

# Peering the Smart Homes

Eduard Turcan, Ross Lee Graham  
IISLAB, IDA, Linköping University, Sweden  
Edu@ida.liu.se, rosgr@ida.liu.se

Jan Hederen  
HomeCom, Linköping University, Sweden  
Jan.hederen@mjardevi.se

## ABSTRACT

*The concepts of Smart Home, Connected Home, Home Networking or Home Communication are quite well known through the media. This interest toward home automation and control leads to a new view for the future home, a new life style, with new services and applications. This paper points out the key features of P2P technology that can boost the optimization of home automation. With this technology in place we find new benefits emerging for both households and real estate companies. Research directions for future work are also suggested.*

## INTRODUCTION

Today the Smart Homes represent a network of connected home appliances, electronic devices, control systems and computers, the main purpose being house automation and control. Emphasis is put on surveillance and other security systems, audio/video equipment, gadgets control, computers and communications (including the connection to Internet). This home network is different in many respects from the known models of computer networks. It has a much higher degree of heterogeneity displayed in a wide range of devices with different characteristics and purposes. All these devices exhibit different levels of intelligence, performance, connectivity possibilities, and related connection parameters. The variety of wiring standards and communication protocols that are developed by each particular manufacturer of one or another device brings to the fore the problem of interoperability. All this has put special requirements and constraints to the design and implementation of a Home Network.

The services that are built on top of such a network are simple and this limits the functionality they provide. In such a situation we find some disadvantages and risks, both for the households and the real estate companies. The devices that form the network become more and more complicated and sophisticated, with a lot of computing power that is unused or little used. This wasted power automatically translates into wasted money. The variety of connection and communication standards lead to problems of interoperability and a lack of flexibility and these reduce the ease of use.

Peer-to-peer technology imposes a different view on networking—the role that network participants (peers) play when they interact and communicate, how services are provided and accessed, etc. For today's problems and concerns in Smart Homes, the possible solutions suggested by this technology render P2P a strong candidate for Home Networking.

The flexible architecture of P2P allows us to apply the technology at different levels and with different purposes in a Connected Home. For example, there is the possibility of peering the home embedded systems, including different sensors that exchange data. Another is to apply P2P to home appliances and electronic devices to evaluate the pros and cons in terms of the final results. Or what if we use P2P technology between computers and other intelligent devices in a connected home, or in a connected building. Sharing of resources between them will make it possible for simple devices to use idle computing power of any other set of devices (subsystems) in the network.

Here we name some of the key features of P2P and relate them to the concept of Smart Home:

- **Self-Organization**—allows the network of connected appliances and devices to be built on the fly, without any central control point. Suppose there is an adopted standard that uses the P2P technology for device interconnectivity and communication (no matter what physical medium is used). Then adding a new device to the network becomes as easy as just plugging it in. A newly connected device announces its presence and the services it provides, as well as finds out about other devices and the services they provide. Using a common interface the user is able to control that device and to define the interaction with other devices in the network.
- **Variable Connectivity**—related to the previous feature, this one allows for mobile and “guest” devices to become part of the network for a short period of time in a Connected Home, without causing any big changes or problems. For example, when a Personal Digital Assistant (PDA) is brought within range of a Home Network, this PDA can become part of that network, and can be used as a tool for accessing and controlling the

network, or it can actively contribute to the network by providing some services.

- **Scalability**—this opens possibilities for applying Home Networking to a house, to a building with flats & offices, or to an area of connected homes. Here one could use the PDA to control or monitor the home surveillance system, for example, while visiting a neighbor or a friend whose home is part of the same network.
- **Decentralization and Redundancy**—increases robustness and reliability of the system or different subsystems. Imagine that different services in the network need to know the exact time. The system is more robust if there are several devices that are able to provide the time when needed. In a more complex case, embedded systems in a house could make use of decentralization and redundancy for their functioning.
- **Sharing of Resources**—in a network of connected Smart Homes, new possibilities open up for both households and real-estate companies through new applications and services.
- **Virtual Communities**—this social feature of P2P makes it possible for households to organize communities according to some interests or common goals.

There are advantages that come as a result of applying peer-to-peer technology with the above mentioned features and possibilities, as well as from the new services and applications that could run on top of this architecture.

The advantages for end-users (households) present themselves in the overall improvement of the QoS (Quality of Service). This is especially important for the normal users who do not need and do not want to know the underlying architecture and other technical details in these Smart Homes. Important for them is an always functioning system that responds on demand and delivers its services with high quality.

In a P2P environment, different services and applications can be thought of that can actually bring today's Connected Home to a higher level of services. Examples: better education and entertainment for everybody through implementing different collaborative services (network games, virtual classrooms, group work/research, etc.). Improved living conditions for elderly, and this could be achieved by such services as prompt healthcare consulting, easy access to different helpful information, interactive communication with friends, relatives, neighbors. Of course, the management and control of different home appliances and devices play an important role too. Resource sharing in a P2P fashion opens opportunities for such services

as computing power on demand, bandwidth sharing, etc. Different storage services could also be attractive for end-users, such as caching services, distributed electronic libraries, media data sharing, etc.

The real estate companies can also benefit from the P2P technology. The optimization of the computing infrastructure leads to increased QoS and less investment. For example, because of a decentralized control of underlying embedded systems and a degree of redundancy in the network, there is an increased robustness of different control and support systems. Also the P2P architecture attracts people and service providers by the variety of emerging services.

This view of a Connected Smart Home may seem too futuristic. But is it? If we think in terms of today's technology, it is not futuristic at all. Even though P2P is still in its childhood for its possibilities, it is a fast growing child and has many success stories to its name. These successes have earned it the prediction that it will be the basis for the Third Generation Internet. P2P technology is already sufficiently developed for highly effective optimization of applications in Smart Homes. We can find good P2P solutions for Smart Homes because they form a smaller scale concrete application.

**P2P Research Directions** for Smart Homes include:

- *Stronger security and trust models.*
- *Privacy issues.*
- *Accountability and logging models.*
- *Social issues.*
- *Business models* for Connected Smart Homes.

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