



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35

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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

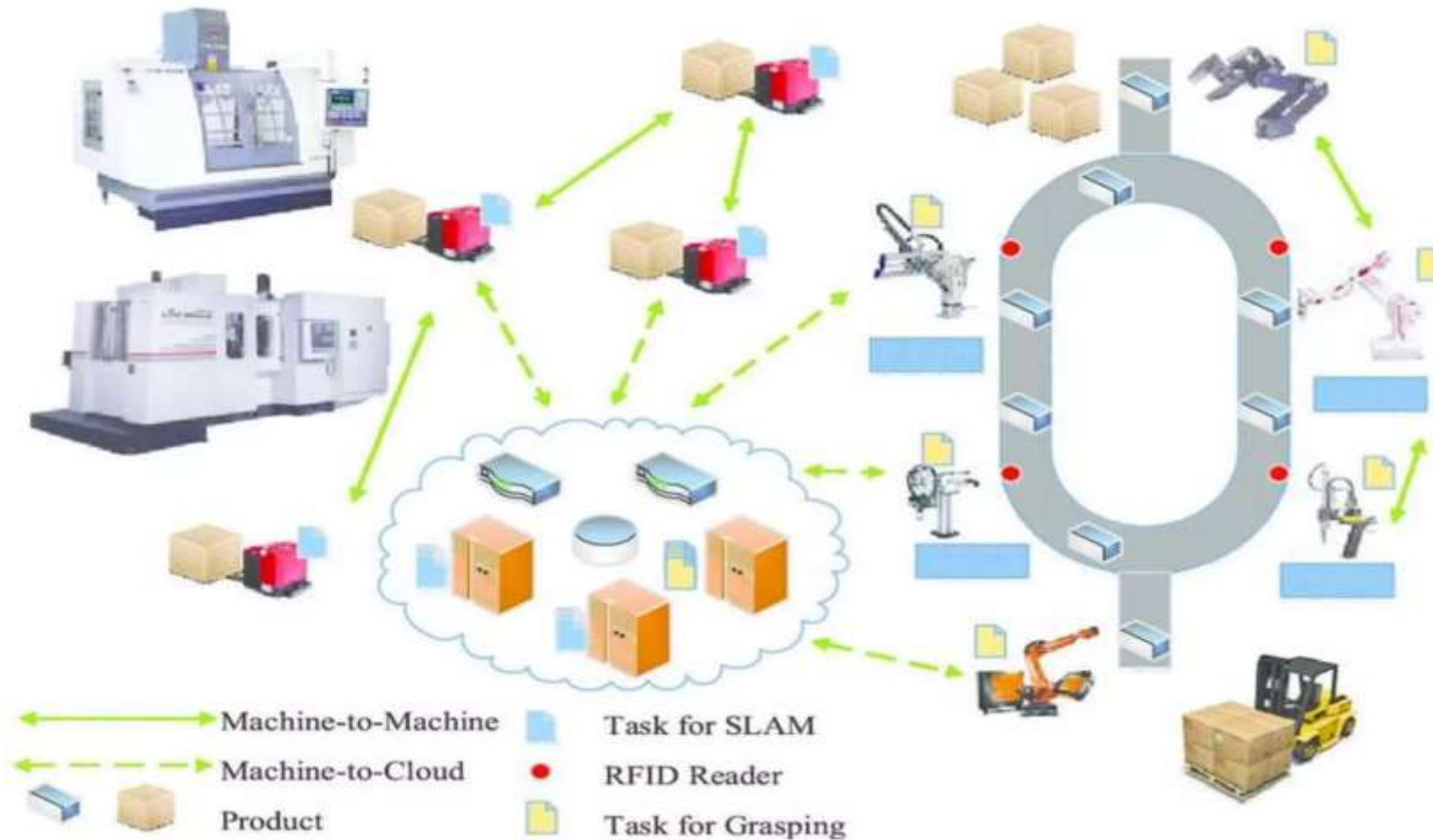


Internet of Robotic Things

- 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



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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.



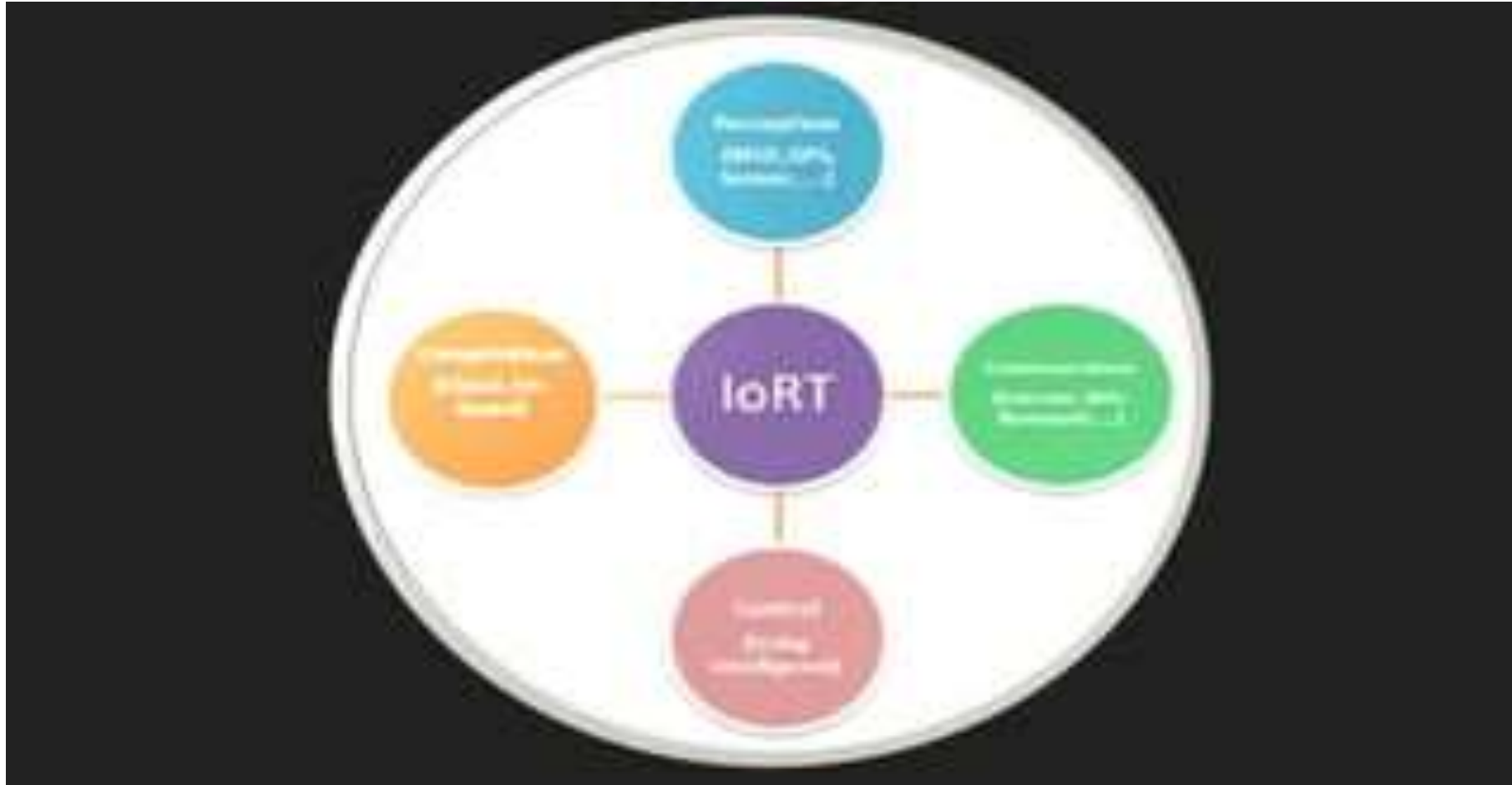
The characteristics of IoRT systems



- 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.



Internet of Robotic Things





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

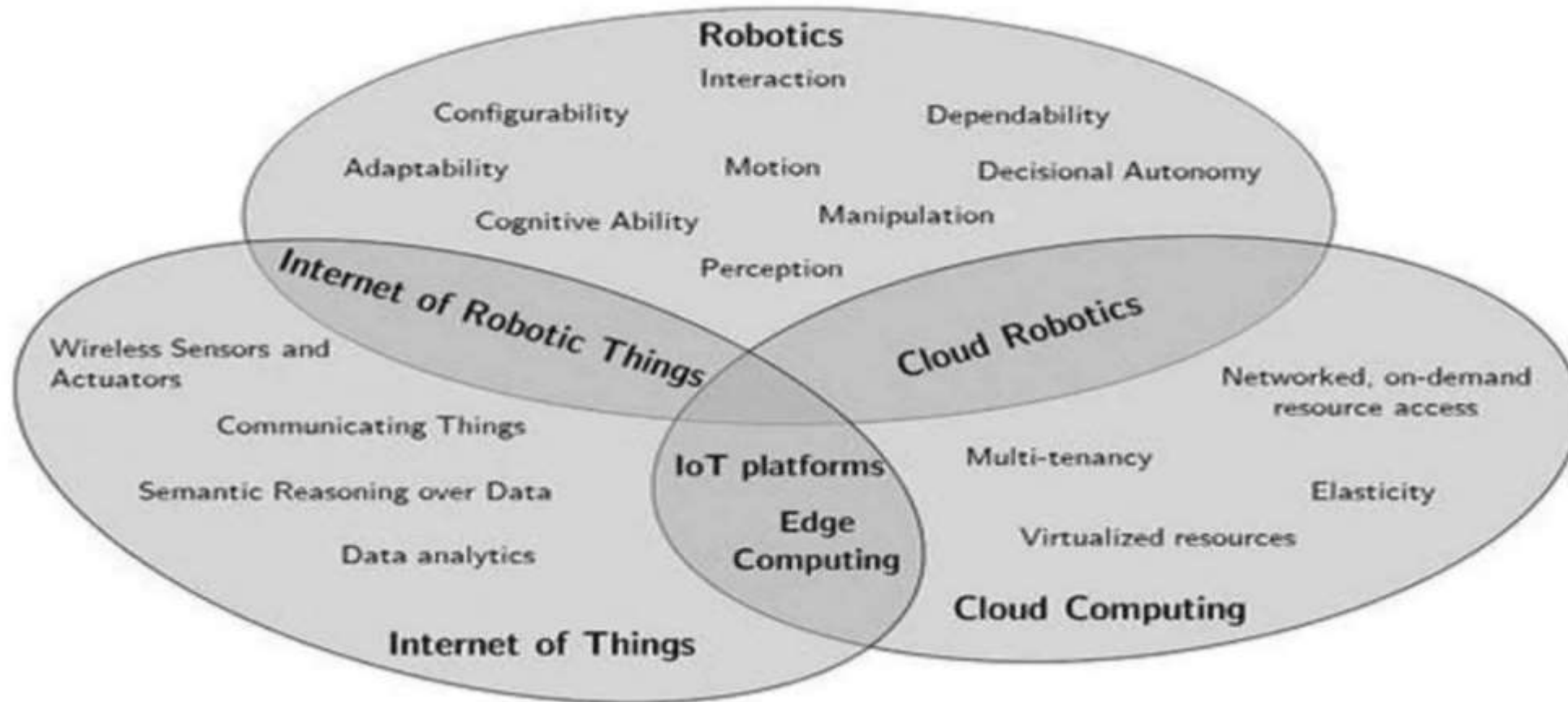


The IoRT architecture

- Hardware Layer (“Robotic Things” layer)
- Network Connectivity [?]
- Internet Connectivity /IoT protocols
- Robotic Platform Support [?]
- M2M2A Cloud Platform Support [?]
- Big Data Services [?]
- IoT Business Cloud Services [?]
- Application Layer



The IoRT architecture





The IoRT architecture

- **Hardware Layer:** Hardware Layer or Robotic Things layer is the bottom most layer in IoRT architecture. This layer consists of different types of things like vehicles, robots, Home Appliances, Health Care equipment's, Mobile Phones.
- **Network Connectivity:** To enable connectivity between sensors and robots and even to facilitate machine to machine communication.
- **Internet Connectivity:** To facilitate connectivity of devices and access to information anywhere and everywhere, Internet connectivity is the only option. Considering the architecture of IoRT, Internet connectivity is regarded as the heart to facilitate all sorts of communication.
- **Robotic Platform Support:** Robotic platforms are highly utilized by researchers to design robots with basic software capabilities to perform experimental works.

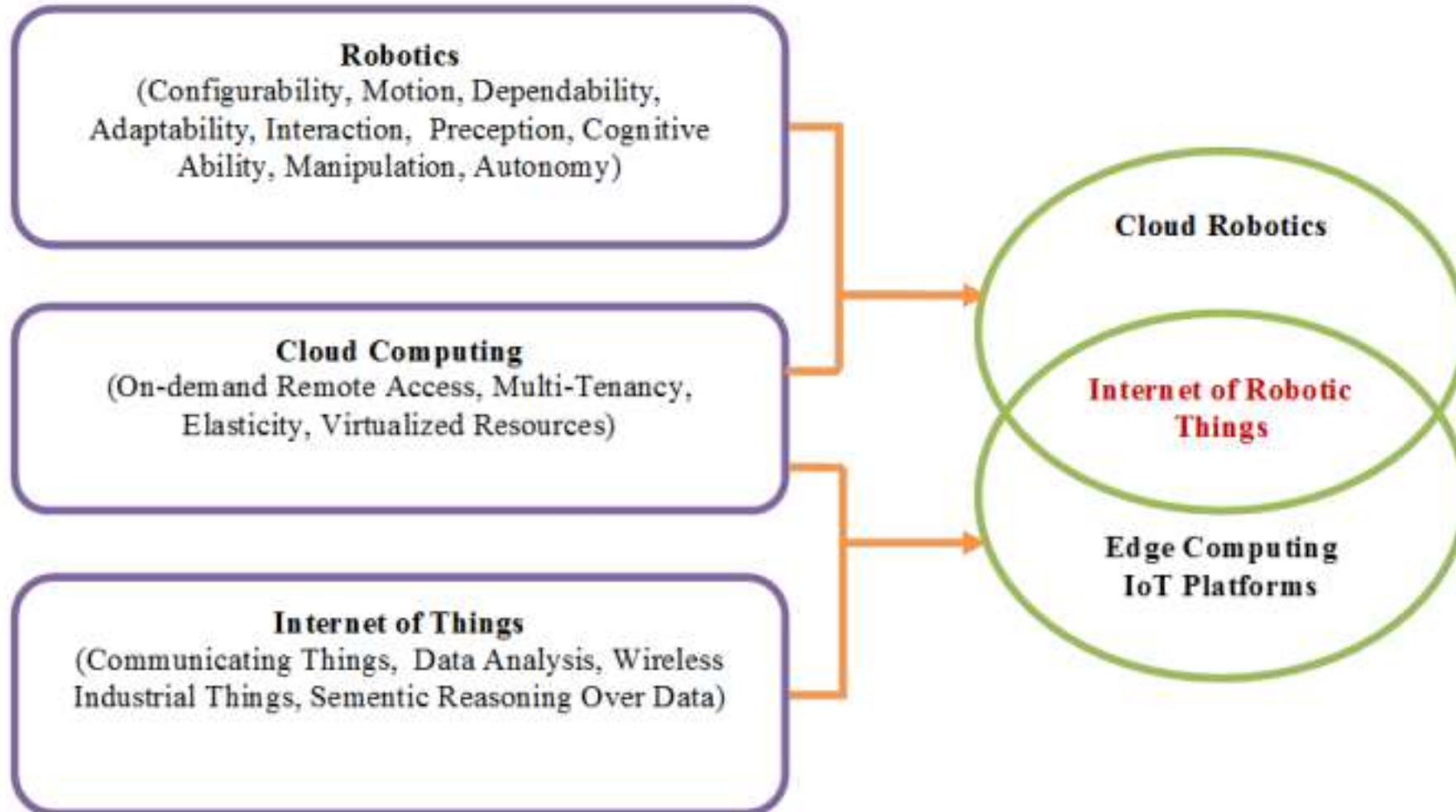


The IoRT architecture

- **M2M2A Cloud Platform Support:** Machine to Machine and Machine to Actuator lays a strong foundation for design and development of advanced robotic systems i.e. IoRT. It is regarded as a collection of information between different machines operating in the network without any support from humans. This component in architecture performs several tasks like: Data Acquiring, Data Analysis, User Data Management and even sensor data management.
- **Big Data Services:** Big Data provides highly value-added services in terms of optimizing, analyzing, prediction, statistical findings etc.
- **IoT Business Cloud Services:** This component is designed to include only service IoT and Cloud assist IoRT to perform various services like Image Manipulation & Correction, Object Recognition, Voice Recognition, Map Navigation etc
- **Application Layer:** Application layer is regarded as the top layer of IoRT Architecture. Robotics when combined with IoT, Cloud can be utilized in various application areas like Business Organizations, Research and Development Centers, Data Centers, etc.

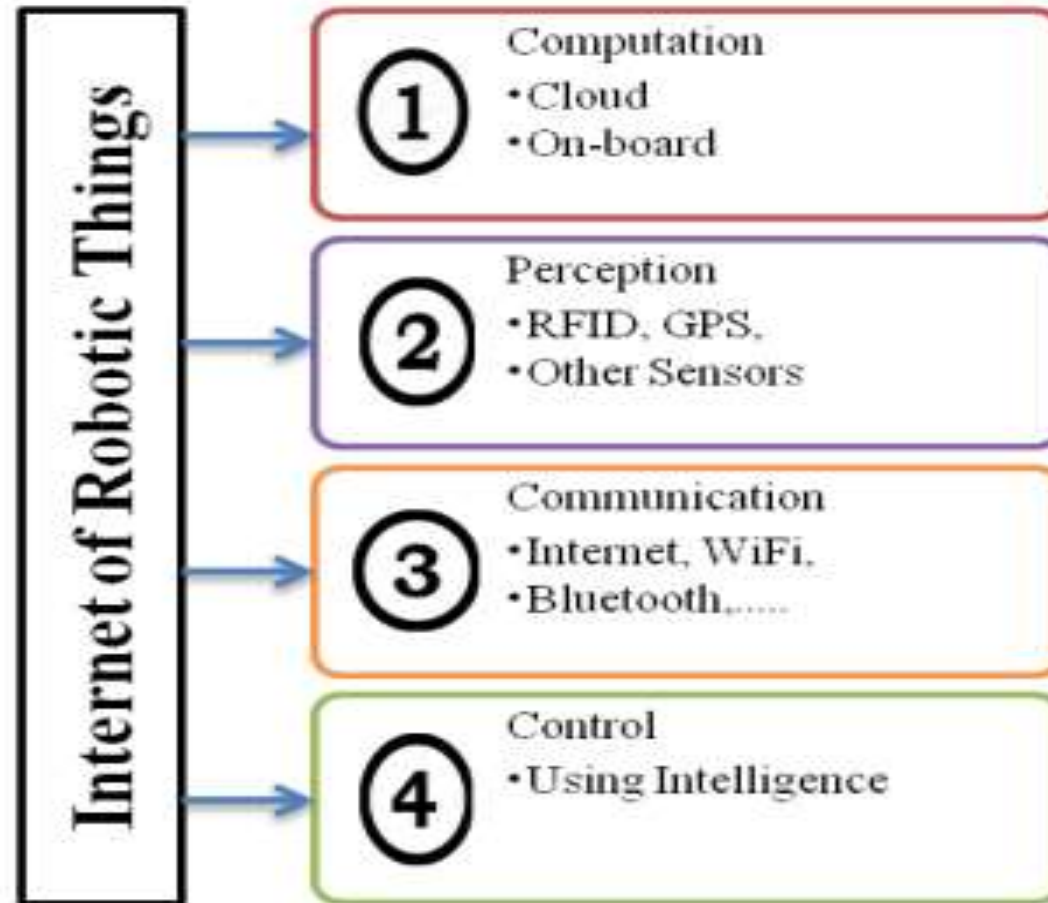


Concepts that merge to form IoRT





Components of the Internet of Robotic Things



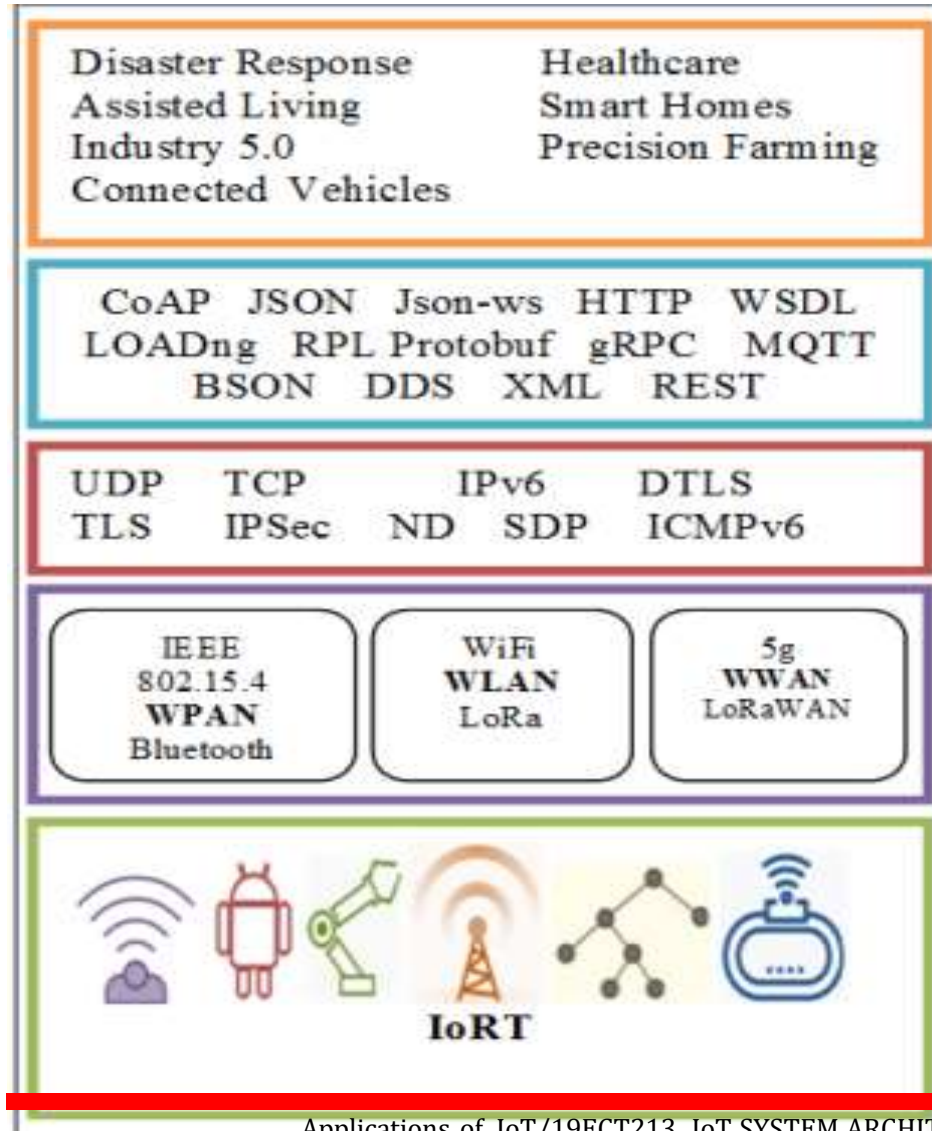


IoRT DATA EXCHANGE : AN OUTLINE

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.

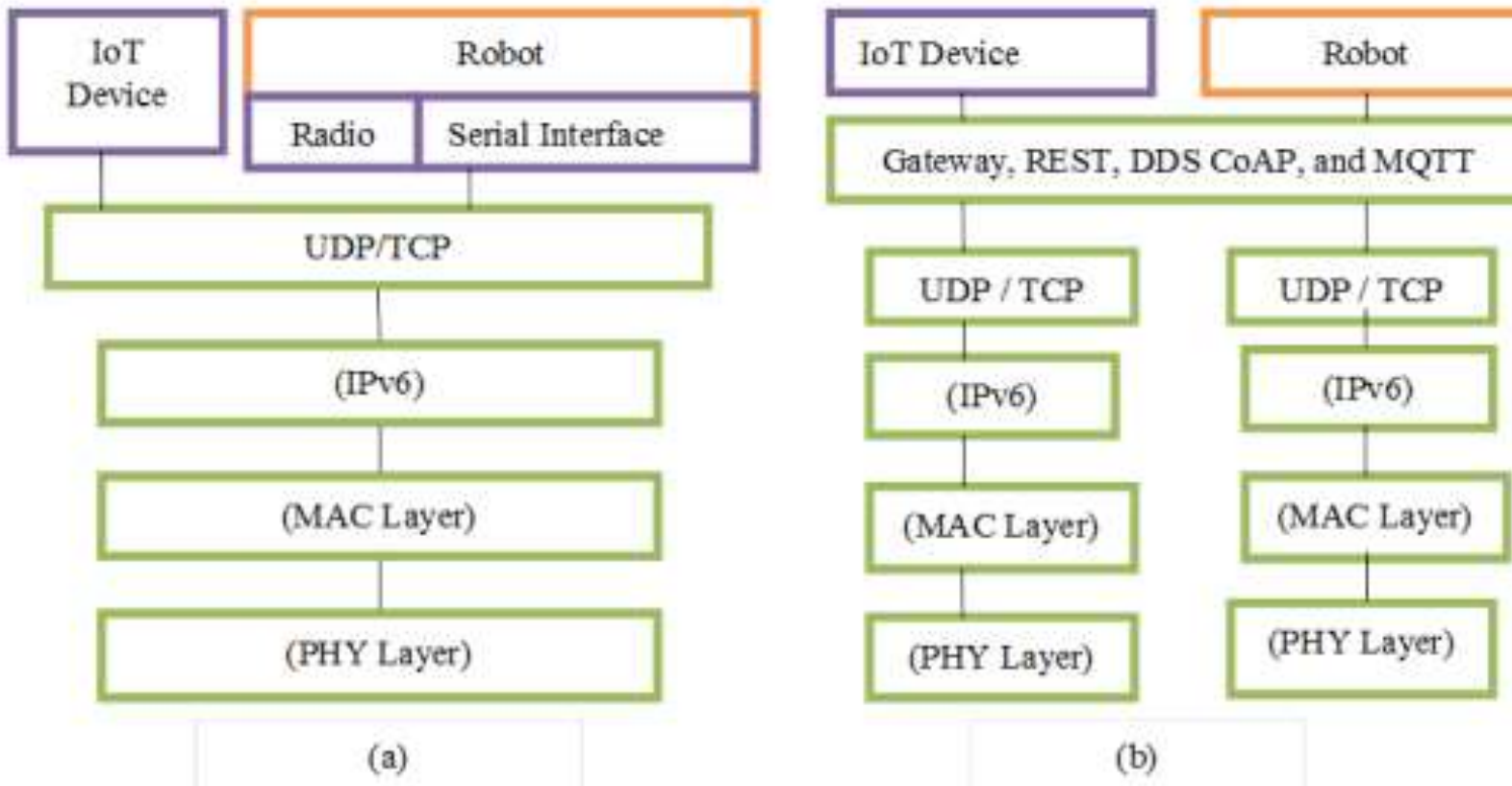


IoRT's communication architecture





IoRT's communication architecture



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