Geointeresting Podcast Transcript

Episode 23: Vint Cerf

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Welcome to Geointeresting, presented by the National Geospatial-Intelligence Agency. For today's podcast we sat down with Vint Cerf, chief internet evangelist for Google, who's widely known as a father of the internet. Cerf's career spans for more than 45 years, from his work on Arpanet, a predecessor to the internet, to leading the engineering behind the first commercial email service. He spoke with us about his role in the creation of today's internet, how this connectivity has impacted society and what he sees for the future of technology. Stay tuned for Geointeresting.

NGA: Thank you so much sitting down with us today. We're excited to have you here.

Vint: Well, I'm looking forward to this conversation.

NGA: Good! Well, I was wondering if you could start by telling us a little bit about your role in the creation of Arpanet and the transition and to what we now know is the internet. Did you realize the magnitude of it at the time and just how much our society would come to rely on it?

Vint: This is question 101 actually; a lot of people wonder about that. I was a graduate student at UCLA during a period when the Arpanet was being built. I didn't have anything to do with the design and construction of the packets, which is, if you recall, the interface message processors, or IMPs for short. That was done by a company called Bolt, Beranek, and Newman in Cambridge, Massachusetts. One of the primary architects of the Arpanet packet switch IMP, was Robert Kahn, who later figures very significantly in the development of the internet. He and I met when I was at UCLA. I was the guy writing the software to kick the tires of this Arpanet idea. The success of the Arpanet led the Defense Department to speculate about the use of computers in command and control. One of the people whose idea started the Arpanet project was JCR Licklider, who was actually a psychologist; he wasn't a computer engineer. He knew a lot about acoustics and became part of the Bolt, Beranek, and Newman crowd because that's what they focused on for quite a long time. His idea was that computers could be used for non-numerical processing. Indeed, as the Arpanet project unfolded, a lot of non-numerical processing was done; network electronic mail was invented by Ray Tomlinson in 1971, resting on the shoulders of other similar kinds of messaging system, but they only ran in one tiny shared machine. Bob Kahn left Bolt, Beranek, and Newman in 1972 and joined Arpa, and he started a program he called Interneting. He came out to my offices at Stanford University in 1973, the spring of '73, and announced that we had a problem. Of course my reaction was, "What do you mean 'we'?" He said, "Well, if we're going to use computers in command and control, we'll have to put the computers in airborne vehicles, ships at sea, and mobile vehicles, not just fixed installations," which is what the Arpanet was used to serve. So we spent six months trying to figure out, how would you make a bunch of different kinds of packet nets, packet radio, packet satellite, the Arpanet, and by the way, ethernet, which was invented at Xerox park, in 1973, by Bob Metcalfe, in May of '73, about a mile and half from my office at Stanford. So we have at least four different network technologies that we were trying to figure out how you would meld together. The solution to that problem became known as TCP

transmission control protocol, which after several iterations, turned into TCPIP — we split off the internet protocol from the original TCP layer. The question then is, what did we imagine was going to happen? I think the Arpanet experience informed our expectations of internet. Now you might wonder, well, do we have any idea how big this is going to get? I think the answer is yes, we did. We couldn't be assured that it would become a global phenomenon, but we knew it would have to work all around the world to support the military's needs because the military's needs could be anywhere on the planet. We designed it to be global in scope. We carefully did not use national identifiers, as are used in the telephone system, because we figured the military had to be able to show up anywhere in the world and execute in command and control. We certainly wouldn't want to have to go and ask the country you're about to invade for access to its internet address space in order to do command and control; that would be silly. So I think it's fair to say that we had a fairly rich sense that this had to be globally accessible; it wasn't commercially available, however, until 1989. From my point of view, that's like 16 years into the program, from '73 to '89. In that year, commercial services were started, with the permission of the federal networking council, and of course, the net took off in even more dramatic ways after 1991 when Tim Berners-Lee at CERN in Switzerland, in Geneva, developed the World Wide Web.

NGA: It's interesting because talking about the commercial side of it, we're going through a sort of similar thing now in the geospatial realm with all of these companies coming into the market —commercial, small satellites and everything. What do you see as that for the future for this industry? How do you think that will change what we do? What do you think?

Vint: I'm sure that it will change what you do for several reasons. The first thing I would observe is that in the history of geospatial imagery, satellite-based imagery, it's not an inexpensive business to launch a satellite and gather the data.

NGA: The government was the only game in town.

Vint: That's correct, and what is interesting here — and it's a phenomenon we must be sensitive to — is that just because it costs a lot of money to get the data does not necessarily mean the data is valuable. We need to make a distinction between value and cost, and that means as the evolving, online and open-source environment continues to grow, a great deal of open-source information may be free of charge and quite valuable, especially if we combine it in smart ways with data that is harder to get. So we want to be smart about how we integrate information that we obtain from open sources and how we understand what the implications of that data are to do that we need all-source intelligence. Of course, NGA contributes in a very special way to part of that all-source initiative.

NGA: Given your work on the Arpanet project, you're obviously no stranger to federal government investment in innovate technologies. How do you see the government and the private industry working together, and how can we best work together to innovate?

Vint: The U.S. government has not only the capacity, but maybe even the obligation to undertake research, which is very risky; which is too risky for industry to attempt. For example, if you think about it, the Arpanet project started in 1969 [and] Arpanet returned in 1990 — that's 21 years. The National Science Foundation got involved in 1981 or '82 [and] they're still involved today; here it is, 2017. The NSFnet, one of the major backbones of the internet, was

started around 1986 or so and was not returned until 1995, so were talking 8, 9, 10 or many, many decades of persistent investment in development of these new technologies. Most industries are incapable of making such long-term investments, so the government role is to take risk in science and technology and engineering. Remove as much risk as possible to the point where the venture-capital guys are willing to accept the remaining risk in order to launch a business. I think the government can actually push that just a little further, it might get out of [inaudible] and into prototype and things like that. Because by removing risk, you encourage investment by the private sector. So the partnership there is this significant risk taking for high pay off, high-risk work, followed by significant investment in expansion. The internet is a good example of that. I'm sure that we have enough, all the money spent on the private sector, compared to the amount spent by the U.S. government, across all the various networks that contributed to the internet and all the applications and protocols, that the U.S. government investment will be dwarfed dramatically by the amount of money spent in the private sector. That continues to be true today as the internet penetrates into economies that are still developing.

NGA: Speaking of the internet, obviously, connecting all of us, it's really kind of broken down some of those geographical barriers in that we now have access to information all over the world. In some ways that's really good, and in other ways it opens us up to vulnerabilities. So what do you think are some of the biggest pros and cons of that connectivity?

Vint: Those are very good questions. It's pretty clear that when the WWW was finally launched and became visible, especially in [inaudible] communications, that an avalanche of content showed up on the internet from people who just wanted to share what they knew. This avalanche of content stimulated several things; first of all, the web made it easier for people to put information into the system. They had to learn how to write HTML, so we had applications that more or less did that automatically. Then there was so much information that search engines had to be developed in order to find things that were [inaudible] on the internet. But the striking thing to me [is] that as the web expands, people are discovering each other, even if they didn't know anything about this other party, except they met on the common website and discovered they had a common interest. This sharing of information is pretty dramatic. At the same time, the interconnecting of every computer on the face of the planet also opened up vulnerabilities, especially when you think about personal computers — who are thought to be personal computers and weren't connected to anything; it was your computer that you used in isolation. A lot of the software that went along with first-world computing didn't contemplate the possibility that they're connected to every other computer in the world, possibly vulnerable to various forms of malware. Malware was not invented on the internet. Malware was around floppy disks; people would copy programs or share things that maybe they shouldn't have. Some people knew that, so they would put viruses and worms on the disks, and when the disk booted up, the malware came with it. That wasn't new, but we do have serious problems with abuse on the network, and people make use of their ability to access anything anywhere to attempt to penetrate or to install key loggers and Trojan horses and things like that. So this is a big challenge for people who write software; internet-connected things. And as the internet of things begins to expand, that same power will rise and has already. So we have new responsibilities as programmers to pay a lot more attention to vulnerability in the software, but also ordinary users have to start paying attention to safer networking. So one of the things I'm pleased to see is increased attention to what's called two-factor authentication, and the government uses their Common Access Cards with their chips in order to identify ourselves

strongly to the system. At Google we issue similar kinds of chips that you can plug into your USB and strongly authenticate yourself. So even if someone gets your username and password, they still can't get in because they don't have your chip. These sorts of concepts of safely networking have to impenetrate the general public, in addition to being a responsibility of the programming community, to minimize the amount of bugs that can be exploited. It does raise one other interesting problem; if we have the zillions of devices in the internet of things, it's almost certain that whatever software is there has bugs in it. We're going to have to figure out how to upgrade the software to fix the bugs. Now we have to make sure the devices ingesting the software can figure out whether the software is coming from a legitimate source as supposed to a hacker. There's a whole ecosystem that needs to be further refined if we are going to take make use of this global and connected environment.

NGA: What do you see as the future of that global connected environment? Where do you see us going?

Vint: First of all, it's been very interesting to watch various technologies emerge into the internet. When Bob and I were doing the original design, when we got to the internet protocol wire, one of the things we very carefully decided was that the packets of internet would not know how they're being carried, just like a postcard doesn't know whether it's going in an airplane or a bicycle. That's important because every time new communication technologies have come along, the internet protocol just sits on top. So the internet keeps ingesting new communication capabilities, and in some sense, mobiles, particularly smart phones, were invented just 10 years ago, in 2007 — they were internet enabled and the consequence of that is that suddenly, we have mobile access to the internet, access wherever we were that we could get a signal, and that opened up use of the internet anytime, anywhere. It also meant that the content of the net was made available to the mobile, which reinforced the value of mobile; that we'll see more high-speed mobile radio communications and we'll see a lot more sharing of radio spectrum. We'll certainly see many, many more programmable devices showing up at home and work and in cars and maybe even on a person or even in a person. We'll be just surrounded by software and communications, which means that we will also have to be a lot more attentive to protect the abusive behaviors; abusive practices. So it's going to be one of those never-ending chores to keep people safe.

NGA: Great. Well, I really enjoyed talking to you today. Is there anything else you want to add for our listeners?

Vint: I want to say to people who are listening, especially if they are a part of intelligence community — their work is very much appreciated. They don't hear this often enough, for ordinary citizens like me, knowing a little bit about what it takes to gather good-quality intelligence and operating essentially in the shadows, these people should be told how much their work is appreciated and how much we depend on them to keep our country safe.

NGA: Thank you so much. We appreciate you joining us today.

Vint: Always a pleasure.

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