PerAdaMagazine
towards pervasive adaptation
10.2417/2200809.1264

Harnessing Social Structures for Tomorrows Wireless Networks

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Devices like MP3 players and personal digital assistants may one day form their own social networks to better share and exchange content.

As technology progresses, more people are carrying small wireless-enabled devices.[1] They store, process, and forward information for people in their everyday physical environments, like work or home. They often have brief opportunities to form short range connections at distances of 10–30m. In these fleeting windows, the devices could share and collect information relevant to everyday life, storing information from places visited and exchanging multimedia or messages.

Convention dictates that engineers should maintain a fully connected, always-on wired network wherever possible. Yet this goal is unrealistic for many small and low-powered wireless devices. Reality requires radical rethinking, where network architecture harnesses opportunistic exchanges[2] and user behaviour. To do so, researchers must understand user mobility, human interactions, and social groups.[3,4] This motivation guides our SOCIALNETS project, which uses an interdisciplinary approach to reveal and exploit the traits of physical and virtual social networks.

To date, emerging methodologies for self-organised networking draw inspiration from biology and the autonomic nervous system. While these approaches can be highly effective, they are not naturally aligned with human behaviour and thus fail to capture whom we interact with, why, and how. Therefore, we are developing a new and people-centred approach by exploiting the core characteristics of human behaviour.

We envision a time when various wireless devices could be engineered to form their own social networks, using principles learned from studying those of humans. These structures could then be exploited to provide content and forward data. For instance, human connections rely on trust and cooperation, which are fundamental issues in electronic communication. Furthermore, multiple relationships build distinctive characteristics, such as short paths, into a network structure. Such insights could, when applied to wireless networks, make them more effective.

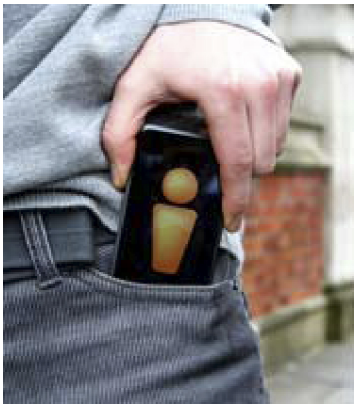

Figure 1. *As portable devices become more powerful and wireless enabled, there are new opportunities to share and forward content.*

Achieving social networking between devices requires a cross-disciplinary approach that spans anthropology, physics, bio-informatics, computer science, and engineering. Stanley Milgram's[5] work is an important starting point. His study led to the small-world conjecture that only a modest sequence of relationships (five or six) is required to connect any pair of people. This small-world phenomenon also persists in nature.[6]

Researchers have recently gained insight into the human brain's social networking capability. In particular, Robin I. M. Dunbar's number[7] dictates that the typical person can only maintain about 150 acquaintances. Additionally, members of an individual's social circle do not all have relationships of equal closeness. Rather, the group is structured into a series of about three circles of acquaintanceship, which scale with a remarkably consistent ratio of almost exactly three.[8] Thus there appear to be important constraints on both the structure of natural social networks and on the quality of relationships.

Further important findings have emerged from physical dynamics. Basic network concepts drawn from sociology have been applied to the statistical mechanics of complex networks. This research reveals that a broad range of real-world systems have common, underlying physical properties that govern their complexity and dynamics.[9] In addition, Mark Granovetter's work[10] revealed that weak social links may play a crucial role in build-

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ing bridges between social groups formed from stronger connections.

Trust and security are also fundamental to decentralised wireless networks.[11] Closely related to trust is cooperation. Under strict economic conditions there is no natural incentive for devices to cooperate,[12] yet such behavior is widespread in human society. As recent simulations show,[13] the tendency to form social networks with those we trust can create a strong global incentive for working together. Cooperation and trust also underpin data and knowledge management. Learning more about these behaviors may help utilise the social network to acquire relevant content for an individual.

We believe that social networking between devices offers a new way to provide content and forward data in pervasive computing environments. The use of such networks does not seek to enforce or maintain end-to-end connectivity. Instead it creates an underlying structure between devices so that brief interactions can be harnessed to convey useful information. Next, we plan to conduct experiments to learn how trust manifests itself across a human social network. We are also developing analytical theory to further characterise the structural properties of such groups. New communications architecture is also being developed along these lines to engage wireless devices for adaptive content provision.

This work has been supported by the SOCIALNETS project, grant agreement number 217141, funded by the EC seventh framework programme theme FP7-ICT-2007-8.2 for pervasive adaptation. See: http://www.social-nets.eu/ for further details.

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