

# Epidemic Diffusion

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## ABSTRACT

New communication paradigms, which use dynamic interconnectedness as people encounter each other opportunistically, lead towards a world where digital traffic flows more easily. Nowadays, the message exchange between people is increasing, either by phone or other applications available on our computers. This article describes the importance of the use of applications that uses epidemic spread and demonstrates a practical example of an application named Epi, which uses the epidemic spreading to make communication exist. We also demonstrate some criticisms and improvements that could be made to make this application more effective and efficient.

## Keywords

Epidemic Diffusion, Epi Application, Network, Ubiquitous Computation

## INTRODUCTION

Epidemic diffusion is now an important topic because of the hectic activity on complex networks. Compared on the previous works which focused on the epidemic threshold and epidemic control, the present study on epidemic diffusion is mainly focused on how the topological structure of a complex network influences epidemic diffusion. It is found that the features of small-world and scale-free networks can influence seriously the epidemic diffusion in complex networks. [1]

The small-world network is currently one of the biggest highlights in the evolution of science and this network features structural properties of high connectivity and clustering. Note that this type of network has the potential to model a variety of social contact network[8].

It is also important to focus that the dynamics of epidemic spreading in networks can be characterized by the maximum size of an epidemic (MES) or by the time of the MES. The MES measures the maximum number of infections in an epidemic, and the time of the MES measures as the epidemic can reach its MES [2].

Epi [3] is an application that allows the exchange of messages between the users connected to the same Wi-Fi access point without need of the internet. The messages exchanged in a given location, are stored and distributed again in other places where Epi is used.

Users can use a Wi-Fi network interface to connect to a network in ad-hoc mode; they can even create their own ad-hoc network or can be connected to an access point without having internet access.

## EPIDEMIC DIFFUSION

### Definition

The spreading epidemic is under constant study, being considered a high level of innovation in area of technology science.

In figure 1 we have a schematic illustration of epidemic diffusion on a complex network, where the centre denotes the original seed. The numbers 0, 1, 2... denote the distance from the original seed, and the arrows denote the possible infection paths [1].

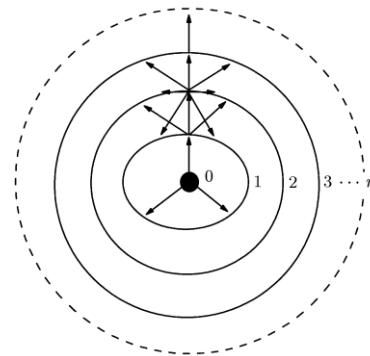


Figure 1 - Epidemic diffusion

In diffusion when a node is infected, one of its neighbouring nodes will be infected at the next step, reducing so the density of infected nodes[8].

However, this diffusion cannot be treated as a random walk in the complex network. We can find several differences between the random walk and epidemic spreading. One of

them is that for the number of moving particles is constant and the individuals cannot duplicate themselves. Another difference is that the random walk can go back and forth, while the epidemic cannot be propagated to the refractory. Namely, there are birth and death during the spreading process[8].

It is in fact a kind of reaction diffusion process and uses a gossip protocol in order to establish the connection within the network.

Because of the form of gossip is seen in social networks, this protocol is a style of computer-to-computer communication protocol. Several distributed systems often use gossip protocols to solve problems that it could be difficult to solve by using others ways, either because the underlying network has an inconvenient structure, or is extremely large, or because gossip solutions is considered the most efficient ones available [7].

**Related work**

It was performed the integration of the epidemic broadcast protocol in flight Simulator 2002 [4], this protocol aims to support scalability limitations, and thus performance that may occur in the exchange of the information among many people, in this case, the exchange of information multi-player games. The main interest of this integration is focused on studying the feasibility of using epidemic protocols that support the dissemination of the information in multi-player games using a peer to peer architecture. The difficulty is that this study is to reconcile the reliability of the information dissemination about the scalability of the system, given that one of the requirements of this type of game is the dissemination of the information by all users on a regular basis.

An epidemic model in mobile ad hoc networks (MANET) [5] was developed for a simple information diffusion algorithm based on simulation results. It was investigated the impact of node density on information diffusion. The analytical model allows the evaluation at runtime, even on devices with restricted resources, and thus enables mobile nodes to dynamically adapt their diffusion strategies depending on the local node density.

**EPIDEMIC DIFFUSION APPLICATION**

**Description**

A vast amount of mobile and handheld devices, such as, laptops, mobile phones, Smartphone's and MP3 players are equipped with one or more radio communication interfaces (GSM, UMTS, Wi-Fi and Bluetooth). Through those interfaces, are established connections to communication networks or to sporadic networks (ad hoc) and allows the access to the Internet, to voice and data services, or even communication between devices.

However, many of the places where these devices are used are not equipped with the necessary infrastructure for their use and in some cases the use of existing infrastructure is very expensive. Therefore, it was developed by the University of Minho, a dissertation theme called "Epidemic multicast messages in Wi-Fi hotspots," the Epi application (epidemic Diffusion).

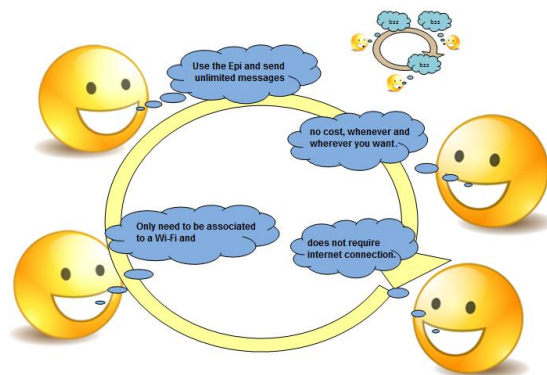
Epi [3] is an application that, using Wi-Fi interfaces, facilitates the spread of text messaging between users that are close, since there is no need to Internet connection. For example, one possible scenario for sending and receiving messages between users of Epi is when we are in a public establishment with one or more Wi-Fi networks, we turn on the laptop and some of these networks presents us with the registration on the network without prior authentication, and provided us with an IP address. Consequently, when we are trying to access the Internet through a browser, we are headed to a service provider authentication site. Then, it is made a record on this network, even without Internet access, and it is possible to use the Epi application.

A special feature of this application is that messages that are sent at a specific location, in which there is no Epi user, are stored and, subsequently, propagated in other areas where Epi is being used.

This application lets you send messages between the users that are connected to a network, even if this connection has been made in differently forms. In other words, the user may be using the Wi-Fi network interface to connect to a network in ad-hoc, can possibly create an own ad-hoc network, or even be connected to an access point that does not have an Internet connection.

**Functioning**

As it was mentioned before, the Epi application [3] allows sending and receiving messages between users who are on the same network, even without an Internet connection (figure 2).

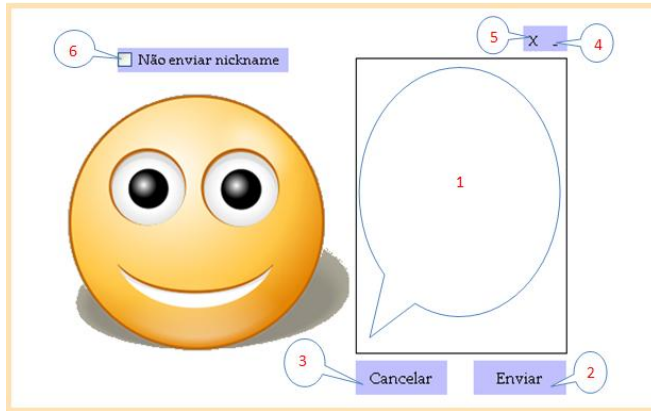


**Figure 2 – Epi application**

To the send messages is presented to the user an interface (Figure 3) where he writes the text in the area marked as 1, and then he must press the "Enviar" button (2). Note that

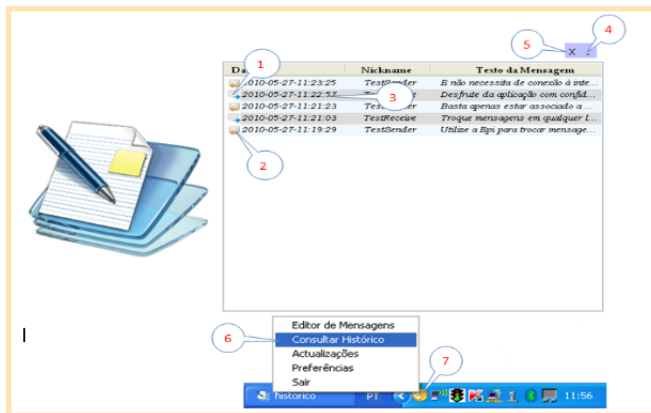
this message can be sent anonymously, being just necessary to select the checkbox "Do not send nickname" (6).

This message editor, when triggered, overlaps any window or application that is open. It is possible to minimize this application in two ways, these being through the "Cancelar" button (3) or through the traditional minimize button (4). If you want to close the application, you must press the "X" button (5).



**Figure 3 – Sending messages**

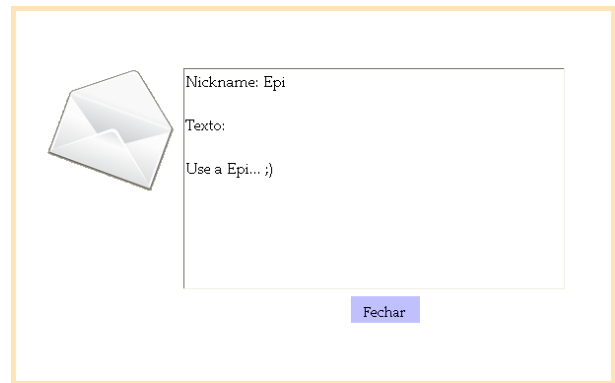
The application also keeps a story of the last twenty sent and received messages. Since this, you can view them by selecting "Consultar histórico" (6). This option is provided in case of pressing the Epi icon with the right mouse button.



**Figure 4 – Stored messages**

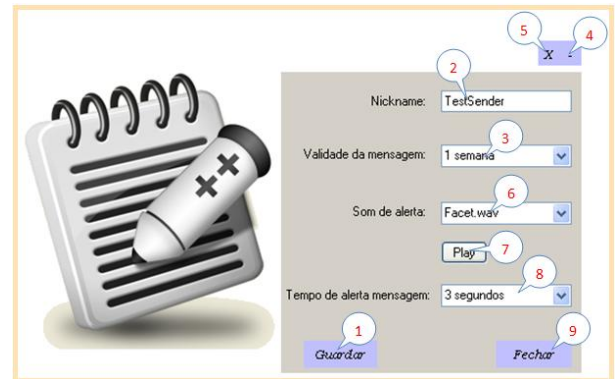
The menu presented to the scenario described above is shown in Figure 4. As we can see the messages sent (1) and received (2) are identified in different ways.

Note that when the messages are too expensive to view the entire message we only need to press twice the mouse button in the message area we wish to view (figure 5).



**Figure 5 – Message interface**

Finally, this application also allows you to configure how the messages are saved and to change the nickname to be used, by pressing the right mouse button and selecting the "Preferences" option (figure 6).



**Figure 6 – Configuration**

The validity of the messages can vary between 6 hours to 1 week (3) and the time of the alert message can vary between 1 to 10 seconds (8). You can also choose different tones for message alert (6) and listen to them previously, by pressing the "Play" button (7). To save the settings chosen simply press the "Guardar" button (1) and to exit the application the "Fechar" button (9).

### Advantages/Disadvantages

The main advantage of this application is that it is possible to transmit messages without internet connection. In other words, with this application the user can send and receive messages, even if it is an establishment whose existing infrastructure does not support the Internet access, or this access is too expensive.

Another advantage is that this application has a privacy policy. The user data are not stored in the content of the messages, because for each sent message only the physical address network card from which the message is retrieved.

The main disadvantage of this app is that it does not work in any other operating system besides Windows.

Another disadvantage of this application is that is only available in one language, i.e., in Portuguese, which makes it hard to use for users of any other nationality. In addition, its interface has some peculiarities that can be misleading to the user's understanding. The fact that, in the sending interface, the cancel button displays the same function to minimize, can induce the user to mistake and make he think that by pressing the cancel button, he will cancel the post and, instead, he will minimize the application.

This application is still evolving and has already undergone some changes, such as improving the level of function of proximity and compatibility with various operating systems. Actually, it is only compatible with Windows XP, Vista and Seven.

### Users Evaluation

After a study of the comments of some users placed on Facebook [6] (social utility that connects people with friends and others), many of them that use this application are considering an innovation in the broadcasting of messages in the network. Some believe that could revolutionize the computer world and can be a substitute for messenger.

As it was mentioned before, this application has the biggest disadvantage of not being compatible for Linux / OSX, do not work on some networks and the fact that those who use the application for the first time does not notice its functionality.

In addition, it does not always work perfectly in the diffusion of messages, because many users complained in comments on Facebook that sometimes when they send messages it is too slow to the other ones get them. Other times they did not even get to send or receive messages.

### Improvements

Since this application can be used by different users, it is necessary to evolve this application so that it covers them all. So it should be possible to choose the language to be used and be compatible to any operating system, in addition to windows.

A major advantage of this application is sending messages even without an Internet connection, so this application could jointly enable the user to send files to your neighborhood. Consequently, this application should also have security and privacy protocols to send files to create a certain confidence to users.

Finally, after some research, we denote that, in the future, University of Minho has plans to extend this project further, to make possible the use of this application also for mobile phones and Bluetooth interfaces.

### CONCLUSION

The purpose of conducting this article was to demonstrate the importance of using an application that uses the diffusion epidemic as a means of communication, named as Epi (Epidemic diffusion).

Initially we installed the application and we test, so we can draw some conclusions. It was found, as many of the comments made by users on Facebook that this application sometimes did not sent messages and took a lot of time to receive messages sent by others.

Another problem diagnosed and may induce the user to error, is that, in the same infrastructure, may exist several available networks. So, if the users who intend to carry out the exchange of messages are not exactly on the same network, they will never receive the messages of the other user that is in a different network.

Finally, we conclude that this project needs more study and exploration to meet all the needs of the USERS, but we think it can make a positive impact in the future because this is viable.

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