UNIT VI

7 IoT Applications

Syllabus

IOT Verticals; IOT Hosted Services; IOT Application development, IOT Connectivity; IOT Software providers; Review of various IoT application domains including agriculture, healthcare, manufacturing, device management, and vehicle to vehicle communication and wearable computing devices.

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7.1 IoT Verticals

- IoT verticals include agriculture and farming, energy, oil and gas, enterprise, finance, healthcare, industrial, retail and transportations. In addition, energy is about managing smart meters, smart buildings and smart cities, while oil and gas is more about process and asset management in the petroleum industry.
- Fig. 7.1.1 shows IoT vertical applications.

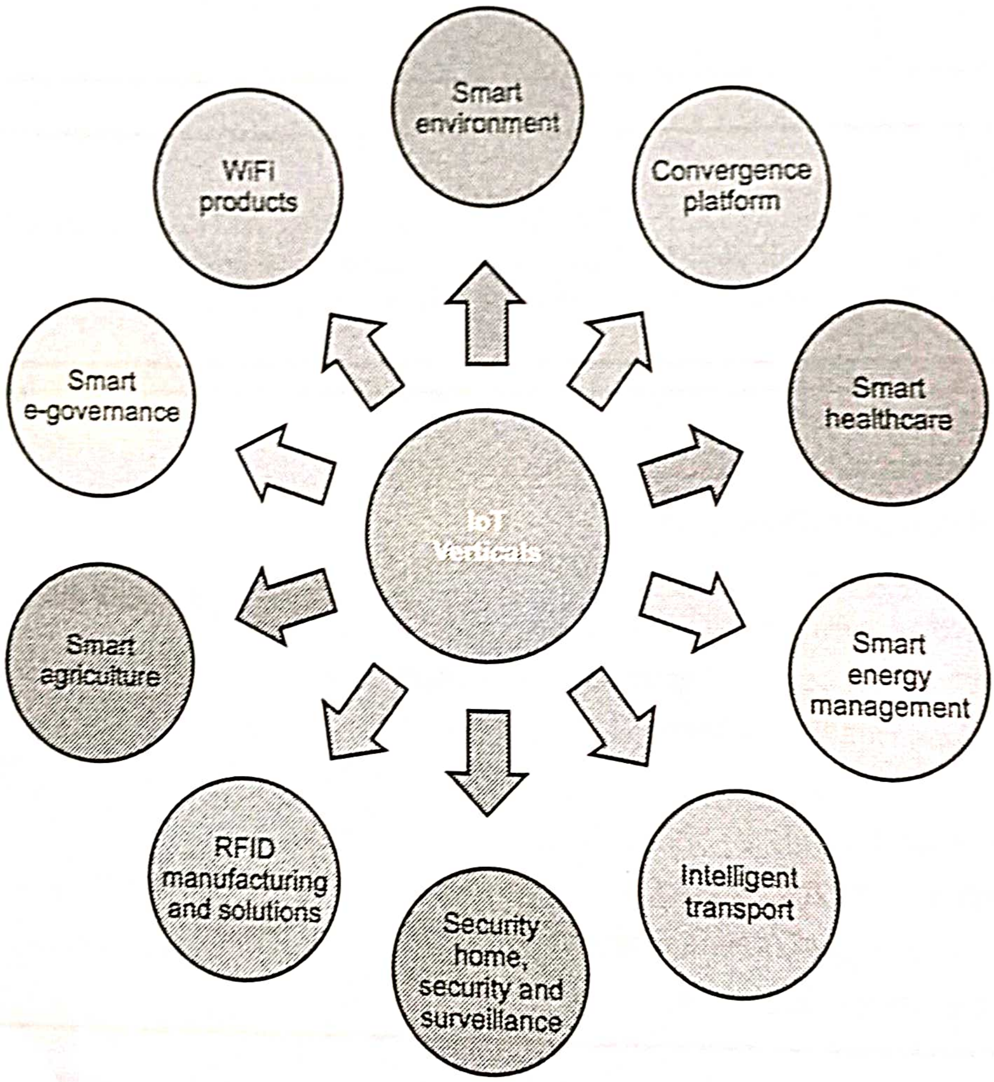

Fig. 7.1.1 IoT vertical applications

- In the vertical business model, the IoT device, the gateway and the cloud-base service are all provided and controlled by the same company. This approach ha the advantage for the end-user that there are no compatibility issues to deal wit among the various elements and a single point of contact to deal with if anythir goes wrong.
- The disadvantages are that the end-user is entirely dependent on the vendor f improvements, enhancements, or upgrades to the offering.

- An IoT home-security system that monitors an empty house for intruders, for instance, has the same hardware as one that monitors an elderly person's activity, if the person falls or loses consciousness. But if someone wants a system that will do both, they are dependent on the system vendor to offer those features when dealing with a vertically defined business.
- Vertical business models can also result in users needing several different systems to achieve a spectrum of tasks, each with its own gateway and cloud operations.
- Most of the first IoT offerings to come to market follow this vertical model.
- The motivation behind a horizontal model is to foster rapid growth and innovation in the industry by allowing multiple providers to work with a common framework. The idea is that by making the gateway and cloud resources something that can be assumed to be in place and have known and open functionality, innovators can concentrate their efforts on creating devices and services.

7.1.1 IoT Hosted Services

- With the advent of the Internet of Things era, homes, cities and almost everything is becoming smart. Those smart objects can sense the physical world by obtaining data from sensors, affecting the sensed world by triggering actions using actuators, engage users by interacting with them whenever necessary and process gathered data to provide useful information to us.
- An increasing number of physical objects are being connected to the Internet at an unprecedented rate realizing the idea of the Internet of Things.
- Examples of such objects include thermostats and heating ventilation and air conditioning (HVAC) monitoring and control systems that enable smart homes. There are also other domains and environments in which the IoT can play a remarkable role and improve the quality of our lives.
- These applications include : Transportation, health care, industrial automation and emergency response to natural and man-made disasters where human decision making is difficult.
- Currently, the IoT vision is mainly focused on the technological and infrastructure aspect, as well as on the management and analysis of the huge amount of generated data.
- Consumer devices are always a public concern, but there are currently five types of IoT applications :

  a) **Consumer IoT :** Such as light fixtures, home appliances and voice assistance for the elderly.

b) Commercial IoT : IoT applications in the healthcare and transport industries, such as smart pacemakers, monitoring systems and vehicle to vehicle communication (V2V).

c) The Industrial Internet of Things : IIoT includes digital control systems, statistical evaluation, smart agriculture and big industrial data.

d) Infrastructure IoT enables the connectivity of smart cities through infrastructure sensors, management systems and user-friendly user apps.

e) Military Things (IoMT) applying IoT technologies in the military field, such as robots for surveillance and human-wearable biometrics for combat.

7.2 IoT Application Development

- IoT applications development is also called **M2M app development.** IoT is a connectivity of all physical devices which are connected through internet and able to exchange (send and receive) data.
- The objects include vehicles, smart phones, gadgets, wearable devices, home appliances and many other physical devices as well as human. IoT app works as a bridge enables physical devices to communicate with each other.
- **Example :** Voice App for IoT Device
  There will be three types of voice communication in IoT environments :
  1. Bi - directional voice communication
  2. Mono - directional voice communication
  3. Voice recognition.
- Reasons that voice is suited to a range of IoT applications :
  1. Speech is the natural mode of communication for humans. It is both intuitive and easier to convey commands verbally.
  2. Voice recognition is particularly appealing when the human's hands or eyes are otherwise occupied.
  3. Voice telephony is an efficient means of bi - directional voice communication with machines that can listen and respond without the need for complex commands.
  4. Cost saving factors : Voice integration could potentially challenge the need for a touch screen on many devices, as it reduces the cost for devices that will be dormant for the majority of the time.
- The IoT market is broad and encompasses a range of consumer, commercial and industrial applications where voice can play a role. There are significant differences between the drivers for implementing voice into consumer products and from those that drive the same technology in the consumer market.

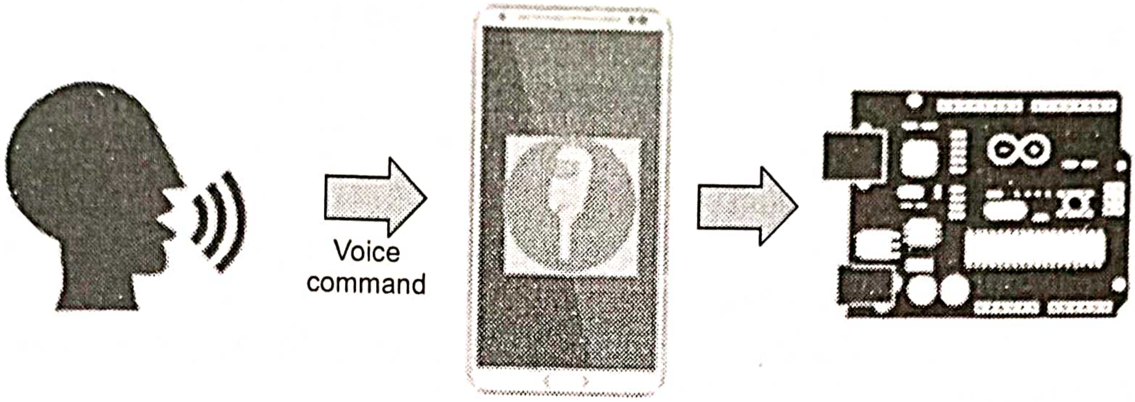

Fig. 7.2.1

- Voice is a feature that does not need to make any consideration for infrastructure, other than the need for an Internet connection.
- Consumer applications for voice include virtual assistants on smartphones as well as devices that do not include integrated telephony functions, such as wearable devices with minimal screen real - estate.
- Devices in this category include smartwatches and fitness wearables that can offer hands - free voice activation of a multitude of functions, through to smart televisions and games consoles.

Alexa Voice Service (AVS) Integration for AWS IoT

- Alexa Voice Service (AVS) Integration for AWS IoT is a new feature that cost - effectively brings Alexa Voice to any connected device without incurring messaging costs.
- AVS for AWS IoT has three components :

1. A set of reserved MQTT topics to transfer audio messages between Alexa enabled devices and AVS.
2. A virtual alexa enabled device in the cloud that shifts tasks related to media retrieval, audio decoding, audio mixing and state management from the physical device to the virtual device.
3. A set of APIs that support receiving and sending messages over the reserved topics, interfacing with the device microphone and speaker and managing device state.

7.2.1 Python Web Application Framework : Django

- Django is an open source Python web development framework. Django is based on the well known model-template-view architecture. It provides a unified API to a database back end. Django is a registered trademark of the Django software foundation and is licensed under BSD license.

- Django is often referred to as an MTV framework. In the MTV development pattern :
  1. M stands for "Model," the data access layer.
  2. T stands for "Template," the presentation layer
  3. V stands for "View," the business logic layer.
- Django was built using Python, an object-oriented applications development language which combines the power of systems languages, such as C/C++ and Java, with the ease and rapid development of scripting languages, such as Ruby and Visual Basic.

7.2.2 Starting Development with Django

- To create the project directory for your blog project, issue this django-admin.py command :

  django-admin.py startproject mysite
- When you creates projects, it creates following files :
  1. The **__init__.py** file makes this project directory a Python package, a collection of related Python modules.
  2. **manage.py** is a utility for working with this Django project. You can see from its permissions flags in the directory listing that it is executable.
  3. **settings.py** is a file containing default settings for your project. These include database information, debugging flags and other important variables. Any value in this file is available to any of your project's installed apps.
  4. **urls.py** is what's known in Django as a URLconf, a configuration file that maps URL patterns to actions your applications perform. URLconfs are an exciting and powerful feature of Django.
- Running the development server is as simple as issuing a single command. The command to run the server is,

  ./manage.py runserver
- You should see something like the following,

  Validating models...

  0 errors found.

  Django version 1.0, using settings 'mysite.settings'

  Development server is running at http://127.0.0.1:8000/

  Quit the server with CONTROL-C
- Open that link (http://127.0.0.1:8000/) in your browser and you should see Django's "It Worked!" screen, as shown in Fig. 7.2.2

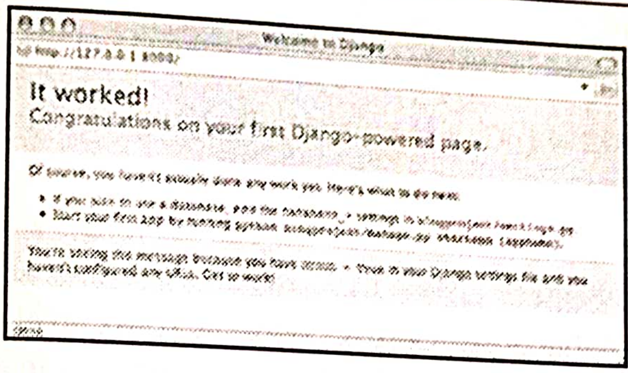

Fig. 7.2.2 : Django initital screen

- **Steps to create new project**
  a. Create a project
  b. Start an application
  c. Create the database (MySQL, Postgresql, SQLite)
  d. Define DB settings in settings.py
  e. Define your models
  f. Add pluggable modules
  g. Write your templates
  h. Define your views
  i. Create URL mapping
  j. Test application
  k. Deploy application (Linux, Apache, mod_Python, DB)
- A project is a collection of settings for an instance of Django, including database configuration, Django-specific options and application-specific settings.

Setting up the database

- If database server is not installed, then uses SQLite as the fastest and easiest way to get going. It is fast, widely available and stores its database as a single file in the file system.
- If you do have a database server like PostgreSQL, MySQL, Oracle, MSSQL and want to use it rather than SQLite, then use your database's administration tools to create a new database for your Django project.
- For using any database, then projects setting.py file is used. SQLite is also one of the most popular choices on Win32 platforms because it comes free with the Python distribution.

- Let's create a db directory as well :

  DATABASE_ENGINE = 'sqlite3'

  DATABASE_NAME = r 'C:\py\django\db\django.db'

  How Django processes a request ?

- When an HTTP request comes in from the browser, a server-specific handler constructs the "HttpRequest "passed to later components and handles the flow of the response processing. The handler then calls any available Request or View middleware. These types of middleware are useful for augmenting incoming "HttpRequest" objects as well as providing special handling for specific types of requests. If either returns an "HttpResponse", processing bypasses the view.
- Fig. 7.2.3 shows complete flow of a Django request and response.

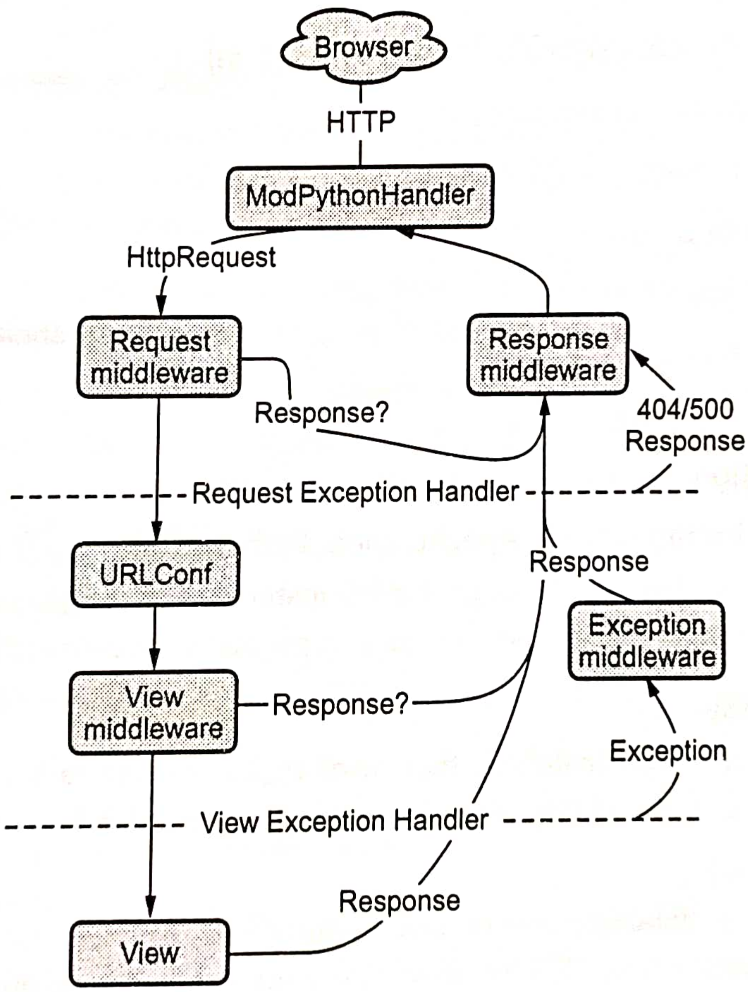

Fig. 7.2.3 : Complete flow of a Django request and response

- Bugs slip by even the best programmers, but exception middleware can help squash them. If a view function raises an exception, control passes to the exception middleware. If this middleware does not return an "HttpResponse", the exception is re-raised.

- Finally, response middleware is good for post-processing an "HttpResponse" just before it's sent to the browser or doing cleanup of request-specific resources.

Template system

- A Django template is a string of text that is intended to separate the presentation of a document from its data. A template defines placeholders and various bits of basic logic (i.e., template tags) that regulate how the document should be displayed.
- To use the template system in Python code, just follow these two steps :
  1. Create a template object by providing the raw template code as a string. Django also offers a way to create template objects by designating the path to a template file on the filesystem; we will examine that in a bit.
  2. Call the render() method of the template object with a given set of variables. This returns a fully rendered template as a string, with all of the variables and block tags evaluated according to the context.
- The easiest way to create a template object is to instantiate it directly. The template class lives in the "django.template" module and the constructor takes one argument, the raw template code.

7.3 IoT Connectivity

- IoT connectivity is typically how we refer to the methods used to connect IoT devices, methods including applications, sensors, trackers, gateways and network routers.
- Elements of connectivity are as follows :
  a) **Power consumption :** How much battery does it consume ?
  b) **Range :** How wide is the area it covers ?
  c) **Bandwidth :** How much data does it transmit ?
  d) **Reliability :** How reliable is the connectivity and what is your network operator coverage ?
  e) **Cost :** How expensive is the connectivity ?
- Cellular IoT connectivity : Cellular connectivity also referred to as satellite connection. It is typically used in machine-to-machine (M2M) IoT connectivity.
- WiFi : When it comes to connecting IoT devices, WiFi can work well for smaller gadgets and appliances within a certain coverage range.

- Bluetooth had a competitive bandwidth of 2 Mbps but only has low range capabilities of below 30 ft (10 m). Bluetooth connectivity is a great IoT connectivity option if you're looking to send information across a close range, with medium to low bandwidth.
- LoRa is Long Range, low data rate, low power wireless platform technology for building IoT network. LoRa is a patented digital wireless data communication IoT technology developed by Cycleo of Grenoble, France.
- LoRaWAN is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery-operated things in a regional, national or global network.

7.4 IoT Software Provider

- An IoT solution provider is a company or organization that facilitates the deployment of the Internet of Things.
- An IoT devices have the potential to transform the way people interact with products which is why app developers should take notice. With McKinsey predicting the worldwide number of IoT-connected devices to reach 43 billion by 2023.
- The rise of IoT is a double-edged sword for many businesses. On one hand, recent advances have made it possible for companies with limited resources to jump into IoT development projects. Sensor technology has become cheaper and more widely available, 5G connections are getting stronger and more real-time analytics functions are moving to the cloud.
- On the other hand, IoT applications are inherently complicated to develop because of all of the moving parts involved. Traditional IoT application development requires the integration of many disparate technologies, from IoT endpoints and back-end legacy systems to various other platforms and data sources.
- To add to this, only highly specialized developers with certain levels of expertise will be able to properly configure and maintain these technologies.

Amazon Web Services for IoT

- American international multibillion dollar electronic commerce company with headquarters in Seattle, Washington, USA. Started in 1995 by Jeff Bezos as an online bookstore but soon diversified, selling DVDs, VHSs, CDs, video and MP3 downloads/streaming, software, video games, electronics, apparel, furniture, food, toys and jewellery.
- The company also produces consumer electronics : Kindle e-book reader and the Kindle Fire tablet computer. In 2006, Amazon officially launched the Amazon Web Services (AWS) to became a major provider of cloud computing services.

- Amazon Web Services (AWS) is a secure cloud services platform, offering compute power, database storage, content delivery and other functionality to help businesses scale and grow.
- In 2006, Amazon Web Services (AWS) began offering IT infrastructure services to businesses in the form of web services, now commonly known as **cloud computing**.
- Today, AWS provides a highly reliable, scalable, low-cost infrastructure platform in the cloud that powers hundreds of thousands of businesses in 190 countries around the world.

What is Amazon Web Services ?

- Amazon Web Services (AWS) is a collection of remote computing services (web services) that together make up a cloud computing platform, offered over the Internet by Amazon.com.
- The AWS cloud infrastructure is built around regions and availability zones (AZs). A region is a physical location in the world where we have multiple AZs. AZs consist of one or more discrete data centers, each with redundant power, networking and connectivity, housed in separate facilities.
- These AZs offer you the ability to operate production applications and databases that are more highly available, fault tolerant and scalable than would be possible from a single data center.
- The AWS cloud operates 42 AZs within 16 geographic regions around the world, with five more availability zones and two more regions coming online in 2017.
- Each availability zone is designed as an independent failure zone. This means that availability zones are physically separated within a typical metropolitan region and are located in lower risk flood plains.

7.5 Review of Various IoT Application : Agriculture

7.5.1 Smart Irrigation

- In our country, agriculture is major source of food production to the growing demand of human population. In agriculture, irrigation is an essential process that influences crop production.
- Generally farmers visit their agriculture fields periodically to check soil moisture level and based on requirement water is pumped by motors to irrigate respective fields.

- The smart irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants.
- Wireless Transmitter Unit (WTU) is comprised of a soil moisture sensor, a temperature sensor, a microcontroller, a RF transceiver and power source. Several WTUs can be incorporated in field to form a distributed network of sensors.
- Input to the micro controller is the reading of the moisture sensor and depending upon the threshold value a high or a low.
- If the soil moisture value is below the threshold or the temperature exceeds the threshold value, then the motor is turned on till the levels of moisture and temperature are optimized. Otherwise the motor is off. The sensor values and motor status is displayed on an Android App.

7.5.2 Green House Control

- In modern greenhouses, several measurement points are required to trace down the local climate parameters in different parts of the big greenhouse to make the greenhouse automation system work properly.
- The most important factors for the quality and productivity of plant growth are temperature, humidity, light and the level of the carbon dioxide.
- Continuous monitoring of these environmental variables gives information to the grower to better understand, how each factor affects growth and how to manage maximal crop productiveness.
- Wireless Sensor Network (WSN) can form a useful part of the automation system architecture in modern greenhouses.
- Wireless communication can be used to collect the measurements and to communicate between the centralized control and the actuators located to the different parts of the greenhouse.
- Fig. 7.5.1 shows greenhouse with sensor.
- Basic factors affecting plant growth are sunlight, water content in soil, temperature, CO_2 concentration etc. These physical factors are hard to control manually inside a greenhouse and there is a need for automated design arises.

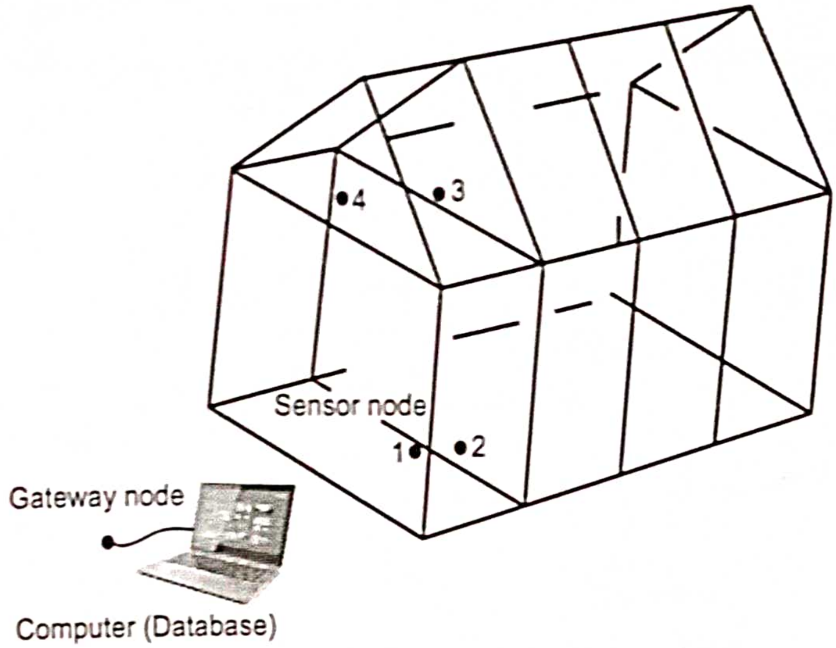

Fig. 7.5.1 Greenhouse with sensor

- Data collected from various sensor is stored on the centralized server and this server process the data.

7.6 Structural Health Monitoring

- The World Health Organization (WHO) defines E - health as : E - health is the transfer of health resources and health care by electronic means. It encompasses three main areas : The delivery of health information, for health professionals and health consumers, through the internet and telecommunications.
- E - health provides a new method for using health resources - such as information, money, and medicines and in time should help to improve efficient use of these resources.
- E - health brings special characteristics. The monitoring device's environment is a patient; a living and breathing human being. This changes some of the dynamics of the situation. Human interaction with the device means batteries could be changed, problems could be called in to technical support and possibly be resolved over the phone rather than some type of service call. In most cases, the devices on the patient are mobile not static with regard to location.
- Fig. 7.6.1 shows high level E - health ecosystem architecture.

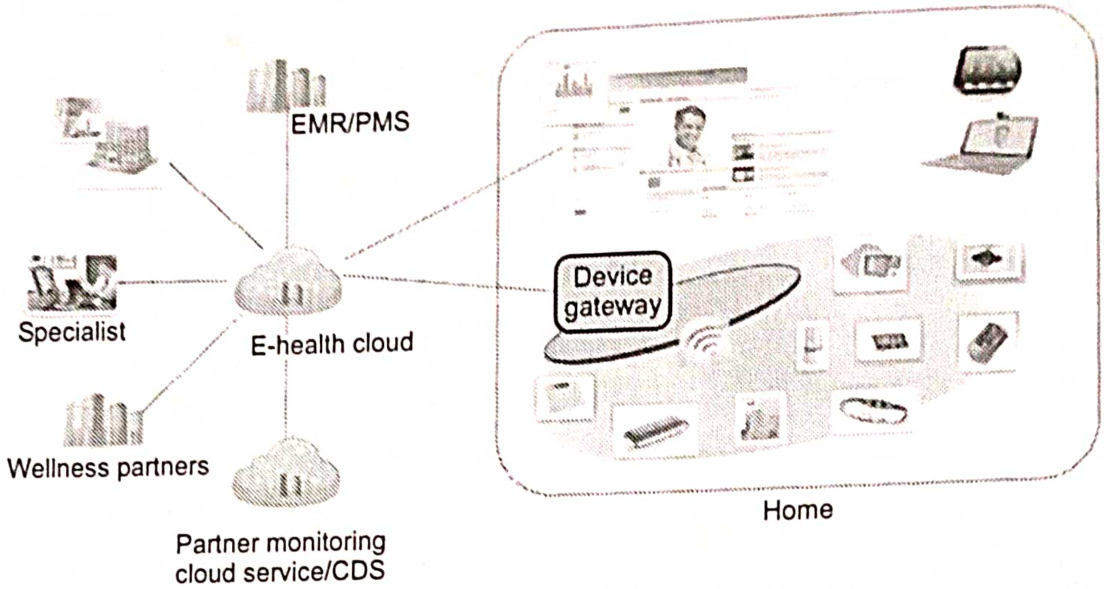

Fig. 7.6.1 High level E - health ecosystem architecture

- The data flow architecture focuses on the source of the data, the destination the data and path the data. The source of the data is typically the sensor.
- The data can be either locally cached or is sent to the upstream systems without storing in the sensor. The path taken by the data includes a gateway, which can also cache some of the data and do distributed processing.
- Intermediate hubs can also store and process the data to filter out or make certain decisions. A distributed rules engine is used to make distributed decisions at the closest point of care. This enables data traffic to be filtered and processed efficiently without having every data being processed by the cloud service

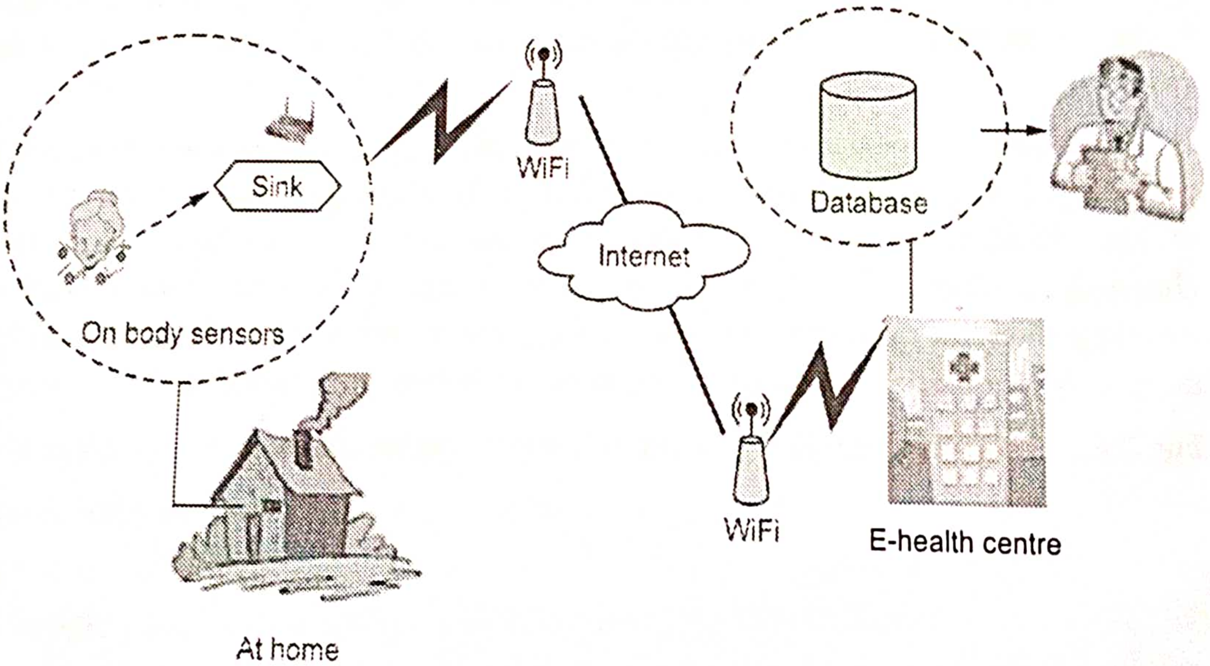

Fig. 7.6.2

- The development of wireless networks has led to the emergency of a new type of E - healthcare system, providing expert-based medical treatment remotely on time.
- With the E - healthcare system, wearable sensors and portable wireless devices can automatically monitor individuals' health status and forward them to the hospitals, doctors and related people.
- The system offers great conveniences to both patients and health care providers. For the patients, the foremost advantage is to reduce the waiting time of diagnosis and medical treatment, since they can deliver the emergent accident information to their doctors even if they are far away from the hospital or they don't notice their health condition.
- In addition, E - health system causes little interruption to patient's daily activities. For the health care providers, after receiving the abnormal signals from the patients, appropriate treatment can be made, which saves medical resources.
- Furthermore, without direct contact with medical facilities, medical personnel or other patients, the patients are unlikely to be infected with other diseases.
- However, to ensure the security and privacy of patient's medical records encounters a lot of challenges :
  1. How to achieve the confidentiality and integrity of patients' information,
  2. The security of wireless body area network,
  3. The privacy and unlink ability of patients' health status,
  4. The undeniability and unlinkability of doctor's treatment,
  5. The location privacy of patients, the fine - grained access control of patient's medical record, the mutual authentication between patients and hospitals, etc.
- It would be useful to create an up-to-date bibliography on secure E - healthcare systems.

7.7 Automotive Applications

- Today, users of IoT devices can evaluate engine performance, control air temperature and measure physical health indicators with only a few clicks.
- Conventional perceptions of the automotive industry are radically changing with IoT development. Predictive maintenance, Wi-Fi capabilities powered by 3G/4G/5G functionality, Car2Car connectivity and advanced fleet management are only a few examples of how IoT-based solutions are shaping the new automotive age.

- The automobile industry is one of the fastest-growing markets for IoT-based solutions. The number of installed connectivity units in vehicles is likely to increase by 67 % between 2018 and 2020.
- Predictive maintenance technology is based on the use of IoT connectivity tools that collect data on the performance of different parts, transfer that data to the cloud in real time and evaluate the risks of potential malfunction of a car's hardware or software. After information is processed, a driver is notified and advised of any necessary service or repair to avoid potential incidents.
- Fig. 7.7.1 shows battery working.

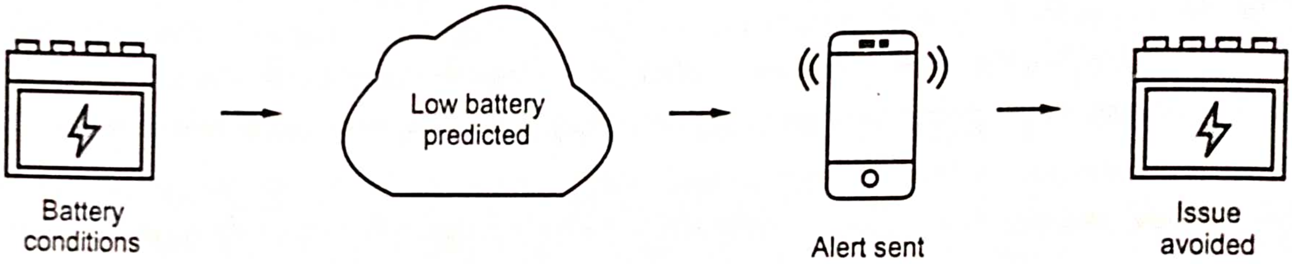

Fig. 7.7.1 : Battery working

- Predictive maintenance can facilitate vehicle use by both private owners and dealerships with large fleets of vehicles. It enables end-users to get the right information in advance. With IoT connectivity tools, you can forget about unplanned stops or breakdowns during the ride.

7.7.1 Remote Vehicle Diagnostics

- Remote vehicle diagnostics solution monitors the health of the vehicle, determines the root cause of the problem / failure and provides real time information of vehicle parameters to assess its performance against benchmarks.
- The solution monitors the health of the electric vehicle, commercial vehicle, utility vehicle and provides insight to field support staff to determine the root cause of the problem. It also enables the customers to access information about the vehicle. Commercial / Utility vehicles being driven across the country extensively over time for various purposes are in need of a diagnostic check which is automated through the offering.
- By monitoring all the aspects of the car is easier to detect any problem in advance by sending all sensor readings to a certified center where technicians and engineers will apply their expertise to find and predict imminent failures of key systems integrated in the vehicle.

- Modern commercial vehicles support on board diagnostic standard. Next generation vehicles will have sophisticated on-board connectivity equipment, providing wireless network access to the vehicle for infotainment and other telematics services. Fig. 7.7.2 shows remote vehicle diagnostics.

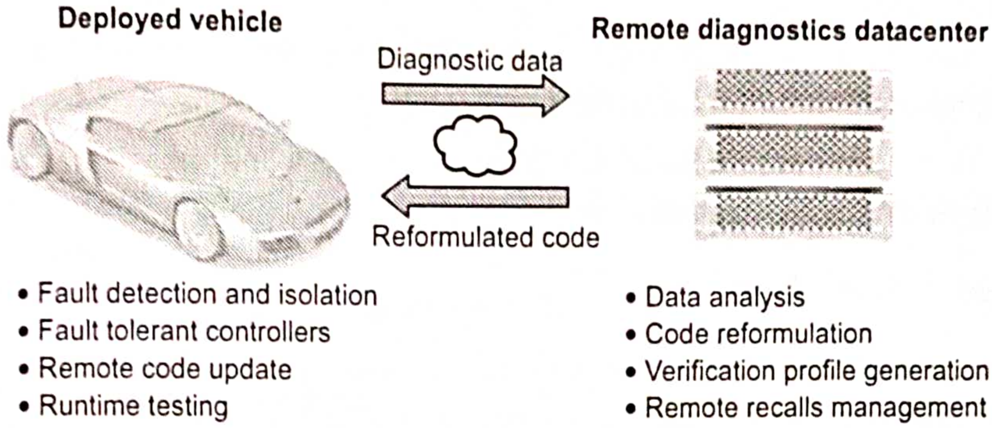

Fig. 7.7.2 : Remote vehicle diagnostics solution

- In vehicle, sensors connect to the vehicle terminal which is responsible for collecting, storing, processing and reporting information and responding to commands from supervision platforms.
- The vehicle terminal consists of the microprocessor, data storage, GPS module, wireless communication transmission module, real time clock and data communication interface.

7.7.2 Machine Diagnosis and Prognosis

- Machine fault diagnostic and prognostic techniques have been the considerable subjects of condition-based maintenance system in the recent time due to the potential advantages that could be gained from reducing downtime, decreasing maintenance costs and increasing machine availability.
- A failure in industrial equipment results in not only the loss of productivity but also timely services to customers and may even lead to safety and environmental problems.
- IoT play an important role in both diagnosis and prognosis. Critical manufacturing processes and equipment must be continuously monitoring for any variations or malfunctions. A slight shift in performance can affect overall product quality or manufacturing equipment health.
- With group of sensing nodes monitoring various manufacturing equipments and processes and transmitting data in periodic manner, situations may arise where the engineer might want to query data from some specific nodes to estimate current status of particular process or equipment.

- There can be situation of unforeseen malfunctioning or variations beyond prescribed tolerance bands. A mechanism is hence required to define tolerance bands for each sensing module. When measurements at particular node exceed the tolerance, the node must breach the periodic cycle to send an alarm about the emergency.
- Case Based Reasoning (CBR) is normally used method to find solution to new problems based on previous experience.
- CBR is an effective method for problem solving for quantitative mathematical model i.e. machine diagnostic and prognosis.

7.8 Plant Automation

- The manufacturing sector supports the development of IoT by the provision of smart products. For instance, 43 million wearable bands were shipped in 2015 and it is estimated that 20 million smart thermostats will ship by 2023. By 2016, smart products will be offered by 53 % of manufacturers.
- At present, the majority of manufacturing plants and production facilities around the world are putting into place systems that will make them adaptive, fully connected, analytical and more efficient.
- These new manufacturing systems are introducing a new industrial revolution, called Factory of the Future (FoF). This model marks the beginning of a new phase of manufacturing characterized by complete automation and involving an increased use of technology and field devices in and outside of the manufacturing facility.
- Factories of the future are oriented toward ensuring the availability of all relevant information in real time through the connectivity of all elements participating in the value chain, as well as providing the ability to deduce the optimal value chain processes from this data at the demand of the individual customer.
- The factory of the future will increase global competitiveness and will require an unprecedented integration of systems across domains, hierarchy boundaries and life cycle phases.
- Many factors can contribute to establishing factories of the future, but consensus-based standards are indispensable in this process.
- The benefits of data to factories are across several vectors. These include :
  1. Improved compliance to environmental guidelines; a major challenge for industries at the moment.
  2. Heightened and improved security, reducing loss due to sabotage, pilferage, leakages and human error.

3. Giving your MES system an efficiency boost from process improvement and reduced down time of equipment realized through real-time alerts and predictive analytics
4. Insights into new product demand from markets thus directly driving RandD spends and design programs
5. Reduced cost through better demand forecasting, sourcing, supply chain management and inventory control.

Smart Factory :

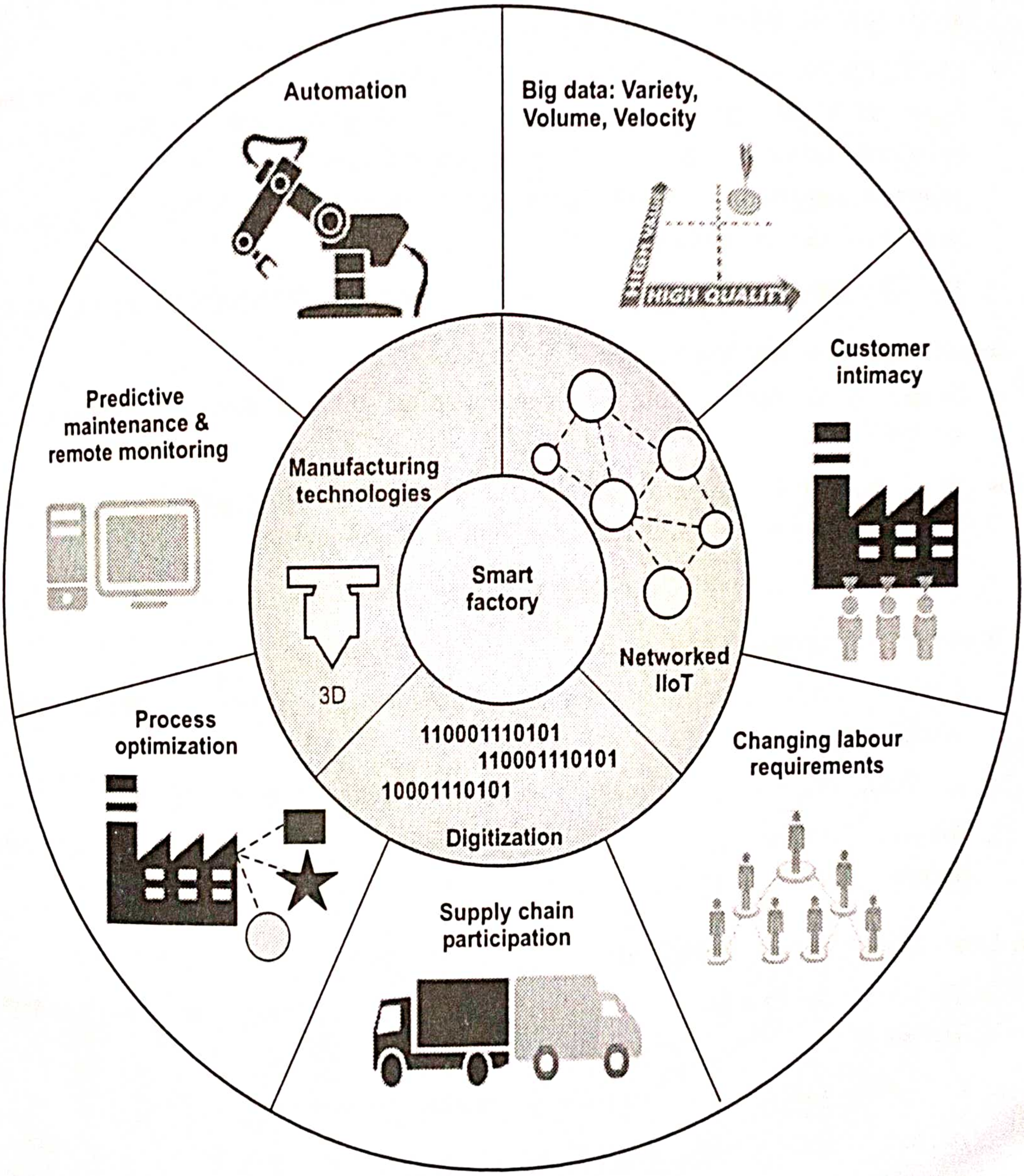

Fig. 7.8.1 : Smart factory concept

- The convergence of the virtual and physical worlds has given rise to the smart factory. This integrates artificial intelligence, machine learning, automation of knowledge work and machine-to-machine communication with the manufacturing process.
- The smart factory will fundamentally change how products are invented, manufactured and shipped. At the same time it will improve worker safety and protect the environment by enabling low-emissions and low-incident manufacturing.
- Empowered by the Industrial Internet of Things, the factory of tomorrow promises to be a proactive, self-healing environment with increased responsiveness and ability to meet consumer demand.
- Manufacturing has made huge progress in recent years. Automation levels have increased in all manufacturing sub-sectors and third party suppliers now have better vertical skills, geographical coverage and greater scalability. The number of products and product variants has exploded. Globalized capability has become the foundation of cost reduction.
- Fig. 7.8.1 shows smart factory concept. (See Fig. 7.8.1 on previous page.)

1. Smart Manufacturing Intelligence

- Deeper understanding of the manufacturing process through modeling and analysis
- New capacity to observe and take action on integrated patterns of operation through networked data, information, analytics and metrics.
- Dynamic management of energy and material resources.

2. Smart Manufacturing Practice

a. Generating and orchestrating the use of sensor-based, data-driven manufacturing intelligence

b. Applying integrated performance metrics constructed for real-time action

c. Reusing, scaling and repurposing integrated practice using a common infrastructure.

3. Smart Manufacturing Execution

a. Dynamic orchestration of decision/action workflows in heterogeneous environments without losing control of state,

i. Across different time constants and seams, including supply chain

ii. Multi-vendor discrete, continuous, operational and human/social applications

h. Applications that can share data and data that can share,

IoT will generate four primary forms of value in terms of manufacturing processes :

1. **Supply chain management :** IoT can help manufacturers better manage their supply chains
2. **Operating efficiency :** IoT provides manufacturers a comprehensive view of what's occurring at every point in the production process and helps make real-time adjustments
3. **Predictive maintenance :** Monitor the status of production equipment in real - time. IoT expected to reduce factory equipment maintenance costs by up to 40 %
4. **Inventory optimization :** IoT helps manufacturers better manage inventory. IoT can drive inventory optimization measures that can save 20 to 50 % of factory inventory carrying costs.

IoT and Smart Manufactured Products

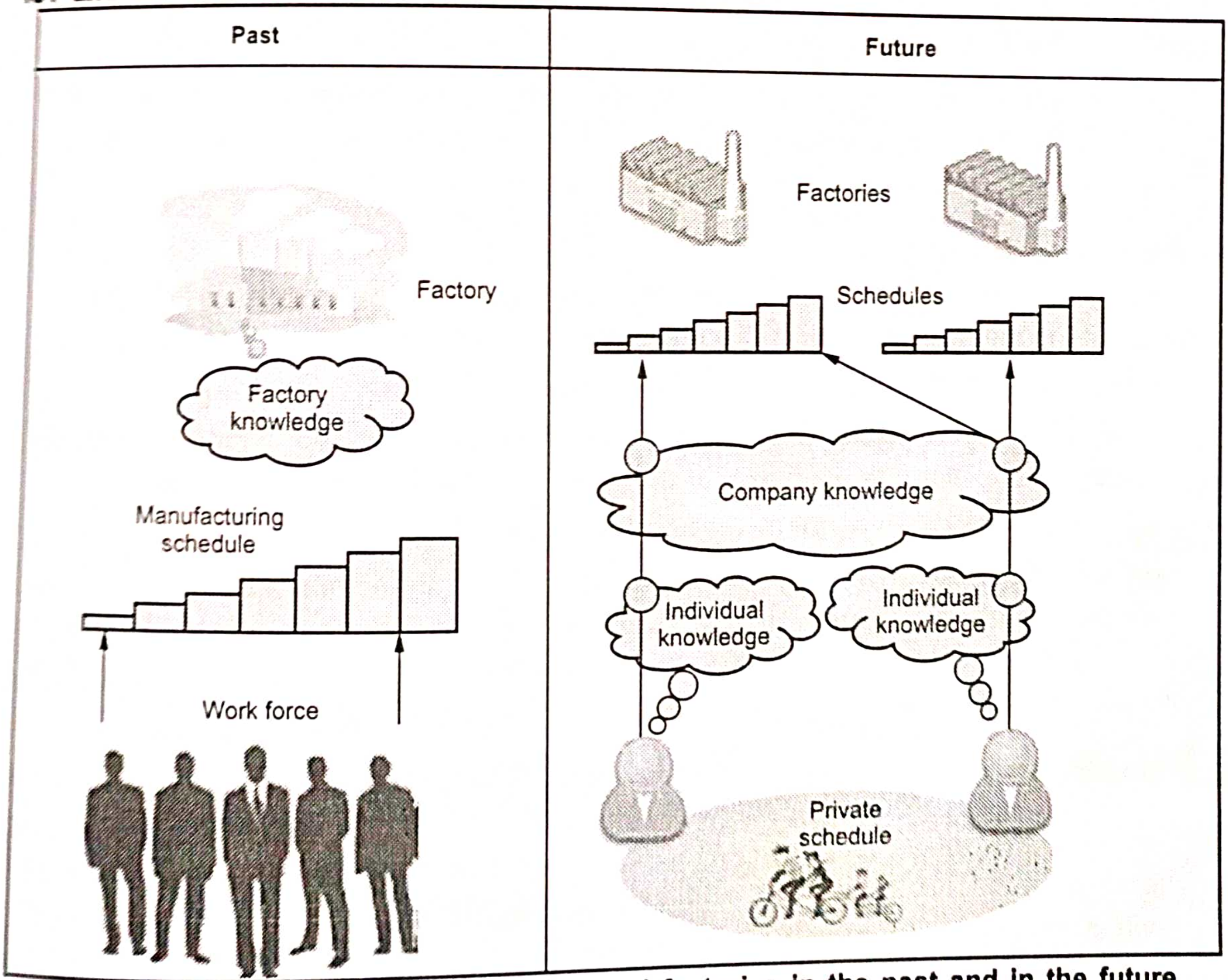

Fig. 7.8.2 : Relation between humans and factories in the past and in the future

- All "smart products" share three key components :
  1. Physical components : E.g., Mechanical and electrical parts.
  2. Smart components : E.g., sensors, microprocessors, data storage, controls, software, an embedded operating system and a digital user interface.
  3. Connectivity components : E.g., Wireless connectivity, ports, antennas, etc
- Fig. 7.8.2 shows relation between humans and factories in the past and in the future. (See Fig. 7.8.2 on previous page.)

Design Implications for Smart Manufacturing Products

1. Low - cost variability : The software in smart, connected products can make variability far cheaper.
2. Evergreen design : Continually upgrading of existing products.

The Augmented Operator

- The utilization of the smart product, equipment and infrastructure will lead to a huge amount of available data.
- The human will need to access situation dependent filter mechanisms in order to decode the data noise.
- Context information such as the task, the role or the intention of the human as well as the location, product status or costumer information can help to identify the situation and to configure the filter mechanisms.

Security :

- In the factory of the future, any physical space connected to cyber space is exposed to the potential threat of a cyber-attack, in addition to concerns regarding its physical security.
- To prevent such attacks, which may result in damage and liabilities, security measures are becoming increasingly important for the factory of the future.
- Typically, cyber security protection is defined as following the path of confidentiality, integrity and availability which still applies for information system networks. However, factory of the future systems which integrate both physical space and cyber space require a protection priority that follows the path of availability, integrity and confidentiality.

7.9 Health and Life Cycle

- Smart health can be defined as medical and public health practice supported by smart devices. The IoT devices will help to test the different parameters so as to facilitate for proper diagnosis. Based on the diagnosis the treatment is monitored.

7.9.1 Health and Fitness Monitoring

- IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants.
- Smart health systems provide health related services using a network some kind of connection between intelligent agents. These intelligent agents could be computing devices, mobile phones, sensors, Fitbit smart bands, surgical devices, devices that measure your blood chemistry, or devices that measure your brainwaves. Any of these things could be intelligent agents.
- The human actors, patients or healthcare providers for example, could be intelligent agents in this system. The sensors, devices, computers, applications, and human actors are all intelligent agents that might be connected in the smart health system.
- Smart healthcare is an important research area for Internet of Things, which employs sensors and other information identifying technologies, wireless and wired networks to realize large-scale, multi-layer interaction between patients and medical equipments, medical staff and healthcare institutions.
- Some challenges in the healthcare system are as follows :
  1. **Smarter hospital :** Smarter hospital is an important improvement of smart healthcare system. A natural problem is how to build a smarter hospital for greatly improving medical services and patient experience.
  2. **Data integration/realtimeness :** How to combine heterogeneous health data sources in a unified and meaningful way enables the discovery and monitoring of health data from different sources. It is also important for smart healthcare to ensure the data realtimeness.
  3. **Medical resource shortness :** There are not enough medical resources for the population. For example, there are fewer doctors and high-level healthcare institutions but more patients.
  4. "Low" usage of community health service centers. In contrast with community health service centers, people prefer the high-level healthcare institutions. This results in the low usage of community service centers.
  5. Bad health habits. The citizens have some bad health habits that contribute to poor health, for instance, smoking and no sport.
  6. Lack of information sharing. hospitals are not sharing enough information. This leads to the following two problems at least. First, the health information records of patients cannot be queried. Second, there is lack of medical cooperation between hospitals.

- The links between the many applications in health monitoring are :
  1. Applications require the gathering of data from sensors
  2. Applications must support user interfaces and displays
  3. Applications require network connectivity for access to infrastructural services
  4. Applications have in-use requirements such as low power, robustness, durability, accuracy and reliability.
- Connected medical devices and associated IoT technologies will primarily be used to achieve the following capabilities :
  1. Access real time visibility of the patient's condition, his/her activities, context and physiological parameters.
  2. Monitor compliance to prescribed treatment, diet and exercise regimes.
  3. Provide feedback and cues to patients, family members, doctors and caregivers in order to implement corrective action.
  4. Leverage high performance computing for real time feedback and use evidence-based medicine for better patient outcome.

7.9.2 Wearable Electronic

- Wearable electronic devices are small devices worn on the head, neck, arms, torso, and feet.
- Current smart wearable devices include :
  1. Head - Helmets, glasses
  2. Neck - Jewelry, collars
  3. Arm - Watches, wristbands, rings
  4. Torso - Clothing, backpacks
  5. Feet - Socks, shoes.
- Smart glasses help us enjoy more of the media and services we value, and when part of an IoT system, they allow a new approach to productivity.
- Smart watches not only help us stay connected, but as a part of an IoT system, they allow access needed for improved productivity.

7.10 Vehicle to Vehicle Communication

- Vehicle-to-vehicle communication is the wireless transmission of data between motor vehicles.
- The technology behind V2V communication allows vehicles to broadcast and receive omni-directional messages, creating a 360-degree "awareness" of other

vehicles in proximity. Vehicles equipped with appropriate software can use the messages from surrounding vehicles to determine potential crash threats as they develop.

- Fig. 7.10.1 shows V2V communication.

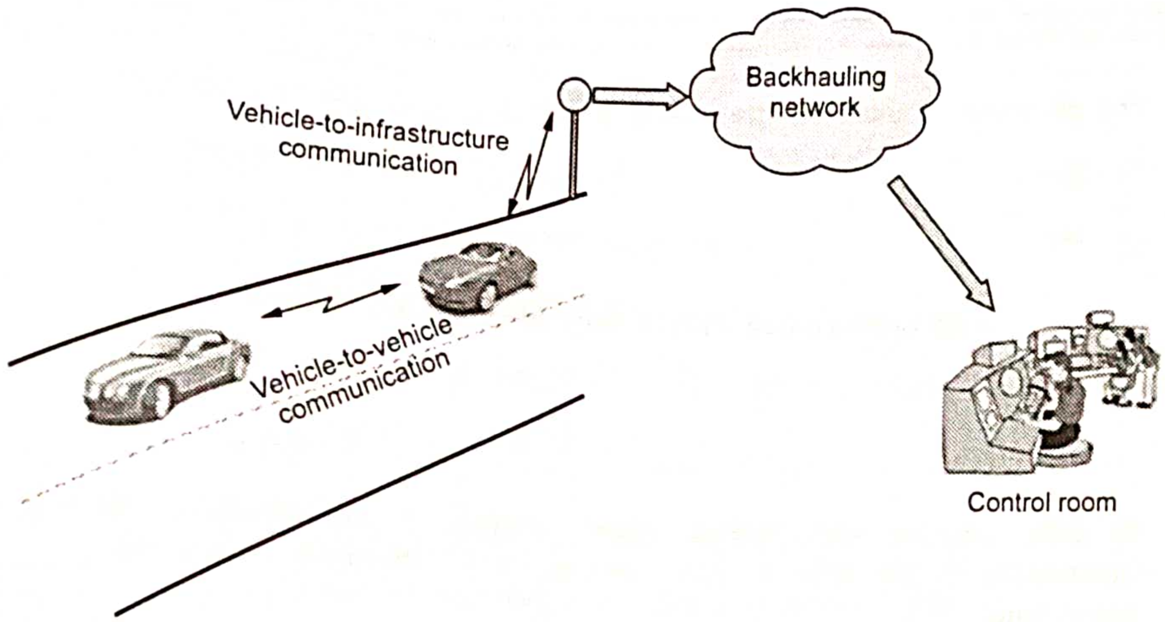

Fig. 7.10.1

- The technology can then employ visual, tactile and audible alerts or, a combination of these alerts to warn drivers. These alerts allow drivers the ability to take action to avoid crashes.
- The implementation of V2V communication and an intelligent transport system currently has three major roadblocks : The need for automotive manufacturers to agree upon standards, data privacy concerns and funding.
- It is unclear whether creation and maintenance of the supporting network would be publicly or privately funded. Automotive manufacturers working on ITS and V2V include GM, BMW, Audi, Daimler and Volvo.

SOLVED MODEL QUESTION PAPER (In Sem)

Internet of Things

S.E. (AIDS) Semester - IV (As Per 2020 Pattern)

Time : 1 Hour] [Maximum Marks : 30

N. B. :

i) Attempt Q.1 or Q.2, Q.3 or Q.4.

ii) Neat diagrams must be drawn wherever necessary.

ii) Figures to the right side indicate full marks.

iv) Assume suitable data, if necessary.

Q.1 a) *Explain different functional units of a digital computer.* **(Refer section 1.1)** **[7]**

b) *Write a short note on PCI bus.* **(Refer section 1.4)** **[4]**

c) *i) Convert 12.125 decimal into binary.* **(Refer example 2.3.9)**
ii) Convert 658.825 decimal into octal. **(Refer example 2.3.11)** **[4]**

OR

Q.2 a) *Explain the various types of computers and their applications.* **(Refer section 1.2)** **[5]**

b) *What is interrupt ? Explain its classes.* **(Refer section 1.5)** **[5]**

c) *Write a note on binary fixed point representation.* **(Refer section 2.5)** **[5]**

Q.3 a) *Explain the I/O data transfer using I/O ports with the help of neat diagram.* **(Refer section 3.1)** **[6]**

b) *Explain the memory organization of 8086.* **(Refer section 3.2)** **[5]**

c) *List the features of 8255.* **(Refer section 3.4)** **[4]**

OR

Q.4 a) *Explain the I/O interfacing techniques : a) I/O mapped I/O b) Memory mapped I/O.* **(Refer section 3.1)** **[7]**

b) *Explain various modes of operation of 8255.* **(Refer section 3.4)** **[6]**

c) *What is ADC and DAC.* **(Refer sections 3.5 and 3.6)** **[2]**

SOLVED MODEL QUESTION PAPER (End Sem)

Internet of Things

S.E. (AIDS) Semester - IV (As Per 2020 Pattern)

Time : 2 $\frac{1}{2}$ Hours] **[Maximum Marks : 70**

N. B. :

i) Attempt Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.

ii) Neat diagrams must be drawn wherever necessary.

ii) Figures to the right side indicate full marks.

iv) Assume suitable data, if necessary.

Q.1 a) *Explain smart IOT-based home automation system.* **[Refer section 4.5]** [8]

b) *Explain various IoT enabling technologies.* **[Refer section 4.2]** [10]

OR

Q.2 a) *Explain SCADA middleware standards in brief.* **[Refer section 4.4.3.1]** [5]

b) *What is IoT? Explain characteristics, advantages and disadvantages of IoT.* **[Refer section 4.1]** [6]

c) *What is telematics and telemetry ? Explain difference between telemetry and IoT.* **[Refer sections 4.3 and 4.4]** [7]

Q.3 a) *Explain any three IoT protocols.* **[Refer section 5.6]** [8]

b) *Explain the following :*
i) YANG *ii) NETCONF* *iii) SNMP* **[Refer section 5.4]** [9]

OR

Q.4 a) *What is WSN ? Explain working of WSN.* **[Refer section 5.1.3]** [8]

b) *Explain architecture and components of M2M. What is difference between IoT and M2M?* **[Refer section 5.2]** [9]

Q.5 a) *Define sensor. Explain different types of sensors.* **[Refer section 6.2]** [6]

b) *What is an Arduino? List its features. Write about power and analog pins.* **[Refer section 6.1.1]** **[6]**

c) *Explain IoT information model specification.* **[Refer section 6.3.4]** **[6]**

OR

Q.6 a) *List and explain IOT functional view specification.* **[Refer section 6.3.7]** **[6]**

b) *Explain IoT security architecture.* **[Refer section 6.5.5]** **[6]**

c) *Explain various IoT SIM card technology.* **[Refer section 6.4]** **[6]**

Q.7 a) *Describe IoT application in plant automation.* **[Refer section 7.8]** **[9]**

b) *What is IoT verticals ? Explain IoT hosted services.* **[Refer section 7.1]** **[8]**

OR

Q.8 a) *What is amazon web services ? Explain IoT connectivity.* **[Refer sections 6.3 and 6.4]** **[8]**

b) *Explain IoT automotive applications.* **[Refer section 7.7]** **[9]**

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