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**GARY GENSLER:** Today's a little bit of a discussion about clearing and settlement systems. Maybe you feel you've heard everything you needed from Jeff Sprecher when he was asked a question when he was with us. Jeff runs some of the largest clearing houses in the world at Intercontinental Exchange not only because he started in the energy business, but he has big credit default swap clearing houses and energy clearing houses and the like.

And he said, well, I don't know about blockchain technology for clearing and settling. But I'm going to try this Bitcoin project that you all know about and he talked about. But today we're going to try to dig into, well, maybe there's something there, because there are projects going on.

And why are there projects? They're mostly permissioned and not permissionless systems. But I think there's something there. This will be one of the more optimistic-- if you're judging how often I get to the maximal side, I think there is probably something there, at least for permissioned blockchain projects in the clearing and settling.

I'm going to-- we'll, of course, go through the readings. And these are the sort of topics we'll go through. Clearing and settling services-- I'm going to try to set this stage as to what this is. Frankly, when I was on Wall Street for 18 years, I couldn't really define what clearing and settling. Sorry, Ross. You thought I could define it when I was on Wall Street? What's that?

**AUDIENCE:** I just strictly know someone else can't either.

**GARY GENSLER:** Yeah. Yeah. Well, when you're in the merger and acquisition area, you usually don't think about what it means to clear something and to settle it. And frankly, even usually when you're on the trading floor, that's something somebody else takes care of.

Just the nature of-- how many people have worked on trading floors here? All right. So I'm going to have seven or eight of you start. And you're on notice now. In about eight to 10 minutes, you're going to help. You might prove what I just said to Ross, that you can't define

what clearing and settling is because somebody else took care of it. But we'll see. We'll see.

And then we'll talk about blockchain technology applicability, some of the projects that are going on, and then move over to this. There was a reading from the International Swaps and Derivatives Association, ISDA, what they're doing around smart contracts in this space.

But what I want to do first is a little bit of talking about final projects, because we're at that time of the year. And this is to help. Then I'm going to go through eight or nine questions. If you haven't already thought through your projects, these are eight or nine questions that I would think you'd want to think about, which is another way of saying it will probably enhance your performance. What else can I say?

And number one-- and it's a little, small print. I'm sorry. Or no, it's not too bad-- is what's the value creation proposition, or pain point, if you wish. So are you creating value? Are you solving a pain point?

Or as Jeff Sprecher would say, what are you doing that's going to make something cheaper, faster, better? What's the value proposition? Whatever space.

There's two or three groups that are doing trade finance. There's one or two doing payments. There's some group doing commercial-- I mean, consumer credit rating or so forth. There's a wide variety. There's one or two groups that have come to see me that are doing things outside of finance.

But regardless, what's the value proposition? What pain points are you addressing? Or as Jeff would say, what are you going to do better, faster, cheaper? If you can't answer that threshold question, shake it loose. Kick it around. Or move on to a different use case, frankly.

Secondly, [INAUDIBLE] you get into, like, what is this blockchain technology? What transactions or data is going to be recorded? Because this is fundamentally, ultimately, a database technology, even the permissionless systems.

And you'll see a later question is why this versus traditional database system? But what transactions, what data-- whether it's health care records, whether it's consumer credit data, supply chain, moving a piece of property along a supply chain, but what is the actual data and transactions that you're recording? Questions?

What multiple stakeholders need to write and read access to the ledgers? And I underline the

word multiple. Because really, when you think about the value proposition of blockchain technology, it's about immutable records, or so-called immutable records. That's verifiable, immutable records amongst multiple parties.

And it cost extra money. Everything we've been studying about in this semester is about there's more complexity. There's more cost, in some way, of this decentralized, even permissioned systems, decentralized system.

But you get something for it. You get some verification of transactions, of data, of mutability. But you also have to have some logic that there's multiple parties that need to both write and read.

A distributed database that just does read only-- I can read my Bank of America bank account. I can see what's in that sort of ledger. It doesn't have to be on a blockchain. So multiple parties writing, why is that important? Forming consensus, in this circumstance.

Which specific cost of verification or networking are you lowering? We talked about a lot of the verification costs, whether it's privacy, censorship resistance, whether it's some direct cost. Maybe you're going right at something that's got a bunch of economic rents in it. So there was a series of verification costs we talked about. What networking costs are you trying to reduce?

There's probably been something in the order of 4,000 or 5,000 white papers, many that you can find. You can't find all of them. But if you're going at something that you think a white paper has been written about or a blockchain company has been started on, figure out what the competition is doing.

And for the two groups, and it may be more, that are doing something around trade, finance, and supply chain, you know there's a bunch of stuff you can read. We'll be studying it next Tuesday. Alin?

**AUDIENCE:** Can you give us an example of a networking cost? I'm not sure what that is.

**GARY GENSLER:** So networking cost is often why people are using a native token. But networking costs are how to jumpstart a network. Uber jumpstarted a network, in a sense, without blockchain technology.

But an example of networking costs are if you walked out of the airport and you didn't think any drivers are using this application, then you wouldn't be terribly interested in using it. So--

**AUDIENCE:** But who incurs the cost?

**GARY GENSLER:** Often the cost of building a network can be a tremendous startup cost. So how to start a network often is you go to a bunch of venture capitalists. You raise money. You advertise. And you try to get participants.

And one of the challenges of health care records-- we don't have our health care experts in here today. I was looking around. We have two students from Harvard's public policy school doing graduate work and sometimes join us.

But health care records, for instance, there's some really interesting blockchain technology solutions. But the networking challenge is how do you get a bunch of medical providers, hospitals, doctors, and users to actually join the network. So that would be an example of network cost is basically adoption often. Does that help?

**AUDIENCE:** Yeah.

**GARY GENSLER:** What are the competitors doing? I'm not looking for plagiarism. But if you're in a space, payments or supply chain or consumer credit or some others, where there's three or six or 10 white papers out there and maybe somebody has even raised 20 million or a couple million in an ICO, then it would be interesting.

You should feel free to look at those. And maybe you'll be informed by it. And you'll say, yeah, I'm doing it better. Or they've got it poorly here. Or their project's in Estonia. And I'm going to do a digital ID project in the US. And our regulatory system is different than Estonia.

But I wouldn't be bashful about looking at the competition. In fact, I would say that's-- we're a business school. You always look at the competition. And you see if you can do either what they're doing better or what they're doing in a different geography or in a little bit different market.

Back to how Alin likes to define things, I've not used the term blockchain technology yet on this slide, have I? But why are append-only logs at multiple party consensus the best solution? Which kind of goes back to why not just a traditional database.

But why append-only, timestamped, verifiable logs? They're connected by cryptographic hash functions. But why have these logs? And why have multiple parties in essence form a consensus about the state of the ledger? Alin?

**AUDIENCE:** Yes. I have a question about the timestamped, append-only logs. Is that only relevant in blockchain, that traditional databases do not have these kinds of features, timestamp and append-only logs?

**GARY GENSLER:** They can have time-- timestamps in essence. In essence, it's innovation of the early '90s. And then Satoshi Nakamoto grabbed it. It was the concept that you take a block of data and you connect it to the next block with a cryptographic hash function. And once you've done that, then it's committed. You can't amend anything that's before because it's a unique hash.

And traditional databases did not have similar commitment schemes. They do have other commitments schemes, but not this commitment scheme of taking a block of data, having the hash function, which then means never shall you amend what came before. That's how I understand it. Did you have a different view on traditional databases?

**AUDIENCE:** Well, I guess this gets to the root of the question. Is there something new about blockchain technology? In my opinion, there isn't, actually.

20 years ago, we knew how to make a traditional database and make it full of power and make it a census protocol, or what people nowadays like to call a permissioned blockchain. So we knew how to do that. And that would give you an append-only log. It's nothing exceptional.

**GARY GENSLER:** Yeah. So there are debates as to where is the border and boundary between a permissioned blockchain and a traditional database. But I've chosen to, at least for this class, a hyperledger fabric, we'll call that a blockchain project. But recognize there are some who would say, well, that's-- unless you have a native token, it's not really blockchain. Eric.

**AUDIENCE:** --one could call point recent days that the trust is the key attribute that's not the factor in this equation, because you can get a multiple-- I mean, multiple party consensus doesn't have value on its own.

It's actually multiple party consensus is-- it's actually something you had to come up as a necessity that stems from the fact that you're dealing with a decentralized arrangement in which you're not trusting any of the parties that intervening in the exchange of information. Right?

**GARY GENSLER:** Well, I agree with the first half, that you wouldn't even want to use Hyperledger Fabric unless you really need multiple parties writing to the ledger. And I think that does separate it a little

bit. You could take an Oracle database and allow it to be multiple parties, too. But I think that separates it.

You might be more the purist than I am, Eric. I don't think it has to be completely open, where you don't know all the participants. But even in a financial-- we'll talk about the Australian Stock Exchange in a half an hour or so. And when we talk about that, that's a limited closed loop.

But they believe that they are actually taking a lot of cost out of the verification side. They think they're getting a lot-- they're lowering verification costs. And they would contend they're lowering networking costs, because they don't have the same reconciliations between multiple databases.

Now, you might call that verification cost. But I think they would call it both verification and networking cost. There's multiple back offices no longer reconciling.

If your final project has a permissionless system with a native token, why do you need a native token? Is it to jumpstart the ICO that you want to raise money for? I'm not averse to that. But at least fess up and say that's how we're crowdsourcing this thing.

If it's about that you really believe there's some benefit to the token economics, that it's an incentive system to run your new competition to Uber or an incentive system for health care records or an incentive system for supply chain, talk about what that incentive system is. And are you trying to motivate jumpstarting the network or maintaining the network later?

And it could be both. It could be either. I'm just saying it would be good to have a discussion. Is the native token just about crowdfunding? Is the native token also about jumpstarting this network and then an incentive to maintain the network amongst multiple parties?

What trade-offs of scalability, performance, privacy, security, coordination? I'm not asking you to solve that. And in fact, you can even jump ahead three and five and seven years and assume that some of these things will be taken care of.

So recognize that in the permissioned blockchains, they seem to have a higher performance, a lot higher performance, than the native token permissionless systems. But if you're proposing a native token permissionless system, I'd just like a short discussion of how much these scalability issues matter to you, particularly when most of the native token permissionless systems can't handle much more than 1,000 or a handful 1,000 of transactions

a day.

It is true that Bitcoin handles quite a bit more than that. But five or 10 transactions a second, is that going to work for whatever your solution is? In fact, I'd like to see some groups use native tokens. I want to have a variety of things I read in December rather than reading all permission systems.

And then again, can a permissioned blockchain or traditional database adequately address whatever use case if you do have a permissionless system? Thinking about that, how can broad adoption be realized? Are you going to use a native token to equip broad adoption?

How are you going to get a bunch of hospitals signed on? How are you going to get a bunch of banks signed on? You're going to do like Jeff Sprecher did and give 50% of his equity away. There was that conversation he talked about he had with Goldman Sachs, that he realized that was the only way to get his business started in the late 1990s.

But just how are you going to get that adoption? And to the extent, this might be a paragraph, but what type of customer interface or how might it be better than other customer UIs?

So these are just some of the things, if you were thinking about a real business. And I think that the market is moving away from that big, frothy bull market, where there was as many as 400 or 500 ICOs a month. And it was raising anywhere from 2 to 5 billion a month.

October was about 200 ICOs. And it was about 800 million. And I think it's going to continue to decline, partly because they don't all work. But partly because people are now getting more rigorous as to what's really going on.

If you are using a permissioned blockchain, you don't have to tell me whether it's Hyperledger or Corda. But if somebody does and you have something thoughtful to say there, I'm intrigued to find out why this one versus that one. It's really just to show your critical analysis of this subject.

And if you want to prove yourself on why it's Corda versus Hyperledger Fabric, that'll be interesting if somebody has a point of view. But I'm not looking for that level of either computer science knowledge. This is from a business perspective. Think of me as a venture capitalist. If I was investing, how you pull it together. So any questions on that?

So we had six or seven people that actually worked in banking. Who did we have at this table?

Ah. So what's clearing?

**AUDIENCE:** If I recall correctly, you need to prove the identity of the other party in order to make sure that you're sending the asset to the right--

**GARY GENSLER:** All right. So you have to prove the identity. So it's about validating and authenticating an identity. Anything else in clearing? Who else worked in trading? I had somebody back at the back table worked in-- ah.

**AUDIENCE:** Is it that they have the assets to be traded?

**GARY GENSLER:** They have the assets to be traded. Well, most equity markets trade on transaction date plus two days. So somewhere in that two days, you have to confirm they have the asset. That is correct. You don't have to do it on  $t$  plus zero, normally by  $t$  plus 1.

**AUDIENCE:** I think-- I could be wrong. But I think you had to do as well would be the stock exchange knowing what is the net exposure that you have at the [INAUDIBLE].

**GARY GENSLER:** Net exposure. Net exposure. Very key thing. So there's authentication. At some point between execution and transaction, you have to actually know you have the security-- and then net exposure, which we're going to look at on another page.

This simple chart of two people cutting the lawns, but a buyer and seller meet. But a buyer and seller meet in an exchange in traditional securities markets through brokers. That's called an inner mediated access.

In the crypto exchange markets, those two brokers on the left-hand side and the right-hand side, the sellers and buyers brokers, don't exist. In the crypto exchange markets, basically you have direct access to the market. But in the traditional stock exchanges, whether it's London, Tokyo, New York, Beijing-- where's the exchange in India?

**AUDIENCE:** Mumbai.

**GARY GENSLER:** Oh, it's at Mumbai now? I forgot. 30 years ago, I visited it and walked on the floor. It was called the Bombay Stock Exchange back then. But regardless of where the stock exchange is, there's some clearing house separate from the stock exchange doing these functions that we just talked about.

So three steps-- execution. What's it mean to execute a trade? Alpha, do you know what it

means to execute a trade without reading? Should I go back?

**AUDIENCE:** Yeah. Because I've traded before.

**GARY GENSLER:** Yeah. That's why I called on you.

**AUDIENCE:** We did a great job with a separate execution team. That helped us with that. But signing the docs, making sure that the account information is all there, if it's been done through NSDA.

**GARY GENSLER:** All right. So this sounds like it's about derivatives, executing a derivatives contract. But what if you're just buying 100 shares of Apple stock? What's it mean to execute a trade?

**AUDIENCE:** To be on the phone or on the screen and agree on a price and a quantity.

**GARY GENSLER:** There you go. It's just you bid a price. And somebody hits the bid or lifts the offer. Those are the terms when you're on the phone. I left your offer. I hit your bid. Or at least it was when I did it. Still? Or no, maybe not. What's that? Still. All right. Question?

**AUDIENCE:** Just not on the phone anymore.

[LAUGHTER]

**GARY GENSLER:** Ah, yeah. That's it. What's that?

**AUDIENCE:** You just hit a button.

**GARY GENSLER:** Just hit a button.

**AUDIENCE:** I worked on the [INAUDIBLE] desk at Goldman So we didn't talk to anyone.

**GARY GENSLER:** You didn't talk to anybody? Can you go months without talking to anybody?

**AUDIENCE:** No, we talked a little.

**GARY GENSLER:** What's that?

**AUDIENCE:** We talked a little bit. [? But it was always ?] [? kinda ?] weird.

**GARY GENSLER:** All right. I guess I'm a dinosaur. Yeah. Yeah. The screens that I used to look at at Goldman Sachs, it was green. Yeah, yeah, yeah. You know. You know the screens. Kelly is thinking, what is he talking about? Right? Look it up on the internet. [? You're ?] [? fine. ?] [? You're ?]

[? fine. ?] There wasn't any color on those screens.

So execution is basically I buy, you sell, we agree upon a price, a price and a volume. That's really what execution is. But when you execute, you still need to do a few other things. And it's called clearing and settling.

When I was on a trading floor, I couldn't have told you what the difference was between clearing and settling. That was something somebody else did, frankly. I'll admit it. They were really terrific professionals. But they had their job. I had a different job.

Clearing is performing all of these functions. Authenticating somebody is there, making sure you actually have those securities, and importantly this thing called netting. How about settlement? Anybody want to say?

I know it's written up there. But anybody want to just say what-- we've talked about ledgers for seven or 10 weeks now. What do you think a settlement really means in the context of a ledger? Did I see a hand up here? Yes, I did. I did see a hand up. What's settlement?

**AUDIENCE:** Running the entries on the ledger. What's in, what's out.

**GARY GENSLER:** Right. It's making a final recording on a ledger, finally moving something on a ledger. You could be moving the ownership of an asset or the ownership of cash. And when you do both at the same time, it's called delivery versus payment, or DVP.

It's just a final change of data record on a ledger. In the old days-- I'm talking about before I was doing it. But 40 years to hundreds of years ago, it was physically delivering a physical piece of paper which was a equity security or a bond security.

But it all got dematerialized starting in the 1970s. And by the 1990s, it was pretty much-- in this country and the UK-- it was pretty much dematerialized securities, that everything's digitized now in the equity markets in nearly every country that you're all from and maybe with some small exceptions.

So execution is I buy, you sell, volume price. We've legally agreed to something verbally. And billions of dollars can trade on the phone or in the computer. Legally, it's executed.

Clearing is trying to make sure that you actually have the securities, and I actually have the cash. We do some netting. We authenticate. And settlement is actually moving the data on the

ledgers. Three steps.

This is the benefit of netting. It was just one chart that I could find somewhere. It's actually the Australian Stock Exchange had it on their website.

But if you have multi-parties in the transaction, which was on the left hand side-- and these are just arrows of all the different transactions that could occur in one little example-- and instead you interpose a central intermediary, you can do a lot of netting.

And look at participant C. Participant C only has an exposure of selling 35 of whatever they're selling, some stock, versus all these other transactions. And this is a very simple case.

But if you have 20 or a hundred clearing members that are all big brokerage houses and they're doing thousands or even hundreds of thousands of trades a day, you have an awful lot of transactions. And the gross transactions versus the net is quite a difference. That netting can bring down numbers 90 plus percent or maybe even 99% or more.

So central intermediaries-- I know this goes against Satoshi Nakamoto's whole concept-- but central intermediaries came about in the securities market for a bunch of reasons. But one of the biggest ones was netting. British? And it's a really important concept in the back office of Wall Street.

**AUDIENCE:** I'm not familiar with the concept. So [INAUDIBLE].

**GARY GENSLER:** You're saying you're familiar?

**AUDIENCE:** I'm not familiar with this concept, so a clarification question.

**GARY GENSLER:** Please.

**AUDIENCE:** When we do netting, it seems that we are losing a lot of information here from the gross transactions. So is it--

**GARY GENSLER:** That's right.

**AUDIENCE:** --just the transfer of the asset is done through the netting, but the records of all the gross transactions are still there with the central intermediaries?

**GARY GENSLER:** Very good question. So are we losing information? Or are we just lessening the lines of counterparty risk in the transactions? And the answer is, if done properly, you still keep the

information of all of these. And in the real world, this is just eight transactions. It's netted down to four. Right? So this is eight transactions netted down to four.

Usually this is millions of transactions netted down to tens of thousands or maybe millions of transactions literally netted down to, if there was 100 clearing members, it would be 100 transactions, because they'd each have one net transaction per security, per security.

And so you need to keep the information of the millions of transactions to properly record for your customers, for your taxes, for all sorts of other reasons. But you've netted down for counterparty reasons. Does that help? Question over here. Sean.

**AUDIENCE:** I was just curious. It's very understandable for equities. But for principal commodities, [? the full ?] commodity derivatives, for instance in the clearing space, does it actually involve the physical delivery of the netted commodity [INAUDIBLE]? Because there's a different type for delivery, and how that--

**GARY GENSLER:** OK. So Sean's asked the question, what if you're not dealing with digitized assets, but physical assets? I think. You used the word commodity. But I was presuming you meant physical.

So some of the innovations of the 19th century relate here when they started to have standardized contracts for commodities that were held in warehouses. In essence, to facilitate some of this netting was also why central warehouses, this clearing house in the middle in physical commodities, could be a warehouse that held the gold, held the silver, held the corn or wheat.

And if they're holding that corn or wheat, they started to have specifications as to what standards there were. In gold and silver, it was percent. It was called the, let's see, assay-- I'm trying to remember the word-- but what percent gold or silver it is.

But in corn and wheat, there was a more detailed what's going into the warehouse to commoditize it so that it was a standard contract. If it's truly physical and not commodity, it's much harder. Then you can't really net down my house versus Shimon's house. They're two different houses. Does that help?

But literally by the late 19th century, even in the commodities space running out of Chicago, they figured out central clearing houses with a lot of counterparty risk. So there's an economic reason we have centralized clearing houses. And the biggest economic reason is netting.

And netting lowers something called counterparty risk. Instead of having literally millions of transactions, you'll have thousands. And you'll have less counterparty risk. It also lowers one other thing. So it lowers counterparty risk. And what is the other thing you think it lowers? Anybody?

**AUDIENCE:** Transactions cost.

**GARY GENSLER:** Transactions cost because it's efficient. We used to call it you take a lot of lines off the page. So in the old human days, you'd have to have fewer humans actually pushing paper. Hugo.

**AUDIENCE:** Another clarification question. So from the participants side, so from a hedge fund side or whatever or a trading desk side, do they just go about their day trading everything? And then the next day the clearing house tells them, OK, you made all these transactions yesterday. But we really only need 35 [INAUDIBLE]. Or how does it [INAUDIBLE]?

**GARY GENSLER:** In that case, looking back to this, you are either the buyer or seller. And you're dealing with a broker. So if you're a hedge fund, you often enter into an arrangement with a broker. And it's called a prime brokerage arrangement. And you might have a prime brokerage arrangement with more than one Wall Street firm. But you rarely would have it with more than three.

So even if I'm doing a trade through Merrill Lynch, if my prime brokerage arrangement is at Goldman Sachs, Merrill is going to get a commission. But they're going to give up my prime brokerage arrangements to Goldman Sachs. And that helps me, me the hedge fund, get more netting as well. And that's a development in the last 20 years, this concept of prime brokerage.

But to answer your question, yes. I go about my business. I trade all day. And unless I get a phone call or an electronic communication from my prime brokerage saying you've hit your lines, you do have credit limits and position limits in essence.

But your prime brokerage-- and I might say, well, I need something moved over. I need some more credit today. But yes. You go about your business until your prime brokerage says slow down. Shimon?

**AUDIENCE:** But [INAUDIBLE] question says that if you're a lot like LTCM--

**GARY GENSLER:** Long-Term Capital Management.

**AUDIENCE:** --at some point, they were running a balance sheet of a trillion dollars. And part of the reason

why, when bankrupt is they didn't want to use one prime broker, because they don't want to reveal all their trades.

But then their prime brokers could not net out their positions, because I may hold one leg with you and another leg with you. The net may be zero. But there's no way for you to actually reconcile that or reconcile that risk. So it's a real problem.

**GARY GENSLER:** Long-Term Capital Management was a hedge fund operating in Connecticut. It was founded in the early 1990s by a man named John Meriwether, who is a very famous trader from Salomon Brothers and very successful. And then he started it with some remarkable finance faculty from here, at MIT, and elsewhere-- Bob Merton, who is a Nobel laureate. Brilliant, brilliant team of folks.

But they ran into a little challenge four years later. They had about \$125 billion balance sheet, \$4 billion in capital, and 1.2 trillion in swaps. Why do I know the numbers? I got the phone call with my one-year-old sitting on my lap.

And I picked up the phone. And I said, hello? And the voice on the other line said, Treasury operator. I've got the Treasury secretary for you. And I get on the phone. I go, yes, Bob?

It was Bob Rubin. It was the Treasury secretary. Bob, what's up? It was a Saturday. Isabel was on my lap. He says, do you know anything about Long-Term Capital Management? He goes through some of the figures.

I'll never forget. He says, I hear from Alan-- that would be Alan Greenspan, who was the head of the Federal Reserve-- I hear from Alan that they have over a trillion dollars of derivatives. That's Shimon's number. He says, is that a big number?

Well, you have to understand, Bob's sense of humor was quite-- at that moment, he knew it was a big number. So I flew up the next day. And with somebody from the Federal Reserve Bank in New York, Peter Fisher, we sat around the conference table looking at these facts and figures.

And then I got back on the plane and flew back to Washington to be with my family. The next day was actually Rosh Hashanah, the Jewish holiday. And I wasn't going to work. And I had to call Bob and his deputy, Larry Summers, up and give them my feedback. And I said, this thing's going down.

Bear Stearns was their prime brokerage. And Bear Stearns, who 20 years later failed themselves, but Bear Stearns said, we're pulling the prime brokerage account if you can't post another half a billion dollars by Wednesday.

Well, there was no way they could post another half a billion dollars, because their \$4 billion of capital we could best figure on that Sunday was somewhere covering around 400 or 500 million at that point in time.

Well, when you have a lot of leverage, you have \$1.2 trillion of derivatives which are all sort of leveraged in one way or another and you've got \$125 billion balance sheet, even with the best minds, the best finance faculty-- and they really are terrific individuals. And Meriwether was quite a trader. Sometimes markets go against you. Correlation risk, liquidity risk, and so forth.

So they pulled the plug the next day, basically. That's the Long-Term Capital Management story I remember. But it's just because I kind of had to live it. But to answer your question, you can trade all day until your prime broker says, Hugo, slow down, because they're extending credit to you-- the prime broker is-- intraday.

And one of the big risks, one of the big risks in the financial crisis-- and certainly Ben Bernanke, who is chairing the US Federal Reserve and others had to deal with it in the middle of 2008-- is most commercial banks, so they don't have a broker. They're banks. They're the brokers themselves-- were extending significant amount of intraday credit to each other that, in 2008, wasn't terribly well measured in the repo markets and in other markets.

And that's changed subsequently. But you wouldn't have been a big bank. You would have probably been shut down. Sorry. Or maybe not. So netting is the biggest benefit of clearing. But it's also efficiency and taking down a lot of operating lines of code.

This is a chart. I'm not going to spend a lot of time on it. But this is right off the Australian Stock Exchange website. And I thought, well, why not take that?

They have 2 million investors, the market participants or brokers in a much smaller market than the US. And Australia has 77 brokers, registered, regulated brokers. And then they have the clearing house called CHESS, C-H-E-S-S, which I can't quite remember what it all stands for. But SS is Settlement System. Clearing house--

**AUDIENCE:** [INAUDIBLE]

**GARY GENSLER:** What's that? What's it?

**AUDIENCE:** Clearing House Subregistered System.

**GARY GENSLER:** Subregistered System. Thank you. Is it Equity for E?

**AUDIENCE:** There is none.

**GARY GENSLER:** There is none. But they have the Australian Stock Exchange Clear and Australia Stock Exchange Settlement, because they actually put it in two different places, two different things. The clearinghouse is doing what we talked about-- mostly netting, lowering the lines of code, and then settlement.

And basically, because we're in a trade day plus two days, on the first day is all the clearing and the netting. And you better show up with your securities. And on the second day is settlement. Electronics and technology could make this simultaneous.

But most market participants like to have some ability to do gross trading against net's positions. So there's a lot of economics and market practice and structure behind keeping some delayed settlement. And the markets have grown up around that. Ross.

**AUDIENCE:** If it's not delayed, if it was instantaneous, wouldn't that get rid of the benefits of net? And you'd have to have every trade go right through. So it has to be that you wait until the end of the day or whatever period [INTERPOSING VOICES].

**GARY GENSLER:** So Ross just raised the number one reason, economic reason, why simultaneous clearing and settling is not that likely to happen. The markets have built themselves around the benefits of netting and also stock loan, the ability to borrow that security somewhere.

But you're absolutely right. If there were simultaneous execution and settlement, which is what the Bitcoin network in essence is supposed to be and blockchain networks can be, then you, in essence, have to prefund. Every time Hugo trades, he's going to have to provide his security to trade.

But then Tom would get the security faster. It would change the entire prime brokerage model. It doesn't mean markets, Ross, couldn't adapt and be structured that way. But it would be fundamentally a different structure. Is this is a hand up?

**AUDIENCE:** So the [INAUDIBLE] is really big with derivatives. I don't see it. I don't see what we use-- I don't

see it being a primary issue with equities. So if you were going to apply this to equities, trading, any cash instrument basically, I don't see the huge economic value for netting.

**GARY GENSLER:** The huge economic benefit for netting currently is a lot of operational efficiency.

**AUDIENCE:** Sure. But if you're going to place that with some--

**GARY GENSLER:** No. And then also, because there is two day counterparty risk, you are lowering that two day whatever measure equity volatility, two day equity volatility risk, usually not collateralized.

**AUDIENCE:** I'm just commenting on whether this-- you said the price that you pay for replacing this system with the blockchain based one would be that you cannot net up.

**GARY GENSLER:** I should have said something in addition. And the market participants would have to then prefund their trades. I think the larger thing-- so if I speak in too much financial technology, let me say current markets are you can sell or buy a security without owning the security or having the cash.

You can buy something and not have the cash. You have to deliver the cash in two days. And usually by that evening or the next day, you have to show you have the cash. You can sell a security without owning the security. And you only have to really kind of deliver it, generally speaking, the next day, on t plus 1.

If you went to a true simultaneous clearing settling and execution market, you'd have to have the cash and the security before you execute. And I think that's the larger piece of it, much larger than netting.

**AUDIENCE:** I understand the cash. But you need the security, right? Because if you're going to buy it-- if you sell it and you don't have it, then you know it's going to take two days to get one to cover your first.

**GARY GENSLER:** So through your prime brokerage arrangement-- Hugo, remember, has a couple. He's a big hedge fund. And he has what's called a prime brokerage account. Not at Bear Stearns any longer, but maybe it's at Goldman Sachs. He's kind of fancy. He's getting that.

Then his prime brokerage account, in his legal contractual arrangements with them, they will find that security for him, maybe from some other customer. Maybe that security is held in somebody else's what's called a margin account. And they will enter into what's called a stock

borrow.

But when he executes on the phone, he doesn't technically already have that security. He could be shorting it. And his prime brokerage account could then go find it from the Goldman Sachs network.

**AUDIENCE:** But it's not because you have plus two. But it's because you have a broker.

**GARY GENSLER:** Yes. That's right, combined with t plus 2. Let's take this. And then I'm going to move on.

**AUDIENCE:** Can you just take that one step further and explain why that's beneficial broadly versus just the system we've grown accustomed to?

**GARY GENSLER:** It's a really good question. Is this just the system we've grown accustomed to? Or is it beneficial? It's hard to tell. It is definitely the system we've grown accustomed to over a couple of centuries.

And as we've gone from transaction date plus five, which most markets were I'm talking about 50 and 100 years ago, maybe it was even t plus 10 at some point. But t plus five to t plus three to now t plus two, we've started to challenge that.

But in the US, the Depository Trust Corporation provides same day settlement. And very few accounts ask to do same day settlement. And I think it might be just they've grown accustomed to it. But I think there is some benefit in this stock, loan stock borrow side.

But I stand with what I said earlier. I think the market could work the other way. But it would be a big adjustment. And there are some benefits, because then Hugo, this hedge fund, is being extended credit by his prime brokerage account. And the prime broker is making some money on it.

But also Hugo's taking risk in that arrangement. Prefunding it would be a different model. Some argue it would have less liquidity in the marketplace. It would make shorting stocks a little costlier.

I'm not sure they're right. But their argument is that I'd have to borrow the securities always, 100%, and halve it off before I sell, even if I'm a multi-billion dollar hedge fund that has some credit worthiness. Kelly.

**AUDIENCE:** So the paper mentions that their new system fails to basically recognize these challenges,

such as the fact that it'd be advantaging the capital and operational efficiencies. But it goes on to say that it would be a step backwards for the world's most liquid market.

So what would necessarily be implications for illiquid markets? Would it basically be that people can make trades without having to interface with extensions of credit?

**GARY GENSLER:** Are you talking about illiquid markets that are centrally cleared or illiquid markets that have no central clearing?

**AUDIENCE:** I guess maybe both. I'm just trying to understand what the counter would be, that saying that there would be advantages, efficiencies in liquid markets. But what with the opposite be? Would there not be implications for the [INAUDIBLE] markets?

**GARY GENSLER:** So Kelly's asking-- I don't remember the comment, because it was in the Australian Stock Exchange one. So in non-cleared markets, things that are just so illiquid-- my house. It's not cleared. It's not centrally cleared.

Certain parts of the derivatives markets aren't centrally clear. They're not, quote, "liquid" enough. So I don't know. I don't know the comment. Maybe see me in class. And I'll look at the comment and try to nail it for you. Is that all right?

So I wanted to put this chart up, because it was from 2011. I remembered it when I was at the CFTC. But somebody at the Fed of Chicago made this chart about the US clearing systems. Yellow are all clearing houses. Red, the SEC, the Federal Reserve, New York--

**AUDIENCE:** SBD?

**GARY GENSLER:** Yeah. SEC, CFTC, and the Federal Reserve. But they might have-- New York. I don't even know who New York SB--

**AUDIENCE:** New York State Board of Derivatives.

**GARY GENSLER:** Yeah. Somebody from the Chicago Fed was trying to make the case that our regulatory system in the US was a little bit complicated. And I think this was in the midst of the debate about Dodd-Frank, that they thought all oversight of clearing houses should move to the Federal Reserve.

But I remembered the chart and found it. And I wanted to share it with you. But the yellow are all the clearing houses. There are a lot of clearing houses in the US. There's one for bonds.

There's one for equities. There's multiple ones for derivatives, both from cash and interest rate derivatives to energy derivatives to credit default derivatives and so forth. There's ones for options.

So I just wanted to lay it out. Finance is pretty complex. This is all digitized, by the way. But in this complexity, that's also where I think there's some opportunity, whether it's permissioned blockchain and not fully permissioned list with tokens, and inspired by-- the green are exchanges.

And I don't even think they put a color up for brokers, did they? Because then you'd have hundreds. There are multiple parties sharing ledgers and reconciling their ledgers. Reconciliation means I keep a ledger. Tom keeps a ledger. It's both on our database systems. And we keep testing and ensuring that we have the same records.

This is a system that, by its complexity and by its copies of ledgers and reconciliation, has a lot of opportunity for greater efficiency. And the question is whether blockchain technology, maybe permissioned, can bring some of that efficiency. That's the thought.

And that's what the chart was just trying-- by the way, the Congress didn't agree with the Fed. They left the authorities at the SEC and CFTC. And those are for stories other times. I personally felt it could be a shared authority. And we ended up with some shared authorities. But I thought that the CFTC and SEC have domain knowledge.

And it really important to keep the SEC involved in securities clearing and the CFTC involved in derivatives clearing for that domain knowledge, but that the Federal Reserve also came in under something called Title VIII of Dodd-Frank. And they also got authorities.

So we made it more complicated, because now there's multiple dotted lines for this. The Federal Reserve basically has an account with everybody. Or they have some oversight of everybody.

So then the question on blockchain technology, could you take the clearing house out of the middle and do the thing on the right? And my question for you all is, do you think the economics-- I'm not talking about the technology. I'm not talking about whether it's performance.

If you wish, you can go five or 10 years down the road and say it's got all this scalability and

performance. Do you think the technology, without something in the middle, what's the economics about that? Anybody? Eilon?

**AUDIENCE:** I still want to support the left side for liquid markets because of the netting.

**GARY GENSLER:** Because of netting.

**AUDIENCE:** Yes. I can't see a blockchain solution working well when you need netting to enjoy the efficiencies of selling and shorting, shorting basically.

**GARY GENSLER:** Yeah. But the question really is, can you somehow, on the right with shared ledger, still get some benefit of netting? Right? You're saying you're inclined here, because you want to get the netting for economic reasons. So as a ledger structure, can you get the netting here? Shimon?

**AUDIENCE:** You don't need the netting if it happens simultaneously. Netting is it is basically-- again, with cash instrument. I'm not talking about derivatives. Derivatives is a different issue.

With cash instruments, the only reason why you have counterparty risk is because it's not clear-- it was my understanding. Correct me-- is because you don't have instantaneous settlement. If you have a [INAUDIBLE] settlement, then you don't care about netting.

**AUDIENCE:** You care because you face so many transaction fees.

**AUDIENCE:** No. But that's going to be a lot more efficient. So why-- again, do you think the [? real ?] transaction fees are a big economic issue here?

**AUDIENCE:** Yes. That's what I think.

**GARY GENSLER:** And I'm sorry that you don't.

**AUDIENCE:** So now it's fine. I don't know. I mean, I don't know. For really intense help, how much do you pay per transaction with the clearing house and without? Maybe the net will give you only 10% of the transaction. But the cost of having the clearing house is more than 10 times.

**AUDIENCE:** Maybe.

**AUDIENCE:** So the economics depends on those numbers, I think.

**GARY GENSLER:** Is that a question? Hugo?

**AUDIENCE:** Yeah. So you still can get some of the netting. Let's just talk about blockchain transactions on Bitcoin. You can batch transactions. So you can have multiple inputs and multiple outputs. And that's kind of like netting.

Then you have to have a second system on top of that that keeps track of what's going on throughout the day. And then it just does the transactions on a daily basis or an hourly basis or whatever. That takes care of that netting. Right?

**GARY GENSLER:** So Hugo contends maybe you can get this economic thing called netting and still have a shared distributed ledger. Or you could do it off chain. I think, Shimon to your question, this is a big economic thing either because we've just grown accustomed to it over a couple centuries or it's fundamental to how markets trade, that we don't prefund.

It's that economics that blockchain technology will challenge. But we might stay with a central clearing house if the economics are that value. Well, the economics of, in essence, not prefunding, and thus, some delayed settlement. Whereas in the past, we always had delayed settlement at first because there was so much paperwork.

We had to have delayed settlement. We went digitized. And now, really in 2018, we don't need delayed settlement or batch processing. So now you've exposed, well, wait. What are the economics? Tom and then Alin?

**AUDIENCE:** Could you still have a delayed settlement with a blockchain system just by using a smart contract?

**GARY GENSLER:** You could. Absolutely.

**AUDIENCE:** I mean, you still keep this system that people are accustomed to, but do it without the economic red for the clearing house's sides or [INAUDIBLE].

**GARY GENSLER:** Yes. And it's what the Australian Stock Exchange says they are using with the digital asset company, Blythe Masters' company that's their outside vendor using the HyperLedger Fabric. And they're using the code. They call a DAML, or Digital Asset Machine Language? I don't know what the M is. But they call it DAML. Alin?

**AUDIENCE:** Yes. We've said you cannot prefund on the right. Is that correct?

**GARY GENSLER:** I think you could through smart contracts. I think you could find this. But the challenge with just

the picture, the picture suggests there's no central counterparty to do all the netting. And so the question is, can you have this ledger structure and still find a way to net down all the positions?

**AUDIENCE:** Well, like Shimon said, there is no need for that. You get that implicitly by recording everything and executing.

**GARY GENSLER:** But if you're recording-- all right. I'm agreeing with that, too. But that's where I get to if you need to do Shimon's approach, which is simultaneous execution and settlement, then you need to prefund, even if that prefunding is by nanoseconds. But you need to prefund.

**AUDIENCE:** Not necessarily. You could, sort of optimistically, you could post a transaction that says, I want to buy a stock. And I'm not going to prove to you that I have money to buy it. You record it, if you were saying optimistically. And later on--

**GARY GENSLER:** It depends. The word record-- let me use a different word, settle. Settlement means final legal rights have moved from one party to another. So the word settlement has a meaning that I just want to come back to.

It means I'm recording on a ledger that I no longer have legal rights. So this alpha has legal rights to it. And I think you would have to prefund if you were doing true settlement ledgers.

**AUDIENCE:** Sure, sure. I guess I'm saying it seems like you could simulate the clearing house. In the right side of this picture, the clearing house just distributed using the consensus protocol.

**GARY GENSLER:** Right. I think you're right that you could. But if you're going all the way to where Shimon is, like Bitcoin, and you're doing final settlement, final settlement recordation, then I think you have to prefund. A couple of questions over here. Eric, Ross.

**AUDIENCE:** The reason that the prefunding was [INAUDIBLE] performed in the validation of the block process, because--

**GARY GENSLER:** It could. I said it could even be done during the nanoseconds. But it has to be done before you move the settlement. And that's what's called clearing.

So it's a question of whether you have simultaneous execution and settlement, or you still have execution, clearing, settlement, even if separated by seconds, but still literally get granular. I apologize. This stuff is that granular. Back here. And then I'm going to move on.

**AUDIENCE:** Why do you consider prefunding-- maybe you don't. But it seems simply you consider prefunding before you're allowed to transact a negative economically.

**GARY GENSLER:** I shouldn't sound that way. It's just that for a couple years, we've had delayed settlement. And so I'm saying if you are a proponent of a system that has simultaneous execution and settlement, you just have to deal with it. You're changing the economic models that have been so common in the capital markets.

And when you take that on, you just have to think through what are the economics of that shift, from in essence a delayed settlement, thus modest but real counterparty risk that Hugo's got a prime broker and he's got that, and moving to this new model in capital markets.

So I shouldn't come across as negative. But I'm saying at least it's a hurdle that you've got an adoption curve that's going to be a challenge, I think, at a minimum.

DTCC, when I first spoke to them-- and I've had a lively, ongoing dialogue with the folks there on an occasional basis. This was the biggest issue they raised. They said they looked at blockchain technology starting several years ago. They talked to their customer base. And they couldn't find that their customer base really wanted to go to simultaneous execution and settlement.

They have same day settlement. But it's end of day settlement. So there's still several hours. But they said, we don't have a lot of customers that really want simultaneous execution and settlement. Now, that was commenting on the demand side. It's another question whether you could adopt this lower cost, do something, and change your capital market.

So this is another look at it. This is also from the Australian Stock Exchange, I think, website if I remember. But maybe it was another website. The question is, could you take out these middle parts? This is like blockchain architecture for clearing central counterparty and the central securities depository.

Because there's also somebody who's got the central registry, and that central registry are the two things. Could you take this out completely? That was the question, in a sense.

So here are the projects that are actually live or being explored. And we're going to talk a little bit about Australian Stock Exchange in the few minutes we have left. But this Australian stock Exchange Project started in 2016. A bunch of requests for proposals, like higher digital asset holding, they're actually actively working on it.

It's a 25-year-old system. And Jeff Sprecher said it, too. He said, you know, they had a legacy system they needed to replace. They decided to go with the new technology of the day. But Jeff wasn't convinced they had to. But they feel that it was the right thing to do, to go with that new technology of the day.

They believe-- and they've put out reports as recently as several weeks ago. They believe they're on the right path and that 15 or 20 years from now, every clearing house will be using what they would consider a permissioned blockchain solution, because it will so significantly lower the back office costs for their market participants who are now holding records.

Each bank, was it 77 members from an earlier-- yeah. Each bank has to hold records. It could be held in a shared ledger. And they would lower the reconciliation cost. And they believe the second advantage is using smart contracts.

Now, are they exactly the smart contracts like on the Ethereum network? No, because they don't have a native token. They don't have a DAP and a native token. But it's still automating certain processes, automating certain I'll call it back office processes.

So they're very committed to it. And they're going to roll it out in 2020. And then, for 12 months, run it simultaneous with their legacy system. So their cut over for assuring that it's resilient is at 12 month test.

Most major market infrastructures that roll things out do not roll simultaneously for 12 months. But they all roll simultaneous. Whether it's a month, whether it's 90 days, you can't cut over the back office of the New York Stock Exchange and just test it for one day. Or you can. It's just kind of choppy and a big risk.

**AUDIENCE:** Quick question. Are they going to use a stable coin to settle the transaction? How are they going to settle the transaction? Because I can see how you issue securities digitally. But you cannot issue cash.

**GARY GENSLER:** So this is very good. It's very good. So all of these clearing houses, they are the final custodian for the security. Securities are dematerialized, meaning they're all digital. And so those digital assets are held on a ledger and what's called the golden record.

This is the words used in the securities business. The gold record or the golden record, meaning it is the legal, verifiable thing you can go to in a court of law. And it says, this is who

owns this. Alpha owns it. Not Hugo.

Sorry. You're working with Goldman Sachs, though, right? That golden record is there for securities. Who has the golden record for cash?

**AUDIENCE:** The central bank?

**GARY GENSLER:** The central bank or the fractional banking system, their commercial bank subledger. Clearing houses around the globe would like to be able to have direct access to central bank money. And they currently do not in any of the major jurisdictions that I know. I think.

So what Australia does now, this is what they do now. They net everybody down. They get to t plus two. They're on that second day. Everything's netted down. And they're about to do the whole closing out. One second before they do the security settlement, they do the cash settlement. They call this Delivery Versus Payment, DVP.

But they're a clearing house. And they do not want to take risk with the central bank. They take all the money and settle all the cash with the Royal Bank of Australia, RBA I guess. Do I have the right name? Or is it a different-- is RBA one of the banks in Australia? But they settle all the cash. And just within a second, they settle.

We think of it as DVP. But it's actually technically not. Inside their clearing systems, they have a form of Australian dollars that is effectively digitally, in their system, digital money. In essence, what they're doing is clearing their internal digital money versus Royal Bank money.

**AUDIENCE:** Thank you.

**GARY GENSLER:** All right. Sorry. So these other projects-- Estonia, the Tallinn Stock Exchange, is exploring proxy voting and registration. What's interesting-- who runs the Estonian Stock Exchange? NASDAQ. NASDAQ. So NASDAQ runs it. And they're doing this project. NASDAQ announced and went live in 2015 on an illiquid.

So Kelly, you asked me about illiquids earlier. NASDAQ started a blockchain technology platform in 2015 on private securities, which were not-- they certainly weren't liquid. I don't know enough about what they did there as to how illiquid they were. But they felt, all right, this is a place we could do this.

And it's still gone live. It's got very little use. But it's still there. And they say they're going to try

to do it for mutual funds, when you and I can just by interest in mutual funds. And NASDAQ's going to offer that to mutual funds, partly because mutual funds aren't in DTCC from what I understand.

The others are just really some tests. Japan Exchange Group for the Tokyo Stock Exchange has done some tests. They've written papers. They're sort of interesting papers. The last one was earlier this year. They're really trying it just on post trade matching.

One of the securities firms in Japan, I can't remember, is really pressing the Tokyo Stock Exchange to do this. So there's some local commercial politics that are going on. I can't remember which exchange is-- not exchange. One of the brokerage houses is pushing them to do it. All permissioned systems. No, to my knowledge, permissionless systems.

Let's talk about ISDA for a few minutes, derivatives common domain model. One of my former commissioner's colleagues, Scott O'Malia, runs ISDA. That's a international trade organization. It's largely, largely dominated by the 16 big banks around the globe that probably transact 98% or 99% of derivatives around the globe.

And it was started in the 1980s to do all the forms, all the forms to enter into the legal contractual obligations called swaps. And over the years, it's transitioned. It's also an advocacy group. And it lobbies various regulators in Europe and the US and Asia.

But they've, a year or so ago, said, wait a minute. We could take a lot of the back office of swaps, particularly swaps that are not going into clearing houses. So it's called the non-cleared or uncleared swaps. And maybe we can create smart contracts to automate a bunch of contractual terms. So that's the second bullet point.

And they contracted out. They put out a request for proposal, basically, for somebody to come up with machine readable standard representation. Call it code, a scripting language. I can't remember if it's-- oh, it's written in JavaScript. So written in Java and JavaScript, a standard machine readable code of various events.

If it's a 20-year swap that's going to pay every quarter 80 quarterly payments, each of those quarterly payments, fixed versus floating payments, is somehow put into machine readable code.

And Scott and ISDA's view was, if we could get a broad consensus and publish that machine readable code that everybody agrees on, maybe that machine readable code could take the

place of legal contracts. ISDA, for 30 plus years, one of their lines of business is creating those legal contracts. Maybe we can get a step ahead of this and get consensus amongst these 16 big banks.

There's about 100,000 users of swaps when you say all the customers. It's not measured in the tens of millions. I doubt anybody in this room personally has a 20-year or 10-year swap. But I don't want to embarrass. Maybe somebody does. But it's an institutional product, largely.

That's their product. And it covers new transactions, rate resets, partial terminations, as I listed up there. Questions? And it's definitely very much inspired by Ethereum and smart contracts and DAPs. But in essence, it's not really blockchain technology. It's inspired by it, in a sense.

**AUDIENCE:** They're just rewriting the contracts instead of-- they think they can have more specificity and certainty of about what the contract means by writing it in contract.

**GARY GENSLER:** And importantly, importantly, efficiency-- to automate that which humans are still doing, even if it's in written contract. So it's also automation that's inspiring them. But you're absolutely right. It's taking legal contract, getting into machine readable JavaScript code, getting consensus on what that code is, getting some courts to recognize it.

And then you won't even need to write some of this, a rate reset or a partial termination, into the contract. You'd be referencing this. The longer term objective is to say maybe we can put even more of it right into code.

**AUDIENCE:** People would have to pool their money somewhere. It's like we were talking about, right?

**GARY GENSLER:** That's correct.

**AUDIENCE:** It's going to execute itself, which is going to have to be a pool of money somewhere.

**GARY GENSLER:** That you might have to some prefund or self fund or something. Let me go back here, and then up.

**AUDIENCE:** If they're using blockchain on it, it can't be--

**GARY GENSLER:** They call it a blockchain project. But it's a-- I think I've tried to capture the essence of what I think they have here. It's definitely blockchain inspired. I'm just not sure it's really stored on a blockchain.

**AUDIENCE:** Yeah. Because if you look at credit default swap, you have to reference a credit rating somewhere digitally. And wherever that's referenced digitally, if someone makes a mistake, does a transaction period that's based on that mistake and it's fixed, someone's going to have to be able to reverse that transaction.

**GARY GENSLER:** So what's raised is what about if it's referencing some oracle, referencing some price source, and there's an error. I believe, as I understand it, they're writing some of that into the code as well. So if it's referencing a price off the New York Stock Exchange, how it does that, what open API it references, how it pulls it. And they're trying to say, let's make sure that it's what's really verifiable.

There's one more slide on this that will help. This is their steps. This is their publicly disclosed five steps. This was in an October paper. It wasn't part of your reading. But select the parts of derivatives contracts first. Automation would be worthwhile. They're effective. It's efficient. Let's find something we can automate. Ross, that's their key driver.

Then try to express it the legal terms in a more formalized way. Get some standardization about the law. Get that be represented as functions, meaning computer code. So where can we be efficient and automate? Where can we take the legal words and get agreement, put it into code, combine that into templates?

I think some of this is referencing oracles. And then validate that the templates actually work and, ultimately, even get some courts of law to accept them. That's their game plan. Shimon?

**AUDIENCE:** I was thinking that there is potentially huge implications beyond efficiency, right? Because if you're at Treasury or Goldman Sachs signs a contract with someone at Orange County, their ability to assess what is actually written in the 30-page contract was minimal or will be minimal.

But it's a lot easier to do risk management or assessment if you could just use it as an API. And you have an outside company's basically providing you with the risk analysis. Right?

**GARY GENSLER:** I agree with that. We're still very much at the early days. But I think this is an interesting, real, live thing. There's a lot of money behind this. The markets are hundreds of trillions of dollars. If my former colleague and ISDA pulls this off, they'll probably drive some efficiency automation. They might lower some counterparty risk and event risk or crisis risk.

I think you could embed these into true blockchain technology. But I'm not sure it's dependent upon it. The automation of a smart contract. Next Tuesday, next Tuesday there's a couple

extra readings. We swapped out some readings. It's trade finance. Thank you.

[APPLAUSE]