



Roaming: Technologies for a Connected Society

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In 1998, Paddy Nixon and Vinny Cahill edited an issue of *IEEE Internet Computing* on mobile computing. The guest editors' introduction to that issue was entitled "Technologies for a Disconnected Society,"¹ reflecting the fact that, although there was a growing demand for mobile computing at the time, the technologies that would support it were still in their early stages.

Almost 10 years later, we live in a truly connected society, at least in the Western world. 3G cellular data networks have literally brought the Internet to the man in the street at broadband speeds, even as WiFi has brought it to the woman in the coffee shop! Smart phones, personal digital assistants, and laptop computers are commonplace. Society now clearly expects connectivity more-or-less anywhere and at any time.

Remaining Connected

Although connectivity is now an expectation, being able to satisfy that expectation still depends to a large extent on exploiting "locality of reference" effects. Connectivity is often good only as long as users

remain within their normal environments, whether we define them geographically ("in the office," "at home," or "in a local café") or, more significantly, administratively ("on the university network," "within my service provider's coverage," or "within coverage of a service provider with which my provider has an agreement"). Moving outside of this environment is often still fraught with difficulty. Although we have near-perfect connectivity within our university campus, for example, we often lose it entirely when visiting another campus, or experience degraded service, an unfamiliar working environment, or at the very least the need to reconfigure some network settings. Unlike 10 years ago, the challenge now isn't in providing connectivity but rather in retaining connectivity as users roam, potentially between unfamiliar and heterogeneous environments. From the user's perspective, the key requirement is to be able to retain the familiar working environment; from the service provider's, it is to be able to accommodate the uncertainty that arises in terms of network provisioning from supporting roaming users.

It's probably true that although we've

seen significant improvements in the technologies available to support mobile users in general – and roaming users in particular – the user experience of roaming is far from perfect. The ideal of “roaming transparency” – that roaming users should be able to obtain the same quality of service on the road as “at home” – is still some way off. Although researchers must overcome various technical challenges to achieve roaming transparency, we’ve identified two key issues that impact user experience directly: connection stability and device limitations.

For most users, the quality of the network connection available when roaming is significantly degraded compared to that available at home, whether for technical reasons, such as the use of wireless instead of wired connections, or administrative ones, such as the availability of limited privileges in a foreign network. In many cases, these limitations arise from the need to use shared (perhaps public) rather than dedicated (private) resources when away from home and result, in some sense, from economic rather than technical limitations. Nevertheless, they represent a reality for roaming users, and techniques to overcome them are the subject of ongoing research.

In this Issue

The articles in this issue address these problems from user, application developer, and network service provider perspectives. In “Pervasive Personal Computing in an Internet Suspend/Resume System,” Mahadev Satyanarayanan and his colleagues consider one approach – Internet Suspend/Resume – to providing users with access to their own personal, and therefore familiar, computing environments as they roam from location to location. Their approach provides access despite the varying quality of service that different Internet connections offer and, crucially, without the need for users to carry laptops or other personal computing devices.

“Understanding as We Roam,” by Declan O’Sullivan, Vincent Wade, and David Lewis, considers the challenges that the increasing use of Semantic Web technologies and ontologies pose, in particular, when roaming. Although ontologies can help address semantic interoperability among applications, the problem roaming users face is that different ontologies arise in different environments. Being able to exploit the semantic information available in one environment by reference to a local ontology might require a mapping between the ontology and the one used in the user’s normal

environment. The article describes a practical ontology-mapping process that service providers or large organizations can apply to address this problem.

Given the variety of different technologies now available to provide connectivity and the resulting requirement to support roaming over heterogeneous networks, application developers are faced with the increasing problem of developing applications that can adapt to changes in available network resources. In “Network Resource Awareness and Control in Mobile Applications,” Arjan Peddemors and his colleagues describe a middleware service that supports the construction of applications for such environments while still being able to use well-known communications APIs.

Finally, Ken Murray and Dirk Pesch take the network service provider’s view in “Call Admission and Handover in Heterogeneous Wireless Networks.” The authors consider call admission and intersystem handover control strategies for heterogeneous wireless access network roaming with a view toward maximizing, for example, revenue. Their approach exploits a combination of evolutionary computing and fuzzy logic to address the problem while taking into account both user and service provider preferences.

This research is only a small part of what is now a huge body of work that will undoubtedly lead to truly seamless roaming within the next 10 years, if the pace of development in the past 10 continues. If these authors’ work is any guide, future roaming users will have access to their personal computing environments wherever they go and be able to use applications that can understand and adapt to the local environment. □

Reference

1. P. Nixon and V. Cahill, “Technologies for a Disconnected Society,” *IEEE Internet Computing*, vol. 2, no. 1, 1998, pp. 19–21.

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