Inowiss: Connectivity Management in Wireless Networking

Riad Lemhachheche
Department of Industrial and Manufacturing Engineering
Oregon State University
118 Covell Hall, Corvallis, OR 97330 USA
riadlem@acm.org

ABSTRACT
In this paper we describe Inowiss, a design to manage wireless network connectivity by providing users with more information to make decisions. By using research in the field of standardized information access, consumer behavior and information policy, we created an infrastructure that simplifies and enhance user interaction with networking technologies, especially wireless networking (e.g, Wi-Fi).

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Wireless networking, information asymmetry, interaction design, information policy, intra-home networking,

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

INTRODUCTION

New technologies have made creating, publishing and exchanging creative content easier and on a broader scale. The digital world has progressively removed barriers to empower information consumers and help them become information producers.

Copyright laws have been supplemented by initiatives likes Creative Commons [4] to provide individuals and organizations more flexibility to share, distribute and control the use of their creation. The next step is to bring this level of flexibility to the networking infrastructure, upon which this exchange of information is based. Consumers have now access to an ever richer choice of communication channels for exchanging digital information, including Bluetooth, WI-Fi, next-generation satellite TV or hi-speed cellular network. Soon, devices that support more than one channel will be the norm and the question in regard to information access will shift from how to access the information to which channel is best suited for this task.

In this regard, we believe that a new model for supporting user choice, in terms of networking use, needs to be defined.

NETWORK CONNECTION AND INFORMATION ASYMMETRY

The Inowiss (INteractions On WIrelesS Systems) project is aimed at reducing the phenomenon of information asymmetry currently existing in network access technologies. Information asymmetry [2] happens when one of the parties in a transaction has more or better information available concerning the transaction. In a wireless network, networking connectivity *consumers* (the users) and *producers* (the network administrators) have access to a highly different level of information. Network administrators usually have access to specialized tools to assess the network performance, detect unauthorized access and troubleshoot connectivity issues.

Recent technological advances have empowered users in several domains to solve the issue of information asymmetry. The internet has enabled consumers to become themselves producers in fields such as movie production [5] or publishing (Web sites, blogs).

In the space of network connectivity, the consumer has also been given the opportunity to become a producer. Indeed with the commoditization of networking equipment, it is not uncommon to find wireless access points, routers or modems in private homes. Intra-home networking equipment has been made necessary by the need to share printing devices or Internet access across several computers. While this has enabled home users with more flexibility in managing their networking needs, it has also shifted the burden of deploying, managing and maintaining the networking services from highly-trained professionals to consumers with a diverse range of knowledge. Previous study has shown that "home networks represent a complex collaborative household endeavour in virtually all of their aspects including design and maintenance as well as use"

[9]. We believe that the main issue with these home networks is that users have generally not been educated into using and managing these networks, but more importantly they lack easy access to the resources they need to perform these tasks appropriately.

STANDARDIZED INFORMATION ACCESS

A way of improve the end-user networking experience would be to give users and home administrators access to some of the same resources professionals network administrators benefit from. A first step toward this goal would be to reduce information asymmetry between network users and administrators. One of the most famous examples of a process used to reduce information asymmetry is the enforcement of the Nutrition Facts Label by the US Food and Drug Administration, which required all packaged foods to bear standardized nutrition labeling. Explicit and objective information on food products gave consumers a better understanding of the choices made available to them and provided them with some of the same information nutritionists use to create a balanced diet.

Our aim is to provide the same kind of objective information to network users as needs arise to manage their network connectivity.

NETWORK AS ACCESS CONTROL

Users of network connectivity, inside or outside the home, usually expect to access information and service independently from the network connection they are accessing. However, network connectivity do not all provide access to the same resources, even when they are connected to the Internet. In some cases, the information systems users are connected to have been designed to provide specific resources over a particular connection. For example, corporate intranets are being designed to give access to local resources only to users connected to the company network. Similarly, universities provide access to academic research publication database restricted to on-campus use. The use of proxies in higher education institutions' libraries enable these institutions to reduce the complexity to manage the access to the digital resources they host locally as well as to the external subscriptions to databases and electronic publications.

The use of the network connection as an information access control mechanisms will become more and more important in the home user experience. Currently, the ability for home users to setup access to local file servers and printers is dependent to being connected to their home network, which usually means being physically present in or around the home. The Internet has diminished the importance of the distance factor in the access of data or services and it is predicted that the notion of distance in network will become totally irrelevant [1]. Users now expect to access seamlessly their work resources from home, their home documents from the other side of the world and a distant file from home. Home users will be faced with the tasks to open their home network for distant access by the members of the household while protecting this access from unauthorized access.

With the convergence between television, phone and Internet service known as Triple Play, home users will be able to subscribe to network connectivity that also accounts for all their entertainment needs. The ability to access securely this kind of resources available at home from outside the home network is a service that will become more and more compelling. Companies have already announced services that will give users the ability to re-broadcast programs recorded at home.

However, the complexity of selecting the appropriate connectivity matching the resource to be accessed will come in addition to the other challenges that users already face in regard to information access. Indeed, for the user to access the information or service of her wish, she will have to not only select the proper connection but also make sure that the information format, the computing platform and the device are compatible with this access. For example, a user wishing to see a streaming video would require a device compatible with the audio and video format, support the eventual digital rights management system associated and have authorized access through the network connection selected. Multi –purpose devices would therefore require the ability to associate these different elements of context (network connectivity, digital rights credentials …) together to provide a seamless user experience in the use of networked services. While it is possible today to automatically associate data format, application and device capabilities to provide the best available experience, we lack information on the network connectivity to be able to dynamically associate it with the rest of the contextual information. Indeed, devices are capable to retrieve information in a format consistent with their capabilities (screen size, resolution) and run the application capable of understanding the data format but they may not yet be able to identify the best connection channel to do so in terns of physical properties (wireless network, Bluetooth, wired connection) or logical properties (home network, corporate network, mobile network). In consequence, a document on the corporate network may require the user to explicitly establish a distant connection from home to be able to retrieve it. Similarly, an application running on the corporate intranet would unlikely be able to determine by itself that it requires to connect to the corporate network first to perform its functions.

Research, such as the Mobile Media Metadata [6], has shown that additional information (metadata) about the network characteristics can improve substantially the user experience. Geolocalization information provided by a mobile phone network (tower identification) helped infer user context and improve results in sharing digital pictures

taken on a cameraphone. Similarly, metadata could be used to match user activities with the best network settings to perform a specific activity.

THE ECONOMICS OF NETWORKING

Market forces

In the past, one of the main limitations to the feasibility of our approach would have been that the form of the interaction between the users and the networking equipment is decided by hardware designers and service providers. A standardized protocol for labeling network connection characteristics would indeed have required a commitment from both networking equipment manufacturers and network service providers. However, it is unlikely that these corporations would have any economic incentive to promote a system that enables their customers to easily compare them with their competitors [12]. As a result, equipment manufacturers would consequently not be interested in designing equipment that their prominent clients would not purchase.

Open source networking

However, recent advances in networking now make it possible for this standard to come from a group of users rather than large networking manufacturers and service providers. For example, Openwrt [11], an open-source networking operating system based on Linux, enables programmers to implement new functionalities directly in networking equipment like commercial routers or wireless access points. There is then a possibility for this labeling protocol to become popular if it is integrated natively in the OpenWRT operating system or any equivalent system.

Community incentives

The incentives to provide users with more information about networking connectivity vary between the different stakeholders in the networking industry. Wireless Internet Service Providers (WISP) could compete better with established providers by being able to distinguish them more easily. Users could benefit from more complete information to make better decisions in regard to their privacy [1], security and the quality of the service. Standardized information provided by networking equipments could be the foundation on which centralized services could be built. Grassroots projects like FON [6], NYCWireless [10] could more easily organize the resources provided by their members. Like in peer-to-peer systems [7], these central services or applications could promote initiatives like FON where households give access to their home network in exchange to the ability to get access to the rest of the network for free.

OUR MODEL

Inowiss will function as an information delivery system. It will be readable by humans as well as by machine. Inowiss information delivery will be composed of three main parts:

- a **Network Facts** module that will provide basic information about the wireless connection
- A **statistical report** about connection speed, uptime and
- A **Connect Commons** sharing license to describe the rights and restrictions set on the wireless connection by the operator of the network.

Network Facts

The Network Facts module provides general information about the operator of the network connectivity as well as the authentication and security settings. Information provided can be used to determine automatically how to connect by proving the proper credentials and determining if the security mechanisms enforced on the network are compatible with the ones implemented on the device performing the access. This will enable the device to select only connectivity options that are compatible and also inform the user of any discrepancies between the network and the device. For example, a portable device that does not support the transmission or security protocol used on one of the network available can chose an alternate network for the transmission or alerts the user that the transmission is likely to fail because of incompatibilities.

As more of the devices support wireless connectivity, gaining information on the wireless network operator can also be useful to make sure that the device is accessing the correct network and also receive support if needed.

Network Facts	OSU_PUB	
Operated by	**OSU**	EDU-ORST
Name on Certification	Oregon State University	EDU-ORST
Operator Type	University	EDU
Contact Name	John Doe	-
Contact Info	541-555-1000	-
Contact Info	john.doe3(@)oregonstate.edu	-
Authentication/Security	**Authentication-No Security**	-
Authentication	ONID Account Holder	ONID
Authentication Scheme	Browser-based	AUTH-HTTPS
Security	NO	SEC-0
Security Scheme	None	SECTY-0

Figure 1. The Inowiss Network Facts module provides with general information about the network.

Statistical Report

A statistical report could contain information like the maximum local and distant transmission rate, current uptime and number of devices or users using a particular network connection. The distinction between the local

access capabilities (speed to connect to a local network) and the distant access (speed to connect to the internet for example) could be important for devices having multiple connectivity options. A particular device may connect more quickly to a cell phone via short distance communication protocol such as Bluetooth, USB or FireWire than it will to a Wi-Fi powered wireless network. However, making decisions based on the connection speed of the link between the device and the local network will miss the fact that the phone access to the Internet may be several times slower than the one afforded through the local network providing the wireless connection.

Connect Commons Legal Licence

Similarly to the Creative Commons license, a Connect Commons license could be provided by the *producers* of the connectivity to inform the *consumers* of the rights and privileges available through a particular connection. It is not uncommon for service providers to restrict or block particular usage of a network connection. For example, a network operator may block unsecured data exchange vulnerable to security exploits (such as File Transfer Protocol (FTP)) or limit services that consumes a large amount of the network resources like peer to peer downloading or video broadcasting. Until now, being informmed of these restrictions proved to be difficult. A license, both machine- and user-readable, could facilitate the access to this kind of information.

Also, a home network administrator would no longer have to resort to use security mechanisms to manage the permissions he wishes to associate with sharing the wireless access to his home network and the Internet. Occasional or temporary use could then be permitted to visitors and neighbors while the use as a permanent access could be forbidden.

Licence	CO-FR-ALL-NOL-NOS-USOR	
Connect Commons Licence	**Community-Free-AllServices-Nolimit-NoShare**	
Access Type	Community	ONID account only
Cost	Free	No Cost
Services Allowed	All	No Restrictions on Services
Time Limitation	No	No Time Limitation
Connection Sharing	No	Retransmission of Signal is prohibited
Jurisdiction	US-OR	USA, Oregon

Figure 2. The Inowiss Connect Commons license defines the permissions associated with a particular network connection

APPLICATIONS IN THE HOME

While this model has been designed particularly for wireless networking, it is possible to imagine its extension to any type of connectivity in the home. As most of the consumer devices found in households will gain the ability to receive updates or exchange content over a network connection, the user will be facing more and more situations where she will have multiple channels over which to perform activities such as sending pictures, downloading multimedia content or even writing email. This multiplicity of choices will require a shift from device (and associated connectivity) to an activity centric view of network connection.

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