NEWS

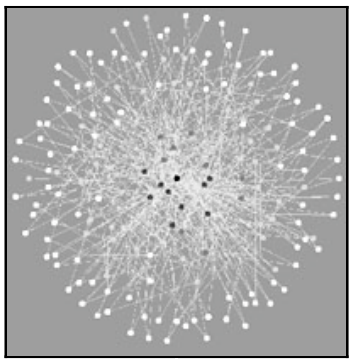
Published online: 09 March 2001; |
doi:10.1038/news010315-2

Networking can be hazardous

Philip Ball

The structure of the Internet makes it peculiarly prone to computer viruses.

Last year's ILOVEYOU computer virus is estimated to have caused losses of $6.7 billion in damage and computer down-time. Despite tightened security measures on electronic systems, its like is sure to happen again. An unsuspected vulnerability in the structure of the Internet leaves it particularly prone to viral attack, a soon-to-be-published analysis will reveal[1].



Plot of infection risk in a scale-free network like the Internet, from minimum risk (white nodes) to maximum risk (black nodes).

Past attempts to understand computer viruses have mistakenly assumed that they spread in much the same way as real, biological viruses, such as that responsible for the outbreak of foot-and-mouth disease currently paralysing the UK countryside.

Real viruses can be transmitted only by close physical contact, and so worm their way through a community in a series of short hops between infected and uninfected individuals.

The crucial difference, say physicists Romualdo Pastor-Satorras and Alessandro Vespignani, the authors of the new study, is that computer viruses spread on a network -- the Internet -- with a very special branching structure. So, on the Internet a virus can always pervade the system,

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albeit often very slowly.

This is because computer networks fall into a newly identified class of 'scale-free' networks in which there is no characteristic, average number of connections to the many nodes (junctions) of the network.

In a regular grid-like network, like a fishing net or the New York street map, each node is joined to the same number of neighbouring nodes -- four, in a square grid. In a 'random network', where all the nodes are connected at random, there is a well-defined average number of connections among the nodes, and the number that have many more connections than average is insignificantly small.

A scale-free network has many more highly connected nodes than a random network, even though most nodes have only a small number of connections. Also, in scale-free networks, unlike regular grids, there are many shortcuts between distant nodes. E-mail servers that are geographically distant may nevertheless be connected by only a few hops.

Pastor-Satorras, at the Universitat Politècnica de Catalunya in Barcelona, Spain, and Vespignani, at the Abdus Salam International Centre for Theoretical Physics in Trieste, Italy, used a standard mathematical model of infection, in which each node (representing a person or animal in studies of biological epidemics) is 'healthy' or 'infected'.

Normally, this model predicts that epidemics happen only if the rate of infection of 'healthy' nodes connected to infected ones exceeds some threshold: unless the virus can transmit itself fast enough, it dies out.

On a scale-free network, the model predicts quite different behaviour. There is no threshold -- a virus can 'survive' even if it spreads very slowly. This sounds like very bad news for the Internet.

Fortunately, even though computer viruses spread far and wide on these networks, they typically do so by infecting only a tiny fraction of the entire system. They are more like a tiny stream sending little branches throughout a landscape than a tidal wave that engulfs it all.

The researchers show that real computer viruses do indeed seem to show this sort of spreading behaviour -- a kind of low-level insidiousness that only very occasionally grows to overwhelming, epidemic proportions, as happened with ILOVEYOU.

Launched from the Philippines in May 2000, ILOVEYOU infected the computer systems of the US Pentagon and the UK House of Commons, and wrought havoc on the internal e-mail systems of many companies, including Ford Motors and Lucent Technologies. The virus deleted files at random on an infected PC machine before e-mailing itself to everyone else on the machine's directory.

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References

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ISSN: 1744-7933

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