Web cubed -- the network of everything

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(PhysOrg.com) -- Handsets, laptops, cars and even clothes: they are all part of the 'network of things', an incarnation of the future internet, and European researchers are working hard to create that future now.

The future internet promises to be a lot bigger than Web 2.0. Call it Web cubed, if you will, but it promises to usher in pervasive networks that link electronics, clothing, cars and pretty much everything in between.

The upshot will be a network that can accompany and support users in any situation, dynamically adapting not only to the location, but also the contexts like work and leisure.

But there are some big problems facing this rosy future. "The first problem is scale. A network capable of linking everything together will be huge, and it will take some serious engineering to create a framework and platform capable of attaining this sort of scope," explains Daniele Miorandi of CREATE-NET, coordinator of the BIONETS project.

The future internet will link billions of devices, or at least must be capable of doing so. It makes the most powerful network paradigms of today appear puny.

And that is just the beginning of the challenges. Miorandi cites a series of obstacles of a similar magnitude that stands between the engineers of today and the internet of tomorrow.

Heterogeneity is problem number two. So far, there is no standards body

working simultaneously on, for example, clothing and cars in a network. Many of the other major devices of the future internet will be similarly diverse.

Natural-born killer solutions

Complexity is another issue, and is the key theme facing the design and deployment of a system on this scale. Dynamism, the constant creation and destruction of networks and services, will be another feature of the future internet, one that poses a whole new set of problems.

BIONETS is a concerted European effort to overcome these obstacles. It comprises major European players in the telecommunications space, companies like Nokia, Telecom Italia and Sun Microsystems, and it enjoys a budget of nearly €7 million, the lion's share funded by the European Union.

BIONETS has been studying the problem for the past three years and believes it has come up with an answer to the question: How do you develop solutions for a very large-scale, heterogeneous, dynamic and complex problem like the future internet?

"You look for existing solutions to similar sorts of problems, and you apply those answers to your questions. You can see the same sort of large-scale, heterogeneous, dynamic and complex organisation in nature," explains Miorandi.
Evolution: the natural internet

BIONETS takes its cues from the natural world, evolution and DNA to tackle some of the fundamental scientific and engineering problems presented by the future internet.

"We need to introduce autonomic properties at the network and service levels, software and protocols, and devices capable of operating reliably but independently," Miorandi believes.

Take the human heart. It beats reliably and keeps its host alive for decades, all without any conscious intervention or control. BIONETS' networks would work in the same way.

The project succeeded in developing its technique by creating information filtering protocols, data dissemination protocols and data cloud protocols that combine and separate according to the specific needs at the time.

This approach is "bottom up", where the devices, or ultimately the services, set up the appropriate network in the appropriate context to ensure the most robust, secure and useful connection possible.

This contrasts sharply with the traditional engineering approach to networks, which was "top down", designing systems to fulfil particular functions.

The project has made some real progress, and it has helped create new trends in computer science and engineering, but it has also hit some real hurdles. "We were sure we would be able to develop solutions to the problem of dynamism - of rapidly changing devices, contexts and situations - but we didn't completely solve that issue, though we made some good progress in that direction," reveals Miorandi.

Impressive results

The project still has several months of its four years to run, but Miorandi does not believe they will be able to solve completely this particular problem. That said, the team has created a foundation upon which other

researchers can build.

And up to this point of the project, there have certainly been many more successes than disappointments. Among their impressive results was a practical technical solution to opportunistic communication in mobile environments, called U-Hopper. This work sprung out of the basic science research the team conducted.

"We are engineers, so we love to do the fundamental scientific research; but we like to play with toys, too," explains Miorandi. U-Hopper started as a proof of principle and a chance to play with some toys for the BIONETS team, but the work could lead to some very valuable commercial applications, too.

BIONETS also helped to found four conferences, BIONETICS, AUTONOMICS, INTER-PERF, PHYSCOMNET. "Among those, our flagship event is certainly BIONETICS an event that well reflects both the multidisciplinary flavour of our research in BIONETS, as well as our attempt to build a community working at the junction of biology, computer science and software engineering."

The team produced high-quality research, too, with over 100 papers published in the first three years by the BIONETS consortium, achieving a best paper award at IEEE Globecom 2007 and one at BIONETICS 2007.

All in all, the project has managed to get through an impressive workload well before it is due to finish, and the work offers some promising routes to the future internet of everything, to Web cubed.

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