# Ubiquitous Computing and the Internet

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Ubiquitous computing, following the vision of Mark Weiser aims to embed small computer devices into every day objects to augment them with new functionality and to build an environment full of distributed computers. In research labs, augmented objects like cups, chairs, book, pens, picture frames are already in use. Here computers are completely integrated in the objects with no explicit user interfaces like keyboards or displays and literally disappear. Due to this lack of explicit interfaces, the interaction with those ubiquitous computing objects will often be implicitly and wireless interconnection is necessary. Those wireless interconnection build networks that are often refered to as Sensor Networks even though the functionalities and capabilities of the various designs differ a lot in attributes like size, life time, processing power, communication behavior. They span a wide field from research and development platforms, such as Smart-Its [1] or Motes [2] until commercial products like bluetooth. There are some requirements that most of the mentioned networks and their devices have in common. Firstly, low power and energy efficient battery operation is necessary to achieve long term operation. Secondly, the wireless communication should scale well for a high number of augmented objects e.g. in one room. Thirdly, the new functions through ubiquitous computing must be reliable and robust to increase the use and acceptance of users. The interesting fusion of ubiquitous computing and the internet promises a whole new area of thrilling applications and user interfaces. Examples are service relocation for mobile devices, access to real world objects and their functions in production process controls or home and office automation.

## HOW CAN UBIQUITOUS COMPUTING AND THE INTERNET COME TOGETHER?

Generally, there are two options: Firstly, the internet technology (especially the protocols TCP/IP including IPv6, mobile IP) is spread into the ubiquitous computing devices to connect them to the global network. Secondly, there are portals and middleware to mediate between the internet and ubiquitous computing devices. It is indeed questionable if internet technology with TCP/IP will become predominating on those sensor networks. The purpose for which the internet protocols have been designed does not match with the environment of sensor networks. The internet protocol's typical properties are packet switched traffic, unique addressing for all participants, communication on best effort basis, end to end error control and open-architecture without global control of the protocol flow. Those attributes serve well for the major internet applications like all kinds of information dissemination, private communication, research, business and entertainment. But it is not well suited for the world of ubiquitous computing. The implementation of a TCP/IP stack on a mobile device requires a lot of resources like processing power and memory. Processing extensive application will significantly reduce the life time of battery operated devices and require to exchange or recharge batteries frequently. Resource extensive design will as well increase the target cost which is especially critical for every day objects. The task of a single peer device in a wireless network of everyday objects is fairly small (e.g. sending out sensor values). The use of ubiquitous computing and sensor networks often originates only from the interconnection of devices and their activities in a group. Therefore a TCP/IP access to a single network device would not emerge in any added value. The connection between internet and the sensor networks world should better be realized through portals that provide the functions and capabilities of the sensor networks as a whole to the internet and vice versa, building services and remote procedure call interfaces. Those portals would bring the advantages of both worlds together, enabling both sides to profit from the new capabilities and build a real symbiosis rather than just force ubiquitous computing into a frame to where it doesn't belong.

## References

[1] www.smart-its.org.

[2] www.xbow.com.