

THE OPEN INTERNET

- what it is, and why it matters

Vint Cerf, vice president, Google

The Internet is an open platform that embraces users' freedom and innovation without permission, says Vint Cerf, vice president, Google. Here, he explains how the design of the Internet led to its remarkable economic

and social success, and why - with specific reference to Australia - sustaining the Internet's fundamental openness should be considered a fundamental objective of broadband policy.

The other day, my mobile phone warned me that the temperature in my wine cellar had risen substantially. I set up a computer application to send me these warnings via the Internet, so that I can keep tabs on my home while I'm travelling.

This use of the Internet is both mundane and extraordinary. Mundane, in the sense that it is rather trivial when considered against the full range of ways that the Internet is improving our access to information and enabling creativity, innovation and economic growth. Extraordinary, in the sense that like myriad other

uses it would have been impossible just a short time ago.

Instead, it is an innovation born of the Internet's fundamental openness, sometimes called 'network neutrality'. The Internet is a general-purpose platform, not designed for any particular application and in fact neutral with regard to the applications it

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and standardising the software protocols that underpin the Internet. From that perspective, I can attest to how the actual design of the Internet led to its remarkable economic and social success.

Today, much of my time is spent preaching the good news about the Internet's revolutionary impact on society and warning of the challenges it sometimes poses. My purpose in this article is to explain what makes the Internet an open platform and what that means for public policy.

One of the core values of national broadband policy should be ensuring robust access to the open Internet. Given this end goal, the relevant question is: how should we achieve it?

This question has been the subject of some controversy over the last few years. The Internet's design is malleable, and broadband Internet access providers (ISPs) increasingly have the ability – as well as the incentive – to affect users' access to certain content or applications. Some people have mistakenly claimed that sustaining openness means preventing legitimate network management or service offerings from ISPs. While discriminatory practices are neither necessary nor beneficial, a wide array of network management and business practices are necessary, reasonable and do not threaten the Internet's openness.

In my view, there is substantial common ground to be found here among all stakeholders. That said, where the market fails, policymakers have a role to play.

UNDERSTANDING THE INTERNET'S OPENNESS

Code is law: how the Internet's design enables user choice, competition, and innovation

As my friend Professor Larry Lessig says, 'code is law'. In other words,

the architecture of the Internet sets the essential parameters that shape how users can communicate, create, and innovate online. To understand why the Internet's openness matters, it is helpful to look briefly at the Internet's virtual blueprints from four different vantage points: the Net's what, where, how, and why.

First: The layered nature of the Internet describes its overall structural architecture. The use of layering means that functional tasks are divided up and assigned to different architectural layers. This simple and flexible system creates a network of modular 'building blocks,' in which applications or protocols at higher layers can be developed or modified without impact on lower layers, while lower layers can adopt new transmission and switching technologies without requiring changes to upper layers. The standardised interfaces between the layers create stability and confer a long-term ability to adapt to new technology and to support new applications. Reliance on this layered system has greatly facilitated the unimpeded delivery of packets from one point to another.

Second: The end-to-end design principle describes where applications are implemented on the Internet. The Internet was designed to allow applications to reside essentially at the 'edges' of the network, rather than in the core of the network itself. This is precisely the opposite of the traditional telephony and cable networks, where applications and content are implemented in the core (in head-ends and central offices), away from the users at the edge. The Internet's design places the power and functionality of the network at its edge, in the hands of the end users and content and application providers.

Third: The design of the Internet Protocol (IP) separates the underlying networks from the services that ride on top of them. IP was designed to be an open standard, so that anyone could use it to create new applications and new networks. By nature, IP is completely indifferent both to the underlying physical networks that carry packets, and to the countless applications and devices whose information is carried inside the packets. The Internet does not need to know what is

supports. End-users are in control of what content and applications they use and create, and that they can use to communicate with anyone else.

In this way, the Internet embraces users' freedom and opportunity to innovate without permission. Sometimes the Internet's innovations are relatively minor or predictable. But in other instances, both individually and in combination with one another, they can be truly world-changing.

I consider myself fortunate to have been one of the network engineers involved in designing, implementing

in the packets to convey them to their destination. The Internet routes data equally, without inherently favouring particular application or content providers over others, and in this way it is not designed for any particular use. As it turns out, IP quickly became the ubiquitous bearer protocol at the centre of the Internet. Thus, using IP, individuals are free to create new and innovative applications that they know will work on the network in predictable ways.

From these different yet interrelated design components, one can see the overarching rationale that no central gatekeeper should exert control over the Internet. This governing principle allows for vibrant user activity and creativity to occur at the network edges. In such an environment, entrepreneurs with new ideas for applications need not worry about getting permission for their inventions to reach end users. Applications and content succeed based on users' interests, not because particular intermediaries have picked them. In essence, the Internet has become a platform for innovation. Again, closed networks like cable video systems provide a sharp contrast, where network owners control what consumers can choose to see and do.

In sum: the very architecture of the Internet maximises user choice, creates a level competitive playing field, and promotes innovation.

The non-discriminatory nature of the Internet is certainly central to Google's story, growing from two graduate students with a new idea to the company it is today. Keeping

the Internet open is not simply about Google, though. It's about all of today's and tomorrow's innovators, tinkering away in a garage somewhere. It's about empowering users as speakers, citizens, and creators, whether they are communicating with friends and family, creating a video to share with the world or collaborating to build resources like Wikipedia.

No one can reasonably dispute the immense social and economic benefits that this open platform has produced, and, looking ahead, online innovation is truly an endless frontier. Like the electrical grid, the Internet is essential infrastructure, which serves as a flexible input into myriad activities and is a cornerstone of economic growth. At the same time, it is also unlike any platform that has come before it – it is among the most open platforms ever devised, and its vast benefits are rooted in this openness.

PAUSE FOR THOUGH

The open Internet has also sustained a virtuous cycle of investment that benefits users, application and content developers, and network operators. New Internet content and applications drive user demand for faster and faster broadband connections that can take full advantage of these innovations. That demand drives network operators' investment in broadband networks and increases in capacity, which in turn drives further innovation, and so on.

That said, do network operators necessarily have the right pro-competitive, pro-innovation incentives to continue sustaining the Internet's open architecture? Some recent developments suggest reasons for concern.

For example, beginning in 2005, US ISP Comcast started interfering with the use of certain peer-to-peer (P2P) applications on its network, as a way of managing network congestion. The users of programs like BitTorrent had no idea that their traffic was being hampered, until a consumer named Robb Topolski identified the issue in 2007 while trying to share some public domain music materials. While in the past it would have been difficult for an ISP to single out and block a particular application, Comcast was able to use 'deep packet inspection' (DPI) technology to do so.

Comcast has since shifted to a non-discriminatory network management scheme that is application- and protocol-neutral. Yet other ISPs are implementing related practices. Other wireline providers¹ as well as various wireless carriers are attempting to restrict the range of services in both the U.S. and elsewhere [2, 3]. The Canadian ISP Primus and the US ISP Cox announced that they are implementing schemes to prioritise certain applications' traffic over others, by implementing Quality of Service (QoS) devices in their networks [4, 5]. These applications will be selected by the ISP according to its own criteria, not by users, and this also represents a deviation from the Internet's traditional functioning.

While such practices can be implemented to manage network congestion, some ISPs might also see a business opportunity here. Certain network operators have suggested imposing additional fees on application and content providers in order for end-users to be able to access their services². In addition, ISPs could set up systems to prioritise certain providers' traffic over others' and charge for that service.

Discrimination among applications and content can take non-technical forms, too. In Australia, a number of ISPs treat their affiliated Internet content services on an 'unmetered' basis, meaning that use of these services does not count against the subscriber's bandwidth cap. As such, competitors' content services are at a disadvantage in the market [8].

In cases where such practices are employed in pursuit of anti-competitive objectives, they obviously raise concerns. ISPs may have incentives to limit innovations that threaten their own business models (e.g., limiting online video's competition with traditional cable TV offerings, or VoIP's competition with traditional voice service).

But even where ISPs are simply guided by good intentions and a legitimate profit motive, discrimination among content and applications can threaten the Internet's openness. Blocking, impairing, and prioritising legitimate Internet traffic can turn ISPs into unwanted gatekeepers in the network; rather than innovations

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succeeding or failing on their own merits and users' desires, ISPs' decisions may effectively pick winners in the market. Big companies may be able to cut deals with ISPs to make sure their traffic is prioritised or not degraded, but start-ups innovators may not have the resources to do so.

Prioritisation and degradation is essentially zero sum: it indicates that ISPs are giving one set of parties an advantage over others. Where ISPs offer users more control over how their traffic is managed, that may be reasonable; for instance, an ISP might, in a competitively-neutral manner, offer a user the ability to prioritise his or her VoIP traffic over his or her own email and Web traffic. If, on the other hand, prioritisation is based on ISPs' unilateral decisions or business arrangements with particular third parties, then ISPs threaten to stifle competition and innovation.

DISCRIMINATORY PRACTICES

Allowing discriminatory practices may also have the perverse effect of creating a disincentive to upgrade the network. After all, if network operators can turn selling traffic prioritisation to application and content providers into a profit centre, then they will be more likely to maintain scarcity in bandwidth available for other providers. That way, third parties will continue to be willing to pay fees for this privilege³.

When looked at in isolation, some discriminatory practices might not raise serious concerns. But we should worry about the open Internet dying a death of a thousand discriminatory cuts, particularly because it is so difficult to predict innovation online and the full impact of any given

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discriminatory practice. Someday, we might find ourselves left with a two-tiered Internet – where only some application and content providers' traffic rides in the fast lane, while everyone else is relegated to a 'broadband' dirt road. As different ISPs institute their own parochial practices, the Internet may become balkanised; while today an innovator in Australia generally can count on ISPs all over the world treating their traffic under the normal, neutral parameters of the Internet, discrimination undercuts that certainty and would add new barriers to entry for all innovators.

In other words, we should not take the Internet's openness for granted. Due to developments like the rapid evolution of DPI, [11] the ability for ISPs to discriminate among content and applications has become more feasible.

ENSURING ROBUST ACCESS TO THE OPEN INTERNET

While these issues have caused some controversy in recent years, there is more common ground here than is sometimes perceived.

Most network management methods are not problematic at all. ISPs have always used a range of techniques, for instance to manage the load on the network, to allocate capacity to different end-users, or to protect network security and integrity (e.g., stopping objective harms like denial of service attacks). All of these are legitimate goals that have historically been met without interfering

with end-users' ability to use the content and applications of their choice, and non-discriminatory network management practices will continue to evolve, adapt, and improve over time. Comcast has recently demonstrated that such non-discriminatory practices remain practical⁴.

Furthermore, most business practices are not problematic. Broadband providers should be free to offer different tiers of service to end-users, just as they always have, without discriminating among applications and content. They should also be able to offer their own content and applications to consumers and to improve their network such as through offering caching services. Finally, users should be able to restrict their own access to certain content through network-level filtering, so long as they can choose to unblock the content if they want (e.g., parents who want to restrict their children's access to certain websites).⁵

That said, some practices are out of bounds. Already, several ISPs have explicitly stated that certain forms of discrimination among content or applications are clearly harmful.⁶

All parties can benefit from recognising the points of agreement here, and in addressing real technical problems that can impact the development of the Internet. The Internet is built on a set of open technical standards, and has always been guided by standards development through recognised, cooperative forums such as the Internet Engineering Task Force. This

tradition of cooperation can continue to guide us still.

Policymakers can help facilitate this process, too. At the same time, where the market demonstrably fails, policymakers must determine, thoughtfully and carefully, how to help it succeed. Policies to preserve openness need not be overly intrusive, and there is not necessarily a one-size-fits-all solution for every context. Below, I address some of the key issues that policymakers ought to keep in mind in order to ensure that users enjoy robust access to the open Internet.

Infrastructure policy

Telecommunications law around the world has recognised that this market is special. Public telecommunications networks are essential infrastructure. However, telecom markets tend towards high levels of market concentration and limited patterns of competition, and thus the potential for network operators to distort competition and innovation in vertical markets. Throughout the world, these points have supported legal frameworks to ensure non-discrimination and competition. The Internet itself was not born in a vacuum, but rather was made possible by a regulatory framework that protected its openness⁷.

While economic thinking around telecom markets has evolved over the years, local broadband markets still tend to feature high barriers to facilities-based entry, high switching costs, and thus limited competition. That does not mean that the same regulations applied to telephone networks ought to be robotically applied to broadband networks, but it does mean the basic principles that guided regulatory policy in the past still hold relevance in today's market.

Competition

Where consumers have many choices in the Internet access market, their

decisions can help check potential or real discriminatory behaviour by ISPs. Consumers can 'vote with their wallet' and choose open networks over closed ones.

Where vigorous facilities-based competition may be unlikely, and even ruinous [15], policymakers have often required network operators to allow third-parties to offer services on reasonable and non-discriminatory terms, along with other structural remedies to promote competition in vertical markets. These policies can help sustain openness, as well as drive investment and innovation in the Internet access market. Here, too, code is law, as certain technical designs for next generation networks can impact the feasibility of open access. [16]

'Network neutrality' rules

Even if vigorous competition in the ISP market does take hold – and particularly if it does not – there are sound economic reasons to remain concerned about anti-competitive or discriminatory behaviour⁸. Policymakers should consider basic, narrowly-tailored non-discrimination policies.

There are several ways to do so. In the United States, the Federal Communications Commission adopted in 2005 a 'Broadband Policy Statement,' outlining users' freedom to access content and use the applications and devices of their own choice. Last year, drawing on these principles, the FCC issued a ruling enjoining Comcast's interference with P2P applications.

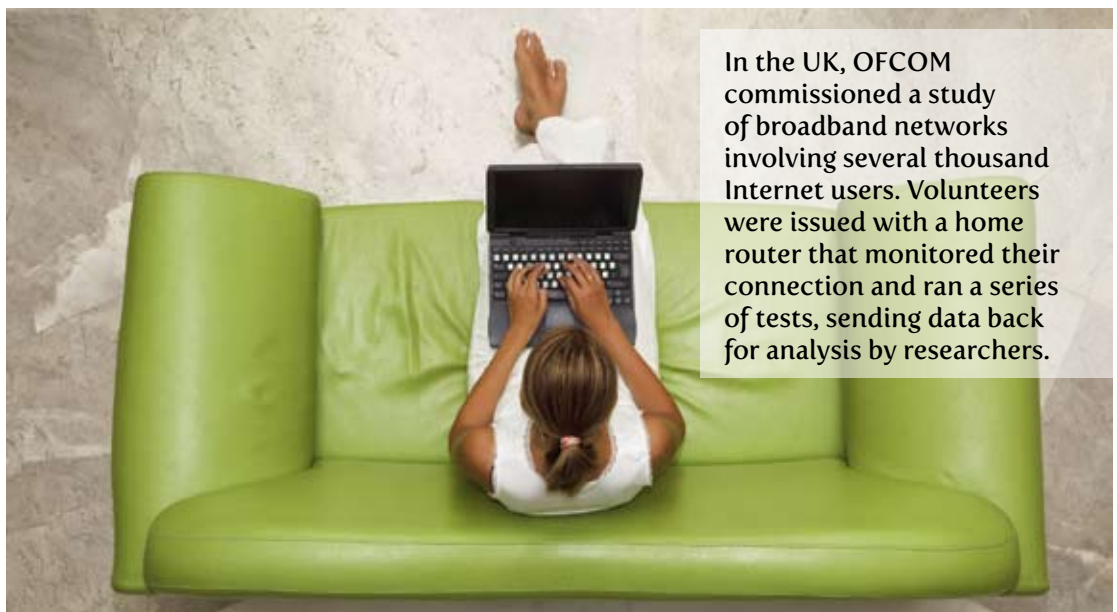
In addition, AT&T volunteered one definition as part of its merger with BellSouth, agreeing to protect those three fundamental user freedoms, and committing 'not to provide or to sell to Internet content, application, or service providers, including those affiliated with AT&T/BellSouth, any service that privileges, degrades or prioritises any packet transmitted over AT&T/BellSouth's wireline broadband Internet access service based on its source, ownership or destination.'⁹

Transparency

In order for the market to function well, consumers need to be well informed. In turn, ISPs ought to disclose, in plain language, the actual performance that consumers should be able to expect from their service tier, as well as any information regarding how applications or content are interfered with or prioritised.

Along with considering whether consumers are receiving proper notice, policymakers can look for ways to help make useful data available. For instance, in the U.K., OFCOM commissioned a study of broadband networks involving several thousand Internet users who volunteered to help. Each user was issued a home router that monitored their connection and ran a series of tests, sending data back for analysis by researchers [20].

More generally, policymakers can help encourage network research that allows real technical problems to be addressed based on empirical data.



In the UK, OFCOM commissioned a study of broadband networks involving several thousand Internet users. Volunteers were issued with a home router that monitored their connection and ran a series of tests, sending data back for analysis by researchers.

As the Internet has evolved – moving from a relatively small set of networks used by researchers to a worldwide platform used by over a billion – it has become increasingly hard to clearly understand how the network is performing. Network management techniques, Internet infrastructure topology, and other factors can significantly impact the reliability and performance of network applications as experienced by end-users, but there is currently a paucity of data to help quantify those effects and allow both researchers and users to better understand network performance. New tools are needed to close that information gap.¹⁰

Broadband v. the Internet, symmetry, and mobility

Policymakers should also keep in mind four important distinctions.

First: It is important to distinguish regulating the broadband ‘on-ramps’ to the Internet from regulating the Internet itself. The Internet as we experience it – the application and content ‘layers’ of the network – has been and should remain largely unregulated, so that competition and innovation can continue to thrive in those markets.

Second: Broadband policy must focus on delivering faster access to the Internet, rather than simply faster broadband networks. The principal reason that advanced broadband



networks are important is that they can be harnessed to deliver faster Internet access, but broadband can also be used for other services. A 12Mbit/s connection can be used to deliver Internet access, but it can also be allocated to 11Mbit/s of proprietary IPTV services and 1Mbit/s of Internet access instead.

Third: The Internet is not one way; upstream capacity matters, too. More and more, users are not just consumers, but also creators of new applications and content. They have the wherewithal to operate home-based servers and the incentive to do so as they share digital information with one another. They also use cloud computing services, which allow users to store data and run applications on

third-party servers, rather than on their own PCs. This shift depends on users being able to send and receive large amounts of data quickly. Thus, another important piece of broadband policy is ensuring the necessary incentives to ensure not just fast broadband Internet access, but more symmetrical speeds.

Fourth: Finally, net neutrality is not just about wired broadband connections. Within the next four years, over one billion people will access the Internet wirelessly through cell phones or other mobile devices [21]. Hence, sustaining open wireless on-ramps to the Internet is also critical.

- *Turn the page for the Author’s Conclusion, footnotes and references.*

COMMENT FROM THE JOURNAL

Here in the UK, Ofcom is planning to consult on network neutrality (probably around mid June) especially as this issue has received an increasing profile in the USA and was covered in the recent EU Framework Directive published at the end of 2009. Ofcom will assist the Department of Business, Innovation and Skills with transposing this Directive. This is a major opportunity for the lovers of free access to internet services to make their views known to the Regulator. Mobile and fixed networks are likely to be treated equally. Work is also underway in a European context, with the Commission likely to report to the European Parliament on the issue by June 2010, with the issue referred to the Council of Telecoms Ministers.

As explained in Vint Cerf’s paper, open access to the internet worldwide has contributed to its enormous success as can be seen from the plethora of new services. With success there are inevitably problems as to who pays, how much and whether tariffs are in line with usage. In the UK, in line with experience

elsewhere, the growth of new services such as the BBC iPlayer has caused the internet to run into congestion at certain times of day in certain areas and with certain ISPs. Sam Knows, a company used by Ofcom to carry out broadband speed studies, has also looked into this problem over several years, not just to see if there is port blocking or traffic shaping, but also to check latency, packet loss, DNS query times and failures, web page loading times, VoIP call quality as well as the obligatory suite of speed tests. All this adds up to form the customer experience of access to the web and its related applications. The results of the studies can be accessed from http://www.ofcom.org.uk/research/telecoms/reports/bbspeed_jan09/

What is clear though is that, as content becomes larger and broadband speeds become faster, more attention needs to be given to the business models to ensure all players in the value chain are adequately and fairly rewarded. Should Regulators be involved? The genie is now out of the bottle!

AUTHOR'S CONCLUSIONS

Australia is at a critical juncture. It is not an overstatement to say that the development of its national broadband policy will have long-term, fundamental repercussions for Australia's economy and society.

Australia has recently taken an important step

forward by committing to deliver fast, affordable broadband access to everyone. Creating the appropriate regulatory framework that ensures robust access to the open Internet will be a crucial part of this endeavour.

ACKNOWLEDGEMENTS

Portions of this essay come from earlier testimony before the U.S. Congress. I would like to thank Derek Slater, Carolyn Dalton, and Rick Whitt at Google for their assistance.

ABBREVIATIONS

DPI	Deep Packet Inspection
IP	Internet Protocol
ISP	Internet Service Provider
P2P	Peer-to-peer
VoIP	Voice over Internet Protocol

FOOTNOTES

¹ For instance, several Canadian carriers are throttling BitTorrent. [1]

² e.g. 'These are the signs that say to me the free lunch of 'we'll just carry this extra data on our network and nobody has to pay' is coming to an end...YouTube is a great idea...It also is underpinned by free traffic on the network where the guys who are providing the 'highways' are going to come after their money as well', Telstra's Justin Milne, [6]; and 'Now what they (Google, Yahoo and MSN) would like to do is use my pipes free, but I ain't going to let them do that because we have spent this capital and we have to have a return on it. So there's going to have to be some mechanism for these people who use these pipes to pay for the portion they're using', SBC CEO Ed Whitacre [7].

³ Engineers at Internet2, an academic research consortium in the United States, found in a recent study that 'It is cheaper to buy more capacity and provide everyone with excellent service than it is to mess with QoS'. [9]

A study at the University of Florida found that broadband providers are more likely to develop their infrastructure, resulting in higher data speeds, if they don't charge content and application companies for preferential treatment. [10]

⁴ See 'Comcast Network Management Policy'. [Internet]. Available from: www.comcast.net/terms/network/. (accessed 28 Apr 2010)

Comcast demonstrates in particular that throttling P2P is not necessary to manage congestion. If ISPs wish to limit particular users from 'hogging' the network, the pertinent issue is limiting that users' consumption, not limiting the use of particular applications. After all, people can use P2P in ways that only cause a light load on the network, and users can also employ other applications to create substantial upstream and downstream traffic. In other words, throttling particular applications is both over- and underbroad.

⁵ Of course, it goes without saying that network operators must also be able to comply with other legal requirements.

⁶ Many ISPs have explicitly stated that blocking or degrading access to content or applications is a harmful practice. See, e.g., AT&T's Marguerite Reardon [12]; Comcast's David Cohen [13]; and the Norwegian Post and

Telecommunications Authority [14].

In testimony to the Senate Judiciary Committee on 14 June 2006; Washington, DC, Cohen said: 'We have never blocked our customers' access to lawful content and we repeatedly have committed that we will not block our customer's ability to access any lawful content, application, or service available over the Internet'.

The Norwegian Post and Telecommunications Authority states: 'The Norwegian Internet industry is in agreement on how it will relate to the issue of network neutrality. A number of parties have now endorsed network neutrality guidelines drawn up by a working group headed by the Norwegian Post and Telecommunications Authority'.

⁷ Developed by the FCC over a decade before the commercial development of the Internet in the U.S., pro-competitive safeguards required that the underlying monopoly providers of last-mile PSTN facilities – the incumbent local telephone companies – allow end users to choose any ISP, and utilise any device, they desired. In turn, ISPs were allowed to purchase retail telecommunications services from the ILECs on non-discriminatory rates, terms, and conditions. One can think of these safeguards collectively as constituting a 'Law of Non-discrimination' governing the Internet's on-ramps. In 2005, the FCC decided to eliminate these safeguards, raising concerns about discrimination by broadband providers.

⁸ Several experts have outlined how, even in a competitive market, broadband providers may have incentives to discriminate in socially harmful ways: [17, 18, 19]

⁹ Letter from Robert Quinn, AT&T to Marlene H. Dortch, Secretary, FCC. Filed on 28 December 2006 at 8–9. The Norwegian Internet industry's set of network neutrality guidelines, see supra note 11, also state that 'Internet users are entitled to an Internet connection that is free of discrimination with regard to type of application, service or content or based on sender or receiver address,' and states that traffic should only be prioritised on a non-discriminatory basis and according a user's own wishes.

¹⁰ That's why, I helped a group of researchers start a new project called Measurement Lab, an open platform for researchers to develop Internet measurement tools: www.measurementlab.net (accessed 28 Apr 2010)

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ABOUT THE AUTHOR

VINTON G. CERF



Vinton G. Cerf is vice president and Chief Internet Evangelist for Google. He is responsible for identifying new enabling technologies and applications on the Internet and other platforms for the company. Widely known as a "Father of the Internet," Vint is the co-designer with Robert Kahn of TCP/IP protocols and basic architecture of the Internet.

For details of Vinton's extensive career, visit: <http://www.google.com/corporate/exces.html#vint>.

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