Traffic Gridlock on the Information Superhighway?

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Congestion on the Internet is becoming a household topic. Internet "brown-outs" are catching newspaper headlines. Even casual users can be frustrated by occasional long waits, forced to stare impatiently for minutes, if not hours, at the "host contacted — waiting for reply" message on the status line of a Web browser. Skeptics predict an Internet meltdown. The staff members of your organization may be expressing their frustrations in your general IS direction. Are there serious reasons for concern? How should you answer your colleagues?

The real question is whether demand for growth will outpace capacity expansion. While it is impossible to tell on the basis of anecdotal evidence, some traffic and congestion data is systematically collected. Matrix Information & Directory Services (MIDS) samples regularly the traffic conditions on the Internet and makes the results available on a daily basis as the so-called "Internet Weather Report" (see Figure 1, http://www.mids.org/weather/).

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The Internet Weather Reports are presented as regional maps showing round-trip times from MIDS offices to approximately 4,500 domains worldwide (see Figure 2 for the Internet weather in the USA on 19 April 1996). Measurements are currently taken every four hours (six times a day), seven days a week. According to the company:

The maps use an intuitive technique for displaying latency data. The size of a circle indicates the round trip time to a host at that location. Bigger circles indicate closer hosts (lower latency) and smaller circles indicate more distant hosts (higher latency), providing a sort of three dimensional perspective view. The upper-left legend gives the latency scale, which is logarithmic. The unit is the millisecond, so 1000 indicates one second. The range displayed is from the very large circles for 100 milliseconds (1/10 second) to tiny circles for 5000 milliseconds (5 seconds). This range goes from response almost like the same room to so slow as to be unusable.

Colors indicate the number of hosts at a given latency and location. The upper right legend gives the host count scale, which is also logarithmic: red for 1, orange for 2, and so on through yellow, green, and blue to violet. For some of the more densely surveyed cities, it is possible to see bell curves in the size and colors of the icons plotted, with red (few hosts) on the outside and inside of the icon, and indigo or violet (many hosts) between. Even on a black and white display, the different latencies are visible, and some of the differences in numbers of hosts can be seen by differences in gray scale, but the maps are best seen in color.

The Internet as we know it today has been in use for more than a decade. Its architecture has been developed to support activities of the academic and military communities, and its recent explosive commercial growth was not anticipated originally. Although some people blame the congestion problem on "greedy businessmen" and "commercial exploitation," you can assure your coworkers that the problem of Internet congestion is not new.

In 1986 Internet backbone traffic was severely jammed. At that time, the culprit was dramatic growth in academic use bumping against inadequate bandwidth of the backbone. The problem was remedied by a major upgrade of the Internet backbone. Internet optimists place their faith in continuous

expansions of Internet capacity (bandwidth and routers). Pessimists point to prospective quantum jumps in demand fueled by a remarkable shift to continuous streams of multimedia data (audio and video) generated by desktop video-teleconferencing and similar applications leading to inevitable congestion.

During congestion, queuing is handled on a "first-come-first-served" basis. In the absence of usage sensitive pricing, economic rationing of Internet traffic flows does not exist. Hence, there is no differentiation between higher-valued and lower-valued packets of information. Some view this system as economically inefficient. The current system is analogous to all mail deliveries handled as having the same priority with no provisions for any kind of priority mail. This denies the users, such as your employer, the option of paying different prices for a different quality of service.

Sophisticated economic pricing mechanisms have been suggested for the Internet as one way to address the congestion. However, the accounting systems required to support billing based on these mechanisms have not been developed. Moreover, existing Internet instrumentation may limit the capability of accounting systems to support complex pricing mechanisms. Yet, without an efficient pricing system, investment in capacity expansion may suffer due to lower expected returns.

All major users of the Internet will be affected by the efficiency of the Internet system. The more they rely on the Internet to conduct their business, the higher their stake is in seeing that Internet congestion be addresed. For now, encourage your users to access the Internet in off-peak hours as much as possible. And tell them to sit tight. The economic payoffs are too great for these problems to go unresolved for long.

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Figure 1

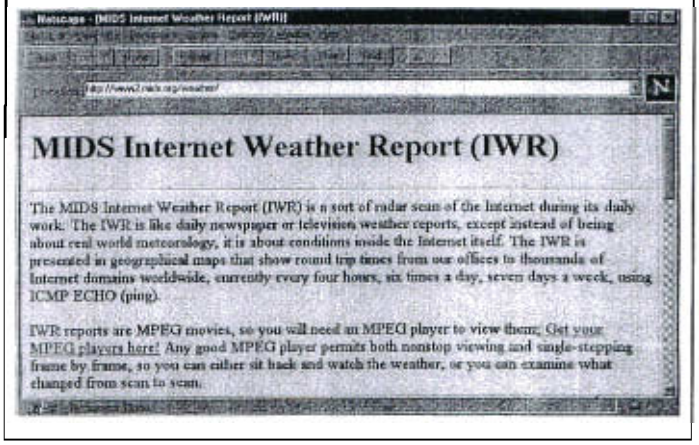

Figure 2