

From the Editor-in-Chief . . .

# The Intelligence Within

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The Internet provides the backdrop for an important technical controversy in the domain of telecommunications. Like all good technical controversies, this one is political as well.

The controversy is interesting to computer scientists because it helps focus our thinking on system design and evolution, and because it gives us an opportunity to reflect on the nature of the Internet. To highlight some differences in a brief format, I will present the controversy in the style of the Hegelian dialectic (admittedly, though, with oversimplifications).

## Thesis

The thesis is the vision of the intelligent network as promulgated by the traditional telephone operators: the telecom system as a big beast, central to everything you do that pertains to communications. If you don't like it, the thesis says, we (and *only* we,



## Antithesis

The antithesis is the vision of the stupid network. This vision is promulgated by Internet anarchists and free enterprisers alike, who would like to see freedom blossom, specifically freedom to introduce new services. George Gilder,<sup>1</sup> David Isenberg,<sup>2</sup> and others have long argued that as bandwidth becomes plentiful, intelligence will propagate to the edges of the network and the network itself will provide no more than bit transport.

The overwhelming advantage of stupid networks is that, like the Internet, they naturally support heterogeneity and extensibility. End users can choose whichever applications they like and invoke whichever services they like without requiring consistent changes throughout a large network. You can plug in a new service as easily as you can plug in a Web server.

## Analysis

(OK, so maybe I should credit Freud as well as Hegel.) There is, as they say, truth on both sides. The first argument in favor of the thesis is efficiency. A managed network can deliver better performance than an unmanaged one. But the disruption offered by communications technology plays an important role here. I am alluding to the rapid improvements in bandwidth supported by optical technology. For the past few years, these improvements have exceeded those in computing power.<sup>3</sup> There is more bandwidth than we can hope to spend, so letting some of it go to waste in exchange for simplicity and openness is a good trade-off to make. That is, the efficiency argument for the thesis doesn't stand.

On the other hand, the traditional telecom approach may be difficult to manage, run, and evolve, but at least it can offer guaranteed reliability. The telecoms are legendary for their "six nines" availability. The Internet, by contrast, is what we—rather euphemistically—call a best-effort system. Internet services, in general, make no guarantees, not even of "six ones" availability.

## Synthesis

So should we pick one or the other doctrine? Far from a straightforward dichotomy, what we see is

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not you) can make it better, which we will do by embedding more and more intelligence in it. As the beast becomes smarter, it can offer newer "services," which look, from the consumer standpoint, like features—caller ID, call forwarding, and so on.

Telecommunication companies have been remarkably successful in carrying this vision forward. Not only is the network more intelligent, it is also highly reliable and appears to scale well. Unfortunately, this approach also makes it harder to add services. To function properly, a new service requires changes in several places internal to a large (and apparently monolithic) system.

each side influencing the other. Telecom networks are becoming more and more like the Internet, not only in being oriented toward packets instead of circuits, but also in becoming open with their services and interoperable with other telecom networks. These changes are most prominent in the arena of mobile third-generation networks (for more information, see [http://www.umts-forum.org/what\\_is\\_umts.html](http://www.umts-forum.org/what_is_umts.html)).

But intelligence isn't just moving outward; some of it is also moving inward. Over the past few years, private networks—physical or virtual—have become a norm over the Internet. Only in these private networks can we hope to make any guarantees for performance or quality of service. We can't guarantee compliance with a service level agreement unless we provision and manage the network. These networks are more than bit transports; they can act intelligently and also support important services such as billing and micropayments.

At the same time, there are services the traditional networks can support more naturally, for example, the location of a mobile device. So it is appropriate to provision these services from the inside, essentially by moving the intelligence inward.

The real question, of course, isn't about intelligence but about innovation. The Internet succeeds because it supports—even forces—innovation, not only on the edges of the network but sometimes deep within. ■

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**Elisa Bertino** is professor of database systems in the Computer Science Department of the University of Milan where she is currently department chair. She has published more than 200 papers on her research in database systems. She was program chair of the 14th European Conference on Object-Oriented Programming (ECOOP 2000). She is a senior member of the IEEE, a member of the ACM, and has been named a Golden Core Member for her service to the IEEE Computer Society.

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