FOUNDATION OF DIGITAL BUSINESS

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Week 01

Lecture 03

Lecture 03 : Overview of Emerging Digital Technologies-Part 1

So, we go to the next module the second module which is overview of emerging digital technologies. In this I will have three sections within this module and I do not have different names will be part 1, part 2 and part 3. Basically this will talk about your various basic principles, some laws, how the whole thing gave rise to the exponential growth of digital technology, that is the essence that this exclusive growth. How did it happen?

Everywhere like in physics and chemistry laws etc. Newton's laws and all those laws we have. Archimedes principle which we will study in all school and colleges. Here also you have some laws which is you can explain why these you know thing happened like it is happening. In this module I will talk on Internet of Things and then subsequently in part 2 and 3 I will cover some of them to give you a high level view of these technologies. This is not again as I said, is a technical course. It is not for the IT personnel who will do programming, and coding.

This is mainly for people who are going to use the systems or exploit the systems like a sales person, or a manufacturing person or a finance and even for that matter or a purchase person. These are the business functions where you want to work, but as I told you every business to survive or to grow needs digital technology. You will be using a lot of digital technology as part of your job. You should know something on this so that you can recommend and suggest new innovations. We will talk about innovation.

What is innovation? Innovation ,as we say you should be very innovative, come up with new ideas, think out of the box. You must have heard all of these things or when you work your boss will tell you or somebody will tell you. What is really innovation is

about? Innovation is all about finding new way of doing things much better, faster, cheaper, whatever.

And how do you find out new way of doing things? These are technologies which if you know there is something called IoT or there is something called blockchain, have read something about quantum computing or something like that anything. Then when you are in your work it might strike you why not try this. It is a good use case for maybe an IoT device and I can use that. Then you go and suggest to your boss. Why do'nt we use IoT for this work and that might click.

This is how innovation happens, but before that you must know what is available today. It is a continuously changing world new and technologies are coming as I said every now and then. You have to keep reading that is the only way you keep yourself updated and that is true for any profession for that matter. As a teacher, I have to continuously read, a doctor has to continuously read or find out what new medicines are coming out. Similarly, in digital technology or any business function for that matter. Today my whole lecture is all about connecting business function with digital technology. You as a business person should know what is happening in the digital world because you will be the user or possible user of some of those technologies.

You must know what is happening; do not depend on just your IT team, or the IT department to feed you things—they will not. It is always much better and advisable for every individual to have a minimum level of awareness about what is happening around them. Now, this is an interesting thing I teach and show in all my classes to my students. The chessboard puzzle—this is a very classical story.

Let us take, say, an Indian scenario where there is a king who has a daughter who is very sick and about to die. The king asks for help from anybody who can cure his daughter, but everybody fails— But a poor fellow, a farmer, comes in wearing very simple, torn clothes—a dhoti, etc.—and says, he can cure the king's daughter. The king was surprised. Fine, but now the king is very desperate; everybody has failed. 'Give it a try.' He tries, gives some medicine, and the daughter gets cured. The king, obviously, is very happy and then says, 'Take whatever you want—any reward, gold, jewelry, diamonds, etc.'

But this farmer says, 'I do not want anything. You just give me—there is a chessboard.' Give me 1 grain of wheat in the first square, then put 2 grains of wheat in the second square, then 4 grains of wheat in the third square, 8 grains of wheat in the fourth square, and so on.' 'So, fill up all the 64 squares of the chessboard with wheat grains, starting

with 1 and doubling square after square.' Now, the king thinks, 'What a stupid person he is! I am offering him gold, diamonds, this, that—he wants some quantity of wheat.' Now, what happens is—fine, he tells his minister , "Get the wheat and give him whatever he wants". I asked him to take gold, diamonds, land, whatever—but he is asking for wheat, so give him that.'

And they start, and that is how the story goes—they ran out of stock within a few squares; and ran out of the entire wheat stock of the whole country, etc. This is what is known as the power of doubling. What happens is that if you fill up the 64 squares, it is equal to some huge number which you can see: 2 to the power of 64 minus 1. That is a huge number—roughly about 460 billion tons. In today's world situation, we do not produce so much wheat in the whole world. So, the whole world's wheat production will not be able to satisfy this required demand from that,

Poor farmer. This is the moral of the story: the power of doubling. If you go on doubling—so, you know, bank interest we say compounded—when it gets compounded, then the interest jumps. If it's simple interest, it will go only 5 percent, 6 percent every year, but if you compound that cumulatively or go on doubling, then something else happens. So, this is the story behind it. I will link it up now with what I am trying to explain: the digital technology's exponential growth.

A gentleman called Gordon Moore—one of the founders, of Intel. I am sure most of you have heard of Intel Corporation in the US, which makes microprocessors or the chips—the brains in your computer. Many other companies do, but they started Intel Corporation, back in the '60s in a big way. In the chip microprocessor, you have what we call transistors. Transistors are electronic components, which functions like a switch, either switched on or off, etc.

And you need N number of transistors in a circuit. Microprocessor chip is actually a computer without the input and output device. If you add a keyboard and a display, it becomes a computer because that is a CPU - microprocessor chip, made out of silicon. Chemical etching, a very complicated process, is used to make the circuit. Moore said back in 1960 that on a given silicon chip every 18 months you can double the amount of transistors you fit in there. For a chip of size whatever 2 centimeters or 3 centimeters or 3 centimeters, suppose you have 100 transistors.

Moore said every 18 months the capacity of the chip you can double by doubling the number of transistors in the same size of the chip. The chip size given same, number of

transistors you can put there doubles every 18 months. What has resulted today that in the small chips you can have billions of transistors e.g. 20 billion transistors in a small chip. Almost 60 years have passed and every 1 and half or 2 years the amount of transistor which can be put on a chip is doubling. The power of doubling it is an exponentially growing thing number.

This has made today's chips very powerful and cheap because you are putting more number of transistors in that same silicon piece wafer, made out of pure very pure silicon. That was the first law. The next was Butters law which states, that the amount of data communicated through a single optical fibre like those optical fibres which you know on the road you must have seen they are laying all carrying your data which is coming to your house. The data carrying capacity It doubles every 9 months.

The amount of data flowing through that same fibre doubles every 9 months and there is somebody called Kryders who said that the amount of data stored per centimeter square of a hard drive. will double every 13 months. Your computer storage we used to have earlier some 100 MBs then became GBs. Now ROM, memory is 250 /500 GB, or even now 1 terabyte in PCs or Laptops. We have hard disks with 1 terabyte, 2 terabytes, but the size of the laptop or the computer have not grown bigger.

The storage capacity of that same size device is doubling every 13 months and today we know it is 1 terabyte easily available for a hard disk and nobody will buy anything below 500 G. What has happened the size of computer remaining same, capacity doubles and the cost per GB of storage is coming down. Take a look at this graph, very interesting graph. The cost of performance here and this is the timeline 1992 and today. If you take the green line, the 1245 dollars per gbps of communication, bandwidth when you communicate, today the cost is less than 10 dollars.

The blue line is storage 569 dollar per GB of data storage cost 1992, today it is less than 0.01 dollar that is 1 cent. 1 dollar is roughly if we take say as 100 rupees then it is 1 rupee per GB of storage cost. For computing cost it was 22 dollar per million transistors, now it is less than 0.6 dollar 6 cents or say 6 rupees. You can imagine the scale it which dropped. Today the prices are this.

We are talking in terms of rupees or prices per unit of whatever storage, communication or bandwidth etcetera. This is the answer to why digital technology has expanded exponentially. The costs have drastically come down. If you want to build an app or do some service oriented business, all you need is a laptop or a phone and an internet

connectivity and that internet connectivity is also very cheap. Again because of this, how much do you pay? Your monthly bill may be 600 rupees, may be 800 rupees per month and having that you can make a video call with your business partner, friends, relative, etc., sitting anywhere in the world.

10-15 years back or 20 years back when the mobile phone in late 90s or early 2000s, cost of one minute of local mobile call was used to be around 8 rupees or so. And international call from roaming charges, I have made calls costing 100 rupees per minute when you are calling from outside to India. I am talking about 2010 when those days, international roaming cost was 100 rupees a minute. Talking 10 minutes at your home was 1000 rupees , while, today it is free. You walk into a hotel having wifi, open your phone and make a whatsapp call at no cost.

You do not pay anything. Free of cost you can make a call and video call anywhere in the world from anywhere to anywhere. Be it for business or be it for personal use. This is the transformation, the exponential growth which has happened because of these reasons. Today, I can have a business partner and they can be located anywhere and the communication cost is 0. You hardly need investment to build an App. Hirea service from platforms like, Amazon, AWS or Azure and take them on rental basis. You do all your development there and launch your product. Then, the res like advertising etc. can be done online through cloud and social media, etc.

All your advertising can be on social media, digital marketing, Facebook, and other platforms. With minimal cost, if you have a good idea, you can start a business. If you have one, two, or three smart people, you can start a business that can be scaled up to any level. Because with the cloud and the internet, there are no limits for you. You can scale up to any level. Now, some of the digital technologies I mentioned earlier.

These are the outcomes of what I was talking about: Moore's Law and others, like Kryder's Law. One is IoT, the Internet of Things, cloud and edge computing, blockchain, and artificial intelligence. Regarding artificial intelligence, we will have many modules later on, so I will not talk much about it now. Then there's virtual reality, augmented reality, 3D printing, and 5G communications. I have told you before, I will give you a brief overview so that you understand what it is and where they can be used. Some use cases can give you ideas for future applications in your work.

Some pictures for you to visualize these technologies. What is the Internet of Things? IoT basically consists of a large number of devices connected via the internet to sense and

respond to environmental conditions. These devices are typically sensors to measure things like temperature, pressure, etc., and actuators that perform actions based on what they sense. They exchange information with controlling software for a defined purpose.

At one side you have the sensors and actuators and then it has to have an internet of things through which the internet is here and then you have a software. You have sensors, actuators, the internet and the software and then of course, the data to complete this what we are calling as IoT internet of things. This is your system architecture. Now, let us take a look at this picture or meme or whatever it is. It is showing a person is running or whatever.

Here sensors, could be embedded in say your smart watch or the phone which is in your pocket. There can be an ECG sensor, there can be a motion sensor etc. Various sensors are possible. Through this phone which has got an internet connection. that information can be sent to anywhere to a hospital to a doctor or to an app which will give you an analysis and you will get the result in the phone itself. This is an example of Internet of Things, IoT.

We have a sensor here this person is walking or running or whatever then using the phone it is being sent to the cloud or somewhere where it is being processed In many cases this thing is coming back to the phone which also has a processor , which is being used by the app, in the phone. It takes the data through the internet comes to this phone where the phone is used to send the data. Or the smart watch can be sending the data to the phone for guys who are wearing smart watch. But those who are not wearing smart watch the phone should be in their pocket. If you are wearing a smart watch, the phone need not be with you, it could be somewhere else.

It is doing an analysis and will tell you that you have walked so much steps or you have consumed so much of calories or energy, what was the heartbeat land whatever it can do depending on the sensor. It can give an ECG report —again, it all depends on what sensors are there. But all of these readings are supposed to be possible to get here, and then either you can take it to your doctor. You take this phone to your doctor. Show him the report, or using the internet , you can send the report directly to his phone, for example, or to the hospital, or to the doctor in the hospital. He sees your report remotely. You have not gone; you are just on your way home, and he sees the report and then can advise you on what is to be done or what nothing is to be done.

This is how we are connecting people to things. This is IoT—one of the examples of IoT. Now, IoT can also connect things to things. Actually, it is anything-to-anything combination. It could be monitoring, like a machine, for example, through an IoT and connecting to an app or somewhere for the maintenance person to take a decision based on whatever the sensor is reading.

IoT is everywhere. This is the example I was talking about—this wearable technology. It can sense many things; it can sense even the oxygen content, the blood sugar nowadays, and it is increasing day by day. Everything—your entire diagnostics—probably, in maybe a year or two, you will find just wearing a watch, and it can probably carry out all your diagnostics for blood report and analysis and whatnot. So, these things will continuously go on; new things will keep coming up. Now, this is an example of a smart fridge—a refrigerator—where it can, you know, predict your needs.

Suppose you have, let's say, for example, eggs in your fridge, and you have, say, 20 eggs. Now, you have set a limit that when the egg level comes down it can order eggs. Say both of you are working and busy and come late from office. Now, there is a smart fridge, and you have set a limit that when the number of egg level comes to 5, it should order again another replacement order. It can be an IoT device which is sensing the number of eggs. As you are consuming, the number can be tracked through some optical device or whatever.

When it comes to 5, and it is connected to an e-commerce site like say Blinkit for example, it connects to Blinkit app and orders 28 eggs. It does on its own, and also makes a payment. You come back home and see that blink has delivered 28 eggs and you put it in the fridge. These are all smart devices which are available today, I mean this fridge can be expensive, but these are all technically possible. It can similarly monitor your entire supply ,whatever you want to put in your fridge, could be fish, chicken, eggs or vegetables, you can do that and it can monitor the situation,

stock out and can give you information to your phone. So, all the stock of chicken becomes 0. You know chicken is exhausted and while returning from the office you should buy chicken or maybe you order it wherever online. Basically you are getting information with the help of this smart device. Similarly, in health care massive applications of IOT because you have sensors all over the place.

ECG etc and ICU and say all these sensors can communicate to the central monitoring facility or to the doctor etc and then they can take actions whatever they want. The IoT

use cases in manufacturing domain are responsive supply chain, predictive maintenance. I have given you some examples, connected asset management, this also I have talked about. Asset management, connected logistics, stores inventory etc. it can communicate like it was doing for the refrigerator. Principles is very similar. You retail store, stocks, maintenance , connected building, connected home, connected cities, connected healthcare, connected car, connected family, connected policing, security. Literally, for everything you can use an IoT.

At traffic signals you have cameras to do traffic management. If you cross the speed limit or you cross the red line, stop line there is a red signal and you cross the signal break jump the signal basically. The camera will identify your license number plate and this will be communicated. This is the sensor (the camera) and it reads then it communicates the data to the police central computer that car number such and such has crossed the red signal. Now, the computer will then search from the number as to who is the owner of the car, where the car is registered and what is his phone number

and a message will come to that person's phone that you have jumped the red line you have been fined 5000 rupees. It is being done in all metro cities. This is IOT and it is part of the smart city. You know what is a smart city , do you ? There is no need to have a policeman to watch to take your car number or may be take a picture then report to the police station. Today there is a speed limit of 60 kilometer per hour, in metro cities.

In case you cross this limit in Kolkata, within 2-3 minutes you get a message in your phone, mentioning that you have crossed the speed limit and the fine is so much. There is a speed radar and a camera. The camera is for recording your number plate and speed radar for measuring the speed. Both of them working together and police can find out from central computer, that car belongs to this person and the system sends him a message about fine being so much. That is an example of a connected city or smart city, or you know how things work in an IoT device. The other advantage of IoT is datafication, because all of these are generating data.

The traffic camera which is there monitoring the traffic conditions—like in a Google map, you get these red lines, etc. How do you get it? There is heavy traffic, congestion, slow traffic—it is all because of the cameras. Cameras are monitoring the traffic volume, and data is send to a central computer. Google subscribes to that central computer, getting the feed for their map, and you, as a driver, can see that. All of this is generating data

through these connected devices—since they are connected and they are working round the clock.

 On 24/7 basis these are generating huge data. This is called datafication. We will have a similar effect of pervasiveness as that of electricity in the 20th century because when you have a lot of data, you can do a lot of analytics. If you can do a lot of analytics, then you can get many insights, much information, and much intelligence—business intelligence. Because without data, without good-quality data, you cannot do any analysis.

So, that is the base. And all of these devices are helping you because they are real data. They are in the field; they are on the street. The actual data taken, is real data, not falsified data or data created by somebody.

It is the actual real field data; you cannot have better data than this. Key impacts are automation, integration, and servitization. I was talking about automation; I have given you many examples. Then integration is the data from machines with data from other sources. Like I was talking about the speed radar and the camera for the license plate recording.

This is data integration. Similarly, in the machines at the plant, data that can get put into the ERP system or any other software which can then give further recommendations, solutions, or whatever. Once you have a sensor sending data, the data can be like medical data, for example, a smart watch; it can go to your hospital record system. That individual name, such and such, phone number such and such, this was the reading. Then, based on the reading, the doctor can give some recommendation of medicine, etc.

This is integration, and servitization in mobility as a service. Everything is now becoming rent, not buy approach. It is even being said that the driverless and autonomous cars, will become very practical and commercially available everywhere. People will stop buying cars because you can get a driverless car which can come anytime you want and you go to office and then you release the car. Why do you need to keep the car when you are in the office 8 hours 9 hours, with the car just sitting there. If you own a driverless autonomous car you go to the office and you release it.

Now that car becomes available to say Uber to be used as a taxi. That gets connected to the Uber platform, then wherever it gets an order it goes, picks up and drops passengers. Time is scheduled that from between 9 and 5 and after 5 that car comes out of the Uber

system and comes back to your office. So, that you now can leave office an the car is there to take you home.

You own an autonomous car, you go to your office, but you do not need the car for 7-8 hours when you are in the office. You can use the car to work as a taxi and you earn some money. This is an example of servitization. It might today look very imaginary or too far in the future, but you never know the way technology is moving, it can be a reality may be one year down the line , say by 2026-27. But there are some challenges which you should note of IOT having diverse standards and technologies and lack of standardization.

Multiple sensors each will have their own technology, own protocols and standards. Sometimes may not match. That is a problem of electronics and digital technologies. Uncertainty and risks in adopting new business models due to a lack of standardization. Since we are still very new,

you just cannot suddenly jump to adopt these technologies because there could be some risks. You have to study it well. Managing a complex ecosystem involving multiple partners as sensors are made by somebody, the hardware is made by somebody, the computer/laptop is made by somebody, and a phone is made by somebody. Multiple software vendors and network service providers, all of these have to integrate, you know, combine together to give you the final result.

Somebody has to do the data analysis; the internet service provider has to transfer the data at a certain speed, not lag too much, etc. depending on the urgency. All of these agencies, you know, they have to work together. That is a risk or the challenge. Uncertain regulatory environments, for example, in connected vehicles or in drones, because drones are also heavily using IoT since they are sensing and transferring data. But drones are now getting regulated, especially now with this war, etc. going on.

Drones are again where the government can stop you from flying a drone above a certain height or in certain areas, like near the airport; they can restrict it in many ways. There could be a lot of government restrictions happening to drones. You have to be aware of that. Finally, if you see what we are saying in today's world, see this picture as either disruption or opportunity. This ball, or the stone, or whatever, is rolling down the slope.

For this person it is a disruption, but for another person, it is an opportunity—since this rolling ball has got a lot of energy. Potential energy is getting converted to kinetic energy.

It can utilize this motion of the stone rolling down as kinetic energy to do something. What he sees is a problem coming; he sees an opportunity—why not utilize it? With that, I will end this section—this session. Then, you have the references, of course, mentioned in the last slide, which you can refer to for further studies. Thank you very much.