Smart Agriculture

Learning Technologies Project Course

Project Report - II

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1. Design a dashboard or APP that will give crop yield estimation, to improve the crop output and efficient use of fertilizers.

With the growing adoption of the Internet of Things (IoT), connected devices have penetrated every aspect of our life, from health and fitness, home automation, automotive and logistics, to smart cities and industrial IoT. Thus, it is only logical that IoT, connected devices, and automation would find their application in agriculture, and as such, tremendously improve nearly every facet of it. How could one still rely on horses and plows when self-driving cars and virtual reality are no longer a sci-fi fantasy but an everyday occurrence? Farming has seen a number of technological transformations in the last decades, becoming more industrialized and technology-driven. By using various smart agriculture gadgets, farmers have gained better control over the process of raising livestock and growing crops, making it more predictable and improving its efficiency. This, along with the growing consumer demand for agriculture products, has contributed to the increased proliferation of smart farming technologies worldwide. In 2020, the market share for IoT in agriculture reached $5.6 billion.

In this article, we will explore the IoT we are using in agriculture and examine its benefits. So, if you are considering investing in smart farming, or are planning to build an IoT solution for agriculture, dive right in. Smart agriculture, on the other hand, is mostly used to denote the application of IoT solutions in agriculture. So what is smart agriculture using IoT? By using IoT sensors to collect environmental and machine metrics, farmers can make informed decisions, and improve just about every aspect of their work – from livestock to crop farming. For example, by using smart agriculture sensors to monitor the state of crops, farmers can define exactly how many pesticides and fertilizers they have to use to reach optimal efficiency. The same applies to the smart farming definition.

We are planning to design a Web application in order to provide the farmers/users an approximation on how much amount of crop yield will be produced depending upon the given input. The application uses a Random Forest Machine Learning model, which was trained on over 20 years of data from 30 districts of Maharashtra, along with automatic live weather fetching for prediction. The model achieved an accuracy of around 86% and can be even further improved with more data.

1. Output

We are more than 80% ready with our prediction model for crop yield estimation. Only the integration with Api is left which will be done by next week. Here are some code snippets which consist of difflibrary, rtd(Real time data) and prediction model.

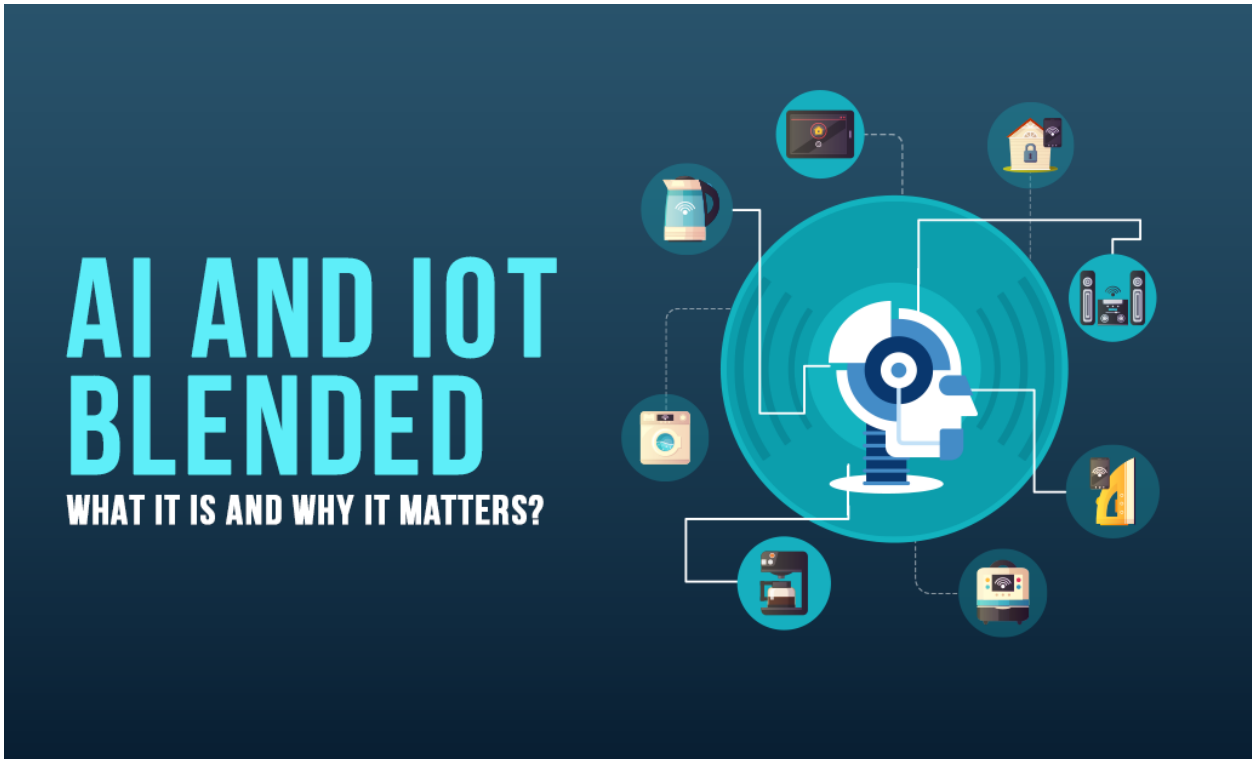
```python
import sys
import pandas as pd
import datetime
from bs4 import BeautifulSoup
import pickle
import requests, json

# print ('Number of arguments:', len(sys.argv), 'arguments.')
# print ('Argument List:', str(sys.argv))

with open('RF_Model', 'rb') as f:
    RanFor = pickle.load(f)


dist_list = ['AHMEDNAGAR', 'AKOLA', 'AMRAVATI', 'AURANGABAD', 'BEED', 'BHANDARA', 'BULDHANA', 'CHANDRAPUR', 'DHULE', 'GADCHIROLI', 'GONDIA', 'HINGOLI', 'JALGAON', 'JALNA',
crop_list = ['Jowar', 'Bajra', 'Wheat']
soil_list = ['chalky', 'clay', 'loamy', 'sandy', 'silty']

district = sys.argv[1]
Crop = sys.argv[2]
Area = int(sys.argv[3])
soil_type = sys.argv[4]

# district = 'PUNE'
# Crop = 'Jowar'
# Area = 598400
# soil_type = 'clay'

district = "District:_"+district
Crop = "Crop:_"+Crop
soil_type = "Soil_type:_"+soil_type
```

```
base_url = "http://api.openweathermap.org/data/2.5/weather?"

# city_name = sys.argc[1]
city_name = 'PUNE'

complete_url = base_url + "appid=" + api_key + "&q=" + city_name

response = requests.get(complete_url)

x = response.json()

# print(x)
if x["cod"] != "404":
    y = x["main"]
    temp = y["temp"]-273
    humi = y["humidity"]
    try:
        preci_humi_link = 'https://www.worldweatheronline.com/lang/en-in/pune-weather/maharashtra/in.aspx'
        p2 = requests.get(preci_humi_link)
        s2 = BeautifulSoup(p2.content, 'html.parser')
        preci_table = ((s2.find_all('div', attrs={'class':'tb_cont_item', 'style':'background-color:#ffffff;'})))
        preci = 0
        for ele in preci_table[21::2]:
            if ele.text == '0.00 mm':
                preci += float(ele.text.replace("mm", "").strip())
        preci *= 6
        # print("Average precipitation: ", preci)
        humi_table = ((s2.find_all('div', attrs={'class':'tb_row tb_rain'})))
        humi = 0
        for ele in humi_table:
            if len(ele.text) > 15:
                humi = ele.text.replace("Rain", "").split("%")[:-1]
        humi = sum(list(map(float, humi)))
```

```
vect = {}
for key, val in index_dict.items():
    vect[key] = 0
try:
    vect[district] = 1
except Exception as e:
    print("Exception occered for DISTRICT!", e)
try:
    vect[Crop] = 1
except Exception as e:
    print("Exception occered for CROP!")
try:
    vect[soil_type] = 1
except Exception as e:
    print("Exception occered for SOIL TYPE!")
try:
    vect['Area'] = Area
except Exception as e:
    print("Exception occered for AREA!", e)
try:
    vect['Temperature'] = temp
except Exception as e:
    print("Exception occered for TEMP!", e)
try:
    vect['Precipitaion'] = preci
except Exception as e:
    print("Exception occered for PRECI!", e)
try:
    vect['Humidity'] = humi
except Exception as e:
    print("Exception occered for HUMI!", e)

now = datetime.datetime.today()
season = "Season:_Kharif" if (now.month >= 7 and now.month <= 10) else "Season:_Rabi"
vect[season] = 1
```

Github Repo link: https://github.com/AvishekRoy16/Crop-Yield-Estimation-NU

2. Role of AI in IOT Project



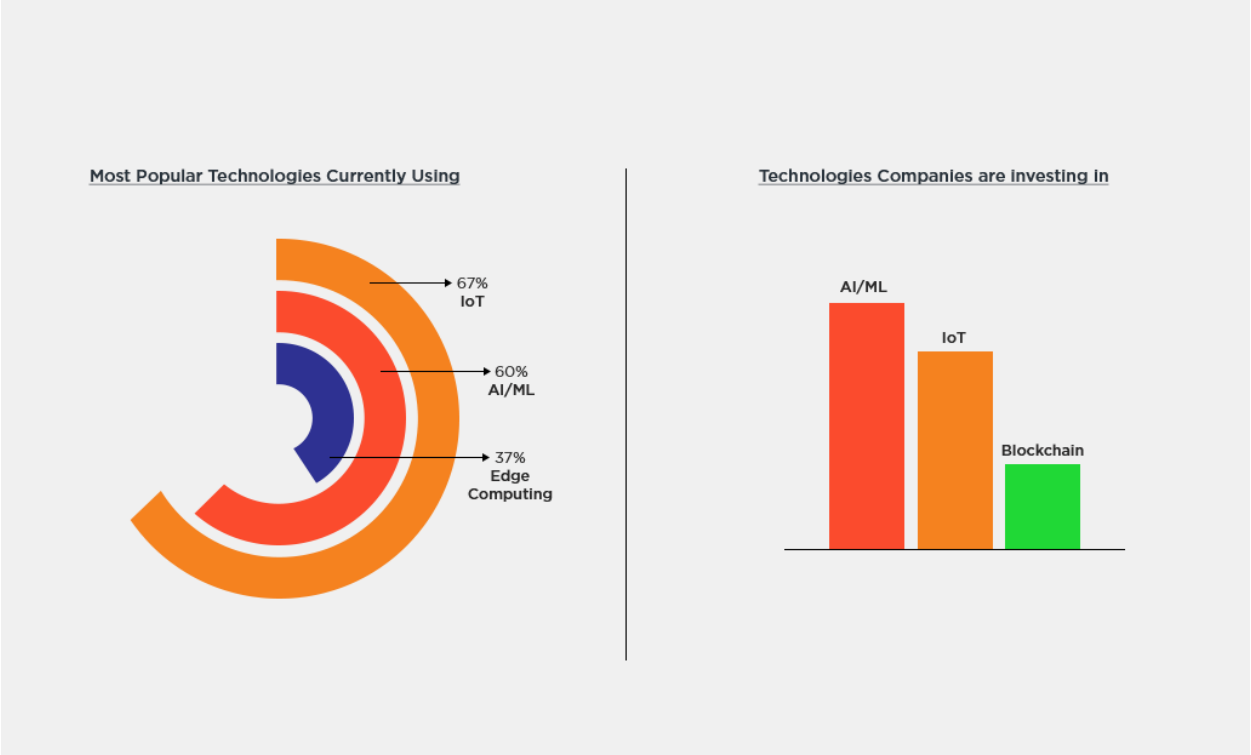
Today's business world is changing with the adoption of IoT (Internet of Things). IoT is helping in prominently capturing a tremendous amount of data from multiple sources. However, wrapping around the multitude of data coming from countless IoT devices, makes it complex to collect, process, and analyze the data.

Realizing the future and full potential of IoT devices will require an investment in new technologies. The convergence of AI (Artificial Intelligence) and IoT can redefine the way industries, business, and economies function. AI enabled IoT creates intelligent machines that simulate smart behavior and supports decision making with little or no human interference.

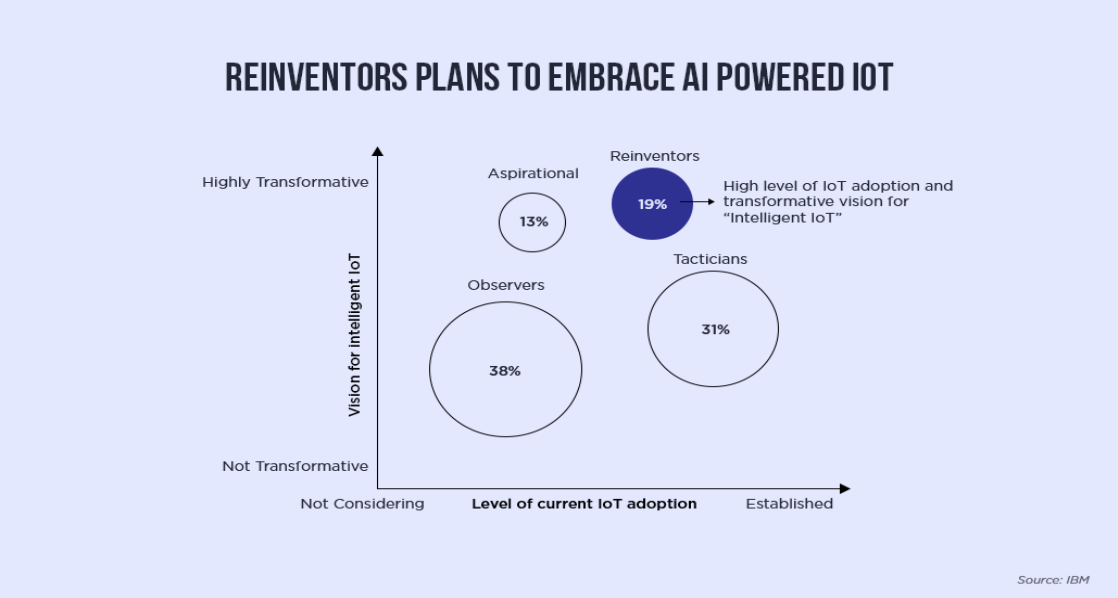
Combining these two streams benefits the common person and specialists alike. While IoT deals with devices interacting using the internet, AI makes the devices learn from their data and experience. This blog highlights why we need IoT and AI to work together.

Increasing Popularity of IoT and AI

Several businesses have already adopted AI and IoT as part of their processes and products. A recent Tech Trend survey by SADA System states that IoT and AI are the popular technologies currently in use today. It also found that AI and IoT are the top technologies companies are investing in most to increase efficiency and provide a competitive advantage.



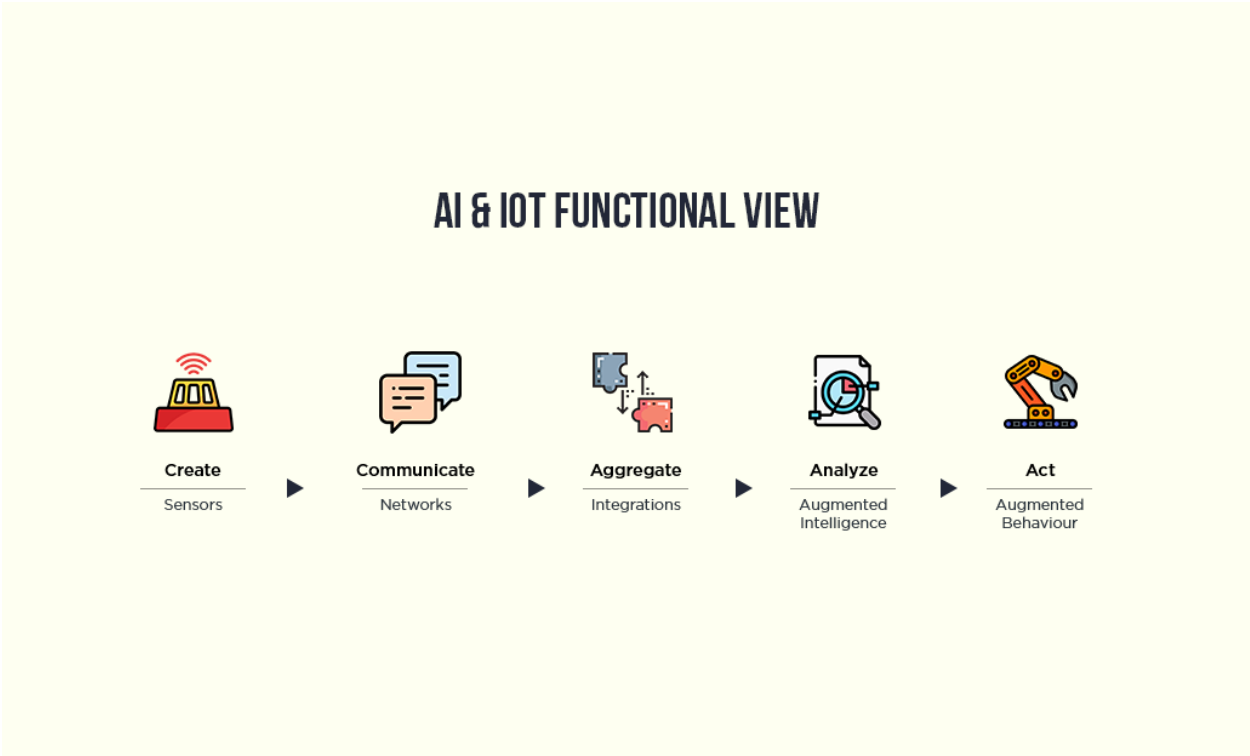
According to the IBM Global C-suite Study program, C-suite executives begin to reinvent their business by digitizing interactions and communications. IBM Institute interviewed a group of C-suite executives and found that 19% of respondents (grouped as high performers called Reinventors) are keenly focused on the benefits of augmented IoT with AI.



Both startups and large companies prefer AI technology for unleashing the full potential of IoT. The leading vendors of IoT platforms like Oracle, Microsoft, Amazon, and Sales Forces have started consolidating AI capabilities into their IoT applications.

Where does AI unlock IoT?

At its core, IoT is about sensors implanted into machines, which offer streams of data through internet connectivity. All IoT related services inevitably follow five basic steps called create, communicate, aggregate, analyze, and act. Undeniably, the value of the "Act" depends on the penultimate analysis. Hence, the precise value of IoT is determined at its analysis step. This is where AI technology portrays a crucial role.



While IoT provides data, artificial intelligence acquires the power to unlock responses, offering both creativity and context to drive smart actions. As the data delivered from the sensor can be analyzed with AI, businesses can make informed decisions. The artificial intelligence IoT succeeds in achieving the following agile solutions:

- Manage, analyze and obtain meaningful insights from data
- Ensure fast and accurate analysis
- Balance requirements for localized and centralized intelligence
- Balance personalization with confidentiality and data privacy
- Maintain security against cyber attack

Benefits of AI Enabled IoT

IoT artificial intelligence leads to a broad range of benefits for companies and consumers like proactive intervention, personalized experience, and intelligent automation. Here are some of the most popular benefits of combining these two disruptive technologies to the businesses:

1. Boosting Operational Efficiency

AI in IoT crunches the constant streams of data and detects the patterns not deceptive on simple gauges. In addition, machine learning coupled with AI can predict the operation conditions and detect the parameters to be modified to ensure ideal outcomes. Hence, intelligent IoT offers an insight into which processes are redundant and time-consuming, and which tasks can be fine-tuned to enhance efficiency.

Google, for example, brings the power of artificial intelligence into IoT to reduce its data center cooling costs.

2. Better Risks Management

Pairing AI with IoT helps businesses to understand as well as predict a broad range of risks and automate for the prompt response. Thereby, it allows them to better handle financial loss, employee safety, and cyber threats.

Fujitsu, for example, ensures worker safety by engaging AI for analyzing data sourced from connected wearable devices.

3. Triggering New and Enhanced Products & Services

NLP (Natural Language Processing) is getting better at allowing people to communicate with devices. Undeniably, IoT and AI together can directly create new products or enhance existing products & services by enabling the business to rapidly process & analyze the data.

Rolls Royce, for example, plans to leverage AI technologies in the implementation of IoT-enabled airplane engine maintenance amenities. Indeed, this approach will support spot patterns and discover operational insights.

4. Increase IoT Scalability

IoT devices range from mobile devices and high-end computers to low-end sensors. However, the most common IoT ecosystem includes low-end sensors, which offers floods of data. The AI-powered IoT ecosystem analyzes and summarizes the data from one device before transferring it to other devices. As such, it reduces large volumes of

data to a handy level and allows connecting a large number of IoT devices. This is called scalability.

5. Eliminates Costly Unplanned Downtime

In some sectors like offshore oil & gas and industrial manufacturing, equipment breakdown can result in costly unplanned downtime. The predictive maintenance with AI enabled IoT allows you to predict the equipment failure in advance and schedule orderly maintenance procedures. Hence, you can avoid the side effects of downtime.

Deloitte, for example, finds the following results with AI and IoT:

- 20% - 50% reductions in their time invested in maintenance planning
- 10% - 20% increase in equipment availability and uptime
- 5% - 10% reduction in maintenance costs

Examples of AI and IoT in Action

Let us have a closer look at businesses that have achieved better user experience and designed new business models with AI-powered IoT.

1. Robots in Manufacturing

Manufacturing is one of the industries that already embraced new technologies like IoT, artificial intelligence, facial recognition, deep learning, robots and many more. Robots employed in factories are turning smarter with the support of implanted sensors, which facilitates data transmission. Moreover, as the robots are provisioned with artificial intelligence algorithms, they can learn from newer data. This approach not only saves time and cost but also makes the manufacturing process better over time.

2. Self-driving Cars

Tesla’s self-driving cars are the best example of IoT and AI working together. With the power of AI, self-driving cars predict the behavior of pedestrians and cards in various circumstances. For example, they can determine road conditions, optimal speed, weather and get smarter with each trip.

3. Retail Analytics

Retail analytics involves numerous data points from cameras and sensors to observe customers' movement and to predict when they will reach the checkout line. Thereby, the system can suggest dynamic staffing levels to reduce the checkout time and increase the productivity of the cashiers.

4. Smart Thermostat Solution

Nest's smart thermostat solution is a good example of AI-powered IoT. The smartphone integration can check and manage the temperature from anywhere based on the work schedule and temperature preferences of its users.

Overall, IoT coupled with AI technology can lead the way to the advanced level of solutions and experience. To obtain better value from your network and transform your business, you should integrate AI with incoming data from the IoT devices.

In field of Smart Agriculture

Data Analytics

The conventional database system does not have enough storage for the data collected from the IoT based sensors. Cloud-based data storage and an end-to-end IoT Platform plays a very important role in the smart agriculture system. These systems are estimated to play an important role such that better activities can be performed. In the IoT world, sensors are the main source of collecting data on a large scale.

Today, agriculture is one of the main industries to incorporate drones. Drones are being used in agriculture to enhance several agricultural practices. The major benefits of using drones include crop health imaging, integrated GIS mapping, ease of use, saves time, and the potential to increase crop yields. With strategy and planning based on real-time data collection, technology will give a high-tech makeover to the agriculture industry.

Applicability of IOT in agriculture

Smart Farming is a hi-tech and effective system of doing agriculture and sustainably cultivating food. IoT farming is an application of implementing connected devices and innovative technologies together into agriculture. Smart Farming majorly depends on IoT thus eliminating the need for physical work of farmers and growers and therefore increasing productivity in every possible manner.

With the recent agriculture trends dependent on agriculture, IoT farming has brought huge advantages like an efficient use of water, optimization of inputs and many more. What made the difference were the huge advantages and which has become a revolutionized agriculture in recent days.

Advantages of IOT in agriculture

All agricultural data can be collected with the help of installed sensors. Such data like weather conditions, health conditions of cattle, and crops. Many business processes

become automated and efficiency is growing. Thus, farmers can pay attention to other important processes.

When farmer’s up-to-date information is collected, they can understand what the situation will be in the future, and they can predict a few problems that may arise. Moreover, farmers can use data to improve their sales and change business processes.

AI(Artificial Intelligence) in Agriculture

Ai technology helps yield healthier crops, control pests and diseases, monitor soil and growing conditions, organize data for farmers, help with the workload, and develop a wide range of agriculture-related tasks in the total food supply chain.

The most popular applications of Artificial Intelligence in agriculture are Agricultural Robots, Predictive Analytics, Crop & Soil Monitoring, Computer vision, and deep-learning algorithms are used to process data captured by drones and software-based technology to monitor crop and soil health, Machine learning models are used to track and predict several environmental impacts on crop yield such as weather changes.

Artificial intelligence is supporting different sectors to boost productivity and efficiency. Artificial intelligence solutions are assisting to overcome the traditional challenges in every field. AI in agriculture is helping farmers to develop their efficiency and reduce environmental hostile impacts. The agriculture industry strongly and openly embraced AI into their practice to vary the overall outcome. Artificial intelligence is shifting the way our food is produced where the agricultural sector’s emissions have decreased by 20%. Adapting AI is helping to control and manage any uninvited natural condition.

Impact of AI in Agriculture

Artificial intelligence technology is rapidly rectifying the problems while recommending specific action that is required to overcome the problem. AI is efficient in monitoring the

information to get solutions quickly. Artificial intelligence technology is being used in agriculture to improve results with a minimal environmental cost. By implementing AI it can recognize a disease with 98% accuracy. Thus, AI helps farmers monitor the fruit and vegetable Artificial intelligence technology is rapidly rectifying the problems while recommending specific action that is required to overcome the problem. AI is efficient in monitoring the information to get solutions quickly. Artificial intelligence technology is being used in agriculture to improve results with a minimal environmental cost. By implementing AI it can recognize a disease with 98% accuracy. Thus, AI helps farmers monitor the fruits by adjusting light to accelerate production.

3. Role of Cloud in IOT project:

Connecting Agriculture to the internet is one of the important activities of the proper operation of IoT devices. It presumes the connection to be wireless, which are classified based on energy consumption, uplink data rate & downlink data rate, packet size, device per access point, topology, frequency band range and channel width. The proposed paper explains about the issues faced in Agriculture and provides the survey of various authors in the field of Agriculture. It also shows the ways of implementing IoT in agriculture.

IoT ENABLING TECHNOLOGIES:

Wireless Sensor Networks (WSN)

WSN consists of a number of sensors or nodes that are connected together to track the various sorts of data.

Cloud Computing (CC)

It is termed as on-demand computing that shares the system resources and data among the requested users. It can be represented in various forms such as IaaS, PaaS, SaaS.

Big Data Analytics

It is the concept of processing large data sets that have various forms of data types.

Communication Protocol

Communication protocols are the backbone of IoT systems. They enable connectivity of various applications and also data exchange over the network.

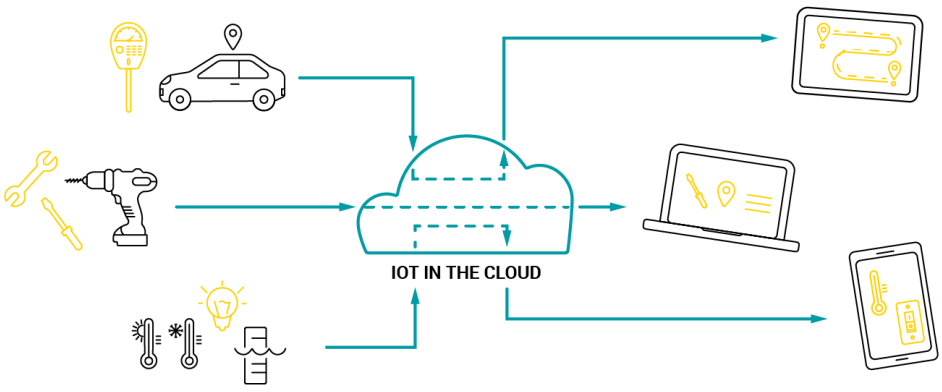
Embedded Systems (ES)

It is a combination of hardware and software,that are intended to do a specific task. It supports the connection of various sensors over IoT.

What’s in an IoT cloud platform?

In an endeavour to bring physical objects online and make them communicate, cooperate and act intelligently without human intervention, the Internet of Things relies on IoT platforms to enable provisioning, management, and automation of smart objects within a given IoT infrastructure. Generally speaking, each IoT environment is a mashup of technologies by various vendors that form a complex and inherently diverse ecosystem which, without a common base for their integration, would stay fragmented, ‘dumb’, and, ultimately, unable to function. Therefore, it can be said that an IoT platform provides a ‘meeting point’ for all the connected devices and serves to collect and handle the data they deliver over the network.

At the other end of the Internet of Things cloud solution, there is cloud computing. Breathing new life into IT services, cloud computing is the latest technology buzz that has moved consumer and business applications to the web, thus enabling enterprises to optimise their IT performance and reduce costs that would be otherwise bloated by the need of creating and maintaining on-site IT architecture for storing data and running applications. Cloud-based solutions are not only more cost-effective in the long run; they also provide better security, corporate data mobility, increased co-worker collaboration, more advanced disaster recovery solutions, to name only a few benefits. What is more, cloud computing offers more flexibility which helps to shift the company’s focus from IT hosting-related issues towards aspects directly affecting its business bottomline.



Benefits of Cloud Platform in IoT

1.Scalability

One of the greatest advantages of placing your IoT system in a cloud is that it is very easily scalable. In case of complex on-premise network infrastructures, scaling up requires purchasing more hardware, investing more time and undertaking increased configuration efforts to make it run properly.

2.Data Mobility

With your data stored and processed in a cloud server, it can be accessed from almost anywhere in the world, which also means that it won't be bound by any infrastructural or networking constraints. Mobility is especially important when it comes to IoT projects involving real-time monitoring and management of connected devices.

3.Time to Market

With IoT cloud solutions, it usually takes less time and effort to implement them and significantly lowers the overall cost, but this is achieved at the expense of platform customization.

4.Security

Security issues, which have been a major concern for the IoT world ever since its inception, can be a tough one here. In the cloud platform vs. on-premise IoT infrastructure clash, it's all about responsibility. In case of on-site servers, it lies in the

hands of the company and it only depends on the security practices within the organisation if the data is kept safe.

5.Cost Effectiveness

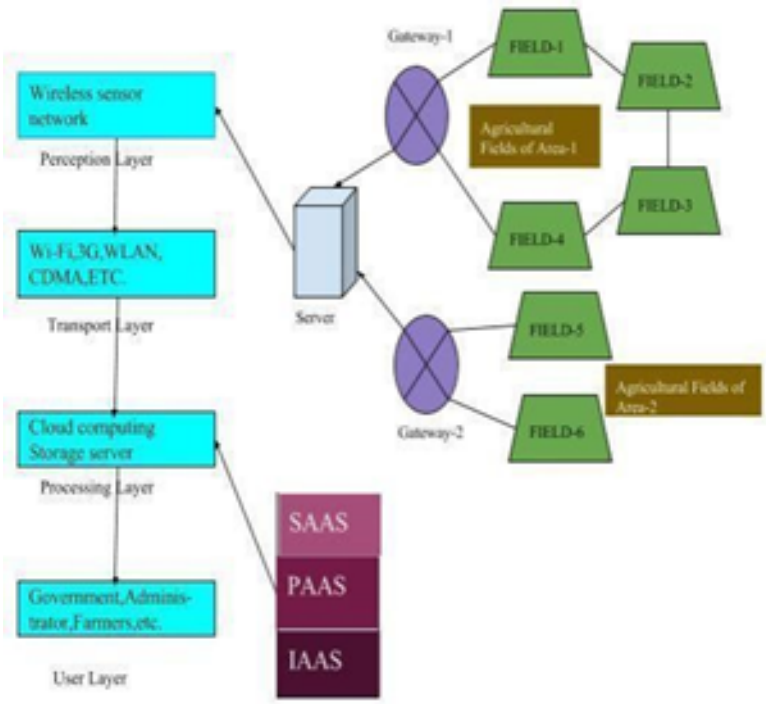
Large initial upfront investments and increased implementation risk in case of an in-house Internet of Things system can be discouraging. Adding to that, there is the issue of ongoing costs of hardware maintenance and IT personnel. From the cloud perspective, things look better. Significantly reduced up-front costs and a flexible pricing scheme based on actual usage encourage IoT-based enterprises to switch to the cloud.

Smart Agriculture Using Iot And Cloud Computing

S.No	Applications of IoT	Sensors used	Measures	Uses
1	Monitoring of Climate Conditions	Temperature sensor, Light Dependant Resistor, sound and CO sensor	Rainfall, Wind speed and direction, Temperature, relative humidity, light intensity and CO level	Reduces labor costs, Effective decision making, Ease of time, Utilization of resources
2	Agriculture Drones	NDVI Sensor, Phantom 4 Pro V2.0 Drone, Matrice 210 Drone, Zenmuse XT2 Thermal Camera, AGRAS MG-1S Drone	Irrigation problems,soil variation, and pest and fungal infestations	Increase crop production and crop growth
3	Crop Water Management	Ultrasonic sensors for water level, Temperature and relative humidity sensor, Soil Moisture sensor,	Focus on climatic circumstances	Understand the soil properties, Demand of water supply for various plants, Control the water wastage,
4	Smart Greenhouses	Temperature Sensor, Arduino compatible Mini Luminance Sensor, light sensor and actuators	Temperature, humidity, Water content, Light level, CO2 level, Soil water potential	Efficient plant growth, Controlled temperature

5	Livestock Monitoring	Connected sensors	Measures the heart rate,blood pressure, respiratory-rate, temperature, digestion and other vitals of the livestock	Saves time, prevent health issues of cattle at earlier stage, Track the location of livestock

PROPOSED MODEL



As per the figure of the proposed model, the data is sent to the server by various gateways. The data at gateways are collected from different sensor nodes which are embedded at different locations of agricultural fields [10]. The wireless sensor network is gathering the data of geographical location by tracking the fields with Radio-frequency identification and other sensing devices [11]. RFID is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The server acts as the perception layer which senses and gives location information. Now the second layer gets the data from the perception

layer and uses different technologies like Wi-Fi, CDMA, 3G, etc. for the transport purpose. Then, the cloud computing technology is used for the virtual storage purpose. The advantage of using the cloud computing storage server is that the cost of data as a service is reduced, as now the user is provided with the extra facility to request only the required service for the required time from the server. The user is not required to pay for the whole service package for a fixed duration which is a costly solution. Thus, if the client is an individual (farmer) then that individual may not be able to afford the entire service package and if the client is any organization (state government) then they are able to purchase the entire package. Basically there are three types of services offered by cloud storage:

1) Infrastructure As A Service (IaaS)
2) Platform As A Service (PaaS)
3) Software As A Service (SaaS)

According to the Pay Per Utility concept of cloud computing, the client can request any of the above services.

Agriculture IOT Solution and Cloud Connectivity

IoT technology is being applied, to great success, in every vertical imaginable. With the global IoT market expected to grow from $157B in 2016 to $457B in 2020, there is no shortage of people and businesses experimenting with the disruptive technology.

IoT is often used to enable heightened levels of monitoring, analytics, production and optimization that is often automated and self-correcting. This makes IoT a useful resource for any industry or user that wishes to improve their processes. IoT can be integrated and applied in multiple ways to provide various benefits, depending on the systemic issues and needs of the industry at hand.

From energy to manufacturing to agriculture, we're seeing IoT solve age-old problems by facilitating the connection and collaboration of electronic devices that work to optimize task completion while reducing unnecessary waste and costs.

More than 80% of companies that adopt IoT technology in their operations report improved efficiency. For the most part, these results stem from a reduction in maintenance costs and times; an essential part of most business operations.

In these scenarios, and many others, IoT technology is often used in tandem with cloud-based services. From its inception, the cloud worked to take the heavy load of any operations on a given network.

Rather than requiring a computer with premium specifications, including RAM and processing power, you can rely on the cloud to shoulder some of the operating requirements by spreading it among multiple computers. Plus, utilizing the cloud allows companies to scale operations, all while handling any fluctuations in processing load with relative ease. Best of all, if one computer crashes, the cloud doesn't go down with it. Cloud technology is built upon the premise that networks can easily be destroyed and replaced at the same time. The cloud doesn't rely on a single server to be failure-proof. Instead, it has an "assembly line" of replacements that can take over at a moment's notice.

IoT and cloud-based services are the perfect pair because they essentially accomplish the same task: optimizing processes while reducing unnecessary cost or waste.

Plus, IoT and cloud-based services have been built on a foundation of affordable hardware and processing power. With a low barrier to entry, anyone and everyone can

experiment with IoT and cloud technology, shaping it to fit their specific needs as a business.

IoT and Smart Agriculture

“Smart agriculture” improves crop productivity and addresses agriculture-specific issues like food demand, land management, and resource depletion. Because of this, the smart agriculture industry is forecasted to reach a market value of $26.8B by 2020.

Smart agriculture relies on IoT-connected devices to make farms more efficient, effective and intelligent. And to meet a growing food demand amongst extreme weather and environmental interference, the agriculture industry needs to be connected with IoT in order to succeed.

If a farmer needs a better way to handle his or her crops, an IoT system can be used to monitor the land with sensors that record temperature, light and moisture among others. Many of these sensors run on solar energy and are extremely energy-efficient. This reduces the maintenance costs of these devices, and saves farmers from having to frequently replace batteries.

IoT can even automate the irrigation system that farmers use, based on the sensor data collected by the IoT-connected devices. As IoT and cloud technology continue to progress, agriculture is becoming more like manufacturing. A farmer's day will consist of monitoring crops using IoT sensors and surveillance networks rather than a physical examination.

IoT technology essentially removes the guesswork and inaccuracy of traditional farming methods by providing an intelligent and efficient alternative method. And because of this, farmers save time and money that could be better used elsewhere.

The benefits of smart agriculture and IoT farming are significant. They apply to local farmers as well as to larger farming operations: efficient water usage, optimal production, and lower costs among others. When it comes to smart technology in the agriculture industry, some nations are more developed than others.

Taiwan has become a global leader in IoT and cloud technology, particularly in the agriculture industry. In fact, some are projecting Taiwan will become the world's largest food producer in the near future. This is an incredible feat, considering Taiwan is a small island (relative to the mega farms seen in Canada and the US), and can be prone to extreme weather. What has led Taiwan to becoming a pioneer in the agriculture industry is its adaptation of smart farming.

Ample land and ideal topography are no longer a strict requirement for agriculture. Multi-story hydroponic farms produce mass amounts of food without using nearly as much space as traditional methods. Plus, IoT, robotics and other technological innovations have enabled agriculture to be less lenient on intensive human labor.

Lin Tsung-hsien, Chairman of the Executive Yuan's Council of Agriculture describes how IoT technology can be used to improve agriculture.

"Unmanned aircraft will fly over fields to monitor crop growth and transmit data to the cloud for analysis of the use of pesticides and fertiliser as well as water resources with results of the analysis lowering costs and minimising impact to the environment."

"All their farmers need to do is to connect to the cloud using a cell phone or tablet."

Existence of IoT and Cloud Computing in other countries

Considering the Asian countries for reference is ideal in our case, as India is a part of Asia continent. Here, the existence of IOT and Cloud Computing for agriculture is explored in two of the Asian countries, China and Japan. Both of these countries are already in the advanced stage in terms of the usage of IOT and Cloud Computing for agriculture.

A. IOT in agriculture at China

The Internet of things attracts much greater attention in China than that in the United States, the European Union and other countries including India. The first Chinese agriculture IOT application service platform has been built by scale, which connects the first group of the 64 IOT bases involved in the production, processing and distribution in China [1]. They can make analysis and decisions with information feedback from the sensing and incorporated with the agricultural knowledge [2][3]. They are now used in agricultural production (in the cities of Beijing, Shouguan and Shanghai), on the fruit (orange) farms (in the city of Chongqing), in the precise husbandry farms (in the city of Beijing) and as well as in the process of the storage, transportation and tracing of agricultural products, etc. [4].

B. Cloud Computing in Agriculture at Japan

Cloud computing is highly suited to further optimize human knowledge to later generations. Fujitsu in Japan has developed a model for using Cloud Computing in agriculture which can also be used in other sectors such as environment, medicine and maintenance sectors[5][6]. The model consists of the following sequence: Inputs-Data storage-Visualization-Analysis-Instruction. The model was field tested for verification in vegetable and paddy cultivation in Miyazaki and Shiba prefectures, respectively.

Benefits of IoT and Cloud Computing in Agriculture

1. IoT enables the large amount of data to be collected over the sensors and thus providing better control over the internal processes and, as a result, lower production risks.
2. With IoT efficient monitoring of the farming environment is ensured.
3. IoT helps the farmers to monitor the fields at multiple locations by enabling remote monitoring. Decisions can be made in real-time and from anywhere. IoT guarantees increased crop production by keen tracking of planting, watering, pesticide application and harvesting.

Various beneficiary applications can be developed based on the proposed model for India. Some of the benefits of IOT and cloud computing applications in agriculture are as mentioned below:

- Improvement in the efficient usage of inputs like soil, water, fertilizers, pesticides, etc.
- Reduced cost
- Livestock monitoring
- Indoor farming – greenhouses and stables
- Fish farming
- Forestry
- Storage monitoring – water tanks, fuel tanks

- Allocation of resources on demand without limit
- Maintenance and upgrades performed in the back-end
- Easy rapid development including collaboration with other systems in the Cloud

4. Role of Cybersecurity in IOT project:

Currently, Internet of things cyber attacks are the major problem that the public are facing. This is mainly because hacking IoT devices became very simple. So, it is essential to have knowledge on defending yourself from cyber attacks.

A lot of precautions have been suggested to prevent the outbreak of a cyber attack on a daily basis wherever IOT is applied. Be it any application and not just efficient agricultural management. We are listing similar such measure below,

- Consumers should investigate before buying any product for their smart homes.
- As there are daily security updates, the device must be updated frequently irrespective of the age of the device
- Changing the password of the devices helps prevent hacking to some extent
- It is important to maintain a separate network for all the smart home devices.
- Make sure when you are buying new devices, you are aware of the security features of the product in detail.

As the devices are connecting progressively, the cyber security in IoT is decreasing. So, there is a need to develop technology with cyber security. To alleviate cyber attacks, people must be educated on the reasons of cyber attacks and measures to be taken to defend from the attack.

The deficiency in the technology architecture and industry standards throughout the IoT is leading to the difficulties in developing security features. The safety measures to be taken by companies in order keep themselves safe from the risks of IoT cyber attack are:

- In order to achieve the security level, companies should devise a well-built governance framework for the Internet of Things devices.
- It is very hard and costly to implement security after the completion of Internet of Things system design. So, make sure that the security is included at the early design stage.
- At first companies are used to bid the security concepts to IoT that are identical for other corporate organizations. But it is necessary to consider IoT as a different data source and integrate security information.
- Companies should communicate with their employees exclusively, providing more knowledge to them about the risks of IoT connected devices. There is no need to convert all the employees into an expert in the IoT cyber security.

Security is a major problem not only in the Internet of Things but also in many other applications. This increases the importance of cyber security. Even though the public are taking measures to prevent cyber attacks, there are circumstances that are not in their control. The industry should make sure that the devices are equipped with enhanced security features.

Privacy is a serious concern not just in the IoT, but in all the applications, devices or systems where we share information. Even when users take precautions to secure their information, there are conditions that are beyond their control. Hackers can now craft attacks with unprecedented sophistication and correlate information not just from public networks, but also from different private sources, such as cars, smartphones, home automation systems and even refrigerators.

Currently, more things are connected to the Internet than people, according to an infographic from Cisco. It goes on to say that 25 billion devices are expected to be connected by 2015 and 50 billion are slated to connect by 2020. In this quickly evolving world, all the things that connect to the Internet are exponentially expanding the attack surface for hackers and enemies. A recent study showed that 70 percent of IoT devices

contain serious vulnerabilities. There is undeniable evidence that our dependence on interconnected technology is defeating our ability to secure it.

Information technology security experts have been warning the public about cyber threats for years, using conferences such as Black Hat to publicize new vulnerabilities in systems and software. At the 2014 Black Hat conference, many discussions were focused on the IoT. Still, users seem not to pay attention to these alerts either because they aren't particularly knowledgeable on the technical aspects of exploits, vulnerabilities and threats, or simply because they do not care.

The top 10 security problems that are seen with IoT devices are:

1. Insecure Web interface
2. Insufficient authentication or authorization
3. Insecure network services
4. Lack of transport encryption
5. Privacy concerns
6. Insecure cloud interface

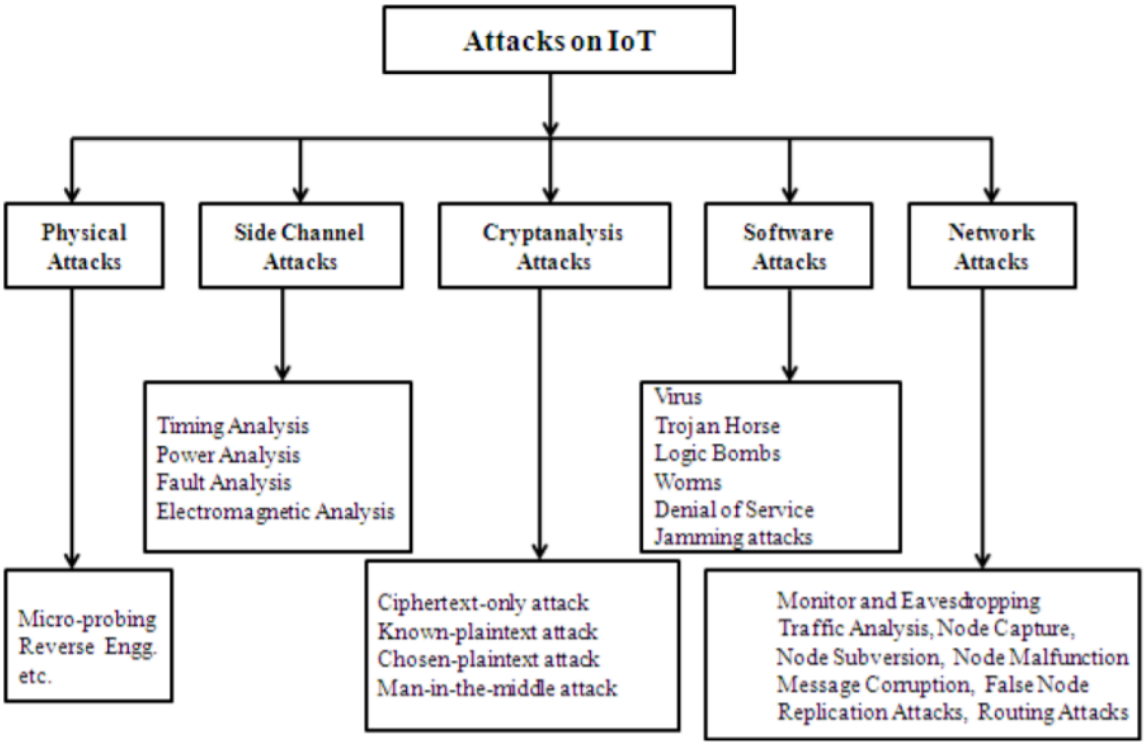
7. Insecure mobile interface
8. Insufficient security configuration
9. Insecure software or firmware
10. Poor physical security

It seems that capable hackers are everywhere, and their growing focus on the IoT is a natural progression since they are looking to where the world's data is flowing. The interconnected world is coming, but so are its hackers.

The good news is that the cyber security landscape is already adjusting to the new demands of this widespread network. The bad news is that we are far away from that utopia, where the IoT manages security automatically by the same interconnected devices and provides a safe infrastructure for users and their personal information.

Just as experience has shown us in the past, in a few years, there could be a whole new class of things to worry about in the cyber security field. Hopefully, by then we will have already taken care of the current problems we are facing in the smart IoT network.

Summary of known IoT attack Types



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Due to the nature of the limitations of computing capability and energy, the algorithm and mechanism applied to the object are relatively simple.

• Conventional security mechanisms such as real-time antivirus scanning cannot be used for the IoT platform due to the unaffordable overhead.

• Attackers can spend much less resources to break in, and thus, the object becomes a target of malicious users. Another good example is the limited logging, which makes the identification of intrusion harder.

• The large number of objects with various, heterogeneous actions and behaviors enables fabrication of identity.

• The mix of infrastructure-based and proximity-based communication technologies causes malware to propagate rapidly.

• Malware propagate via infrastructure-based communication technologies such as GSM/General Packet Radio Service (GPRS)/Universal mobile telecommunications System (UMTS)/Long-Term Evolution (LTE) and wireless local area network (WLAN).

• Alternatively, Using proximity schemes BLE, Wi-Fi direct, and NFC, attackers infect the objects in the vicinity and cause an epidemic spread.

What makes the Internet of Things (IoT) different from the traditional Internet? People, for starters. The IoT doesn't rely on human intervention to function. With the IoT, sensors collect, communicate, analyze, and act on information, offering new ways for technology, media and telecommunications businesses to create value—whether that's creating entirely new businesses and revenue streams or delivering a more efficient experience for consumers.

But this also creates new opportunities for all that information to be compromised. Not only is more data being shared through the IoT, among many more participants, but more sensitive data is being shared. As a result, the risks are exponentially greater.

Take the smart home as an illustrative example. Imagine a garage door opener with the added functionality to deactivate the home alarm upon entry. This is a convenient feature for a homeowner entering their home in a hurry. However, now the entire alarm system could potentially be deactivated when only the garage door opener is compromised. The broad range of connectable home devices—TVs, home thermostats, door locks, home alarms, smart home hubs, garage door openers, to name a

few—creates a myriad of connection points for hackers to gain entry into IoT ecosystems, access customer information, or even penetrate manufacturers' back-end systems.

Many technology, media and telecom companies are already grappling with these cyber risk challenges. What are they finding? In this issue of Flashpoints, we'll take a closer look at some of the more notable developments in the battle to combat cyber risks and take advantage of new opportunities as the IoT expands its reach:

- An integrated risk philosophy is not optional
- Cyber risk management and innovation must be on equal footing
- No global risk standards? No excuse.
- Retrofitting can work – but it introduces new risks
- Loosely coupled systems can help now—in lieu of an overhaul

In most large organizations, the approach to cyber risk may differ by region, product, or business unit. For many, that has worked well enough—parts of the company that require a heightened approach to cyber risk handle their threats in one way, while others take a different tack. But the IoT is forcing many technology, media and telecommunications business leaders to reassess this decentralized approach, since it tends to connect enterprises and their operations in unexpected ways. Safeguarding the IoT is complicated by the scale and scope of data being generated and collected, not to mention the fact that much of it is actually held or accessed by third parties. As a result, many leaders are implementing an umbrella-level cyber risk paradigm, raising standards for cyber risk at every level of the organization, enterprise-wide, from pre-threat to post-event. That means preventing and anticipating IoT-related cyber threats before they take hold, monitoring and neutralizing threats already in play, and restoring normal operations as soon as possible when an organization is struck by a threat.

More information creates more possibilities to create value: This is the promise of the IoT. Today, entire business models are launched on the idea of tight collaboration between organizations – and data is often the glue holding them together, propelling companies to invest significantly in customer analytics capabilities to discover new value streams for their customer. These collaborations are taking advantage of an exceptionally broad portfolio of data types—not just device and system data, but everything from employee rosters and inventory records to non-traditional data types such as facial recognition data, facilities access data, industrial control system data, to name just a few. For many, this is uncharted territory, and along the way, data governance has failed to keep pace.

How do you exercise firm control over data governance in that environment? Tighten the controls too much, and you could squeeze the life out of much-needed innovation. Pursue an approach marked by loose oversight, and you could be exposed to outside cyber risks. Cyber risk and innovation are inextricably linked—one shouldn't be

subordinated to the other. Some of the most forward-looking executives in technology, media, and telecommunications are harmonizing these business imperatives by engaging with business leaders both within their organization, as well as outside, to establish a “baseline of normal”. By understanding what “normal” data activity looks like, possible abnormalities can be quickly and accurately flagged for further review.

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