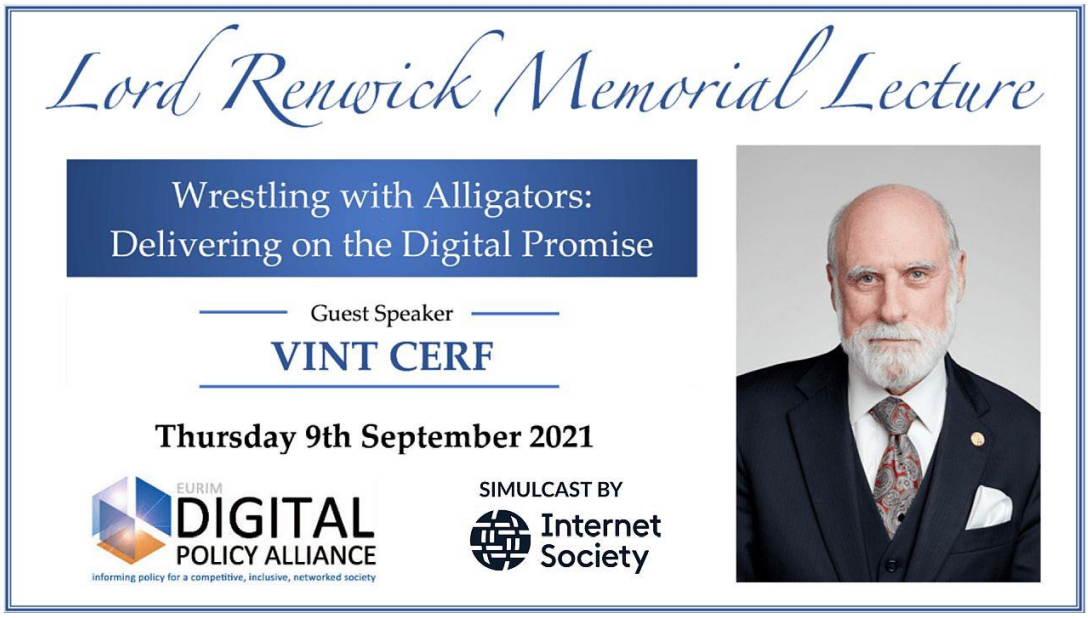

Inaugural Lord Renwick Memorial Lecture with Vint Cerf

9th September 2021

Lord Erroll
Hello, everyone. A very warm welcome to this inaugural lecture, in memory of Lord Renwick.

I want to first inform you this lecture is being live streamed and recorded for posterity. And if you want to ask a question, please use the q&a button, and our co director Derek Wyatt will put questions to Vint Cerf after the lecture itself.

Lord Renwick, Harry, founded the European Informatics Group in 1993 as an offshoot from PITCOM, which was the all party parliamentary group, and EURIM was to carry out research into IT issues and produce papers for parliamentarians to brief them, and this became the present Digital Policy Alliance, which I chair today. Harry was our president, but sadly he passed away from COVID-19 in August, 2020, and to honor him as the renowned technology advocate and visionary that he was, the DPA will host an annual lecture in his memory, exploring the digital future and where it might take us. Now, I would like to ask Homayoun, Harry's widow, to say a few words in Harry's memory before I introduce Vint. Over to you, Homayoun.

Lady Homayoun Renwick
My Lords, Ladies, and Gentlemen, I am delighted that the Digital Policy Alliance is marking the life of my beloved departed husband Harry by holding an annual lecture with such a prestigious

inaugural speaker as Vint Cerf. They have both shared the passion of harnessing innovation, while respecting the need for morality and global humanitarian aims. Harry was a champion of special needs education. The freedom of individual without total reliance on machines, and man, not continue to pollute the universe. Long may his legacy continue. My thanks go to Lord Erroll and his team members, past and present, for all the friendship they extended to Harry, and for creating this special memorial for him. Thank you.

Lord Erroll
Thank you very much indeed, Homayoun, for those kind words and setting the scene. Now I want to introduce Vint Cerf. I suspect the name of Vinton G. Cerf is known to all of you, as he's known as one of the fathers of the Internet, and he's now the Vice President and Chief Internet Evangelist for Google. He's held numerous positions, MCI, Corporation for National Research Initiatives, Stanford University, UCLA, IBM -- I don't want to give you an endless list, if you really want to know, go and google it, and you'll find it really easily -- but he's widely known as one of the fathers of the Internet. He and Bob Kahn designed the highly resilient Internet and its protocols so well that we're still running on the trial version, as you pointed out in London a few years ago, when he was asked about why it was only designed for 2 billion addresses.

So, it just shows how good the design and the vision of a couple of people can write better software, than having huge armies of people thrown at it. Anyway, I won't belabor my point, I just have a bee in my bonnet about [unintelligible]. Closer to home for us, he received the ACM Alan M. Turing Award, and he's also received the Queen Elizabeth II Prize for Engineering. He holds numerous degrees, honorary degrees from several universities, I won't bother to go into. What I really want to do is let him get into his subject today which is 'Wrestling with Alligators: Delivering on the Digital Promise', and he will take us through how the benefits of digital technology have been broadly demonstrated, but it's lowering barriers to access that's going to make the difference in the future, and the problem is also how we deal with the harmful behaviors as well as the good things. So, I think, over you, Vint.

Vint Cerf
Thank you so much. Now I have to work on getting my speech in front of me. Sorry for the momentary fussing. There we go.

Chairman Erroll, Vice Chairman Wyatt, members of the board of the Digital Policy Alliance, distinguished guests, ladies and gentlemen, it's a great honor and challenge to offer the inaugural Lord Harry Renwick lecture. The second Baron Renwick of Coombe was the champion of the UK and EU interests in information technology, urging attention to privacy, encryption policy, legal

jurisdiction, intellectual property rights, and data protection in 1997, as the so called 'dot boom' exploded across the virtual landscape. It seems entirely fitting to consider now five alligators of the Internet in honor of Lord Renwick's prescient vision.

Why alligators, you might ask? There's an old story about a man sent to drain the swamp. His boss calls about six months later, how are you doing draining the swamp he asks. Well, when you're up to your ass in alligators, sometimes you forget your job is to drain the swamp. I have been up to my rear end in Internet alligators from the very beginning, and I have come to know great many of them better than I would have liked.

While many parsings are possible. I have chosen to partition the range of Internet challenges into five categories, each reflecting a variety of domains demanding attention. These are technology, regulation, institutions, digital divide, and digital preservation. This is not a complete list by any means, but enough to reflect the extraordinary impact of the Internet on so many aspects of 21st century life. In the time available I will only be able to explore the first two of the five alligators.

So, alligator number one, technology. In 1968, the American Defense Advanced Research Projects Agency began work on a project to explore the use of packet switching technology for inter computer communication. At the time the agency was supporting research at a dozen or so, universities, and wanted to do ensure that all the researchers could share their computing resources, software, and research results, so as to speed progress in Computer Science and Artificial Intelligence. Thus was born the ARPANET project, the Advanced Research Projects Agency Network. Bolt Beranek and Newman, a research company in Cambridge, Massachusetts, won the contract to build the ARPANET. Each packet switch was a small refrigerator sized computer called an Interface Message Processor. The packet switching concept was drawn from work at Rand Corporation, MIT, UCLA, and the National Physical Laboratory in Teddington UK.

Packet switching technology might be characterized as electronic postcards, because much of what we know about postcards applies to packet switching. Each packet has a to address, a from address, and some content. Like postcards, digital packets can be lost and get out of order. They may even be duplicated as a result of retransmissions if the system thinks one was lost. These electronic packets do not know how they're being carried, it could be wires, radio, optical fiber, nor what they are carrying, just a payload of uninterpreted digital bits, and this ignorance confers surprising benefits which we will revisit shortly.

The ARPANET project was extremely successful, and led to the early development of networked electronic mail, remote interactive access to timeshared computers, and digital file transfers. What

is particularly important to recognize is that the IMPs formed a homogeneous network of packet switches, but this network connected a wide range of different brands of computers that were not naturally compatible or able to exchange information. The demonstration of the ARPANET in 1972 at the International Conference on Computer Communication in Washington DC is a major milestone in packet switching technology history. Overcoming the heterogeneity of the so-called host computers on the ARPANET was a defining success in the history of computer networking.

Concurrent with the ARPANET project, an experiment in digital radio communication at the University of Hawaii introduced another kind of packet communication technology. The ALOHAnet developed radio terminals that shared a common radio link -- think about taxi radio -- to communicate with a central computer. Each keyboard terminal had a radio, and it would transmit to the central host which was called a Menehune, which is Hawaiian for IMP, whenever it had a line of text to send. Since many terminals shared the common radio link there could be collisions at the receiving central host. The clever strategy of the ALOHAnet was to wait for a response on a different radio channel from the central host and, after a timeout, retransmit the line of text. If the failure to respond was a result of a collision, the standard would randomly vary the delay for retransmission to try to avoid a second collision. While not very efficient, it worked -- as long as the offered traffic was roughly not more than about 1/6 of the actual capacity of the radio channel.

Interestingly, a researcher involved in the ARPANET project visited the University of Hawaii, and saw this ALOHA idea in action, and returned to the Xerox Palo Alto Research Center in 1973 to invent a high speed version of this protocol on coaxial cables that he called Ethernet. Despite skepticism, this idea worked extremely well, especially because it was possible to detect a collision on the wire almost instantly, so as to minimize the period of collision rather than having to wait for a timeout. Retransmission was randomly scheduled just as in the ALOHAnet. The success of the ARPANET project, which continued until 1990, led directly to several ancillary developments.

Once it was clear that heterogeneous computers could be interconnected by a homogeneous network, and successfully interoperate, DARPA initiated a new project it called 'internetting'. The idea was to allow different kinds of networks to be interconnected in a network of networks, and to allow essentially an unlimited number of networks and computers to interwork. Two new networking technologies were added at this time, a mobile packet radio network, and a shared satellite channel packet satellite network, think Ethernet in the sky. Together with the Ethernet, these outlined the challenge of designing a system to accommodate existing and still to be invented networks in a common framework we now call the Internet.

To achieve this objective, the Internet concept introduced gateways to interconnect the disparate packet switched networks, and a suite of protocols, to make uniform the interface to the network of networks, as seen by the hosts on each network. Through several design and test iterations, two protocols were developed, the Internet Protocol, which we call IP, and the Transmission Control Protocol, which we call TCP, and a number of application protocols, borrowing heavily from the ARPANET experience. The IP layer protocol provided a best effort packet communication service, the protocol had the benefit of being able to deliver data quickly, if not reliably and in sequence. For real time applications such as packet speech, video, and radar, low latency was more important than sequenced reliable delivery of the packets. To support applications requiring reliability and sequenced delivery, such as remote access, file transfer, or electronic mail, TCP would discipline the potentially unruly stream of IP packets.

The IP layer provided a way to refer to any host on any network with a numerical IP address, that included a combined network and host identifier, that was understood by all the hosts and gateways. IP packets were encapsulated as payload in local network packets, and then routed either to the destination hosts, or to intermediate gateways that would decapsulate the IP packet from the underlying local network envelope, determine where the IP packet should go next, re-encapsulate the IP packet in the payload of the packet format used in the next hop network.

For the benefit of human users a scheme was developed to associate the numerical addresses of the IP layer with text based domain names such as the familiar www.google.com, or dpalliance.org.uk. The so-called Domain Name System forms a distributed hierarchical and expandable database that maps domain names into IP addresses for the benefit of protocols at the application layer of the Internet architecture.

As was mentioned earlier, the IP packets have no idea how they're being carried, or what they are carrying. This ignorance had the benefit that, when new networking technology was introduced, no changes were needed in the Internet Protocol, since the IP packets were encapsulated in the payload and format of the new packet switching technology. So, optical fiber, Wi-Fi, 4G, 5G, free space lasers and a range of other transmission technologies, are now in use carrying IP packets around the world, and off the planet. Moreover, and equally important, the new applications do not require changes to the Internet Protocol, because the IP packets do not know the meaning of the bits they carry. Only the hosts that the edges of the network interpret this information at higher layers of protocol. As a result, new applications do not require changes to the Internet Protocol, and the Internet has seen a plethora of new applications developed, among the most important of which is the World Wide Web.

The World Wide Web introduced a new layer of protocol called the Hypertext Transport Protocol running over TCP/IP, and an information encoding scheme called Hypertext Markup Language, as well as a way of referencing content in any host on the Internet, called a Uniform Resource Locator. It would be hard to overstate the importance of the World Wide Web, it opens up a vast array of new application development opportunities that worked, especially, anywhere the Internet went. The success of E-business can be attributed to the World Wide Web and this introduced its own collection of alligators, some of which we'll encounter later.

Just getting the Internet to work was an alligator unto itself, but there were other alternatives, leading to another kind of alligator wrestling -- the protocol wars. In truth, these were simply competing alternatives to the Internet which had their own varying successes and methods. In 1978, the Organization for International Standardization introduced a competitor to the Internet Protocol suite called the Open Systems Interconnection model, or OSI. These were layered, as were the TCP/IP protocols, although there were seven layers to OSI, physical link, network transmission session, and application, versus five for the Internet, physical link, network transmission, and application. During the period from 1978 to approximately 1993 these two protocol suites vied for national and private sector attention and endorsement.

The arrival of the Mosaic graphical user interface web browser in 1993, and the subsequent formation of Netscape Communications in 1994, and its wildly successful initial public offering in 1995, triggered the Internet 'dot boom' in the United States. By 2000, many startups ran out of capital, so-called 'dot bust' but, by that time, the Internet was taking off around the world.

By 2007, the mobile phone, that had a history parallel to the Internet, was transformed by the introduction of the smartphone in the form of Apple's iPhone. Ironically, the mobile phone project began at Motorola in 1973, and went live in 1983, exactly in sync with the Internet. The two were dramatically joined by the smartphone. These two technologies reinforce each other. The smartphone and 3G, 4G, and 5G wireless services, made the Internet more accessible from more places, and the Internet made the smartphone more useful, thanks to millions of applications supported by the Internet, and reachable from the smartphone.

The success of Ethernet for local area networking led to a number of explorations of local networking technologies, among which what we now call Wi-Fi is included, standardized in the IEEE as 802.11. Wi-Fi is widely adopted by business and residential users as a convenient way to access the Internet at high speeds. Early work on wireless local networking culminated in 1997 with the first 802.11 standard, which has evolved to achieve gigabit levels of speed in recent years, paralleling increases in optical fiber and coaxial cable speeds.

Satellite communication for access to the Internet reaches back to the first experiments with the Internet's design. At that time the packet satellite system used the geosynchronous Intelsat-4a, over the Atlantic Ocean, to link western Europe to the eastern United States. A commercial service ViaSat also uses geosynchronous satellites and, since that time, Medium Earth orbit services such as O3b, and Low Earth orbit services such as Starlink and SpaceX, have become available. Other similar LEO services are planned or in development, including Kuiper, Oneweb, and others. If these various services prove successful, it may become impossible to avoid Internet access in the future.

Now we come to the alligator number two. The Internet has benefited from a largely unregulated history. It began as an experiment, and was viewed, at least in the United States, as an example of an unregulated value added service. The American Federal Communication Commission as far back as 1966 began considering notions of pure communication and pure data processing in its Computer I proceedings. It quickly became apparent that there were many hybrid applications that involve the use of data processing to add value to the otherwise pure communication offerings. The presence of a rapidly growing number of hybrid applications led to the Computer II inquiry in 1976. Computer II drew a sharp distinction between basic and enhanced services. Most of the hybrid operations fell into the enhanced category, and the FCC chose not to regulate these in the same way it had adopted [for] regulation of traditional telephone services. This hands off approach contributed significantly to the rise of the Internet, and its many service providers, as well as the Internet hardware and software industries that contributed to its infrastructure.

By 1985, the structural separation concepts that distinguish basic and enhanced service providers morphed into the Computer III inquiry, that introduced an alternative to structural separation, namely comparatively efficient interconnection and open network architecture. The latter led to such ideas as intelligent networks, and advanced intelligent networks, that exposed internal features of the network to users who could fashion their own mix of switching functions from these now accessible features. This was the polar opposite of the Internet design, which focused applications in the computers at the edges of the network, and limited the functions of the underlying Internet to provide the very simple best efforts Internet Protocol service. Neither intelligent networks nor advanced intelligent networks gained much success in the marketplace, and were overtaken by Internet style simplicity.

By 1996, the US Congress undertook to amend the 1934 Telecom Act with a major revision. In principle a major objective of this act was to increase competition by allowing for non facilities-based Competitive Local Exchange Carriers to offer services based on access to wired facilities-

based carrier assets. Unbundling of these assets did not work as planned, and the facilities-based carriers emerged victorious in the wireless space. There's been more success with a number of Mobile Virtual Network Operators offering resold services to consumers and the private sector.

Concurrently, the US Congress passed a Communications Decency Act that same year, in which Section 230 was designed to shield application service providers or platforms from much responsibility for user-generated content. The theory of the time was that the Internet, and the growing World Wide Web, were still very young and their evolution should not be prematurely constrained. 25 years later, we now confront alligator number two in Europe, the UK, the US and elsewhere, that sees the harmful potential of applications using the global Internet, and which wants to do something about it. There's ample evidence that anonymity or even pseudo-anonymity and open networking have empowered harmful behaviors and practices that include malware, hacking, ransomware, misinformation, disinformation, fraud, bullying, stalking, Dark Web criminal activities, loss of privacy, and a host of other activities that lead many governments to take steps to protect their citizens from harm. On the flip side, there are authoritarian governments that consider freedom of expression, virtual assembly, social networking, and collaborative activities to be threats to their regimes.

Ironically, both perspectives lead to an interest in controlling what activities can be undertaken online. It's also stunningly clear that the openness of the Internet, so-called permissionless innovation, and freedom to implement global applications on a wide range of networks, devices, and platforms, has produced a cornucopia of benefits. The challenge of this particular alligator is to find ways to protect citizens from online, and often consequent offline, harm, while preserving the demonstrated value of access to global computer networking, computing, and information services.

The Internet's design makes this problem particularly knotty. The IP addressing structure is deliberately non-national, unlike the country codes of the telephone system. Consequently the packets of the Internet transit international boundaries without scrutiny for the most part. The so-called Great Firewall of China does its best to monitor and filter or block traffic when it is considered in the Chinese government's interest to do so. Other countries have similar desires, regardless of the motivation. Concerns over the content of the Internet and the World Wide Web have led to substantial debate over regulatory reform, in the name of safety, security, privacy, and preservation of competitive business environments. It seems inescapable that international agreements must be reached if the users of the Internet are to be protected.

Despite significant advances in the use of cryptography to preserve privacy and to offer strong authentication of identity and increased attention to security of software, it's still the case that a perpetrator can be in one jurisdiction, and the victim in another. The obvious consequence is that identification of harmful actors, whether persons, organizations, or governments, is difficult without some degree of international cooperation. The Secretary General of the United Nations António Guterres is calling for a Roadmap to Digital Cooperation, leading to the successful achievement of the UN Sustainable Development Goals, that include the safety and security of citizens in digital environments. The existing mutual legal assistance treaties, while well intentioned, have proven to be ponderous relative to the speed of the Internet. The challenge is to improve responsiveness, while not losing the concept of due process that protects citizens rights. If ever there were an opportunity for innovation, this is one area that could use it.

Now let's turn to alligators three, four, and five -- institutions, the digital divide, and digital preservation. These topics deserve their own hour each of discussion.

Regarding institutions, it's important to appreciate that many of the institutions associated with the Internet have been created only as the need became apparent. There are many, and to name a few, I would include the Internet Architecture Board, the Internet Engineering and Research task forces, the Internet Society, the Internet Corporation for Assigned Names and Numbers, the five regional Internet registries, the 12 root server organizations, the various network operators groups, and the international and regional or national Internet Governance Forums. Other organizations have undertaken roles in support of the Internet, among which are the IEEE Standards Organization, the International Telecommunication Union, the Organization for International Standardization, the European Telecommunications Standards Institute, the Third Generation Partnership Project, 3GPP, and many others whose mandates touch tangentially, and sometimes more directly, on the interests of Internet users and providers.

The digital divide is a term that originally described access to computing capabilities, but now covers a vast range of inequities. I have to believe we should measure the divides not in absolute terms, but as relative measures of capacity and utility. Dimensions that I would include are privacy, speed and performance of Internet access, cost of access and necessary equipment, range of applications that are supportable, attention to local language and culture, policies facilitating Internet utility, regulatory posture, security and safety and reliability. It's also important to recognize that access to reliable sources of electricity may be just as important as these other considerations.

And finally, digital preservation is an alligator of many dimensions as well. The longevity of digital media have not equaled stone, clay, and vellum and, if anything, they're going in the wrong direction. Worse, many digital objects cannot be accessed or used without running software -- think about spreadsheets, video games, and web pages -- software may not run on the operating systems of 100 years from now, or even next year. It's possible that it will prove necessary to emulate old hardware, to run old operating systems, to run old software, to gain access to the use of old digital objects. Intellectual property rules, copyright and patents, make it impossible, or at least expensive or difficult, for archives to provide users with tools they need to use aging digital content. Perhaps changes in intellectual property treatments will be needed to allow long term archiving of digital material. Finally, there's a question of cost, there appears to be exponential growth in digital content, think trillions of digital photographs and tweets. So, what business models will allow individuals, organizations, and governments to preserve useful access to more and more digital content over decades and even centuries. Some information is vital to retain, think National Archives, real estate transactions. And before you say it, let me assert, blockchains are not the solution to everything, although I will stop short of saying, anything.

Thank you so much for your patience and for giving attention to the alligators of the Internet. I hope many of you will have a role to play in wrestling them into submission.

Thank you very much.

Derek Wyatt
Well, now I'm just going to check the technology, can you hear me all right, Vint?

Well thank you for that. If there was a Netflix series we should perhaps start to work on it now. I think you should be the host and the writer. But let me just talk about a couple of pre-alligators. So in 1948, Paramount was dissembled, in 1984 AT&T -- at least there was an attempt to assemble it by the Department of Justice. Here we now have the Department of Justice, looking at Apple and all the all the west coast things. Where do you think that's going to go to? And how soon?

Vint Cerf
We've seen examples of this sort of disassembly, and we've seen what happened as a result. Some of your visitors today will remember the Terminator movie series, and in the second serie,s Terminator 2, this robot is frozen and blasted apart in liquid helium or nitrogen or something, and then reassembles itself. Well, we watched the AT&T baby Bells reassemble themselves into an almost unique whole, now we have the former AT&T still exists, and Verizon is the other. So, it's not clear whether breaking things apart necessarily is a permanent solution to anything. I think

there will be persistent concerns about maintaining competitive environments, and that signal is very clear, at least here in the US, and perhaps also in Europe and the UK, but I hope that the evaluation of scale does not shield from an understanding of the economy of scale, which is driving a great deal of the growth of these companies. There really is a true economy of scale there just as there is in manufacturing. Building large scale and large numbers of data centers, for example, has its own important economy of scale for the operation of many of these large service providers.

Derek Wyatt
In the United Kingdom, we have six deposit libraries, you'll probably know best the British Library, you might know the Ashmolean. Do you think it's time globally that there was a deposit library for digital?

Vint Cerf
Absolutely, and some of my colleagues, Raj Reddy at Carnegie Mellon in particular, have been very vocal, just in the past few weeks, speaking at an Internet Archive hosted event, arguing -- I guess the Computer History Museum also engaged in this -- to talk about processes for the archiving of digital content, and the desirable registration of that digital content, as a normal practice, along with mechanisms for protecting it. The important fact here is that registration will allow others to find the holders of rights, so as to negotiate to get access. If you don't register, you can't find anything. And so there's a very strong desire, I think, to return to a natural registration regime for digital content, let alone all the other kinds of content which are still being produced.

Derek Wyatt
Okay, my last question. So, when we had postage stamps, eventually, between America and France and Britain, we created the International Postal Union, the IPU, and then exactly the same with technology, we had the ITU. So, is it time, or is it just past time that there should have been a kind of new global digital version of those kind of practices?

Vint Cerf
So it's an interesting question, because the edge case for the Internet, of course, is the Internet Governance Forum, which was created because the World Summit on the Information Society couldn't quite figure out what the right outcome should be, and so the IGF has been discussing and debating this since 2006, if memory serves. It's not clear to me whether a purely multilateral agreement or arrangement is the right answer. You'll find multistakeholder arguments, and demonstrated for example in the methods by which the Internet Corporation for Assigned Names and Numbers works. to be, in my view, compelling, because you want all of the parties affected by

policy to engage in the development of the policy, even if the responsibility for enforcement is assigned to a smaller group. I'm not yet persuaded that an international organization is needed, but I do see a desirable network of agreements, which would follow along the Roadmap to Digital Cooperation that the Secretary General at the UN has promoted. That might be the path that we can follow, as opposed to creating yet another international institution.

Derek Wyatt
Okay, let me go across to - we've got 20 or so questions, we won't get through them all.

Vint Cerf
Wow.

Derek Wyatt
Vint has said if we don't actually ask your question, that you should email it to him at vgcerf@gmail.com, and he will answer, so there we go.

This one's from David Wright. Is net neutrality an alligator, part one, and part two, what is happening at the FCC, and the NTIA and so on? Where are the appointments, that Biden signed an executive order to, gone?

Vint Cerf
On the first question, on the net neutrality, I still believe that it's important for those who control the channels of communication, not be allowed to use those to act in an anti-competitive way. And so, we want to make sure that, just because you have control over the coaxial cable, or optical fiber, or the satellite channel, that you don't prevent others from providing Internet-based services that might be competing with your own vertical services, so I still think there's a role for net neutrality. I do not however think that Title II of the Telecommunications Act is the ideal vehicle for expressing that. We really SHOULD have a new Title in the Telecom Act for Internet. However, getting the American Congress to agree on such a thing, looks like it would be quite a difficult uphill road to follow. Nonetheless, that would be preferred.

Vint Cerf
As to, I'm sorry, the second question, it went out of my head...

Derek Wyatt
Biden signed an executive order.

Vint Cerf
Oh right, yes.

Derek Wyatt
And the FCC is, and the -- had these, well I think they're coming to the end of the term, aren't they? What is happening? Why is Biden delayed?

Vint Cerf
I don't know. The President does not consult with me on a regular basis on these topics,

Derek Wyatt
(laughs)

Vint Cerf
So, I apologize for my inability to give you a firm answer. I think filling these various posts is a big job, there are 4000 presidential appointments that have to be filled. In any case, the most important thing which is happening, with regard to the FCC and NTIA, in my view, anyway, is the infrastructure effort in order to provide, especially, access to Internet in the rural parts of the country, and to increase access to Internet for everyone. So, I think the matters are continuing in both organizations, even though the leadership has not necessarily yet been either fully approved by the Senate. So, to first order, things are moving along. To borrow a UK phrase, we're muddling through.

Derek Wyatt
This is from William Robebuck. Vint, it's now time to put more humanity, ethics, and etiquette, into how people use the Internet, including social media, to communicate with each other, and discuss important issues, preserving democracy, that we share in common, and setting an example to young people. How can we how can we make it more, as it were? You get the drift of his question. Is there even an interest in American society in making this possible?

Vint Cerf
This is a very good question, and one which I find myself asking myself repeatedly, as I looked at headline news. The first observation I would make is that civility is a social decision that we either choose or don't. Creating norms is very important. I think norms are not necessarily backed up by, you know, law enforcement for example, they're considered societal values, and I fear that openness in the Internet has led to a, let's say, a diminution, erosion, of civil discourse. I would suggest to you, however, that it's possibly understandable in the following analog. Those of you

who drive cars may, like I do, say things to the other drivers, or about the other drivers, that I would never say face to face, but there's this windshield separating me from the other drivers, and I feel free to express myself, in ways that I would not if I were face to face. Sometimes I think the computer screen acts a little bit like the windshield of the car and allows us to behave in ways that we wouldn't otherwise if we were right there with the target of our comments. Somehow we have to infuse back into society the value of civil discourse, and the only way to do that I think is to start very early on in school to introduce children, and their parents, and adults, to the value of civility in terms of making progress in coming together, finding common ground, finding solutions to things, as opposed to simply firing our 45 caliber Internet packets at each other. I really hope that the person asking the question has some ideas for introducing incentives for exactly that behavioral change. I will point out that seatbelts and smoking has possibly some lessons to teach, where we incorporated not only advice but we also said, by the way, if we catch you smoking in this building, there will be consequences, because we said you shouldn't do it. So, maybe we have to have some kind of social consequence for bad behavior.

Derek Wyatt
This is from Christopher Forrest. By the way, all of us to saying thank you so much for your talk, but I can't read them all out each time. The historical roots of the Internet in DARPA are well documented, but at what point did you realize how the Internet would become the mass worldwide ubiquitous network that it is today? And has it surprised you?

Vint Cerf
Well, it has surprised me in some respects. Imagine going back to 1973, and being told, this is going to become a global infrastructure and, you know, countries will fight with each other over various terms and conditions for its operation, and I'm sitting here thinking, we're just putting this together as a network to support military command and control. But to be honest with you, over the course of decades, the realization that this could become a major infrastructure on a global scale, became increasingly apparent and, for me, I think the turning point was 1988 when I realized that there was no way that the general public would get access to the Internet unless we built a business model that would support it, because I didn't think the governments of the world would pay for individual or private sector access. And so, it was in 1988, and from my point of view 15 years into the program, that I began lobbying for commercial use of the Internet backbones that had been built by the federal government in the US, and we got permission to interconnect MCI Mail, which was a commercial email service, to the Internet in 1989. That same year, as soon as we did that, three commercial Internet Service Providers popped up in the US, UUNET, PSINet and CERFnet. So, we also saw in that same general timeframe mid late 1980s interest in academic

networking in Europe and elsewhere. And that too, in its own course, led to commercialization. So, for me, this was a kind of an incremental realization that, Holy Moly, this is really going to get big.

Derek Wyatt
This is from Kamala Delic at the Open University, would you mind talking briefly about quantum Internet?

Vint Cerf
So, I have to admit to you that, at the beginning of the term quantum Internet, I remember thinking, well, you know, this is all pretty complicated, and what the heck does a quantum Internet mean anyway? Turns out, at Google, we are working very hard on quantum computing, and it turns out that building a large quantum computer, with a lot of different qubits, gets harder and harder the more qubits you add, until finally you might come to the conclusion, Well, if I could build a quantum computer of this size, and then replicate that, and figure out how to connect them together in such a way that I could exchange entangled photons, so that the separate quantum computers become entangled with each other through this photonic quantum network, then I could build a much larger quantum system with a larger number of qubits, and solve much harder problems. So, I now realized, and have come to the conclusion that figuring out how to do quantum relays, that preserve the entangled state of photons, is actually a very important challenge, and one which could have enormous benefit, if we can figure out how to do it, and we're still some ways away from being able to do that. I want to distinguish that from quantum key distribution, which is a very different process, and does not have quite the same functionality. So, don't get those two mixed up. The quantum Internet and quantum computing, however, could be massively powerful capabilities, if the network part can be solved.

Derek Wyatt
This is from Roger Ellis. When we last met, you were working with other countries on blue sky thinking about a totally different method way of intergalactic transport. Has there been any progress on this? Incidentally, is Carla keeping well?

Vint Cerf
Thanks so much for this question. First of all, JCR Licklider, who was a visionary at MIT and the first director of the Information Processing Techniques Office at ARPA, wrote a letter to his colleagues in somewhere around 1962, telling them about his intergalactic network idea. Well, here we are, fast forward to 2021, there has been work at NASA, ESA, JAXA, and other space agencies on the interplanetary extension of the Internet. I've been personally involved since the beginning in 1998 at the Jet Propulsion Laboratory. We just released a report from the Interplanetary Networking

Special Interest Group of the Internet Society describing the possibility of designing and building an interplanetary backbone network over the course of the next 100 years, to serve manned and robotic space exploration, and ultimately commercialization of the system.

What is exciting to me is that we've gone through multiple iterations of a new protocol suite, not TCP/IP, which deals with the variable delay and disruption of deep space communication. The so-called Bundle Protocols have been standardized by the Consultative Committee on Space Data Systems, and also the Internet Engineering Task Force, and we are expecting to launch some terrestrial testing at scale of these new protocols. They're already running on the International Space Station, and we look forward to their use in the return to the moon, and the Artemis and Gateway programs, and, of course, as we move to Mars, those same protocol will be needed. So, I'm really excited to tell you that the interplanetary network is a real possibility. Now, intergalactic and Interstellar, I can tell you the problems are much harder, and we don't have good solutions to those yet.

Derek Wyatt
Fascinating. This is from Ian Sutherland: How far are we from a regulated Internet with no anonymity? Can it be timed by years, or is it lifetimes?

Vint Cerf
So, this is a very interesting question, because anonymity is valuable in many cases, I'm sure you appreciate that, whistleblower situations for example. However, anonymity also gives people the feeling of freedom to do things that they wouldn't do if it was known who they are. So, I have come to the conclusion that absolute anonymity is probably not in our best interest. I think of this as kind of a differential traceability of the users of the Internet - and by user here I mean individuals, organizations, and even governments -- that there should be some differential ability to trace who those parties are under the right circumstances. The analog I would offer, it's not perfect, is that a license plate, which we see, as ordinary citizens, as a random string of numbers and characters, and we don't know who's associated with that, but the law enforcement people have the right to penetrate that, in other words a differentially traceable license plate to figure out who actually is the owner of the car that the license plate is attached to. I think we are going to end up having that kind of regime introduced in order to prevent people from abusing absolute anonymity.

Derek Wyatt
That's a great idea. Very good. This is from Tim Cowan. Do you think technology standards should deal with engineering and efficiency of engineering processes, or should they also deal with things that have commercial impact?

Vint Cerf
Well, that's an interesting question. I think that both of these things are very important, and, you know, commercial impact doesn't happen unless things actually work. So I think good engineering practices are central here, but the commercial impact has a lot to do with sustainability, and business models are key to that. And so, I think that, as new technologies are developed, and new potential applications are developed, recognition of the business import is -- to sustain useful results -- is a very, very important part of understanding what to invest in next.

Derek Wyatt
This is from Angela Mills Wade, very good question. In the European Parliament many MPs are calling for a ban on the micro-targeting of advertising. Concerns arise from web wide tracking, the so-called surveillance economy, the link between disinformation and advertising. What is your view of the ad-funded model of the Internet?

Vint Cerf
Well, first of all I have to say that it is a very clever and very successful model. When Larry and Sergei started Google, for example, I don't think they had a model in mind of how they would fund the indexing of World Wide Web, and there had been some attempts at using advertising to fund operations in other web-based applications that were not successful. I think that it's arguable that this three way arrangement has been very beneficial, lots of services for free to users in exchange for exposing them to advertising that might be of interest to them. So, I don't think that model is going to disappear, but there are an increasing indicators of alternative models that are working, subscription models being a good example of that. Most of the ISP services are subscription based, and I'm noticing, by the way, that newspapers, which have really suffered from a loss of advertising revenue, are starting to recover by introducing subscription-based models. So, I suspect there will be other alternative models that people will adopt, and we have situations at Google where people would prefer to pay for, for example, YouTube access rather than watching advertisements, and so these alternatives, I think, as they prove themselves, will provide other ways of sustaining the operation.

Derek Wyatt
Terrific. Two more questions. This one's from Michael Bowkis. Interesting to hear what Vint's view is of the eighth alligator, that is, end-to-end encryption.

Vint Cerf
Well, I can tell you that that alligator has risen more than once. In 1992 there was the so-called Clipper Chip proposal during the Clinton administration, and many of us, including me, were very much opposed to a backdoor process that was suggested for purposes of law enforcement. I continue to feel that backdoor processes are unacceptable, and the reason is simple. They never stay secret, eventually it leaks out, and, at that point, now everyone's vulnerable. So much for end-to-end safety and security. My view is that end-to-end encryption is our friend here, it is a means of protecting privacy and confidentiality, and cryptography is also very powerful for doing strong authentication. And so, although I don't mean to divert away from the basic question, I want to mention that strong authentication is a really powerful and important tool. If you don't want someone else to pretend to be you, then you want tools for strongly authenticating yourself, so others can’t break that authentication and take actions on your behalf, when you haven't authorized it. Strong authentication uses cryptography, the same kind of cryptography that's used for end-to-end key distribution. So, I see these as two very important mechanisms, we should not allow backdoor arguments to overcome the importance of end-to-end protection.

Derek Wyatt
Seems to me, I mean I'm just going to interpose a question here, that you're doing a lot of thinking at Google, why don't we share what you're thinking to a wider audience?

Vint Cerf
Well, frankly, you've just given me a lovely opportunity to have this discussion with you here online. It's been offered, this video being made available on a website. I think the Internet Governance Forum is another venue in which a lot of these discussions can happen. I think that we have many different ways of disseminating some of these ideas, in many different groups that have already expressed an interest in this, so I'm actually feeling fairly comfortable that the ideas are percolating out.

Derek Wyatt
Vint, you've been absolutely spectacular. On behalf of DPA I'd like to thank you, but actually that's not my job, that's up to Louise Bennett, so I'm just now going to hand over her to wind up this wonderful day.

Vint Cerf
Thanks so much, Derek, I appreciate it.

Dr Louise Bennett
Thank you to everyone involved in this first Lord Renwick Memorial Lecture, but particularly the staff at the Digital Policy Alliance who've worked tirelessly to organize it. It was really marvelous to have Lady Renwick here with us to give the opening remarks. Thank you Lady Renwick. Harry would have been delighted that Vint Cerf agreed to give this inaugural inaugural lecture.

As Vint said, we've been admiring the conundrum of how to retain all the benefits of the World Wide Web, while defending it against abuse, for too long. We'll all take away many insights from today. In particular, I was struck by the fantastic history that you've been central to, also, the exquisite nature of the problems that your alligators proposed.

Vint Cerf
(laughs)

Dr Louise Bennett
For DPA, it's the second alligator, let's call it the digital regulation, and the fifth, digital preservation, that pose many of the problems DPA want to address when draining the swamp. Digital Policy Alliance members are trying to ensure protection of everyone through adopting effective policies and laws. However, as he reminded us, the victims of online harm are often in one jurisdiction, and the predators in another. Even though the UK has a principles-based law that's better suited to the fast moving digital world than the rules-based laws, we have failed to keep up with the speed and universality of Internet adoption. We need to help our government to work globally to adopt laws that clearly kept tackle abuses, while permitting the beneficial permissionless innovation that you helped to give us.

I'd also just like to touch on digital preservation. When and how to keep content for posterity, while also considering the very vexed question in European terms of the right to be forgotten. History versus privacy is a growing conundrum, which you've reminded us, we need to consider alongside that old seesaw of anonymity, which you've just spoken about, balanced against responsibility and security.

DPA members will consider these, and other points, in the coming months through our policy working groups. I hope that, inspired by Lord Renwick and Vint Cerf, we can move from admiration of these conundrums, to appropriate policy action that will help to deliver the web that

we want. Anyone in the audience who is not a DPA member who would like to join, please visit our website www.dpalliance.org.uk. We have membership packages for commercial organisations, startups, institutions and academia, as well as individual membership. Our website has information on our current work program, and all upcoming meetings. Thank you to everyone, and enjoy the rest of your day, as much as I'm sure you have enjoyed this lecture.

Lord Erroll
I would like to just say thank you as well. It's been a very interesting afternoon. Thank you very much, indeed.