

Transcript
Lecture 4: The Internet
11 October 2006

(00:00:00)

Welcome back to Computer Science E-1. My name is David Malan. This is Lecture 4: The Internet.

So we have talked briefly and, you have been inundated perhaps on the website with links to podcast this and podcast that. But, we are at the point that now on the agenda to discuss such things as podcasts, which begs the question what is this podcast that we have been touting? Anyone at all... Great... putting it to good use already I see.

Podcasting... Would it help if I reminded you that with Problem Set 1 submissions come an opportunity to win this iPod Shuffle and better yet this iPod t-shirt, which we will distribute, at some point, over the next week or two, once we have graded the problem sets. Anything... podcast....

STUDENT: Inaudible

Ok, good. It is certainly refers to, in part, the ability to download audio content and video content in such a way that you can transfer it to something like an iPod Shuffle, or video iPod, or if you aren't even familiar with these things, just a little electronic device that is small enough these days to fit in your pocket, on your shoulder while jogging and so forth. And perhaps, podcasting is best explained by just a demonstration of precisely the term. So, on E-1's web site there is a link in the left hand menu as well as via this John Harvard statue, if you haven't noticed, is toting an iPod himself. If you go to that page, you will see a typical web page in the same style as the rest of the website but, with links to all of this so-called podcasting content. Well, to be clear, the idea of a podcast is not to download the information, necessarily, through a web page... right? Otherwise this is just a web page. There is no need to call it podcasting but, really if you look at this same content, for instance, through the view of what is called a podcasting client, like iTunes, you will get a better sense of what this hype is all about. So, in fact, if we follow the link on E-1's website called Subscribe to the feed directly through iTunes, assume that you have iTunes your computer; you will see a web page like this, which I brought up briefly in a previous lecture. And essentially, this shows you exactly the same content. What is this content? Well, as you can sort of see from the small text there, we have been posting, as you probably know, videos of these lectures, audio files in the form of MP3 of these lectures, as well as the TF's fantastic work on these new series of the videos of the week (a couple of these we showed 2 lectures ago.)

So, what then is a podcast? At the end of the day, it is a new buzz-phrase around the very basic idea that has long been possible on the Internet, the distribution of audio, video, and other kinds of content, but it's done technologically in a way that is somewhat new. Specifically, even though you are seeing all of these videos and videos of the week via iTunes, none of that content currently is actually hosted by Apple. None of it is actually hosted by iTunes itself. This in contrast, for instance, with a lot of the music you buy from iTunes; which presumably is hosted in some sense by Apple itself. Rather, what we did at the start of the year was signed up for an account with Apple for

iTunes. They approved us because they do a manual process still these days to sort of moderate the kinds of content that's posted. And what we did was simply maintain in E-1's website is what's called RSS (really simple syndication, or there are other expansions of that acronym.) But in short, it is literally just a text file. A text file with a lot of phrases and sentences that describe what is in this so-called podcast. Because at the end of the day, a podcast is just a feed, if you will, of video files and audio files and PDFs for instance. And we will actually spend more time in our multimedia lecture what we mean by M Peg 3s and M Peg 4s and Quicktime movies. But for now, just take it on faith that those are just videos, just audio files. So what we do every week is, when we release a new lecture or a new volume of videos of the week, we simply edit these text files with a simple text editor (Microsoft word, or something much simpler in fact.)

And all we do, for instance, to say that we have just released the video for lecture 2, is the following. We type up this short paragraph. But you'll notice if you glance closely even though the text is a little small, but notice that next to a lot of these words are these angle brackets, open brackets, something, close bracket. And those are examples of XML elements, or tags. In fact, what you are seeing now is a glimpse, a sneak preview of what you, yourself will be typing in a few week's time when we get to the website development aspect of the course. You yourselves will be developing websites, not in XML per say but in a derivative called XHTML (or perhaps the more familiar term HTML) which is the language in which web pages are written. So long story short, every week we update this file. We say what the lecture's called. We give it a bit of a description. We say who gave the lecture, how long the lecture is, and most importantly, we tell iTunes and really any one else that wants to look at this file where the movie file is. And what I've highlighted there is just a URL: <http://www.fas.harvard.edu> and so forth. So really, what a podcast is, from one perspective, is just a big RSS file, an XML file, that describes what is in the podcast and where you can actually go to download the actual content. So when you actually pull up the site like iTunes or a whole bunch of other programs or so-called podcast directories, all you are seeing is one company or one individual's presentation of that material. And if I double click on one of links provided in iTunes, I'm not downloading the video from iTunes per say, but rather iTunes is directing my computer to wherever the actual content is so that it can be copied to my local computer and then subsequently played or transferred to my iPod, or equivalent device.

Well, E-1's podcast is now in its second year. And last year we would not, perhaps, have had some of the success that we did, not only with our own local students but with also reaching other non-potential students via the Internet. We received a good amount of attention from a gentleman that you are about to meet. Victor Cajiao is the host of a podcast called the typical PC user podcast. We will post a link on the lecture's page after tonight to his own podcast. But this is a gentleman who sought us out, after E-1 was cited in a number of blogs and news articles, for having been among the first courses, at least within Harvard University, to provide students with access with its content via podcast.

Victor, given that he does a weekly show about all things related to technology, took an interest in us. He was kind enough to invite us onto his radio show for a series of interviews and so forth. And so, what we've done is invited him here tonight to speak for just a few minutes about what it takes for a typical person, if you will, someone like Victor, someone like yourselves, to actually get a podcast of his or her own up and running. Let me be clear, a podcast does not need to contain video content. It does not need to contain PDFs. In fact, at the very beginning, if you will, podcasts were

really just Internet based radio shows. But they were radio shows that you really didn't tune in to live, but rather someone in their studio or their basement or their living room would record a radio show of sorts, using a nice microphone, headset and so forth; maybe playing music and so forth. They would save that recording as an MP3, just a computerized audio file. They would post it via their own RSS feed so that other people on the Internet could download that audio file. So, it's a radio show in spirit, but at the end of the day you are not listening to these things live, you are downloading them and listening to them sort of a la Tivo, but for radio and for other video content.

So with that said, I thought a fun introduction to tonight's lecture on the Internet would be to make use of precisely this technological tool of the Internet. And one of the up and coming trends, certainly, is this use of not only listening to audio and watching video, but delivering video and delivering audio. So what I've pulled up here in this small window is a program called Skype. How many of you have ever used Skype before? Anyone? So, 2, 3 people... So, what is Skype? What is this little thing I've pulled up here?

STUDENT: Inaudible

Ok, so it's pretty much a telephone in your computer. It's several things and that is certainly one of them. One that is perhaps most familiar to the audience, it's a program in which you can instant message other people. But that's really just an after thought with this program because the crux of Skype, the real value out of it, the real feature is that it does a really good job of allowing you to conduct voice over IP, or VOIP (if you've heard the buzz phrase.) And this is essentially, as you have said, is just the ability to make phone calls via the Internet.

What do you need to do that? Well, you need an Internet connection, obviously, and dial-up doesn't really work so well these days for something like this which is fairly bit-intensive, but rather something like DSL, or cable modems are wonderfully suited to this kind of technology. So in a moment, I'm going to click this big glaring green button, which is going to dial up Victor who is sitting in his own office far away. He is going to connect with his own copy of Skype. Using this freely-available Skype software, it's going to cost us zero cents a minute. We are going to have an audio phone call with each other. And in fact, though my camera won't be turned on since it's not so interesting to see me up here yet again, Victor's camera will be on so you will actually see this gentleman, himself. The video quality tends never to be as good as the audio, but the wonderful thing again, about Skype, and even I have used this, it's free. And if only for the audio based phone calls, I have spoken with mine in other countries for free. And even with a decent Internet connection, it sounds just as good, if not better sometimes, than telephones, but it certainly depends on your connection. I will say that we are going to use this fifty cent microphone here tonight. And this will actually, probably suffice, we are going to use the speakers built into the lecture hall, but typically the only down side to using software like this is that one, you need a microphone and you need speakers, at least you probably have the latter with your computer. But the problem, at least for neophytes when it comes to using this sort of stuff, if you have a desk top computer that usually has 2 speakers (sitting right here) and you have a microphone (no matter how cheap or expensive) if you keep that microphone too close to the speaker... What's going to happen?

STUDENT: Inaudible

Yes, you are going to get really annoying feedback or that really high pitched screech if it's even close enough. And that is the only logistical issue to work out that can, at least initially, be enough of an impediment to even bother with the technology. But for ten, twenty or more bucks, you can actually get little head sets, which if you are embarrassed to wear them on the street, you can at least wear them in the privacy of your own home. And that gives you really high quality audio back and forth.

So, with that said, let's dial up Victor and ask him just what it takes for someone like him, or someone like you to go about presenting your won podcast.

noise

Victor: Hello?

David: Hi Victor. Can you hear me?

Victor: Yes David. How are you?

David: I am well .Good to see you. This is working well, it seems. I just put up your video and we have your audio going through the lecture hall here.

Victor: Hello everyone. It's nice to be here.

David: Well Victor, I've given a quick introduction, but one question first. Where are you geographically right now?

Victor: I'm living in beautiful Southern California, where it's so warm.

David: Well fantastic. This is actually a really good connection. And so, if you would, why don't you tell us a bit about your experience podcasting. What it would take for the folks like these to get it up and going with their own podcast. And then if you don't mind, I can try to relay a couple of questions, if they come up.

12 minutes 53 seconds

Victor: Yeah, Thanks for inviting me. It's all about content first. Podcasting is one those phenomenon in media that we use. That is, you and I gave a voice where we can let people know what we are actually about, whether it is about journalism, music, comedy, couple cast, or just computers, like in my case. There is no formula today for creating successful podcasts. It's about all of us telling our stories.

The first thing you need is good content, and a good story to tell. Once you have that, the rest of it is simple technology. Let's talk about what that looks like. You are going to need some type of platform to start your podcast, primarily your computer. You can start with something simple like this head set mike. You can buy one of these for about \$20. You can use something like that to record your audio. You can use something like that to record your audio, or even something like a

USB microphone, like this [Johnson?] here, which is like \$80. You can plug it directly into your PC format. So, that's the first thing on my list.

Next, you need some kind of a sound card. Most of our computers, today, have a sound card, so that makes it very easy. Now, you need a way to record the sound onto your computer. If you have a Macintosh, GarageBand has a built-in capability to record your voice, so you are all set. No matter what platform you have, one of the most favorite applications for podcasters is called Audacity. It's an open-source, cross-platform application that lets you mix together the sound of your voice, some music, some sound effects. And then combine those into a podcast as an MP3 format file. So, you record your voice; you mix those elements; you save the file as an MP3; and now, you have your content ready to put somewhere for people to listen to.

This then, brings us to the next set. How do you get your information from your head and your computer, out into the internet. The way you do that is you need to get yourself a hosting provider, or a blog provider. So, just like blogging, where you are writing down your journal, or if you use stories, or so on, there are providers that are giving podcaster the ability to save those MP3 files, upload them to their servers, as well as a place to put your show notes, and they will provide you with those services for no money. For example, Switchpod.com has a service that for free. You can insert their commercials, [Inaudible] anything you want, or you can pay money to them or other providers like iTunes or Juice.com, and it is a \$5 - \$30/month and you can host all of your content there.

What that does is leaves all that trouble of hosting your files, and telling people where to go get them. They take care of all of that for you. You don't have to worry about that at all. Bandwidth is an issue, but if you use a service like that, you don't have to worry if too many people try to up-load your show. It was a big compliment, at first, because people didn't have it out there. People like this and Switchpod.com to the rescue, for very little money.

So, now we have our content, we have a place to put that content, and now we need to publish it, or put it out on the internet so that people can go to a URL and they can either listen to right from the website, or they can download it by using a podcatcher [Inaudible] but programs like iTunes, or like Juice, that lets you go and get that [Inaudible] They can say, "Oh, Victor has a new show up there. I subscribe to it." And they can go down and grab that show from that server. And now, once you have posted that podcast and made it available to the world.

Now it's up to you to do what I call the last part of podcasting which is promoting your podcast. This is a very [Inaudible], you get a lot of different opinions, but first, I would say, promote it with your friends and family. After all, they are the kindest people to us. They let us know that we are doing well. It takes a lot to get comfortable behind a microphone. We are not professionals. We didn't come from the [Inaudible] of America. We are just people that are talking.

Some people do their podcasting live, stream of consciousness, without any editing. Other people, like me, do editing and use sound effects and things that give it a more polished appearance. It is pure preference and style.

So, I want to mention that [Inaudible] let good friends know about it at first. Give them the URL. Have them listen to it. Make sure someone can download it. Then, and only then, should you really go out and promote your podcast to the world. The way you do that is that you let podcasting directories know that you are there.

I will give you 3 major ones, although there are literally, now, hundreds. The iTunes music store you are all probably familiar with. They will be happy to reveal your content, the name of your show, and where the [Inaudible] is located. And they simply go and review to see that the content is not questionable. Usually, you are on their directory in about a week. And you can tell your friends that you and your show is now on iTunes. There is also podcasts[Inaudible] dot com, and podcastpickle.com. Those are 2 of the biggest directories.

Those are places where you and I as listeners can go and look for podcasts on all types of content. Believe me, there are lots of them. There are not 1, but 2 different podcasts on curling and on knitting. So, you can imagine that anything you want to look for, it's out there. Once you have your show, it will be put in those directories, and people will find you.

If you are looking to be a star, or to get rich off podcasting, this is probably not the time that you want those. I think I heard that more than... less than 10% of all podcasts have more than 100 people listening or subscribing to podcasts. So, it is a little easier to describe that it is a long hill which says there are lots of people listening, but there may only be a very few listening to your specific type of show, because of their preferences.

So, do it for the passion. Do it because you want to get the message out. In my case, my show deals with the difficulties [Inaudible] people that use PCs, typical Mac users, people like me who just switch to wacky-weirdo [Inaudible] teaching. I have a podcast that is called "immigration Tales" I tell people stories about immigrating from one country to another. Those are all about passion for me. yes, I have a few listeners that [Inaudible] I will be hounded at [Inaudible]. I could have thought of how [Inaudible] about. Even if I had 100 listeners, I would still do it. So, it really becomes, at the end of the day, creating your content, publishing your content and show notes, promoting your content, and then [Inaudible]. [Inaudible]

David- No, not at all. That was fantastic. Would you mind fielding a few questions if some hands go up here?

Victor- I'd be happy to.

David- All right. I'll be the one to stand here awkwardly and look for the hands. Yes.

STUDENT- Thank you Victor, what do you see as the future of video podcasting?

David- Thank you Victor. What do you see as the future of video podcasting? Is the question.

Victor- That's a huge future now. [inaudible] there are more and more examples of video podcast [inaudible]. The complexity is quite a bit more. There are [inaudible] out there, and other shows that are out there [inaudible] . The editing process [inaudible] case [inaudible] is a lot steeper curve. I see

that there will be a little bit more like traditional media, but I don't see it as being as heavily geared for people like you and me, who might strap on a microphone, and get our message out. [Inaudible] about.

David- Thank you. Any other questions from the audience? Yeah.

Student- As some [inaudible] casting, it doesn't seem like you could put a podcast out and get a large audience or even a significant audience right now. Is there a really huge demand out there for podcasts of all kinds?

David- So, as someone starting off his or her own podcast for the first time, is there really demand out there for say, one lone individual's podcast, or for these podcasts in general?

Victor- Well, that is a [inaudible] podcasting. You'd be surprised. There are some shows that take on or [inaudible] music. There's a wonderful [inaudible] show called Keith and the Girls. They are kind of R rated. [Inaudible] all of [inaudible] had a massive audience. Now they do a new podcast [inaudible] get yourself into the podcasting community. [Inaudible] if you listen to podcasts, send them out an e-mail saying hey, I have this new show about photography. Would you mind a promo for my show from your show? It could add a lot of people. And so from the inside, we sort of get to know each other. We go in forms and in to [inaudible]. The podcasting community organically grows. If you have good content, people will come to the show.

David- One more question?

Student- Is there a possibility for podcasting to generate income in the future?

David- Is there a possibility for podcasting generating income in the future?

Victor- I sure hope so. [Laughter] Let me tell you, I think there is. [Inaudible] generating income through podcast [inaudible]. There are plenty of podcasts today. There are plenty of [inaudible] million downloads a month, and that are starting to generate some dollars. I think for the majority of the people, that's the great unanswered question of podcasting. How do we turn podcasting model with [inaudible] more traditional media with an advertising model, in a way that some people will make money? And most people will be ok with it; maybe just paying for the hosting cost every month that \$10-\$30/month. So, right now that is the big question in podcasting. [Inaudible]

David- Well Victor, thank you so much for joining us today. We will be sure to post some links to your podcasts on the course's website after tonight.

Victor- It has been my pleasure. Thank for having me.

David- Take care. Thanks.

Victor- Bye-bye.

noise

23 minutes 43 seconds

Only because we have the window up now (and this may be somewhat anticlimactic rather than having audio and video up there,) but one of the neat things you can do with Skype as well today, is if you pull up this little button here, you will see something quite similar to a telephone keypad. And in fact, am I allowed to type in this number or should I use a different one? It's ok? Ok. If we go ahead and type... no... ok, so as of a few weeks ago you were able to do this completely for free and you were able to call land-line phones using Skype. And I was doing this briefly, or at least a friend of mine was doing this briefly and calling me all of the time from Skype because it was entirely free and he was in California, thus avoiding the long distance. I do realize now and remember that they turned back on the feature, it's still incredibly cheap. If I used Skype to talk to my friends when I was in Argentina for a week, it was pennies per minute as opposed to dollars per minute using an actual land-line phone. And again, you have to contend sometimes with quality issues, and you want to have a decent enough quality setup so you don't get feed back, but it certainly is a wonderful alternative. The upside of Skype now charging us is that I will not reveal Rei's personal cell phone number to everyone on the podcast. But know that that is an option and that is one of the ways Skype aspires to make some money. And also Leo, in part answer to your question about making money off of these things, and perhaps those aspiring entrepreneurs among you take some comfort in knowing that you can start a huge video focus business that doesn't make money, e.g. YouTube, and still sell yourselves to the tune of 1.6 billion dollars as of this past week.

STUDENT: Inaudible

No, and that's quite true. And just to summarize, there has long been a services, and especially these days, ever since the .com era, where you get the same idea. The same technology has been around for years, but all of a sudden, for whatever reason, you to get critical mass around some product or some website. And there's just huge valuations put on these things, YouTube being an example of one of them. And long story short, if you are not familiar with these things, YouTube is just a video sharing website. You sign up for a free account, you upload your own personal videos that you maybe took with your own little video camera or shot with your regular camcorder and then digitized; then really it is used just to share videos with people. And it has become incredibly popular and Google, for one, sees upwards of 1.6 billion dollars of value in this. I will say, play the other side of the coin as devil's advocate if you will, I think only time will tell if a lot of these ideas and a lot of these technologies and a lot of the sites are worth the valuations that are being put on them. And one might argue that even with what is happening in the past couple of years with the prices that are being tacked on to my-space and YouTube and Facebook and so forth, it almost makes me wonder, sometimes, if people have already forgotten the lessons of 1999, 2000. And so, like there was similar money being thrown around. Even then, time will tell.

That is a perfect segue to a video that Dan brought to our attention. You will recall a couple of weeks ago we passed around a hard drive, both one closed and one open, and we showed our own animation of what goes on inside a hard drive. Well, Dan found on YouTube and if you are wondering what YouTube is... this is YouTube. So this is just a site where you are able to share and watch and play videos. This is a video that someone made. Rather delicately, by taking the lid off of their hard drive, but a working hard drive that was physically connected to a computer. They just physically removed it from the box, but they left the ribbon cable connected. And you will see what

is going on inside a hard drive when it is actually running in your computer. It's just a minute or so long here. So here we go.

See if I can make it a little bigger for us.

Have you ever wondered what that sound is... or that sound?

This is why they have lids. They very quickly become uninteresting. But you see what's going on inside the drive. But that was sort of a lot of activity and a lot of noise for deleting a folder. What do you think explains the relative length of that process of deleting a folder? That would seem to be an atomic operation.

STUDENT: Inaudible

Ok, perhaps finding the folder, seeking to empty the folder. It looked like the reading head was doing a lot of back and forth though, which would suggest that it did not find the folder, but it probably did. Why else would it have been toggling back and forth so much?

STUDENT: Inaudible

There could have been information on different parts of the disk. The folder itself might have been fragmented. In an implementation sense, folders themselves don't really require a lot of storage space because they can be rather efficiently represented, but what sometimes is inside the folders is the question. So, in this case, it is the gentleman, I think, explains in the comments accompanying this video, there were actually a whole lot of files in that folder, which explains for whatever the operating system he was using was recursively going through and deleting those files and maybe other folders as well. So we will put a link to this on the course's web site as well. If you'd like to take a look or at YouTube in general...

29 minutes 55 seconds

And it is worth noting too, just to tie in our first 2 discussions of hardware with tonight, the Internet and also to play off of something that Victor said, in addition to this pod cast being available to students via iTunes, it is available to really, anyone with iTunes. At least some of the lecture content and this year the videos of the week content, but the teaching staff and I spend last week struggling last week was the load that was apparently being placed on this podcast this year. Based on the answers tonight to what is a podcast and the deafening silence that accompanied it, I can only hypothesize that it was other people that were downloading the podcast this past week. But long story short, thanks to those students who subscribed, really thank you, we crippled one of the extension school's servers early last week, such that I got a nice e-mail effectively explaining that we have been booted from the server that all other courses use at the extension school use. That way, it produced a last minute scramble.

We then contracted with an outside, third party, host; a company called DreamHost that you will see later in the semester because we will use them for you, the students, when you develop your own personal websites with your own personal domain name. But at DreamHost we signed up for a

relatively inexpensive plan that gave us plenty of disk space, a few tens of gigabytes, maybe a few hundred or more gigabytes, but storage space is not what we have, but what it did offer 1.6 terabytes of transfer, or of bandwidth. That is to say, we were allowed, according to this plan over the course of a month (30 days), this is what our contract allowed to have people on the Internet, wherever they are download up to 1.6 terabytes of information. now none of our E-1 videos are nearly that huge, the biggest file is maybe 250 megabytes. Well, what's one order of magnitude larger than a gigabyte--- damn--- a megabyte is a gigabyte. Well, what comes after a gigabyte?

STUDENT: Inaudible

Terabyte... So, -tera, essentially denotes what numeric value?

STUDENT: Inaudible

Trillion... So you are familiar with megabytes in terms of floppy disk 1.4--- this is what we did in the first lecture too—1.4 megabytes. You are familiar with hard drives that you have, which have 20 to maybe 400 gigabytes. Imagine now, having access then, or the ability to let people on the Internet download 1.6 terabytes of information over 1,000 gigabytes of information. Well, we got a nice note from DreamHost 4 days into our contract explaining that in the first 4 of 30 days of the month; we had used 1.4 of our 1.6 terabytes. And just like the cell phone companies do, they will charge you if you go over for every gigabyte. And you know, if you have ever gotten a \$300 cell phone bill, that the cell phone cost tends to be high. So, I passed it along to the extension school--- our estimated bill of \$6,000 for the first month of our free podcast. It's free, we don't charge for it, mind you. So, we quickly upped the plan to a 4 terabyte plan, now an 8 terabyte plan, which should hold us over. But again, thank you, all of you, for tuning in remotely. It's been wonderful challenge.

But this is, honestly, the first semester in 11 terms of teaching this class, that we have even spent even a split second using the term terabyte. And it is a fascinating thing, just technologically these days, to be getting into these kinds of numbers. So, perhaps only a geek could take pleasure in that idea, but it's amazing what's happening. And it is ideas and technologies and websites, like YouTube, that are really driving some of this growth in data storage requirements. I mean, a typical video that's uploaded for E-1 is between 25 and 250 megabytes. Contrast that with 1 MP3 of a song that for instance you might have downloaded back in the day from Napster, or these days from iTunes itself, 3 megabytes, 4 megabytes. You start talking about distributing 200 megabyte video files, you start to deal with some interesting server-side issues. And that is precisely what we coped with this past week; so, more on those kinds of things in the future.

For now let's dive into the topic we have skirted over until now, which is quite simply the Internet. What is it? Well, I'll turn it over to you since my first question of the night went over so well. What is the Internet? This is a clip, you will see that the slides, because we have notes, and because I like things to be rather dynamic and not follow a script. I mean slides cannot get any fluffier than this--- a guy surfing the Internet. So, we will use this for 10 or so minutes or so while we talk about the Internet. What is the Internet? Yes?

STUDENT: Inaudible

It's a series of tubes, it's not a truck. And none of you are familiar with the quote that senator--- watch Jon Stuart and it comes up every other night. Watch Jon Stuart and that joke will make sense. So, what is the Internet, for real?

STUDENT: Inaudible

So, it is a large infrastructure of servers and routers, and just really computers, that are interconnected somehow all over the world. It is the network of networks. Even if you aren't the technophile and are still taking this class you probably have an idea already that a network is simply just a bunch of computers connected together. Well, how that's done and what kinds of technologies you can use to connect those computers together will be one of the foci of tonight, as well as next week's lecture. But for today, we focus more on mostly the higher level details. What is the Internet? What can you do with the Internet? And in our continuation of this lecture next week, we will dive down deeper, and look under the hood, so to speak at how it all actually works in a more technical--- technological level. But let's, for tonight, first start off with softballs.

So, what is a domain? You have probably heard this term, but give me a definition for it, in layman's terms. What's a domain?

STUDENT: Inaudible

So, it's an address of sorts. You probably have said out loud CNN.com before or Harvard.edu before. Well, that's just a domain. It is sort of an English-like phrase that describes some kind of network of computers; and a network of computers that are geographically related. Right? It's pretty reasonable to assume that all of the computers related to Harvard.edu are kind of/sort of in the same area. It doesn't need to be the case technologically.

Well, let's actually take a step back then, because if we are already getting ahead of ourselves, if we are already talking about the Internet, before we talk about it's basic building blocks, well, this is easy. Right? We talked about this in our first couple of lectures. Here is a computer. Well, you can tell that even the course becomes dated when computers don't even really look like that anymore. So that's kind of sad. But this is a monitor from yesteryear on top of a desktop from yesteryear. I'm not very good at drawing LCDs, so we'll stick with this version.

Add 2 computers to the picture; connect them somehow, with some kind of wire (who cares what) and what do you get? You've got a network. This kind of network might simply be called a peer-to-peer network. Why you might guess... because you have 2 peers, or 2 equivalent types of computers somehow communicating with each other. A peer-to-peer network can also involve many, many other computers. Napster and it's infrastructure was in a sense a peer-to-peer network because all of these peers, all of these individual consumer PCs were eventually connected to one another albeit through one central server. So it was peer-to-peer in a sense, but software today that is particularly used for file sharing are more peer-to-peer in this sort of sense. I'm not going to draw hundreds of computers on the board here, but if you can imagine a whole bunch of computers really arranged in an ad hoc fashion, where some computers might have direct connections with one another, some can only talk to other computers through other computers. That's a peer-to-peer network as it is usually understood today. It's sort of an ad hoc network that is formed using various types of

Internet connections. And though I draw them with lines here, I don't mean that these 2 computers are physically connected. I just mean that they have some kind of Internet-based connection. They could be in completely different states or countries. The lines just represent software-type network connections.

Well, with that said, let's go to a more common scenario. At least consistent types of networks you use each day. If I all of a sudden, and just for the sake of dramatization, draw one of these computers as bigger, just because it's stronger, it's more powerful, it has more RAM, it has a better CPU, I'm going to call this thing in this context a server. And meanwhile, I'm going to call this thing on the left a what?

STUDENT: Inaudible

A CPU, but in this context you might have heard the phrase or the word...

STUDENT: Inaudible

LAN would describe the whole thing. We'll come back to that in a second, but what I'm looking for is the relationship between this server and what might be called... a client computer.

So if you have ever heard the phrase a client-server relationship, or really if you just hear these words tossed around... a server, a client, it's pretty much just like what happens in a restaurant. You sort of have one guy who's running the show, the waiter or the server, he will answer your requests, or provide you with information or really food that you as the client asks for. And this is terribly representative of how most Internet-based applications work today. So, for instance, you sit down at your computer, and you pull up Internet Explorer, and you type in cnn.com, you- in that context- are acting like what is called a client. And you are making some type of request over the Internet will expose the inner workings next week to cnn.com. which is obviously the server in this case. Cnn.com's server looks at whatever request you have sent and that request is going to be along the lines of give me your main page, your home page. The server is going to grab that home page, or generate it and just reply just as you have received your dish at the restaurant. And it is precisely that sort of subservient relationship asks the server for something and gets something back. That sort of captures, in fact, what we were just doing with Skype just now, albeit only one side of it.

When we dialed up Victor the way that Skype and programs like it tend to work, there is clearly a server in the middle, because even I, personally, had no idea where in the US at the moment Victor was. Apparently, he was in California. If I wanted to make a direct connection, like a peer-to-peer connection to his computer, well, that's kind of a chicken and the egg problem. How do I contact Victor if I don't know where I should contact him? So, that's why a lot of technologies, a lot of websites, a lot of software products use central servers. So, in effect, when I double clicked on Skype on my computer--- well, my version of Skype made a connection to the server and it wasn't just this onetime request response, rather is a persistent connection, like calling up Skype's main server on the phone and maintaining an open connection. The technology is different, but the spirit is the same.

Meanwhile, guess what happened over here. Well, if this is Victor's client, it too made some type of connection to Skype's server. Skype now knows where David is; Skype know knows where Victor is; and Skype's server can effectively now put us two in contact with one another. How many of you use AOL instant messenger? It's pretty much the same exact design for that, right? You sign on to AOL instant messenger. You are running a little client on your computer. It connects to AIM's main server, which is called (I think) oscar.aol.com, is the host name, the address they use for it, something like that. And then, your friends connect to AIM's server as well, and then all of you can instant message each other because you are all using AOL instant messenger server as the intermediary. Now, this sort of implies what about the privacy of your instant messages?

STUDENT: Inaudible

Not very... literally, all of your instant messages, for the most part, go through AOL instant messenger and AOL's main servers, which certainly means they can do what with them, if they so chose?

STUDENT: Inaudible

Read them, certainly... store them in perpetuity, certainly... it's really up to them. If they do this I don't know. But this is certainly an issue when it comes to say... current proposed legislation, which I think we touched upon briefly, in lecture one or two where ISPs, which are not AOL instant messenger per say, but your ISPs can certainly look at all of the e-mails and all of the web pages you are accessing from your computer. Right? After all, who do you use to connect to the Internet these days? Anyone?

STUDENT: Inaudible

Comcast? So, if your computer, in that sense, is the client and you are using Comcast's servers to access the Internet, well, that suggests that they, in that case, are the intermediary between you and everyone on the Internet. Now for the most part, ISPs don't retain data. They don't retain data on what websites you have visited, or what e-mails you have sent, or at least the content of them, just because they are more legal trouble than it's worth, if it's not required. It's just costs money to store this data, and what do they really need it for. They maintain logs that you sent an e-mail likely, and maybe who it was to, but not usually the content. But if you pay attention to current media goings-on, one of the proposals from at lease this country's government, is that they want to keep around information for at least 3-6 months. This is a huge deal for the ISPs and others because it's just expensive, if nothing else. And never mind all the civil liberties issues that it might raise.

With that said, back to technology. We have these 2 basic relationships; either a client/server relationship or sort of a tiered model where you have multiple clients connecting to a central server. Now, consider what Victor and I, when we were doing, we were transmitting not only audio, but video as well. Now what do we already know from our brief chat about podcasting that is implied by the distribution of video in general? Sort of a leading question, but... Which costs more now, in terms of space, to send an AOL instant message, like a smiley face or to send your smiley face over the Internet? All right, so your smiley face in the form of a video. So, all of a sudden all of these very popular services, like Skype and AOL instant messenger are using these centralized server models.

You would think that this quickly becomes problematic, especially for video. Consider the issue of our podcast. We had one central server, originally at the extension school, and it was just serving content to clients. It was not even serving as the intermediary to other clients. Well, now imagine Skype. Do you think that Skype routes all of our audio and all of our video content through Skype's server? Does AOL instant messenger do that when you do a "direct connection" and send someone a really big file or a really big image? In theory no, and ideally, no because what the server simply does, as I sort of suggested in the voiceover is that it informs this client and that client how they can directly contact each other; and thereby by circumventing intermediary because once the servers put those 2 clients in touch. What do you really need him for, after that?

45 minutes 28 seconds

Now that's a simplification because that is actually problematic these days because how many of you, with your DSL or cable modem connections have home routers or firewalls? If you know what that is. How many of you have not only your modem plugged into your cable line, but also into a black or blue box that allows you to share your Internet connection among multiple computers in your house? Well, if you have one of those things--- more hands are up, and we'll come back to that either tonight or next week--- you are sharing your one pipe to the Internet among multiple computers. The effect of that, usually, is to create the appearance that even though your home might 10 computers in it, or 3 computers in it, to the outside world it looks like there's only have one of you. Comcast only presents you with, and we'll get back to this, one IP address as it's called. One means of addressing your computer. This is a problem though because if Skype knows where you are coming from, and Skype knows where Victor is coming from; well, suppose that Victor is on a network with a whole bunch of other people, and suppose that I'm on a network with a bunch of people, in other words, we might be sharing our Internet connections for purposes now realize (or at least get a sense of the fact) that the server can't necessarily put 2 people in touch with each other that are behind these so-called routers or firewalls, for reasons we will get back to. But this is why if you've ever tried with MSN messenger or AOL instant messenger to do audio conferencing or do video conferencing, it usually doesn't work. Those programs are not nearly as good as Skype is or say Google talk is these days at using various tricks to get around those kinds of issues. And we will get back to that in more technical detail in a bit. But if you've ever tried, and you may try it tonight, try to initiate a voice or video connection with someone with AOL instant messenger, or MSN messenger, if either of you are behind one of these home routers, chances are it will not work as well at least as well as Skype or Google talk do. More on that in a bit.

So you've got a couple of computers connected by a cable. You've got now a (let's do it this way) you've got not just a server here, but you've got a whole bunch of computers in your home, as you were just saying. All of these guys want to connect to the Internet. Well, it stands to reason that if you want to connect multiple computers together and not just 2, you need to wire them, not necessarily to each other, but to some central point. And as soon as you start connecting multiple computers together using whatever type of technology, you put all of these computers inside of a very oddly shaped building, as suggested by this rectangle on the door, well... what do you then have? Well, you have now what was described earlier as a LAN. So, from the beginning, a computer (you know what it is), a peer-to-peer network (is just 2 computers connected together), a LAN is (multiple computers connected together) usually very geographically proximal to one another. That's why I drew this very goofy looking building. It's just to suggest that if you just have a bunch of

computers connected together in some very tight space, like a building or maybe even a city block, the general term to describe that would be a LAN.

Contrast that with something you might have heard, more so perhaps in years past, WAN. What does LAN stand for? Local Area Network. The acronym pretty much explains what it is. It's just a vague term. It doesn't have any minimum number of computers you have to have. It doesn't have a maximum number of computers you have to have. It is a general term you can whip out to describe a bunch of computers connected together that are sort of related to one another, because they are in the same building, or maybe because they are physically connected to the same central device. A WAN, by contrast, is a Wide Area Network. It's just more than that. Maybe you have a WAN, for argument's sake, when you have a building here and a building here and you connect those buildings together via some kind of cable. You might then say this is a WAN, because it is spanning multiple LANs. So, you have a computer, a peer-to-peer network, you have a LAN, maybe you have a WAN. What do you get when you connect all of these LANs or WANs together, somehow or other?

STUDENT: Inaudible

A network, yes, but you get THE network, if you will. You get the Internet. And that's why I introduced this as the Internet being the network of networks. You can take it one step further; the Internet is the network of networks of networks. It is sort of the uber network to which the entire world, at least with networks, is interconnected these days.

So what is a domain? Well, domain is just a way of describing a LAN, or a WAN, or a bunch of LANs or WANs. There are really no hard and fast rules around any of these. Atop there, I've put Harvard.edu. Well, that's just the name given to describe all of the computers on Harvard's campus. At right, there's a column called sub-domains. Well, sometimes, only for administrative simplicity, it's nice to sort of organize your own network (your own WAN, your own domain.) into hierarchies with different people, with different people administering different parts of the university, or the company. So you have the ability on the Internet to describe computers, not only by their domain name, but by sub-domains. For instance, how many of you already have a FAS account? Ok, so about half of you. And if you don't already, the current problem set charges you with obtaining one or the previous one does. If you have an e-mail address of the form malan@fas.harvard.edu. Your domain name is generally called Harvard.edu, and your sub-domain is fas.harvard.edu. How many of you have an e-mail address in Harvard.edu? Ok, so many of you as well. So if you have that address, how many of you a @harvard.edu address is something like not quite like this, but not quite like this, David_Malan, something like that. Well, Harvard does that in its domain name, it will give you David_Maln@harvard.edu, but most of you, then, have more local (departmental) accounts that David_Malan@harvard.edu, is just a so-called alias to. This is just one way that Harvard administratively and technologically keeps things nice and separate for different for people to administer.

What's another example or entity with sub-domains? Anything come to mind? Anything at all? What about Craig's list? If you go to www.craigslist.org, what city's listings do you get?

STUDENT: Inaudible

San Francisco's, in fact, which is their default website. If you go to bos.craigslist.org, you get, instead, Boston's listings. But it turns out, in that case, [bos](http://bos.craigslist.org) is something that is called a host name, which looks sort of like a sub-domain, but it is a little different. So, let's take a look here. If we... let's take a look, a little bit more, at these sub-domains and we will see where the technological relevance. Here's a whole bunch of suffixes, many of which you are probably familiar with. What immediately looks familiar on this list, besides...

STUDENT: Inaudible

.com, .gov, .edu, .net, and then there a bunch of other, some of which do already exist, some of which have been proposed to exist, perhaps the latter one on the far right gets the most attention in the media these days. But these are all what are called top level domains. Right? So, we did this little exercise on the board to sort of give us the basic building blocks of what a network is, and what a network of network is. Well, the means by which you describe networks is by domain names, part of which is this so-called top level domain. In cnn.com, inferring from these mere descriptions alone, what is the TLD, or top level domain of cnn.com?

STUDENT: Inaudible

Dot what is it?

STUDENT: Inaudible

Dot com, dot com. This is just a generic way, general way of saying that CNN's domain is generally speaking, commercial. If I contrast and ask you to visit www.whitehouse.gov, what does its TLD imply? Again, it's sort of an easy question.

STUDENT: Inaudible

It is somehow government related. In fact, until a couple of years ago, if you ever made the mistake of visiting www.whitehouse.com, at least one of us has been there, you would have seen a very different website than the one currently presented by the Bush administration. If you Google around for it, I don't think it's still active, but you will perhaps find screen shots, or actually if you're really curious, you can probably go to a Google search for, I don't know why I'm promoting this, go to the Google search for the way back machine. Just, I'll show you this website, but we won't actually use it. You go to way back machine who's URL I never quite remember. So, there's this website, which is wonderfully interesting, if not a little scary... what's the domain here? Archive.org, the way back machine. This is actually a service that works to varying degrees of success, that has been over the years, archiving websites. And it's sort of embarrassing. You can scroll back in time and see my college website and my terribly limited HTML skills at the time. I think you can find old versions of E-1's website from years ago, and I don't know (I'll leave this as an at-home, unendorsed) home exercise... if you look up www.whitehouse.com, you might see old versions of that website as well, or at least, if you Google around, I'm sure people have talked about what it was all about. For those of you who have no clue, well... just ask the person next to you. There seem to be enough people around who seem to know what's going on right now.

Anyhow, TLDs are meant to organize, hierarchically, domain names in a way that gives you a sense of what kind of domain it is. Are there restrictions? If you, the user, want to go in and buy a domain name in .net, .org, or .com these days, what kind of entity must you be to buy a .org, .net, or .com?

STUDENT: Inaudible

A business for .com, ideally. At least that was the original purpose, but it turns out these days, no restrictions on any of those 3. You can have .coms, you can have .nets, or you can have .orgs owned by anyone. Which one you choose is simply a matter of choice, but really, a matter of availability. As you will see when we get to the website development of this course, choosing a domain name, at least one you want, is a nontrivial matter. One- A lot of good names have been taken up by actual websites and companies. Two- A lot more domain names have, perhaps been taken up by squatters, folks that have just bought these domain names, thinking that some day someone will come knocking and want to pay them more than the \$7/year or so that it is costing them to maintain it, hoping to cash in on the \$1,000 domain name, or the \$1,000,000 domain name, or even something more than that. You will perhaps feel that frustration when you seek out your own domain name. But it turns out that among the TLDs you can choose from today are many. One of the best registrars that I have used, in my experience, to register my domain name is “go daddy.” It is a goofy name, and the website is kind of overwhelming because they try to up-sell you every time you visit a page, but if you sort of ignore all of the up-sells and just seek out your \$6.95 or \$8.95 domain name, you can get a good deal. And they have a good interface for managing domain names you might own. Again, we will come back to this in our website lecture, but for tonight, I just wanted to the drop down. If the name is available, you are allowed, these days, to register a website in any of these TLDs, and more than these in fact. Go daddy doesn’t necessarily allow for, doesn’t necessarily let you register all the available ones. But if you want to host davidmalan.jp, if it’s available, you can create the illusion (in effect, by name) that your website is in Japan. This is only to say that TLDs, though originally intended to create very obvious hierarchies, with very obvious distinctions, has begun to relax somewhat. Each country gets to manage its own domain. In fact, if you have ever been to something like... anything that ends in .tv... Have you ever been to a website that ends in tv? Well, .tv is the domain name that belongs to a little southeast pacific country that decided to sell off the rights, effectively, to its domain name because, at least in the English-speaking world, .tv could perhaps fetch a pretty price for TV shows, if nothing else. So, I’ll leave that as more of a family-friendly at-home exercise, if you would like to figure out what country it is that allows you to register names in the dot tv TLD.

A hand went up earlier.

STUDENT: Inaudible

A very interesting question. Many websites these days don’t even have the www any more. In fact, if I go to cnn.com, I will get the day’s news. And I stopped there intentionally because I always say cnn.com, because it’s such a short domain name to type during lecture, but I’ve made the mistake for years of pulling up the current events on the news, and then all interest goes up there. We won’t see what’s going on in the world now, but if we go to godaddy.com, it’s probably going to pull up www.godaddy.com, if I pull up just craigslist.org, it too will... woops... if I pull up, well if I do, what’d we do? If I pull up instead www.godaddy.com, well that too works. Long story short, back in

the days when the Internet was first becoming popularized, you would often see URLs described as `http://www.cnn.com`. Well, the world very quickly acclimated to the fact that ok, I know that this goes on the Internet, so gradually you see `http://` being dropped. What that is... we will come back to in this course and so all you saw was `www.cnn.com`. Well, that's sort of a mouthful, and that's even `www` sort of becoming gratuitous today because if you say dot com, you know, unless you have not been paying attention for several years, you know what that means, and what that is, so the `www` has been dropped. And technologically, it is very easy for you to set up a website that either uses `www`, or doesn't use it. And what good, well managed websites do these days, is they let you visit both. They usually route you to the same location, and just like what happened with godaddy, if godaddy just likes to present itself to the world as `www.godaddy.com`, they will use a server-side trick to just change the URL on you, just so that they are sent some unified marketing face. If you visit a website, or try to visit a website like `davidmalan.com` and hit enter, and it just doesn't work, even though `www.davidmalan.com` does work, then frankly, that's just a stupid decision by the administrators of the website. Because it appears that the website is broken when really they haven't flipped a switch that makes that version of the URL work without the `www`. In fact, on that note, why don't we go ahead and take a 5 minute break and when we resume we will dive in deeper.

1 hour 1 minute

1 hour 7 minutes 47 seconds

ok, so we have our basic building blocks tonight of what a network is. It is a bunch of computers connected together. You can describe a bunch of computers connected together by the domain name, so, `Harvard.edu`. Let's actually consider what some of the components are so that some of these matters like... do you need the `www`? Do you not need it? Start to make a bit more intuitive sense. If I write down something like `www.cnn.com`, the part I have underlined is the?

STUDENT: Inaudible

Top level domain, the TLD. In general, it is a hint as to what kind of website it is, though to be clear, earlier, even though you can choose a website these days in `.org`, `.net`, or `.com`, I would wager the most popular is `.com`. Only because those individuals who don't really appreciate that it doesn't matter, for the most part what your TLD is these days, they think... they see `.com`, they think website, they see `.net`, or `.org`, they may not necessarily be as clear to the person on the street that it is, for instance, a website they should visit. I would argue that even the potential for that confusion is going away in time. So, this is generally called a domain name. This is called the host name. if you are talking about the address of a website, it is usually broken up into the host name and the domain name, part of which is the domain name. But it is certainly possible for a website to only have this part, which means it effectively has no host name. It's just to say that when you visit `cnn.com`, the server configuration is such that it just routes you to a computer that is nameless, in a sense, but it is- in effect- CNN's web server. Or the server could just add the `www` and just make more explicit the host name.

What do we even mean by host name? Well, how many servers do you think CNN has? So, they typically have a lot. Any of these big websites, they don't just have one big server as I drew it on the board today. They have a lot of smaller, but faster, if not, inexpensive servers. Google works in this

way with thousands of computers, but you don't have to know the name of the Google server that you happen to be searching on. You just go to Google.com, or you go to www.google.com, and through several server-side configuration tricks, when you go to google.com, your search query, for whatever you are searching can be routed randomly, or in some special fashion to one of these computers. Well, computers, like people, tend to have names so you can refer to them in some way to say that the alpha machine is broken, or the Donald machine is broken. Computer people, as you will see, tend to give their computers goofy names, though my laptop is being seen. By contrast is seen as laptop. So, when you have multiple computers, just to handle the sheer demand of your website, you don't want to advertise the names of all of those computers, you just want to provide one unified face to the world. Weather it's www.cnn.com, or cnn.com. But as soon as you hit enter, and your browser tries to visit this website, CNN's infrastructure routes you to one of those computers. And the computer it sends you to might be called www1.cnn.com, www2.cnn.com, it's entirely the prerogative of the owners of that server, but for the most part, you-the user- don't ever see the host's names of most of the computers that you are, in effect, being connected to when you visit a website, or when you use some other Internet-based technology. So, www-hostname... is the name of the computer, and a website doesn't necessarily have to have a host name associated with it, so summarize.

You will also see addressing schemes like this, not just for website. Right, after web, what is the next most popular Internet program you might use every day? E-mail is a big one. Well, e-mail similarly makes use of domain names and TLDs, and even what look like host names. But rather, if you send an e-mail to malan@fas.harvard.edu, well, here again, is a TLD, .edu instead of .com. Here's a domain name. And what did we say this is called? So this is a sub-domain. So, in the context of a web address, you would usually call the first thing, that's not the domain name its self, the host name. it is the name of the server you are visiting. But really, when you send an e-mail to someone you really don't care what machine that e-mail is being sent to. You care more, conceptually, that it go to the right domain. And so, in that sense, and it is a slight distinction, when you send an e-mail to malan@fas.harvard.edu your e-mail goes to whatever server it is on the Internet, that manages e-mail for this domain, specifically, this sub-domain.

STUDENT: Inaudible

Ok. So, it's a good question. To summarize, it sounds like you have someone on one of your e-mail lists that is receiving your e-mail. But they are complaining that they don't want to receive your e-mails; but that person's sub-domain of that person's e-mail address just so happens to be the same... what happens to be the same?

STUDENT: Inaudible

So, you have this user who wants to opt out of your e-mail list because, for some reason, she is getting some e-mails that are clearly meant for someone with a similar user name, but a different sub-domain, or domain name. So, I can only hypothesize that either one, there's some typo going on, a slight distinction, or perhaps more likely, is one of the e-mail addresses on the mailing list is forwarding to maybe her address. And maybe that person made a typo, and is thus forwarding their e-mail to the wrong person. But without actually seeing the data, it's hard to be more accurate than that.

STUDENT: Inaudible

If you want to send us an e-mail or reveal the details, we can try to advise. Ok, we will get that one off of your list soon enough. Ok.

STUDENT: Inaudible

Yes, that will be the challenge, indeed.

1 hour 14 minutes 45 seconds

So, probably everyone in this room uses e-mail at least once a day or perhaps too frequently. Perhaps, more frequently than you would like. Perhaps some of these questions might seem pretty easy, but at the end of the day, these are perhaps common points of confusion, at least for neophytes. What does the typical e-mail address look like? There are 2 [inaudible] forms. If you have an e-mail address it probably looks like the first one, with just that the domain.com, like david@gmail.com, don't e-mail that. It goes to some other David, or you can e-mail some user name at some sub-domain dot domain dot TLD. You can have multiple sub-domains, but after a while, it tends to get ridiculous, and so you don't tend to see them that often. So perhaps, these would be the 2 most common forms. So, a bit of a quiz... These are examples of legitimate e-mail addresses. They might not go to real people, but syntactically, these are valid, syntactically correct e-mail addresses. You know, frankly, these days on the Internet, I bet there's someone there that gets each one of these e-mails, so maybe another at-home exercises, e-mail these people and see what kind of curious e-mails you get back. So those are valid e-mail addresses. Points to take away are perhaps implicit, so clearly you can use letters of the alphabet, you can also use numbers. What other characters are clearly valid characters in an e-mail address?

STUDENT: Inaudible

Underscore... what kind of symbols?

STUDENT: Inaudible

Symbols in general are too general? Be more specific. So, underscores, that underscore bar which creates the illusion of a space, but is just kind of a hack around it. What else is clearly valid?

STUDENT: Inaudible

A hyphen is valid.

STUDENT: Inaudible

An end dash, which would just be a hyphen in this case, would be valid.

STUDENT: Inaudible

A forward slash in an e-mail address would not be valid. No slashes in e-mail addresses ever. You clearly need the @ sign. That's in both of the [Inaudible] forms we looked at. What do you not notice here? There are not things like spaces. Spaces are not allowed. There are not things like dollar signs, or what you might think of as weird characters. It's fairly safe to say that these are the most of the valid symbols that can appear in an e-mail address. It can have a period, and it had different meanings if it is to the left of the @ and to the right of the @. To the right of the @, it has some clear conceptual distinction. It is sort of demarcation between the TLD and the domain and maybe a sub-domain. On the left hand side, it's completely arbitrary. People use dots sometimes in lue of underscores because they look better, but there is no inherent meaning. If it's david.malan, that's just because David Malan though that maybe the dot looked than no character at all, maybe better than an underscore. Harvard, arbitrarily, for those of you who are staff, chose to make e-mail addresses of the form david_malan@harvard, for instance. Capitalization... does it matter? It does not. It is tacky, daresay, to e-mail someone with their address all capitalized. It's sort of silly with some people to write their e-mail address as, if only, because that's not consistent with convention, but there's nothing wrong with it. E-mail addresses are case insensitive. You can capitalize, don't capitalize, it really doesn't matter, at least for this part of the domain name. But, I have yet to meet a mail server that doesn't ignore capitalization in the user name. Theoretically, you could make a server that would make the distinction, but I wouldn't think on that too much.

Quiz

Take a moment... Which of these are syntactally valid? It's a good time for it. I know you can't see them, but there you go. Which of these are syntactally correct?

STUDENT: Inaudible

Ok, we'll jump right into it. Jay@nbc.com is syntactally valid, tried to throw you off with the capitalization, but completely legitimate.

STUDENT: Inaudible

Mine being malan@post.harvard.edu, good

STUDENT: Inaudible

Somebody... franklin.ma.us, so that's an interesting point of discussion, if briefly. That looks like it's somebody from where?

STUDENT: Inaudible

Right, Franklin, Massachusetts. So, it turns out that in addition to TLDs, like .org, and .com, and .gov, there are also 2 character TLDs. And these are generally called country code TLDs. And we mentioned one earlier, even though it is abused these days, but with permission. It is .tv. It is technically a country code, and it is a TLD, but it's originally under the control of just one country. And it is still, but they have allowed anyone to just use it. Even the US has their own TLD which is

.us. And a lot of governmental entities like local townships, or if you have a city-oriented website, the mayor's office, those sorts of domains, even though they could be in most any TLD, even .com if they wanted to, just send a weird message. Well, .us is a common form for municipalities and so forth .ma.us is for Massachusetts, franklin.ma.us denotes Franklin, Massachusetts in the United States. If we have .us, why do most websites in the United States end in just .com? whereas, if you went to visit CNN in the UK, you would instead visit something like cnn.co.uk, or I think cnn.so.jp, if I'm remembering them correctly. So, "co", in a lot of countries, is the convention that they adopted. It denotes commercial, but it was sort of arbitrary, but no... CNN's website in Japan, the one that brings up Japanese text is not cnn.com. That seems to be the US one, but if you bring up most .coms, though that might be slight exaggeration these days, many .coms, they pretty much look like English based, United States websites. Why is it that the United States has this sort of luxury of not needing to use their country code all over the place.

STUDENT: Inaudible

We were the first ones there. It's sort of what it boils down to. Who was the Internet invented by? Not Al Gore.

Laughter

The Internet grew out of what? The US military project called ARPA net, Advanced Research Project's Association, if I'm getting the acronym right. So, it was originally a military project, it was designed, in effect, to allow computers, which at the time were huge and expensive and slow, to communicate throughout the country. It was designed in a way to redundancy, so that if one sever, or even one city were taken out, the rest of the network, in theory, could continue to function. That's why today, and especially next week, we will look at the interconnections that exist on the Internet. There are so many different ways to get from point A to point B and it sort of looks like a mess. It's a really good thing for dealing with problems if servers go down, if connections break and so forth. That grows out of, to some extent, a military mentality; having redundancy, the ability to withstand nodes or computers being taken offline, for whatever reasons. Well, fast-forward to today, popularize the Internet by universities using it after that, and now typical people in the mid-90s and so forth; and so for the most part, just the US just happen to set most of this stuff up. Can you live in Japan, or in the UK, and have a .com?

STUDENT: Inaudible

Yes, so .coms, .orgs, .nets, just as you Americans, or most of you in America can buy a .com and use it here, so can most anyone else. So there really aren't restrictions on a lot of these TLDs these days. It's sort of broken down. Partly for financial reasons, I'm sure. The bigger audience you have to sell to, the more money you can make. And partly because the networks are getting larger and more nebulously defined, so I'm sure you can site other reasons for it. But, know that it does not necessarily mean that a website is here if it ends in .com anymore. It can end up anywhere.

Back to the list at hand. Somebody is correct, Malan is correct, J is correct. What's wrong with the other 3?

STUDENT: Inaudible

Spacey and Daffy Duck that one won't work.

STUDENT: Inaudible

Dave@cbs is missing the ever-important TLD. The sub-domain you don't need, the TLD you do. Finally, what is wrong with User?

STUDENT: Inaudible

The exclamation. All right, if it looks funny, it's probably not legitimate these days. Periods, underscores, hyphens; plus is valid, though it often has special meaning and you don't see it in most normal people's e-mail addresses.

Netiquette... so, a goofy sort of word that was adopted years ago. What is netiquette all about? And this is very much related to, again, tonight's theme of the Internet and the usage thereof, not necessarily the implementation thereof. What is netiquette?

STUDENT: Inaudible

Yes, Internet etiquette; it's not hard to come up with that word. Do not, if you are new to e-mail (or if you aren't new to e-mail, but have been doing this for years) do not e-mail people in all capital letters. Even if your caps lock key happens to be on by accident, take the time to turn it off, and retype your message, or at least be aware of what is appearing on your screen. I don't do it now so much since we film these lectures, but for years, I would offer family anecdotes (of people in my family who would do these kinds of things, I am not allowed to say who in my family still does things like this, because I didn't realize that the cap lock key was down.) it is considered bad etiquette. What does it imply if you consider an e-mail in all capital letters?

STUDENT: Inaudible

That you are shouting, I mean, more than likely these days, you're a doofus, but it implies you are shouting. All right?

Related to e-mail usage, of course is spam. For a while we had to define spam is. I think it goes without saying what spam is today. It is a huge, huge problem on the Internet, to the extent that it uses up so much bandwidth. But you wouldn't think so based on the e-mails, because they are pretty small usually, a few kilobytes, if even that... a couple of paragraphs maybe a small image attached, but if you send out a million of those small e-mails, and you do it all the time or you send out 10 million of those e-mails because, at the end of the day, marginal costs of sending one more e-mail is pretty much zero cents. That's pretty good marketing technology. If you can, at nearly zero cost, spam thousands or millions of people, even if only one percent of those people are clueless enough as to click on the e-mail, or buy whatever you are spamming them with, 1% of a million, that's a lot of people. It may be worth your while, especially if the cost of doing so wasn't even all that expensive. This is an example of spam. Those of you who are in debt might take heed from this

particular e-mail. You get all sorts these days about debt, Viagra, Cialis... what are some of the other popular ones that you get every day?

STUDENT: Inaudible

Ok, porn is popular too, you get those as well. What else?

STUDENT: Inaudible

For loans.

STUDENT: Inaudible

Oh yes, the Nigerian, what is it? The 409 scam? It has a name that refers to the first part of the penal code that describes those kinds of scams. And you read every year, like an article will come up where people are duped by these things into looking 10s of thousands of dollars, or even their life's savings. Spam, besides being sort of a sociological problem for various reasons, it is also a technological one. Because what are you increasingly seeing in your spam or tell me about a typical spam. It probably doesn't always look like this these days. What do you often see if you scroll down further?

STUDENT: Inaudible

A bunch of addresses, perhaps. What else has perhaps confused you about spam you have received sometimes?

STUDENT: Inaudible

Ok, so it often has bogus return addresses, which is problematic because you don't know until you reply. And incidentally, before I forget, a lot of spam from non-legitimate companies will often include links or instructions say reply to this e-mail with unsubscribe in the subject line to unsubscribe or click this link to unsubscribe. If you learn nothing else tonight, learn that you should never click links in spam to unsubscribe. Because what are you effectively doing by replying to spam or clicking that unsubscribe link?

STUDENT: Inaudible

Right, you are confirming to the spammer that you just got a sucker there. And you are going to get more spam, potentially, because of it. It sounds like a nice idea, to opt out, but generally, if you inform the spammer proactively that I want out, what you are really saying is, "Hi. I exist." Because a lot of these e-mails especially in domains like Hotmail and Gmail and Yahoo, the really popular domains, a clever spammer will just start to e-mail randomly generated e-mail addresses, because if you have millions of customers like Hotmail probably does, well, odds are that even if you guess a lot of them, some of them are going to be d-a-v-i-d or something more cryptic, but nonetheless a valid e-mail address. And so, it's to a spammer's advantage if you proactively tell him or her, "Hey, you got a good one there."

STUDENT: Inaudible

Good question. How do they get e-mail addresses? One is randomness. Two is if you go on E-1's website, you can call 2 or 3 e-mail addresses--- mine, Rei's, the course e-mail address. Any time you publish an e-mail address on a web page, if you are a spammer, you would use what is called a spider, or a bot, which is just a program similar to what Google and reputable companies use to crawl the Internet to index it for subsequent searching, but you can write a bot or a spider that just crawls the Internet, looking for Internet addresses. After all, you, the students, know that any e-mail address is likely to be of one these forms. It's not hard to write a program that just looks for that pattern on a webpage, grabs it, and then sends it to a spammer's data base. So, that's one other way, as well.

STUDENT: Inaudible

If you have a hyperlink on the webpage with which someone can e-mail you, it's the same thing, even if you don't see the e-mail address. It's imbedded in the so-called HTML and a program can find it. You will see that a lot of websites will say e-mail me at Malan and then they may put a space or two, and then they will put @ and then they might say Harvard.edu. I bet that there are enough spammers in the world, someone has taken the time to modify their program to also look for things of this format, and can figure out that you are just trying to trick them. What other websites will do, especially websites like Facebook, or a lot of these personals type websites, where they might list your e-mail address... they won't show your e-mail address as text, they will instead convert it to a JPEG or a JIF, that is an image. So, an image is not something you can just sort of high light like you can with Microsoft Word.

1 hour 30 minutes 3 seconds

You would have to figure out what that image is actually representing. It is similar in spirit to... if you have ever visited those websites, and in order to confirm that you have to type in that cryptic-squiggly words and numbers that are sometimes too squiggly to understand correctly... same idea. The idea with those is that it's hard for a computer to figure that out. Similarly, if you show the e-mail address as an image, it's marginally harder for a computer to figure that out, or at least, it takes more CPU cycles to process that kind of thing.

Personally, I don't care any more about posting my e-mail address everywhere on the Internet. I actually think there's a technological solution to this problem in that though it is very reasonable to assume that you will get less spam if you don't publish your e-mail address in printed forms or on web pages, that's a hard thing to prevent all of the time, especially if you want to keep an e-mail address for years. It only takes once or twice for it to get slurped somehow and then just get propagated through databases. And anti-spam software is definitely getting better. I mean, I use to get probably, 500-1,000 total e-mails a day, many of which are spam. 200 of which are real e-mails. And among those 200 real e-mails that I actually see in my in box, I'd say on a typical day, I get 4-6 spams these days. I think that's pretty good. I'm rarely having to delete them. So, in short, spam detection is getting better, but the fundamental problem is that e-mail is not designed correctly to deal with this problem.

There is no security implemented in e-mail and the fact that spam is such a problem is because there was no forethought given, or at least, there was no... this was not raised as an important issue initially. That's partly because no one saw, or many people didn't see the Internet becoming used by people like you and me. Who's going to want to e-mail a few hundred researchers who are using the researchers who are using the Internet for research purposes? So, that's part of it as well.

Another example of spam... If you are finding E-1 a little too much work, you can call the number on your screen, or you can wait for this spam to arrive, and you can cash out with your degree much more quickly than any kind of university program. And there's a whole bunch of others these days. Only so we can slap another piece of jargon on it... What is an emoticon? Without looking down at your paper...

STUDENT: Inaudible

It's a smiley face. So this is a non-exhaustive list of the emoticons that people have not only come up with a word for, but also all the different emotions that they might express. The only one that we like to point out each year is somewhat apropos is...

Laughter

One of them is funny. This one too, is kind of funny, only because here we are tonight. So feel free to assert any of those as your own in future e-mails.

Ok, so let's do this. Let's pause for 5 minutes so I can turn your attention to one of the white pieces of paper tonight. This is a survey of the course... you know offer sections and workshops. One, we'd just like to get some feedback from you now, for no more than about 5 minutes. I want you to think of the course, the lectures, but more importantly, to be honest, why you are or are not going to sections or workshops. Just to give you the historic perspective, when I was the TF for this course, years ago, we had 3 or 4 sections of 15 or 20 students and 15 or 20 students were attending each night. And we'd like to think that we're not just doing a bad job, these days, but there's more interesting issues involved as to why more students in the class tend not to be as interested in the course's sections and workshops anymore. Perhaps it's more savvy, perhaps it's because of scheduling, but if you can just give us your candid thoughts. Don't put your name on them, that's not necessary. We would love to understand what you like and what you don't like and what's driving you to come or not come to these things. I'll even put on a little bit of background music.

1 hour 33 minutes 50 seconds

1 hour 38 minutes 23 seconds

Feel free to continue jotting down your thoughts until tonight's end. But let me as Rei to come up for a moment and explain this week's sections, which are tonight and Saturday. It's not that I always need to be on film, it's this thing. I'm always in the frame.

Rei- This week's section is going to be on exploring the Internet. This week and next week in lecture, David goes through, rather quickly, the Internet and how things work. And we are going to take a little time to explore things. Both a little bit deeper for those of you who feel comfortable with the pace at which David is going and take a breather to review some things he has already covered for those of you who would like to go, "What?" so, we are going to explore the Internet and talk about how e-mail works. We will talk a little bit about how servers work, that sort of thing.

And this Saturday's workshop will be led by Dan.

Dan- Hi everyone. This Saturday we will have a workshop on the Mac OS. I invite all of you to come. It doesn't matter if you have never seen a Mac before or if think you are quite a bit savvy, I guarantee you will learn something. We will talk about the Mac OS its self. We will talk a little bit about Apple, the company. We will talk the Intel switch. We will answer any questions we have on basic trouble shooting. There is a lot we are going to cram into 2 hours, so I hope to see all of you there.

And finally, this Sunday, we have a back-to-back workshop. Dan's is on Saturday. On Sunday, at 11am, we will all meet, if you are interested, at the Kendall Square T stop, for a field trip of sorts to the MIT swapfest. This is something that happens every month or so up until... I think it's between April and October. We will post a link, for more details, on the website on the lecture's page. But the short of it is, this is a wonderfully fun, low key afternoon where you see a lot of crazy guys who have a whole bunch of stuff in their basements, and garages, and vans, that they drive up to a lot at MIT with, and every month have stuff to give away, to sell. We are talking old electronics, old computer parts, really interesting. You can ask questions of these types of folks who really know their stuff on things about radios, and computers, and other types of systems. So, if you are at all a geek, or you would like to take a stroll through yesteryear's hardware and just have a good time, and we'll all grab lunch or something afterwards. So feel free to attend. We will do RSVPs over e-mail just so we will know how many to expect, roughly. But question 1 on this survey is just about whether you think you will join us this Sunday at 11am. You would be welcome to bring dates, as before, and family, and friends, and so forth.

It turns out that problem set 3, which was distributed this evening, is due this evening, in fact, an hour and a half ago. So, that's my fault. Per the syllabus, this is actually due on Wednesday 25 October so you have 2 weeks, not T minus 1.5 hours to do it. So, my apologies. We will update that on the website for problem set 3, which was just handed out tonight.

So, there are just a couple other things that are in the slides. I'm going to skip over SSH, and SFTP because we will come back to that, but just so we tie... wrap up this discussion, and I want to conclude with a really neat demo. Let's look at the ever enlightening slide on the World Wide Web.

So, what is the World Wide Web?

STUDENT: Inaudible

So, the network of al networks. So, the answer to that is actually no, and this is where you can make a subtle but useful distinction. The Web or the World Wide Web, and the Internet are not the same

thing. So, what you just described, actually, was a perfect definition of the Internet- a network or networks. But the Internet is really an infrastructure or something that takes physical form and is the physical incarnation of what we have described as the network of networks of networks. It's sort of the backbone on which a whole bunch of neat services run. And the World Wide Web is an example of such a service. It's something you can do with the Internet, something on the Internet. I would liken it to other Internet-based services like e-mail, and instant messaging, and podcasting. These are sort of higher level programs, if you will, or services that you do using the Internet; but, the Internet itself that infrastructure underneath the hood. A URL is something that you have typed every day. Here's another thing where I won't name names within the family, do not call the an "Earl" it's really difficult to keep a straight face when someone in your family is asking you to pull up the Earlwww.cnn.com. It is a URL, a Universal Resource Locator, you don't have to know that, but notice that a URL, even though it's the more inefficient way of saying it the canonical form is this. And we will see other incarnations of this. But when you see something :// something, it pretty much refers to a URL. And even though you, a typically user, might only see things that are http:// something, it turns out that you can have some other formats, for other types of services. Most of which, typical users don't use, but one of which you will use later in the course; namely ssh, or even sftp can be written in this way. More on that in the future.

Some examples... all of these are valid URLs... these are all valid addresses of servers. So, essentially, a URL, even though you almost always see it just for the web, it's really just a general way of describing the protocol that you must use to talk to a machine. A protocol, as suggested up there, is just the language that your computer needs to use to access the service. So when you, the user, use Internet Explorer, to pull up cnn.com, the language that your computer and that server are using to communicate is called HTTP (Hyper Text Transfer Protocol), or transfer protocol. This is just like English is to us. We have a way of communicating with each other via the standards known as English. Computers, specifically, web browsers and web servers, have their own language called http. That's what they use to speak back and forth to one another. Think of it as the language that you might have to use to order meals in a foreign restaurant, with a foreign waiter.

1 hour 44 minutes 52 seconds

Meanwhile, underneath that is html, which we will come back to on our website class. Html, by contrast, is the language that web pages are written in. So, whereas you might speak French in a French restaurant to the waiter, if you were to hand him a note, or rather if you were to... this analogy is very quickly going to break down... let's not even try to use an analogy... let's just focus on http, which is the language that web browsers and web servers use to communicate, and leave it at that.

So, some examples of protocols, and sites one can visit are these: foo.com, foo.com (with or without the host name), Capitalization you see in the third row doesn't seem to matter. You can have slashes in URLs. In fact, when you see a slash it's usually because you have something like the example... look at that... none of them have the example... if you have something like http://foo.com/bar/index.html, especially if you are a PC user, you've seen things that actually look like this. But, you've seen things like c:\program files and so forth. They are both just paths. They tell you where something is on the Internet; just like this tells you where something is on your hard drive. Use the language http to access this information. The server is called foo.com and that's also

the domain name, but again, you don't necessarily need a host name. It's up to the server administrators.

This is... take a guess... what does it represent? Think about what this is. This is just a folder on that web server. This is just a file in that folder. And as you see, as you start making web pages in this class, you will be creating text files something.html and in that file you will write your web page. You can put it in a folder in your domain, so it could be davidmalan.com/something/mypage.html. But the only reason you would use folders is just for the reason that you would use them in a local computer, just to keep things neat and tidy, and organized. That's really the only reason. But notice this, you can visit (oh, I'll do it anyway) cnn.com (let's hope nothing bad has happened.) if you visit (can't win) if you visit not just CNN, just notice it's going to be small text, cnn.com/index.html (I'm really going to have to pick a new demo for next year, like yesterday's news) index.html tends to be the default name for most home pages. So, even though you don't have to type it, because in the absence of specifying what file you want, a web server will usually give you some default file name, which happens to be (as you see here) index.html. But more on that in our Internet class. I'm going to close that headline so we can get back to this.

So, with that said, and we will focus some just on a couple of these before our final demo. Which of these are syntactically valid?

First one?

No. the slashes are in the wrong direction. Another way to make sure that tech people don't laugh at you behind your back... this is a forward slash, this is a back slash. Do not confuse them. It's a silly semantic thing, but if you start calling a forward slashes back slashes, and back slashes forward slashes, the person (if they are technophile) that you are talking to, you are going to lose some credibility very quickly. I actually have an example photo that I will bring in next time. What you also don't want to do is make mistakes (not even verbally or semantically) but when I was home in Connecticut once, I went with my mom to Bed Bath And Beyond, and they had in their window, a really big and probably expensive poster advertising their new web site as bedbathandbeyond.com. it's probably a \$200-\$500 sign in their window advertising their website. Visit us at www.bedbath&beyond.com that is bad marketing. That is not a valid URL. You type that into a web browser and you will not go to Bed Bath And Beyond. The obvious reason, perhaps being, what is not allowed in URLs? The ampersand. I don't know what marketing genius got this wrong. When you are advertising your company, it's best to advertise the correct URL. That will not work... that is, in fact, a-n-d they meant to write. So, it's a funny thing. There too, if next time you walk into Bed Bath And Beyond, just smile to yourself if the ad happens to be up and try to explain to the manager why it should really come down. Frankly, we tend to make fun of it. But a stupid little thing like that, if you are an uninformed user and you say ok... bedbath&beyond... you pull this up and it doesn't work. That's bad business. You are probably not going to go back at least not for a while. So, sales might be lost.

The second one. Www.bar.com... so, this is sort of a trick question. It's not officially a URL because it is missing the protocol specification. But, it turns out these days, you don't need to type it, at least in a browser. Technically, when you visit a web page like we just did with CNN, you are visiting a URL. But most of us don't bother typing http:// any more because you just don't need to.

Browsers, if you don't specify a protocol, assume that you want http, because you are using a browser in the first place, after all.

It turns out that there are other types of URLs. FTP is another protocol... file transfer protocol. You will use this later in the term. But that's just a program with which, whose sole purpose in life, is to copy files from your computer to some remote server. You would access that via ftp://

But this last one is not valid. Why is it not valid?

STUDENT: Inaudible

Wrong slash. So, one slash rather than two actual slashes.

What I will do is keep a few remaining things for next time, but in the remaining 2 minutes, I just wanted to wow you. If you have never used this before. So, let's very quickly... when you've had to look up directions, what websites do you tend to use these days?

STUDENT: Inaudible

Ok, I heard Google Maps and Mapquest. So, Google Maps tends to be the best. Not necessarily in terms of the directions they provide, but in the aesthetics. The maps, I would say, subjectively, look so much better than Mapquest or Yahoo's ever did. And that's enough reason, I think, to try this site out. If I search of 1 Oxford Street in Cambridge Mass 02138, the beautiful thing about Google maps, like these other sites, it whisks you, right away, to it. And then you can scroll around. You can zoom in. These days you can actually click satellite, and actually get a satellite version of the same area. And this is literally going to be a 60 second teaser. If you think things like this are cool, the note I would like us to end on tonight is another one of these applications, these services.

We talked, initially tonight, about networks and the Internet, and then a couple of services on top of it (the most popular, perhaps), e-mail, and the web, and we used Victor as an example of Skype, VOIP- Voice Over IP is another program. Well, if you download, and this is more of a software product than a specific service, if you like this sort of thing, and we will provide a link to it, Google Earth, which is actually software that Google bought from another company. I spent 2 hours this afternoon, preparing the lecture looking up, with this program, for one thing... we can type in again, the science center... ok, that was helpful... there we go...if you can see that... ok, let's go back to this view... there we go... Where is the science center on Earth?

STUDENT: Inaudible

So you can even zoom in for (and I swear to God that this whole lecture would have been about this program had we started with it and not ended with it. This is my way of self-regulating.) Here's the Harvard science center. You are roughly over here in the building, where the cursor is. Cambridge Massachusetts might be fine, but let's just for the sake of it, zoom on over to.... Venice. This is just a brilliant interface and the coolest thing I've seen today, frankly. And her ewe are in Venice.

I was taking a little vacation in my apartment this afternoon. So, here's Venice. You can zoom in and zoom out. You can change angles, and the software sort of interpolates things. Things will look very flat and that is not what Venice looks like. It is sinking, but it not entirely flat. But the software, and this is an example of really neat tricks with really fast processors, is giving you different perspectives based on its inferences of what the landscape looks like. Italy is interesting.

Let's zip on over to New York. And again, we will provide you with a link to this on the website. It is entirely free. It takes a couple minutes to download. You install it. It's a wonderful way of spending time in the middle of the day, frankly with kids too, I think they would get a real kick out of this too, and the reason I brought it up this afternoon, is I'm auditing an archeology course at the college this semester. And the professor used, for the first time today, used this to show us the pyramids of Gaza, the... oops, I've got a really cool one...

Here we go: the great sphinx. And the photography, the aerial photography and satellite imagery isn't perfect. You can't totally zoom in and see things like you could on the ground, but my God, from an apartment in Boston, to be able to take this virtual tour of the world with such a neat clean interface. There you see it, the great sphinx.

On that great wow factor, why don't we call it a night and we'll see you next week.