**Demetri Kofinas:** 00:00:00 A bunch of derivatives suddenly have to be settled simultaneously, and everybody starts panicking about, Oh, is the market going to be able to handle this? And then like 80% of the market starts asking, "Well, what does that even mean? Is that how clearing and settlement works? Wait, you're telling me you can stop my trades. Oh my God. Is that true? Really?" Yeah, really. That's how the world works for you. You don't know it because people don't want you to know it.

And you're looking at cryptographic guaranteed systems like DeFi and Bitcoin, and you're thinking that they're the unreliable ones. The only reason they're unreliable is because the small portion of unreliability or risk with them is so immediately clear to you because they're purposefully built not to hide it from you. And that lack of kind of bullshit basically was very attractive to me.

**Demetri Kofinas:** 00:01:13 What's up, everybody? My name is Demetri Kofinas, and you're listening to Hidden Forces, a podcast that helps investors, entrepreneurs and everyday citizens get an edge by equipping themselves with the knowledge needed to anticipate the challenges and opportunities of tomorrow. By sharing my critical thinking approach and by challenging consensus narratives about the power structures shaping our world, I help you make the connections to see the bigger picture, empowering you to make smarter decisions.

**Demetri Kofinas:** 00:01:47 On this week's episode, I speak with Sergey Nazarov, co-founder of Chainlink. The leading decentralized Oracle network used by global enterprises and projects at the forefront of the blockchain space, which enables smart contracts on any distributed ledger to reliably connect to real-world data, securing billions of dollars in value across decentralized finance, insurance, gaming, and other industries.

**Demetri Kofinas:** 00:02:14 If I were to try and describe Chainlink to you, what it is and what it does, I would begin by encouraging you not to think of it as a blockchain. In other words, I'd encourage you not to think of it as one monolithic network. Instead, it's a potentially infinite subset of networks that support blockchains and operate in parallel to them and to each other, relying on a common framework that is highly customizable and adaptable to the unique needs of its users who come in a variety of flavors like decentralized applications, data providers and enterprises.

**Demetri Kofinas:** 00:02:51 The purpose of today's conversation is to help educate you on not only what Chainlink is and its value proposition, but also to help you understand how this industry is evolving, the design choices that are being made at the heart of these critical networks, and the opportunities that have, and will continue to present themselves to anyone interested in capitalizing on the disruptive efficiencies created by these systems, and on an entirely new set of use cases that would have been previously unimaginable.

**Demetri Kofinas:** 00:03:24 In the subscriber over time, Sergey and I delve deeper into Chainlink's architecture, how smart contracts interface with Oracle networks, how such networks come together to service their users, how they come to consensus about events in the real world, and much, much more. Sergey also shares his more philosophical thoughts about internet culture, what the future is shaping up to look like, and how governance is going to work in a world where more and more of our lives, relationships and experiences are happening online.

**Demetri Kofinas:** 00:03:57 And with that, please enjoy this extremely thought provoking, educational and unique conversation with my guest, Sergey Nazarov.

**Demetri Kofinas:** 00:04:11 Sergey Nazarov, welcome to Hidden Forces.

**Sergey Nazarov:** 00:04:15 Thank you for having me, Demetri, good to chat with you.

**Demetri Kofinas:** 00:04:18 The pleasure is all mine. I've listened to a number of interviews you've given on other podcasts, Sergey, and lectures you've given and talks you've given, and there are certain things that I've noticed haven't come up or that I haven't learned about you. And that begins at the beginning. I don't know much about your life and how you got to this point in your career. So maybe you can start us off by telling us a little bit, give us your five minute elevator pitch life story. How did you get to be where you are today as the co-founder of the largest decentralized Oracle network of its kind in crypto?

**Sergey Nazarov:** 00:05:03 Yeah, of course. I think what it comes down to is I've always been fascinated by two things, technology and philosophy. Both of those things have always fascinated me more than anything else. From very early on, I was taking things apart, putting them back together. TVs, vacuum cleaners, whatever else. And from a philosophy point of view, I always wanted to understand how the world works and try to understand what is a defining truth of what ethics is and things around metaphysics and epistemology and all those types of things. I think the thing that attracted me to the blockchain world was actually weirdly digital currency and how digital currency worked. I think the thing that got me initially exposed to it was actually through gaming because back in 2011, I would say probably the majority of people that were doing something with cryptocurrency were either crypto punk people that really understood it, or they were gamers that had GPUs lying around that they could mine with.

**Sergey Nazarov:** 00:06:12 I was in the gamer side of things and I knew a good amount about the history of digital currencies already. So I was fascinated. There were all these markets for trading [inaudible 00:06:21] gold on eBay, and there were all these dynamics around various digital currencies. But even beyond that, I knew about the history of digital currencies from the nineties and it was just always fascinating to me. In any case, I initially thought Bitcoin was a very normal type of digital currency. And then as I dug into it, I realized that it was much more advanced because it could operate without an entity, which is something that actually kills a lot of digital currencies historically, is that the entity that's operating or storing the record of the digital currency ownership happens to stop doing that because it stops operating.

**Sergey Nazarov:** 00:06:57 Bitcoin didn't have that issue. So it was unique in that you had this perpetually existing digital asset, digital currency, but all I really did with it for a few years was mine it and one or two other tokens. And then in 2013, you had the first smart contract capabilities, what were then called AppCoins. AppCoins were the name for chains that were in Bitcoin that had application-like properties. So an AppCoin back in 2013 or '14 was a coin that wasn't about digital currency. It was about making an application of some kind. They were built in a way where, because you didn't have smart contracts as something you could write on top of a chain, the smart contract feature like a decentralized exchange or the ability to make tokens like each smart contract type was actually built into the AppCoin or the blockchain protocol itself.

**Sergey Nazarov:** 00:08:02 It took a very long time to build any kind of new smart contract because you essentially had to change the blockchain protocol that was used for the whole thing. And then everybody would have debates about, do we want to change the blockchain protocol to include a decentralized exchange in addition to a tokenization feature? Everybody had their pros, so it took six months to make some new capability in the blockchain. And then Ethereum came and made that an obsolete problem because you could just code whatever capability you wanted as long as it fit within the parameters of solidity and as long as it didn't need external data.

**Demetri Kofinas:** 00:08:39 So to go back to what you were saying about what attracted you to Bitcoin, well, you got into it because of, you said gaming, but what attracted you to it was censorship resistance. Was that the quality that most intrigued you?

**Sergey Nazarov:** 00:08:54 I don't think it was censorship resistance. I think it was the longevity of it. Well, there was an initial property and then there was a second realization of blockchain and Bitcoin is. And then there was a final third realization about what it actually means for contracts. So the first realization was, there is no company behind Bitcoin and a Bitcoin could theoretically exist for 100, 200 years. There's no real reason why they can't exist for 100, 200 years. Many companies have average lives of something like 40 years. Many corporations, public corporate entities, the average life, I don't know, it's anywhere 40 or 50 years. So the average life span of corporations, even ones that are considered moderately successful is not large because there's something with them going public, there's changes in market dynamics, competition, capitalism takes hold and successfully replaces them.

**Sergey Nazarov:** 00:09:56 For digital currencies where people want to retain their value in a certain format, that doesn't really sound great. It's like, Oh, okay, I'm going to sink a ton of my money or a ton of my physical time into getting some kind of currency or digital asset. And then the company will go out of business. Or maybe the people who make world of Warcraft gold will change the terms of how it can be consumed or sold and all of my efforts will go out. There's just a lot of risks in relation to whether the digital asset will even exist at all five or even 10 years from now. And it was clear to me that Bitcoin was architected in a way that that was much more unlikely. That was not unlikely outcome for Bitcoin. That was the first unique property.

**Sergey Nazarov:** 00:10:42 The second unique property was that in the history of industrialized production, I've never heard of a system where you could simply provide machinery and you get back money. Usually what happens is you have to do a deal to get a resource, and then you have to convert that natural resource into another good, and then you have to take that good and you need to sell it somewhere. So you need to take cotton and you need to have a mill and you need to turn it into cloth and just sell the cloth. Or you need to get wheat and turn it into flour, and then you sell it to a bakery. Then that's a largely a matter of doing deals. You have to make a deal to get the wheat. You have to make a deal where you're going to sell the flour. You have to make a deal for labor. It's a large collection of deals that collectively add up to more than their individual parts.

**Sergey Nazarov:** 00:11:38 So the second amazing thing about Bitcoin was that you could turn on a machine and it would give you something of value. I didn't really understand how that worked initially. It was very confusing to me. It seemed illegitimate in

some strange way, because it was so different. But when I looked at it and I understood the reason behind it, and some of the security assumptions, I realized that it's actually a very unique model to basically monetize infrastructure and turn the value of infrastructure into some kind of secure resource for other people to consume in individual small, easily consumable pieces of value. That was the second realization.

**Sergey Nazarov:** 00:12:20 And then the third realization was more along the lines of censorship resistance and tamper-proofness, and really the guarantees of smart contracts in all the relationship with private keys and what smart contracts are able to do, in that when you look at something like multi-signature as maybe the simplest initial smart contract out there, you realize that it's actually a more secure and much more useful functionality than many banks can offer you. Banks right now can actually offer you multi-signature escrow the way Bitcoin does. It's not something they have in their legal framework. It's actually very strange. But when you expand the idea of highly reliable contracts, which is essentially what Bitcoin is, Bitcoin is a highly reliable contract about one thing, Bitcoin ownership. And when you expand the concept of highly reliable contracts beyond the concept of a Bitcoin ownership contract, you start to realize that it can actually completely revolutionize entire industries because those industries are really just based on trust and agreement between the users and the institutions and maybe the users and the other users through the institutions.

**Sergey Nazarov:** 00:13:38 For example, with Bitcoin, when you really think about it, when you have a bank account, what do you really own? You don't really own anything. You own a relationship with a bank that you hope will remain solvent and you hope will be able to give you your money in the way that you would like to receive it. That's really what you have when you have money in a bank. And if the bank becomes insolvent or the bank has a withdrawal limit or of the bank, for whatever reason, doesn't give you your money, you can't do anything. You don't really have that money, the bank has that money.

**Demetri Kofinas:** 00:14:13 Well, you have legal recourse, but I see your point, the fact that ultimately the bank, absent FTSE insurance, the money is a liability of the bank. If the bank's insolvent, you have to go into bankruptcy proceedings in order to try and get back whatever percentage of your assets you originally owned.

**Sergey Nazarov:** 00:14:33 Right. So in other words, you physically, you control nothing. You control the ability to maybe go to court and even FTSE insurance, wonderful, stopped bank runs, it's a great innovation, no doubt about it. However, FTSE insurance, as I understand it, can pay you out over 99 years at their discretion. That's fascinating. Absolutely, you have the FTSE insurance, you have a nice piece of paper with your name on it, you have a big bank with marble columns. It's the biggest building in the town. It's bigger than the church. It's a big building. It's a very secure looking building. You feel very safe, but what do you really control? You really control nothing. That's not a problem, because that's better than the alternative where everybody keeps gold shavings in bags under their mattress or something. It's obviously better. There's no doubt about that.

**Sergey Nazarov:** 00:15:30 But if you compare the bank to a private key, to a cryptographically signed transaction from a private key, and you have the private key, you have the ability to sign transactions and move assets wherever you want to move assets, whenever you want to move assets, and you know where your assets are

exactly, and you know that they aren't at risk of insolvency or they aren't at risk of... This isn't a first world type of problem, or this isn't a very common problem. I can guarantee you, it's a problem for people that have the ATMs in their country locked up and they can only withdraw 66 euros per day, whether they're a business or an individual getting money for their family. So whether you need to pay millions in invoices, or whether you're an individual with a family, guess what? ATM is going to give you 66 euros a day? Why? We decided. We decided. You have millions of dollars in a Greek bank. Guess what? 66 euros, that's what you can get. And that's when people start figuring it out.

**Sergey Nazarov:** 00:16:39 Same story with Robin Hood. People are like, "Hey, I control my assets. It's all good. I have control." Guess what? You have a password to a system that controls and owns your assets, that they could essentially do whatever they want with, and then you'd have to go figure it out. Now, is that better than the alternative, where in the seventies, everybody was rolling around hand carts full of paper documents? Yeah, it's definitely better. 100%, it's better. Is it better for you to have actual control over your financial life? And is it better for you to have full transparency about the risks of your assets and the risks taken with the thing that you've put your economic life into accruing? That seems an equal order of magnitude improvement. I think the reason people don't realize that as much is because they haven't been given a reason to pay attention to it. The unfortunate reality is that I think that reason is coming pretty quick. That's the longer version of it.

**Demetri Kofinas:** 00:17:47 So as a great answer, I heard a couple of words over and over again. One of them was control, another one was assurances. Is what you're saying that what attracts you and what attracted you to these types of systems and currencies? In this particular case we're describing Bitcoin, is that they give you the type of control and assurance over an asset that you have worked for, that you could get with, you mentioned shavings of gold, but with the portability and auditability of what we are traditionally used to with paper money. That they combine some of the features of both of those, is that generally accurate.

**Sergey Nazarov:** 00:18:33 I think I liked all those features and those features are wonderful. I think what I liked is the lack of bullshit. I think at core level, that's what I liked, and that's what a lot of people that got into Bitcoin early on... When you would talk to people about being in the Bitcoin industry, they would associate you immediately what a dark market, because all the stories were about how Bitcoin was used for the Silk Road or something?. I think the thing that attracted me to the whole thing was that if you look below the surface of the glossy wonderful logos, and you look at the actual agreement that you have about your financial life, your relationship to governments, your relationship to a number of things, a lot of it is not what people think. It is not what they think, because that benefits certain groups and that's the way the world works. Certain people don't seem to care. It just seems fine to them as long as the world keeps spinning. I understand that and that's fine.

**Sergey Nazarov:** 00:19:34 For me, somehow I always wanted to understand all that. I always want to understand, well, how does it actually work? I would take apart televisions. I'm like, well, how does a television work? What is a cathode-ray tube? How does that work? How does the pixel get different types of colors? I would just dig and dig and dig and dig until I'm holding a cathode-ray tube in my hand. And it's the same thing with this, I guess. I would just dig and dig. And the more that I would

dig into how agreements and the world actually works on the backend, the more I would realize, it's not what people think. It sounds great, and it's better than what came before, but it's not what people think they have. Then I would look at Bitcoin and I would see mathematics, that just explains what it is. And it's super clear. Here's a Bitcoin, here's its value, here is your guarantees. This cannot change. Won't change. You'll always be able to move it, the values determined by these and those market forces.

**Sergey Nazarov:** 00:20:34 I think it looks less clear to people because it's so volatile and that volatility suggests that there's something wrong. But the difference with Bitcoin is that all of the volatility and all of the confusion and all of the risk is right in your face, it's immediately obvious to you what the problems are. Whereas all the other options, they pretty much have a lot more problems, but they're unbelievably well hidden. And then those unbelievably well-hidden problems come up in the worst possible time, where a bunch of derivatives suddenly have to be settled simultaneously, and everybody starts panicking about, Oh, is the market going to be able to handle this? And then like 80% of the market starts asking, "Well, what does that even mean? Is that how clearing and settlement works? Wait, you're telling me you can stop my trades. Oh my God. Is that true? Really?" Yeah, really. That's how the world works for you. You don't know it because people don't want you to know it. And you're looking at cryptographic guaranteed systems like Defy and Bitcoin, and you're thinking that they're the unreliable ones.

**Sergey Nazarov:** 00:21:44 The only reason they're unreliable is because the small portion of unreliability or risk with them is so immediately clear to you because they're purposefully built not to hide it from you. And that lack of bullshit basically was very attractive to me. I think it's fundamentally very attractive to a lot of the ideologically aligned people that are attracted to Bitcoin on the basis of what it does rather than what the price is today and whether a pundit somewhere says it's the future. I think there's people, libertarian people and various other people that have a sense that the systems that they rely on do not work the way they think they work or the way they're being told they work. And those people of which there are a lot more than people might think, they are naturally and very, in my opinion, legitimately attracted to a system that is clear about how it works, guarantees them certain things, won't be able to deviate from those guarantees, and basically provides them clarity and assurances beyond just some glossy story.

**Demetri Kofinas:** 00:23:00 So I have a question. I think what you're getting at is that the opacity that exists in the world actually serves the interests of powerful people and powerful entities. And that by introducing a radical level of transparency, that you are in a sense reclaiming power or redistributing power. Is that accurate, is an accurate representation?

**Sergey Nazarov:** 00:23:27 I think there's all these wonderful theories about how efficient markets work and how capitalism is supposed to work and how everyone gets a fair shake and how everyone gets a fair start and how everyone has the ability to participate in markets equally and fairly globally and so on. Those are attractive ideas that in the modern world, have been propagated and have been considered to be the winning ideas that overcame other competing political and economic systems. What I think that a lot of other people want is the delivery of those ideas. And the degree to which technology does that for them is the degree to which they

adopt that technology. Whether that redistributes power from one group to another group, I don't think that that is necessarily what everyone's thinking about. I think what everyone's really thinking about is a sense of economic fairness.

**Demetri Kofinas:** 00:24:30 Let's rephrase it because inevitably, power has to redistribute. If there is a collection of elites who are controlling the system and the capacity of the system functions in a way that is beneficial to them, I think that's what we've seen in the case of financialization and financial markets. The opacity works to the benefit of certain individuals and financial crises like the one we had in 2008 are both a result of the way the system operates. And also the way in which this wealth was redistributed after the crisis as a reflection of the distribution of power. So rather than talk about redistributing power, let's talk about it in terms of the realization of the way in which we have been told the system is supposed to work.

**Demetri Kofinas:** 00:25:11 The reason I'm bringing up transparency is because what it seems to me, and this is a long-winded way of pivoting us to a conversation about the Oracle problem, it seems to me that part of what you want to do with Chainlink is to port over some of the principles and ideals around definitive truth that exists within the world of distributed public database technology into the real world and back again. Reorganizing the analog world in a way that is more transparent and definitive, and bring that level of certainty and clarity to the world of blockchains and distributed ledgers. Is that accurate? Does that begin to capture the essence of what you would call the Oracle problem?

**Sergey Nazarov:** 00:26:04 I think that's accurate in terms of what we want to achieve. The Oracle problem is really about getting data to these deterministic decentralized blockchain infrastructures. I think in terms of what we want to achieve and what I would like to achieve is a fair economic world for everybody. And when I say everybody, I mean everybody, I mean every single person on the planet, regardless of where they're born, if they're born in an emerging market or a developed market, if they have a little money or a lot of money. At the end of the day, I think the way that the world should work, and definitive truth has a big part to play in this and smart contracts have a big part to play in this, is that everyone can fairly and equally participate in global markets. Everybody can fairly and equally acquire insurance. Everybody can fairly and equally have a bank account to combat inflation, and should be able to make an agreement to start a small business, make an agreement to own a house, make an agreement to insure themselves against various negative outcomes.

**Sergey Nazarov:** 00:27:13 While all of those things sound pretty obvious and basic, if you really dig in to how the world works, it unfortunately doesn't work that way because there are huge asymmetries about how people participate in markets. Certain smaller groups or smaller participants can't participate in markets the way that larger participants can. Certain people in certain countries, even though their entire livelihood depends on it, can't have crop insurance against unfortunate weather events like lack of rain, even if that would allow them to continue being a farmer, whereas not having that insurance means they have to close down their farm and basically become a migrant and travel the world looking for work, which is not the best experience.

**Sergey Nazarov:** 00:28:01 Likewise, with savings accounts that allow people to combat inflation, I think what all of this is going to lead to is the developed world's markets working properly and fairly. For example, the 2008 financial crisis basically occurred because there's a huge information asymmetry. There's a huge information asymmetry between the actual quality of certain assets and the market's consumption of that quality with the exception of a few people properly discerning the real quality of those assets. So it's essentially an information problem. And that information problem screws with a lot of individuals, small players, and then also with governments and pensions and actually to a certain degree, certain societal dynamics simply because that information asymmetry became so vast, so large, so quickly for so much money.

**Sergey Nazarov:** 00:28:55 And then in emerging markets, people can't even have things like crop insurance because an insurance company won't come to their geography. I think what definitive truth and smart contracts have to do with all this is that at the end of the day, all of these problems are about two things. They're about forming agreements, about assets or about people's economic relationship with the world. And they're about proving things about the world. Contracts fundamentally consist of two parts. They consist of the agreement, the contract itself that defines what would happen if something happens, and then there's performance, there's consideration, there's the outcomes of the contract that trigger the events, the clauses, the consequences of the contract to unfold.

**Sergey Nazarov:** 00:29:48 As long as you have both of those building blocks, as long as you have the ability to define the contractual outcome, and you have the ability to prove that the contractual outcome did or didn't happen, those are the two building blocks that are needed to solve all of these problems. What definitive truth is really talking about is proving those outcomes. Because even if you can codify the contractual conditions, if you can't prove what happened, the contract can't really solve your problem. It can't resolve the contractual question it was made to resolve. So definitive truth is this key building block in defining what happened and in defining what a contract and an agreement should do.

**Demetri Kofinas:** 00:30:45 So is that another way of talking about finality if we're in the distributed ledger world?

**Sergey Nazarov:** 00:30:52 Yeah, I would say so. Finality comes down to what is the final version of a transaction? What is the canonical golden record, final state of a transaction? That partly has to do with whether a blockchain has confirmed that enough times or whether a blockchain could somehow change what happened with the transaction. And then I think it also has to do with the proof that went into the transaction to trigger its events.

**Demetri Kofinas:** 00:31:20 Right. So we're going to draw a distinction between finality and truth, right?

**Sergey Nazarov:** 00:31:26 I think so. I think finality is a property of transactions that's important because it allows further parts of the transaction to happen. It allows for the release of money. It allows for the legal closing of certain questions about the agreement. And it's a critical part of what defines a contract in that sense. I think it's actually very compatible with state machines and the storing of state in a blockchain and in a distributed ledger environment. So it's actually very technologically aligned in that sense. That you can just say, this is the state of this smart contract, and that'll give it a certain finality. And then truth is definitely something different in

that the conceptions of truth are very complicated depending on what you consider to be objective truth in a philosophical sense or in a technical sense. So there's a very, very wide spectrum there.

**Demetri Kofinas:** 00:32:28 It's a fuzzier concept.

**Sergey Nazarov:** 00:32:30 Yeah. It's fuzzier. You eventually arrive at metaphysical questions about, can we know anything? Is the color red for all of us? 50 different weird metaphysical questions about the nature of perception and an empirical evidence. It's definitely a much wider spectrum of variance there. But from a technical point of view, I think what definitive truth is that there's a certain committee of independent evaluators or validators of a truth that somebody somewhere has agreed that committee defines truth for me. Somebody somewhere is making a transaction. And then they say, "If this committee decides that the weather in a specific geographic location was no rain for three months, then the transaction will pay out the policy to the policy holder through their $50 Android phone."

**Demetri Kofinas:** 00:33:30 So consensus truth, consensus reality, we all agree that this is what happened, whether or not it really happened. We may never know, but we all agree that we've come to a common understanding that it happened and are prepared to move forward in confident agreement that had happened.

**Sergey Nazarov:** 00:33:50 That's the reality that you can really hope in financial markets and largely in many computing systems, is you arrive at a place where people define, this is the threshold at which enough systems have agreed, enough people have come to consensus, enough people have defined something to be a final state. At this threshold, we consider it to be final. After this many blocks or after this many nodes have confirmed something, we consider it to be in a certain state of finality. It's a very similar thing with Oracles and definitive truth. People define how many Oracles they need. They define the data sources that they consider to be sources of truth. They define how much agreement there needs to be among those data sources. And once that level of agreement is achieved, they have de-risked the possibility that the truth was manipulated against them. And that de-risking is really, what's important here.

**Demetri Kofinas:** 00:34:48 So again, I want to bring it back to, I think we've done a good job of exploring some philosophical ideas here early on, where we spend most of our time discussing blockchain and distributed ledgers, and basically public databases with very specific sets of rules that can come to finality on certain questions. But the problem is that as these systems scale in terms of what they can do with using, for example, smart contracts, they need to depend on data from the external world in order to execute.

**Demetri Kofinas:** 00:35:24 As we establish the external world is fuzzier and truth in the world is fuzzier, but you need to find some way to convert what we generally come to consensus agreement about in our own qualitative ways and day-to-day life or through legal agreements, et cetera, and converted to some consensus truth, or maybe use the word definitive truth, and then import that into a blockchain. Is that the Oracle problem? I want to try and get clear on what the problem is that you feel needs to be solved and then how Chainlink goes about trying to solve it. So maybe feel free to rephrase it if you like.

**Sergey Nazarov:** 00:36:05 Yeah, sure. I think there's two problems. I think the Oracle problem is essentially the problem that a blockchain and a smart contract, where the agreement is codified in this highly tamper-proof highly guaranteed manner, it cannot access data on its own. So the Oracle problem is really that the system that you have a key transaction or a key operation happening in cannot get the data or the proof from somewhere else that it needs. There's a brick wall there. That brick wall is there for blockchains for security reasons. There these highly deterministic systems that have to achieve consensus. So they have to limit the scope of what they achieve consensus about and delimit that scope down to the transactions that they make and the contract code that they operate, assuming that that contract code then receives inputs from somewhere else. So the Oracle problem is really the problem of, how do I get any kind of input or data into a smart contract? I think there's confusion around what this problem is because-

**Demetri Kofinas:** 00:37:14 Wait, so you're saying the problem is simply getting data into a smart contract?

**Sergey Nazarov:** 00:37:18 That's right. I think the initial version of the Oracle problem, how you define it initially, and then there's a second problem around definitive truth and de-risking the world's non-deterministic information by turning it into definitive truth. That's a separate more advanced problem that's necessary to solve in order for data to reach the high standard of a blockchain. Because otherwise, the data would be largely useless because you'd essentially be automating billions of dollars with insecure systems, which would defeat the purpose of the whole blockchain think. Imagine you have a really secure system, but then it's controlled by a really insecure system. That doesn't really give you a secure system. It gives you a system that's holistically insecure. That's a separate problem around generating the necessary security and guarantees around what is controlling the data that is then triggering the contracts.

**Demetri Kofinas:** 00:38:15 So what is the technical challenge of getting data onto a blockchain? Because it's always been my impression that this is relatively straightforward and that the challenge has been getting trusted data onto a blockchain. So it can execute an agreement and reach finality because you've got that liability outside of the system where it can actually tell what is, and isn't true.

**Sergey Nazarov:** 00:38:41 Right. I think there's two kinds of sides to this problem. If you're just asking about in the simplest terms, what is the Oracle problem? The Oracle problem is the realization of people that a smart contract, despite having the naming of smart at the beginning, because all of these things that have smart in their name are connected. Smart cars, smart fridges, all the smart things are connected to the internet. The funny thing is that smart contracts, despite being called smart contracts, are not connected to-

**Demetri Kofinas:** 00:39:13 They live in a black box, they're blind, deaf.

**Sergey Nazarov:** 00:39:17 Right, exactly. They're really, really secure. You can write some code and put it in there and it's guaranteed to act the way that you told it to act and engage in the operations you coded into it. Much like if you own a Bitcoin and you send a private key transaction into the Bitcoin network that says, move the Bitcoin from address A to address B, it'll do that and you're guaranteed to do that. That's what they're very good at. And they're very good at because they are hyper limited in their security dynamics. That hyper limitation is what gives

them that unique tamper-proof property, which is their truly unique property. That's the property that blockchains as an infrastructure maintain and generate as a new unique value to the world of computing and finance and insurance and all these other verticals, but that's their unique property.

**Sergey Nazarov:** 00:40:11 Then there's the problem of, okay, well, that's a wonderful property. I can define a contract and put it in this really secure world garden and I can maybe sign transactions and trigger something in the contract with those transactions, but something needs to sign those transactions. If I want to put data in there, the contract can't even go get the data. Let me give you an example. Smart contracts don't even really have a conception of time. You can't tell smart contract, Hey, at midday New York EST time, I need you to run. You actually need to tell them what time it is. You need to what's called kick them. You need to kick them with the relevant time from an off-chain system to tell them, "Hey, it's midday at the stock exchange. I think you should go check the price." And then when you tell them, go check the price, they can't go to an API and check the price. They actually need another contract in their world, in their universe to have the price to give to them.

**Sergey Nazarov:** 00:41:17 So the complexity of the initial problem is, how do I get all of this information into this universe, into this closed universe, while maintaining the security of how that information is put in there? So the first question is, how do I transmit all the necessary information into this universe? And then the second question is, how do I guarantee that the information that's now controlling the contract is reaching the same levels of reliability as the contract itself? Because let's think about what a smart contract is trying to give us. It's trying to give us hyper automation. We have some degree of automation in that there's centralized web systems that can move around certain amounts of money.

**Sergey Nazarov:** 00:42:12 They can control certain amounts of value, but they have these limitations, which is why it takes two weeks to settle the certain transaction. Or it takes three days to send money to somebody because people need to be involved. There need to be manual checks. There need to be all these guardrails in order for the systems to operate properly. There is no physical limit. It's not like we can't send a message to somewhere and say, give the money from this person to that person. It's not like the information can't reach the other side of the planet sooner than three days. It's because the way the systems work can't allow them to finalize the transaction in that speed because fundamentally, they can't automated that speed while controlling that much value because there's too much risk. And there's too much risk because the systems that control the value are gameable to a certain degree. So what you're trying to do with smart contracts is you're trying to create a form of hyper automation. And what are we saying when we say hyper automation, what is that concept?

**Sergey Nazarov:** 00:43:25 Basically means no people. It basically means no checks, no balances, no fallbacks. It means everything is so well-defined and everything is so well architected that we can automate the resolution of a billion dollar transaction. And it doesn't have to go to somebody's desk or somebody's terminal for them to read about it and to think about it and to approve it. And what does that depend on? Well, it depends on two things. It depends on the agreement being codified in some kind of container or in some kind of place that runs code that is ungameable. So you need the agreement itself to be unalterable. You need it to be guaranteed to operate in a certain way if it receives the command to operate

in that way. So you need the agreement to be safe from tampering, and then you need this system that's going to tell the agreement what to do to also be safe from tampering, and to also be able to meet the burden of hyper automation.

**Demetri Kofinas:** 00:44:34 What about intentions? The challenge of translating your intentions into code so that the actions as a result, meet those intentions. And does that become increasingly difficult to do as you increase complexity in the system?

**Sergey Nazarov:** 00:44:49 I think there's categories of contracts where the intentions are very clear. I think a lot of those contracts are in the financial system and the global trade system and insurance world in the ad network world. Did somebody view a page? Should someone get paid for that? And then there are agreements that are very vague. Did the person paint the house blue? Did they paint it the right color blue? Did they paint it the way you wanted it painted? I'm actually not saying that all agreements will be in this format. There will be agreements where you hire somebody to paint your house blue and they didn't use the right shade, or they painted the windows too much or too little, or they didn't do something you liked and you don't have a data source to tell a smart contracts what happened. And it's going to be very complicated to define it anyway.

**Sergey Nazarov:** 00:45:39 But what I'm also saying is that there's a huge, huge world of digital agreements in the global financial system around stock ownership and trading. That should be clear. They're pretty clear to people. You have an asset, you can trade it, you can trade it in these time windows under these kinds of conditions. Here's what the margin call is, here's what this is, here's what that is in terms of the details of your capacity to trade something. Agreements are very clear. You own this exact amount of money in this institution, and you're allowed to withdraw this much whenever you want. That's very clear and it's also very important. I would say there's quadrillions of dollars in agreements in that format.

**Demetri Kofinas:** 00:46:28 Yeah. So just to be clear, because I think we're in agreement here and I think I understand what you're saying, which is there is a huge amount of opportunity to create efficiency in the construction of agreements in the world today, especially as machines increasingly interact with each other without humans in the loop. But also, you can strengthen agreements that have a, let's say a legal arbitration layer by having this functionality built in as well. It can cost much less to arbitrate that or to build qualitative assurances around it. This is a much more efficient and robust way of structuring the world that we're moving into.

**Sergey Nazarov:** 00:47:09 That's right. It's a much more secure, reliable, efficient way to structure the world. You can build in escape hatches. You can build in multi-signature schemes where you have an arbitration council that can decide what's going on. If one of the parties see something happening in the smart contract that it decides it's not happening correctly. The important nuances that everyone involved in the smart contract will know that, they'll see that in the code, they'll see who the arbitration parties are because they'll know what their public key addresses are. Let me give you an example. This is one example I'm personally very, very excited about, and I think will have a lot of positive impact on society, that probably people don't think about it, but it's very, very impactful in my opinion, insurance. Insurance for something like crops and weather insurance, people, I think don't think about what insurance does, but what it actually does

is it allows people to pursue their economic goals because they can remove risk in ways that allows them to continue to operate.

**Sergey Nazarov:** 00:48:13 For example, if you're a farmer and it doesn't rain for two seasons and you have insurance, you're made whole, and you can continue to be a farmer instead of closing down your farm and having to reinvent your life, which by the way, probably isn't good for your society or for the global economy or for anybody. There are plenty of places where people in many countries can get this insurance, but then there's probably the majority of countries out there with emerging markets and a lot of the world's farmers that they can't get crop insurance and weather insurance, simply because the burden of an insurance company coming to their geography and offering that insurance in their local legal system is too risky. Because let's say they don't pay the premium, or let's say the policies and paid out, there's a court battle and it's very complicated. Maybe the court system is corrupt.

**Sergey Nazarov:** 00:49:10 So the local system of contracts just doesn't work. What that means for people in those environments is they simply don't have certain contracts. They don't have bank accounts because there's no way to make a bank charter. Nobody wants to do it. There's some weird legal framework that nobody understands. Nobody can offer people banking services and people can't combat inflation. People don't have the ability to get insurance because no insurance company comes. But let's just think about a world where, and we don't even need to think about it because this actually exists today, thanks to Oracles and smart contracts. Let's imagine a world where somebody has a $50 Android phone, where they've been reading Wikipedia, they've been watching YouTube videos, Stanford YouTube videos, getting basically a world-class education, which wasn't possible a decade ago but it's possible now. So what the internet did for information, I think smart contracts will do for people's economic life.

**Sergey Nazarov:** 00:50:07 Now imagine that in that same $50 Android phone, they can open it up and they can designate where they are and they can pay for an insurance policy if it doesn't rain. And let's say it doesn't rain for two seasons because of global warming or some other reason, and all of a sudden, they get a payout on their Android phone and they can sustain their livelihood and their family and their life until it does rain a season later and they can continue being a farmer. Guess what nobody had to wait for. Nobody had to wait for their local government to get it together and make a legal system to allow an insurance company to come and offer this. Nobody had to wait for an insurance company to come and offer this to them at all.

**Sergey Nazarov:** 00:50:50 The only thing that needed to exist was an internet connection, a smart contract that defined the conditions of the agreement and an Oracle that proved whether there was rainfall, which that's the final piece of the puzzle. Once you have those three things, once you have an internet connection to access the smart contract, the smart contract to define the agreement, and then Oracle to prove things about the world so the agreement can resolve itself, that's it. You don't have to actually believe in the brand of some insurance company. You don't need an insurance company to come and tell you, "Look at my big, beautiful logo. I've existed for 100 years, I'm going to exist for another 100."

**Sergey Nazarov:** 00:51:34 You have access to the internet, you see how this system works and you see that it verifies data in a reliable way. And you see that it's coded the contract in

a hyper reliable way. You see how much money it's paid out, you see how many people it's paid out money to, you see how much they've gotten, you see if it honors its commitments, you see how much capital reserves it has so you know when it has enough money to cover your policy in addition to the other policies it's underwriting. And then you basically purchase it through your $50 Android phone. That's mind blowing. If that doesn't exist, what's the alternative? Well, the alternative is we have to wait a decade for the government to get their act together. And then we have to wait another decade for an insurance company to decide to come to your geography. Why? Why does anyone have to wait for any of that? Doesn't seem like they do.

**Demetri Kofinas:** 00:52:27 So just in the interest of time, Sergey, I want to make sure that we have ample time to really get into Chainlink because there are also some other questions that I want to ask you as well, that aren't necessarily directly related to Chainlink. So maybe just answer that question for me. What is Chainlink and how does it relate to everything we've discussed so far?

**Sergey Nazarov:** 00:52:48 Yeah. Sure, of course. Chainlink is a decentralized Oracle network that provides definitive truth about the external world to smart contracts. What that means is that you are able to prove things to smart contracts and actually increasingly to existing web systems in a way that allows those smart contracts and web systems to reliably act on the information about what's going on in the real world. And that allows them to build hyper automated systems that deliver on all these high value interactions with the real word.

**Demetri Kofinas:** 00:53:25 Here's the challenge that I had when I was beginning to prep for this conversation, which was trying not to import my models of blockchain databases to thinking about Chainlink, because it operates very differently. How would you describe the architecture of Chainlink? How does it work? How is it different than a blockchain database?

**Sergey Nazarov:** 00:53:49 Sure. I think it's good to discuss a higher level architecture and then we'll jump into exactly how Chainlink achieved some of these goals. So at a higher level, I would think about blockchains as databases. I would think about smart contracts as application code. And then I would think about Oracles and Oracle networks as all the services and all the resources that application code uses. So for example, if you only have application code and database, you can only build so many things. And when you can build Uber and more advanced applications is when you actually have application code that you've written that is then connecting to other services. It's connecting to the GPS API to prove where a user is, it's connecting to Twilio to send SMS messages to the user, and it's connecting to a Stripe API to send payments to a driver. That's how you build an advanced application like Uber.

**Sergey Nazarov:** 00:54:44 What Oracles are and Oracle networks are the onion layer that connects everything to the application code or smart contract. The way that this is achieved by Oracles and Oracle networks is actually through the same security guarantees and assumptions of blockchains. And it's important to understand what the security assumptions and guarantees of blockchains are. What blockchains essentially do is they arrive at consensus about transactions that they then package into blocks of transactions. And they arrive at this consensus through multiple independent nodes, agreeing on what transactions fit into a

block and the state of those transactions and come into consensus on that and then progressively layering on more and more blocks on top of each other.

**Demetri Kofinas:** 00:55:31 Network-wide consensus.

**Sergey Nazarov:** 00:55:34 Right. They achieve a network-wide consensus and there's a definitive truth in that sense that they've arrived at agreement and they've codified that agreement to do a final state. And they've put that transaction to a block of others. Then that block is connected with other blocks and that creates its own sense of security and finality. What Oracles and Oracle networks do, is they arrive at a similar type of consensus, but not about transactions packaged into blocks. They arrive at consensus about external events. What that means is just like in blockchains, you have independent miners coming to consensus. In Oracle networks, you have independent Oracle nodes that basically independently go and verify something. So an Oracle node connects to an API about market prices or about weather or about any other set of events and it verifies through that data source that something happened. And then another node goes and does that somewhere else.

**Sergey Nazarov:** 00:56:33 In fact, some of our Oracle networks are so advanced now that we have 20 or 30 nodes all getting proof from multiple APIs each and then combining that proof across all of them. And then coming to a final consensus into a final value about what the weather was or what the price of an asset is or what the state of a certain asset is somewhere else. So the degree to which you're arriving at consensus and the degree to which you're achieving decentralized computation is the amount of nodes that you have verifying things, the amount of data sources that you're pulling from to verify the data and with each additional node, each additional data source, you're getting additional decentralization, additional proof, additional guarantees about the definitive truth of that specific value in that specific piece of information.

**Demetri Kofinas:** 00:57:32 I just want to clarify some terms here for listeners, so people don't get lost. Chainlink is a framework for independent nodes or independent Oracle nodes or independent networks of Oracles or independent networks of nodes, in other words, running Chainlink software to operate. And any of these networks can spontaneously emerge. We can try to get into the details exactly of how that happens, but it sounds like when the network first started or when you first started Chainlink, you had individual node operators.

**Demetri Kofinas:** 00:58:06 These individual node operators have added additional nodes to their network or additional node operators have come onto their network. So the more node operators you have in a given network, the more robust it is, but I'm envisioning this flower patch of flowers with petals. Each petal is a node. Some flowers have more petals than others, but there really is no limit to the number of flowers that you can have. Each of these networks within the broader Chainlink network, which isn't system-wide, operate independently. And all of them operate in parallel with blockchains. Is that generally a good framing?

**Sergey Nazarov:** 00:58:46 I think generally that's right. I think with-

**Demetri Kofinas:** 00:58:48 It's not a monolithic Oracle network, in other words.

**Sergey Nazarov:** 00:58:51 Yeah. I think that's an important nuance. What blockchains do is they have a single chain and a single network that is responsible for that single chain. And that's one chain of transactions packaged into blocks connected to each other. Those transactions can be about a certain number of topics with a certain size of transaction and certain amount of transactions per block and certain limitations of what code can be written about and how much code can be written in any one transaction or any one block. That's what blockchains do. That's what they achieve. Oracle networks, we don't have a blockchain. There is no Chainlink blockchain. What there is, is many, many Oracle networks. So there's an Oracle network for each individual piece of definitive truth. And then as users come and use that definitive truth, they each individually pay a small fee that's contributed to a shared pool to sustain the creation of that one individual piece of definitive truth.

**Sergey Nazarov:** 00:59:53 So you're absolutely right and understanding that we're approaching now hundreds of Oracle networks. And then we're probably going far beyond that pretty quickly. This is in the flower patch analogy, we're probably going towards one of these endlessly large Netherlands greenhouses, where they just have a massive amount of flowers. In any case, the nature of Oracle networks is that they are spun up to solve specific problems. They're getting spun up to solve a specific problem about a specific piece of data, a specific data source, a specific answer to one piece of definitive truth, such as, what is the Bitcoin to you as the price? What is the weather in a specific geographic location? What is the location of a certain collection of goods? And then they deliver that piece of definitive truth to a smart contract on one blockchain or multiple blockchains.

**Sergey Nazarov:** 01:00:53 Then that piece of definitive truth goes on to trigger those contracts. And the triggering of those contracts by that definitive truth is what gives them that reliability, which enables more and more value to be put into their control. Because the alternative is that somebody in some IT departments somewhere controls that contract, which is the way the world works now. The second problem, and this is where we're really discussing the second more advanced problem, is how do you generate these hundreds and thousands of Oracle networks to create all of these pieces of definitive truth to answer all of these questions and resolve all of these contracts in a way that reliably triggers and settles them?

**Demetri Kofinas:** 01:01:43 Just to further that point, if an individual Oracle network fails or succeeds, that doesn't necessarily have bearing on any other Oracle network. They could if both of them are servicing the same smart contract, but it isn't necessary. Whereas in a blockchain database like Ethereum, a failure in any part of the system is a failure or system-wide

**Sergey Nazarov:** 01:02:10 Yeah. I think there can be Oracle networks that operate correctly and then there can be one or two Oracle networks that don't operate correctly, maybe because somebody configured them incorrectly, maybe because somebody connected the wrong data sources to them for any number of reasons. But yeah, there's a separation of concerns between the different Oracle networks. I think, the nature—

**Demetri Kofinas:** 01:02:30 It's just something that seems important when thinking about both the robustness and survivability of, again, what do you call Chainlink? You call it the

network, because again, it's all these different Oracle networks. So how do you refer to the entire thing, the protocol, how do you think of it?

**Sergey Nazarov:** 01:02:51 We're talking about it more and more as a mid-layer and as a layer of these Oracle networks in these collections of decentralized Oracle networks that are essentially orchestrating all of these events, both for web systems and smart contracts. I think it's really a collection of networks and you're right in calling it a framework to create these networks. I think one of the important things to understand about that framework is that the networks are different sizes and have different security guarantees on purpose because what you actually need from an Oracle network, is its ability to scale its security and its guarantees as the amount of value it controls scales.

**Demetri Kofinas:** 01:03:33 It's flexibility. You have a greater amount of flexibility with what you have here than let's say on Ethereum.

**Sergey Nazarov:** 01:03:40 Well, I think this and Ethereum are fundamentally different problems. And I think that it's actually extremely complimentary. You need a place to write smart contracts and you need a place to trigger those contracts from. So it's a very complimentary dynamic. It's just different.

**Demetri Kofinas:** 01:03:55 Could you have different consensus mechanisms or processes or ways of arriving at finality within each Oracle network? Is that customizable as well?

**Sergey Nazarov:** 01:04:06 Yeah, I think that's the nuance point here, is that oracle networks are highly configurable to meet the demands of a specific user and their specific contracts. For example, we have some oracle networks where the nodes are actually the data providers themselves. So there are some oracle networks where the data providers are running their own nodes and they're feeding the data. That's a preference that maybe a user might have. There are other oracle networks where there's a different model of consensus because that's the preference the user might have. The most common preference that we see is that as the amount of value secured by an oracle network increases, the amount of nodes in the oracle network should increase. And what this does is it actually provides two very valuable properties. The first one is efficiency and the second one is the scaling of security. Efficiency in the sense that if you have a smart contract that secures £1,000, you probably don't need a lot of nodes because chances that an adversary is going to go and spend a substantial amount of money and resources to compromise those nodes is very low.

**Sergey Nazarov:** 01:05:12 You can have an oracle network of a certain size, but then as that smart contract achieves a million dollars, a hundred million, a billion, five billion, there are contracts we work with those types of numbers and those contracts do need larger amounts of nodes, a larger distribution of different data sources, various additional security methods, such as circuit breakers and trusted execution environments, zero knowledge proofs and any number of other things that go on to guarantee greater and greater security. This is really where oracles are different than blockchains. They're different in that oracle networks are generated on a case by case basis to solve specific problems around triggering contracts with certain specific goals such as, what is the weather in this specific geographic location? What is the value of a certain asset and so on? And then they are also, if they are built correctly or built in the conception of oracle

networks that we have, they are highly configurable to meet the demands of the smart contract.

**Sergey Nazarov:** 01:06:21 For example, you can even configure oracle networks so that the nodes are only from a certain geography. Therefore, the data is retained in that geography. Maybe that's a condition of how the smart contract works. You can actually also do certain amounts of computation in the oracle networks themselves. And this is a more advanced functionality, where if you want to keep certain information private or certain parts of the computation private, you can put it in an oracle network. But I think the configurability of an oracle network and the fact that it can do and is already doing lots of computation and going well beyond data delivery, is a more advanced point in feature. Because I think the real value of oracle networks just, the real way to conceptualize them beyond these initial problems of data delivery is as a collection of decentralized services.

**Sergey Nazarov:** 01:07:17 Those decentralized services go well beyond data. So data is the initial obvious critical piece of it the puzzle that oracle networks provide. But really the conception of oracle networks that we have is one where you build what we call hybrid smart contracts, where you essentially build a smart contract that is computed on-chain to the degree that it needs to be computed on-chain, or you want to compute it on-chain in regards to fees, privacy, the information that you want to share. And then there's an off-chain of the contract, which is often related to the data that it needs to consume, the part of the contract you want to keep private, or the part of the computation that perhaps due to scalability reasons, can't be put on a blockchain or can't be written in a blockchain specific language.

**Sergey Nazarov:** 01:08:12 I think the way to look at oracles and oracle networks and Chainlink is as a collection of services that are provided from a decentralized infrastructure, that are all of the services that a blockchain cannot provide. Blockchain can provide the place to run your smart contract code. It can provide transactions in terms of tokens that are on the blockchain. It can provide private key signatures for voting or for triggering things in the contract. But then all of the other services around computing things, providing proof about the world, generating randomness inputs, which one other example is something like NFTs. You have an NFT or you have a lottery. And what does that really composed of? Well, it's composed of two things. It's composed of the contract that generates the NFT or generates the lottery outcome. And then it's composed of the randomness that generates the input to prove that the lottery was provably fair or that the NFT was generated in an ungameable way.

**Sergey Nazarov:** 01:09:17 So this pattern of a smart contract and an agreement written into smart contract format has actually two problems. It has the problem of how do I build a smart contract? How do I write the code itself? And then the second problem of how do I trigger the contract, or how do I control what it does in an equally decentralized, equally hyper reliable manner, is not just about data. It's actually about all the services, all the resources that are needed to build that contract. While the initial conception of an oracle network is around computation related to definitive truth in generating data inputs, we have already expanded it well beyond that to create these hybrid smart contracts, which are much more feature rich and have the trust minimization that they need to have while having all of the features that centralized applications have. While decentralized applications don't have the trust minimization, which is becoming more and

more apparent from the cases of Robin Hood and GameStop and Wirecard and 50 other things like that, that'll just make it more apparent why people want a highly trustworthy, smart contract based application.

**Demetri Kofinas:** 01:10:33 What I've really enjoyed and found exciting about going down this rabbit hole is seeing how the industry continues to evolve and how the underlying technologies further down the stack say that support the application layer that most people interact with and which gets so much attention, are becoming more complex in their functions and needs for interoperability in order to actually build out this decentralized server-side infrastructure that was represented in the minds of many people early on, mainly in terms of winner take all touring complete blockchains back in say 2017. And this is where Chainlink fits in because you aren't just intermediating between the fuzzy world of off-chain humanity and the on-chain world of deterministic self-executing agreements. But you're also helping to intermediate interactions between various types of ledgers, each of which can provide different categories of assurances and performance. And you're also endeavoring to be able to offload some of that on-chain computation for things that may be don't need immediate or regular final settlement, as well as, and we'll talk about this in the overtime, things like deco, which provide privacy services that would otherwise be impossible to achieve on a radically transparent public ledger.

**Demetri Kofinas:** 01:12:10 Sergey, like I said, I'm going to move the second hour of our conversation into the overtime, for anyone who is new to the program, Hidden Forces is listener supported. We don't accept advertisers or commercial sponsors. The entire show is funded from top to bottom by listeners like you. If you want access to the second part of my conversation with Sergey, as well as the transcripts and rundowns to this episode and every other episode we've ever done, head over to hiddenforces.io to check out our episode library or subscribe directly through our patreon page at patreon.com/hidden forces. The rundown to this episode is 74 pages long. It isn't just all the notes and questions that I put together, it's full of memes. Sergey, I'm going to ask you about memes for sure, and what it's like to see your face all over the internet and all these different fascinating ways.

**Demetri Kofinas:** 01:13:04 But also, it's full of many of the resources that I relied on in order to prepare for this conversation and links as well. There's also a link in the summary page to this episode with instructions on how to connect the overtime feed to your phone so that you can listen to this extra discussion that I have with Sergey and every other previous overtime I've ever done, just like you listen to the regular podcast. Sergey, stick around, we're going to move the rest of our conversation into the subscriber overtime.

**Demetri Kofinas:** 01:13:33 Today's episode of Hidden Forces was recorded in New York city. For more information about this week's episode, or if you want easy access to related programming, visit our website at hiddenforces.io and subscribe to our free email list. If you want access to overtime segments, episode transcripts and show rundowns full of links and detailed information related to each and every episode, check out our premium subscription available through the Hidden Forces website or through our patreon page at patreon.com/hiddenforces. Today's episode was produced by me and edited by Stylianos Nicolaou. For more episodes, you can check out our website at hiddenforces.io. Join the conversation at Facebook, Twitter and Instagram @HiddenForcesPod, or send me an email. As always, thanks for listening. We'll see you next week.