Exhibit B: Video Transcripts

Faster, Cheaper & Decentralized Internet - How Althea Works

Jehan:
Time for the first presentation. Hello everyone, I'm Jehan. I'm the CEO of Althea, and I started working on this project probably in 2015, but Justin actually had been working on it in 2013 but took a pause for a while. Anyway, we're trying to create a faster, cheaper, decentralized internet, and in this presentation, I'm going to go over basically the 101 of what that means. In the later presentations in the day, Graham's going to be going over how to actually set up networks. And Graham comes from the WISP world, wireless ISPs. These are traditional ISPs that use wireless hardware. And an Althea network will use all the same hardware, so his knowledge is basically very applicable to Althea.

Jehan:
But I'm going to explain a little bit about what makes Althea different from a traditional wireless ISP. So next slide? So what we're trying to do is allow communities to build and maintain their own profitable, decentralized internet infrastructure. And so the reason for that is in a lot of places, the internet is provided by a really big company that's from a different state or even a different country, and they're not very motivated to improve service a lot. I mean, sometimes the service is really good, some places have fiber. But some places the service is really bad, and they don't really care too much to improve it.

Jehan:
And so with Althea, we're trying to give people the tools to set up networks where the whole network is not owned by one company. We think that's good ideologically, because we believe in decentralization, we believe in people owning their own infrastructure and stuff. But we also think that it will make it easier for communities to set up better internet for themselves, because you eliminate the whole thing of one person needing to be the business owner who gets the loan, who sets up the network and stuff, because our software makes it so that different participants in the network can all work together, and all the payments and the coordination of the participants is handled automatically by our software, basically. So next slide?

Jehan:
Basic system is ... So you've got to pay for the internet. It's not like ... There are more nonprofit mesh networks, and I volunteer with one in Oakland. And Althea is not

necessarily free internet, it's decentralized. But basically what you do to pay for the internet, instead of sending a check to Comcast or whatever every month, you load some tokens into your router. So these are, at the moment Ethereum-based tokens, and we are also, right now we're prototyping with Ether itself, but it's a volatile cryptocurrency that's not really ideal for the users. So we're right now trying to get it to work with a stable coin, which people don't have to worry about loading up their router and then having the value crash and then having their month's internet cut short because the cryptocurrency market.

Jehan:
That's basically what you do, you load up dollars basically into your router at home. That router is then hooked up usually to an antenna that's on your roof. It depends, maybe if you're in an apartment building, you just plug it into the wall. The physical scenario is different everywhere. It really depends on what the line of sight is and how the internet is getting to you. Graham is going to tell us a lot more about that, too.

Jehan:
So then basically, you've got this antenna on your house, and it's connecting to other houses. Some of them are closer to a source of the internet, it's called a gateway, and some of them are further away. And they pass the signal among this network of nodes, and then each node along the path gets a little bit of what the end user is paying for the internet. So next slide?

Jehan:
And so the big thing we're trying to accomplish here is instead of everybody paying the ISP, who is depicted up here, it's what they look like usually, and everyone paying Comcast or whatever to sort of provide this network for them, it's more that people are paying each other. And if somebody wants to upgrade their equipment on their house, upgrade their hardware, create a better router or whatever, they'll get more of the traffic. They'll essentially be supplying more of the traffic to the neighborhood and make more money, so it's this form of almost like a bandwidth market in a way locally. So next slide?

Jehan:
I'm going to go through this sequence of images here. This kind of illustrates what we're doing. This is a depiction of our firmware. That's what it looks like inside the router. But what this is meant to communicate here is that our software essentially puts an ISP in every router. What I mean by that is that you might not be familiar with how ISPs work, but they'll make deals among each other for peering, to connect to each other, and so

we put that into the router, so the router connects to other routers, and it peers with them. And the router also, the firmware here, figures out what's the cheapest available internet at the time, what's the best quality, and it balances these factors, and it handles a lot of other things. It handles the payments. It pays second by second to the neighbors. Next slide?

Jehan:
These routers all link together, and this is more abstract here, obviously. It's just like the peering I was just talking about. They use something called a routing protocol to find out what the path to the internet is, and not only what the path is, but what's the fastest path and the cheapest path. For more of a technical, technically we use the battle routing protocol, and we have some patches for that, which help it route based on price as well as quality. Next slide?

Jehan:
Bringing you into the real world, each of those routers in the previous picture is inside someone's house. And you can see here on the left, we've got, this would be the gateway and it's connected to some other houses. Then on the top here, this house is supplying their neighbor with internet. You can see here, the internet connection here represented by zeros and ones is going in one direction, and the money is going the other direction. That's how the ... it's sort of like if you buy a candy bar from the store, the store bought that candy bar from a distributor, and the distributor bought that candy bar from a factory. We're sort of bringing that to internet access on a very granular, local level. Next slide.

Jehan:
Oh, we've gone to this slide before! This is a depiction of the internet here. That's plugged in with a big plug, so this is the gateway, like I was just saying. And generally, with Althea software, a network can have many gateways. You can have a lot of different places in the network where it's connected to the internet, and they're all competing. But in general, when you get to the practical realities of it, most networks are going to have, at first, they're at least going to have one gateway. That's due to a lot of factors that Graham will get into, but a lot of it is you really want a very reliable, commercial grade connection to supply your town with internet. You don't necessarily want to be piggybacking off of another retail ISP.

Jehan:
So the gateway is attached to, it's called backhaul, usually. A commercial grade connection to the internet is backhaul, and that's how the internet access is getting into

this network here. And if you can see here, this gateway is making a good amount of money, and it's good because we actually have to pay a lot of money for a backhaul connection. But then, also, this guy at the top here, intermediary node, it is making money by carrying the traffic from this node on the far right. So that's this built-in incentive for expansion as well. So next slide?

Jehan:
There's another factor as well, the subnet DAO. DAO means decentralized autonomous organization. It's kind of a mouthful, and we might change the name of that. But basically, the idea is that that's the organization of people on the local level who are maintaining a network. The reason the DAO comes in there is that they're using a blockchain based organizational system.

Jehan:
The payments that I talked about, the direct payments between the routers, those are based on blockchain, and also the subnet DAO is too. So each node of the network, as well as paying its neighbors for the bandwidth that it's using, also pays a fixed monthly fee to the subnet DAO that it's connected to. That organization ... I'll show some screenshots of the software a little bit later in the slideshow, and also Justin I think is going to do a more in-depth tour of it later as well.

Jehan:
But that software lets that organization both hold the fees from all of the routers, and spend those maybe on promoting the network or providing tech support to people. Those are both important things that ISPs do that you wouldn't necessarily get in a decentralized network otherwise. The DAO also lets them add and remove routers from the network. And that's important if there is someone who is trying to jam the network or mess it up or something, they can just remove them. That's usually not going to happen, but it gives it a point of sort of administrative control of the network.

Jehan:
I also want to point out, with the subnet DAO, so this intermediary node on the top here, it could actually be part of two different subnet DAOs at once. That's kind of a key difference from how ISPs work today, because today, the way ISPs work is that they'll usually own their own equipment, their own radio equipment, and they'll oftentimes rent towers that are also rented by other ISPs and stuff. But with this system, you can actually have parts of the infrastructure, the whole node that's being used by these different subnet DAOs.

Jehan:
So you might have one subnet DAO that provides a very full service kind of experience. You call them up and they come to your house, they screw the thing to your roof, and they show you how to plug the router in. And you call them up, and they might have a higher subnet DAO fee. You could have a node that's on the same network, connected to the same intermediary nodes, that's on a subnet DAO that's like a more bare bones, so it's really for the techies. Like if you really want to set up your own thing, you really want to do it yourself, and you can save on these subnet DAO fees in that case.

Jehan:
Subnet DAO fees could really be as low as you want, but we are thinking typically, the way it would work, probably will, on a lot of networks is to have those be half, or maybe a little bit more for like the high service kind of subnet DAOs, of the total payments people are making, with the rest of it being made up by bandwidth payments that fluctuate as you're using bandwidth. Yeah, I guess that's subnet DAOs. Next slide?

Jehan:
Then it's just showing the expansion. As you can see, this node on the top used to be the only intermediary node in the picture. And just terminology, when I say intermediary node, I mean a node that is serving other nodes in the network. This software will let any node be an intermediary node, however, practically, in the real world, to provide good service, intermediary nodes are probably going to be using different radio hardware. They'll want to make sure that their router is plugged into a good source of power and stuff like that.

Jehan:
So intermediary nodes, a lot of the time, there's kind of a dichotomy between client nodes, which are very small, then intermediary nodes. You might jump up not just to serving one other node, but like 50 with a tower or something. But in this picture, obviously, this node here just started out as ... the one on the far right ... started out as just a client node, and they upgraded their hardware a little bit. They had some neighbors down over further right, who also wanted to get access to this, and they installed another radio thing. You can see this bar shape that is supposed to represent a sector antenna, which is a more powerful radio thing that can do a wider field projection of a signal. And these two houses got added, as well. That's what this depicting here.

Jehan:
Then the subnet DAO is helping them with that, too. We anticipate that being a function of subnet DAO organizations as well. So next slide?

Jehan:
This is a little bit about the software. I want to also ... There is a thing called exit node, and the exit node is, this is just showing the screen on the dashboard where you select it. The exit node is like a VPN server out on the internet. The exit node actually does speed tests to make sure that the nodes in the network are providing good service, and it also functions as a VPN so your neighbor can't see your browsing, for instance.

Jehan:
Then also, another important role is that a lot of the time, people are worried about being responsible for, if you are using, if you're selling your internet connection into one of these networks, sometimes you're worried about what people are doing on the internet, whether that's going to come back to you. With the exit node, it doesn't because for anyone monitoring the traffic on the internet, it appears to come from the exit node. So it removes any liability from people who are selling their connection into the network, so that's an important role. Next slide?

Jehan:
This is the interface of subnet DAOs. It doesn't quite look like this anymore, but we're building on a platform called Aragon. Some of you may be familiar with it, it's a Ethereum kind of organization platform where you can design organizational rules. And these are a lot like the rules that govern corporations and non-profits, except this is all done on the blockchain, so you can have votes. Instead of using board meetings and having a binder with meeting minutes and stuff, it's on the blockchain. And instead of a bank account, it just holds it in like a multisig wallet, basically.

Jehan:
Here, it's showing the node lists. You can add them, remove them, that's kind of the administration function of it.

Jehan:
I'm also going to add, with the subnet DAOs, the blockchain does give us all the tools to allow them to perform their basic business functions without any legal registration. But in a lot of cases, there are benefits to legal registration with the government as a non-profit, or as a for profit because there is liability protection. There's also, non-profits, there's tax benefits, though you'll have to jump through some hoops to get that.

Jehan:

We expect that probably a lot of subnet DAOs will elect to do this, but it's also nice in areas where it might be difficult to get registered with the government, or that kind of infrastructure might not exist. This allows people there to set up organizations that have the same capabilities as a corporation would in a first world country. So that's cool. Next slide?

Jehan:
I just want to show you some pictures from a couple of our ... We, right now, have two deployments underway. One of them is in Medellin in Colombia, and one of them is in Clatskanie, which is like an hour from here. And this is Medellin. This place, very, very steep, very steep hillside. Beautiful view. I think I might have a few of the view in here. But it's basically, it's kind of a low income community, and they don't have a lot of very good ... They do have power, and they have sewers and stuff, and they have some infrastructure, but these areas were historically not even part of the municipal city. They've been getting them more connected and stuff, but the internet access is still pretty spotty and pretty slow up there. Also, I think it's about $40 a month, but that's very expensive for most people in that area.

Jehan:
With Althea, we've set up these little ... We came in and did a network of about 40 nodes, and this here, on the right here, is an intermediary node. So he's got the dish, which is pointing up at a school that's on top of a hill in the area, which kind of functions as the gateway node, and then he's also connected to his neighbors with outdoor ethernet cables. They just ran those kind of across the streets and over the roofs and stuff like that. A lot of times, radio hardware is really practical, but you can also use ethernet, and that was a really good fit for this location. Next slide?

Jehan:
And here is a view from ... this is not a view from the gateway, but it's kind of a little bit below the gateway. You can see, these are all the houses. I don't know if this was from before or after we installed this stuff, but also it's a little hard to see the dishes in this scale of shot because it's just too small.

Jehan:
But as you can see, this area was very kind of ideal for setting up a line of sight wifı network. Because ... And that's something I think Graham will touch on, line of sight is really important with a lot of this directional radio equipment because that's how it works. Some frequencies, like the frequency used by cell phones can go through walls and stuff like that, but most unlicensed frequencies that are easy to set up and stuff,

you do need to be able to see the other transmitter on the other end. So this was great, because all these houses are all within sight of the gateway. Next slide?

Jehan:
This is in Clatskanie. This is a tower that was built by the residents there, by Sean. This is where they were loading it up, and that tower is on the top of a hill. So again, that's the line of sight thing. It's useful. Obviously hills and towers and stuff are all very good for getting up high and being able to see a lot of different places from them. Just logically, a high place is going to have more line of sight to different places.

Jehan:
Then here is one of the client nodes, and they've attached it to the side of the house. That's actually, I don't believe that one's pointing at this tower, it's actually pointing at Deborah's Computer Repair Shop. But unfortunately, the tree has grown a little bit now, so they're going to have to trim it a little bit. One of the things that really blocks line of sight is wet foliage, and Oregon has a lot of wet foliage, so ... Next slide?

Jehan:
Oh, that's it. I think that's the last slide. So yeah, how am I on time, actually, right now?

Speaker 2:
You're good. We have some time for questions.

Jehan:
Okay, cool, yeah. Are there any questions.

Speaker 2:
You have about a half hour, actually.

Jehan:
Yes, Clark.

Clark:
So on the one you did in Colombia, what did you end up using for a price for a user fee, just out of curiosity?

Jehan:
He was asking what was the price per user in Colombia. The one in Colombia is still in progress. We're still trying to get the backhaul hooked up, which often is pretty

challenging. And actually, I should've put a picture in the slide deck of that, but there is a place that's more in the city proper that has the fiber connection coming in, and it beams it up to that hillside.

Jehan:
That's not live yet. What we want to target, though, is ... The way we ... Sean just walked in.

Speaker 2:
Oh, look.

Jehan:
Anyway, back to the subject. The way we target is, if you look at the median use in the US, people use about 200 gigabytes a month. That can vary a lot, of course. So we try to target that so people are going to be paying, in the US, something comparable to what they would be paying at that level of usage. In Colombia, the people probably, people don't have as much money, and I'm sure they might use less because of that. So what we do have to think about is that the backhaul is costing, once it's on, it's going to cost I think about $300 a month, and that's a hundred megabit backhaul. That can comfortably serve the number of homes we have connected, but basically what we'll probably be charging, I think, is around maybe five cents per gigabyte.

Speaker 2:
I think we basically figure it around a $20 a month fee.

Jehan:
Yeah, so it's always very variable. And the other thing is that obviously we have a heavy hand in this whole thing because we're showing them how to set it up, and the software is still early, it's not intuitive and stuff. But ultimately, it is up to the gateway and intermediary nodes to decide how much they want to charge. And if you charge more, you might make more money, but people also might use less, people might, when there are more routes in the network or more nodes set up, they might even just, the routers might just switch over to a cheaper route, if that exists.

Jehan:
So yeah, that's what we're trying to target. But it should be, if everyone who is using it is paying about $20 in per month, that should give them a pretty good amount of data, and also be able to have the backhaul and the intermediary nodes break even. So that's what we're thinking.

Jehan:
Yes.

Speaker 4:
Could it be set up to be more of like a premium kind of thing, where it's like a lower speed for free, but you can upgrade your connection?

Jehan:
Yeah. So you're asking can it be set up to be a freemium model, so you have a lower speed for free, and then upgrade your connection. That would be ... We already have something that's a little bit like that. So basically, it's a setting on the routers. You can change how much the routing protocol is going to prefer a low price or a high quality. So if you wanted to have it set up in a freemium model, people who don't want to pay as much can just set their balance down to a lower price and a lower speed.

Jehan:
So right now, in the state of the software, that's not going to do much unless there are two other nodes, one that's cheap and one that's expensive, but we do have some stuff in the works where one node could essentially offer both of those rates. And also, right now there is like a ... I guess that's fine. There is a free tier, which is used just for ... that's actually in there just for bootstrapping, like payments and stuff like that, but that would be usable at a very slow speed.

Jehan:
Yes.

Speaker 5:
How much was the upfront cost to these communities for the hardware?

Jehan:
Oh, for the hardware. He's asking what the upfront cost was for the hardware in the communities. In Clatskanie, the initial cost, I think, totaled out to maybe $1200. And that was ... How much was ... That was the gateway, and then it was maybe eight nodes?

Speaker 2:
Yeah, eight nodes.

Jehan:

Yeah, so it's pretty affordable stuff. In Colombia, it ended up being more. I think more like $6000 with all of the equipment because that involved-

Speaker 2:
40 nodes, I think, we started out with, right?

Jehan:
Yeah, it's like 40 nodes, 'cause that involved ... So if you break it down, there was the radio equipment, there was these big dishes that were getting the signal from inside the city up to the hill, and then there was these sector antennas, which are the ones that do the wide beam. Those are also a little bit pricey, those are around $200 a piece. Then we had, I believe, seven of those dishes like you saw mounted on the window for the intermediary nodes. Then we had a bunch of switches. Each intermediary node get a switch with eight ports. And of course, the routers for everyone.

Jehan:
So we use these. Oh, well, it's kind of short cable. I was going to show you the router. We use this type of router here, it's $90, for the intermediary nodes, that can do 100 megabits. Then we use this other type of router that's a little bit slower for the client nodes to be connected over the ethernet.

Jehan:
So all told, it was about $6000 for 40 households.

Speaker 5:
And were you able to .... people in the community, were they able to set it up on their own, or did you need to bring in specialists or trainees?

Jehan:
Well, me and Deborah went down there, so we showed people how to do stuff. Generally, as it usually is, you have that one guy who is more techie. So there was this kid called [Tomario 00:25:55], and that was actually his house we were showing there, and he basically learned very quickly how to crimp ethernet cables. He basically was running around the whole time we were there. He was running around getting everyone hooked up.

Jehan:
We brought down a big roll of ethernet. So crimping is when you put the ends on it, and we'll have a thing about that here, too, I think. But yeah, he went around, hooked it all up,

and the people in the community, they had a really easy time grasping the concept. I feel like almost easier to explain than it is in the US, maybe, because they were like, "Oh yeah, I can pay for as much as I use, and I can sell it to my neighbor too." They got that pretty quickly, so they were excited to get hooked up.

Jehan:
Pascal?

Pascal:
I'm interested what type of agreement was done with wherever you install hardwares, being that it's somewhat of a responsibility for whosoever has equipments in their vicinity. Was there any challenge, as far as maybe telling someone, "Hey, I want to hook up antenna here to serve the community"?

Jehan:
Yeah, he was asking what kind of agreements we were doing with people who were hosting equipment. The answer is, we didn't do any kind of agreements. So we, as a company, we did pay for the equipment. We consider them test networks, so they're not really getting very good service right now 'cause we're working out the bugs and stuff.

Jehan:
But in general, the model that we want to have is where there is no agreement with a company to get the equipment. It's like, people buy the equipment, and at a ... it's not necessarily, like it's not free, it's not really, really cheap, but it's like a setup might be ... If you look at a setup with a radio dish, and a mount, and a router and stuff, it might be about $200.

Jehan:
And if it's just, like let's say in Colombia, if it's just set up where it's an ethernet cable coming through the wall and then hooking into the router, it's just the cost of the router, which those routers are like $20.

Jehan:
So yeah, we're not leasing people the equipment, or doing anything like that. And our hope is that as this starts to work and people start to use it, people will buy the equipment themselves. And we want to change, that's actually an important part of what we're trying to do, is we're trying to change it from where the network is just something that someone just comes in and gives you and you have no control over, to where it's almost like a home improvement kind of thing.

Jehan:
So you need ... Like if you have a house, your toilet is not owned by the municipal sewage system, right? You have your own bathroom. So like, if you need to fix that, you might not know how to do plumbing, but you can hire a plumber. That's more of the model that we want to have for the internet as well. It's like where you own your equipment, and you can hook into this network, and you can hire a specialist if you need to, but it's not like this big, monolithic thing that comes in and says, "This is how you're getting internet."

Jehan:
Clark?

Clark:
Will the equipment that the user is going to use, is that going to be ... do they have to use that equipment? In other words, whatever you're going to put in the house or on top of the roof, do they have to use that hardware?

Clark:
Currently, as an example, Frontier, they want you to use your modem and router, and it's a piece of crap. But that's my point, is what if a user wants to change something hardware wise at the point they're using, I guess, is what I'm trying to say?

Jehan:
Yeah, so he was asking, do people have to use the equipment that ... a certain piece of equipment that they might not like. The answer is kind of nuanced. So in theory, no. In practice, we do have a few models of router that we support. Just developing software, it's going to be a lot easier to debug one model versus like a hundred. But if somebody wants to get it working, and it's not ... for someone who is experienced with Linux and stuff, it's not too hard, they can get it running on basically any kind of router.

Jehan:
But yeah, we recommend a few. Here, this is the basic model. This is the small on here, it does about a hundred megabits. Then this thing is deluxe, this'll do I think like 300.

Speaker 7:
400.

Jehan:

400, yeah. So that's kind of ... Then we have these ones, there's one in the back, I don't have it up here, but they'll do about 20. We're always trying to figure out what the better options are, but at the same time, we mainly support this $90 router. There's the edge router, too. This is more for more of a commercial setup. This doesn't have, it's not a wifi hotspot, it's just for cables.

Jehan:
But as far as the radio equipment outside goes, it's generally better to use ... on two ends of a link, it's generally better to use equipment that's made by the same manufacturer and is designed to work together because they'll have different things they do to optimize it and stuff. And then manufacturers will generally only test their equipment with their own equipment, right? They're like, "You should buy all our equipment."

Jehan:
So practically, that's like what you want to do. That's also going to be part of the role of the subnet DAO. So in Clatskanie, let's say, Clark is an intermediary node, and he's a property owner. He's got some equipment set up, maybe a tower or something. Then the subnet DAO is run by Deborah, and her group of volunteers, and they're kind of showing people how to set stuff up. They might give Clark advice on what equipment to use as well. Then, also, the end users probably want to get equipment that's matched up to Clark's tower equipment.

Jehan:
Yes.

Speaker 8:
I saw you guys have used Ubiquity for it. Is it like you want to use this, or this is our [inaudible 00:32:15], or was there some kind of constraints?

Jehan:
Yeah, so the question was, we're using Ubiquity, that's a manufacturer of radio hardware. And we use that mostly just because I have experience using Ubiquity, and it's also one of the cheapest brands. And they are generally very good, so a lot of wireless ISPs uses them too, it's one of the most popular brands.

Jehan:
Our software doesn't actually do anything to the radio equipment. It's all in the router. So it just hooks up to the radio stuff over ethernet, and that's all normal. There's another

one that we've experimented with, it's called Wireless Wire, it's by another company called Micro Tik. That can go a lot faster, but it's also a lot shorter range. So there's a lot of options. We're personally more familiar with Ubiquity, but every network might use different equipment.

Jehan:
Yes.

Speaker 9:
So as a user, would I be sending my traffic to an exit node? Could I also still do https over top of that?

Jehan:
Yes. He's asking, as a user, you're sending your traffic to an exit node. Can you also use https? Yes, the exit node is basically like a VPN, it's almost completely transparent. There's just that one screen where you select it. You want to select one in your region. Right now, we run the exit nodes. In theory, to be fully decentralized, we would want people to sort of be able to choose their own exit node. In practice, obviously we have to be able to give people an easy option.

Jehan:
Yeah, so that exit node is going to encrypt your traffic, and most traffic is going to be https anyway, which is the encryption that webpages use, so the exit node will not be able to see what you're doing on a webpage, but it will be able to see what webpages you're on, and that's what any ISP can see. And there's really no way around that other than using Tor, which is like a dark net protocol, which slows things down quite a bit.

Jehan:
So yeah, that's how the exit nodes work. You don't necessarily want your neighbor seeing the websites you're on. Like, even if they can't see what you're doing on the websites, it's maybe a little weird.

Jehan:
Yes.

Speaker 10:
For payments, how often do you actually settle up for that? 'Cause, like Ethereum is not going to scale for a billion routers.

Jehan:
Yeah, so he's asking for payments, how often do we settle up? What we do is we use something called payment channels. We use a simple form of payment channels. That's basically ... I'm not going to get too deep into the exact particulars of it, but basically two routers see each other, and they basically, using some different metrics to judge on it, they establish whether they might want to pay this other node in the future. Then they do what's called opening a channel, so they basically lock some money up, they lock some tokens up, which can then be slowly released to the other node.

Jehan:
So that locking up of the tokens, that does require a blockchain transaction. And at current gas prices, that would be about 20 cents, which is probably kind of on the upper range of what can work, 'cause you imagine if you're locking up two dollars to possibly pay for internet from some node, that's 10%. However, there are a lot of improvements. Ethereum is known to be rather slow and expensive, so there are a lot improvements on the horizon. We have been looking at one, another blockchain called Cosmos. The benefit there is that in theory, it should be able to run our existing code, which is made for Ethereum. There's also Eos. I know we have some people in the room from Eos. It's also a much faster blockchain as well.

Jehan:
So those faster blockchains, I think those fees are going to be a lot lower. And also, the speed is not actually a big deal for us, but yeah, the fees are. So yeah, that's how that works.

Speaker 11:
Yeah, there is no cost for the transaction on Eos.

Jehan:
Well, the developer pays for it, so-

Speaker 11:
It's a RAM cost, compared to the per transaction fee like there is on Ethereum. So that makes it easier.

Jehan:
Yeah, so there's a lot of details to it, but that's basically ... yeah. Complicated blockchain stuff. Yes?

Speaker 12:
You mentioned that the routers, these folks would have to preload some currency on there in order to [inaudible 00:36:44]. Now, if someone forgot, as luck would have it, and somehow there is nothing on their router, if they are standing between someone downstream and another router upstream, does that router still allow the information to pass?

Jehan:
So are you asking if an intermediary node that's both paying for bandwidth and also serving other nodes, basically forgot to load up their router? That wouldn't be an issue because the intermediary node is getting money in from the nodes it's serving, and is using that money to pay for the bandwidth from the node that's upstream of it. Upstream means like closer to the internet. And generally, they'll also be getting a profit off of that was well. So not only would they have enough money to pay for it, they'd also be earning money.

Jehan:
Yeah, it's a big concern with the intermediaries is someone tripping over the power cord or something. That would be bad. So in general, there is two solutions to intermediaries being flaky. Number one solution is to use ... and this is also an issue in any network, not just ours. One solution is to use more intermediaries so every node has at least two paths, because the odds of two intermediaries being flaky at once is very, very low, even if they're both pretty flaky.

Jehan:
The other solution is to have intermediary nodes that are more professionally run. So you might have a battery backup, or have somebody ready to fix it really quick if something does go wrong.

Jehan:
And most wireless ISPs, they have the second solution where they really take their tower maintenance really seriously, but there's also some ISPs that are coming out that use more intermediaries where there's more paths to the internet. So Althea software doesn't, it will work with both 'cause it will switch over to whatever is working pretty quickly.

Jehan:
Yeah?

Speaker 13:
It's connected to US West right now, this one, and that's the exit node?

Jehan:
Yeah, that's right.

Speaker 13:
And that's like a WireGuard VPN server or something?

Jehan:
Yeah, exactly. So he was asking, the router in this room right now is connected to an exit node US West, which is at Hurricane Electric in Fremont in California, and it is using WireGuard. WireGuard is a VPN, a very fast VPN technology.

Jehan:
The exit nodes also do a few other things. They also can do speed tests, they can make sure that the intermediary nodes, they're not running some version of the firmware that's lying about the quality and stuff. It's always sort of double checked with what the exit node is seeing for quality. So they have a few different functions, they're not just a VPN server, but that is the main thing is VPN server.

Speaker 13:
So do the downstream nodes pay that, also, to US West servers? Is that right?

Jehan:
Yeah, so I actually have another presentation where I get more into the protocol, and there's a lot of circles and lines and stuff in there, diagrams and stuff. But basically the way it works is that every node, it's not actually, technically paying for internet access, which would be both upload and download. It's actually only paying for upload. So your client node is paying to forward packets to the exit server. And the client node has a payment channel open with the exit server, where the exit server then pays to have the response traffic go back down through the network, back to your client node. That's kind of how it works at a very low level.

Jehan:
Yes?

Speaker 14:

Do you have a name for all of like ISPs and intermediaries, like autonomous systems or something?

Jehan:
No. He's asking if we have a name for intermediaries like autonomous systems. The autonomous systems is like how BGP works, which is the routing protocol that's used on the backbone of the internet, and the backbone of the internet actually functions a lot like an Althea network. Or it should be the other way around, an Althea network functions like the backbone. But basically, an autonomous system on the backbone is an ISP or a network, and that network is making decisions about who to connect to and who has the best prices, and those decisions are made by people 'cause they have really big networks, people in data centers and business people making deals and stuff.

Jehan:
So as far, if you want to use that metaphor, every Althea router is actually its own autonomous system. But the autonomous system concept is a concept from the BGP routing protocol, and we use Babble, so it's not really. The router's IP address is basically like its autonomous system.

Jehan:
One other detail, though, is that the subnet DAOs, they each have a network. They're essentially giving out IP addresses. So they have a range of IP address, and they give that out to the nodes that are one the network, out of that range. They basically can be up to, probably, 10,000 routers in one network. And over that size, you'd need multiple subnet DAOs. But we want them to be local and stuff anyway, so that makes sense.

Speaker 2:
Time's up.

Jehan:
Oh, time's up? One more question.

Speaker 15:
Well, I had two questions, so ... So right now is pretty easy to set up a network, people just have to patch their router with the Althea firmware, and then mesh them together. Once the subnet DAO is in place, would it be necessary for each router to register with the subnet DAO for it to function in the network?

Jehan:

That's a good question. He's asking, right now, it's pretty easy, the routers will connect to each other with no problems. Once subnet DAOs are in place, will it be harder to connect routers together?

Jehan:
The answer to that is kind of. You don't have to ... You could just set up your own subnet DAO on the spur of the moment, and do that. Or you could even turn it off on the router. I don't know if we have that, we certainly don't have turning off the subnet DAO in the UI right now, but you could turn it off. At the end of the day, though, the routers are going to need to have IP addresses. So if you turn off, like if you're not using a subnet DAO, and your router is just going to generate a random IP address out of the private range, which is for like local networks and there's no coordination with other networks, so if there are other Althea networks around, it's not going to be able to talk to them to route traffic over.

Jehan:
But it will still be possible to do things the way they're done now, which is basically like a private network. Which, the Althea routers now are essentially hooked up on a network using these randomly generated IP addresses, which is the same as it is in like your home network, basically.

Speaker 15:
[inaudible 00:43:37] for future internet.

Jehan:
Right.

Speaker 2:
All right, thanks for that.

Jehan:
Thank you.

Building a net generation ISP - Community Connections

Justin:
Hi, everyone. I'm Justin.

Deborah:
I'm Deborah. We're co-founders of Althea. We're going to talk a little bit today about the network that we have set up in clocks [inaudible 00:00:11] running off the app? And so Justin has a picture up here of the network in class gahnite and as you can see the geography is challenging and there there's these large hills and ridges, canyons and rivers. And of course we also have large trees, you know, 100 foot tall fir cedar trees. So we have a lot of challenges here. So from the map you can see we have represented with different colors, the different types of connections. So the blue here represents what's [inaudible 00:00:48] to direct you to what we call the gateway. So in a gateway is just where we have some antenna equipment connected to a high speed, a wholesale fiber line, and then these other different colors represent different relays and a relay, in this case, is just a home or a business or a farm in the area that is hosting some equipment like the sector antenna that will broadcast and connect up their neighbors to the network.

Deborah:
So you have this in purple, the orange and then the green relay out there on the low lying dyke lands there. So Yup, that's the one out there on the kind of low lying farmland out there. What's really exciting about this is that because of the challenging geography, the existing wireless ISP and traditional wireless ISP use would have trouble existing here because what a traditional ISP typically does is rent space on a large tower, the several thousand dollars a month and then put some heavy duty equipment up there and they're able to see only what they can see from that particular view shed. So in this case you could see they would only see a very small part of the town.

Deborah:
They'd only see one ridge or one hillside or one kind of area and it would cost them lots of money for just that that section of town. And how we're able to make this economically work and be more advantageous is that we can utilize what already exists, existing homeowner's farms, to set up some and inexpensive antenna architecture and serve people that we would not normally be able to connect up. And it doesn't cost $1,000 a month. It just costs us the privilege of incentivizing those homeowners through the [inaudible 00:02:36] software. I think Justin is going to take us through a little bit what that looks like from the technical side of things.

Justin:
Yeah. So in my last video in the series, I focused on Alfia on how Alfia makes individual connections better using caudal. And this time I'm going to focus more on routing. We use Babel to bring a lot of the routing and fail-over and link quality detection features that you find in more

advanced routing appliances into the user's home or into the installation to let us do things that traditional ISPs just can't do. For example, here we have a feed shop. It's an animal feed shop and it is connected to two relays and in a particularly unusual way. So here you can see there are two antennas, one going to each relay and both of them ... This is one direction and this is the other direction. Go through trees and this isn't normally possible. These line of sight antennas are called line of sight antennas for a reason because they cannot penetrate trees typically, and we can only do this at all.

Justin:
The only reason there's any signal on these antennas is because these hops are very short. This is about a quarter mile each. On the other side of this is that Alfia is making each of the individual connections better with coddle. And on top of that all, it's actually using both connections at once. Now I'm going to explain a little bit what I mean by that. So here we are connected to the [inaudible 00:04:15] gateway and I'm looking at the routes we have to the feed shop in both directions. So as you can see, we have two and they're pretty close. And what will happen is that if one antenna becomes disrupted or there are problems with it, or a branch moves in the way it'll switch to the other. And the chance of both antennas being completely obstructed at the same time is very, very low.

Justin:
So a traditional wireless ISP would be completely unable to do this because if they were up here on this tower, not only would it take them two years to set it up while they got a contract with the tower and then thousands of dollars a month for that one tower, they would be too far away to go through trees anywhere where they could not directly see the target location. So we were able to install this in about two days, one day for each antenna, because we sort of ran out of time stapling the cables. These costs $65 each, not $3,000 a month for five years. So it's a very different picture and lets us do things that are just not even within the realm of possibility for traditional ISP.

Getting Backhaul (Purchasing Bandwidth) for an Althea Network

Graham:
Quickly again, I'm Graham Castleton and I appreciate John's info here. I'll be going through really a lot of hopefully very practical stuff about how to set up a wireless network. Specifically, wireless, but also talking a lot about just networks in general. Hopefully, we're sending everybody home with all the tools and information you'd need to go and set up a network in your community. That's the goal, so hopefully we get there.

Audience:
Questions at the end?

Graham:
No, please raise your hand and ask questions because if you have the question, somebody else probably does and I'll end up skipping it and we won't get there. Raise your hand, ask questions, and let's have a conversation as much as possible. But I think we will have time at the end for questions if you have something that comes up later.

Graham:
We have several sessions throughout the conference. We'll hit different topics at each time. The first thing I've got on the list, we talked about backhaul and getting internet service to your customers, how do you get the internet service that you can then give to your customers. That's the first thing we're going to talk about using my... you can tell I'm an artist and that this is something that I do, draw stick figures, but hopefully we can make it work. We'll talk about that first.

Graham:
We're also going to talk a lot about wireless in general, how wireless works, and how you can use it to build your networks out. A lot of hands on stuff with how to actually put these things together and make them work together and getting into things like if you want to go lease space on a commercial tower, how do you do that and who do you talk to and what do you ask them and that kind of thing. We'll go through a lot of stuff over the next couple of days.

Graham:
But first, let's talk about backhaul and how to get internet service. I think we have until noon and then we're going to have lunch. Just so we know where we're at.

Graham:
I'm going to use my little whiteboard here and just draw at a really high level how a wireless ISP internet network works. Again, with Althea there's some more interesting things that can happen here, but just to get a really high level of how your internet service provider works. I just wanted to start with that and make sure we're all on the same page.

Graham:
We've got here, we've got up in the clouds representing the internet. We talked a little bit about how these work if we... The internet isn't just one big cloud out there, it's a bunch of clouds. We've got AT&T, I'm going to use a different thing here, CenturyLink, and Comcast, and all these different internet service providers and internet networks, L3. And they all have connections to each other in different ways.

Graham:
Like we talked about earlier, those connections are mostly negotiated by people and they're buying circuits from each other, they're paying each other to have connections. Then at some point, you as a homeowner or as a residential person or a business, you buy a connection from one of these companies and then you're connecting through one of them and they're connecting you out to everyone else who's then letting you get to Facebook and Google and Reddit and all the other things that you use.

Graham:
In order for our little home here to get internet service, they've got to get connected to something that has connections out to the rest of the internet. Again, today, you might buy that from Comcast and they sell you a connection that they have then brokered out to go to everybody. Our hope is that we get it through Althea and we can start building these networks that mesh together and you won't have to pay Comcast anymore. In order to do that, in order for you to go back and create this organization that's able to provide internet service, you've got to get your own connection to the internet. That's the first thing that we're going to talk about.

Graham:
A lot of the times, the way that that works is the first thing that you do is buy, we've been calling it backhaul, you buy a leased connection, a high-capacity connection to the internet, usually it's on a fiber line. Sometimes you're buying that in a data center, sometimes you're buying it at a commercial building. Maybe you can even get it in a residential area. You're going to buy that and then you're going to build the network out that will share that connection out into the community.

Graham:
The way that might work here, you might purchase that line from AT&T. You might get it to a commercial building in the area. A lot of times what happens is, is you're in a suburb or something, there's commercial buildings and then it goes into suburbs and you might buy a connection at the commercial part of town. Then you might start using wireless links to build that network out into the community where you'd like to provide service. That ends up happening a lot of the time. You might even buy a connection from somebody else at, say a commercial tower. You see the big cell phone towers along the freeway, those are available for leasing, we're going to talk about that, I think, tomorrow. If it made sense for you and for your community

to lease space on that tower, you could do that. You could purchase a connection there from somebody and start to build a network from that tower out in the community.

Graham:
Following along with the wireless, once we have that, we're going to start building our wireless connection out into our community. You might put an access point up on your building here and your community members could put little antennas up on their roof that would then connect wirelessly up to your access point and that's how they would get service. At a really high level, that's how this can work. We can start letting people expand these networks, in keeping with Althea, somebody else could purchase a connection here to this other building and create their own community over here with an access point. In theory, these customers could decide which one to connect through based on price or based on speed or whatever factors are important to them. We'll talk about this wireless stuff more in a little bit.

Graham:
Right now, the first thing I want to talk about is getting the fiber connection to the upstream broader internet. That can be one of the trickier parts of making this work. It's kind of expensive, it takes a long time, and the sales process is pretty opaque. In the U.S., the way that this works, and it's similar in other places, I'm just most familiar with the U.S., the way that this normally works is that you start calling a bunch of people, getting quotes, and they unfortunately will not give you all of the information that would be very helpful to be able to start doing this.

Graham:
The way that it might work is you would drive through your community and find some areas that you guess might have fiber service. You can make good guesses based on... you can ask the people, you go to a commercial building and sometimes you can just go ask them, "hey, do you have fiber service here?" And sometimes they'll say, "yeah, we have AT&T." Sometimes you can see the infrastructure, sometimes you can see their green pedestals sometimes that have AT&T's name on them, you can see the fiber equipment in there or the fiber lines. That's a really good sign that there's service in there. I'm saying AT&T a lot, but it's not always AT&T, there's a lot of other providers that sell internet, a lot of times it's called DIA, Dedicated Internet Access. There's other providers that sell this. You can even get it from Comcast, you can get it from CenturyLink, there's companies like Zayo and L3, Hurricane Electric, Cogent. A lot of times there are local providers as well that will sell it to you specifically that are more local to your area.

Graham:
Finding a commercial building like that is great. It's very common at a commercial tower, that there will be fiber because Verizon and Sprint and T-Mobile are putting their equipment up there and they need to have a fiber connection as well. If it does make sense to you to go to a commercial tower, it's common that there will already be a fiber connection there that you can purchase.

Graham:
One of the most straightforward ways to do this, although not the cheapest, is to go to a data center. There are a lot of data centers, places like Digital Realty have data centers all over the place, but in most areas where there's some kind of commercial center, there might be a data center nearby. You can rent a cabinet in the data center and then they will always have internet service there that you can purchase directly from them. Most of the time they'll work with you on allowing you to put equipment up on the roof that you can then-

Audience:
Could you expand a little bit more on what you would ask for as far as cabinetry and roof access and what the conversation might be like?

Graham:
Yeah. The question here about data centers, going in and asking a data center to rent and what do you ask for as getting a cabinet and there's a bunch of different stuff that goes into that. Let's talk about that... let me answer this question. If you're going to look at a data center, if that's what makes sense for you, there's several things to look at. Usually what you'll do is purchase some cabinet space. That means you get either a whole rack in their data center somewhere or sometimes you can purchase part of a rack. You're leasing that monthly usually and that includes basically just the space and maybe power to power up your stuff.

Graham:
In most cases, actually, as an ISP, you probably won't have very much stuff in that rack. You might just have your one server device running the Althea software and that might be it. If you rent a whole rack, you'll have one in use and the rest empty, that's not uncommon. You might put some battery backups in there, but usually the data center provides their own backup power and it's usually sufficient, so you probably aren't putting all that much in there.

Graham:
The things you will need to work out with them though, if you are going to purchase fiber service from them, usually they'll have an array of providers that you can purchase from. They might have three to five carriers in the data center and you can purchase internet service from any or all of them. You'll work that and usually that's a two-way relationship where the data center is assisting with the relationship, but isn't actually selling you the service. You're purchasing from someone else directly, like AT&T or Zayo or Level 3.

Graham:
Then you'll need to work out how they're going to hand off that fiber service to you. It's usually handed off with a fiber line. I actually have, let me pull up my picture here of that.

Audience:
The commercial building [inaudible 00:12:21] commercial building, say like a mom-and-pop store. You're saying commercial building with a specific type of business in mind? Is it like a

telecom dedicated, commercial building that's dedicated to telecom or what kind of commercial building is it?

Graham:
Good question. The question is, if you're looking at a commercial building, correct me if I'm wrong... you're saying you find a commercial building and you're trying to determine whether or not they might have fiber already there and how do you know if that's the type of building?

Audience:
Why would they have that fiber there?

Graham:
Okay. Good question and there's not a perfect answer unfortunately. The answer is if the fiber company thought that it was profitable to put fiber in there, then they did. Unfortunately, not a straightforward answer. The reasons can be somebody in that building already ordered fiber for their own needs and then the company would've built it out, put it in, and could pretty easily expand it to include you. That's not uncommon for a business park type building, like a high-rise office building. It's not unheard of for a mom-and-pop store to have that, but less common.

Graham:
The other answer, though, is that it's quite common for fiber providers to run their fibers down the streets usually. Part of their infrastructure, they have pedestals and stuff where they can serve their equipment. If that pedestal of theirs is near a building, then even if somebody hasn't bought it yet in that building, it's pretty easy to get from the pedestal to the building. So that's the other thing. Every company does it a little bit differently, so you have to get familiar with the companies in the area and what their infrastructure's like. But if you can start to notice their pedestals and their infrastructure stuff in the streets, then you'd know what buildings are close to that. Does that make sense? Yeah.

Audience:
Do you have an actual picture of the pedestal?

Graham:
Yeah, that's a good question. Yeah, let's find that. They vary a lot, so it's hard to... but I'll find a couple examples. Here's an example. Let me make that a little bigger. It's kind of hard to read, but here's an example of something you might see. If you look, you'll probably start to see things that look something like this, they are usually this bright color of orange. You'll see them just along highways and freeways and sometimes even city streets. Probably hard to read, but if you're up close you can actually see, this particular one is Zayo. I can see their name here, so I noticed it, got out of the car, went and took a look. It's got their name and phone number on it. It means there's a pretty good chance that if I wanted to buy service near this thing, I would still have to pay some money for them to get it from here to wherever I want it to go, but at least they wouldn't have to dig up streets through the whole city to get there. That's one example.

Graham:
I see these a lot, so you'll probably see something that looks like that, at least in the U.S. in whatever area you're in.

Audience:
Question about... you started out saying if you want to start this [inaudible 00:16:06] negotiate with a major ISP [inaudible 00:16:09] and then also the data center space, et cetera. Are those two separate steps or do data centers have some sort of... can they negotiate on your behalf or is there some sort of combination of that?

Graham:
Good question. The question is if you're using a data center then you have to negotiate with the data center for space at the data center et cetera. You also need to negotiate for fiber connection through the internet. Are those steps separate or can they be combined?

Graham:
The answer is in some cases they can be combined. In some cases the data center will sell you directly. They call it their own... they act as their own internet service provider, but usually what that means is that they are offering a service on top of what these other providers are offering, so they're taking the providers that are already in the building, maybe they're adding some redundancy for you or some managed services for you and then they're selling that to you as a package.

Graham:
I've normally found that that's quite a bit more expensive than dealing directly with the ISPs that are already in the building. So I typically don't go that way just because you can save 500 bucks a month right off the back by just going directly, but it is a little bit more work to deal with them directly.

Audience:
You're talking about expense for something like a data center, are we talking tens of thousands a month?

Graham:
Good question. The question is how much exactly do these things cost really. It varies a lot, again, from place to place, but for just the space in the data center, depending on where you are and how big of a cabinet you get and what you are able to negotiate for a rooftop lease space, which you'll probably need also, it'll probably range from 500 at the really low end to maybe $1500 or $2000 a month. For your internet service, a lot of the things that I've done, we usually start at about one gigabit of service, we buy a gigabit circuit. You can certainly buy circuits that are smaller than that, but that's a good price point to understand where that price is. That's

usually, for a full gigabit link from these providers we've talked about, depending on your area, is usually 800 to maybe $2500 a month.

Audience:
I was wondering if you could explain some of the terminology, like I'm looking here at this quote from Hurricane Electric and it talks about burstable and then it also talks about GigE versus Transit and some of maybe those opaque terminology?

Graham:
For sure. We asked here about some of the terminology that goes into negotiating your fiber circuit with the provider. I'm actually going to go back to this other slide that I had that has some of this in it. Here we go. When you call a fiber provider and start asking about internet service, they're going to pepper you with a bunch of questions that have some kind of opaque terminology. I'm just going to assume for the conversation that we're asking about getting one gigabit of service, that may not be right for you in your community, maybe you can do with less or maybe you need a lot more, but I think that's an easy place to start the conversation.

Graham:
When you call CenturyLink or Zayo or whoever, the thing to ask for is a gigabit of dedicated internet access. There's a couple of important distinctions there. One is that a product that a lot of these companies will sell you is a point-to-point circuit. A lot of times they don't really know what it is that you're after, so you have to understand that so that they don't try to sell you that because that's, in most cases, not what you need. What that means, a point-to-point circuit means, I have my business over here in this city and I have another satellite office over in this city and I want to gigabit connection between them so that we can share files and do video conferencing and whatever. So, I want a point over here and a point over here and they talk to each other, but they don't go out to the internet.

Graham:
Sometimes you might want that as you expand your network, maybe you already have a connection at a data center and you want a point-to-point from that data center to somewhere else, but when you're just getting started what you really want is a connection to the internet. So you'll ask for a dedicated internet access connection.

Graham:
The other things that they're going to ask about are, one of them is committed rated versus burstable rate. The committed rate is essentially what they should always be giving you no matter what. You should always at any time of day be able to test that connection and get that committed rate. For example, let's say you bought a circuit that had a 500 megabit per second committed rate, burstable to a gigabit. That means that 500 should be reserved for you and only you, but above that 500 you're sharing with other people. What that would mean in practice is that during slow times of the day, late at night, early in the morning or late morning, you might be

able to hit that full gigabit, but during peak times of the day when other people are using their circuits you might only get 500 megabits.

Graham:
It also means, usually what that means is that you pay extra if you burst over that 500 megabits. Usually you're negotiating a rate that is, I'm buying 500 megabits all the time, but the provider is going to watch how much you use and they're going to bill you more and they'll arrange with you how the billing is done, but they're going to bill you more if you go over the 500 megabits.

Audience:
I got a quote at a flat rate for a 300 committed or 600 for burstable. How would that work when it's a flat rate for the burstable?

Graham:
They didn't have a 95th percentile usage above the 300 megabit?

Audience:
Maybe, I didn't get the actual terms and conditions, it was just over the phone.

Graham:
Usually what that means and a lot of providers throw around different terminology, usually what that means... The question was, he got a quote for 300 megabit committed, 600 megabit burstable and it was-

Audience:
Sorry, it was a quote for a gigabit, but the burstable would be the 10 gigabit.

Graham:
Okay.

Audience:
Sorry, gigabit committed.

Graham:
Gigabit committed.

Audience:
10 gigabit burstable, the price was $300 a month for committed, $600 a month for burstable.

Graham:
Okay. The question again is gigabit committed rate, 10 gig burstable, $300 a month for the gigabit, which is really good, really, really good. Even for Cogent, that's really good. And $600 flat for 10 gigabit burstable. I can't say exactly what they're quoting without looking at the terms,

that might just mean if you're using the 10 gigabit all the time, it'll be $600 a month, if you're using less than that it'll be somewhere between 300 and 600. That might be what it means, but I'd have to look at it for sure. Usually the way that that works is they bill you based on your 95th percentile usage, so if you're buying a gigabit, but you're 95th percentile usage is two-and-a-half gigabits, then they bill you at two-and-a-half gigabits.

Audience:
What's a 95th percentile usage?

Graham:
Good question. What's a 95th percentile usage. That's the rate that your circuit was using 95% of the time or less. Does that make sense?

Audience:
Say it again.

Graham:
One more time. 95th percentile rate usage, because a lot of fiber companies will bill based on this, 95th percentile usage is the rate of throughput that your circuit is using 95% of the time or less.

Audience:
That allows for large spikes that don't happen very often.

Graham:
Right, exactly. That allows for large spikes that don't happen very often without being billed for them, but the more you use, the more you'll be billed.

Audience:
That's for the burstable part?

Graham:
That's for the burstable part.

Audience:
Committed to paying the committed.

Graham:
You committed to paying the committed. That's for the burstable part. Moving along and hitting some of this other terminology that you might encounter. We hit burstable versus committed, we talked about point-to-point versus internet access. Another thing that you're going to run into, especially with companies that also sell service directly to residential or commercial customers

is that most of them have a clause in their agreements that doesn't allow that circuit to be shared.

Graham:
For example, if you go to buy a circuit from Comcast, they do sell this type of connection, like a gigabit committed connection on a fiber line, but there's probably a clause somewhere in the agreement, and you got to watch really carefully for this because the salespeople a lot of the time don't know, there is probably a clause that says that you can't resell that service. Obviously you're welcome to risk it if you want, but just putting it out there that if that clause is in there that's some risk that you're taking on.

Graham:
Companies like Cogent or Zayo or Level 3 that don't usually sell to residential customers or to mom-and-pop commercial customers are less likely to have that clause in there or at least more likely to get rid of it if you ask them to. But companies like AT&T and Comcast and Verizon that sell directly to customers will a lot of the time have a no resell clause, so you got to watch for that.

Graham:
Question?

Audience:
It's a little bit changing subject, but I was super curious about the tower stuff, if you could talk about that a little bit?

Graham:
Yeah. We actually have a whole section dedicated to the towers, so I think I'm going to hold off until then just so that we can make sure we cover everything here. You're just asking about commercial towers and how that works. Yeah. There is a whole section on commercial towers, so we'll hit that, yeah, I think it's tomorrow. Good question, though. Yeah?

Audience:
I have a question. Basically, as far as the communication, a lot of these backhaul service providers, they're used to dealing with bigger organizations and they have a method of business communication. If you're calling us an individual, sometimes there's some challenges there, so what is your advice to how you communicate with them? For example, I think once I called one of them and they were asking do I have a business sales department, all this questions, and I just wanted to find out what their rates are. What advice can you give us on making ourselves look, I guess, appealing to them so that we can at least get the information we need from them?

Graham:
Yeah, good question. The question for the mic is, and this is true, these companies are mostly accustomed to dealing with large organizations, dealing with each other or companies of similar

size to themselves, and as an individual or as a very small organization it can be intimidating to contact them and a lot of the times things are missed in communication. They're accustomed to dealing with something else and they don't really know how to deal with you and we don't really know how to deal with them. Is that your question?

Graham:
Yeah, that's a good question. A couple things I would point out. One is that, I think that knowing what you're asking for and understanding the terminology that they're going to use goes a long way. Hopefully this is helpful in that we can, if you're asking the questions that they're expecting, I think that that actually goes a long way.

Graham:
The other thing is that they do, their sales departments, I think, do more often than we might think deal with smaller organizations. Like a small mom-and-pop shop that just needs a bigger internet service connection or something, they're calling these same people too. So positioning yourself in that kind of similar small business mindset can also help I think. My experience has been that if you get with the sales people, they're anxious to sell to you, usually they'll try to help but they don't always know exactly what the terminology means either. So if you're not able to help them understand exactly what it is that you need, then sometimes communication breaks down. Does that help?

Audience:
You're saying appear more as a small business than an individual just trying to find-

Graham:
I think so. I think that's more helpful. Telling them exactly what it is that you're trying to do, even though sometimes that is intimidating because you don't want to give the impression that you're, if you're calling Comcast you don't necessarily want to say, "hey, I'm trying to go get everybody off Comcast." My experience with that, even though has been that the people at Comcast who sell these big connections are more than happy to sell to you because they don't care if the residential service... they're not getting paid based on the residential service people. The salespeople selling these things just want to... they just get your commission and that's what they want to do.

Audience:
Where would you find... obviously, you said that on the poles or whatever you could see the phone number, but where else might you find information how to contact these people?

Graham:
Question is just how to find out how to contact these people? The sales department. It's usually just... the keywords to look for are their business internet connections. Usually that's a separate sales department than the residential ones and usually that's the right one to start with to start asking for dedicated internet access.

Audience:
I'll just mention, when I was looking at this in Vancouver, I looked up the data center and then they had a list on their website of all the carriers that were in there. You can just go through and say, "okay, I can call each one of these carriers and go to their website and say, 'hey we have a connection in the data center in my town, what is it going to cost to get a connection?'"

Graham:
Yeah, that's a really good point. For the mic, looking at data centers in your area, a lot of times they will list what providers they provide in the data center. You can start calling them directly. The other thing is that if they're in the data center it's a decent sign that they have a good presence in the area, as well. So they might be good ones to call even if you want it somewhere else not at the data center to see what else they have available.

Audience:
If I can offer part of the answer to this question about how do you get them to take you more seriously? Generally understanding how a sales pipeline works. If you just call up, you're at the top of the pipeline, they're not paying you a lot of attention. But if you call up, get a few answers, follow up with the same person or somebody farther into the pipeline at a regular timeline, be honest about the other companies you're talking to, what service you're looking for, the timeline you're looking for, and the closer your timeline looks to the type of sales cycle they're looking for, the more likely you are to get quicker callback in general whether you're buying this or any product. Just understand the general sales pipeline that corporations use to track their salespeople, that's their numbers, we're in technology, it's what did we deliver? For salespeople, it's what did I sell?

Audience:
Different companies have different pipelines, but the general pipeline works in a similar way. Just do a little reading on basic pipeline and follow the behavior as a customer that they want you to follow. Companies that you're narrowing from just curious to closing on a deal, including the part about being honest about the fact that you're looking at their competitors and what your timeline is. If your timeline's a year out, don't tell them it's six weeks out because at 10 weeks when you're still calling, you're just wasting their time. If you tell them it's a year out, they'll give you appropriate responses and they won't be impatient with you.

Graham:
Yeah, that's a good point. Just to summarize for the mic. Understanding the sales pipeline and giving them honest answers and trying to fit yourself into their model helps. And the other big thing is just to remember that they're salespeople and they're paid on commission and if you buy something from them, they make money. In that sense are working for you. It's okay to make them work for you and let them know that you're looking at other providers, let them know what you're looking for, and they really want your business as long as they think it's a serious opportunity.

Graham:
Jumping from that, a couple other things you're going to look for as you're negotiating these contracts. One thing is that the big risk that you will end up probably having to take is that these are usually quite longterm contracts, five to 10 years. That can be a tough pill to swallow as a small organization just getting started, to have that kind of commitment for that long, but I haven't seen a provider break on that term contract. They usually will want that five to 10 years. That can be difficult. If we have time at the end, I'll throw out some other creative options for that. But just to get to this because this can be a difficult thing, I think, when you're first getting started. Once you've negotiated and you're ready to purchase, you've negotiated the committed rate that you would like, you've negotiated the burstable rate that you would like, you have the right place and you're ready to go, the next things they'll start asking about is what kind of handoff do you want.

Graham:
Basically that means, how do you want us to deliver this to you? That can be a little bit tricky to negotiate. Usually these are examples of different styles of fiber connector. Some of you might recognize these, maybe some of you don't, that's fine. If you're buying a fiber connection, usually they're going to give you basically a cable and the end of it is going to look something like this. If you're buying an ethernet connection, I think we're probably mostly more familiar with those, and you can ask them for ethernet handoff. Ethernet handoff is convenient because all of our equipment already supports ethernet. The downside is that they usually won't provide more than a gigabit of service on an ethernet connection. So if you think you're ever going to need more than a gig, it's usually best just to have the handoff be fiber originally and then it's less of a pain to upgrade later.

Graham:
I'm not going to run through each of these individually, just to say the... I think most common for what we're trying to do is this one in the top right called LC. I usually just ask for LC handoffs. In this picture it only shows one, but it always comes as two, they come in a pair, they're TX and RX. One of them sends, the other one receives. You would get basically two of those from the... Yeah?

Audience:
What does LC stand for?

Graham:
I don't know. Question is what does LC stand for and I don't know. Does anybody know?

Audience:
It's something along the lines of low control or something like that. It has to do with the [inaudible 00:36:38] that you're getting.

Graham:
Oh, there you go. Yeah, I don't know.

Audience:
It's been like five years so I'm probably [crosstalk 00:36:44].

Graham:
Good question, I'll try to remember to look it up later. I usually ask for LC connectors. The other thing that they will ask is what type of fiber you would like, single-mode fiber or multi-mode fiber. There are some important distinctions, we can get into them but I think right here I'm just going to say the industry seems to be standardizing on single-mode and so it's in my experience usually just easier to just always ask for single-mode.

Audience:
LC is Lucent connector.

Graham:
It's what?

Audience:
Lucent.

Graham:
Oh, okay. LC stands for Lucent connector. There you go. Thank you.

Audience:
LC standard connector.

Graham:
Yeah, so this one down here is the standard connector. It's hard to tell in the picture, but these ones are actually quite a bit bigger than the LC. If I remember correctly. Those are the some of the next things that you'll negotiate as you do this. The handoff. Let's see, we hit... They'll want connector type, they'll want fiber type, which again would be usually single-mode, and they'll also want media rate meaning... Yeah?

Audience:
You said single-mode and one other, what was the other one?

Graham:
The other one is multi-mode. Single-mode and multi-mode. But yeah, I typically just ask for single-mode. They both will support easily up to 10 gigabits per second. If you're ordering a one gigabit circuit, they'll usually give you a circuit that on the other end can only do one gigabit. But if you're ordering a circuit that is burstable to 10 gig, then they'll give you a 10 gigabit circuit.

That matters because where you connect it into your server, you need to have a one gig or a 10 gigabit capable port. So if you're going for 10 gig, you have to plan ahead for that. If you're going for one gig, then you can just get the one gig hardware.

Audience:
How hard is it to upgrade later? Are they pretty willing to go ahead and [inaudible 00:38:53]?

Graham:
Good question. Question, how hard is it to upgrade later? At a data center it's usually really easy to upgrade later because they already have all the infrastructure and at most, they need to do a little bit of service there on-site and you're up to 10 gig. Out anywhere else, out in the city or out at a building somewhere else, they may not have built 10 gig infrastructure to that building and so it may be really, really difficult or even impossible to go from one gig to 10 gig. It depends on where you are and what exactly you're trying to do, how hard it is to upgrade.

Audience:
Do the data centers ever furnish the actual hardware for you or do you always have to order it yourself?

Graham:
Good question. The question is do the data centers furnish the hardware for you? Usually the data center will give you that end. They'll get that end all the way into your cabinet and the hardware from that point beyond is on them. But you furnish the server it plugs into and the connector it plugs into, typically.

Audience:
Do you have a recommended server?

Graham:
That would probably come from the Althea folks. Something that we'll... any server.

Althea Rep:
We're going to have a recommended probably Supermicro machine and then it just needs a fiber card. We're talking about maybe $1000 if you want something good that'll last a long time. If you really want it to be cheap, you can put a used desktop in there and slap a cheap fiber card in there and probably get away under $300 and it would still perform okay. But especially for something that you're going to use for backhaul, you want the redundant power supply, et cetera, et cetera.

Althea Rep:
You can get tricky and just have two gateways in there and let Althea do the failover for you. But the data center may start looking at you funny if you cart in beat up, used desktops and try and put them in the rack.

Graham:
In my experience, they don't care. You're buying it from them, they don't care.

Audience:
So the cost of the hardware is pretty trivial compared to the cost of the service, don't really worry about it.

Graham:
Yeah, I think that's true. Once you're trying to push 10 gig it can get a little harder to get something that works, but usually it's a while from when you get started until you're needing 10 gig.

Audience:
Do the data center go into power utilization and space, as well? I'm assuming the smallest space you have on the rack, the cheaper you might pay, which in that case maybe a [inaudible 00:41:28] solution, might not?

Graham:
Good question.

Audience:
Do they go into... I guess, do the fee, the power consumption and space, does that impact how much you pay?

Graham:
Good question. So the question is, does the power consumption that your servers and equipment use and also the space in the cabinet, how much can you save by minimizing both of those things? Is that right?

Graham:
A couple of things here. One, my experience with the data centers I've worked with, a lot of them, the smallest rack you can rent, the smallest space you can rent is a full rack or sometimes maybe a half a rack, which is like this. They won't actually rent you anything smaller than that. Again, like I said, a lot of times you end up with just one tiny little thing in all this space, but that's the smallest that they'll go. You can negotiate that with the data center, a lot of data centers are different. Some will rent you just a teeny, tiny little cabinet. I just haven't personally worked with ones like that very much. So if they do that, you might be able to save some money by negotiating a really small cabinet space.

Graham:
With the power, they do bill you for the power that you use. It usually ends up being a very tiny amount of the total cost that you're paying, maybe like $30 or $40 a month or something, maybe

only $20. Even if you're using a lot it probably won't save you more than a few dollars a month, I guess, but every little bit helps.

Audience:
I remember earlier when someone asked about your average cost for everything, I think you mentioned on the higher end, let's say $2000. Would that include your power utilization, your space, and the service and all of that?

Graham:
Yeah. That would not include the service. So you'd probably be paying... if you go to a data center and altogether for the rack, roof space, and a fiber connection, I would expect that to be, it really depends on your area, again, but anywhere from $1500 to maybe $3500 a month altogether. Good question.

Graham:
Fifteen minutes left, I'm going to try to hit a couple more things. One, I just wanted to point out, I've used this a lot before, this is a great resource. It's called fiberlocator.com, I don't have any relationship with them, it's just a helpful tool. It has fiber maps from a lot of different providers, not all different providers, but from a lot of different providers. It can be really helpful as you start to expand your network and need to find new places where fiber already exists. It is kind of expensive though, I think a few thousand dollars a year. It probably only makes sense once you're somewhat established and looking to maybe expand networks or whatever. Or if you want to pull together in some kind of community way and get access to it or whatever, but it can be really helpful in the first parts of the search.

Audience:
How long is the free trial for?

Graham:
I don't know, good question. I don't know. There's a couple other sites like this too, this is just the one I've used the most. So that's helpful. Another thing I wanted to point out is that sometimes you can purchase from other types of organizations like, for example, another wireless internet service provider. I know a lot of providers, especially in more rural areas, who have gone to a neighboring county or a neighboring city and found the local wireless provider or the local, local provider and purchased directly from them. The benefit is that they're a smaller provider, they're local, they understand what you're trying to do. And while you might end up paying more probably, they're also more willing to have a shorter term with you. So you might be able to go to Bob's internet service from the county next door and pay him five hundred bucks a month for a 100 megabit connection and he'll help you set it up and get it working and only put you in a year contract or something.

Audience:
Could you touch on oversale for consumer versus dedicated connections?

Graham:
Oversale, you mean how much do you need to service a certain number of customers, is that what you're asking?

Audience:
Yeah.

Graham:
Okay, good question. Yeah, I do have-

Audience:
The fact that you're paying for a connection that's not oversold specifically.

Graham:
Right. Good question. So the question's about oversell in two ways. One that you should be buying a connection that isn't oversold really. Two, how much do you need to provide service to a certain number of customers? To answer that. We talked about committed rates and that's really when you buy a connection from somebody, you should be asking them for the committed rate and they really should be giving it to you and you should probably be checking that once in a while to make sure they really are delivering that committed rate. Althea's service will help with that with running the automated [inaudible 00:46:52] tests if you can be watching that and making sure that it matches up with what you're purchasing because there are some budget providers, Cogent, that will sometimes not deliver everything that you're paying for. If you hound them about it they'll fix it, but they're a business like everybody and things fall through the cracks and whatever.

Graham:
The next question, I think this is an important question that a lot of people wonder about, especially in the beginning, is how much internet service do you need to buy or do you need to get for your community to be able to provide good service? It's hard to know exactly, it varies a little bit and there's no exact math to it. I did put a little chart together. Okay, here we go. The question is, I've got my community, a rural community or a city center or whatever it is and I know I've got X number of people who might be using the service, how much of a connection do I need to go buy to go give them service that's not going to really be awful in the evenings when everybody's streaming Netflix?

Graham:
It's not an exact math, this is the high-level numbers that I use. Basically, for a few dozen customers you might need something like 150 megabits. For ramping up to hundreds, you get pretty quickly to where you'd need at least a gigabit. For somewhere between 250 to maybe 500 customers, you're going to need a gigabit of service. Going beyond that, you start needing to burst up to 10 gigabit.

Althea Rep:
For reference, most ISPs like to sell you a speed, specifically basically they can sell that speed many times. For example, my apartment building sells everybody gigabit. There are 300 units in the apartment building. There's only a two gigabit line to the building. The oversale ratio is quite large. Selling a given speed or a given connection 20 times that's considered to be rule of thumb, but in reality, especially coaxial networks like, for example, if you were buying internet from Comcast over cable, you're real oversale rate is probably closer to 100, to 100 to 1 [inaudible 00:49:33] greater. This is why you don't want to use consumer connections as backhaul, other than the fact that Comcast will come after you, is the fact that you will really see the impact of this oversale.

Althea Rep:
So don't do a speed test, use fast.com, which connects directly to Netflix, so you can't throttle it without throttling Netflix. So speedtest.net, [inaudible 00:49:57] will always get full speed day-in, day-out, anytime, and that's because you actually slow down everyone else's Netflix when you use it.

Althea Rep:
If you go to fast.com, you'll get your real internet speed and you'll notice that this curves with people's usage. For reference, you probably want four megabits for everyone when you divide it out because four megabits is HD Netflix. If everybody on your network can get four megabits at once, everyone will be happy.

Graham:
That's not bad.

Audience:
This may be a little bit off topic, but do you have any personal experience in terms of retention rates for internet plans? How often people change?

Graham:
Yeah, good question. Question is retention rates, how often do people change their internet service? Most of the places I've worked, we've seen anywhere from half a percent to a percent-and-a-half of turn rate, meaning somewhere around one percent of the customers will cancel every month. Which I think if you do the math ends up being they're keeping their service for anywhere from four to 20 years, typically. That really does depend... a lot of that is just people moving or whatever. But you definitely will see those turn rates creep up if the speed isn't good or if the price isn't good. Or if the reliability... The three things people care about, price, speed and reliability. Largely in that order, maybe reverse order.

Althea Rep:

It's in reverse order. People care about reliability ahead of anything else. For quick reference, 99% uptime means your down almost 72 hours a month. 99.9% uptime is three hours a month. You need 99.999% uptime before people no longer notice that anything's going wrong. The cool thing about Althea is that it emulates a lot of the more complex wireless ISP setups.

Althea Rep:
If you have two connections, it will load balance, it will reallocate traffic, it will move things around and make sure it's online and you'll go to conferences with serious wireless ISPs and they have trouble doing some of the stuff that Althea does automatically out of the box for you. As far as making sure that the network is as reliable and fast as possible. You can take advantage... if you have two boxes north of somebody and they're both on only 80% of the time, 80% as we established is horrible, 99% as we established is still too bad. But if they're both on 80% of the time and fail independently, then you'll be up to that 99.9% because it becomes the chance of a simultaneous failure. If I had the whiteboard and I was willing to think about it for a few seconds we could do the probability math and I'll do that later.

Facilitator:
During lunchtime if you want. We're probably going to wrap it up.

Graham:
Yeah, there's just a few more minutes. Any other questions about fiber?

Audience:
Yes. Just to get clear, for example, let's say for [inaudible 00:53:05] you're buying service [inaudible 00:53:09]. Now if you're selling that to 20 customers, you're not just aiming to sell two megabits per customer, is it straight division?

Graham:
No. Good question. It's kind of hard to keep all these things straight. If you're buying 100 megabits from somebody, the first thing to know is that you should be buying 100 megabits committed rate. What that means is that if you go to Comcast residential service and you buy their connection that says 100 megabits, that is not 100 megabit committed rate. You may sometimes get 100 megabits from Comcast on that connection, but you're sharing that 100 megabits with 50 other people, so you won't always get that 100 megabits. It's important to make that distinction. I think that's what we were trying to talk about here is that residential products are almost never sold as committed rates. They're always a burstable rate and the committed rate is actually much lower. That's kind of the top-level thing.

Graham:
If you were to go to your customers, you could if you wanted, position a product and say, "hey, I have two megabits for you that is only yours and no one else will ever use it," and maybe that customer base really appreciates that and so you certainly could do that. But what most people do is sell basically, what's the average rate that each of my customers are actually going to see?

If you have 100 megabits, 100 megabit connection and you put 20 customers on it, the internet traffic from those 20 customers ends up being really spiky. They hit a webpage and what they use spikes way up for a very brief amount of time and then spikes right back down.

Graham:
What happens is that all those customers, because of the probabilities of their usage, end up each individually able to browse the internet and it feels good, maybe they can even watch movies and whatever. And because they're not all using it at the same time, they can on average get a lot faster speeds than the two megabits per second. You can go in and say, "hey, I have these 20 customers, I've been watching their service, I know what they're experiencing, most of the time they actually get about 20 megabits per second," or whatever that average ends up being. And you can go ahead and sell that as a 20 megabit product with the understanding that that's the way residential products are sold, at the average usage, not at an actual committed rate. That makes sense?

Althea Rep:
I'll just add really quickly to that. Althea doesn't provide, your data won't be selling [crosstalk 00:55:36]. It's more consumer, more like a cellphone plan where you're selling a certain amount of data.

Graham:
Sure, yeah.

Audience:
That's because we want it to remove the ultra high oversale incentive.

Audience:
So you're committed rate is going to be your maximum throughput divided by your number of customers?

Graham:
Yeah.

Audience:
And then the oversale would only apply to your burstable rate? It doesn't necessarily have to be your burstable rate, like your maximum burst speed would be like 10 GB, but you could sell a two megabit per second service to 100 customers, something like that.

Graham:
Yeah, you could. You would position that however you'd like. If you really wanted to get into doing that, you would want some other controls in there because you would actually have to limit everybody to that two megabits, otherwise they would end up stepping on each other. But yeah, you could potentially do that if you wanted to.

Audience:
Have you ever seen backhaul providers sell service in terms of data rather than speed?

Graham:
Not directly, although if you back out from the 95th percentile burstable rate, that's kind of where you end up. Not directly, I haven't seen them directly bill based on bits passed, they usually bill based on 95th percentile throughput.

Facilitator:
Take a break?

Graham:
Yeah.

Facilitator:
On your sheet, it has some suggestions for lunch. There's a little café nearby or you can walk and then we'll see you all back here at one.

Graham:
Thank you.

Physical intermediary (relay) node locations in Althea

Speaker 1:
All right. Cool, okay. Thanks, Justin. I appreciate ... I'm still learning things about Althea, so that was helpful for me as well, hopefully for everybody else. For the next hour and a half-ish ...

Deborah:
Hour and ten minutes.

Speaker 1:
Hour and ten minutes?

Deborah:
Yeah, so ...

Speaker 1:
No, that's fine. We're going to talk a little bit more about intermediaries and specifically from my perspective, how one would go about building, what in Althea terms is called an intermediary, including potentially a cellphone tower. We'll talk about some things about how if it makes sense for you in your community to lease space on a cell phone tower, the things you might consider for that as well as other things you can use for intermediaries.

Speaker 1:
First, I think a quick definition of intermediary. In our network here, we have homes. So, if we have a really simple network, we have a customer home that is a customer. We have somewhere over there a connection to the broader internet, which is where we purchase a fiber connection or something like that, what we talked about yesterday. In between those two spots, usually there are some other installations. It's uncommon that we are close enough to be able to connect our home directly to our fiber connection and get them hooked up directly. Usually we need some spots in between to get them connected. So, an intermediary is how you take the fiber connection that you're purchasing and get it closer to the community.

Speaker 1:
You have extra spots, they could be ... If we're talking about a wireless network, usually these are high kind of vertical real estate places, grain silos and homes and commercial buildings, et cetera, that you can put wireless equipment on to relay it out towards your customers. It could also, if you're building a fiber network, these are the pedestals in the street that extend the network and add management ability, et cetera. But mostly for what we're talking about in wireless, we're talking about wireless installations where we can install access points and wireless point-to-point connections to extend our service from our fiber out towards our customers.

Speaker 1:
Does that make sense? Any questions on what that means or is?

Deborah:
And of course with the Althea network, they can get paid.

Speaker 1:
Right, exactly.

Deborah:
Either the the individuals or business owners or property owners that can get paid and work together with the subnet DAO to loosen it up.

Speaker 1:
To Deborah's point and for the microphone, in Althea's system someone who is ... If I own a tower or a grain silo or something, and I say, hey, I'd like to help out the community, extend service out to people. I don't really care to be an internet service provider, but I have this resource that could be helpful to people. I'd like to be compensated for making that resource available. I can build an intermediary, allow other people to use it, put Althea's hardware and software at the location, and then be compensated for usage at the intermediary for traffic that passes through that site. Cool. And in addition, I think if I am interested in becoming a DAO, a subnet DAO, I am also interested in building intermediaries in order to expand my network and connect people to the subnet DAO. Right? That's fair to say, right?

Deborah:
Yeah, so if you're a subnet DAO, it's more of a collaborative nature. The subnet DAO may act to help get subscribers and work together with that intermediary node, you wouldn't necessarily directly built it, necessarily, it depends on the application and all that intersection wants to work, it's more of a collaborative. And then adding more subscribers benefits both the intermediary tower and the DAO.

Speaker 1:
Sure. Okay. So the point is more that, as a subnet DAO I might work collaboratively with someone who can be an intermediary, and we might work together to build this and extend coverage out to potential customers, but there is interest to both parties, right?

Deborah:
Yeah.

Speaker 1:
Great. Okay, so a few things I wanted to run through on the situation that you are looking to build one of these wireless sites as an intermediary, and kind of physically, how to go about building it and things to be concerned about, and how to make sure that this site isn't gonna

burn down and that kind of thing. So in a lot of situations, when a wireless network is being built, what we're looking for is tall buildings. It's quite expensive to build a tower, and it's expensive to build a tall structure. So a lot of times when we're getting started, we're looking for existing structures that we can go put wireless equipment on to act as an intermediary that's already there, it's already being used for something else, and we can now use it to distribute internet out into the community.

Speaker 1:
So it doesn't have to be a cell phone tower, like I said, in rural communities, grain silos and water tanks make great intermediary sites, they're already tall, they can hang wireless gear on them. A lot of times they already have power close by. So physically, a lot of times the way that this works is that I as a person who wants to build an intermediary, either I own the equipment or I'm looking to assist with that. I'll go and start looking at the location and the things, the top things that I'm looking for are if I can hang wireless devices on the structure, like access points and point-to-point radios, and if I have easy access to standard 110 AC power. If I have those two things, I can most likely turn this site into an intermediary. And then once it's turned into an intermediary, I can then begin to serve customers, any home or other building that has line of sight than can physically see this intermediary, I can now get connected to the network. Any questions? Okay, cool. So, yeah?

Speaker 3:
So isn't a water tank going to experience absorption problems?

Speaker 1:
Yeah, potentially. So the question is, would a water tank experience absorption problems? So you would want to make sure that you're not trying to shoot through the water tank, the wireless connection. So you'd have the access points kind of out around the tank and shooting away from it. There could still potentially be a problem with reflections reflecting off the tank and back into the access point on the back, and in that situation you might want to put the access points actually up above the tower or a little bit farther out or closer in. But usually there's ways to make that problem go away if you need to. Good question though.

Speaker 1:
So let me pull up this other, okay. So looking at this, this is information I have on my website, you're welcome to look at it and use it, this shows kind of the components of what might be an intermediary, the addition here that I haven't added would be an Althea router. But what we have here is kind of abstract, we have at the top a mount that holds our access points and our wireless equipment, cables running down to some kind of a switch, and in Althea, that would then terminate into an Althea router, and then we have typically a cabinet near the bottom of the structure that holds all of our equipment and is where our power is connected.

Speaker 1:

So to go about building this, we find a way to mount our antennas to the structure. We can use a variety of different mounting devices. I think I have a list of them somewhere. Something like this can be used, this is designed to be, yeah?

Speaker 4:
I'm just ... how stable does the wireless, like the antenna have to be if there's a one-inch wiggle? Or is it three feet?

Speaker 1:
Good question. Yeah. The question was, how stable does the antenna have to be, as in, how much can it move in the wind before it starts to cause a problem? And that's a good question, it depends a little bit on the frequency that you're trying to use. At 5 gigahertz, if it's moving, if it's wobbling a little bit in the air, it probably won't be noticeable. If it's swaying like this back and forth, it might be. At 60 gigahertz, even a little wobble probably won't drop the length totally, but it could cause quality problems, so you have to mount that more securely. But at 5 gigahertz, you've got quite a bit of room, wiggle room. Good question.

Speaker 1:
So a mount like this is designed to be put on a flat roof. A common situation is maybe there's an apartment complex with a flat roof. We want to come into the apartment complex, we've put something like this on the roof, it's held down with cinder blocks. That's great because the apartment complex doesn't want us to put holes in their roof to mount our equipment, we don't want to do that either because it'll cause leaks and nobody wins. So we put something like this up on the roof, there's a mast in the middle that can go up to about 10 feet. That gives us a great place to mount our antennas, and it should be plenty secure. If we look at the technical specs here, it'll tell us how much wind loading there is on this, but this will hold in most non-super-extreme weather situations, this will hold quite a lot of equipment.

Speaker 5:
Do you know what price it is?

Speaker 1:
Oh, these usually go for like 400 bucks, or 450 or something, and then you have to buy the cinder blocks, but that's another 50 bucks or something.

Speaker 6:
We had a guy make one of these in Columbia for what, like 60 bucks?

Speaker 1:
Yeah, I mean, this is, yeah.

Speaker 6:
You can weld it if you know how to weld.

Speaker 1:
Yeah, if you know how to weld, you can make this for yeah, 50 bucks.

Deborah:
We got a pretty smaller one of these for like 100, 150, something like that, yeah.

Speaker 1:
Yeah, Deborah points out, this is a pretty heavy duty one. There are ones that are, this will hold I think 12 cinder blocks. There are smaller ones for like on top of a customer roof that'll only hold 6 cinder blocks and they're like 50 or 75 bucks. But they won't hold nearly as much equipment.

Speaker 3:
So [inaudible 00:11:16] agreements or [inaudible 00:11:18] agreements, what complication happens with I guess the building owner, building manager [inaudible 00:11:27]?

Speaker 1:
Good question. The question is, what kind of agreement do you get with the building owner? So let me describe my background a little bit, and then I'll try to relate that to Althea. So in my background from more traditional wisp, wireless ISP background, the situation is, I as the wisp would approach the building owner and would say something like, I would like to lease some space on your roof so that I can provide internet service out to the area. If this is an apartment complex, I can also provide service to your tenants, and I would begin to negotiate a contract to lease some amount of space on their roof, and also compensate them for power usage. Power usage is usually in the US, markets can be anywhere from 5 to like maybe 20 dollars a month, and then I might also offer somewhere between 200 and 600 dollars to rent space on their roof.

Speaker 1:
In the Althea system, supposedly I could probably also do that as a subnet DAO, but ideally I would probably be trying to get them interested in acting as an intermediary on their own, such that we would put the Althea router in there that would belong to them, and then any traffic that goes through there, they're compensated based on that being an intermediary. So we're collaborating together, but I'm maybe just ...

Deborah:
So the role of the subnet DAO in that case would be to help maybe administrate the equipment, maybe to keep it up and running depending on that situation that you work out between you and the building owner, and the role of the building owner would be to maybe to the initial investment, to keep the power on, to pay for that, and then they would get the reoccurring income from that.

Speaker 1:

Right, so just to recap for the mic, in the Althea system, the building owner would kind of hopefully be in charge of keeping the equipment running, and keeping the power on, et cetera, they get compensated for forwarding traffic through their router. The job of the subnet DAO would be to maybe do some maintenance on the tower and make sure they have that expertise to keep the tower maintained and running, but there's a collaboration there that would work. Did that answer your question? Yeah?

Speaker 7:
In case it's like a water tower, is it hard to get power to the tower?

Speaker 1:
Yeah it can be, so the question is, in the case of a water tower, can it be hard to get power there? And the answer is yes it can. It depends on the jurisdiction, some water towers and water tanks do already have power, for maybe they have some monitoring there or something that already happens and they already have it. Or it's in kind of a residential area and it's easy to get. In some cases, there is no power at the water tower, and the options are, build a solar installation, which is feasible but can be kind of expensive, or trench power there, which is also feasible but can be expensive, so. Good question.

Speaker 7:
And so the tree would be the same I guess? [inaudible 00:14:22]

Speaker 1:
Yeah, so if you wanted to use a tree to hold one of these equipment, yeah, a tree, I've seen people do that, it seems pretty risky to me, mainly because trees grow and turn and fall over and whatever.

Deborah:
Also they sway.

Speaker 1:
And they sway, yeah.

Deborah:
And the higher up you get, I mean there's quite a bit of sway on those, so you want to put a sector antenna if you're gonna do tree things.

Speaker 1:
Yeah, so ...

Speaker 4:
Guide the tree?

Speaker 1:
What's that?

Speaker 4:
Guide the tree.

Deborah:
Guide the tree.

Speaker 1:
Yeah, so if you really are interested in, and it works good for your community to put it up in the trees, you do probably want to somehow secure the tree and you know, you probably want to take some extra steps to make sure that that won't be a maintenance nightmare, but maybe it can work.

Speaker 7:
For like telephone poles or power poles, and that's how these usually open negotiations about [inaudible 00:15:09] worry about that stuff?

Speaker 1:
Cell phone and power poles?

Speaker 7:
Yeah.

Speaker 1:
Yeah, so I think we're gonna talk in just a minute really specifically about cell phone and power companies, but just as a preview, they usually are, but it's expensive.

Speaker 7:
Thank you.

Speaker 1:
Yeah. We'll talk about that specifically in just a few minutes. Any other questions? Cool. Okay, I'll just show a couple of other kind of mounting structures, I think it's helpful, this is helpful for me to able to see what's out there, and then as you look to go start building these on your own, you at least have an idea of maybe some of the options that you can use. Okay, a couple of other options. This is just called a tripod mount, this is great for mounting over the peak of rooftops. Mount this over the peak and drill it into the roof. The downside of something like this is that it does require penetrating a roof, so it needs to be sealed really well so you're not causing any leaks. But they are very sturdy once they're in place, and it means that you don't have to haul 300 pounds of cinder blocks up on the roof which is great. But you definitely don't want to put this on a flat roof.

Speaker 1:
Point of caution, you should never, ever, even if the customer says it's okay, never penetrate a flat roof. Never drill anything into the flat roof. The flat roof, water will pool on the flat roof, and they will leak at some point, if you put a hole in it, it will leak. A sloped roof, they've got shingles, the water slides off. You can seal it and water won't penetrate because the water will slide off, the water's not pooling up. But on a flat roof, you should never ever drill through a flat roof. Yeah, even if the customer says it's okay. But for a sloped roof, this is a good solution, they're cheap and easy to put in, and can hold probably a 7 or 10 foot mast, plenty of room for equipment, and easy to install.

Speaker 1:
Another option for a sloped roof, this, a non-penetrating peak roof frame is similar, it's meant to go over the peak of a roof like this, holds cinder blocks on either side. So this is one that will go over a peaked roof but not penetrate the roof, so if the customer insists that you don't drill into the roof, even if you're sealing it, you can use something like this that holds I think eight cinder blocks, again, puts a mount up 7 to 10 feet in the air, plenty of room to hold equipment. So mechanically, after we have a mount up in place, a place to hang our equipment, we hang our access points, yesterday we talked about how you might put four or six access points around that to give you full 360-degree coverage around the site. So a typical situation might have four access points around the top of the antenna, and then a point-to-point wireless radio, one or two of them, providing service to the site and potentially out to another site. So you might have four to six devices on that mount.

Speaker 1:
The next thing you'll do is run a bundle of cables, each device needs its own ethernet cable. So we're gonna run a bundle of cables from there down to, somewhere ideally where we're gonna put a box in where there'll be some equipment, and it'll be equipment that you'll want to be able to get to for maintenance, whoever is gonna be maintaining this thing, you'll want to be able to get to it quickly in an emergency, if something's broken, so that you can fix it without having to call the maintenance person or find keys or whatever. So in an ideal situation, we might put our box, if it was on a house, outside where it's accessible externally. We'll run all those cables down to the box, and in the box is where the Althea equipment would go, that's also where the power's hooked up.

Speaker 1:
So each of the devices are powered over ethernet through their ethernet cables, and our Althea router goes in the box. And really, for minimum setup for an intermediary, that's really all there is. A box with a router in it, and power, equipment up high, wireless equipment, and that's it. If we want to add in things like battery backup, that's something that can be added, but to just get off the ground and running, that's all we need. Questions so far?

Deborah:

And this is at the Tesco vendor? Where would you recommend that people buy this sort of equipment from?

Speaker 1:
Oh yeah, good question. So the question is, where might people buy this kind of equipment from? Tesco is a vendor, what I usually recommend, there's a handful of different vendors in the US and I'm sure there are even more outside the US. I have a short list of them somewhere.

Deborah:
You can plug your website if you want.

Speaker 1:
Okay. Where is it? Okay, here we go. Here's a few kind of US vendors, I don't know if you can see that very well. You can always look it up on my website, I think it's listed in there, and I'm sure that there are others that I'm missing, and I'm sure there are some outside the US. What I typically recommend is call a few of these and see which one of them has the best prices on the specific equipment you're looking for, and also which one of them has distribution centers closest to your area so that you can get fast shipping. I don't necessarily have a preference among these other than just those two things, prices and distribution points.

Speaker 1:
And when you're very first getting started, most of this equipment is available on Amazon for a little bit more expensive than what you get from one of these places anyway, so sometimes it's easier just to do your first batch of ordering from Amazon to figure out exactly what it is you're using a lot of, and then start looking for a vendor.

Speaker 3:
In this scenario, let's say flat land and no structures, no structures [inaudible 00:21:42] limits of building some type of structure, right? So what would be your recommendation [inaudible 00:21:53] because you obviously can build the tower [inaudible 00:21:56], so I mean, I guess you can, but if you're limited now by budgets and stuff like that.

Speaker 1:
Yeah, good question. Okay, so the question is, in the situation of a very flat area, there are no tall structures, there are no towers, what are your options, what can you do specifically on a budget to be able to start distributing, right? And so the first thing I would point out is that there are actually pretty good and not terribly expensive ... trying to find it here, options for building a tower. And I think I'll actually use this to move into both building your own tower and also leasing space on a commercial tower that we asked about as well. So let me pull this up. Okay, so this is an okay example. Yeah?

Speaker 8:
Fundamentally, [inaudible 00:22:44] ham radio tower, correct?

Speaker 1:
Yeah.

Speaker 8:
Okay. I mean they looked like it, just verifying that there wasn't something different.

Speaker 1:
Yeah, that's a good point. So the point made up here is, there are actually fairly cheap tower structures, and a lot of them are advertised toward ham radio enthusiasts. And so something like this, ROHN is a company that makes quick, easy to assemble, relatively inexpensive towers, and a lot of them are targeted toward ham radio people who are largely individuals building something in their backyard, so they're relatively cheap. They can't hold a whole lot of equipment, they're not really, really sturdy, but they're fairly cheap, easy to install, the way that this works is you usually buy them in 10-foot sections, and this ROHN 25, you may start to recognize them if you haven't before, they're kind of a triangle, so there's three poles going up, and then they have these cross-sections supporting them, and you can build them in 10-foot sections.

Speaker 1:
There's lots of instructions from them as well as from other places on how to actually assemble them. And usually what you're doing is just pouring some cement in a hole, putting the base of the tower, securing it to the cement and then building it up 10 feet at a time. And it's not free, but it can be done quite cheaply. In most US jurisdictions, the hardest part of this is permitting. So if you are in a fairly lax regulatory environment, you can pretty easily throw up a tower on somebody's land like this and kind of do whatever you want. If you're in a more regulatory, heavy environment, it can be really hard just to get the permitting. Question?

Speaker 9:
Okay, so you know you can find a great way to rent the tower cheaply, but is there any way you could recommend for someone considering upgrading their setup, to assess whether the upgrade is going to make a difference? Is there some sort of makeshift solution someone could use to maybe extend their existing tower or pole or something, to temporarily check that it's actually [inaudible 00:25:08] reception?

Speaker 1:
Okay, good question. So, to make sure I understand the question, question is, you think, you're saying okay, maybe I need a tower, I don't want to invest in it until I can confirm that putting up a tower actually fixes it? Yeah, that's a good question. So there are some things actually, I wonder if I can find one, there are temporary portable towers that are used pretty specifically for that kind of thing, again, a lot of the time marketed toward ham radio enthusiasts that you can temporarily put together. They won't stay there permanently but it would be enough for you to check it out and see how much the signal has improved. I don't ...

Deborah:
Military surplus has something cool.

Speaker 1:
Yeah, military surplus has these kinds of things, and the one I'm thinking of is a large, it comes in a duffel bag, and it's a large tripod that you kind of quickly assemble, and then there's like six or seven foot sections of poles that you kind of push up through the middle. And so you put your antenna on the top one, and then you just start pushing it up, and you can kind of twist it to adjust it, so it's just a really quick, throw-it-together way to do that. The other thing you might consider is just using a drone. Another thing you can do is fly a drone up to the height you might be looking at, get some good video, and see if that gives you line of sight to wherever it is you're trying to go.

Speaker 9:
Actually, I remember there was a project, we could use drones, and [inaudible 00:26:44] where you find the [inaudible 00:26:45]. You just send a drone and use antennas attached to it.

Speaker 1:
Yeah. You can even try to attach antennas to drone.

Speaker 4:
Just for reference, what's the length that a pole turns into a tower? Say I put a satellite dish up, that's not a tower, just a dish, network dish, but do you have a rule of thumb that more than 5 feet off a roof, 30 feet in the air?

Speaker 1:
Okay, so the question is, at what point does just a pole, now all of a sudden do we call it a tower?

Speaker 4:
Yeah, for permitting or anything else.

Speaker 1:
Sure. Okay, so there's a couple different ways to look at it. From permitting, it really depends on the municipality. And they are frustratingly opaque, often. But usually it's if the mayor drives by and doesn't like it, then it's a tower, and you shouldn't put it up, you know.

Speaker 4:
I know what you mean, [inaudible 00:27:43].

Speaker 1:

Some more practical concerns, if it's tall enough that you can't get to the equipment to service it, then it's gonna be really difficult to do anything, and particularly where with these equipments, you need to be able to get here behind it and aim it, and you need to be able to aim it not only left and right, but up and down. If I can't get to the top of my structure to be able to do that, that's gonna be really hard. So if I put up a 50-foot pole, and then what? Because I can't get up there and do anything to it. So at that point, it starts to make sense to maybe put up one of these towers that I can then either lean a ladder against or climb. I think that's more practical.

Speaker 4:
I didn't know if there was a rule of thumb, like, over 10 feet over a rooftop is considered something else.

Speaker 1:
I usually, if it's gonna be, at 10 feet, I can set up an A-frame ladder and still get to the top, barely.

Speaker 4:
What I'm thinking of is I put one on my roof, it's like 12 feet, but I have a mount on the side of my wall like this, so I can slide it up and down, do whatever and then put it back up and turn it, but I just didn't know, like if my neighbors are reporting me or [crosstalk 00:28:51].

Speaker 1:
Yeah, that's a good point, so there are telescoping towers that you can bring down with the telescoping slider thing, adjust and then crank back up. And yeah, those can be great. It still can be kind of hard because visually, it's nice to be able to actually look at this thing that you're aiming, rather than having to crank it up and down. But yeah, those can be good options and it just depends on your municipality.

Speaker 3:
[inaudible 00:29:18] on weight, just, if you were to [inaudible 00:29:23] build the tower, is there anything different as far as how much wind loading of the tower, stuff like that?

Speaker 1:
Yeah, so the question is, if you're building your own tower, how much stuff can you put on it, and how do you determine that? So, there's several things to do. One is that the company you're purchasing the tower from, so if it was ROHN for example, they will publish pretty accurate and useful statistics of that, of what you can put on the tower. And so a ROHN 25 for example, that's this model, it's a small and fairly, not really heavy duty tower won't be able to hold as much equipment. They have like a ROHN 35 and a ROHN 45 that are designed to be more sturdy, and so you can look at the statistics, and obviously those ones are more expensive but they can hold more stuff.

Speaker 1:

And typically when you're looking at it, the weight is a concern, but the probably even bigger concern is wind loading. So if you're putting the more surface area of antennas you're putting on there, the more wind it's gonna catch, and then that's when it'll really start to test the structural integrity of the tower, that's when the wind is hitting it. So there are things that you can do to increase the structural integrity of the tower, things like adding guy-wires, if you're unfamiliar, let's see if any of these have good examples. Yeah, oh yeah, that is a good one.

Speaker 1:
So these wires you see coming off, those are guy-wires, they're called guy-wires. They are attached to the tower and then also anchored some distance away from the tower. Usually there's three coming off the tower and then each of them are tightened. And if you have the physical space to be able to put those, because often they need to go pretty far away from the tower, but if you're putting it in the middle of a field or something, you can add those guy-wires, and that'll add a lot of structural integrity to the tower and make it able to hold more equipment with wind loading. Again, the specs for that are typically published by the tower company, or if you really want to be correct about it, an engineering firm should review the design and stamp and confirm what the tower is capable of holding, but you can get quite a ways just looking at the literature provided by ROHN or whoever's giving it to you.

Deborah:
How would you find these engineering firms [inaudible 00:31:52]?

Speaker 1:
Oh good question, question how would you find an engineering firm? I've found they're not too hard to find in most, at least in the US metro areas, just searching engineering firm and calling a few around, I've never had too much trouble finding them but they are kind of expensive.

Deborah:
So it's just a generic engineering firm and [crosstalk 00:32:11]?

Speaker 1:
Yeah, they're the type of people who stamp bridge drawings or new buildings or like water stuff, like when you're building a new community and you need to make sure the ...

Deborah:
They're not specific to ...

Speaker 1:
Yeah, it's usually not totally specific to towers, they just have a bunch of smart engineers who can say it looks good or not.

Speaker 13:

If you have a contractor that you're gonna have help you put in the tower, ask what firm they recommend.

Speaker 1:
Yeah, that's a good point. A lot of this stuff, especially if you're doing this for the first time, it would be good to have a contractor do it, or at least work with you to do it, and they will usually have contacts into either engineering firms or kind of hopefully have done this before and will be able to help out.

Speaker 13:
I think I get permits too, so.

Speaker 1:
Yeah. Yep. So definitely possible, and commonly done to build your own tower. Again, one of the more difficult pieces comes in at you still need power. So if you are building in a really rural area, again, you might be back to solar power or trenching power and from the nearest available power.

Speaker 10:
How much does it cost to build something like this?

Speaker 1:
Let's see, I think the sections can be as low as a few hundred dollars each, so you're probably looking at minimum, several thousand dollars to get a tower up, or maybe more. For something really short, like if you just need 20 feet off the ground or something, you can probably do it for a few hundred dollars, but to get more than a few dozen feet up, it'll be more than that. Good question. Any other questions about building your own tower before I move to commercial towers? Yeah?

Speaker 7:
So if you have a solar panel, could you have the panels up on the tower? Or would that [inaudible 00:34:11]?

Speaker 1:
You probably don't need to put them on the tower, because just as much sun hits the ground as the tower. So you put them in an area where they're angled toward the sun, and then they can usually be on the ground. I guess if you're in a really dense forest or something, maybe you'd want them a little bit higher up, but usually you just put them on the ground, just one second, and then actually one of the bigger concerns is you need a pretty big bank of batteries. You need to make sure that you can power through days without sun, so depending on your environment, you might need to be able to power it for several days during winter months without sun.

Speaker 7:
Is there a rule of thumb for batteries?

Speaker 1:
What's that?

Speaker 7:
Is there a rule of thumb for batteries that you want? [crosstalk 00:35:01]

Speaker 1:
The way to calculate it is to look at the longest your area goes without sun on average, or like how many cloudy days in a row, basically, and then how much power your tower is using, and basically give yourself enough batteries that you could power through that length of time. So it varies a lot, I mean it can vary from almost nothing in really sunny areas to huge buildings full of batteries in really cloudy areas. So yeah.

Speaker 9:
Is there any effective way to deal with wobbling with long towers? Tall towers.

Speaker 1:
To deal with wobbling? With the tower just swaying back and forth?

Speaker 9:
Yes.

Speaker 1:
The best thing is guy-wires. So yeah, if you've got a really tall tower and the top of it is gonna move, you can try to bury the base deeper and harder in the cement to make the base stronger, but really the best thing to do to keep it in place is guy-wires. Or, we'll look at a few more, the other thing is to build, if you really can't do guy-wires ... that's just a tiny picture but you can tell that it's angled, it's more of an A in this particular type of tower, and that will wobble less than a just straight up tower as well. Does that make sense?

Speaker 1:
And you can purchase ROHN I think and other companies make this kind of tower, so if that's better for you, if you can't use a guy-wire, that might be better. Good question.

Deborah:
Half an hour.

Speaker 1:
Okay. Half an hour left, so let's move on to concerns about commercial towers, and how to go about interacting with and potentially leasing space on a commercial tower.

Speaker 11:
Before you jump off, a basic question. Climbing these things, I mean there's obviously safety equipment, but how dangerous, I mean, I imagine you've planned out these things, what is that?

Speaker 1:
Yeah, so the question is, how do you climb these things, and concern yourself with safety, make sure you don't fall off, or fall over, whatever. Yeah, and that's a good question, and actually, there are two or three companies in the US that will certify a person as able to be tower-trained, or able to be a tower climber. If you are using a commercial tower owned by somebody else, they will require anyone that climbs the tower to have that certification. So that'll be there, it's not very hard to get, usually it's a two or three day course, probably costs, I don't know ...

Deborah:
About 1500.

Speaker 1:
1500 bucks, yeah, to go get certified. If you have a crew you're trying to do, you can send one person to get certified and have them come back and certify the rest of your crew. The primary purpose of the certification is to learn how to rescue someone from a tower. So staying safe on a tower yourself is pretty straightforward, you put on a harness and then you have what we call Y-lanyards, you got basically two hooks and you never leave yourself unconnected. So as you climb, you hook with one hand, then you hook and climb with the other hand, so at any point if you fell, those Y-lanyards would catch you. That in itself is pretty simple and straightforward, you can do it with an hour of practice.

Speaker 1:
But the harder part is if you're climbing a tower and you bash your head on something, or some ice breaks off up higher and hits you and you are unconscious, someone needs to rescue you, and the idea is that you should always have two people working on a tower at any time, and you should both know how to rescue the other person safely. Just briefly the way that that works is that the rescuer climbs the tower to above to person who's unconscious, comes down, hooks themselves to that person, cuts that person off the tower, and then descends to the ground. So to get certified you have to practice that, you have to both be rescued and rescue, once a year.

Speaker 9:
So what sorts of limits can you have on a tower? Depends on like how much equipment you can put up, there's how heavy can you be, max [inaudible 00:39:34].

Speaker 1:
Yeah, good question, so the question is, how much equipment can you put on there and what are the limitations. So the overall process of figuring that out is called a structural assessment of the tower. When you are leasing a tower from a tower company, they will sometimes require you

to have a structural assessment done on the tower. Usually what they do is they'll do a structural assessment initially, and as they get closer to having that tower maxed out, they will require new entrance to the tower to have a new structural analysis done, to make sure that their equipment won't overload the tower. Again, that's something that should really be done by a professional engineering firm. It's math above my pay grade for sure. But you can also, if you're building your own tower, rely on the published stats from the manufacturer of the tower, and they'll give you some information about wind loading and weight. Did that answer your question?

Speaker 9:
Yes, thank you.

Speaker 1:
Okay. Okay, so commercial towers, let me pull up, well, we'll let that load for a minute. I was just gonna pull up, in the US, there's a number of tower companies, there's two that most people end up dealing with that are pretty national, American Tower Company and Crown Castle. I was just gonna pull up their website just to show what they look like, but they act mostly as tower management companies. They do own some of their own towers, but mostly they are managing other people's towers. So I'm a property owner and I say, I'm gonna build a tower, but I don't really wanna deal directly with the people leasing it, so I hand it over to American Tower, American Tower now resells the space on the tower, and anyone looking to lease space goes through American Tower and doesn't have to deal with me. So they're in a lot of cases, just middle men to the whole situation.

Speaker 1:
Okay, so here's an example for American Tower, just their home page. So let's start from the beginning, so you're in an area and let's say you know of a tower, you're driving around and you see a tower that looks like it would be great for your community and you want to go figure out how to get some equipment on it. The first thing to do is just drive as close as you can or walk as close as you can to the tower, almost always there will be a big sign that has an FCC ID on the tower, and it will also say the name of the company that manages the tower, and potentially the name of the company, the name of Verizon or T-Mobile or whatever who has equipment on the tower. But the sign that says the FCC ID is pretty standard, I wonder if I can find a picture of it. Oh this one, this is a better example, smaller, but this is one for Crown Castle, I know it's harder to see.

Speaker 1:
There, there's a little bigger one for Crown Castle. So a sign that looks a lot like that will be at the base of basically any commercial tower that you run across. And I believe that it's required if the site is hosting cellular equipment, basically using licensed frequencies. So this makes it really easy to figure out who to get in touch with if you would like to lease space on that tower, phone number is right there, you can call them and you know what company it is. You can also, I believe both Crown Castle and American Tower do publish maps of all of their tower properties. You just have to sign up for I think a free account on their website and then they'll

give you a map of all of their towers. It's possible that the tower you're looking at will not be Crown Castle or CCI, it might be somebody else, either a local company or another more regional tower company, but they should still have this sign and a phone number for you to call, so it's easy to get started.

Deborah:
Sometimes in the more rural areas, they're run by the Department of Forestry or the government [inaudible 00:43:42].

Speaker 1:
Yeah, Deborah just pointed, sometimes in a really rural area, the tower might be run by the Forestry Department or some municipality or something like that. And it might end up being more difficult to get in contact with, but should still have something like this to be able to find.

Speaker 12:
Assuming that most cell towers are in the highest points of the area, right, for maximum coverage, if you wanted to put up, say if you got permission to put up your own tower somewhere in that vicinity, would you have problems with interference or anything on the cell tower?

Speaker 1:
Good question, so the question is, if you put up your own tower, or presumably if you put up equipment on a tower already there, will it interfere with the existing equipment? The answer is typically no, because cell phone providers are using very different frequencies than we are. If there is another wireless, like a wisp on there, then you might run into concerns about that, and you'd have to work with them or figure out a way to not do that. But if it's only cell phone companies, you probably won't have any interference. So the next step here, you're gonna call this company and ask about leasing the tower, and they're gonna start asking some questions. This can be a difficult process because usually the tower company has wrong or outdated information, or just no information about the tower.

Speaker 1:
So often you have more information looking right there standing at it than they do. But the things that they are gonna ask you are, how high do you wanna go on the tower, and where are you gonna put your ground space equipment? So when you're looking at the tower ... Each of these, you can kind of see on this tower, there's bands of equipment. There's, I wish I had a laser pointer or something, but there's a section with equipment around it and then a little bit lower, another section. Each of those, they're usually 10 foot sections, and they're called RAD centers, RAD. I can't remember what it stands for. But it basically just means the height, that's the height you're gonna lease. So basically you're gonna say, I want to lease the 60-foot RAD center, and that means you can put your equipment between 55 and 65 feet.

Speaker 1:

So usually on a large tower, they're rented in 10 foot sections. If you're in an urban area and the towers are really dense and the equipment's really crammed together, it might not be 10 foot sections, it might be more like 3 foot sections, but a bigger one's usually 10 feet.

Speaker 7:
Does it cost more higher up you are?

Speaker 1:
Yeah, question is, does it cost more higher up you are, and typically yes. So it's quite common for a large cell phone provider to have the top, top spot, and often, especially in somewhat rural areas, they're the only ones on the tower. And you can save money by renting lower RAD centers, so you might not even want that second spot, if the tower's 100 feet tall, but 50 foot gives you everything you need, you may as well take the 50 foot spot and save some money. So you'll call the tower company, you'll say, I'd like to rent some space on this tower, I'd like to go at 65 foot RAD, it looks like it's empty, I'm here at the tower looking at it, it looks empty, please send me a tower application. And they're gonna go through a sales process and get you set up in their system and a bunch of other stuff, and you're going to need to fill out a tower application.

Speaker 1:
The tower application is gonna ask you ... Oh, actually, you know what, let me back up, before I get into the tower application. While you're there checking out the site, you want to make sure that you can cheaply, relatively cheaply get your own power at the site. So you will have to have your own account with the power company providing power to the site, you most likely will not be able to share power with someone else, that means you need your own meter on the tower. Usually when a tower is built, there's something like this built, this is an inside one, so not a perfect example, but you'll see something like this outside, usually built on some like unit structures where you just have a whole bunch of power meters.

Speaker 1:
If you're lucky, and usually, most of the time you are, at least one or several of these won't have a meter in it. So the meter will be missing and it'll just be a blank spot there. That means that the power company can come in and install a meter in that meter bank that can be assigned to you, you can pay for the power through that meter. The problem is, if that meter doesn't exist, they have to expand this whole installation. That can be quite expensive, and they are going to make you pay for that. And in a lot of cases, what happens is the existing structure isn't big enough to hold more of these, so they actually make you pay to tear all the existing ones out, and put a whole new one in, including extra for yourself, which is very expensive, on the order of 15 to 20 grand. So you don't want to pay for that.

Speaker 1:
So in my best experience, if there's not a free meter bank, usually that means we're not getting on the tower, but fortunately, usually they build enough ahead that there are some extra.

Speaker 6:
How likely is it to be able to get a quote with a ballpark of the price before you fill out the application and really get deep into planning exactly what gear and stuff, will they be able to estimate?

Speaker 1:
Sure. The question is, how likely are you to be able to get a price quote before you get too far down the road of filling out the application and getting all set up? I think most of the time you're gonna end up having to fill out the application to get a quote, but that shouldn't cost too much to fill out, I think sometimes there's an application fee, but it's not terribly high. You might be able to get them to give you a ballpark estimate, but a lot of times the salesperson won't before you fill out the application.

Speaker 6:
Also I don't know if you're gonna cover this, but do you have any sites to recommend or resources to sort of search, like a list of people who supply information on where towers are and who owns them and stuff?

Speaker 1:
Yeah, so the question, are there resources available for finding basically where towers are and who owns them, et cetera. So yeah, both of these companies, American Tower and Crown Castle I think do publish their own maps, so you can look at those. You can also, the FCC has not a great map, but ways to kind of search for towers in an area, so even if it's not one of these two major ones, as long as it's known by the FCC, the FCC has a database that you can search and find those. In the US, I don't know much about outside the US.

Speaker 1:
Okay, so typically, the first thing I do again, go to the site, figure out how high I want the equipment, make sure there is open space on the tower, check the power situation, make sure there's an open meter bank that I can use, and then go back and start calling the tower company. This is where it does get kind of hard, if it's the first tower you've done, they're gonna want your certificate of insurance, and a lot of times they want like a five million dollar coverage, so that can be kind of expensive if you're just getting started, to get that amount of insurance. And they are also going to want things like being able to see that everyone who's going to be working on the tower has safety training, a lot of times they want to see your OSHA logs from doing similar work and proving that you are working safely. So building that relationship with the tower company can be difficult just getting started.

Speaker 14:
Can you contract that out to have someone else put your equipment on?

Speaker 1:

Yeah, so the question, can you just contract this part out, and the answer is yes, definitely, there are quite a few companies that will just build this for you. In fact, most large carriers in the US don't do this themselves, at least in some areas, they hire out tower contractors, and those contractors are typically more than willing to take your business.

Speaker 14:
You would look for specifically a tower contractor, or would like a general engineering firm do that kind of thing too?

Speaker 1:
So sometimes, large electrical contracting firms have a tower division that does tower work, or sometimes there's just a more local tower-only contracting group that does this for a variety of different cell providers. Again though, they're gonna be quite expensive. So usually, they'll have a crew of two to four technicians, and the technicians I think rightfully are pretty well paid, because they're climbing towers and that's kind of a dangerous situation, and there's overhead on top of that. So it can be quite expensive, but certainly possible. Good question. And a lot of times they won't do this negotiation process for you, you still have to negotiate directly with the tower company, and then get the contracting crew to go do it. So usually you're still doing the tower piece yourself.

Speaker 8:
I mean as long as we're out in that [inaudible 00:53:01] field, are they typically doing things like aligning your point-to-point? Or is that something you would need to look into separately?

Speaker 1:
Question, so the question is, if you're contracting this out, are they going to be skilled enough to align your point-to-point stuff correctly, or do you need to figure out how to train them or something like that? It depends on the firm, usually they have at least enough experience, they've been doing this stuff for cell phone providers, and maybe they haven't done a lot of point-to-point stuff, but usually they can with some training, but it is something you would kind of want to assess if you're looking at a contracting group, you probably do want to spend some time with them and make sure they understand the specific equipment you're using and how to aim it. Or you may potentially be able to have yourself or someone from your organization that are with them on the ground making sure that it's done right and done well. Good question.

Speaker 7:
Is there a concern somewhere of estimated tower costs or recommendation? Can I [inaudible 00:53:59]?

Speaker 1:
Oh, I don't know of one. That would be nice. Usually my experience is that it's anywhere from 800 to 2500 dollars a month for a tower, and they do often want fairly long term contracts, 3 to 5 to maybe 10 years, so that's a rough ballpark. There are sometimes some startup fees, the next

step here is you fill out a tower application, and they're gonna want to know everything you're going to put on the tower, all the lines that you'll run to the tower, whether or not you want to use their battery backup or generator system if they have one, and how much power you'll be using, although you'll be paying for that directly. And they'll want to know everything about the antennas you put up, their size, their weight, the direction that they'll be aiming, what type of mounts you'll use on the tower. So they really are gonna want a pretty thorough application, and then once you've submitted that application, they may come back and say hey, we need to do a structural analysis to make sure this tower can support what you're doing, and you will of course have to pay for that, and that's usually around 2500 to 4000 dollars or something.

Speaker 1:
They'll usually take care of having that done, but they'll bill you for it. So if you've made it to this point, and you've got the tower application, and they're going to allow you to do it, the next thing to do is to find a contractor, an electrical contractor that'll come in and install the electrical for you, that probably does have to be done by a contractor. Just for permitting, the power company will want to come in and inspect it before they actually turn it on, and they will get very mad at you if you didn't use a certified electrician, so unless you are a master electrician in your area, at least in the US, you probably will have to contract out the electrical part. And then if you get to that point, that's when you can then start installing equipment on the tower.

Speaker 1:
So it is a pretty long and involved and difficult process, but you know, sometimes this is the only way, or a really great way to get service out into the community. A couple of other things to note, there are some regulations in the US requiring cell phone companies to allow co-location on their towers. So even if Verizon for example owns the tower, they are required to at least put forth some good faith effort to allowing you to add equipment to their tower, even if you will be competing with them. They may drag their feet, it may take 18 months, but they are required to do it. So you know, don't let them brush you off if you really need that tower.

Speaker 14:
So how selective are they? Is it like if you wanted to pay them money and put big googly eyes over something, can you do that, or like a weird science experiment or something? Like how much do they want to make sure that you're doing something ISP-related?

Speaker 1:
I don't think they care. As long as it passes the structural, it's not gonna blow the tower over. There may be city regulations for aesthetics, which actually I should talk about that, so there may be some municipality regulations for aesthetics that you have to abide by, but other than that, the tower company will take your money, as long as it's not gonna hurt the tower. But that is a good point to talk about aesthetics, if you go to a tower and you're looking at it, sometimes you'll see a tower that is made to look like a tree, I think we've all seen those. Also sometimes you'll see one that has kind of a fiberglass covering around the equipment, so it looks just like, I wonder if I can find it ... there's one.

Speaker 1:
So there's a lot of different ways that tower equipment, sometimes even you'll see a church, and it'll have this massive steeple in front, and oh yeah, cactus. If you see that, it's probably not because the tower company did it out of the goodness of their heart. It's probably because the city requires it, and so you'll probably have to do the same thing. That can be really difficult and expensive too, so if you see a tower that has these stealth features built in, kind of be wary that you're probably gonna have to do something similar.

Speaker 15:
Do those impact signal strength?

Speaker 1:
Yeah, question, so does the fiberglass covering impact signal strength if you're trying to shoot through it? It does, it can. What I understand is it can be as low as like a dB or two loss, which you have to account for, but maybe can still be manageable for what you're trying to do. But yeah, it can impact that.

Deborah:
So how about getting the fiber to the tower? Is it always there? I mean, you know.

Speaker 1:
Okay, so the question is, how about getting fiber or whatever service to the tower. Is it already there or how do you go about doing that? So it really is like any other location, it's somewhat more likely that there has been fiber run to the tower because if there's another provider there, they may have required fiber to be there, and you may be able to also lease it. But it's just as useful and often cheaper and better for what you're trying to do to just use a point-to-point wireless connection to get your service to the tower, and then also go out so you're not paying for that fiber lease. If you already have a fiber connection within line of sight of that tower, it's probably cheaper just to feed it that way rather than buying a new fiber connection.

Speaker 7:
So what's the security story with the ground equipment? Like do they typically, once you're [inaudible 00:59:51] do they just like give you a key to a padlock? Or are there security cameras typically, or like barbed wire?

Speaker 1:
Good question, so the question is, how secure is the ground facility? And it does vary, usually there's at least a fence. A lot of time, either they will give you the code to the gate key, or sometimes they'll just have you loop your padlock through the other padlock so that everybody has their own padlock. And in denser urban areas, they might have more physical security, but they're not tremendously secure. I haven't often seen security cameras, unless they were put in there by them. A lot of times the cell phone companies will actually build a hut, like almost a

shed, where their equipment is secured, and those are fairly secure locations, big metal doors and solid construction. But as far as just getting into the facility itself, usually it's just a fence.

Deborah:
Five minutes, or a couple more questions.

Speaker 1:
Okay. Five minutes for a few more questions about commercial towers? Was there anything I missed? I think I haven't.

Speaker 14:
So how much would it cost in total to get it up and running to that point? I know you said you got to analysis, that would cost you three grand, and then to install it and everything, on average?

Speaker 1:
Yeah. So question is, ultimately how much does it end up costing to get yourself on a tower? And so I would say the startup, just getting to the point where you can get on the tower will range anywhere from maybe 1500 dollars to 7000 dollars depending on what they require, and then again, most likely you'll end up spending 800 to 2500 a month to lease the tower space. Any other questions?

Deborah:
So normally they're dealing with a business, so is there any way that you ... is it a problem just as a regular person, or is it that you always have to have some sort of legal entity to be able to engage in these agreements?

Speaker 1:
The question is, they're accustomed to dealing with businesses, so can you engage with them as an individual, or do you have to have some kind of legal business entity? And I think the primary answer to that question is that they do usually require a pretty high amount of insurance before you can engage with them. Whether or not they actually require a business entity, I don't know that they necessarily do, so it may be possible if you are contracting all of the labor to engage with them as an individual with letting them know ahead of time that you're using a contractor to do the actual build, and that the contractor will carry the insurance, that may be possible, I haven't personally tried it.

Deborah:
All right, you want to go ahead and break for lunch?

Speaker 1:
All right. Lunch time.

Deborah:

Let's break for lunch and we'll see everybody back at 1.

Radio equipment in an Althea network

Lecturer:
... talk about RF chat ... How RF works, how we build networks with it and some basics of channel planning and building networks with wireless links. I've got a bunch of slides on that. I think we will skip around in them a little bit because there's probably more than we can or need to cover in the next hour and a half. Then we've got some hands-on stuff where we're going to build our network here, get our Barbie internet service and then practice with some cable crimping and some hands-on stuff, see how that works and move from there.

Lecturer:
Cool. Okay. Jumping right in then, let's talk a little bit about RF. RF comes in, like we mentioned earlier, all the networks don't have to be wireless networks. There's no requirement or probably even really recommendation that they necessarily be wireless networks other than just that in a lot of cases that's the easiest and fastest way to get started with a wired network, you have to start tearing up streets and laying cable and doing all that, that's expensive and difficult and not what most of us are probably going to be doing immediately.

Lecturer:
Building a wireless network is the fastest way to get started, get building a network, expand it into communities and be able to provide service.

Lecturer:
With that in mind, we'll talk about some of how that works and how we build these networks. I guess just to get started, this is a little wireless radio. There's another one in the back of the room there. If you're not familiar with these, these are made by a company called Ubiquiti. They are primarily for building this type of network. They're used in a lot of different ways but one of their primary uses is to build wireless internet networks. The idea for these is that you point these two devices right at each other and then you get a connection between them that could, in theory, have something like a few hundred megabits of throughput.

Participant:
What is the device called?

Lecturer:
This this particular model is a Nanobeam. Ubiquiti makes a lot of different devices with a lot of different model names that I can't ever really remember but-

Participant:
[inaudible 00:02:28]

Lecturer:

What's that? You got it? Okay. There you go. I'm going to rely on you. I know a lot of them but they have a lot ... Their most recent product line is based on five AC WiFi, so it's 5 gigahertz stuff based on AC WiFi width and then Ubiquiti has some of their own tweaks. If you're using all Ubiquiti equipment, you can use some of their enhancements to the protocol to make the devices work a little bit better with each other although they are backwards compatible with WiFi. You could, in theory, connect a regular WiFi device of any kind up to one of these, it just wouldn't have all of the extra Ubiquiti specific enhancements.

Lecturer:
In this situation where we have one device pointing at one device like this, we call this a Point-To-Point Connection. These devices are only talking to each other so this is I could have my internet connection here and I could have a customer over there but there's also this situation where you have a point to multi-point connection. That means I put an access point up here that covers a specific area and then I can have multiple devices connecting back to this device. I probably would not use this specific Nanobeam in that situation, there's other models of radio that are more designed for that. We'll talk about that a little bit in the slides, but that's what I would do if I have my data center here, put some access points up on the top and then connect multiple customers or multiple other connections back to each of those access points.

Lecturer:
Any questions on any of that so far? Cool. Okay. Try to breeze through, I think for me personally, it's helpful to understand at least at a high level some of the terminology discussing Wireless and RF so that we are all speaking the same language. I'm going to run through that quickly and then we'll get into how to plan these networks and how to build them and how to troubleshoot them. I think we have until a quarter to two, right?

Lecturer:
I can keep track.

Speaker 3:
Yeah, quarter three.

Lecturer:
Quarter to three? All right. Okay.

Speaker 3:
Yeah, [inaudible 00:04:41]. Yeah, perfect.

Lecturer:
Okay. Cool.

Speaker 3:
Gives you some time.

Lecturer:
Cool. Okay. Where is my monitor? There we go.

Lecturer:
All right. RF stands for Radio Frequency. RF is part of the electromagnetic spectrum. Visible light is also part of the electromagnetic spectrum and other things like x-rays and gamma rays and things that we've heard of. We're going to talk about some of the ways we measure and talk about radio frequency.

Lecturer:
Frequency just means how often something happens per second. This little graph explains it nicely. The RF wave, one of its properties is how often it oscillate per second and that's measured in hertz, abbreviated Hz. We'll get the end of that.

Lecturer:
Wavelength is another ... Basically just another way to measure hertz which is really just the distance between the peaks of the wave. We hear that commonly but it's just another way of measuring an RF signal and the wavelength of the signal is correlated with the size of the antennas. There's some relationship there if you understand that and then look at the antenna there's a relationship.

Lecturer:
The wavelengths that were mostly talking about most of wireless internet networks today are built primarily using frequency in this range, 5800 Mhz. Megahertz meaning millions of times per second. This is also described as 5.8 gigahertz, 5.8 billions of times per second. The reason is there's a chunk of spectrum around this area that's been set aside by the FCC and other governing bodies to be open to use for this kind of thing with few regulations. I can put one of these up on my roof or up on a tower, I don't have to tell the FCC that I'm doing that. I don't have to buy a license. As long as I'm operating within the specs that this thing has and I'm not adding an amplifier to it or something, I can just use that without any extra permission from the FCC or for the most part, similarly in outside the U.S. with other countries' governing bodies in those similar bands.

Lecturer:
That's why this band is so useful and so commonly used. Some of these others have similar properties and are also commonly used, 900 megahertz can be used that way, 2.4 which is the original WiFi band can be used that way and recently, there's been a lot of work in the 60 gigahertz band which also is similarly licensed or unlicensed and easy to use. Each of these have some different properties that can be used differently.

Lecturer:
Questions so far?

Participant:
I don't know [inaudible 00:07:51] have some of experience with this but if you're going got long distance, the 2.4 is better from what I understand?

Lecturer:
From a strictly RF perspective, yes. Yeah, from strictly just the way the radiofrequency transmits through the air, the lower frequencies will go farther. There's a couple of other things that come into play there though. One of them is that 2.4 and 900 tend to be a lot noisier, there's a lot of other stuff operating those bands. Even though the signal propagates farther, there's a lot of other noise and that might make it just as hard or even harder to get that link to work well as if you were just using the 5 gigahertz.

Participant:
Okay. If you're in an environment where you didn't have that density of other connective ... or whatever [inaudible 00:08:46] using that, if you didn't have that kind of a density you would over the 2.4?

Lecturer:
Yes. The one other catch though is that there's a lot more spectrum available in the 5.8 gigahertz band and with more spectrum you can get more throughput. Depending on how much throughput you're trying to get, you might even still be able to get more throughput at the same distance with a 5.8 gigahertz link versus similar 2.4 gigahertz link.

Lecturer:
There's some other things going to play there but it is true that if you're strictly going for distance you don't have a lot of noise and you don't have really high throughput requirements, 2.4 is probably going to be better.

Participant:
Where would you cap it? Where you say high throughput requirements, what do you do?

Lecturer:
A 2.4 gigahertz link, if you don't have a lot of other noise ... Let's see. I'm trying to think of what products are available in market right now. If you need more than about a few dozen megabits or maybe 100 megabits, you're probably going to be looking at more like a 5.8 gigahertz link. Depends on your situation but probably.

Lecturer:
A good question.

Participant:
[inaudible 00:10:05] in a rural environment.

Lecturer:
Yeah. Yeah, how long distance is?

Participant:
Let's see. I don't know. Miles. Let's say 10, 15 miles long.

Lecturer:
Even at 10 or 15 miles, even just because of the products that are available, 5.8 is probably still going to end up being what you use just because there's a lot more products available, a lot more spectrum available but you can check out what's available and see what works for you.

Participant:
What's the 60 is used for?

Lecturer:
Sixty is used for really, really short links. The interesting thing about 60 gigahertz is that it has a very, very short propagation which in some cases is obviously a downside but in a lot of cases is actually an upside. The reason is once you start getting really dense deployments like inside of a city or a dense suburb, you will become your own worst enemy. You will become your own worst interferer. Each of your customers adds interference to the neighborhood and you are dealing with all of that and have to make all these links work.

Lecturer:
The problem with 900 megahertz is it goes forever and so you can be 10 miles that way with your tower and it's interfering with your tower over here because it just goes through the trees, it goes through everything.

Lecturer:
The great thing about 60, 60 has this interesting property where it's right at a wavelength that the air really interferes with it, it's called Oxygen Absorption, and so 60 gigahertz has much lower propagation distance than even 70 gigahertz, which is also open for use in this band.

Lecturer:
If you're doing a really dense deployment inside of a city center or inside of a dense neighborhood and going just a few hundred feet on each wireless link, 60 gigahertz is great because you can reuse it everywhere and they won't interfere with each other.

Participant:
Does the Nanobeams do that?

Lecturer:

The Nanobeams do not do 60 gigahertz. Ubiquiti, somebody correct me if I'm wrong, but I don't think Ubiquiti has a 60 gigahertz product yet. There are other, we mentioned earlier. MikroTik has a 60 gigahertz product called the Wireless Wire. It's a pretty great product. It's 200 bucks and it's a Gigabit link that'll go up to 200 meters or something.

Participant:
Yeah, Ubiquiti has a 200 ... They have a 24.

Lecturer:
Yeah, Ubiquiti has a 24. Yeah, yup.

Participant:
But that's strictly [crosstalk 00:12:31].

Lecturer:
Yeah, strictly on the site. 900 megahertz is the only one on here where you might consider an online off site shots and it's only going to be really low bandwidth. Yeah.

Participant:
If I connected this to antenna to my computer, what would I see? Would it be transparent to my wired [inaudible 00:12:52] interface?

Lecturer:
You would connect to it with your wireless just like you were connecting to WiFi. If you were going to try to connect directly to this thing, you would just see an SSID and you could connect to it.

Participant:
Okay, so it is USB?

Lecturer:
I'm sorry. I thought you meant if you were connecting wirelessly to it. No, this has Ethernet coming out of it and so you would connect Ethernet and then it has-

Participant:
It sounds like it's between Ethernet and [inaudible 00:13:16]?

Lecturer:
Right, exactly. Yeah, that's a good point. The question is how do you connect to this and how do you get throughput to it?

Lecturer:

This acts as a wireless bridge. It takes Ethernet in one side, regular wired Ethernet, and bridges all of the data out the wireless interface, so data just goes back and forth.

Participant:
Yeah, I do want to add a note for Althea specific. These will be connected to the Althea router and you won't connect them with computer except maybe when you're setting it up to configure it.

Lecturer:
Right. Yeah. Yeah, and the Althea network ... Yeah, these ... The only time you really connect to it is just to set it up and test it.

Participant:
If you're in a hotel room and there's free WiFi across the way or something, couldn't you use something like that to connect to it [inaudible 00:13:59] with that?

Lecturer:
Yeah. Yeah, you could.

Participant:
Yeah, when you set one of those up you see every hot spot on the list, like every hot spot-

Lecturer:
Yeah, in that direction. Yeah.

Participant:
[inaudible 00:14:11] the pair on the other side.

Lecturer:
Yep. Yep, that's true. Moving along here a few more terms. Amplitude also defines our RF wave. Basically, the loudness of the wave is called the amplitude. That's how loud it is.

Lecturer:
Let's talk about the TX power in a minute too. We put all that together and we get this RF wave the RF wave. It's an electromagnetic wave and so it has a wave in two directions, the electrical one and the magnetic one that go in different ways. That doesn't really matter other than just maybe it's interesting, but we put all that together and we get the definition of our RF wave which is how these signals are actually propagating together.

Lecturer:
Any other questions so far? Cool. Okay.

Lecturer:

We're going to talk about quickly the dB measurement scale. A lot of stuff that you talk about with RF networks and RF planning, a lot of the things we talked about are measured in DB for various parts of the antenna and the equipment.

Lecturer:
dB stands for Decibel. We can actually measure anything with dB. I'm going to explain how it works and then we'll talk about some of the things that we use it for.

Lecturer:
We use dBs to measure stuff when we want to be able to talk about really, really big numbers and also really, really small numbers using just a small number of digits. It's a logarithmic scale that lets us measure really, really big things and really, really small things without using massive long numbers. I'm going to run through how it works quickly.

Lecturer:
The origin point is whenever you see zero dB of something, that's the same as saying one of that same thing. In our case a lot of the time we are measuring milliwatts. If I say zero dBM meaning zero dB milliwatts. That is exactly equivalent to 1 milliwatt. Everybody on board with that? Zero dBM, one milliwatt.

Lecturer:
As I go up, every 3 dB I go up, I double the thing I'm measuring. Three dBM goes from 1 milliwatt to 2 milliwatts., so it doubles. If I go up to 6, doubles again. 6 DdM is 4 milliwatts. As I keep going, it keeps doubling. 9 dBM is 8 milliwatts. 10 dBM, if I add 10 to the number of dBM I multiplied by 10 the number of milliwatts. It's basically just a different way of doing the same thing.

Lecturer:
Zero dBM is 1 milliwatt, 10 dBM is 10 milliwatts. Okay.

Participant:
Is 20 dB, 20 something?

Lecturer:
20 dB, any guesses how many milliwatts is 20 dB?

Participant:
Zero?

Participant:
Is it linearly?

Participant:

No, 100 because ...

Lecturer:
One hundred. I heard 100 over here. It is 100. Once we get to this point, they start to diverge a lot. 20 dBM is 100 milliwatts. 30 dBM is?

Participant:
A thousand.

Lecturer:
A thousand, that's right. A thousand. You can see quickly and the reason I like to point this out, 100 dBM is 10 million reason I point this out is because when you're putting one of these links up and you're at the home here and you're aiming this thing at your tower or whatever it is on the other end, the number that you see in in here that you're watching to make sure these things are aimed well is the receive signal level. That's how loud this thing can hear its partner and we measure that in dBM.

Lecturer:
It's helpful and important to remember that if you are aiming this thing and you have it at, say -57 and you can spend an extra five minutes and get it to -54, that's double the power. It's twice as good. If you can even get it 1 dB, that's significant so it's worth spending a few extra minutes.

Lecturer:
It's important to look at these things going down too. A lot of times we'll see negative dB numbers. That doesn't mean negative milliwatts, it just means less than 1 milliwatt. Going from zero to negative 3, cuts our milliwatts in half. Negative 3 dBM is half a milliwatt.

Participant:
Is it helpful to realize that this is exponential?

Lecturer:
Yeah.

Participant:
Okay. I don't know what everyone [inaudible 00:19:01] but that's what's going on here.

Lecturer:
Yeah. Yeah. Yeah, it's a logarithmic scale that just condenses the numbers into easier ones to see.

Participant:
How many negative dB is zero milliwatts?

Participant:
Yeah.

Lecturer:
Infinite. Trick question.

Participant:
Do you have a [inaudible 00:19:21] of this?

Lecturer:
I don't. It'd be good to have though, but I don't. I'm sure we can find it. Yeah, it's a linear or not an exponential graph.

Lecturer:
Same thing as we keep going down, -6 halves again. -10 divides by 10 decimates, -100 is a very, very small number.

Participant:
In case where both of your transmitter is a receiver, so I guess transceivers are within a short distance and it's pretty high, what happens in that scenario because you mentioned the way you make sure you have a perfect link or a perfect line of sight is by looking at the dBs, right?

Lecturer:
Yeah.

Participant:
What if your dB is extremely high, do most equipment provide some type of power reduction [crosstalk 00:20:22]-

Lecturer:
Good question.

Participant:
... or at that point do you just decide, "Okay. I'm just going to be a fire dB and just operate at that power."

Lecturer:
Good question. I think your question has a couple of parts here, let me make sure I'm getting it right.

Lecturer:
One part is can receiver signal be too loud and is that a problem?

Participant:
Yeah.

Lecturer:
Right? Then the other question is, what do you do in that case?

Participant:
Yup.

Lecturer:
Good question. Let me start by saying a common scenario like this radio, I think these are broadcast at 7 dB. Do you guys remember I think it's around 7dB. That's how loud this one is talking and the other side, even if you're only, say, you're a half a mile away, you might be receiving at like -40 dB. If you look at this scale 7 down to -40 has a big difference. These things lose a lot of signal going over the air. That's okay. That's the way that they're designed to work, -40 is actually pretty good. They're designed to work down to maybe -80. They'll still connect at -80. It won't be a very solid connection but they'll connect. That's the range that they work at.

Lecturer:
Where it comes into your question, if I'm right here and I'm looking at this and I'm looking the receive signal level, if it's hotter than about -30, if it's louder than about -30, that's too loud and the connection will actually start to suffer, which is I think part of your question.

Lecturer:
In fact, I have a slide about that at some point but anyway, at that point what you would want to do is turn the other side down so that this side isn't hearing it quite so loud. You can do that. they can be turned all the way down to, I think, -4 dBM transmit power which would let us, even at this distance, they should be able to talk without being too loud for each other.

Lecturer:
Does that answer your question?

Participant:
Is it common for antennas like this one to regulate the power? To rebate [inaudible 00:22:31] consumption or maybe interference?

Lecturer:
Yeah, these radios do have a feature that, I think I have a slide on called Automatic Power Control that will ... Basically you set a target, you say, "This is where I want my receive signal level to be," and if it's louder than that they'll turn themselves down until they hit that, will try to hit that.

Lecturer:

Not all radios have that but Ubiquiti does have that feature and a lot of radios have that feature.

Lecturer:
This is just a quick visualization of that same thing. Piece of paper, 0.0001 meters tall. Anybody recognize that building?

Speaker 3:
Burj Khalifa.

Lecturer:
Yeah, Burj ... Yeah, 828 meters tall. If we tried to measure these in meters or centimeters, you can see that regardless of how we do it it's hard to measure both of them in ways that are compatible but if we use dB, it gets a little bit easier. It's just a little visualization of why dB is handy rather than just using milliwatts.

Lecturer:
Cool. Okay. Everybody good with that. We move on to a little bit different topic.

Lecturer:
Okay. Let's quickly talk about a radio and its components. All of the different stuff that is inside here that is part of this network. When I say radio, what I mean is the part of the device that is actually creating or receiving the RF signals, the part that's actually modulating the data onto a radio frequency network.

Lecturer:
In this case, you're seeing the whole ... Everything is contained inside this little unit.

Participant:
Quick question. These slides are available after?

Lecturer:
They could be, yeah. Yeah. Yeah. They're being recorded and I think that will be distributed.

Participant:
Okay.

Speaker 3:
Yeah, yeah, yeah. They're being recorded but maybe we can also get your slides as well.

Lecturer:
Sure, yeah.

Lecturer:

What I'm describing here is all contained inside this unit. We can't really see it as components inside this unit but they're still in there somewhere. We'll get that.

Lecturer:
We have a radio, that's what generates our signal. When we say transmit power, what we're saying is how much power is this radio generating, how much energy is it generating and sending out on the wire. There is a cable in there. That cable is important because it can introduce some loss so it's important to keep it in mind. We probably don't have to worry about it too much but there is a cable. Then there's what we call a Driven Element and it's just going to be a little piece of metal in here. That's what actually sends out the signal onto the air. These are probably driven elements. There's some metal in there and that's where the signal actually exits and goes out into the room. The radio that generates the signal is inside but these are the driven elements.

Lecturer:
This one has one built into it somewhere too and this one has it built in. Those are component ... Then there's also a reflector. The reflector ... I wish we had a light beam or something. The reflector you can think of satellite T.V. antenna. The signal comes in. The big dish on the back of the satellite T.V., the dish part is a reflector. It's not active. It's not powered at all. It's not generating any energy or even really receiving any energy. All it's doing is basically acting as a mirror to bounce that energy back into the element that receives the signal. It's kind of a magnifying glass, takes it in and focuses it in one direction.

Lecturer:
Most antennas, especially ones that we work with including these ones, have some kind of a reflector inside of them that directs the energy in the direction that they want. They're directional. This this device is sending more energy straight forward than out the sides and the reason it's doing that is because of because of the reflector that's built in.

Lecturer:
Questions on that? Cool.

Speaker 3:
Maybe some of the Ubiquiti gear on the radio is like a separate piece and some of it is integrated. I don't know if you-

Lecturer:
Yeah, I actually ... Oh, I think actually the next slide has a breakout of them so we'll see that. The next quick thing I wanted to point out is that most modern wireless radios for this type of application including these ones will have at least two and sometimes more radios, that's called my MIMO. Maybe you've heard of my MIMO, multi and multiple out?

Lecturer:

It's a way to increase the throughput on the link and the way that they do it is by adding multiple antennas in different polarities, different directions and then sending data across multiple polarities. We don't have to get too much into that other than just basically to understand when you hear MIMO, what that means is that each device has multiple radios in it, that different radios are each transmitting and receiving separately and that's a way to get more throughput across the channel.

Participant:
Does one radio handle 2.4 and 5 gigahertz?

Lecturer:
With these radios, typically not. These are 5 gigahertz only radios. It would potentially be possible to make a radio that did but you probably lose some efficiency that way so usually they're a little more specific.

Lecturer:
Good question.

Lecturer:
Some real examples of radio and antenna components. This one I put on here, this is a pretty old style of antenna I think was maybe a Wimax antenna but it's something I've had for a long time but I put it on here because it shows separately the antenna which is this panel on the back. It's a flat panel antenna. It has the cable, which is the other component that is important. It introduces some loss into the scenario and then it has the radio separate. It's nice to see them all separated out.

Lecturer:
Here's another similar one, a little bit hard to break down but it's got the big reflector cable coming off the side back here and off the bottom. This actually has two like in the last example, and then the radios are all inside this device here.

Lecturer:
Then Ubiquiti one, this is what everyone was asking but this is another Ubiquiti product called a LiteBeam. Ubiquiti products are great. Everything comes in a box and they fit together nicely and for in a lot of ways is really great. This is the reflector, in this particular situation and everything else is built into this. All this stuff is just for mounting it on the pole.

Lecturer:
Questions?

Participant:
My question is more for the Althea Team. I. just wondering if all of your hardware is outdoor rated? Do you guys look into that or you just ...

Speaker 3:
Yeah, we mostly just been using Ubiquiti gear this LiteBeams. You'll see the LiteBeams in the pictures at [inaudible 00:30:07]. That's all outdoor rated. The only thing that I probably have is not is the little antenna that we made.

Participant:
Is directional gear preferable for mesh applications?

Lecturer:
Good question. The question is, is directional gear preferable from Mesh applications? I would say yes, but there might be situations where you would want something less directional. In general, directional gear will always give you a healthier wireless connection with less noise, less interference and better throughput.

Lecturer:
The hard part about directional gear is that it's directional and you have to aim it and you have to aim both sides at each other. It can be harder to build in a mesh system where every time you add a note to the mesh you then have to go back and aim stuff, but I would say is more performing when you do it that way.

Participant:
It's all about the compound chances of packet loss, directional antennas have lower packet loss and the more hops you can go without packet loss the higher throughput so it's better to aim?

Lecturer:
Yeah.

Participant:
Yeah. There's something coming out the gain electronically at the wireless devices at some extent.

Lecturer:
Yeah?

Participant:
When there is a gear similar to, I don't know, this Linksys router that's sitting on that desk. This hardware, I can imagine, it uses some phased-related tricks to direct the where is listening from.

Lecturer:
Yeah.

Participant:

Is it also worth it to apply something like this with antenna arrays to mesh applications?

Lecturer:
Yeah. The question is phased arrays which are used in these MIMO applications, is it useful to use that in building these larger networks? Is that right? Is that the question?

Participant:
Yeah.

Lecturer:
Yeah. The answer is yes. Actually, these radios have some of that built-in, the wireless wires that we just mentioned, have some of that built-in. That's becoming more common and newer radio hardware will certainly contain even more of that. Yeah, I think that that's important. It probably doesn't totally replace aiming, at least not yet, but certainly helps. Good question.

Lecturer:
Okay. TX Power. We mentioned TX Power a little bit when you're planning wireless networks and deciding how to hook up a customer or hook up a site to a site. One of the first things you look at is how loud do your radios need to talk to be able to hear each other. We call that TX Power. As we've already discussed, that's measured in dDM or decibel-milliwatts. The FCC does set limits how loud your equipment can talk. These radios won't let you broadcast louder than the FCC limits or if they're in another country, you set the country code and then it limits it that way but whenever possible we want to talk as quietly as possible so that we're not interfering with ourselves.

Lecturer:
This is more just a terminology thing. TX power, if you hear that or see that all that means is how loud is my antenna talking? How much energy is a sending out?

Lecturer:
Opposite of that I think is the next slide is RX Power or ... There's a couple of different names for it. RSSI is one name we see a lot, receive some things ... I don't remember.

Participant:
Receive signal strength indicator.

Lecturer:
Yeah, receive signal strength indicator. There you go. RSSI is sometimes called RX or RSL receive signal level. What that means is how loud ... If I'm here, that's how loud this radio can hear that radio. This is the important number to watch when you're aiming to make sure that these devices are lined up. That's the number that you're going to be optimizing and you want it as ... It will usually be a negative number and you want it as high or as close to zero as possible.

Lecturer:
Skip that. Questions about that? Okay, cool.

Lecturer:
Okay. We talked a little bit about the reflectors that goals and antennas. That when an antenna focuses energy in that way that's called Gain.

Lecturer:
We take our regular antenna without any reflector on it and it broadcasts and receive in a certain way. We add a reflector on it and that focuses the energy better, that's called adding gain to the system. If we have an antenna without any gain, literally zero gain, that's called an isotropic antenna. It's not actually physically possible to build one like that but it's a mathematical theory that they exist. We can compare things to them. We imagine it being like the sun and that is broadcast roughly equally in all directions. Then as we add gain, that focuses the energy coming out of that thing in one direction.

Lecturer:
Another example with a light bulb. We have our antenna broadcasting out in all directions but if we want our signal to just go more specifically in one direction, we can add a mirror. That's similar too in the radios adding a larger dish on the back to focus the energy in one direction.

Lecturer:
Yeah?

Participant:
Why would we care about that? Is the equipment come pre-configured or are we able to change the size of the input?

Lecturer:
It does mostly come pre-configured. It's a fair question. Why do we care about that is the question. The reason is so that when you're looking at the five different models that Ubiquiti offers and you're wondering which one to buy, you can look at the gain because they'll tell you how much gain they have and understand which one is better for your application. That's the reason.

Lecturer:
Because like this, these devices have pretty low gain. Ubiquiti has another one that has pretty similar performance properties other than it has a bigger dish, that's higher gain, and might be better for some applications. That's why.

Lecturer:
That make sense?

Participant:
Is there a rocket dish?

Lecturer:
Yeah, there's a rocket dish that's a really big one. There's a LiteBeam that's a smaller one, still sort of big. There's a variety of different sector antennas that have different amounts of gain.

Speaker 3:
Yeah, even this model comes in a couple different ...

Lecturer:
Yeah, even this. Yeah.

Speaker 3:
Yeah. Same models, different gains.

Lecturer:
Mm-hmm (affirmative). Yup.

Participant:
Do anything that [inaudible 00:37:17] when we say scenario is besides distance, what other ... You said Ubiquiti have five different models, works in different scenarios. Besides distance, what other scenario would this [inaudible 00:37:29]?

Lecturer:
Distance is probably the main one. The next one would be for point-to-multipoint. How big of an area is it going to cover? If I say, I'm putting a tower right here and I want to cover 90 degrees then I have a variety of different options to cover that 90 degrees off the tower or maybe I only want to cover 60 degrees, I have a couple of different options for that. It's always a trade-off between gain and distance versus degrees covered. That's the other scenario. Yeah. Yeah.

Participant:
This is related to trigger section of ... Do you happen to know why the FCC decided to make 2.4 available? I think it's roughly the frequency at which water resonates. That's to me, intuitively, it seems that it is not preferable to use that frequency because water and water-based than water-based life-forms absorb that.

Lecturer:
Yeah, and you have stumbled on a reason why the FCC let everybody use it. The reason is that it's in using microwaves which is because its resonant frequency of water, and so nobody wanted it. The FCC, "Go ahead and use it because nobody wants it."

Participant:

Is that also why 60 is used for the [inaudible 00:38:48] absorption?

Lecturer:
Yeah. That's also why nobody ... Yeah.

Participant:
What's the 5.8?

Lecturer:
5.8-

Participant:
Double the frequency of water which effectively-

Participant:
Okay.

Participant:
... the same.

Lecturer:
Yeah. Yeah.

Participant:
[inaudible 00:39:01] harmonic theory of [inaudible 00:39:03].

Lecturer:
Good questions. I also had a just an example with those flashlights that you twist and they get brighter but narrower versus broader and less bright, that's another example of gain but this may be helpful in visualizing adding gain.

Participant:
I don't know if this is going to have a new one but I want to say this very cool metaphor of gain which is basically a balloon which you can squeeze. You have a finite amount of balloon but if you squeeze it from top and bottom, you can shape it into reaching farther out or maybe in some certain direction. That's my understanding of how this works maybe that helps.

Lecturer:
Yeah. Yup. Some quick usage scenarios. We talked about this just a little bit back here but these are towers. We've probably all seen towers that looked like this driving down the freeway. These antennas up at the top, these are point to multi-point antennas. These are the type of antennas that your cell phone is connecting to probably right now. it's something that looks like that and has similar properties to an antenna like that.

Lecturer:
These types of antennas ... They're called sectors and they're designed to cover kind of a pizza slice coming off the tower. It could be like 60 degrees, could be 90 degrees, could be 120 degrees and they're designed to cover that whole section and anything in that section anybody cell phone or whatever that connects is going to connect up to connect up to one of those.

Lecturer:
For example you see in here, it looks like there's three of these mounts hanging off the tower, each of them might be designed to cover a 120 degrees giving full 360-degree coverage around the tower. That's an example. Those are going to be not super high but not super low gain. They're going to be medium gain antennas.

Participant:
What about the vertical?

Lecturer:
Good question. The vertical ... Yeah, the question is ... Horizontally they cover section, vertically what do they cover? Each antenna has somewhat different vertical properties. You can usually find it in the specs of the antenna. Something like this, a lot of times it's 15 degrees or so vertically and so they aim it to try to have that hit the ground where they want to cover. Yeah, that's a good question.

Participant:
Looks like these four covering each 120 degree sector?

Lecturer:
Mm-hmm (affirmative).

Participant:
Why four or why more than one?

Lecturer:
Yeah. Yeah. Good question. The high-level reasons is capacity. One isn't enough. Mechanically, how exactly that works? I don't know. It probably just depends on the tower and who engineered it. It could be that each one is covering a slightly different vertical chunk and splitting them up that way. It probably more likely they're all covering the same chunk but on different frequencies so they have blanket coverage on all frequencies in the band across all four.

Participant:
Is distance the only thing that gain commutes or is there something like penetration signal strength also?

Lecturer:
Yeah, so gain as signal strength. You can use that however you'd like. If you are going to try to blast through some trees, which I don't suggest but you're welcome to try it, then the more gain you can get the better. Interestingly, adding gain adds directionality to the signal which means it goes farther. It also cuts out noise because gain actually works in both directions.

Lecturer:
If I add gain to my signal so that it's going all directly in that direction, that equally has the impact that I hear from specifically that direction more. That makes sense? The gain really works in both directions; both hearing and sending. It also has the impact of, I hear more from that direction then I hear less from over here.

Lecturer:
In a noisy environment, the ideal thing to do is to use a high of gain antennas as you can. The reason is so that then you can turn down the transmit power on your radios as low as possible so that you're emitting very little noise into the environment. Because you have high gain antennas, you're not taking noise from these other places. Your radios can operate efficiently even at really, really low transmit power.

Participant:
I have a question about planning because I guess for us, we will not just go and buy an equipment first and then try to prevent this whole [inaudible 00:43:49] one that as $8,000 or $500 cheaper and do the same thing. How do we do planning? How do we decide if we want to provide services X distance away? What would be the ideal?

Lecturer:
Yeah. Let me see where I've got that. As it happens ... They're right here. To do that you use what's called a link budget. You can do this mechanically. In fact, if you Google link budget planner, you'll get a bunch of different things showing you calculators to do it. The way that that works is you take all the properties we've just talked about; the transmit power on one side, the receive power on the other side, the gain of each antenna, the cable loss if there's a cable involved. You add all that together. It also depends on the distance between the two, the frequency that you're using and any other lost you might need to count for like if you're in a heavy rain area, you try to account for the rain. You add and subtract all that together. That gives you your expected receive signal level.

Lecturer:
In fact, I think I have ... This links to a calculator but I can't ... I don't know if I can get to it. I have to pull it up later. Yeah, that gives you your expected receive signal level. Then ... yeah.

Participant:

On that specific [inaudible 00:45:35] rain and we talked about what volume, did the humidity might help? Like the difference between Salt Lake City and New Orleans, would you give the broadcast because you're like 15% humidity consistently versus 80%?

Lecturer:
Right. It's a good question. I don't think it does enough except for maybe in really high bands you have to account for it, but it certainly wouldn't hurt to account for it. it's probably like a dB or something off so that ... But yeah, it's a good question. Yeah?

Participant:
My question, the original question is, is there any tool that we aware that we can use for designing and planning like something cheap where you know someone can be at one end and at another end and then we can see how strong the signal is or service? Have you come across anything like that?

Lecturer:
Yeah. I think I meant to actually follow up with that. The antenna manufacturers will provide ... In most cases, they'll provide a table that shows at this received signal level, you can expect to have this throughput rate. Ubiquiti for example on the website and in the statistics for each radio, they have that published so you can say, "Okay. I did my math. I know I should have a -67 received signal level so I should expect this throughput rate." That helps, I think, with what you're getting at.

Lecturer:
The other thing is, these will tell you when you're at one side one and one of other you can log into them, and we're actually going to do an exercise on that a little bit, they show all of that information in here. If you're actually there physically doing it, you can pretty easily get all the information. Does that answer your question?

Participant:
Then Ubiquiti has an actual descriptive tool where you can place the antennas, [inaudible 00:47:20] using distance, this is the height, it'll give you a theoretical-

Lecturer:
Yeah, it is free.

Participant:
It is free. All right, okay. Things called airView?

Speaker 3:
[inaudible 00:47:31] Ubnt.com.

Lecturer:

Yeah. airView, I think, is their spectrum analyzer, yeah.

Speaker 3:
Link.ubnt.com.

Lecturer:
Link.ubnt.com.

Speaker 3:
Yes.

Participant:
Just make sure you repeat the question on the mic.

Lecturer:
Oh, yeah. Yeah. Yeah, thanks. Is there-

Participant:
Yeah, the same thing.

Lecturer:
Okay, same thing. Okay. The question for posterity is basically how do we ... Is there a free or inexpensive tool for link planning and understanding ahead of time what kind of equipment you'll need so that you don't have to figure out when you're there, right?

Participant:
From previous slide, what was the difference between the drum antennas versus the ...

Lecturer:
Oh, yeah. Yeah. Let me get back to that. Let's go ahead to that. This slide, right? We've talked about these antennas. These drum antennas are going to be really, really high gain antennas. This situation again is for typically point-to-multipoint. I'm putting my equipment at a tower or at building or whatever and I'm going to ... Multiple of my customers are going to connect back to that antenna.

Lecturer:
This type of antenna is a really high gain antenna. There's probably another one just like it on the other side and they're pointed right at each other and they're a point-to-point connection. That connection, you really just want them to be as high gain as possible because like I said, you want all of the energy from one going to the other and as little as possible going anywhere else. Whenever you see those, that's probably what that is.

Participant:

What do you think is the hardest thing to debug when ... To troubleshoot and setting up a wireless mesh?

Lecturer:
The hardest thing is when the numbers say you should have X throughput and you have less than that and you don't know why.

Participant:
You have to go through the whole stack in order to find.

Lecturer:
Yeah. Yeah.

Participant:
The drums aren't using like eight to 11, they're ... At what-

Lecturer:
No, these are ... I don't know what these are. I just pull them examples out of the ... They're probably something that's licensed, FCC licensed. Yeah. They are examples of high gain antenna or something.

Lecturer:
Are there any other hands? Cool. Okay, let me see where we were.

Lecturer:
I wanted to show this. This is a radiation pattern. I think this is for Ubiquiti product called the LiteBeam. What we're looking at here is a top -down view of the strength of this signal at different angles coming off of that antenna.

Lecturer:
If you imagine we're looking down at an antenna like this, that big lobe off the front is straight off the front, that's where most of the energy is coming out. Then there's these little side things where some of the energy comes out and then a little blip off the back.

Lecturer:
Most antennas that you'll look at including all the Ubiquiti products have these published. Can be useful if you're trying to plan a really dense deployment and you want to make sure these things aren't stepping on each other. If you are in a sparse rural environment, you probably don't need to look at things in this level of detail but if you are trying to get a really dense deployment, it's helpful to be able to look at this and see where all the energy is going especially because things like these side lobes, this amount of energy coming right off the side, you might not expect that if you didn't look at the didn't look at the radiation pattern.

Lecturer:
The other reason that it's important is here. If you have two of these, I'm at this side and somebody's at that side and we're trying to aim at each other, maybe we're a long distance from each other. We can't see each other, this can be tricky getting these things aimed, can be difficult. You have one person on either side.

Lecturer:
The way that you aim this is by just moving a little bit back and forth at a time and watching the receive signal level to see when it's at its loudest point. That's the way the aim them. What can happen is you can end up in this situation where this one is aimed that way and I'm supposed to be aimed at that one and I'm stuck on this, this is called a side lobe, and I'm stuck on that. Any direction I go it gets worse but it's not aimed as well as it could be.

Lecturer:
This is something you have to watch for when aiming these big point-to-point links. It's best to do the link budget ahead of time so that you know what the receive signal level should be on either end, so that you know when you actually have it right. Otherwise you can end up operating on that side lobe and it won't work as well as they could and you may not even know.

Participant:
Gain is all nice but what we called careful renewal, this probably packet loss. Could you give us the ballpark of what good packet loss looks like? What bad packet loss looks like?

Lecturer:
Sure. Yeah, that's a good question. A good point. In a lot of ways these radios will abstract the packet loss away from you because they're doing stuff internally so that you're not going to see packet loss at even layer two because-

Participant:
Okay. It's going to get internal retries or something like that.

Lecturer:
Yeah. You may not see that but what it will give you is these. What happens is once these two are talking to each other at a pretty low level that they don't really expose very much, they will negotiate what's called MCS rates ... I'm sorry, repeat the question. Your question, what's a good level of packet loss and how does that play into the link quality, right?

Participant:
Yes.

Lecturer:

Yeah. Okay. The way that this works is ... Yeah, again, once these two are connected they will start negotiating their MCS rate. What that means is how much data do these two devices believe that they can pass between each other reliably.

Participant:
It's roughly like when you don't understand someone and ask then to repeat slower?

Lecturer:
Kind of, yeah. The way it works mechanically, I believe, is that they'll send a bunch of packets and if they get X number in a row that all passed their CRC checks, they'll bump up the rate. Then if they get packet loss, basically they get one that doesn't mingle or doesn't pass at CRC check then they bump down the MCS rate.

Participant:
It's like [inaudible 00:54:31].

Participant:
Yeah.

Lecturer:
Similar to lots of other discovery protocols.

Participant:
Is there a way to turn that to turn off retry? This is something I wanted to do a lot because I think it can handle the better that way.

Lecturer:
I don't think that there is a supported front-end visible way to do that.

Participant:
Just to address also Justin's question. This is actually not retries, it's actually how many distinct frequencies it's using to try to transmit the data.

Lecturer:
Right, that's involved here as well. The thing I was trying to drive at is each of these ... Let me back up a little bit. Each of these rates represents a different level of throughput and there's a lot that goes into the throughput. One of the things is how many of the antennas are being used. Another thing is how much spectrum is being used; 20 megahertz versus 40 megahertz. There's a coating rate which I think is refers to some forward error correction. There's the modulation type which is how the data is actually going out on the wire.

Lecturer:

These two things will try to negotiate as high as they can to be able to have as high throughput as they can with low error rates. Driving to your point, once these two things have come up and connected and maybe passed a little bit of data, they're going to settle in on an MCS rate where they're comfortable communicating. That MCS rate will report back to you what the data rate should be and that is, I think, the lowest level you can get without really breaking into the hardware that will tell you in a roundabout way the loss. It's using lost to get to that rate.

Participant:
I have a follow-up question to that. Do know of maybe dumber hardware which would maybe translate Ethernet to 11 one-to-one? My intuition for this is that for example, I'm running [inaudible 00:56:40] somewhere in the forest and want to hold the image back to my home, but with stream media you generally don't really care about losing some of the footage, you care about real time, maybe?

Lecturer:
Sure.

Participant:
Yeah, so there's that.

Lecturer:
Yeah. The question is, is there a way to not have the radios try to be smarter than they should be and just throw the raw data at you. I don't know of a way to do that. My intuition is that if you want to just using UDP rather than TCP to throw the frames, that would get you pretty close. It doesn't quite get you there but pretty close, but there could be another way.

Lecturer:
The question is, once you've got your links setup is it set it and forget it or is there maintenance like expected maintenance but also probably unexpected maintenance you have to do down the line.

Lecturer:
Yeah. Certainly you want to be watching them and make sure their performance stays consistent. Some of the things that can come up when can come up and move it, you can get around that by trying to install it better so that it's stronger against the wind but sometimes happens a tree can grow up in the way. It happens, or even the building can be built up in the way. Yeah, there's only things that happen you have to go back in.

Participant:
But it's not something that's common it's like, "Oh, I have to go [inaudible 00:57:58] every day or every week or-

Lecturer:

Right. The only thing that might be like that if you're in ... Depending on the weather environment you're in, sometimes you want to go back yearly and put some waterproof coating on it so that ice doesn't stick to it but other than that, there's not much you can do. Yeah.

Participant:
I was going to ask, the frequency was ... That was frequent. I was wondering if there was tool that will allow you ... If you had several ... I mean, one, two, three, four, five [inaudible 00:58:26] easy to do but when you got up to the 60, hundreds, is there a tool that would allow you to [inaudible 00:58:32]?

Lecturer:
Yeah. I don't know that it integrates with all Althea yet but there are a number of tools. If you're using Ubiquiti equipment they provide one called UNMS, Ubiquiti Network Management System. It's free and it does a really good job of managing Ubiquiti equipment. There are a number of others including several open source ones that can monitor any type of equipment. Yeah, there are.

Participant:
Yeah, just a note on how they use Althea. Yeah, right now we don't touch the lower layer stuff. We're handling the payments governance and routing in the networks that's all kind of about that level so you might want to use. If you have a tower with a bunch of clients you're on Althea Network, you might want to use something like that to manage them all.

Lecturer:
I think the one question we had earlier is Ken, the routing actually be built to allow them to route through but ... Weaken.

Participant:
Oh, sorry. The routing will choose the best path for Althea.

Lecturer:
I mean to be able to get from an essential NMS to the device, is their routing built up that will actually allow that?

Participant:
Not yet but it shouldn't be too hard to ... It shouldn't be too hard to do something that would let the antennas get out to Ubiquiti's Cloud management service and then you just go to Ubiquiti's website, you see all your antennas.

Participant:
Well, it's supplying internet access so you can get to any destination on internet.

Lecturer:

Right if you put them on DHP or something.

Participant:
Yeah, yeah.

Lecturer:
Yeah, We can do that later. Yeah?

Participant:
Just more thing before we [inaudible 01:00:11] aiming. IJ noticed there are dead zones in between the lobes on those point-to-point ...

Lecturer:
Let me go back to that. This one?

Participant:
Yeah. I was wondering where the sector antenna, like the multipoint ones, do they have the same lobes?

Lecturer:
Yeah. Let's see, I think I have one here. Here you go.

Participant:
Yeah, [inaudible 01:00:38] not really ...

Lecturer:
Yeah. The question is, the radiation pattern that I showed just a minute ago was for a point-to-point style high gain antenna and it had dead zones in between. There are these lobes and there's dead zones in between the lobes. Question is do commonly sector antennas have those same dead zones?

Lecturer:
Here is an example of one Ubiquiti product that is designed to be a sector and you can see, to the extent that we trust their marketing material which is these, they have pretty, nice, clean, radiation patterns.

Lecturer:
That isn't necessarily true for all antennas of this style. This antenna is also sometimes called the horn antenna. It's not very tall. It's about that tall and about that like wide.

Lecturer:

The sector antennas that are taller and thin, they often do have a little bit more the lobes with, not quite dead zones but lower zones in between the lobes. Yeah, again, you can always see those from the manufacturer and at least in this case, you can see that they're pretty clean.

Participant:
Usually aiming is done for the point-to-point?

Lecturer:
Right. I would have something like this on one end that I would need to end carefully at the sector, but the sector would stay in one spot and as you know, covering that whole area.

Lecturer:
Let me see if I have ... It's here. Let's see what I've got. Yeah, a good question. Anything else about that before I jump on?

Participant:
Yeah, I was wondering if you would explain the azimuth and elevation in those graphs and what that means?

Lecturer:
Oh, yeah. Yeah, let me go back to that. This one, right? Yeah. Okay. The question is, explain azimuth and elevation in these graphs. That's a fair question.

Lecturer:
We have four radiation patterns here. The difference is we have vertical and horizontal, that refers to the polarity so that there are two antennas inside this devise; one of them is vertically polarized and one of them is horizontally polarized. That gives us our MIMO. We talked a little bit earlier, haven't gone into it too much, but there are two antennas, both of them can broadcast and receive, one of them in the vertical plain radiofrequency and electromagnetic radiation are polarized meaning that they can come in different polarized planes. I'm not going to get into too much of that other than say that a vertically polarized signal can carry data while the horizontal carries data as well and they won't interfere with each other.

Lecturer:
We're looking at here on the top, is the azimuth radiation. Azimuth meaning my direction around the circle like this, this is my compass direction. We also have the elevation one, meaning up and down.

Lecturer:
This one, top left, is what the radiation pattern looks like looking top down this thing with the widest part of the lobe going right up the front. The one top right is what it looks like looking at it from the side, vertical. Then the bottom two are the same thing but in the horizontal polarity. Did I answer your question?

Participant:
Yeah.

Lecturer:
Anything else? Cool. Okay. I was going to show this real quick. We talked about rain fade. When we're planning networks, a lot of things plan for obviously; trees, vegetation, all kinds of stuff. One of the things we plan for is rain fade.

Lecturer:
The way mathematically to plan for that is to look at a map like this that shows basically what's the worst storm, rain storm you expect to see over, say, a 10-year period and that's going to put us in a zone with millimeters per hour of rain here at the bottom. We look here, we are in ... I don't know what the white zone is.

Participant:
It's not even covered [inaudible 01:05:08].

Lecturer:
Yeah, that's weird. I don't know why it's not colored there. We're closest to the D zone which is-

Speaker 3:
[inaudible 01:05:13].

Lecturer:
Yeah, right? Yeah.

Participant:
It's the D zone right there, it's just white.

Lecturer:
Oh, yeah. Yeah, yeah. That's D. Yeah, you're right. Okay. Good point. D zone, we're at 19 millimeters an hour. Again if you use a link budget calculator or the Ubiquiti one or any other, it will let you put in that rain fade number and then it will account for that in your link. Basically, what it's doing is saying when it's raining that heavy, you'll have a predictable amount of dB loss in between your antennas and so you want to make sure that you have that much fade margins so that when it is raining that heavily, you have enough room that your signal levels decrease but the links don't go down and they stay up at a rate that you would like.

Participant:
Is there a setting for that somewhere? Have you seen that? You just tap off the power in terms of fade [inaudible 01:06:06]?

Lecturer:
Yeah, it really just goes into the link budget when you're planning it because once it is there, you can only broadcast as loud as the FCC lets you and if the rain gives you more fade than you can deal with, then the link will go down.

Lecturer:
The question is, is there a way to have it automatically turn up the power when the rain comes and the signal starts to fade? Right, Is that your question?

Participant:
Yeah.

Lecturer:
These radios do support Ubiquiti radios and a number of others do support that, it's called ATPC, Automatic Transmission Power Control, I think, or Automatic TX Power control.

Lecturer:
The only catch is that it will only go as high as the FCC lets you. You can't go above that but it will at least turn itself down if it can so that you're not spurring as much noise out in the environment and then turn itself back up if the signal starts to fade because of the storm.

Participant:
Okay. That's great.

Lecturer:
Yeah, good question. Any other questions there?

Participant:
A question on that chat.

Lecturer:
This chart?

Participant:
Yes. That type of intermission, weather information and all of that, is this ... I mean, I'm probably testing it wrong [inaudible 01:07:20] here, but this information is widely available for most environments in the world or something similar to ... Or is it just like weather intermission layered on each other or what are we looking here? Do you have any idea?

Lecturer:
Yeah, a good question. The question is I think where does this graph come from and what does it include, I think is your question? Yeah, the answer is I don't have all the information about this

graph. Curiously, every time I Google RF raid fade, this is the graph that comes up exactly this one. I don't know who made it or why it's only this one.

Lecturer:
Presumably, you could do some research for any area and find out. What you'd be looking for is give me the heaviest rainstorm over, say, the last 10 years and I want to know the millimeters per hour of rain. Presumably, you could probably find that in publicly available weather data for any location you're curious about but this seems to do a pretty good high level job of just telling you roughly what type of area you're in. Good question.

Participant:
So the day-to-day condition is going to change? It's not going to fit exactly, that's an average of the weather pattern based on the geography.

Lecturer:
Yeah.

Participant:
You can see like in India, they have monsoon season, right? Monsoon season in India and also Japan and so there's corresponding color and wind speed or rain fade. You see like the rain forest, the tropic region. Over Brazil, over the Amazon rainforest and over Indonesia, there's similar patterns there?

Lecturer:
Mm-hmm (affirmative).

Participant:
But this is not ...

Lecturer:
This is intended to indicate worse case, like 10 year worse case. For the benefit of the mic and to answer that question, let me try to summarize.

Lecturer:
There's a couple of important points here, the question being, what happens if you go follow the FCC, right? How can you avoid that? How does Althea deal with that? How should you, as a provider, deal with that et cetera. Right, is that fair?

Lecturer:
A couple of things. One, a little bit of back story, but Ubiquiti actually got in trouble with the FCC somewhat recently for allowing people to accidentally or maybe some of them were on purpose not obey FCC limitations. Ubiquiti and I think other similar providers as well have done a lot of work to make it really difficult to accidentally do that.

Lecturer:
In fact, you have to work pretty hard to get a radio in the U.S. that will let you choose anything other than U.S. It's not really as easy as a fat finger, at least with Ubiquiti and with other ones that I've used as well. At least in the U.S. and with somewhat normal level of trying to stay on the right side of the line, it will be pretty difficult to really accidentally be broadcasting on a channel not allowed by the FCC. Similar with the power level, they pretty tightly regulate the power level and won't go over that.

Lecturer:
If you're just concerned about it accidentally happening,, it's probably not going to happen. You really have to try to do that. I guess that answers your question.

Participant:
If I am to set up a wireless mesh while I look at this map from my region, where do you think lies the point where I might want to start considering a wired deployment instead because the cost might be too big?

Lecturer:
Yeah, good question. The question is looking at basically environmental factors, at what point would I want to consider a wired network because wireless seems unfeasible. Is that your question? Yeah, that's a good question.

Lecturer:
I don't know that this map would necessarily be the deciding factor. Probably, it's some combination of this plus none of the buildings can see each other because there's all trees or buildings or whatever. If you have very low line of sight availability from points to other points and you also have high rain, at that point wireless starts maybe looking unfeasible. Good question.

Participant:
I've got another one, actually. In what cases might you want to consider passive repeaters instead of maybe side notes and [inaudible 01:12:00] something like that?

Lecturer:
Okay. The question, at what point would you consider passive repeaters.

Participant:
I mean, like reflectors something like that even. Not the dumbest kind available?

Lecturer:
Right. A question about passive repeaters and quickly, just to sketch out a passive repeater. What you mean is basically an antenna, a cable connecting to another antenna and nothing ...

The signal comes in here, goes out here and vice versa but there's nothing here, right? Is that what you're referencing?

Participant:
Yeah, that or something that's completely passive. It would help power reader.

Lecturer:
Yeah, that's what I'm trying to draw here. No power, no amplifiers.

Participant:
Oh, okay. I didn't even know that was possible but okay, let's suppose that's that.

Lecturer:
Okay. The problem is the limits by the FCC for transfer of power ... In this situation, you've got a broadcaster over here as well and a broadcaster over here as well. In order to make it through this and actually work, I don't know. It does, in theory, work. You could, in theory, do this and it will work but you have to be broadcasting pretty loudly at either side because this is going to add quite a bit of loss.

Participant:
Okay. Because there is something like that for ham radio. You get an mountain range, you put some repeat material like that bounce on the other side of the building.

Lecturer:
Yeah, that's essentially what this is.

Participant:
Okay.

Lecturer:
You just have to be ... But it is going to add a certain amount of loss and you have to deal with that. That's a good question.

Lecturer:
Okay, I'd like to get into ... Let me get rid of that. I'd like to get into ...

Speaker 3:
It's [inaudible 01:13:51] three.

Lecturer:
It's L3? Okay. It's half an hour?

Speaker 3:

Yeah.

Lecturer:
Okay. Cool. The rest of the things I'd like to cover are basically channel planning and deployment planning. Figuring out how to cover a whole area without stepping on yourself too much and then depending on how long that takes, we can get into trouble shooting and stuff. Any other question so far before we shift gears?

Lecturer:
Cool. Okay. Let me make sure I'm on the right side here. We've talked a lot about ... Well, a lot of different things but the spectrum that's available for us to use and things like that, this is a pretty nice chart for North America that shows everything in the 5 gigahertz band and how it can be broken up.

Lecturer:
Five gigahertz band, sometimes you'll see it referred to as UNII-1, 2, and 3, they're along the top. This from 5170 to 5835 megahertz is the spectrum that's most ... That's the 5 gigahertz spectrum, basically. That's what we mean by 5 gigahertz or 5.8 gigahertz and that's, again, probably the most commonly used chunk of spectrum for this type of network.

Lecturer:
You can see that each of this represents a different way to break up this spectrum. When you are connecting these radios to each other, one of the things we're going to do is decide how much spectrum we're going to give them to use to talk; 20 megahertz, 40, 80 or 160. You can see these down the left.

Lecturer:
Less spectrum means we can more of these talking in the same area without talking over each other. More means that they'll have more throughput but we can't have as many of them. That's the tradeoff.

Lecturer:
I think these Ubiquiti ones in point-to-point mode, they do support 80 megahertz but they don't support 160, I don't think. Point to multipoint mode, they support 20 and 40 as well. You can see that at 20 megahertz you can have a lot of access points up or links at each other without overlapping. I haven't counted them, I don't know how many there are but there's quite a few along this row.

Lecturer:
Forty megaghertz, this starts getting a little tighter. Eighty megahertz you can only have six or whatever without ... Once you get to that point, you have to start doing a little more work to have them not interfere.

Participant:
I just like to note this for the room. If you have two channels that are overlapping, it's better to put them on the same channel.

Lecturer:
That's true.

Participant:
If you have Channel 1 and Channel 2, Channel 1 and Channel 2 overlap with each other on 20 megahertz channels. You want to put both on Channel 1 because when you put both on Channel 1, 80211 smart is smart and they're both see time to each other and they won't interfere. If you have one on Channel 1 and one on Channel 2, they're going to interfere.

Lecturer:
Yeah. That's true unless you're using airMAX. Yeah, I'll repeat that.

Speaker 3:
Do you want to repeat that [inaudible 01:17:08]?

Participant:
Yeah.

Lecturer:
Yeah, yeah. The point being made here, if we say Channel 1, Channel 2, Channel 3, Channel 4, Channel 5, Channel 1, which isn't quite right, but you would not want to put one on this channel and then have one on right in the middle. That's half on here and half on here. If that's the situation that you're in, it's better to put both of those access points on this channel so that they're right on top of each other rather than having then partially on top of each other.

Lecturer:
The reason is they will attempt to work with each other if they're on the same channel. Even if they're not both your access points, even if somebody else's access point is on that channel and your choices are slightly overlap or sit right on top of each other, it's better to sit right on top of each other.

Participant:
What does it mean when you have the width of a channel? You're actual wave is going to be on one frequency?

Lecturer:
Kind of. It has to actually modulate data onto that wave. The more data is modulated, the more that wave will vary in frequency. If you have a 40 megahertz channel that means you've got a lot of room to modulate data on it and let it take up that whole slice. Where if you have a smaller

channel, it can't modulate as much data but it won't interfere with channels beyond it. Does that make sense?

Participant:
Yeah.

Lecturer:
Yeah. Okay. Keeping this chart in mind, we're going to move on to, "Okay. I want to light up my city and I've got this tower and another intermediary point at these other places. How do I provide blanket coverage throughout the area without interfering with myself?"

Lecturer:
Okay. This situation, if each one of these circles is a tower and, say, I'm using 90 degree sectors at each tower and I want to be able to cover this whole area. As we saw in that last slide, if we're using 40 megahertz channels there's no way I'm going to have enough channels to put each of these on a unique channel. At some point, I'm going to have to reuse some channels. Not only that but I'm probably not the only person using the band in the area so I'm going to have to contend with what other people are doing.

Lecturer:
How do we do that?

Participant:
Like a graph or [inaudible 01:19:52].

Lecturer:
Yeah. Yeah, there's a lot of different strategies and that's one way to start it. Yeah?

Participant:
How do you combat echoes because ... Well, I can imagine a situation where for example, you have some service that will reflect your own signals with a significant delay. Effectively, your nodes are played by doing replay attacks on themselves [inaudible 01:20:27] to avoid that.

Lecturer:
I'm not quite sure I'm following your question. Are you asking if there's something that's RF reflective that bounces the RF back directly or something else?

Participant:
Maybe to the recipient of your message, like another copy of what you sent arrives a little bit later because of a reflection because of multi path.

Lecturer:

Yeah, you're talking about multi path which is ... I believe what you're talking about is multi path where part of the signal bounces off something and then hits a little bit later.

Participant:
Sounds like it, yes.

Lecturer:
Yeah. Yeah, that is a good question. Yeah, Let's talk about it. The question is, how do we deal with what's called multi path interference. What that means is if this is my broadcaster and this is the receiver, and this is sending out a signal but, say, there's a building right here. Part of that signal hits here and bounces here. So far on track?

Participant:
Yeah.

Lecturer:
Then this piece of signal is going to arrive slightly out of phase with this, with this main one because the time is a little bit different.

Participant:
This phenomenon is probably happening at different levels, you can get different phases or maybe a completely different instance of a signal that's been parsed by the receiving lobe?

Lecturer:
Yeah, it could be that far removed.

Participant:
What are the differences between the two? Is there any different dynamics related to that?

Lecturer:
Yeah. There's a couple of things that go on with this. Let's see. One is that some MIMO solutions, multi in multi out solutions, actually make use of multi path, will try to detect these alternate paths and use them for data to send data along alternate paths as well. In some ways, this is used as a beneficial thing particularly an indoor WiFi but it's attempted to be used in outdoor WiFi where the multi paths are used beneficially.

Lecturer:
That's one thing and that's because each side has multiple antennas. One antenna can hear this multi path while the other one here is the main one and they can try to pull data out of both.

Participant:
Okay.

Lecturer:
That's one situation. Another one that we'll get to in a minute is as long as you keep the Fresnel zone clear, we'll talk about Fresnel ... I have a slide on Fresnel we'll get to, then the Fresnel zone defines basically the area where if you can keep it clear, the reflections shouldn't be so strong as to totally cancel out the signal on the other side. Watching the Fresnel zone, which we'll get to in a minute, is one way to combat that.

Participant:
Thanks.

Lecturer:
Yeah. We'll get there. Okay, back to this.

Lecturer:
Okay. We're planning a tower. We want to put some access points. We want to be able to cover the area around the tower. When I say tower I mean, it could be, it could be your house, it could be the library, it could be a school, it could be a grain silo, whatever it is. I'm using tower as a catch all term for that and you're saying, "I want to be able to provide coverage to my community from the central location. What I need to do is put access points up on that tower and I want to make sure they're not interfering with each other to the extent that I can. Also that I can go out through the rest of my community as I expand and add more coverage that then doesn't interfere with itself."

Lecturer:
The kind of easiest naive way to try to do that at a single tower is this, this is called like ABCD Channel Planning where each letter represents a non-overlapping channel. We're just going to put four access points on our tower, each of them on different channels and they won't interfere with each other.

Lecturer:
This works okay for small and somewhat sparse deployments, where the towers won't be stepping on top of each other a lot. If you're in that situation in a rural area, this is a great and easy way to start. Just put each access point on the tower on a different channel.

Lecturer:
Moving beyond that if you need a little bit more density, there's some other things we can do. This is called an ABAB Channel Plan, what that means is that you put antennas that are back to back on the same channel. If you have four antennas, you use two channels. The back-to-back ones use a different channel.

Lecturer:

The risk here is that, if you remember from our radiation patterns, there is some radiation that comes off the back of the sectors. In some cases when these are back-to-back, this coming off the back is enough to interfere with the customers or the access point pointed the other way.

Lecturer:
There's a couple of ways to combat that. One is to just use better antennas. The number there's the front to back ratio, that's the number you look for. That's basically the ratio between how much energy is coming off the front of the antenna versus how much just coming off the back. An antenna with a really good front-to-back ratio will work better in this deployment than one with a worst front-to-back ratio.

Lecturer:
The other thing we can do is what's called GPS timing. GPS timing is a really helpful tool. It's not part of the WiFi spec. We're going to talk about how it works because it can be really helpful as you starting to deploy more dense networks. The way that that works is in this scenario, we're using our antenna here again. One thing we haven't really touched on is that these radios are half duplex. They can only either be talking or listening at once, they're never doing both. When this radio is talking, that one's listening and vice versa. With regular WiFi that our devices use, the way that the devices decide who talks when, is by using what's called contention.

Lecturer:
Contention means, it's similar to the way that humans interact in a group. What it means is that the first thing that this one does is listens, briefly. If it doesn't hear anyone talking on his channel, it will go ahead and talk. If it does hear someone talking on this channel, it'll wait a random amount of time and then it'll check again and then try to talk again.

Lecturer:
The nice thing about contention is that everybody gets to share the channel. That's how when we talked about putting antennas on the same channel so that they will share the bandwidth, that's how that works. When anybody using that same channel goes to talk, they'll listen first and if they hear anybody on the channel, even if it's somebody on a different access point, somebody they know nothing about, if they can hear them, they won't talk. If they can't, they'll go ahead and talk. That's contention. That's how it works. It works really well especially in indoor deployments but for us in outdoor deployments, sometimes we want something different so we use what's called GPS timing.

Lecturer:
The way that GPS timing works is that each device, and I don't know if these ones do, but the devices that can do GPS timing have a GPS chip inside them. They can get a GPS sync. Part of the GPS signal includes a very, very accurate timing pulse at a very, very, very accurate and like a beat that's very accurate.

Lecturer:

What they can do is time each other's broadcasts. When two devices are GPS synced, they can say, "I'm going to talk in the on beats, you're going to talk on the off beats. We're never going to talk at the same time." We can even do that with point to multi point, so this is an access point and I've got multiple devices out there. My access points can say, "You talk on beat 1, you 2, you 3, you 4," et cetera and then none of the devices ever talk at the same time.

Lecturer:
What that means is, say I have four access points coming off of this thing; one, two, three, four. If all of them are GPS time to together, they're all we're going to talk at the same time then they're all going to shut up and listen at the same time. Talk, listen. Talk, listen. Talk, listen.

Lecturer:
The reason that works is that ... That means that the devices they're talking to are all listening at the same time and all talking at the same time. What that means is that my device over here, that's trying to listen to this, when it ... I'm sorry, let me back up.

Lecturer:
What that means is that when this device is aiming this way, is trying to listen for its clients that might be way out there away and their signal level might be low. When it's trying to listen, this one is quiet. These two pointing opposite directions from each other won't ever hear each other because they want to one of them won't be talking while the other ones listening.

Lecturer:
Does that make sense? Am I making sense? Okay.

Speaker 3:
[inaudible 01:29:52] someone far away, right? You don't want the next to you talking.

Lecturer:
Right. Yeah. It's like I'm trying to yell at somebody that way and somebody standing my back trying to yell the other way. We both yell at the same time and then we both listen at the same time. This person isn't yelling while I'm trying to listen over here. Make sense?

Participant:
Sorry. Just a question about this negotiation phase of when someone talks and someone listens with this GPS timing process?

Lecturer:
Mm-hmm (affirmative).

Participant:
Is there some sort of master or how is this ... Is there a senses algorithm that [inaudible 01:30:29] to decide that?

Lecturer:
Kind of. The question is, using GPS timing we decide who talks when and how is that decided, right?

Participant:
Yeah.

Lecturer:
The way that that's decided is based on what we call our duty cycle and a few other little factors. What that means is, when you don't use GPS timing, you don't have to tell the access point how much room to reserve for download versus upload. The access point configure that on its own and just do it as needed.

Lecturer:
The downside of GPS timing is that we have to set a specified percentage that will be reserved for download versus upload on the access point. When you set GPS timing you'll tell it, "Okay. I want to use 80% of my airtime for download toward the customer and 20% for upload." Then as long as all of the access points are set the same way, they will all use the same ... If you have them all set to 80/20, then they'll all use the same slots for download versus upload. Does that answer your question?

Lecturer:
The other downside that may have brought up is that, again, all of the GPS timing implementations are specific to the device manufacturer. Ubiquiti has its own GPS timing implementation that does not work with Mimosa, that does not work with Cambium, that does not work with MicroTik. If you're trying to co-locate all those different ones, GPS timing will help you.

Lecturer:
Do you have a question? I thought you raise your hand.

Participant:
Just jumping all the way back to beginning. In a two-way antenna [inaudible 01:32:03] then the back-to-back channel, you have more of the same channel? That's what you're saying?

Lecturer:
Right. Yeah, and bringing the GPS timing into it. This, ABAB, where you use two channels per tower will work a lot better if you do the GPS timing. If you don't do GPS timing, this might not work very well for you because the antennas will be talking over each other. If you implement GPS timing, this will work well.

Participant:

Have you used the prisms, sector prisms. I know they have the GPS-

Lecturer:
Yeah, they have the external GPS intel. Yeah, and that's what that's for.

Participant:
I see. That is what it's used for?

Lecturer:
Yup.

Participant:
Okay.

Lecturer:
Yup.

Speaker 3:
[inaudible 01:32:46] set up for the ...

Lecturer:
Mm-hmm (affirmative). Yeah. Yup.

Lecturer:
Another implementation that works, again, better if you're using GPS timing, this is for 60-degree antennas which is somewhat common. You put six up around the tower, it gives you 360 degree coverage. You would use three channels, let me call that ABC channel planning. Again, back-to-back antennas use the same channel. The reason that you might use six instead of four is all about capacity.

Lecturer:
Each one of these antennas, the Ubiquiti ones, recently I've noticed the customers will start to slow down and get not quite full speeds at about 10 to 15 customers per access point. It's somewhere around 30 or 40. It gets pretty noticeable during peak times. The speeds slowed down quite a lot. If you put four access points on there and the customers are roughly evenly distributed, you could expect to hook maybe 50 to maybe 100 customers on that tower without severe degradation. If you need to be able to do more than that, then you can start looking at six access point deployments.

Speaker 3:
Ten minutes [inaudible 01:34:09].

Lecturer:

Ten minutes?

Speaker 3:
Yeah.

Lecturer:
Okay. Cool. Let me see if there's anything else I really wanted to hit. Let's run through this. I think I got two more slides and then we'll just open up to questions.

Lecturer:
Fresnel zone, this is pretty important. We talked about this a little bit. Consider these are buildings and we are trying to connect them together. We talked a lot about line of sight that these things need to be able to physically see each other. There can't be anything on the way; no trees, no buildings, no mountains, et cetera. Fresnel zone describes an area around that line of sight that needs to also be clear in order to get a strong signal between the two points. That green shape indicates the Fresnel zone. Not only do I need to be able to see it, but I need to have some clear path around it.

Participant:
The shape of that, of the radio frequency, the radio waves or ...

Lecturer:
Actually, I'm going to show why here right now. The reason I tried to draw it up here. The reason is that if there's something in the way, the risk is that part of the signal bounces off of that thing and arrives out of phase on the other end. What out of phase means is we have our main signal, right? A wireless signal. If a part of that signal comes in like this, they end up canceling each other out and the signal degrades. That's called multi path interference.

Lecturer:
Don't you worry about that too much. We can pretty much just track this. As long as my Fresnel zone is clear, I'm probably okay.

Lecturer:
You can calculate the Fresnel zone. Let me pull this calculator up. Actually, it's handy to see. Yeah, I think I'll pull that up later. If you just search for Fresnel zone calculator, you'll get a plethora of them. The things that go into it are the distance between the links, the frequency, and ... That's it. The distance and the frequency. For 5 gigahertz links at a half a mile, I think if I remember correctly, it's 10 feet is the Fresnel zone. It is shaped like this, the green shape. At the edges, if you don't need much clearance, much of any clearance around the path but right in the middle is where you need the most.

Lecturer:

Some common scenarios where this happens, if you're trying to shoot across a neighborhood and you're on one house on one side of the neighborhood and then another house on the other side of the neighborhood, sometimes the Fresnel zone will clip down into the roofs like that.

Participant:
Is it a horizontal as well, 360?

Lecturer:
Yeah, 360. Yup.

Participant:
I always see it going vertically, so I never really ...

Lecturer:
Oh, yeah. Yeah. It is all around, yeah.

Participant:
[inaudible 01:37:19]

Participant:
Does it have also to do with the reflective property of the surface turn over? If you're going over snow or water, do you need a bigger-

Lecturer:
Yeah, that's a good question. There are multiple Fresnel zones that you can calculate and there may be something like that if you wanted to really heavily optimize, you could. I've never seen it necessarily calculated separately to base on the reflectivity but maybe you might need to. I have seen weird situations where it snows and all of a sudden, things are worse.

Participant:
I was wondering, does frequency have anything to do with the size of the Fresnel zone?

Lecturer:
Yeah. When you do it a Fresnel zone calculator, the two things going are the frequency and the distance; higher frequency, smaller Fresnel zone, lower frequency bigger Fresnel zone. Sixty gigahertz has a very tiny Fresnel zone, another nice thing about it. Seventy, even smaller. Five gigahertz isn't too bad usually.

Lecturer:
Yeah. If you're planning a link, this is another thing you might want to look for. You look for a Fresnel zone calculator, double check. Again, if you're shooting across rooftops, what you might want to do is get a little bit higher up off the rooftop to make sure the rooftops in between aren't

in your Fresnel zone or if you're trying to shoot right between two buildings or right next to a tree or something, you might consider moving one side to make sure that your Fresnel zone is clear.

Lecturer:
Questions about that?

Speaker 3:
Is there anything you can do from the radio perspective to minimize this if you can't help the obstruction?

Lecturer:
Yeah. The question is, is there anything from the radio perspective you can do to minimize this if you can't get rid of the obstruction? You could and it might help to try to go higher frequency at the top of the band or just broadcast louder.

Speaker 3:
Or so 60 gigahertz [inaudible 01:39:18]?

Lecturer:
Yeah or just higher frequency, yeah. Anything else?

Participant:
Did you say or broadcast longer?

Lecturer:
Louder. If you're not already broadcasting as loud as you can, you can try louder.

Participant:
What kind of roof-

Participant:
Why would that [inaudible 01:39:41]-

Lecturer:
Yeah.

Participant:
Why would increase in power not, I guess, eliminate the interference from the different phase?

Lecturer:
Yeah. Good question. The question is, why would rising the power not just cancel itself out with a different phase? Yeah, that's a question that I don't think I actually know the technical answer to, but what I will say is that the way that Fresnel zone interference manifests, is just by a lower

receive signal level than would be expected with path calculator. Raising the power on one side does end up directly raising the power on the other side.

Participant:
The fact is it just works?

Lecturer:
Yeah. There probably is a real reason and I just don't know it. Yeah. Good question.

Speaker 3:
[inaudible 01:40:29] a couple of questions and then ...

Lecturer:
Yeah. I just wanted to hit ... Sorry, I know we're getting close on time but I think that this is important. Let me just get this one last thing and that is DFS.

Lecturer:
DFS is, in the U.S., when the FCC released, I think, the UNII-3 band, they only did it under conditions that the people using it abide by what's called DFS. There are some weather broadcast stations that you us some parts of that same band, of the five gigahertz band. Any device like a Ubiquiti, radio or any other device that uses that part of the band has to do with DFS.

Lecturer:
The way that works is the devices have to consistently listen for signatures of this radar starting up. If they hear the radar starting up, they have to drop off the channel and they have to listen ... They have to immediately drop off the channel if they hear the radar and you can't broadcast on any channel in that section unless you first listened for 60 seconds to make sure that there is no radar going on at that time.

Lecturer:
In practice, what that means is two things; one when you plug your radio in it can't broadcast for 60 seconds, two what it means is that if your radio hears the radar, it will drop off and will most likely be off for 60 seconds until it comes back on.

Lecturer:
A couple of practical things here. One is that there are pretty well-defined areas where this is an issue; near airports and military installations where you need to plan ahead for this. The problem is that the detection algorithms are not perfect. Most of the detections that I've seen are false detections. They are picking up reflection or something else that isn't actually radar but the radio has to err on the side of caution, think that it is and switch off the channel. That's a problem.

Lecturer:

There are parts of the band, the lower and very top parts ... I guess now, just the top parts of the band, that don't have to abide by DFS.

Lecturer:
In a situation where you know this is going to be a problem, if you are in an area where this happens a lot, you can try to only broadcast in those channels. The downside is that those are already the most heavily used parts of the band. There's already a lot of noise in there. It's a trade-off to use them.

Lecturer:
I think anything UNII-1 and UNII-2 has to do DFS.

Participant:
Yeah, because you could see where the-

Lecturer:
Yeah.

Participant:
It's there.

Participant:
It is right there.

Lecturer:
Well, this is where the part of where they actually broadcast but anything from here to here, you have to be listening for it.

Participant:
Yeah, like [inaudible 01:43:16] listen.

Lecturer:
It's only up here that you cannot have to abide by DFS. Anything along here, you have to do.

Participant:
[inaudible 01:43:23]

Lecturer:
Yeah, that's the nicest part of the band to use. It's the least used by other stuff but you have to abide by this. In practice, the detection algorithms have gotten a lot better. In recent years, I haven't seen it be as much of a problem. Still sucks to drop your customers for 60 seconds at random times you don't control over.

Lecturer:
One cool feature that Ubiquiti doesn't have but other companies like I think Mimosa have, is they actually have a second dedicated radio listening all the time and clearing a channel consistently so that if they do take a DFS hit, they can swap to that new channel immediately. That's a cool feature. It would be cool if Ubiquiti added that as well, but yeah, it is what it is. Questions?

Participant:
Do you have any with approximate distance? I mean, like an airport or something would trigger DFS all the time?

Lecturer:
Not exactly. It depends on if you're pointing at it or away from it or side. I'm not even sure exactly which airports use it. You'd have to do a little research on your area to figure it out.

Lecturer:
Do you have a question?

Speaker 3:
Go ahead. Go ahead.

Participant:
Yeah. This is probably some other cynical question. With a different audience they will be, they will understand it. Here it goes. If someone wanted to disrupt your signal, so you're probably [inaudible 01:44:55] along that.

Lecturer:
Mm-hmm (affirmative).

Participant:
Is that a feasible thing for someone to do easily or-

Lecturer:
To try to force your radios to do this? Is that what you're asking?

Participant:
Yeah, just interference peer, just-

Lecturer:
Oh, interference and all? Yeah, somebody can do that.

Participant:
Is there anything you can do about it?

Lecturer:
Not really. Yeah. If somebody really wanted to just generate 5 gigahertz signals really loudly for no purpose just to mess with your network, there's not a whole lot you can do about it. The FCC might offer some recourse if it really was strictly malevolent but-

Participant:
[inaudible 01:45:39] outside of the U.S.

Lecturer:
Outside the ... Yeah.

Participant:
You should be able to track such a signal?

Lecturer:
Yeah. You could probably try to find it with spectrum analyzers and things.

Participant:
If everything ... You would know if something like that is spread, yeah?

Lecturer:
Yeah, yeah. These radios do have built in spectrum analyzers. You will be able to get into them and run the spectrum analyzer and see a lot of noise and places where you maybe didn't expect it. Yeah, good question.

Speaker 3:
Go ahead.

Participant:
Are these the finest granularity channels that you can transmit and receive with?

Lecturer:
I think technically you can go smaller but it gets to pretty unusable bandwidth rates. Even at 20 megahertz, it doesn't give you a lot of throughput.

Participant:
[inaudible 01:46:28] 20. If you tell a driver to do less than 20, it'll just say nope.

Lecturer:
Yeah.

Participant:

When you really want to go up as high as possible like 40, 80, you're going to do it.

Lecturer:
Yeah, you got a lot more throughput.

Participant:
Yeah. Exactly.

Lecturer:
Go 40 to 80.

Participant:
Twenty is not a high.

Lecturer:
Yeah. Yeah, I think so.

Participant:
Out of the box, everything's 80 on five gigahertz these days.

Lecturer:
Yeah. They do randomly at ... You could set it to an auto adjust [inaudible 01:46:56] 40 or 60 with the Ubiquiti. Most of my 20 40 base set.

Lecturer:
Yeah. I think point to multi point, Ubiquiti will only do 40. I don't think they'll do 80. They'll only do 40.

Participant:
Right, just the 20, 40-

Lecturer:
Twenty-forty, yeah.

Participant:
[inaudible 01:47:13]

Lecturer:
Yeah. Okay. Shall we move on?

30 second video script

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