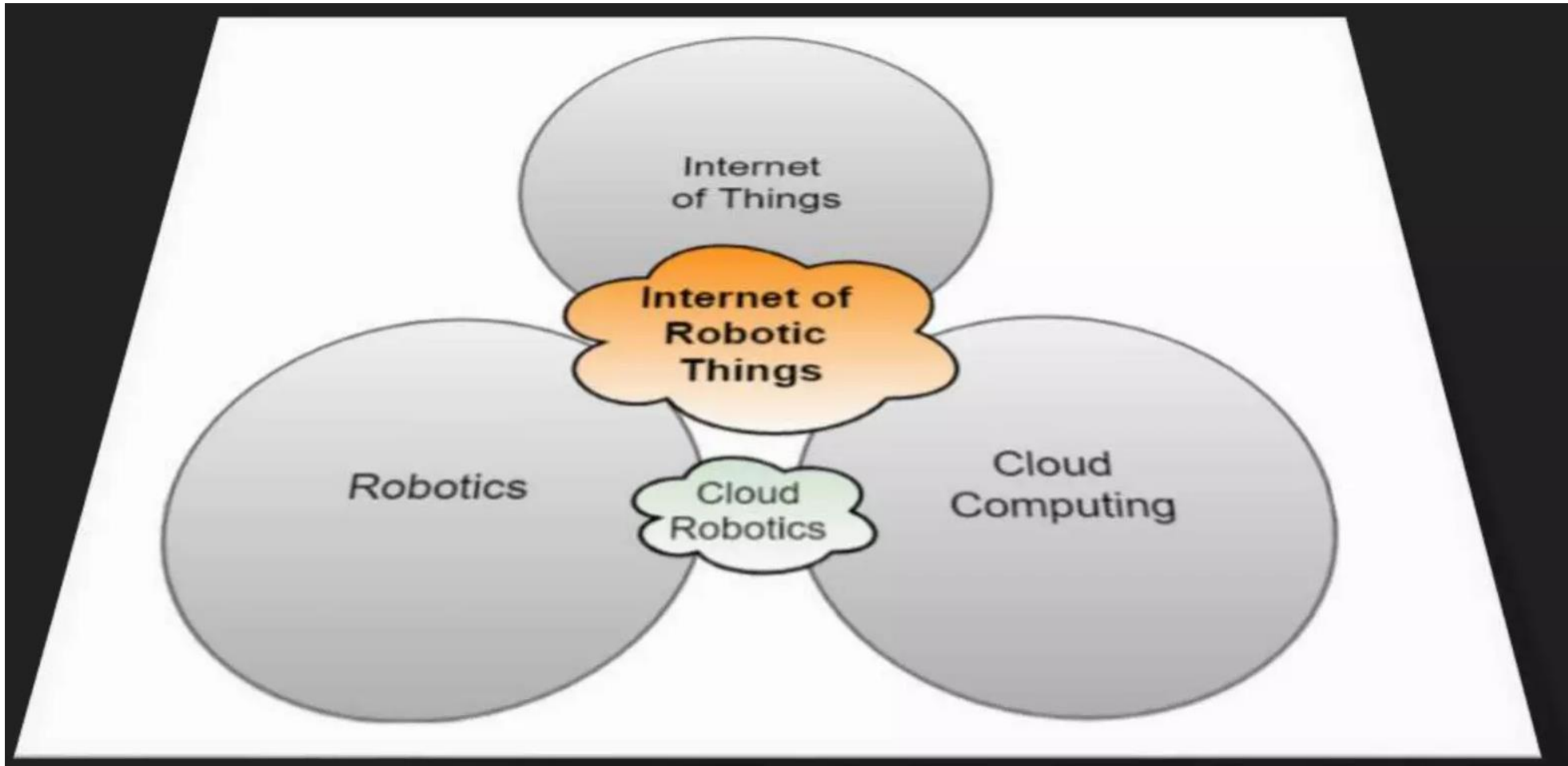
Internet of Robotic Things Concept



- Currently, most IoT initiatives are focused on using connected devices with simple, passive sensors to manage, monitor and optimize systems and their processes, usually as part of supply chain optimization efforts.
- The combination of advanced sensing, communication, local and distributed process, and actuation take the original vision for the IoT to a wholly different level, and one that opens up whole new classes of opportunities for IoT and robotics solution providers, as well as users of their products.



Internet of Robotic Things





IoRT Defined as



- Intelligent devices that can monitor events, fuse sensor data from a variety of sources, use local and distributed ‘intelligence’ to determine a best course of action. [?]
- Mostly, the brain of robots and control mechanisms are local i.e. Microcontrollers or Microprocessors attached on Robotic systems themselves.
- But in IoRT, the computation and control can be performed in the cloud.
- Internet acts as the primary medium for IoRT robotic systems to get connected to the cloud. With advancements in robot operating systems framework, there is no longer any complexity in communication.
- All the communication can be performed with just a simple call of the API (Application programming interface).



IoRT Technologies behind



- Communication Technology: Multiple radio access technology acts as a bridge to connect Intelligent devices at the edge and has given birth to heterogeneous mobile networks that require efficient configuration, management and regular update to cope up with next generation robotic things. [?]
- Artificial Intelligence (AI): With Artificial Intelligence techniques, IoT based robotic systems can be integrated with diverse IoT applications without any hiccup and create optimized solutions for complex problems in real-world. [?]
- Cognitive IoT Technologies: Cognitive IoT technologies will play a significant role in enhancing intelligence in systems to allow operational efficiency in all complex business operations and explore new business ventures.
- So, IoRT systems should be able to efficiently handle all complex situations and challenges in IoT environments.



The characteristics of IoRT systems



- Sensing: Sensing, being common functionality of IoT and robotic systems interact with other IoT devices and people to facilitate intelligent machine to machine and machine to human communication [?]
- Actuating: Actuating is regarded as taking necessary action considering all types of physical/virtual activities which is right now not available in IoT landscape.
- Actuating needs to look for a trusted, protected and secured development, deployment and operation of open multi-vendor.



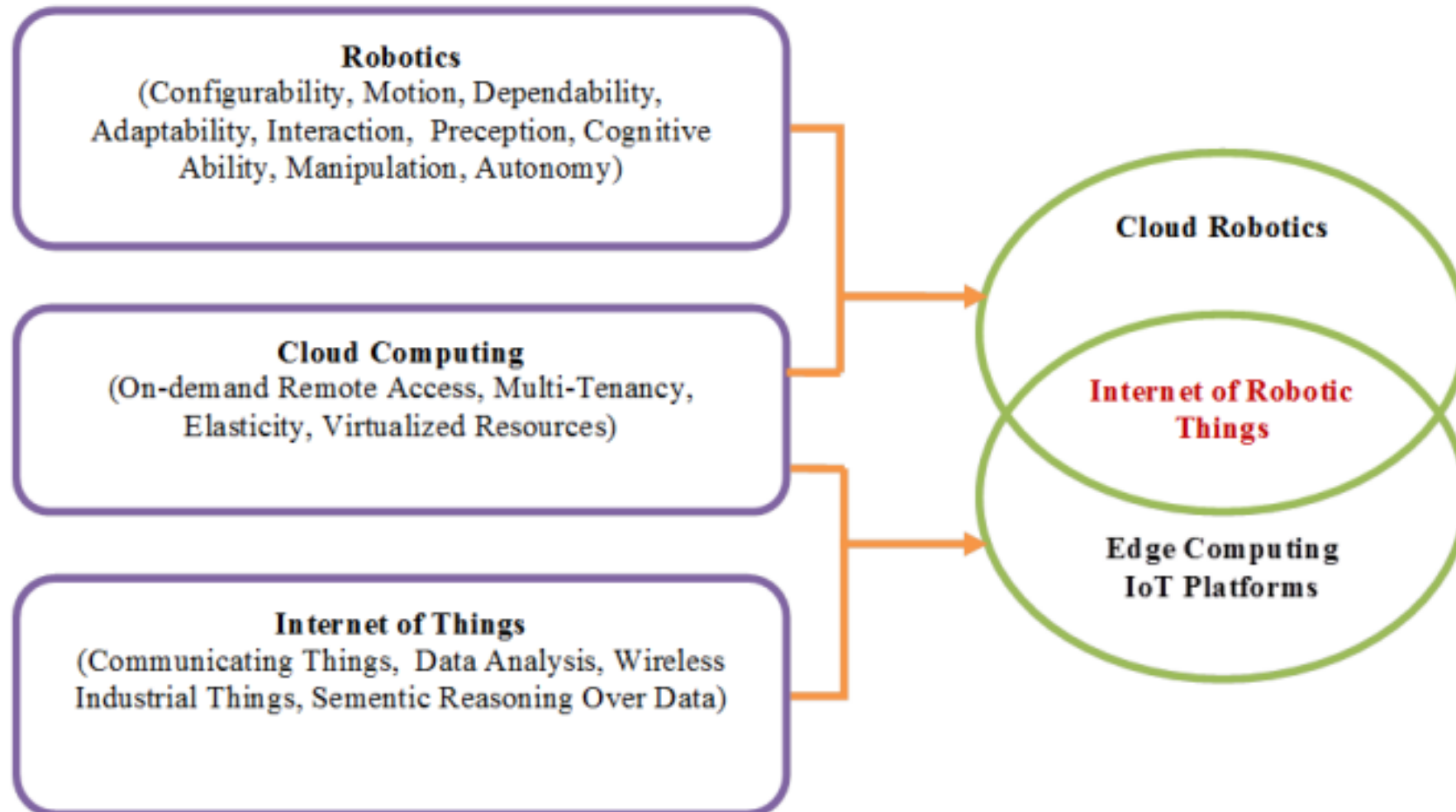
The characteristics of IoRT systems



- Control: With IoT, advanced control mechanisms can be provided to IoRT via Control Loops or Sequence of loops. Control loops can be easily mapped to almost anything from virtual objects to physical objects, from cloud to all sorts of networks giving IoRT more autonomic control. [?]
- Perception: With IoT, perception power of robotics can be highly enhanced. Perception, in terms of robotics, is regarded as sensor information combination with knowledge modelling to enable robotics to perform machine to human interaction using diverse areas like Software Engineering, Cloud Computing, Big Data, Machine Learning, Sensor Communications and Artificial Intelligence.
- With IoT, IoRT robots can become more intelligent towards sensing the real-time environment and carry out complex operations.

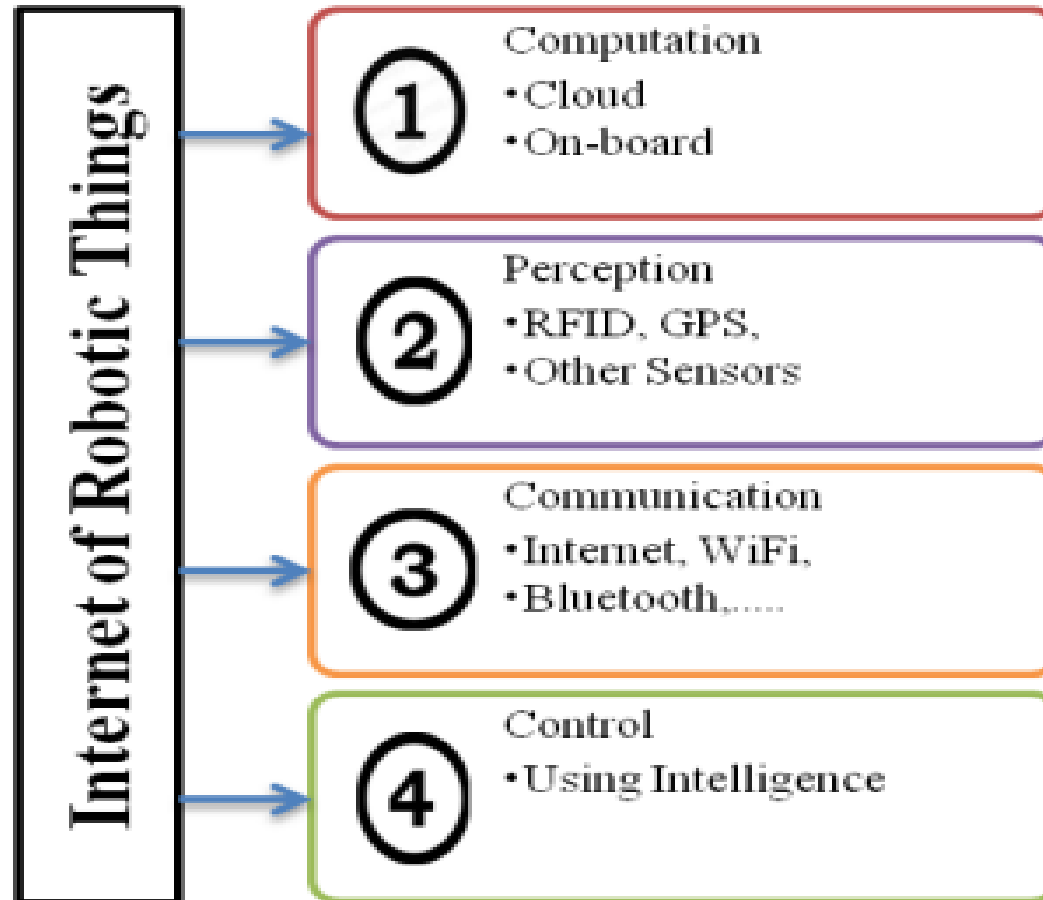


Concepts that merge to form IoRT





Components of the Internet of Robotic Things





Components of the Internet of Robotic Things



Components inside Internet Of Robotic Things:

1. Robots: Autonomous or semi-self sufficient machines that carry out duties in the physical global.
2. Sensors: Collect facts at the bodily international, enabling robots to understand and understand their surroundings.
3. Connectivity: Wireless or pressured communique protocols for robots to speak with every different and different gadgets over the internet.
- 4 . Cloud Computing: Provides infrastructure and assets for storing, processing, and reading robotic statistics.
5. Data Analytics and AI: Analyzes records to allow robots to make clever picks, examine, and adapt.
6. Human-Machine Interfaces: Interfaces for human beings to have interaction with robots, collectively with GUIs, voice interfaces, AR/VR interfaces.
7. Security and Privacy Measures: Measures to shield closer to unauthorized get admission to, facts breaches, and misuse of robotic facts.
8. Standards and Protocols: Established requirements and protocols for interoperability and conversation among precise robot systems.

IoRT being a mixture of every has quite a few these components in it with higher integration and big abilities.



The IoRT architecture



- It requires additional components and layers to address all sorts of challenges with regard to connectivity, sensing, security, controlling and link to cloud services, data analytics and other API's.
- The IoRT architecture will facilitate robotics to operate in smart environment with high precision performance to perform anything



The IoRT architecture



IoRT Architecture Consists Of Mainly Three Layers.

So, These Layers Are:

1. Physical Layer Which Consists Of:

- Robots
- Sensors
- Actuators

2. Network And Control Which Consists Of:

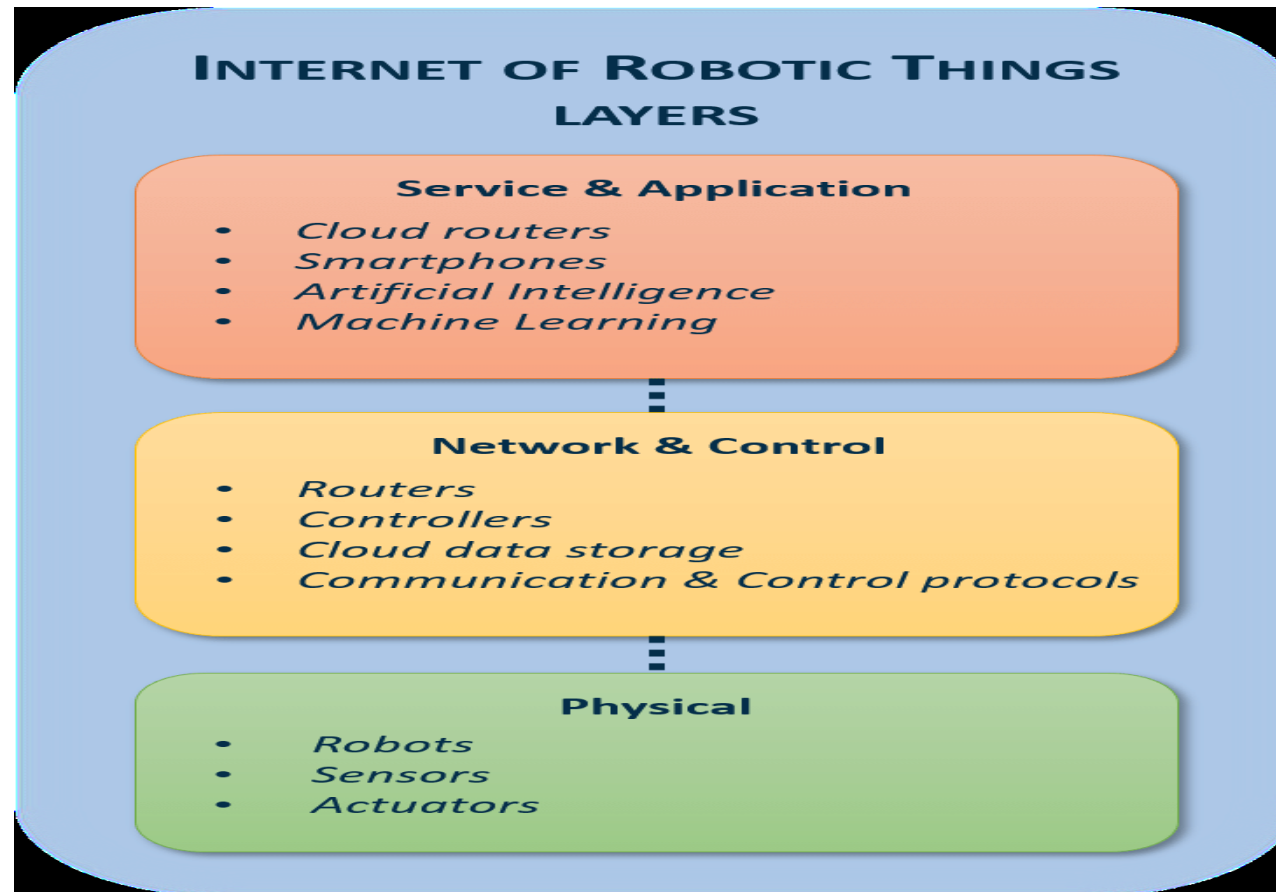
- Routers
- Controllers
- Cloud Data Storage
- Communication And Control Protocols

3. Services And Applications Which Consists Of:

- Cloud Routers
- Smartphones
- Artificial Intelligence
- Machine Learning
-



The IoRT architecture





The IoRT architecture



1. Physical Layer

- Physical Layer Is Basically The Lowest Level Of The Architecture Of The Internet Of Robotic Things.
- This Level Includes Robots, Sensors, And Actuators.
- Thus, **Robots** Means Drones Or Unmanned Vehicles. Sensors And Actuators Are The Systems Which Help Robots To Do Tasks In A Real-Time Environment.
- Sensors And Actuators On Combining With Robots Leads To Better Optimization, Monitoring, Navigation, Calibration And Tuning.



The IoRT architecture



2. Network And Control

- Network And Control Is The Second Layer Of The Architecture Of The Internet Of Robotic Things.
- Therefore, This Level Consists Of Controllers, Routers, Servers And A Large Number Of Communication And Control Protocols.
- Some Of The Communication Techniques Used In IoRT Are IPv4, IPv6, 6LoWPAN And Also Near Field Communication (NFC).
- These Communication Techniques Are Used To Achieve Effortless Transmission Of Information In Robotic Systems.



The IoRT architecture



3. Services And Application

- Services And Application Is The Third Layer Of The Architecture Of The Internet Of Robotic Things.
- This Level Consists Of Cloud Routers, Smartphones, Artificial Intelligence And Machine Learning.
- This Layer Helps In Implementing Programs To Control, Process And Examine Various Parameters Related To Robots, Sensors And Actuators In Real-Time Environment.
- Artificial Intelligence And Machine Learning Ensures A Smooth Combination Of Robots And IoT Applications.
- This Smooth Combination Helps The Robotic Machines In Solving Complex Tasks And Situations In The Physical Environment.

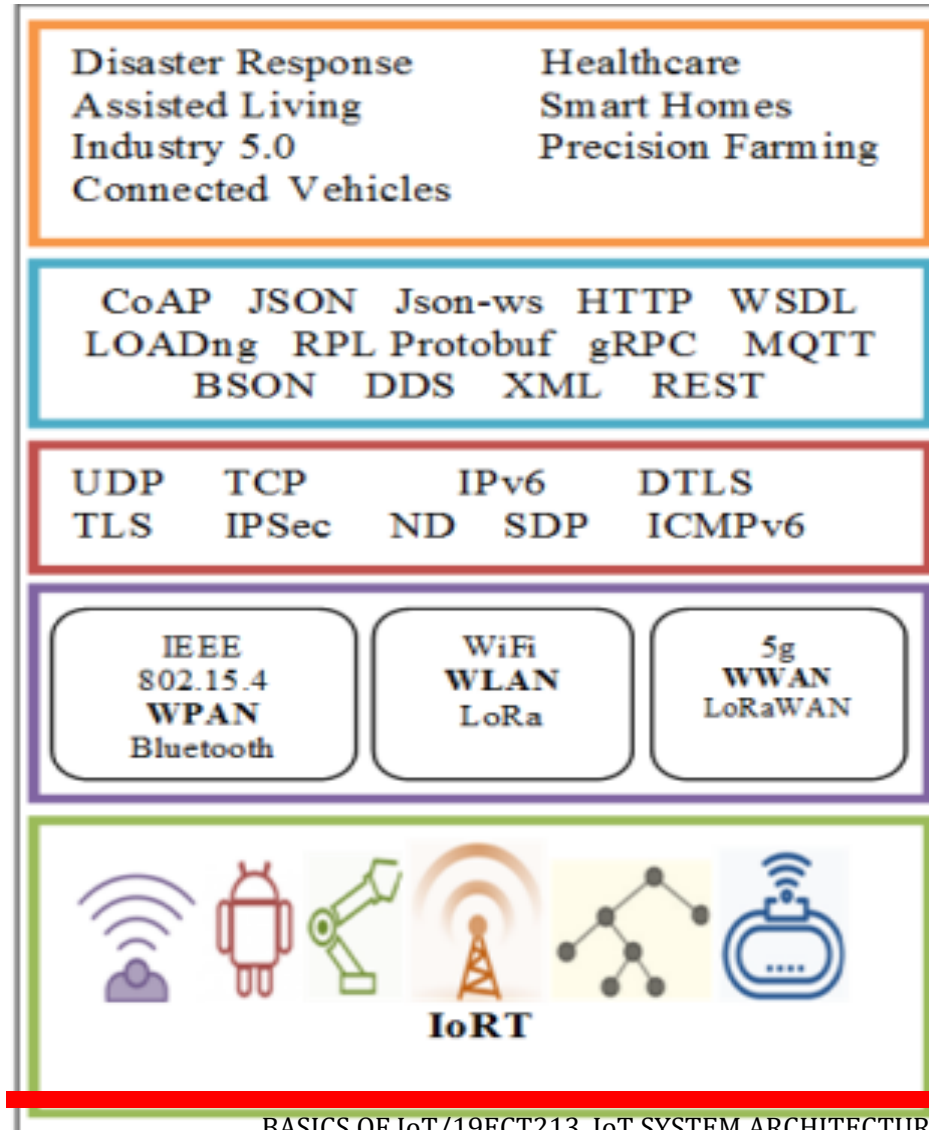


IoRT DATA EXCHANGE : AN OUTLINE

| S.No. | Capability | Description |
|-------|--------------|---|
| 1 | Sensing | The Robots use their ability to sense to know about their surroundings. They sense the environment by employing their sensing technology using sensors embedded within them. |
| 2 | Intelligence | The information captured by Robots is processed by using their sensing technology to produce outputs for control, decision making, and coordination. |
| 3 | Motion | The instructions produced in real-time or the pre-programmed instructions are followed by Robots automatically based on sensor input to carry out controlled, iterative, and premeditated mechatronic acts which include point-to-point mobility. |

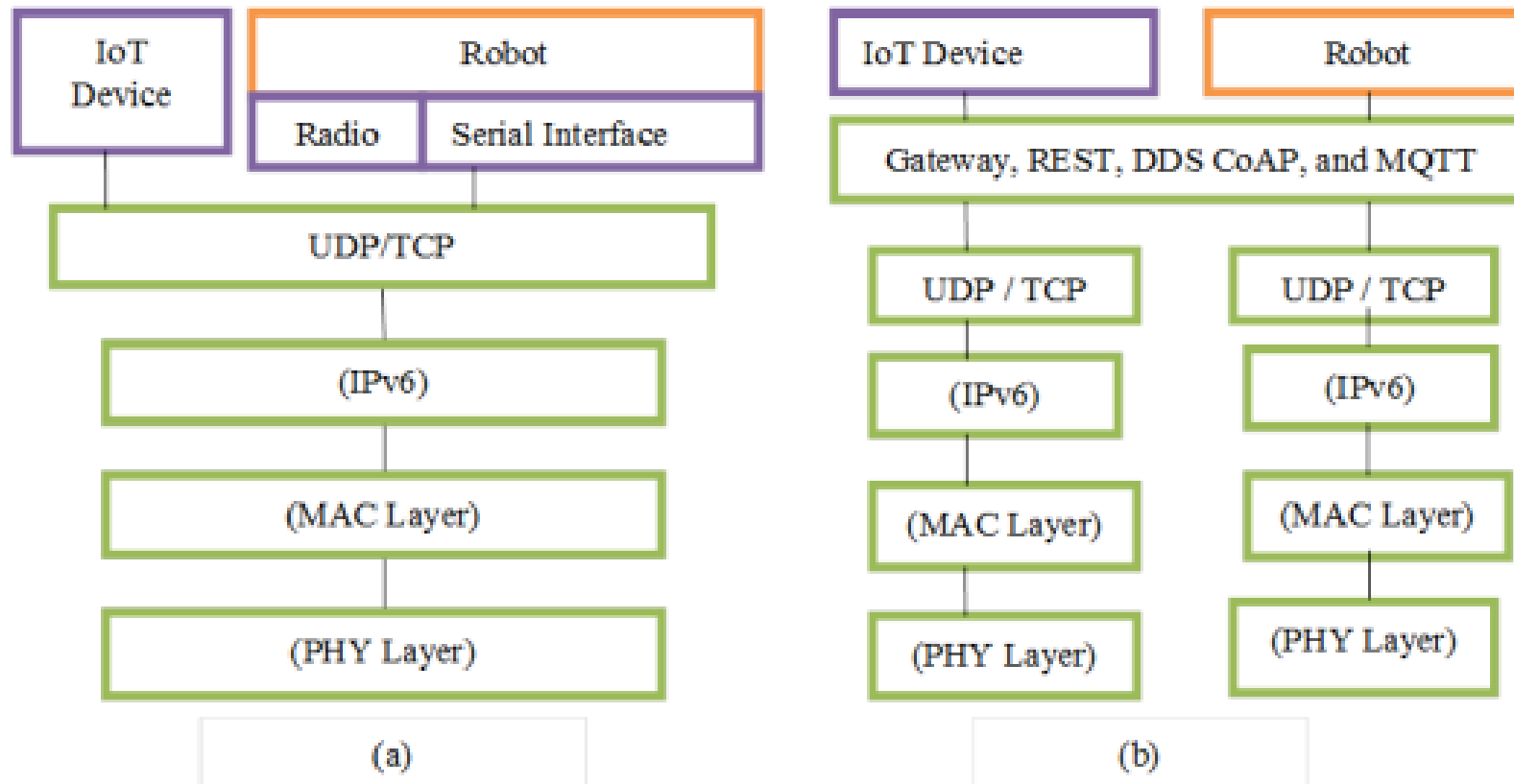


IoRT's communication architecture





IoRT's communication architecture



. (a) Robot acting like a node and (b) Robot acting like a client in IoT.