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INTERVIEW ANTONIO LIOTTA, NETWORK EXPERT

All of YouTube through a 40-year-old funnel

The internet is bursting at the seams under the tsunami of data that we all want to transmit over it. And that isn't going to get less any time soon. That means the protocols used will need to change. And networks should be able to grow like plants, says Antonio Liotta of Eindhoven University of Technology. By **Peter van Ammelrooy**

The internet has now reached a critical point in its ability to meet the world's data demands. Two days before his inauguration as professor at Eindhoven University of Technology (TU/e), Antonio Liotta is sure of that. But he isn't prepared to name the year in which our digital Valhalla will collapse under the strain. So there won't be a 'blender moment' for Liotta.

Robert Metcalfe certainly had one of those moments. He invented Ethernet, the standard that allows computers to communicate by means of cables. And back in 1995, he predicted a catastrophic collapse of the internet in the following year. Metcalfe promised he would literally eat his words if he was proved wrong. So at a conference in 1997, the American placed a copy of the printed column containing his prophecy in a blender together with some juice, and then consumed the resulting pulpy mass.

Since then the downfall of the global computer network has been predicted repeatedly. But that's not really the problem, says Liotta. "The internet isn't just going to stop working from one day to the next. We've always been able to handle the growth in data traffic by increasing the capacity of the network." But sometimes it doesn't take much to bring the internet to a standstill. That happened in 2009 because of just one man – Michael Jackson.



Antonio Liotta: "10 to 15 per cent of the data doesn't reach its destination at the same time." Photo by Mike Roelofs

On the day the King of Pop died, Google wasn't accessible for quite some time. And Twitter welcomed its users with a 'fail whale', an icon that appears when the service has gone down. Wikipedia too was inaccessible some of the time.

But even without the death of a musical legend, you can see that the internet doesn't always work perfectly. "You can see that when you're holding a video conversation using Skype. The data packets into which the message is divided are received at average intervals of 110 milliseconds, while for good quality that shouldn't be more than 40 milliseconds."

"Skype has solved that problem by deciding that the sound is the most important part of the message. So they designed smart software that gives priority to the audio signal. They obviously think what matters most is being able to hear each other properly. And as far as video is concerned, they just do whatever they can."

"All the Internet Service Providers use techniques of this kind, by which they're anticipating potential bottlenecks in data transmission. They give priority to some kinds of data traffic, which they are able to do by looking at the type and content of the individual data packets." The use of this 'Deep Packet Inspection' technique caused some embarrassment last month for the telecom companies KPN and Vodafone, because by using it they may possibly be in contravention of privacy legislation.

This need to take a closer look at users' data is sure to increase. Last week Cisco Systems, the major supplier of network equipment, made some new predictions about the internet. It expects the number of devices using the network to increase to 15 billion in the next four years. The five-billionth device already logged-on last August. And by 2015, more than 966 exabyte (10^{18} bytes or 1 billion GB) of digital data will be carried by the network's copper and fiber-optic cables. That's four times as much as today's figure.

"Cisco predicts a growth in data volumes of 34 per cent a year between now and 2040. That sounds on the conservative side to me. They aren't allowing for someone thinking up another smart app that causes even more data traffic. Remember that YouTube didn't even exist just seven years ago."

Lots more applications are also waiting to make their appearance on internet. One of them is 'cloud computing', the development that means we no longer keep our software and files on our own PCs, but instead they're permanently online.

Last week Apple announced a free service through which consumers can automatically store copies of all the photos, music and videos they have on their mobile phones in the digital cloud.

"Digital television uses the internet protocol, but the data is still carried on the separate networks of the cable companies like UPC. If that data was to move to the open internet, today's network would never be able to handle it." According to Liotta, the same applies to another potential source of large volumes of broadband data – computer games. "If gaming goes entirely online, the internet would grind to a halt."

However big the data tsunami gets, it will have to use a network that was never designed to bring YouTube clips to two billion users. "But we still transmit data in the same way, using the same protocols as 40 years ago. Packet by packet, each of them checked one by one by the routers and sent on to their destinations."

The routers that direct the data traffic are the bottlenecks in the network. "In principle, a router treats all data packets equally. A video gets the same priority as an e-mail. And while it's no problem if an e-mail is delayed for a minute, an interruption of less than a second in a video is enough to cause irritation. The data transport process is far from perfect – between 10 and 15 per cent of all data packets never arrive. So the

destination computer then asks for the missing parts to be resent. And that results in a lot of extra, unnecessary data transport.”

Even if we don't mind some loss of quality, there's still another argument for making the routers more efficient. “Of all the power that a router consumes, 80 per cent is used for investigating and selecting the data packets. Providers increase the capacity of their networks by adding more routers.” Which means more and more energy is needed. “Four years ago, Telecom Italia was named as the second-largest electricity user in Italy.” The country's biggest internet provider was second only to the national railways.

“The internet may just turn out to be the best self-learning machine we've ever built.”

There are a number of ways to make the internet more efficient. The simplest is to use a protocol that allows networks of clusters of computers to be created ‘spontaneously’, with only one of them having physical access to the internet. The advantage would be that the data traffic would continue, regardless of whether other computers joined or left the ad hoc network.

Liotta has carried out tests in Goes with a network of this kind, connecting simple, low-cost gas and electricity meters that automatically transmit consumption data to the energy company. Instead of all the meters having their own wireless connections to the internet, which would be a very costly solution, all the meters joined together to form a network that even kept working if half of the nodes stopped working. “Networks like this are a good solution for developing countries, where broadband connections are scarce.”

To make today's internet more efficient, we need to look at how nature works, Liotta believes, and make routers that can control themselves. “Just look at the human body. The autonomous nervous system controls numerous bodily functions all by itself, without any conscious intervention.”

“Strangely enough the internet is already organized partly in this way. A balance has already arisen between speed and stability – two requirements that are normally conflicting. I think internet has developed the way it has because it was designed by people. And the engineers unconsciously copied a network that was already familiar: the human brain.”

The final step is to create systems that can learn from their experiences. As an example, Liotta refers to a video clip that is transmitted on the internet. By studying the behavior of the viewer (does he watch the whole clip, and does he search for more content from the same source after viewing it), a machine can find out what quality the video needs to have to keep the viewer's attention.”

“Research shows that interruptions in the pictures of a football match lead to irritation. But it's no problem if a router allows gaps to fall in a TV news broadcast. Because the pictures mainly show ‘talking heads’ that hardly change.”

“In this way each object in a video has its own curve, that determines how long interruptions can be before they become noticeable. The curve increases more rapidly for pictures of a flowing river than for shots of a blue sky. A machine can learn the shape of each curve by trial and error.” The ‘irritation threshold’ also differs for each connected device.

All these new ideas are turning network technology on its head. Engineers should get ready for a lot of new challenges, says Liotta: “Instead of programming computers with what they have to do, it's better to help them to learn. The internet may just turn out to be the best self-learning machine we've ever built.”