Report on

Industrial Visit

at

TCS, Innovation Lab, Kolkata

Organized by

ECE Department,

Narula Institute of Technology

22nd January, 2015

One Industrial visit to the TCS, Innovation Lab, Kolkata was held on 22nd January, 2015. A group of 13 people from ECE Department including Faculty members, Technical Assistants and M. Tech Students of ECE, Narula Institute of Technology visited the TCS, Innovation Lab, Kolkata. During the visit the M. Tech students were benefitted by the information they have gathered from the Research scholars of TCS. By this visit the technical knowledge on the fields of signal processing and communication enhanced different research aspects to the students. Mr. Sanjay Kumar Das, CTO Innovation Lab, Kolkata guided us and introduced some of the Research associates of TCS to us. He was all through with us and described different aspects of research at TCS very nicely. Regarding the Innovation Lab we quote as per the TCS "We help you achieve and maintain a competitive advantage through our TCS Innovation Labs and Co-innovation Network. We offer research-based solutions in advanced technologies that help support your business objectives."

The global network of Innovation Labs provides an environment for sophisticated IT research in leading-edge technologies, as well as in various domains. In collaboration with technology partners and universities, they are researching key emerging trends, including mobility, cloud computing, business analytics and social networking to develop new, practical, powerful applications and to deliver strong business results. Innovation offerings

address the IT expectations, support the business objectives and social concerns: Innovation Themes and some samples of their offerings:

- **Analyse** – Understand customers and markets: SaaS platforms, Agile enterprise architecture, Decision Support Systems
- **Digitise** – Deliver digital experience: Virtualization, Cloud Computing, Managed Evolution of Infrastructure
- **Optimize** – Elevate business performance: Smart Cards, Copyright protection offerings, Surface Computing, Unified Communications and Multimedia Gateway solutions
- **De-risk** – Safeguard the enterprise: Content Management Systems Offerings and Enterprise Social Networking
- **Sustain**- Build sustainable enterprises and community: Knowledge Portals and Mobile Based Advisory systems, Life Sciences and Green IT solutions and consulting

Research areas which were discussed with us - Cyber physical systems, Human systems, TCUP and Internet of Things.

I. Cyber physical systems includes:

IoT platform enhancements: Lightweight protocols, distributed computing, privacy and security of IoT platform, and stream reasoning and processing support in IoT platform.

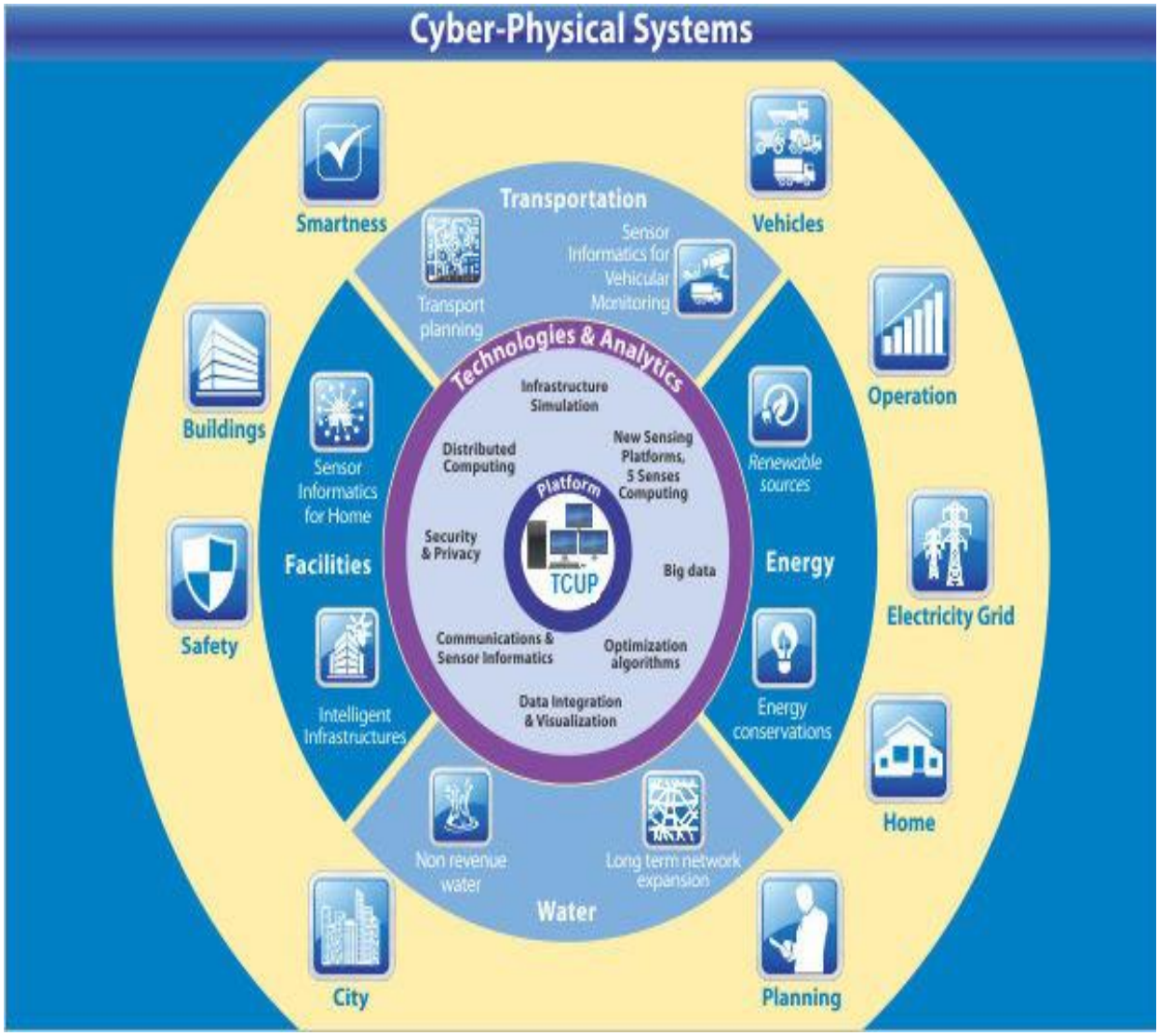
Intelligent facilities: Model-driven energy consumption optimization for buildings, sensor-driven emergency evacuation planning for buildings.

New sensing platforms (5 senses computing): 3D reconstruction from un-calibrated 2D images from mobile phones.

Computing systems are being increasingly used to gather data from physical infrastructure related to individuals, enterprise and communities; and to make such infrastructure intelligent through powerful analytics of the data. Sensors, wireless connectivity and robotics are the new technologies coming into the computing systems fabric in order to enable computers interface with physical infrastructure and human beings.

The Cyber-Physical Systems research group in TCS mainly focuses on making the physical infrastructure for buildings, transportation, energy, water and healthcare “Intelligent” through smart adoption of technologies related to “Internet of Things”. TCS has an “Internet-of-Things” service platform called TCUP (TCS Connected Universe Platform) to efficiently develop and deploy “Intelligent Infrastructure” applications. TCUP is backed by strong research in the areas of Communication, Sensor Informatics, Data integration and Visualization, Optimization & Prediction, Infrastructure Simulation, Big Data, Distributed Computing and Security/Privacy.

The complete research landscape is depicted in the figure.



The projects undertaken in this sub-area are:

- Sensor Informatics for Vehicular Monitoring
- IoT Platform Services (Secure M2M)
- Intelligent Facilities
- UAV Based sensing and monitoring of Infrastructures
- Building Energy Management
- Renewable sources & Energy conservations - Wind Energy
- Smart Water Network
- Large Scale Infrastructure Simulation
- IoT Platform Enhancements (Lightweight Protocols and Distributed Computing)
- 5 Senses Computing (Un-calibrated 3D reconstruction from 2D images)

II. Human systems includes:

Intelligent health care through unobtrusive sensing: Elderly people and people with chronic disease monitoring at home using mobile phone based localization, proximity sensing and activity detection; mobile phone based physiological sensing; Kinect-based people identification, and activity detection and social network mining.

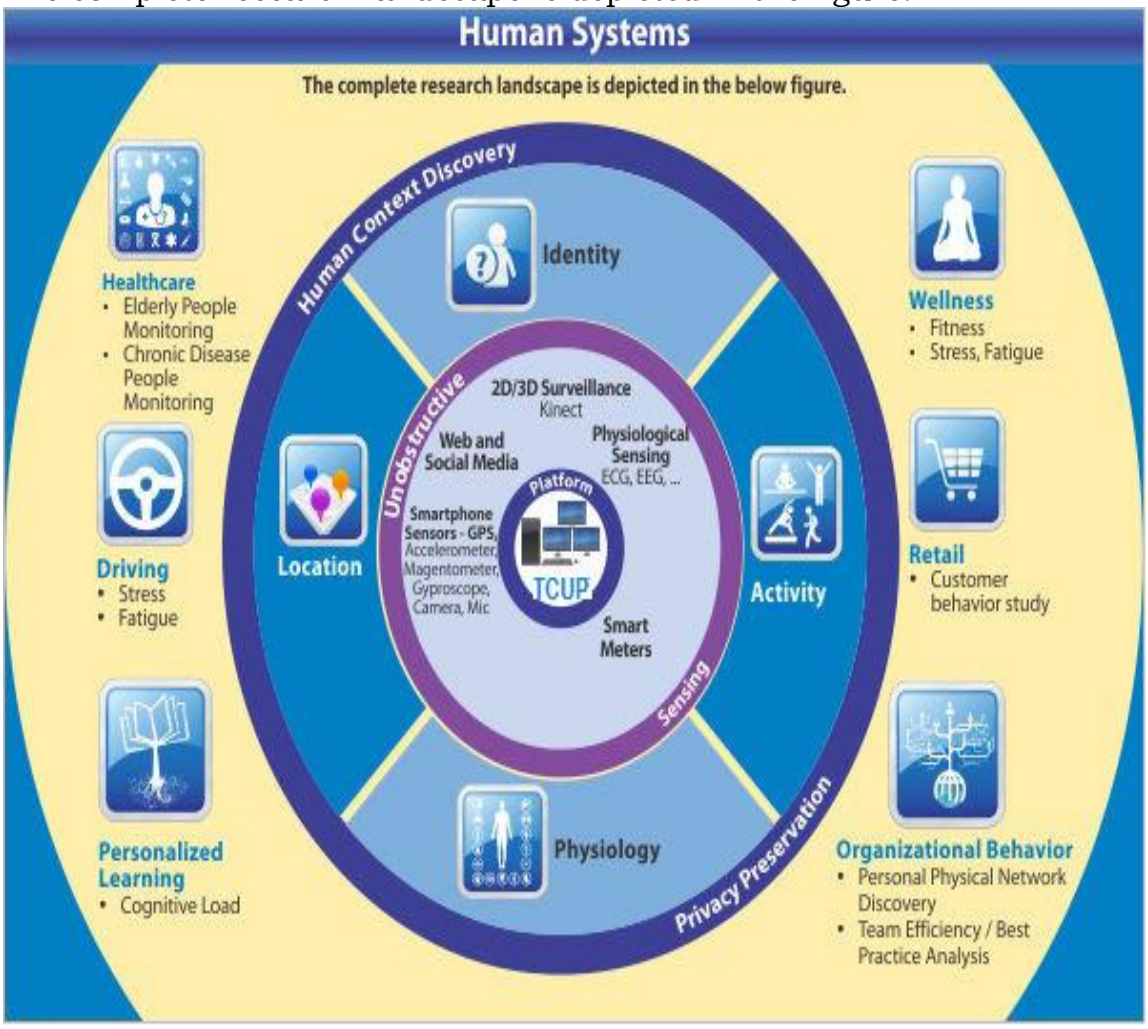
Bio sensing for cognitive load: EEG-based cognitive load detection.

The human systems research group mainly focuses on discovering physical and social context of human beings through exploration and sensing of sociological, physiological and psychological information.

Specific research areas include: Human Context Discovery through unobtrusive sensing of Location, Identity, Activity and Physiology, Sensing Platforms Smartphone sensors (Accelerometer, Magnetometer, Gyroscope, GPS, Microphone, Camera) 3D cameras like Kinect, ECG / EEG, Electrical Meters, Web and Social Media.

The projects undertaken in this sub-area are: Bio sensing for Safety and Wellness at Workplace, Intelligent Healthcare/Wellness through unobtrusive sensing, Bio sensing for Cognitive Load.

The complete research landscape is depicted in the figure.



The group is headed by:

- Dr. Balamuralidhar P
- Dr. Pal, Arpan
- Dr. Vin, Harrick

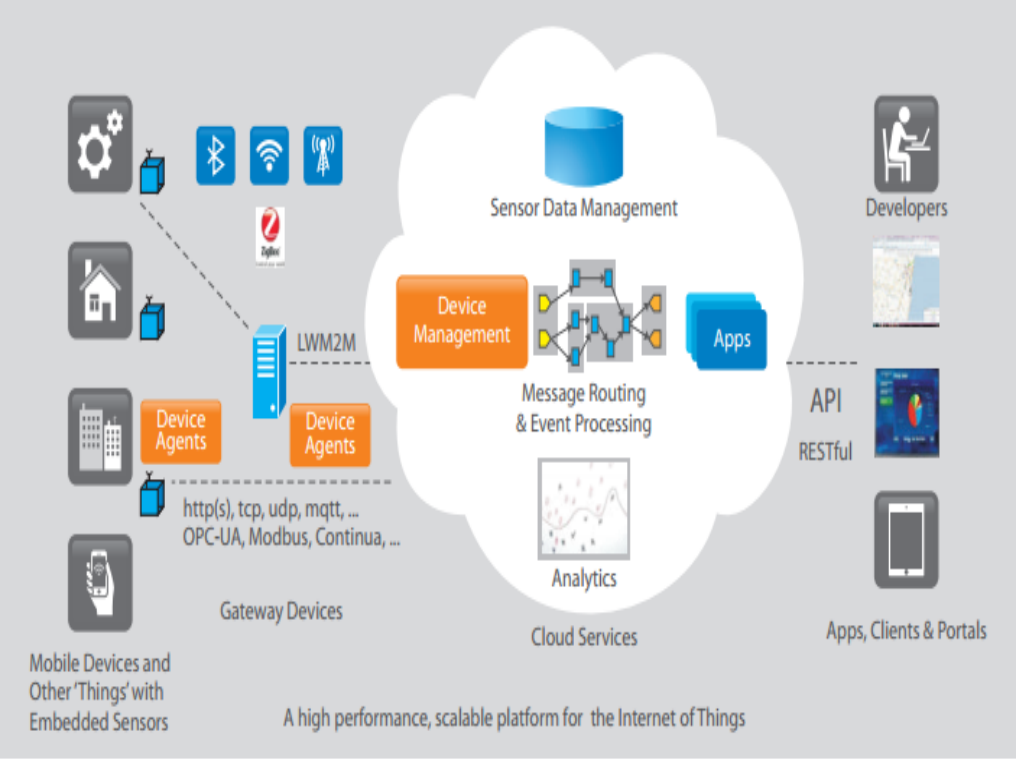
III. TCUP

TCUP is Platform-as-a-Service (PaaS) cloud computing platform that allows quick and easy development, deployment and administration of sensor driven applications. TCUP provides sensor device management, data acquisition, data storage and analytics services. These services are made available to application developers in form of APIs and SDKs. TCUP aims to provide a highly scalable platform for sensor integration, sensor data storage, analytics (including real-time and Big Data processing), rich query capabilities (including geo-spatial queries and continuous queries) and visualization.

At the core of TCUP is Sensor Web Enablement (SWE) services – a set of services related to sensor description, discovery, integration, sensor observation and measurement capture, storage and query. TCUP provides these services in form of APIs and libraries. App developers will develop, test, deploy and manage Java applications in TCUP. TCUP supports multi-tenancy and provides secure sandboxes for testing and deployment of applications by each tenant. End users will download Apps, subscribe & unsubscribe to them, control their privacy settings, and view usage history and billing information.

The group is headed by:

- Dr. Balamurali P
- Prof. Sivasubramaniam Anand
- Dr. Pal Arpan



An Overview of TCS Connected Universe Platform

IV. The Internet of Things – an Unparalleled Opportunity for Enterprises

IoT (or the Internet of Everything, as Cisco terms it) is all about connecting cyber-socio-physical systems using sensors at the core. Sensors may be human, biological, mechanical, or electronic; they sense and respond to stimuli and emit their state. Sensors can be as diverse as condition-monitoring sensors, bacteria, bi-metallic strips, and electromechanical and electronic ones. IoT systems also vary: they can be as simple as those programming and receiving alerts through your wearable devices, or they may be powerful enough to remotely control a Mars Mission.

We are talking about several trillion physical objects that connect to several million computers and several hundred million devices such as mobile phones, wearables, industrial equipment (gas turbines, oil rigs, utility grids), connected cars and fleets, smart city assets (parking, lighting, surveillance cameras). And all of these interact with a world of billions of people and pump context-rich information to back-end enterprise systems.

This interconnection of this universe of cyber-socio-physical systems interacting, communicating, and exchanging information in new intelligent, exciting and amazingly diverse ways will enable businesses to achieve an economic impact of trillions of dollars and re-imagine how products and services are conceptualized and delivered.

What are the opportunities?

For the enterprise, IoT will:

- Enable so-far unthinkable ways in which their products will be used by consumers
- Illuminate the complex relationships between their customers, providers, end-users, and other stakeholders
- Provide real-time information that will allow the enterprise to disrupt the market with newer product and services, Examples of applications range from life-saving to practical to esoteric.
- Remote healthcare can save lives: remotely monitoring patients' contextual and medical behavior can enable much faster responses to emergency situations. (refer : Shine)
- With smart manufacturing, the machine or a part can be upgraded or serviced before failure occurs, thus eliminating costly downtime and inconvenience. (refer: TESLA)
- Smart supply chains will have real-time information of demand, supply, and – for the customers – shipments. Deliveries can be traced and recovered if misplaced or stolen.
- Smart infrastructure would include energy saving and eco-sustainable facilities, buildings, and cities.
- Gaze enabled, pattern changing fabric used in wearable's, dresses
- Driverless cars

For several industries that provide industrial and consumer products, delivering a 'product as a service' will be a new business model, as companies will be able to remotely monitor, automate, and manage assets throughout the asset life cycle.

Enterprises can also leverage much deeper levels of consumer insights, if they can figure out ways to persuade consumers to share personal data from wearables, connected cars, and smart home gadgets. This would lead to a better customer experience, usage-based services, and related incentives such as driver-behavior based insurance.

What are the challenges for enterprises?

IoT systems are complex–they are distributed, networked, dynamic, evolutionary, Holonic.

Enterprises need to manage:

- The complexity and scale of interconnected cyber-socio-physical systems
- The diversity of thousands of sensor types and functions, and vendors and their ecosystems
- The interoperability of different communication protocols, hardware, software, middleware, and enterprise systems
- Technology evolution – as the IoT landscape rapidly evolves
- 'Big Little Data' – processing real-time streams of data and configuring intelligence at the edge to enable Big Little Data
- Privacy, security, and regulatory compliance
-

What should enterprises consider?

IoT brings together several types of complex systems – i.e., cyber, social, and physical systems. For development of IoT platforms, the challenges of complex systems need to be solved holistically rather than in silos. As my colleague Dr.Balamuralidhar succinctly puts it: "Architecting IoT systems requires a holonic approach; coupled with distributed data reduction techniques for transforming IoT Big Data problems to IoT Big Small Data problems".

IoT-based solutions will touch every imaginable aspect of our lives as well as every industry– be it healthcare, city services, energy and utilities, manufacturing, transportation, or agriculture.

Enterprises need to develop a reliable ecosystem of partners to put the pieces of the IoT puzzle together and to be able to provide value-generating solutions. They need to find newer ways to remain ahead in the rapidly evolving IoT landscape.

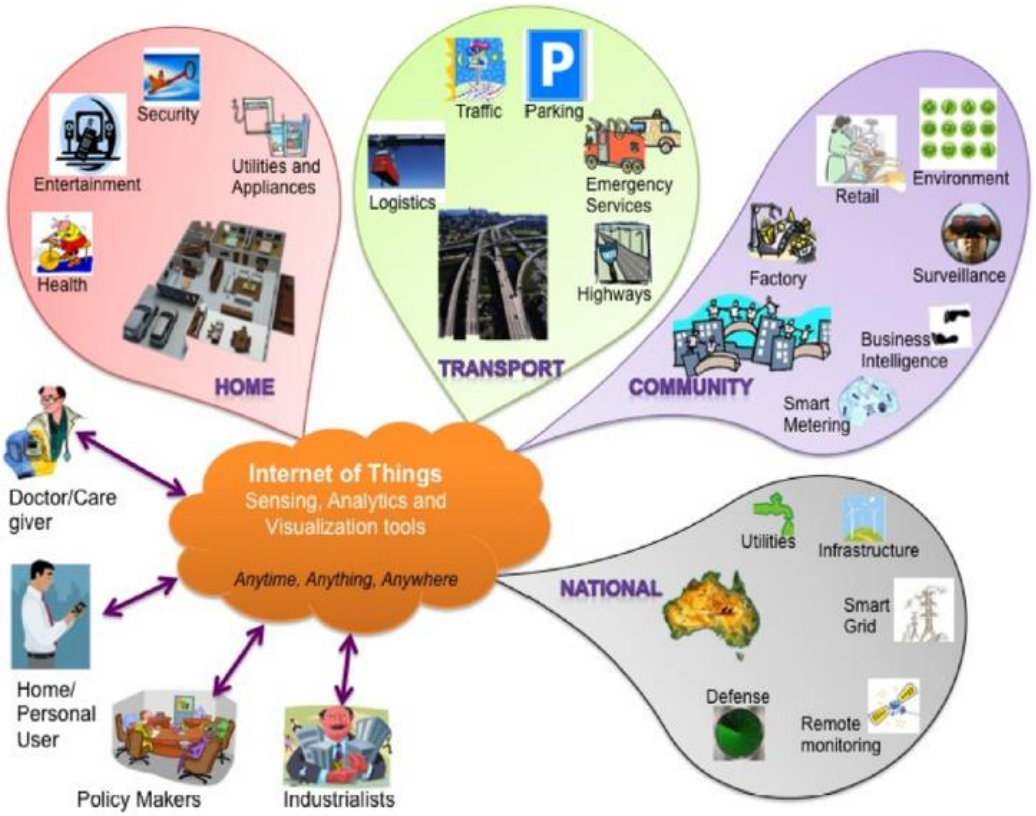


Fig. 1. Internet of Things schematic showing the end users and application areas based on data.

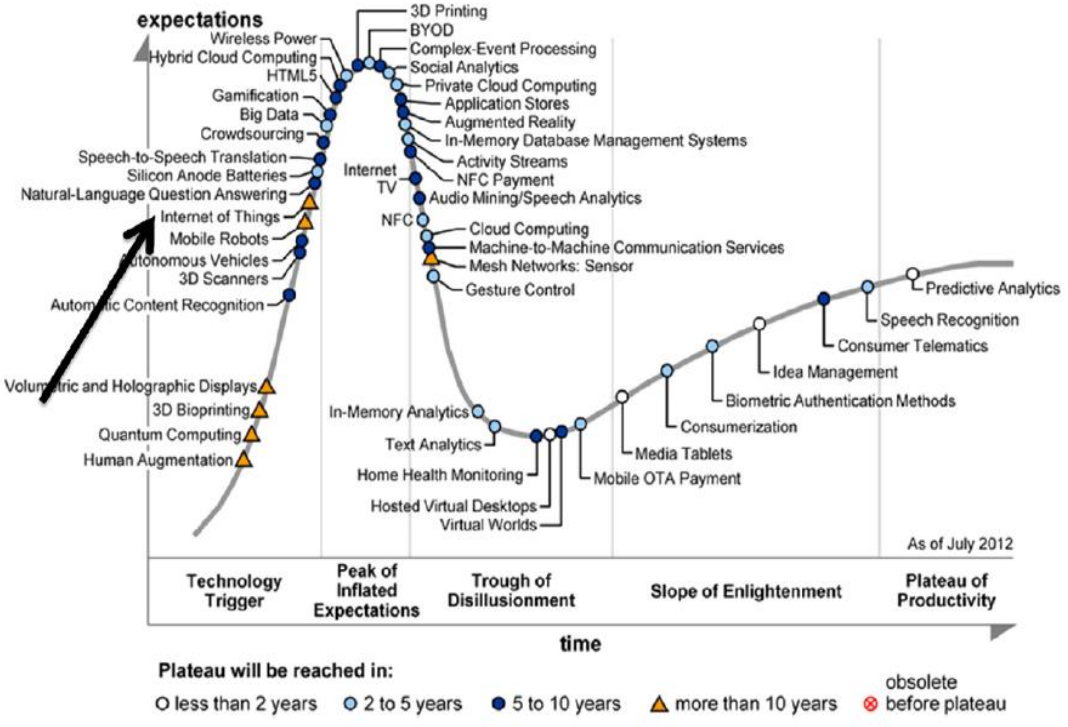


Fig. 2. Gartner 2012 Hype Cycle of emerging technologies.
Source: Gartner Inc. [10].

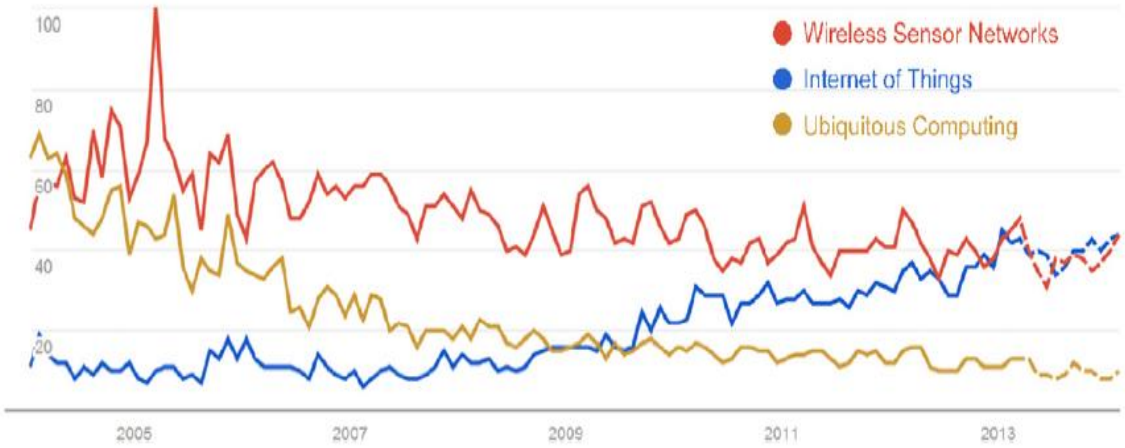


Fig. 3. Google search trends since 2004 for terms Internet of Things, Wireless Sensor Networks, Ubiquitous Computing.

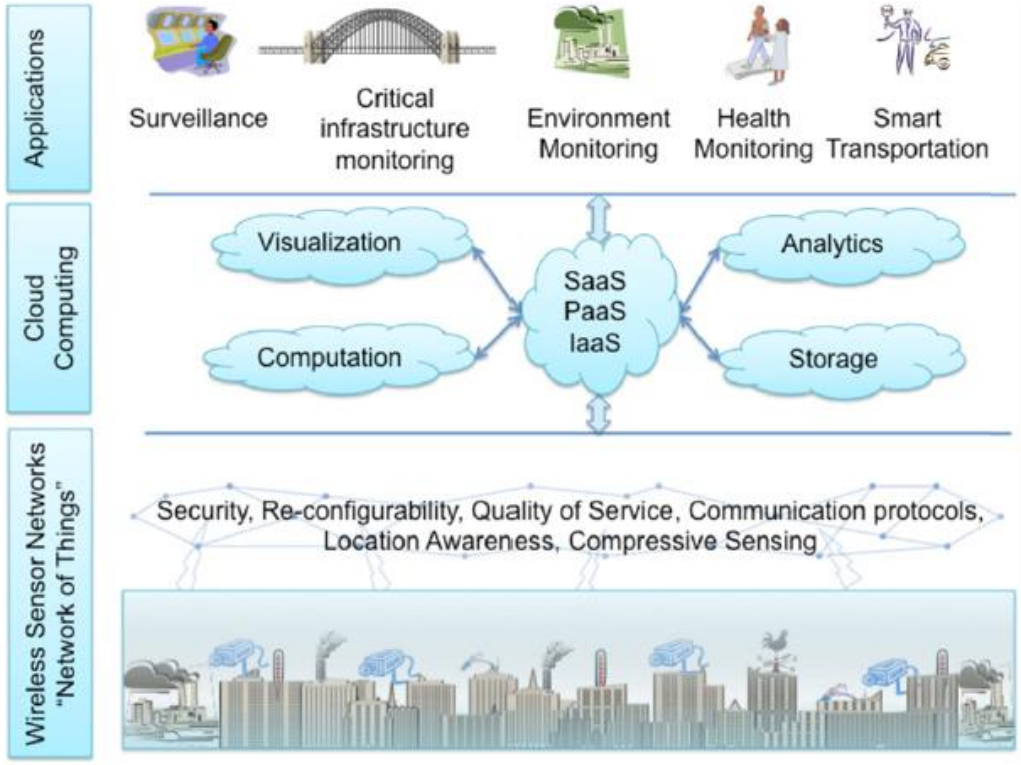


Fig. 4. Conceptual IoT framework with Cloud Computing at the center.

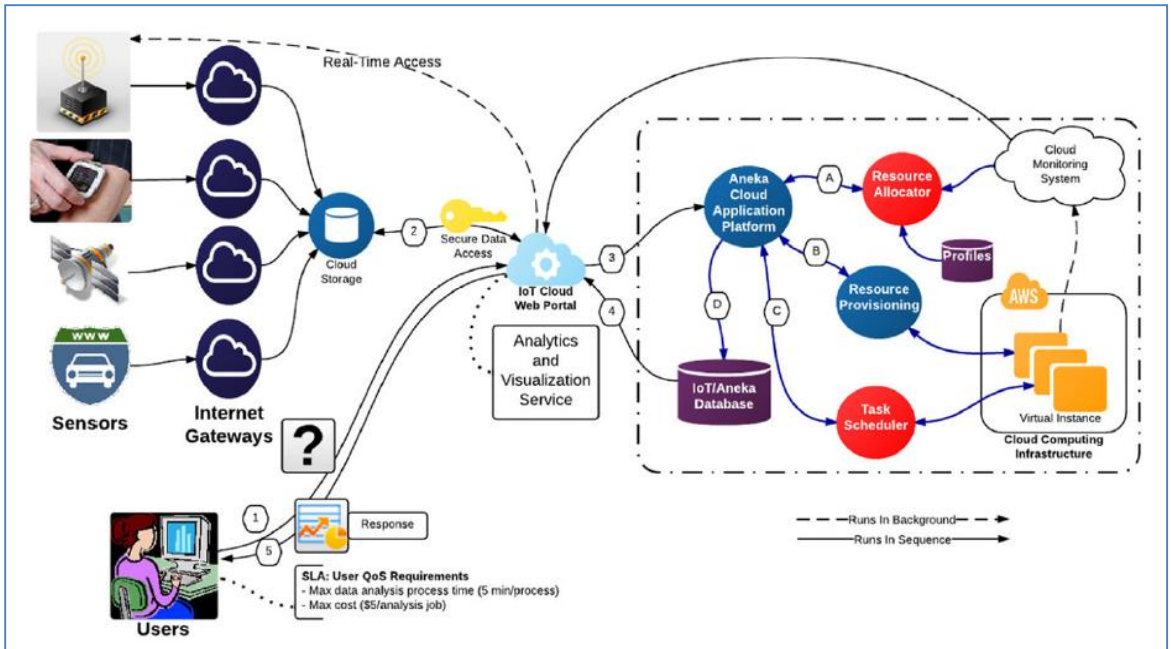


Fig. 5. A model of end-to-end interaction between various stakeholders in Cloud centric IoT framework.

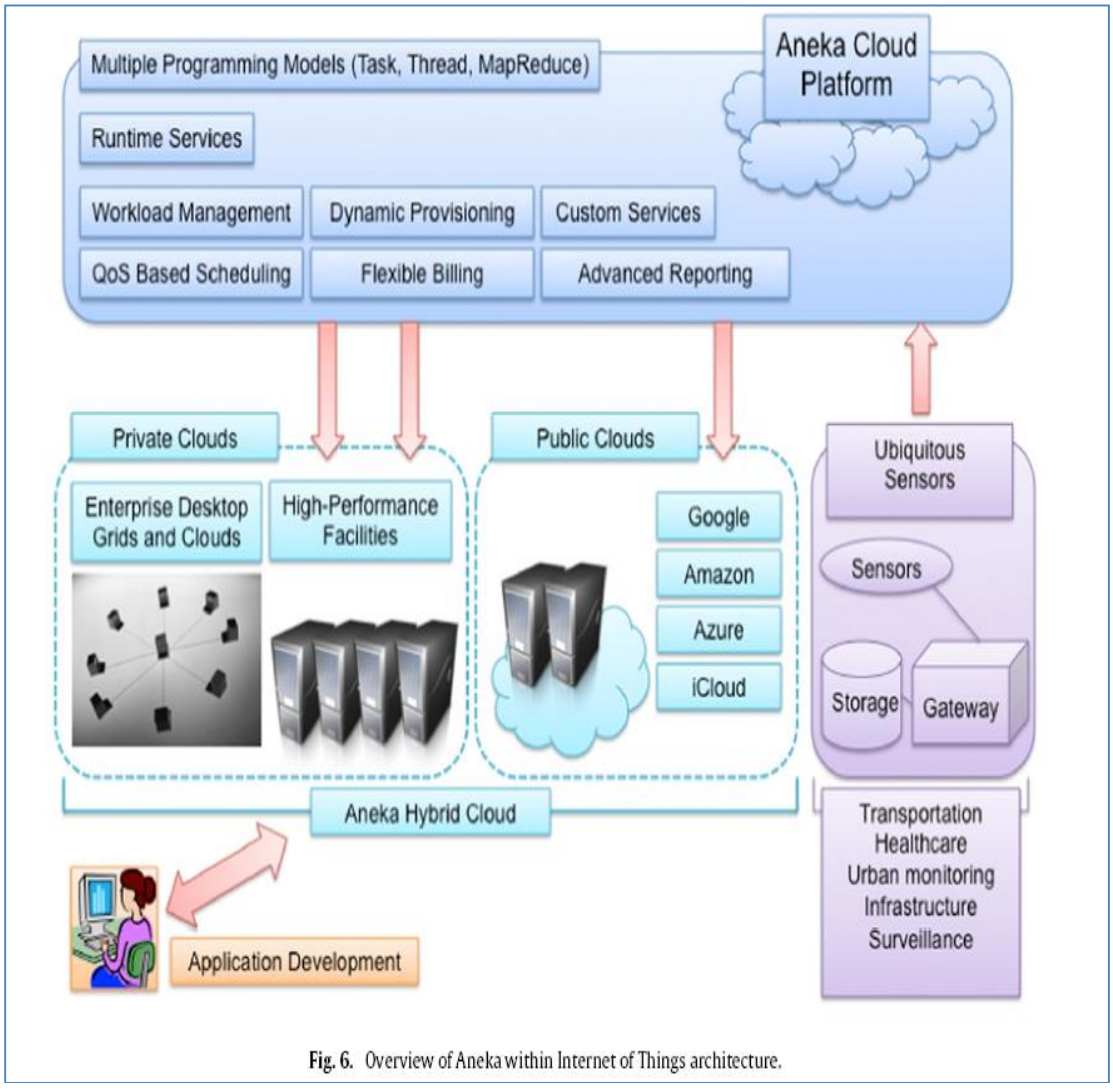


Fig. 6. Overview of Aneka within Internet of Things architecture.

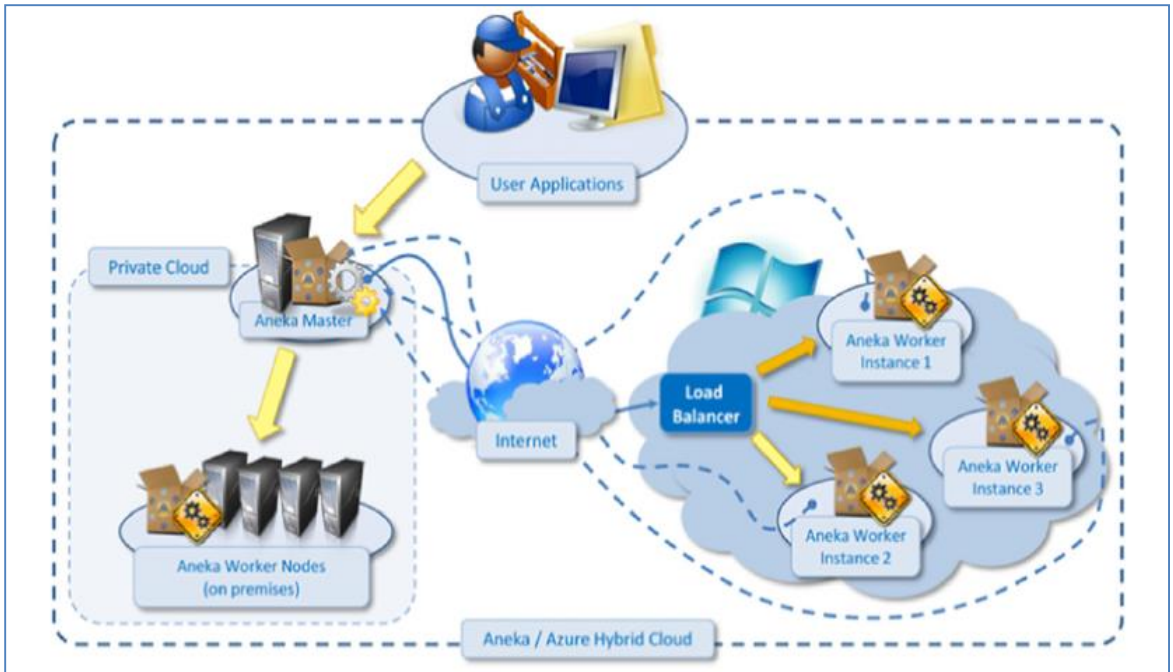


Fig. 7. Schematic of Aneka/Azure Interaction for data analytics application.

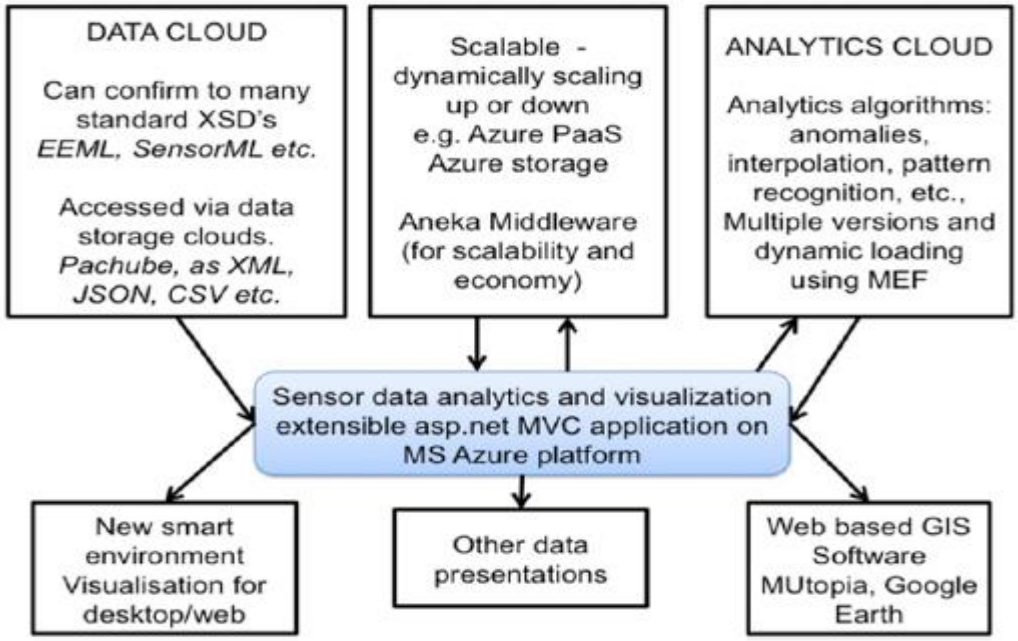


Fig. 8. System context diagram.

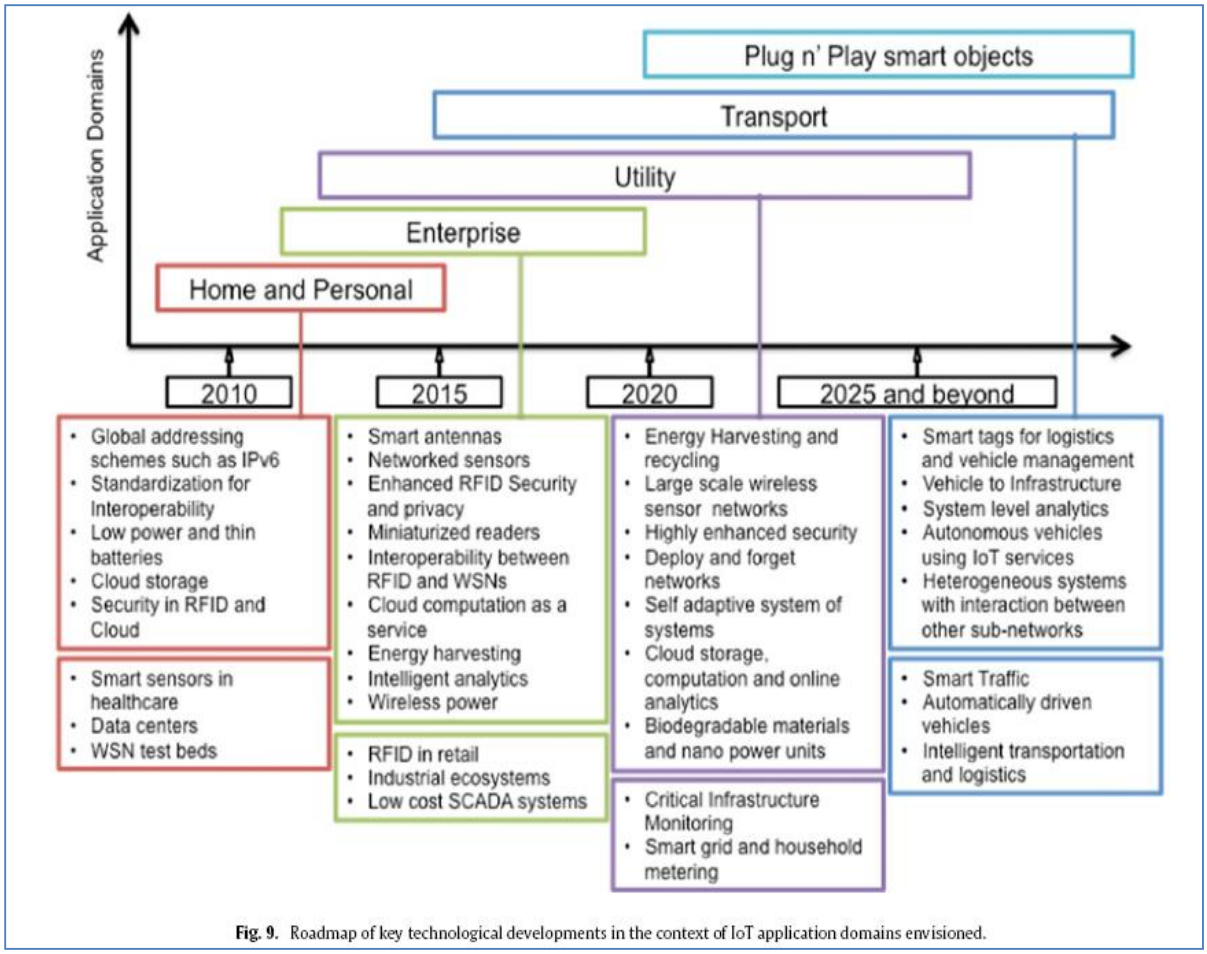


Fig. 9. Roadmap of key technological developments in the context of IoT application domains envisioned.

Through this visit the technical knowledge as well as the practical importance of applications by the discussed topics improves the thinking quality as well as the practical aspects to the M. Tech students. Some Internship proposal is also placed before them for our M. Tech ECE Students of Narula Institute of Technology.