**IlLUminate Blog Transcript: Zach Zacharia on the Disruptive New Paradigm of the Physical Internet**

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| ANNOUNCER: 00:00 | [music] This podcast is brought to you by *ilLUminate* the Lehigh Business blog. To learn more, please visit us at business.lehigh.edu/news. [music] |
| JACK CROFT: 00:13 | Welcome. I'm Jack Croft, host of the *ilLUminate* podcast for Lehigh University's College of Business. Today is May 18th, 2021. And we're talking with Zach Zacharia about a topic that is generating considerable interest in the logistics and supply chain world: the physical internet. Dr. Zacharia co-authored an invited editorial with Eric Ballot and Benoit Montreuil on the initial results and next challenges facing the physical internet that was published in the Journal of Business Logistics. He is an associate professor of supply chain management and director of the Center for Supply Chain Research at Lehigh. He teaches graduate and undergraduate courses in supply chain operations management and logistics and transportation. Dr. Zacharia, welcome back to the *ilLUminate* podcast. |
| ZACH ZACHARIA: 01:07 | Thanks very much, Jack. |
| CROFT: 01:09 | For those who may be unfamiliar with the concept, what is the physical internet? |
| ZACHARIA: 01:14 | So the physical internet uses the digital internet as a metaphor to help us rethink how logistics organizations could work much better. It brings this idea of universal interconnection of logistic services and networks. |
| CROFT: 01:33 | OK. And how does that relate to the digital internet? And particularly, are there lessons we can learn from the way the digital internet grew that would be applied to the physical internet? |
| ZACHARIA: 01:46 | Absolutely. The digital internet has three main components, if you think about it. It has a set of protocols independent of the technologies that underlie those protocols, a business framework, and a mostly independent, state-independent governance body. So let's look at the protocols that really make the digital internet work, and then we can see how it relates to the physical internet. So one of the most famous protocols is called TCP/IP, or Transmission Control Internet Protocols, which ensures that it doesn't matter whether you're connecting to the internet with a Windows machine, a Mac, a Unix mainframe, the web page will look the same because the protocols tell the computer, how does it have to read that kind of information, and it's independent of the kind of technologies. So without those protocols, you cannot have a seamless exchange of information that's independent of the technology or the platform. And another thing to think about, because you have this protocol, you can have digital information as it moves from one location to another location, it can be moved seamlessly. For example, let's say you're sending a very large, complex email. You could take that email, and it'll get broken down into data packets that could potentially travel in different networks and get reassembled at the destination. So we're using that as a metaphor, in the physical internet, to think about ways that the freight can move across different types of modes, whether it's rail or truck or ship, and look at ways to make the exchange more efficient. Right now, there is a standard for ocean-going, 40-foot containers worldwide and globally accepted in full terms. But there really is no accepted standard for cardboard boxes or pallets. |

ZACHARIA: 03:46 Every major company uses their own design, which means that it's not seamless. There's no way to easily transfer. So unless you have universal standards, you cannot have shared solutions, and thereby, you lose a lot of logistics efficiency when you're trying to interconnect these somewhat different networks.

CROFT: 04:10 And then, there's also the Internet of Things, does that tie into this in some way?

ZACHARIA: 04:16 Yes. So many people sometimes think of the Internet of Things as being part of the physical internet, but they're much more distinct. The basic definition of the Internet of Things is that it connects physical objects to the digital internet so that you can actually get some visibility into that particular product and some control. So the Internet of Things enables you, in a way, to facilitate the physical internet because you now know where those physical products are and maybe the environment around them. But it's distinct from the basic idea of a physical internet.

CROFT: 04:55 In the invited editorial I mentioned at the top, you state, and this is a quote, "Ultimately, the physical internet will enable universal interconnectivity with any organization, any time, and anywhere." Can you paint us a picture, so to speak, that shows us what universal interconnectivity looks like?

ZACHARIA: 05:21 Sure, and I think the simplest example to go back to is the digital internet. The idea that you can be across the world and look at something that is hosted in some other mainframe or some other computer system somewhere else because the information is exchanged across the network without any specific direct rules because it's independent of the technology. So universal interconnectivity for digital can also perhaps be looked at in the physical world. Wouldn't it be very cool if the freight logistics systems could share information so that you could exchange products, exchange freight virtually seamlessly because now you know where that product is and you can get it from one location to another? Now, let's be clear. Private networks already do this. For example, you get into the UPS network or the FedEx network, they are seamless within the network because whether it goes from a FedEx box to a truck to a plane and back to a rail car or another truck, that's relatively seamless because they have developed and set up that process. The problem is that if you go outside the network, you don't have that kind of seamless exchange. And that's where there's sort of a lot of pain points, so to speak. So with universal interconnectivity, you could take a lot of the cost out of the system, and thereby really improve the efficiency and effectiveness of the whole freight logistics system, and thereby directly reduce carbon emissions and improve sustainability.

CROFT: 07:14 All right. Now you call the physical internet, another quote, "a new paradigm for logistics networks." How disruptive will that new paradigm be to the way logistics networks have operated in the past, and currently, for that matter?

ZACHARIA: 07:29 Well, clearly, if the physical internet was able to be completely, universally interconnected, there is going to be a significant disruption to the large companies that make their revenue from having proprietary networks because these proprietary networks are what people pay a premium to use. And there's a lot of built-in security. For example, if you're mailing a passport, you're going to pay $20 to FedEx to mail it, even though the post office could mail that same passport for 55 cents. Right? But you pay for that extra security. And FedEx has invested a lot of money in their system so that you can track the product when it enters their system, and it can guarantee that it actually gets there. So now that they paid all this money to do this, what are

we going to give if we now say, "Hey, let's use their system. Let's make it all interconnected?" How is FedEx going to recoup some of their investments back? And what happens if there is a problem in the shipment now? If a part of the time, it was in the UPS network, then went to a FedEx network, and then went to another network, who is going to actually pay for damage? Where did it actually take place? So one of the things that you're going to have is it is going to disrupt existing networks because we haven't figured out some of those aspects of making sure that there's responsibility for any kind of damage, and if there's cost that people have already built into their systems that you have to be able to sort of pay for going onwards.

CROFT: 09:07

You also talk about the need for concept proofing, pilot testing, experimentations, and improvements to build trust and consensus about the way the physical internet designs protocols, interfaces, and tools. What are some of the specific examples that you think are helping to set the stage for widespread adoption?

ZACHARIA: 09:30

So there's a lot of research labs around the world that are actually working on these kinds of issues. How do we improve interconnectivity? For example, they've already designed a container, so that's a 40-foot container that can be broken into eight specific sizes that allow you to ship products that vary from something that fits in a much smaller, maybe a one-foot container, all the way to the full 40 feet. What's unique about these containers is they sort of fit together. This idea of Legos, where you don't necessarily need to have a container because these smaller versions, they're modules, they fit together, have become a larger single piece. The beauty of that is, is that you can now take that 40-foot container and now you're going into a different kind of transportation mode. You can take it apart and ship it on a specific mode that is more conducive to that particular design, so to speak. So there is technologies on that. There are research projects that are looking at using tunnels to sort of the pneumatic tube system where freight can travel at much, much higher speeds in through this pneumatic tube. And they've actually tested this. I think the tunnel is about a mile long, but they were able to show how quickly they could move freight because, of course, the G-forces are not there. And that could be some way to get products from one city to another very efficiently without using surface kind of transportations. So there's a lot of technology that's looking at how can you get these products and freight moving. The other part of that is, is that how can you share information so that you can actually identify those places where there are inefficiencies?

ZACHARIA: 11:30

One of the things that we always think about, we know here in the U.S., for example, 20% of all trucks are traveling empty. But if you had a good information system and if the logistics companies work together, then you could ensure that you fill the truck up to the full amount and you don't have trucks traveling empty. So again, there is this kind of research work that's being done. And hopefully, as these become more and more efficient and they start to get more real applications, companies will start to adopt it. And this will lead to this idea of, as you said, a widespread adoption of some of the things that would make this process more efficient.

CROFT: 12:12

Now, when you talked about disruption, and your answer to this last question made me wonder, the trucking industry, in particular, you were talking about kind of the dead-end loads that they carry now. What will the effect be, as far as you can predict, on the trucking industry when the disruptions and the physical internet finish shaking out?

ZACHARIA: 12:44

I mean, that's an excellent question. The point is if you're a truck driver-- and there is well over half a million truck-driving companies in the U.S., but something like 98% of them are truck companies with less than 10 trucks, meaning a lot of them are just individual driver/owner operators. So if you could figure out a way for them to not have to travel empty, that which you refer to about deadheading, then they would actually gain some efficiencies. But then, there might be a whole bunch of other things that they have to take into account that they have to now adopt to make it. Technology that is additional cost. When they went to those electronic notebooks, the larger companies had no problem agreeing to those things. But the owner/operators were very concerned because that was extra money that they had to set aside, and also, they couldn't get around the system. Now, you could track exactly how many hours people are actually driving. So I think that if you can show the benefits, then you are going to see more companies and more people willing to adopt these kinds of technologies. And this is always that case where when people start to see that there's a benefit, then they are going to be more likely to try and adopt some of these things.

CROFT: 14:15

Our Lehigh Center for Supply Chain Research works with numerous businesses and corporate clients developing innovative solutions to supply chain and logistics issues. And that kind of collaboration between industry and academia seems to be one of the keys to growing the physical internet. So what's happening on that front?

ZACHARIA: 14:39

Well, you're absolutely right. We for the Center for Supply Chain Research actually talk to our member companies and talk to the executives to give us good ideas to research. And there's a couple of research projects we're looking at right now. One that the executives are talking about, some of the issues they're dealing with the shortage in labor too for their warehouses and for some of the manufacturing that they're involved in. And also how COVID has changed some of the relationships between buyers and suppliers. We've got this idea that, when COVID first hit, for the first three or four months, many of the buyers and suppliers waived the contractual requirements because they realized they were all sort of in it together. And so there's that kind of research that we're working on. Now, to your specific question, when you talk about the physical internet, there really seems to be a real difference in how different parts of the world are focusing on the physical internet. The largest sort of government research or government investment is actually going on in Europe, where they actually have a specific research project called ALICE, which stands for Alliance for Logistics Innovation through Collaboration in Europe, and it uses 2050 as a target date to try and bring this about. But they spend a lot of money in funding this kind of research. So that's sort of where they are trying to put money into bringing more of these kinds of interconnectivity ideas to the forefront.

CROFT: 16:23

As part of the journal article that you were co-author of, you also did a review of recent research in the field looking at the physical internet. So I'm wondering, what were some of the most interesting trends or possible game-changers you found during that review?

ZACHARIA: 16:45

So again, this goes back to that idea of new research techniques. And one thing, for example, there's a lot of research going on in terms of autonomous vehicles and interconnected autonomous vehicles that sort of travel as a platoon. Again, the physical internet is ways of moving this freight and reducing this seamless transfer. So if you can figure out a way to do it autonomously, then there would be a good way to

have these autonomous vehicles work together. That was an interesting research project. I talked to you about the idea of tunnels for high-speed freight. Another thing that they're looking at is, is there's a lot of work collecting this data and seeing how you can actually look at mapping out what's going on in terms of these networks and mobile networks that we have. So there is, again, ways to move products efficiently so that if you can let people know where there's going to be a problem upfront, whether you need to divert shipments, a lot of simulations are going on to be able to identify these kind of bottlenecks and be able to move the freight around those kinds of areas. The other thing that people are doing is looking for ways to improve efficiencies just in terms of utilization. We talked about truck utilization. Warehouse utilization is another factor, again, because logistics companies invest in their own warehouses, and there are many times where they have to-- it's not always full because they don't know what the demand is. And so we have simulations that people are working on that shows that if you could share that information where it's empty, then you could actually, again, improve the efficiency of the entire network. But it goes back to this idea of interconnectivity.

CROFT: 18:54

Right. And that brings to mind one of the interesting things I noticed in the paper was an example with sea containers where they were able to take what had initially been patented, which was the twist lock, modify it, and open it to all. And I'm wondering, first of all, if you could explain what happened there a little more, and then, are there lessons we could learn for all of the other kinds of containers and ways that we move freight?

ZACHARIA: 19:25

That's a great question, Jack. So what's interesting there is, is that when you patent something and you create a cost associated with it, businesses sometimes are willing to pay for the patents or look for ways around it. And when you want something to be ubiquitous, to be used everywhere, sometimes putting a patent on it or charging costs actually reduces the effectiveness. And I think, when we talk about the digital internet, one of the things was that if there was a cost associated with every single one of the innovations that were going on when they were developing the digital internet, then it really wouldn't have taken off. Because they tried, even when the digital internet started, they tried to develop proprietary networks. But then people had to pay a certain license fee, and things like that, it didn't necessarily survive. So the freight law is a good example of where if it was always patented and every container need to have it, they'd be a good chance that containers would not have taken off as much as they did. So that was a good example of where you need to be able to allow some of that sharing so that you can actually get something that's used everywhere. And so, when we look at the physical internet, you have to look at some ways to share. And actually, one thing that I didn't mention-- but it's critical to sort of understand and maybe it goes back to this idea of what are some things that are stopping the physical internet? Well, it's actually people issues, really, when you think about it. Because human beings, at the end of the day, do they trust that they're going to be able to get some of their money out? That they are going to be able to share this information, now we have this network that we could actually all work together? So I'm glad you brought up the twist lock example because it’s very easy to lock these containers.

ZACHARIA: 21:27

You've got to imagine that in a large ship that carries these massive 10,000 containers or more, you need an easy way for a container to just sort of flip on top of each other and lock in place, and very easy to unlock and lock. And that's what the twist lock did

because you now have a ship that comes with 10,000 containers, and a person can unload those containers about one every 30 seconds, that should be two every minute. And that's because it's so easy to lock and unlock. And that's how, if you didn't lock it, you can't have these containers stay stable when you go across, imagine, the ocean. So that's a great example of an innovation that really enabled the much more quicker interchange, which is this idea of that seamless way of freight to move from one mode to another. That is really critical to the success of the physical internet.

CROFT: 22:23 The idea of sustainability. Again, going back to the paper, there's a point where it talks about how the physical internet paradigm appears particularly suited to the needs of reducing the environmental footprint, as well as improving agility and other things. But that's an interesting idea. Can you talk a little about what this concept means as it moves forward in terms of improving the environmental footprint of supply chain and logistics?

ZACHARIA: 22:59 Basically, the idea is, is that you've got to take that example that I gave you where the 20% of the trucks are traveling empty. A significant percentage of warehouses are standing empty because it's waiting for that extra demand. We use this idea of safety stock when we talk about supply chain. Your safety stock is extra inventory that you have to ensure that you can meet demand that could be it's much, much above and beyond what is normal or stable demand. And so, as I mentioned earlier, transportation, freight transportation, the logistics industry is almost the second largest producers of carbon dioxide. And so, therefore, if you can figure out a way, so you have less trucks on the road, if you have a need for less warehouses, and if you can improve it, we have data, and you've actually done these simulations where, if you started to use the trucks more efficiently, the networks more efficiently, you can have a significant impact. Something in the order of about 20% reduction in carbon dioxide, an improvement in fuel efficiency, and all of these kinds of things. Ocean-going freight, those ships pump out a lot of carbon gas. And so, when you think about it, if you can make those processes more efficient, it is much, much more sustainable. And that was one of the original reasons that the physical internet was proposed, because of all these built-in inefficiencies that you have when people have their own networks, their own warehouses, their own trucks, and there's no sharing of that empty space that you actually have.

CROFT: 24:52 Are there any other difficult challenges you see standing in the way of broader implementation of the physical internet at this point?

ZACHARIA: 24:59 Well, and let me just again reemphasize that it's the human issues that really stop. If we can figure out a way that we can get more people believing that they're going to get their investments back out of it, there's a greater trust, and there's greater sharing and willingness to share, and that would make some of these kinds of technological issues sort of fall down. I think it's the people issues that are more stronger barriers than the technical issues that are stopping the physical internet from becoming more of a reality.

CROFT: 25:33 And you had mentioned ALICE, I believe it was, had estimated 2015 or 2050, or set that as a target date by which they hope to have the physical internet up. And I'm wondering what your idea of that prediction is. Does that seem overly optimistic? Does it seem about right, or--?

ZACHARIA: 25:57

Well, I don't necessarily think it's overly optimistic. That's well over almost 30 years from now. I do imagine that we are going to go through several iterations of this so that we can figure out ways to share that information so that we can improve the interconnectivity between the different kinds of networks. So I think ALICE, they just went a little further out ahead because they didn't want to deal with specific issues that are happening right now. They want to think about how can these different companies, how can these different transportation companies, warehouse companies, logistics companies, all sort of work together and share maybe even just their empty spaces? So that instead of going on, "Look, I'm shipping this product, and if you have some product that's much higher volume--" There's a great example where you are shipping, for example, chips, which is very light, but takes up a lot of space. So potato chips, for example. And then you've got another company that is perhaps shipping soap. Tide was the product. And so you just imagine that Frito-Lay and Procter and Gamble got together, and you put Tide in for the heavy weight, but didn't necessarily have a lot of space on top, and then you had chips. A full truck, 40-foot truck, can fit 9,000 pounds of chips. Which means that, essentially, 31,000 pounds of capacity is wasted. While at the same sense, you put a lot of Tide soap liquid in there, then you're going to have some empty space on top. Here's an example of where if they could actually get together and use both of their kind of strengths in this point, they could actually reduce the total cost of transportation, improve sustainability. So those are the kind of examples that they've already tested, and they've shown it to work. But for this to become ubiquitous, there are going to be some challenges and, probably, 2050 years might be the goal to get this thing done.

CROFT: 28:09

And finally, is there anything I haven't asked you about? We've covered a lot of territory here today, but anything I haven't asked you about that you think our listeners should know about the physical internet?

ZACHARIA: 28:21

No. I think you've covered all the key issues. I guess one final thing that I guess I should say that when you talk about innovation, and I neglected to mention when I talk about the digital internet, that one of the reasons it really took off was not just the protocols, but it was an independent state, independent kind of governance. So it was actually done by innovations at the local level as opposed to mandated from somewhere on top. And I think we never really got into it, but for these kinds of large societal changes, like the physical internet, there is a real need for that kind of innovation independent of sort of a state authority to be able to make these kinds of innovations stick so that it could benefit us all. So that would be my final point.

CROFT: 29:10

Dr. Zacharia, it's been a most informative conversation, as always.

ZACHARIA: 29:14

Thanks very much, Jack.

CROFT: 29:15

OK,  I want to, again, thank our guest, Zach Zacharia. As director of the Center for Supply Chain Research at Lehigh, Dr. Zacharia and the faculty and students at Lehigh Business are generating new ideas for education and future knowledge in the field of supply chain management. This podcast is brought to you by *ilLUminate*, the Lehigh Business blog. To hear more podcasts featuring Lehigh Business thought leaders, please visit us at business.lehigh.edu/news. And don't forget to follow us on Twitter @LehighBusiness. I'm Jack Croft, host of the *ilLUminate* podcast. Thanks for listening. [music]