Blockchains Architecture, Design and Use Cases

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Lecture – 31
Blockchain in Financial Services: Payments and Securities Trading

Hello everyone and welcome back to our lecture series on the Blockchain course Architecture, Design and Use Cases.

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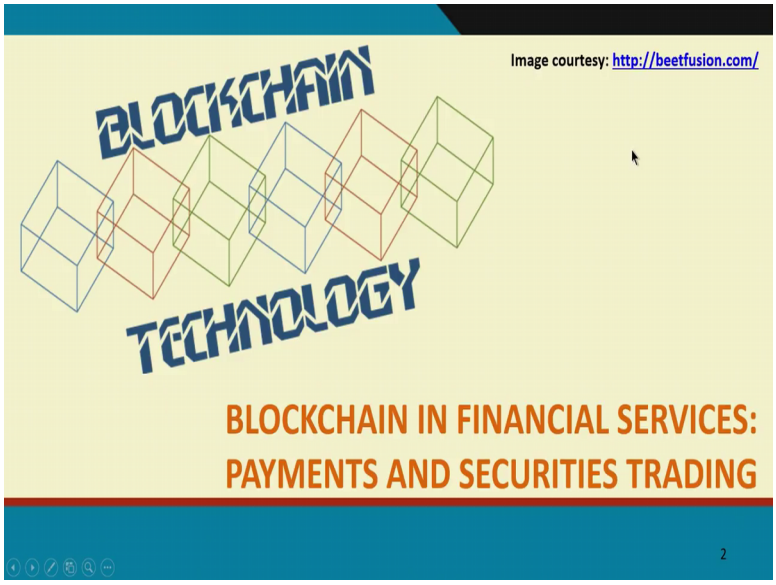

We are now going to dive into the financial services industry and why people think it is Blockchain is going to completely transform the face of how financial services is work today.

So, we are going to look at 3 lectures looking at different use cases. So, this lecture is going to be focusing on just payments and securities trading. So, it is one aspect of financial services we going to look into today. And how Blockchain can completely transform this landscape and how what are the existing pieces of work who is working on this, what are they doing and it gives you a sense of where we are and how some of the first production networks are coming out in this area.

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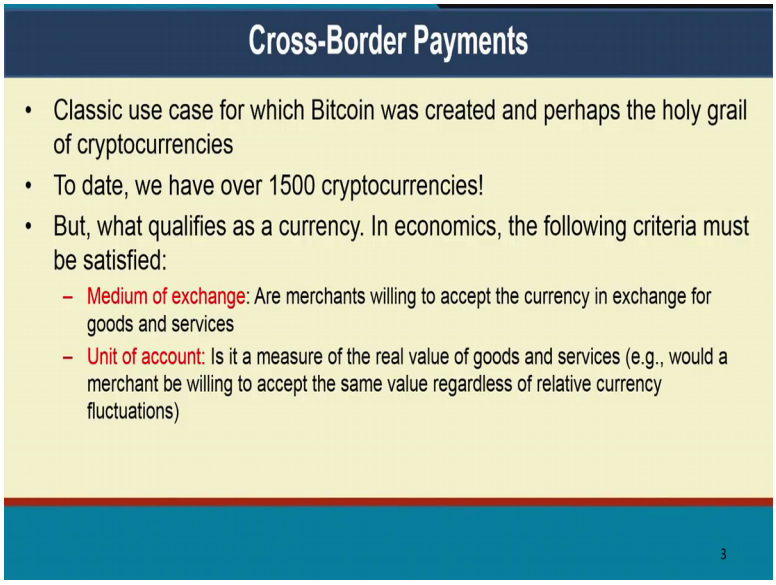

Cross border payments.

So, this is the classic use case for which Bitcoin itself was created and you could call it the holy grails of cryptocurrencies right. So, today we have over a 1500 cryptocurrencies a huge number of them providing various different kinds of concepts, there are a lot of a ICO's coming up, this is the initial coin offerings. There is a whole lot of activity here is a lot of startups, lot of venture capital funding in the space. I would really call this completely this is too much action going on for any person to even follow.

But what is really a currency, right? I think we should have we should step back and take a technical look at whether these cryptocurrencies are really currencies in some way. In economics a currency has to follow the following criteria and only then it is actually accepted as a currency. Today and in for regular layman a currency is something like the Indian rupee or the US dollar or the Euro they are all currencies. But why do we call them currency, what are the some of the properties that all of these satisfy for them to be accepted as a currency.

So, first is it has to be a medium of exchange. So, in some sense what this means is are their merchants today who are willing to accept the currency in exchange for goods and services. Can I go to a shop or can I go to an online place where I pay in INR today that is true for Indian rupee, it is true for USD. I can go to a shop. I can buy a TV with in exchange for Indian rupees. Now that is a medium of exchange where there is an exchange of goods. So, a seller is selling a set of goods or services to a buyer and the

buyer pays in terms of this currency right. So, that is a medium of exchange and that is important.

So, merchants should be willing to accept this currency. In the Bitcoin world yes there are a few very limited set of merchants who are a accepting Bitcoin today as a medium of exchange, but in many countries the government has actually banned the use of Bitcoin or any other currency has a medium of exchange. There are many reasons for this: maybe if we already covered that some of the operational issues, some of the technology issues, with Bitcoin and other cryptocurrencies why people are not recognizing this as a medium of exchange. So, my vote on this would be Bitcoin satisfies these criteria only partially there are, a very few merchants today in the world who would accept Bitcoin in exchange for goods and services. So, that is the first criteria.

The second criteria again an important criteria is that it has to be a unit of account. So, what is that mean. What you means is that, is it a measure of real value of goods and services. So, today if I go to let us say a store I want to buy a television, if the price would be say maybe it says 10000 rupees, I am just going to take it as an example. The television is tagged as 10000 rupees and the value of that 10000 rupees is typically independent of the value of the Indian rupee itself.

So, you know that Indian rupee the there are exchange markets that would price the Indian rupee with various other currencies: for instance conversion with the UD dollar or the Euro. So, that rate changes on a daily basis actually you know we one intraday right the value of the rupee keeps fluctuating. But just because of the value of the rupee fluctuating the value of the good that you pay for is not fluctuating you are always whether it is you go today or tomorrow it is going to be 10000 rupees.

There might be other reasons why the price changes; there might be inflation over 3 months the 10000 may become 11000, but that is not what we are calling; called talking about here. Regardless of the fluctuation and currency is what I pay for a good or service is that the same right. So, that is the real value of goods and services that is what we call as a unit of account.

And for almost every cryptocurrency today I would say that it actually fails these criteria. Today people even merchants are willing to accept cryptocurrencies in exchange for goods and services. But the amount of cryptocurrency they accept they would actually do

a conversion factor with how it is trading with let us say the USD. Say today let us say Bitcoin is trading at 8000 dollars; you might say I will accept so many Bitcoins in exchange for this service. But let us say the Bitcoin price goes to 9000 or 7000 they will adjust it to match the USD price. So, they have actually have a USD price and that is the real value and Bitcoin is just a medium of exchange in that case, it is not a unit of account.

So, it has to be independent of fluctuation and currency and that is when it will be accepted as a unit of account. So, merchants should be willing to accept let us say I put a price as 2 bitcoins, it has to be 2 Bitcoins regardless of what the price of Bitcoin is relative to other currencies that is when it is a unit of account.

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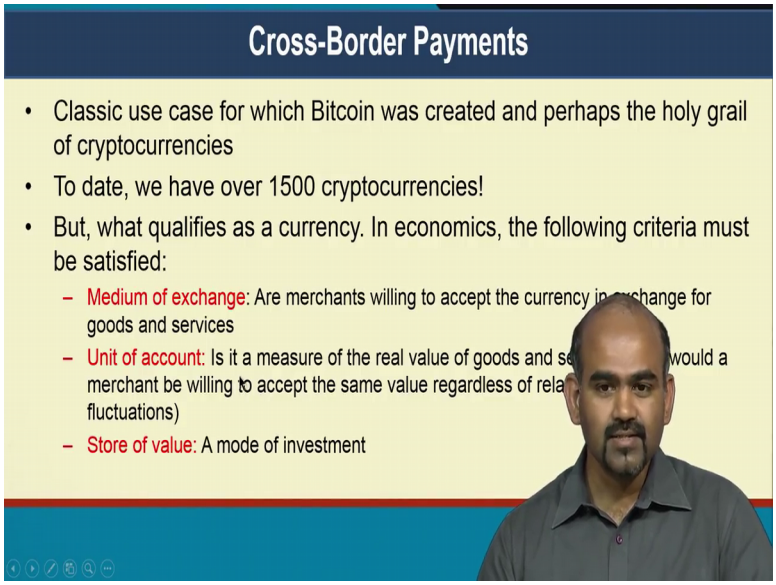

And the third criteria is it a store of value. Today, if you take for instance gold, I would say gold is a store of value people are willing to invest an gold as a trading instrument.

So, I could park some amount of the currency that I have I can exchange it for gold. And so gold is a store of value is almost never a medium of exchange. Today if I take some gold coins and try to buy a television it is not possible, a merchant is not going to accept that right, but it is a store of value right.

So, that way gold is a mode of investment and all and today's world actually is treating crypto currencies more a store of value than of anything else right. It is a more of

investment may be speculative investment they speculate that the value of these cryptocurrencies will rise over time. And so, they are investing it in buying those cryptocurrencies.

So, this I would say the cryptocurrency world today is actually satisfying the store of value criteria for a currency. It almost never satisfies the unit of account criteria and maybe in some cases satisfies the medium of exchange criteria. So, I would say until it satisfies all of these criteria it is not going to be called a currency in the true sense at least in the sense that economics economists think about it.

And that also may be a way to explain a lot of the hesitation to get into crypto currencies that there are lot of people have shown right. I hope this gives you a perspective of what we mean by currency and what it means to exchange currency for goods and services. And that is the core of payments right. You need this kind of a currency that satisfies these properties to be able to do payables.

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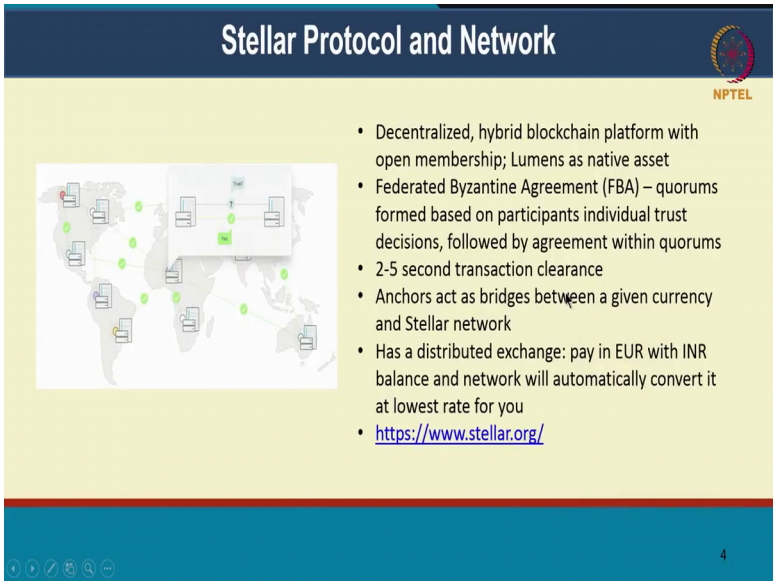

So, we look at a few networks Blockchain networks or disputed ledger networks that are all payment networks in some sense or primarily for the purposes of payment. So, the first one we look at is called the stellar protocol and they have the network running it is a global network. It is actually a decentralized hybrid Blockchain platform with open membership. So, what this means is, anyone can join this network run a stellar node and they can be a participant in this network, execute transactions and store the state of

payments or accounts in this network. And they have a cryptocurrency called lumens right and that is the native asset on which trading happens on the stellar network.

But what I like about stellar really is the protocol that they have a Federated Byzantine Agreement protocol what is fed rate, what is this mean and there was also a term hybrid here that I did not take strain properly. So although, this is an open membership where anybody can join, what happens is the way consensus happens on the network is actually happening in 2 layers.

The first layer is creating a set of quorums or a subset of these nodes in some way amongst this large set of nodes. So, it is a there are thousands in the network I can break these up into smaller quorums based on current business agreements of the participants. And within each quorum there is going to be a byzantine agreement there is going to be a byzantine algorithm that happens and that byzantine agreement if you think about it is a is something that runs in a closed network.

So, within that set of small subset of nodes they are going to or execute a byzantine fault tolerant the algorithm, but that happens several times over several of these quorums across the network and many of these quorums can also intersect with each other they will in fact, intersect with each other. And the higher level protocol will ensure that everyone in the network sees a consistent state. So, it is almost happening at 2 levels, one is at the breaking things down into quorums agreement within each quorum and then agreement at the overall network level.

So, it has a good properties, it has 2 to 5 second transaction clearance. So, when I submit our transaction for a payment on the stellar network it will pass through in 2 to 5 seconds, that is not too bad for a for a Blockchain platform. It is still not at the level of let us say a visa or a master card network, where I can swipe a card it will get through in a fraction of a second.

But it is still reasonable, reasonable I would take. What the network itself is formed by a set of anchors or they act as bridges that allow you to convert existing currency. So, you can convert US dollar to sinner Lumens right and then the Lumens pass across in the network. So, that these actually act as the currency converters and internally it also has a distributed exchange.

So, let us say me sitting in India I want to transfer money to somebody in the US in US dollars. So, what then stellar network will do is I ask stellar to transfer let us say 50 dollars. The stellar will stellar network will figure out what is the best way to convert Indian rupees to in this case let us say Euros right. So, what is the best way to convert from one currency to another, it might be because based on how the network is created there might be a direct conversion available INR or to Euro or it might be INR to USD, USD to Euro right that is possible, but all that is happening automatically within the network will be converted for you at the lowest rate that is available.

So, I would encourage you to look up stellar, it is a very interesting project and they have a good set of people on board using that network.

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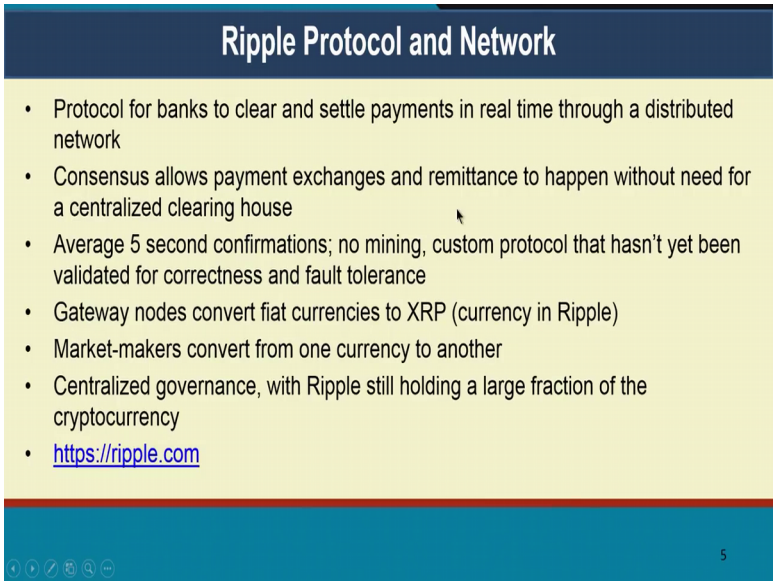

So, another interesting project is the ripple protocol and the associated network, actually stellar was a spinoff from ripple. So, ripple was the first one that came out in terms of being creating a such a payment network I will say after Bitcoin and stellar is an offshoot of ripples so, they broke away from ripple. So, it is a protocol that instead of end users they actually look at banks, they target banks to help banks do clearing and settlement of payments and it is done in a decentralized manner.

They have their own consensus algorithm again it allows exchanges and remittance to happen and they also have a similar transaction clearance. They have about 5 seconds to run their transactions, but important thing is there is no mining in this case unlike Bitcoin

right. So, Bitcoin has proof of work and it involves mining, but here they are only looking to create that network among a set of permission entities or banks and they have a custom protocol, but that protocol unfortunately has no one has validated it for correctness and fault tolerance.

So, it is still being debated whether it is a good protocol to use, they have again similar to stellar they have gateway nodes to current to convert currencies from fiat currencies that is like the US dollar or Euro to Ripple and for Ripple it is the XRP that is the cryptocurrency that they use and they have market makers that help convert one currency to another.

And unfortunately ripple has a centralized governance model so, ripple controls who joins the network how is this created and so on. And they also hold a large fraction of the cryptocurrencies still, and the last I saw they were holding about 60 percent of all XRP, which is a bit of a concern because people are worry that they can manipulate how the price of XRP using the large pool of currency that they hold with themselves.

So, that is ripple again an interesting protocol from at least. So, technical standpoint it is an interesting one to still look at. So, I would encourage you to look up look up Ripple.

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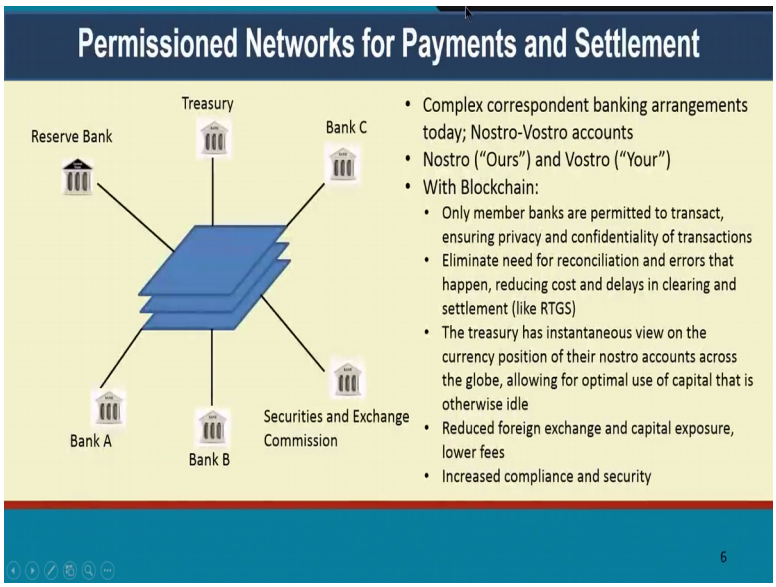

So, apart from these networks people are looking to build permission networks for payments and settlements. So, if you look at the current way in which the world operates

today for payments, it actually if happens through a very complex set of correspondent banking agreements.

So, today if I let us say I am to send money from India to the US, then I will ask my bank to send money to my friends bank in the US and the way it will work is there will be a set of banking arrangements between my bank and the US bank either directly or through intermediate banks and all through all this happens to through what is called Nostro-Vostro accounts.

So, what are these? Right, so nostro is a Latin word which actually means ours. So, it is really nostro account is let us take a particular bank rate let us take bank A, a nostro account for bank A is bank A's account in bank B. So, bank A holds an accountant bank B and likewise a vostro account is your account so, bank A will hold an account for bank B. So, it is a correspondent agreement, A has our account would with B, B has an account with A, from bank A's terms that account in B is called their nostro account, bank B's account with them is called their vostro account. So, this is used now primarily because bank A and bank B might be trading in different currencies. So, bank A might be using INR bank B might be using USD. So, bank A's account with bank B will actually have it is balance in US dollars.

So, that allows it to you to perform transactions in the native currency of the other country. So, those Nostro- Vostro accounts are helpful for that. Now people are looking to put some of these kinds of accounts on Blockchain all right. So, with Blockchain again we are only going to have a set of member entities, set of permission, set of banks participating in this network. And all transactions can be held private and confidential to the transacting entities and what Blockchain helps bring about is completely eliminate the need for reconciliation or errors that might crop.

So, today the way the Nostro - Vostro of banking accounts work is let us say there are 100 such people from bank A transacting with bank B, likewise there may be 200 people from bank B sending money to bank A all of these are netted together. So, in some ways they are all cumulated and together they will determine, what is the exchange between bank A and bank B, at the end of the day? In some ways it is like the RTGS, if you are familiar with Real Rime Gross Settlements with we have it in India as well. It is a popular way of exchanging money in some ways it is the same thing as that, but it can

significantly help to reduce the cost and delays involved in clearing and settlement of payments in these in these networks.

And the other advantages let us say the treasury is part of this ecosystem then they have an instantaneous view into the currency position across all the accounts. So, I can immediately see how much INR is held in US banks in US dollars and vice versa. So, it gives you an immediate instantaneous or almost a real time view of currency positions in various banks across the world. And likewise it can the Reserve Bank if they are part of this network, they can use all of this information to do some of their policy management right.

So, monetary policy is determined based on how much liquidity is there in the market, how much cash is flowing around. So, all of these the Reserve Bank can have a clear view into all of this if they are also on the Blockchain as maybe an auditor right they may not be transacting on the Blockchain themselves.

But the visibility helps them and it can also help increased compliance and security. So, making sure there are only legitimate transactions there is no money laundering that is going on all of them you can get a real time visibility into those transaction. So, those are the key benefits of bringing this into Blockchain.

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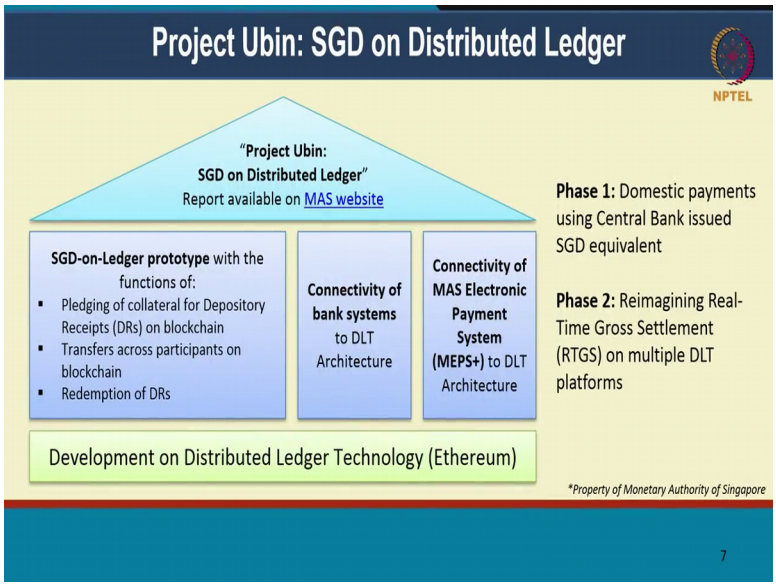

So, I am going to take one specific application. So, this is actually a project that was initiated by the monetary authority of Singapore this by the way I am grateful to them for some of providing some of these slides. So, the monetary authority of Singapore is the central bank in Singapore. So, the currency there is the Singapore dollar SGD and that this "project Ubin: is about bringing the Singapore dollar onto a Blockchain platform onto a distributed ledger". So, what is this really means so, they want to experiment with trying to bring the Singapore dollar as a virtual currency on Blockchain.

So, this is over and above the physical currency that is actually transacting in Singapore today that people might have as physical cash they are trying to bring Singapore dollar as a virtual currency on a Blockchain platform. It is an experimental phase of course, but it is a very welcome step and many other central governments are looking to do the same. And by the way the Indian government the RBI has also issued statement saying it is exploring some of these applications as well, but Singapore is always at the forefront of innovation so, they are already trying this out.

So, the phase 1 of this project Ubin is just handling domestic payments within Singapore itself using the central bank issued SGD equally. So, I said this is a virtual currency is an equivalent of the SGD today and they are testing it out. So, the first phase of the project was implemented on a theorem which is another Blockchain platform and these are some of the things that they try to do, what are some of the functions they try to do is pledging collateral for depository receipts.

I am not going to go into the details of some of these financial terms, but think of it as just payments in some ways and there are many instruments of payments. So, some of those with they tried to do it on Blockchain and it was trying to explore connectivity of existing banking systems with the blockchain, how does that work, what is it, what do the banks have to do to connect to the Blockchain to exchange payments on Blockchain right and it also looks at connectivity of the current MAS electronic payment system.

So, they have something called MEPS and they were trying to connect that system with Blockchain. So, that was the overall scope of phase 1.

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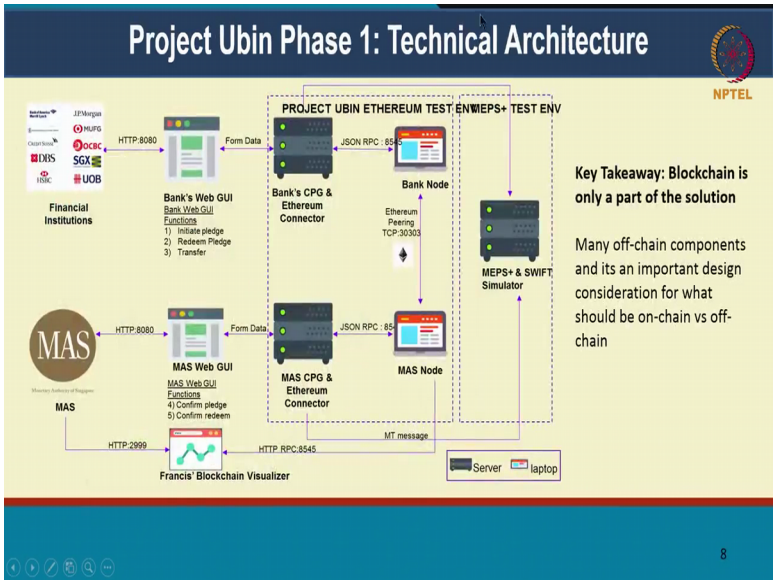

And this is a high level architecture of the phase 1 Ubin project itself. So, I am just going to look at I am not going to go into too many details, but I think the key takeaway is that the Blockchain is going to be only a part of the solution like I mentioned before there are many other components that you have to integrate with.

So, you will probably have to integrate with the banks existing systems their web interface for banking employees to be able to access this should be made available. So, if they make a payment from their existing UI it should then get connected to bank the backend bank systems and then connected to the network Blockchain network itself and of course, MAS needs to connect to this to see what transactions are going on.

So, MAS has a portal for seeing what transactions are there and of course, the payments themselves have to move around. So, how the how those connectivity's are made, all of those have to be figured out. So, there are really many off chain components beyond just the block chains, so Blockchain maybe 20 percent of this entire architecture. But there are many other things that you need to be taking care of to bring the whole application alive and actually being able to do even something like payments.

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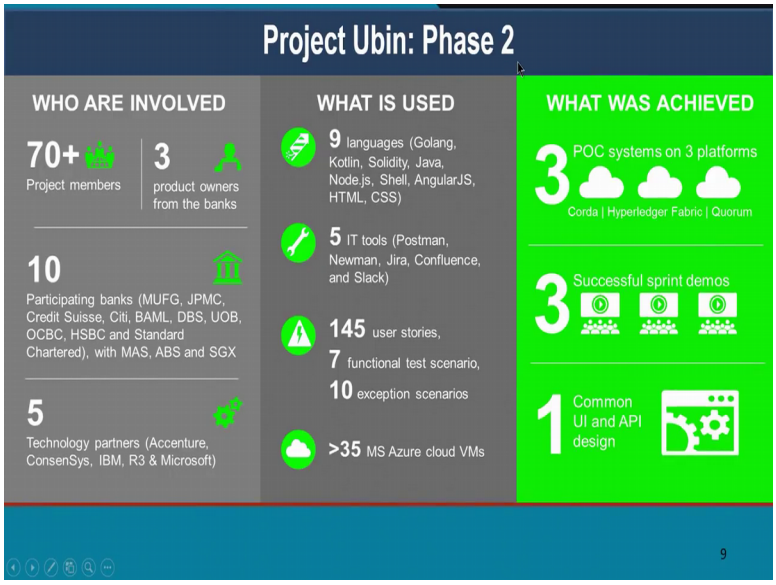

So, phase 2 of the project they are going taking it a step a notch further, they actually now have 70 plus project members there are 10 or 11 participating banks today some big names in there. They are all trying this out on Blockchain and there is the Monetary Authority of Singapore, as well as the Association Banks of banks in Singapore and the Singapore Stock Exchange.

So, all of them are part of this ecosystem now trying testing the waters and there are 5 technology partners Accenture, Consensys, IBM, R3 and Microsoft. So, these are the technology partners and what they are doing is: they are implementing this kind of a payment application on 3 different platforms. So, they are implementing it in on the Corda, Hyperledger Fabric, in Quorum.

So, we looked at Hyperlarger fabric in detail later in the course we will look at a briefly we look at a probably Quorum and Corda as well. So, these 3 platforms were evaluated for the payments application and they were multiple banks they were participating in this and they were many tools that were used and there were many learnings from this exercise. So, it is I think the project the phase 2 just cut completed and they are really looking to ramp up to future phases are going forward.

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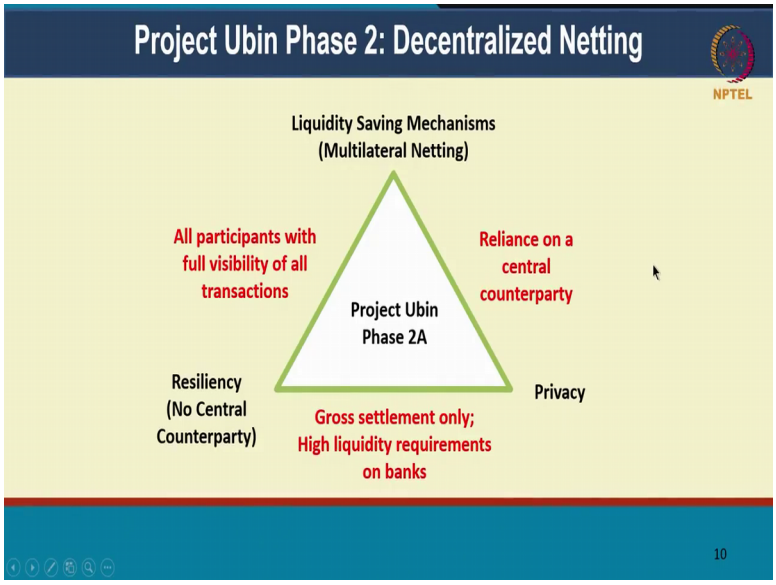

What was some of the learning's? I think one of the learning's was there is actually a tradeoff that you need to be aware of right one is on one side resiliency a centralized counterparty, let us say MAS previously was handling all the block all the transactions all the payment transactions.

But then it made sure that if the resiliency was limited only one node was one organization was doing that, other side that is privacy which is who can see which transactions. In the current world when you are relying on a sent one central counterparty which is this end of the spectrum what you get is you get privacy no one else can see which transactions you perform. So, you get privacy and you also get liquidity I am not going into the details of this.

But it allows you to maintain a low liquidity to be performing these transactions. So, you do not need to have a hike high amount of currency in hand to be participating in this. So, that is what is the case in the current centralized system, you get privacy and liquidity, but you do not get resiliency.

If you are looking to do all participants with full visibility of all transactions which is how it is within the Bitcoin world or in the ethereum world everyone can see all transactions that are going on. In that case you get resiliency you get liquidity, but you do not get privacy right. So, that is the trade off, but if you are doing let us say a permission like network like hyperledger fabric or corda you can do gross settlements only.

So, you can get privacy of transactions because these platforms support privacy you can get resiliency because it is still a decentralized system multiple nodes are executing these transactions there is problems with liquidity so, that is what they realize. So, there is actually a tradeoff between what you can get and they are trying to see if this tradeoff can be resolved, somehow whether some of these platforms can give you a mix of everything right a good mix of all of these properties.

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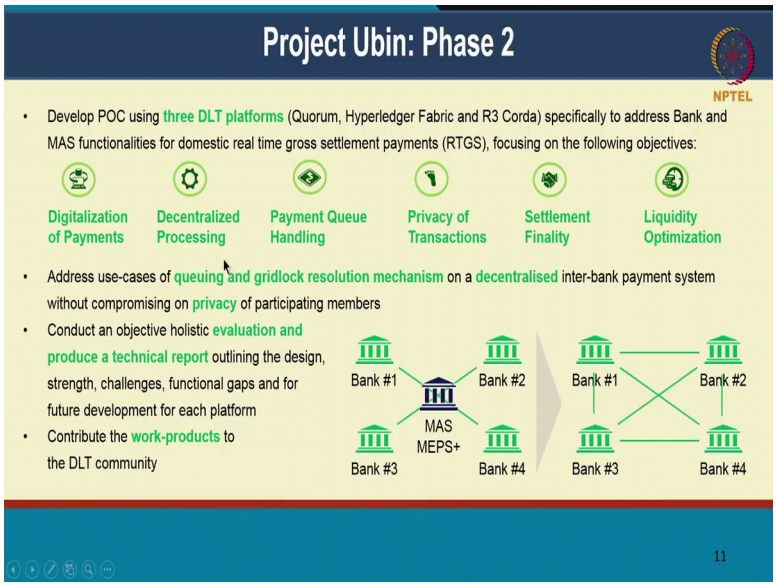

So, I am going to go over this side slide quickly right in phase 2 some of the things that they are looking to get is of course, digitization of payments, you want decentralized processing.

So, you just do not want one node to be doing the clearing and settlement you want all the nodes to be involved in that and you want to do that in a decentralized fashion on Blockchain. You want privacy of transactions; so only the participants of a transaction should be able to see what the transaction is about. You want settlement finality, which again is not there in the Bitcoin and ethereum world, because they use proof of work and that could be forks it is actually pause you might not know immediately if you are transaction is final. It might take maybe even and nor or you to see whether your transaction is final and there is also liquidity optimization which is on the financial side ok.

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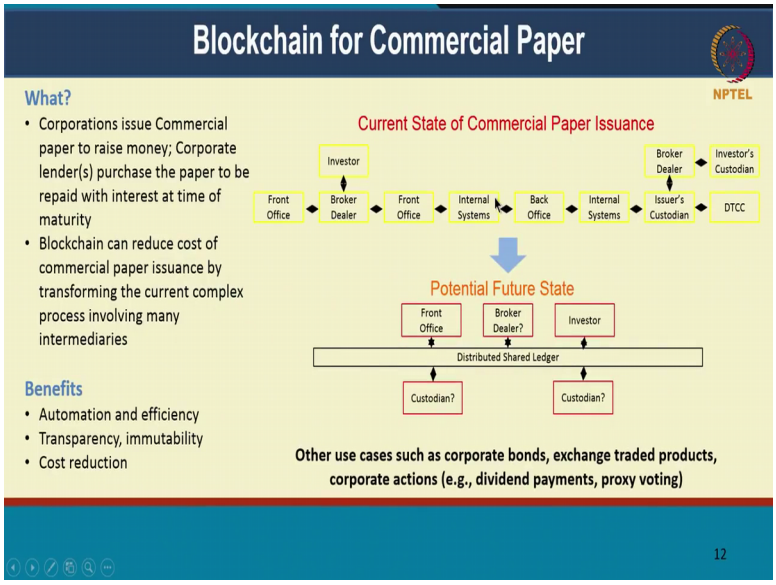

So, that was project Ubin, I hope you got a flavor of some of the real assessments that are going on for building some of these production grade networks especially for payment. So, I hope you got a flavor of that.

Now, you are going to slowly transition towards some of the securities trading aspects for capital markets. In some sense capital markets is probably the biggest in terms of monetary value the be the biggest transformation one could think of in that Blockchain could come up. People as trying to test the waters with small use cases today if you wanted to bring the entire stock exchange on Blockchain there is not feasible today I would in my opinion because the scale is just way to too big Blockchain is not mature enough to handle that.

But if we can scale up to that there are significant benefits to bring in bring in some of these securities trading onto Blockchain. So, what are some of these things that are being done, the one use case is on commercial paper right. So, today what is commercial paper? So, commercial paper is again a trading instrument. Organizations routinely come up with commercial paper. So, this is a kind of an agreement that they say this is like an IOU, they sell this commercial paper in exchange for money in exchange for some amount of investment and one commercial paper can be bought by multiple people.

So, let us say I release a commercial paper worth 100,000 dollars I could find 10 participants 10 other organizations willing to pay 10,000 dollars each to buy that

commercial paper. So, each of them buy a portion of the commercial paper and together that commercial paper is then issued.

Now, what happens is the commercial paper has a certain time period for which it is valid, at the end of that time period the borrowing organization will repay all the initial investing organizations right. So, when they repay they of course, repay with a certain interest associated with that commercial paper, this is standard practice in the enterprise world today and enterprises exchange these commercial papers on a routine basis.

So, today this process is extremely manual, there are many intermediaries that are involved that that make this system possible and this top level picture shows the current state of how commercial paper works today. A potential future state this is not a reality today people are investigating this, there are some proof of concepts that have been developed. A potential future state is to bring some set of these entities onto a Blockchain platform, where they can get some of the benefits of automation. So, you can get away from some of the paper exchanges that are being made today, you can get to automation, you can improve the efficiency of these processes, you can improve transparency and immutability.

So, today there could be discrepancies on as to let us say when the actual paper matures, when how much interest needs to paid, be paid, there might be discrepancies and there is also high volume. So, because of that there could be discrepancies, because people are manually noting down some of these details. And hopefully because of these improvements you can bring down the cost of issuing some of these papers commercial papers.

So, that is one use case where Blockchain is being actively investigated.

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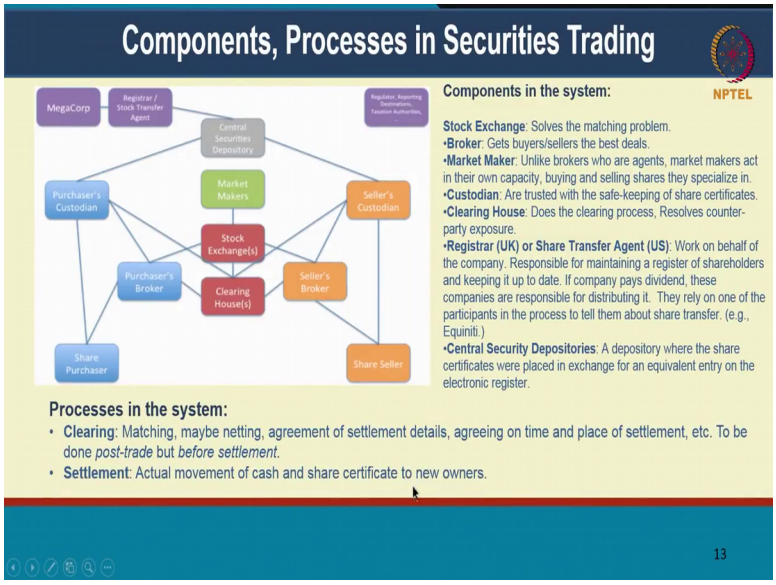

So, securities trading like I mentioned is again a important area where Blockchain is being applied. So, today IBM is working with both Japan stock exchange, London stock exchange and many other entities to actually do some of the post trading settlement. So, what does that mean?

So, let us take this picture this kind of describes some of the entities that are involved how they are actually participating in security trading. The stock exchange so, the let us first stock there is a purchaser and there is a seller, typically they do both of them have a custodian that they work with these might be service providers these are organizations that manage the stock holdings of the seller and the purchaser.

Now, the stock exchange is responsible for matching bits. So, the seller will say I am willing to buy a particular piece of stock at this price the purchase sorry the other way around the purchaser says I am willing to buy this stock at this price, the seller will say I am willing to sell the stock at this price. And the stock exchange will match these bits so, that is what the stock exchange does.

So, there are brokers in between that get the sellers and buyers the best deals possible there are market makers involved and the clearing house. The clearing house is an important entity that is responsible for validating these transactions. So, for instance; it will validate I am just going to make it up they going to validate whether the seller actually has the stock to sell whereas, I likewise the purchaser have the money to buy right.

And the clearing house also does the function of netting, what the netting is? The seller for instance might be doing multiple transactions each selling some amount of the stock or they might within a day also they might be selling and they might be buying again. So, all of these are all compacted together and at the end of the day they will resolve and say this is the net result, saying A has purchased so much stock, B has sold so much stock, they have looked at all the transactions combine them together to look at what the final balances should be right.

So, that is the job of the clearinghouse there is also a settlement phase. So, there is a settlement phase which is basically actually executes the final state. So, you will actually go and set the final state of all holdings to there to the correct numbers. There are security depositories that keep track of ownership of each stock how much each who owns which stock and so on right so, all that is being held.

So, if you think about it is a very complex ecosystem of participants each performing a different function in this ecosystem and there are a lot of an inefficiencies today and there are mistakes that happen that need to be manually resolved. And the hope is with Blockchain some of these processes can be automated, can be made more efficient and reduce cost and time for settlement.

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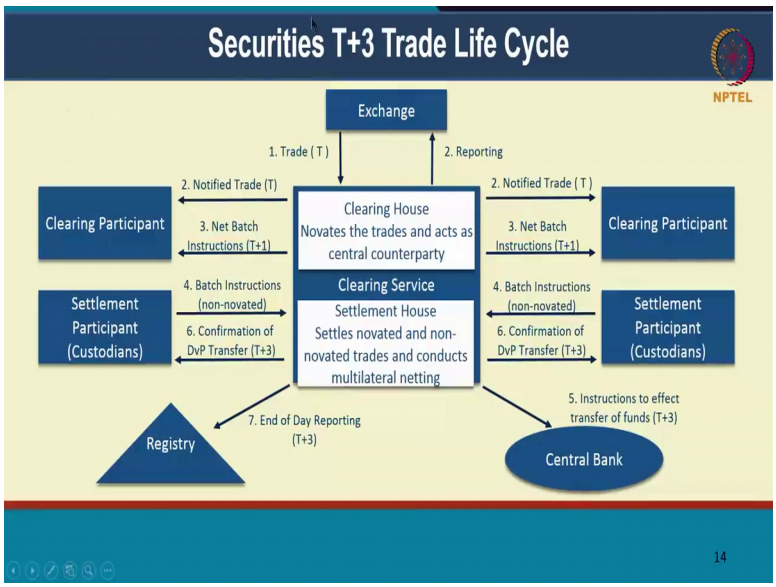

So, this is again just a life cycle I am not going to go into too much detail. So, the clearing like I mentioned there going to be multiple transactions that are submitted.

These transactions are all batched together maybe at the end of a day it could be at sub other intervals as well, but let us say at the end of the day they are all batch together. They will the clearing house will then determine what is the net settlement across all of these entities, who owns how much of which stock at it at that time.

So, now the clearing house is a centralized entity here and then there is a settlement house again a centralized entity today which is going to figure out, which is going to execute these transactions in that across a batch and say this is the final value for all of you right for it every participant.

And today it happens T plus 1. So, T plus 1 is today, if the trade happens today the clearing will happen the next day and settlement might happen 3 days from now, with some countries follow a T plus 3 trade a life cycle, some of them follow T plus 2, some T plus 1 it depends based on country, but roughly the process followed in the stock exchange and post trade settlement follows this life cycle.

So, we want to bring this process onto a Blockchain network where you can provide some of the same transaction properties along with privacy that is needed and improve efficiency, automation, visibility into what is are really happening right.

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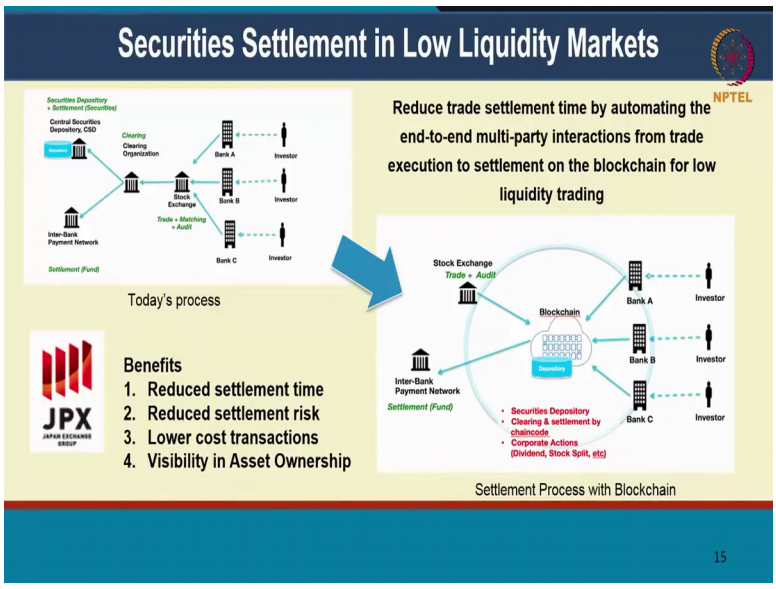

And people are because the volumes can be really big people are trying to do this in some of the low liquidity markets right. So, these are some of the benefits that I

mentioned reduce the settlement time, reduce the risk of settlement, what is something does not happen right, a transaction does not go through there is a certain risk that you are you are incurring.

So, you are trying to reduce some of those risks. So, people are trying out with lower transaction volume markets rather than going to the entire trading volume people are just testing waters I would say at this time.

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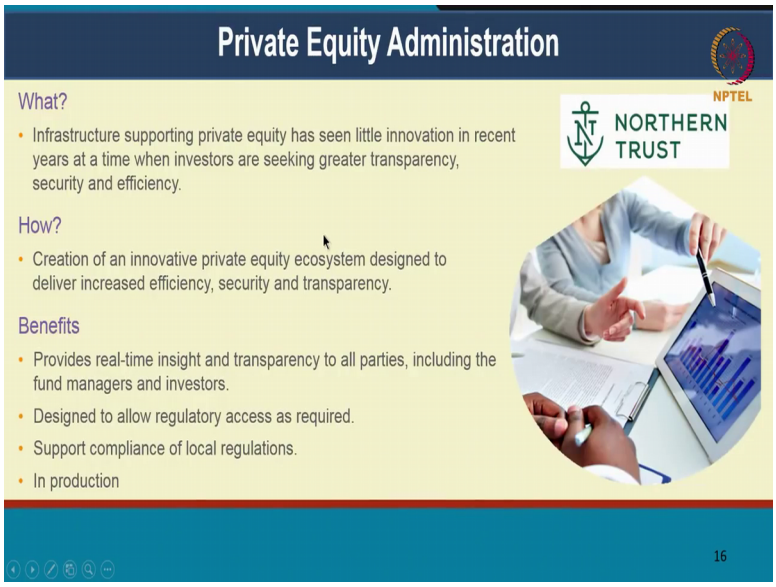

There is also the area of private equity. So, there are certain companies that are not publicly listed in the stock exchange, but they do have provide a notion of equity and ownership and different people organizations may be owning different amounts of equity with a private company. And today there is a whole ecosystem and infrastructure that supports private equity handling. And very little innovation has come into this whole private equity space in a very long time right is this very little innovation that has happened and this is very little transparency also.

So, really people do not know who really owns portions of this company and there are lawsuits that happen because people claim different amounts of ownership and so on right. So, what Blockchain can bring in is, if you actually bring in all the owners of. So, these owners at owners of private equity are typically high net worth individuals, it could be institutional investors, there could be large banks, there are investing in companies right. So, bringing all of them onto a Blockchain network can significantly improve

insight into transparency you can provide transparency. It can also support compliance and regulations that come that local countries might have on private companies.

It can help bring in the required amount of regulatory access right. Today there are a lot of compliance issues although garments do have compliance norms provided for private equity, there are a lot of issues that happen lot of a lawsuits. So, we can bring in that regulatory oversight almost in the real time manner and there are lot of benefits for that.

And today IBM is working with Northern Trust and this private equity administration is actually running introduction on hyperledger of fabric today ok. So, that brings us to the end of this lecture where we have looked at just 2 applications right almost at a broad level payments and securities trading, in financial services we are going to look at other applications in financial services over the next 2 lectures.

But I think there is a lot of fun reading that you can look into there is a lot of financial services concepts. For instance, if you are not aware of the real time gross settlement system that is in vogue today RTGS you should check out the Wikipedia article does that describes this lot of countries adopt this today.

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You can look up project Ubin and the there are a lot of reports that are available. So, the code for project Ubin is also made publicly available it is in Github. So, you can go look up the code as well Github link is here.

So, if you are not aware of commercial paper, then you can look up the Wikipedia article of what commercial paper really is in today's world. There is a small demo on hyperledger of fabric of building a commercial paper application there is a YouTube video of that. And again private equity and what it means some of the issues with it again a Wikipedia article for that.

So, I would encourage you to explore the space. If you are really interested in the financial services space and how people think it can completely it is going to completely transform the financial services industry today with that.

Thank you and see you soon.