University Communication at Intelligent Ad Hoc Network using SIP services

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Abstract

The frantic nature of technological advances in the area of multimedia communications, compounded with the convergence of telecommunication and computer networks has led to the emergence of new class of applications sometime called ubiquitous computing or ambient intelligence.

In this paper we present a project which converges with this new generation of intelligent applications. We have named this project UCIAN for "University Communication at Intelligent Ad Hoc Networks". This project is dedicated to university teachers; it consists of creating an intelligent environment at the university that allows teachers to explore SIP (Session Initiation Protocol) services, in particular Instant Messaging (IM) service and Presence service.

Key words:
Smart communications, Ad hoc, SIP, IM, Presence.

1. Introduction

Ad Hoc Networks [1] provide a real opportunity to design flexible networks, very simple to deploy. However they remain a particular computation environment, characterized by the deficiency of pre-existed and centralized infrastructure. In the other hand, SIP protocol [2], which knows a huge booming in internet networks, requires centralized entities, like proxy server, registrar server and location service; consequently SIP is not adapted to Ad Hoc networks. We have presented in [10] a new technique VNSIP (Virtual Network for Session Initiation Protocol) to fix the problem related to constraints of SIP deployment in MANET (Mobile Ad Hoc Networks) [8][9]. The main idea of this paper is to describe how we adapt VNSIP approach to be explored by UCIAN project. In fact we will explain the changes that we have made to allow the use of Instant Messaging and Presence services under an ad hoc network. In this way and thanks to UCIAN project, university teachers can initially register for presence information and receive notifications when such events occur, for example when a participant (university teacher) logs in or comes back from lunch. And In second step, teachers can send short messages, analogous to SMS or two-way paging, or manage a session of real-time messages between two or more participants, without using any preexisted infrastructure.

This paper is organized as follows. In the first section we'll present SIP services: Instant Messaging and Presence solutions. In the second section we'll give an overview of VNSIP approach. Afterword in the next section, we'll present the adaptation of VNSIP to support Instant Messaging and Presence services. In the last section we'll evaluate performances of UCIAN. In the end we'll achieve this paper with a conclusion.

2. Presence and Instant Messaging

Presence is the ability to sense the willingness of another user to communicate. Instant Messaging (IM) is a way of exchanging short text messages in near-real time. Presence is often used to determine when another user is available in order to start an instant message exchange. Often, messages are grouped together in a window and shown in sequential order, turning it into a conversation.

To address IM and interoperability, the IETF standardized two IM and presence protocols. One was a set of SIP extensions known as SIMPLE (SIP for Instant Messaging and Presence Leveraging Extensions) [3] and XMPP (Extensible Messaging and Presence Protocol) [4], which are based on the Jabber open source client. Today, both SIMPLE and XMPP are used to interconnect various closed IM systems. The Instant Messaging architecture is shown in figure 1 and its elements are in table 1. Presence architecture is shown in figure 2 and its elements are in table 2.

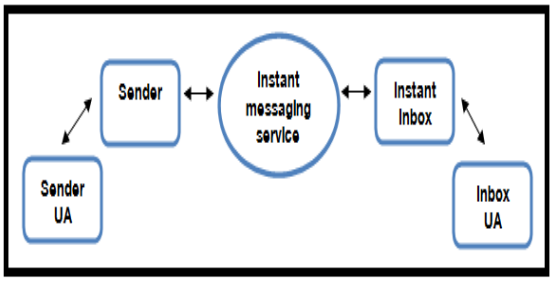

Figure 1 IM architecture

Instant Messaging Service	Protocol used to transport IM
Sender	Formats message for IM service
Instant inbox	Receives message from IM service
Sender user agent	User interface for gathering IM contents from user
Inbox user agent	User interface for rendering IM to user

Table 1 Instant Messaging elements

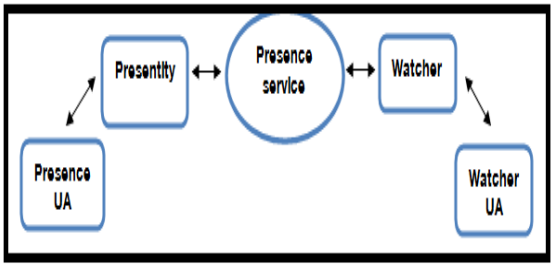

Figure 2 Presence Architecture

Presence Service	Protocol used to transport presence information
Presentity	Publishes presence information to presence service
Presence user agent	User interface for gathering presence information about user
Watcher	Requests and receives presence information from presence service
Watcher User agent	Renders presence information received to the user

Table 2 Presence elements

2.1. Presence with SIMPLE

The SIP events framework was defined in RFC3265 [5] which defined the *SUBSRIBE* and *NOTIFY* methods. *SUBSCRIBE* is used to establish a dialog and ongoing association between two UAs. In the Presence architecture of figure 4, the watcher send the *SUBSCRIBE* request to the presentity. If the subscription is authorized, the presentity will send *NOTIFY* wherever the state of the presentity changes, and at regular intervals. The basic call flow is shown in figure 5.

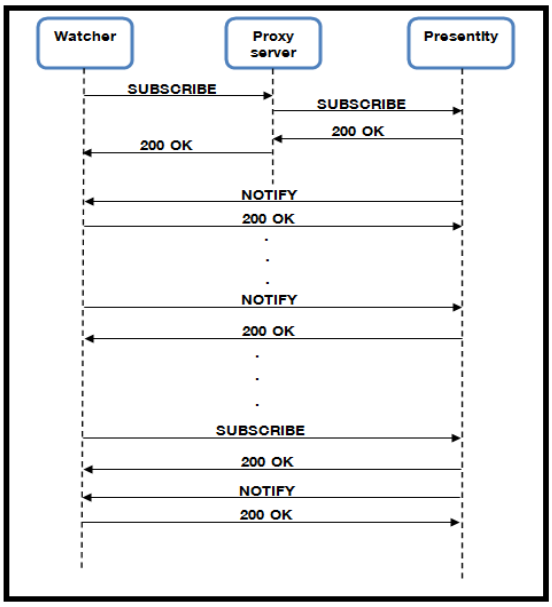

Figure 3 Example SUBSRIBE and NOTIFY call flow

An example *SUBSCRIBE* request is shown below:

```
SUBSCRIBE sip:ptolemy@rosettastone.org SIP/2.0
Via SIP/2.0/UDP proxy.elasticity.co.uk:5060
  ; branch=z9hG4bK34841123
Via SIP/2.0/UDP parlour.elasticity.co.uk:5060
  ; branch=z9hG4bKABDA ; received= 194.0.3.4
Max-Forwards: 69
To: sip:Ptolemy@rosettastone.org
From: Thomas Young <sip:tyoung@elasticity.co.uk>;
   tag=1814
Call-ID: 452k59252058dkfj34924lk34
CSeq: 3412 SUBSCRIBE
Allow-Events: dialog
Contact: sip:tyoung@parlour.elasticity.co.uk
Event: dialog
Content-Length
```

The *NOTIFY* method is used by a user agent to convey information about the occurrence of a particular event. A *NOTIFY* is always sent within a dialog when a subscription exists between the subscriber and the notifer. An example NOTIFY request is shown here:

```
NOTIFY sip: UDP parlour.elasticity.co.uk SIP/2.0
Via SIP/2.0/UDP  cartouche.rosettastone.org :5060
  ;branch=z9hG4bK3841323
Max-Frowards: 70
To: Thomas Young <sip:tyoung@elasticity.co.uk>;
   tag=1814
Call-ID: 45k59252058dkfj349241k34
Cseq: 3 NOTIFY
Contact: sip:ptolemy@cartouche.rosettastone.org
Event: dialog
Subscription-State : active ; expires=180
Allow-Events : dialog
Content-Type : application/xml+dialog
Content-Length : …
      (XML Message Body npt shown …)
```

2.2. Instant Messaging with SIMPLE

Instant Messaging with SIP was a very early SIP extension in RFC 3428 [6]. In addition to this simple transport, SIP extensions for "iscomposing" or "istyping" have been standardized. The *MESSAGE* method is used to transport instant messaging (IM) using SIP. IM usually consists of short messages exchanged in near-real time by participants engaged in a text conversation. All UAs that support the *MESSAGE* method must support plan/text format; they may also support other formats such as message/cpim or text/html. A *MESSAGE* request normally receives a *200 OK* response to indicate that the message has been delivered to the final destination. An IM response should not be sent in the message body of a *200 OK*, but rather a separate *MESSAGE* request sent to the original sender. An example of *MESSAGE* call flow is shown in figure 6.

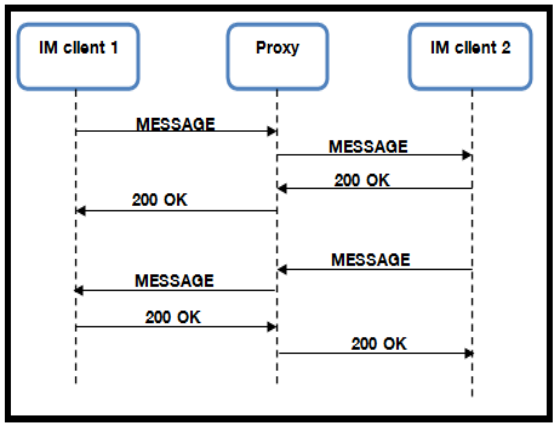

Figure 4 SIP MESSAGE call flow showing instant message transport

An example of *MESSAGE* request is shown here:

```
MESSAGE sip:editor@rcs.org SIP/2.0
Via SIP/2.0/UDP lab.mendeleev.org:5060
   ;branch=z9hG4bk3
Max-forwards: 70
To: editor@rcs.org
From: " D. I. Mendeleev" dmitry@mendeleev.org
    ;tag=1865
Call-ID: 93847197172049343
CSeq: 5634 MESSAGE
Subject: First Row
Contact: <sip: dmitry@lab.mendeleev.org>
Content-Type: text/plain
Content-Length: 7

H, He
```

3. VNSIP overview

In [10] we have designed a new solution to adapt SIP protocol to Ad Hoc network; we have named this solution "VNSIP" (Virtual Network for Session Initiation Protocol). It tries to define a dynamic virtual network inside the MANET, to be exploited by nodes, to adequately choose which one will be in charge to execute SIP server tasks. VNA (Virtual Network Algorithm) will be the entity in charge to activate or deactivate SIP server functionalities in each MANET node. A VNSIP node (see figure 5) consists of several entities, when interacting between them; they allow communication in MANET using SIP protocol.

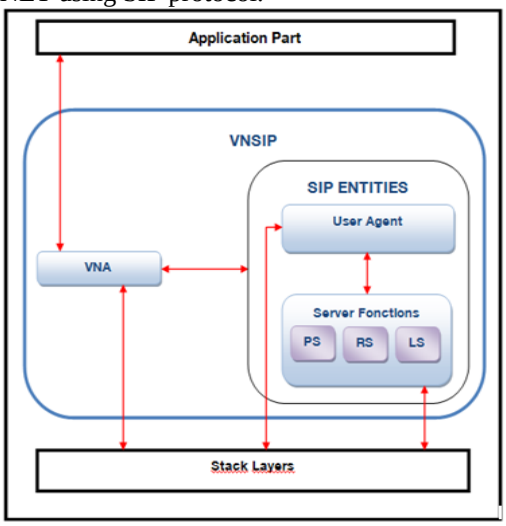

Figure 5 VNSIP Node Architecture

3.1. Virtual Network Algorithm (VNA)

VNA starts by the construction of neighbor tables. VNA defines a flag "VN_membership_flag" which shows if a node belongs to the VN (Virtual Network) or not. When executing VNA, the VN will include all nodes having VN_membership_flag=1. VNA is characterized by two conditions:

- Condition1: if a node doesn't belong to the VN and the number of its neighbors which belong to the VN is lower than the number of its neighbors which don't belong to the VN then the VN_membership_flag of this node is set to 1.
- Condition 2: if a node belongs to the VN and the number of its neighbors which belong to the VN is higher than the number of its neighbors which don't belong to the VN then the VN_membership_flag of this node is set to 0.

To complete the construction of a connected VN, we define Gateway nodes to ensure connections between all nodes belonging to the VN. When finishing the selection of gateway nodes the construction of the VN is completed (see figure 6).

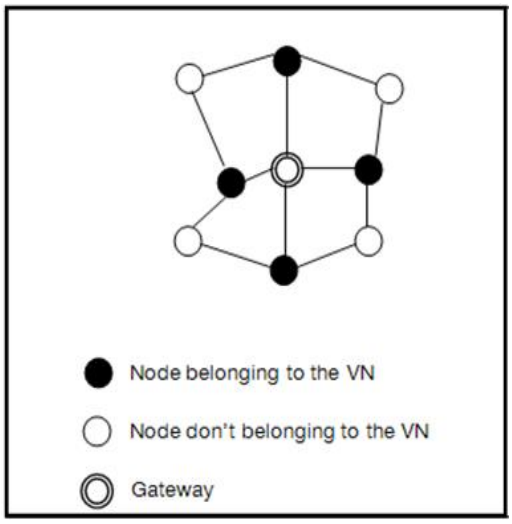

Figure 6 VN construction

3.2. Interaction between VNA and SIP entities

As it shown in figure 6, when finishing construction of the VN, three kinds of nodes are defined:

- If a node belongs to the VN, then it plays SIP User Agent role and all its SIP server's functionalities (Proxy server (PS), Registrar (RG) and location service (LS)) [11] are activated,
- If a node is a gateway, then it plays SIP User Agent role and PS role. RG and LS are deactivated.
- If a node doesn't belong to the VN, then it plays only SIP User Agent role and its SIP server's functionalities are deactivated.

4. Adaptation of VNSIP approach to support Presence and Instant Messaging services

UCIAN project consists of offering a smart communication environment to university teachers inside the area of the university. The main idea is to allow teachers to use SIMPLE (SIP for Instant Messaging and Presence Leveraging Extensions) functions under an Ad Hoc network. We use our solution VNSIP [10], described in section I, which enables adapting SIP to Ad hoc networks. However VNSIP as it's designed actually doesn't support Presence and IM services. Thus it's necessary to modify VNSIP architecture to be able to provide SIMPLE functions. The figure 5 in section II describes VNSIP node architecture before modifications. And figure 7 shown here describes VNSIP node architecture after modification to support Presence and IM services.

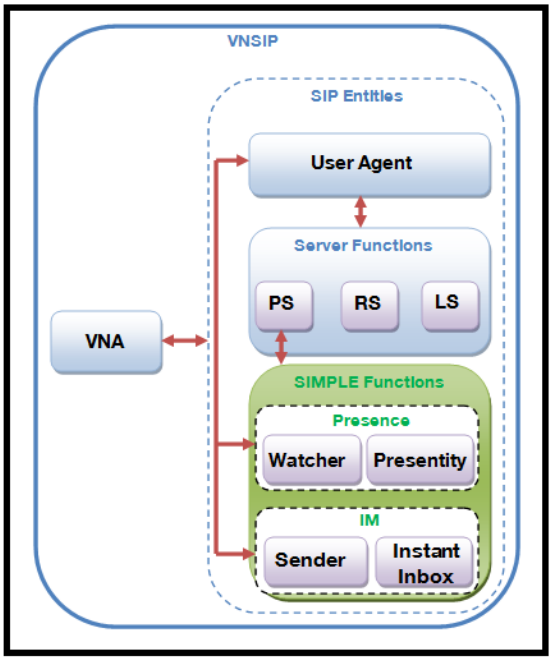

Figure 7 VNSIP node after modification, to support SIMPLE functions

Two additional entities are added to VNSIP approach. The first one is Presence, which contains two sub-entities achieving "Watch" and "Presentity" functions as described in Figure 2 and table 2. The second entity is IM, which contains tow sub-entities accomplishing "Sender" and "Instant Box" functions as described in figure 1 and table 1.

These two entities, as User Agent function, are always activated, regardless of the node position in the virtual network, as described in figure 6.

When a node A decides to establish an Instant Messaging communication with node B; If its SIP server functions are activated then it sends MESSAGE method directly to its own PS. In the other side, if its SIP server functions are deactivated, in this case, it broadcasts the MESSAGE to its 1-hop neighbors. When a PS receives the MESSAGE, it sends a request to its LS to verify in the data base if he knows the route to B. if it does, then it redirects the MESSAGE directly to B (see figure 8). If not, it broadcasts the MESSAGE to its 1-hop neighbors.

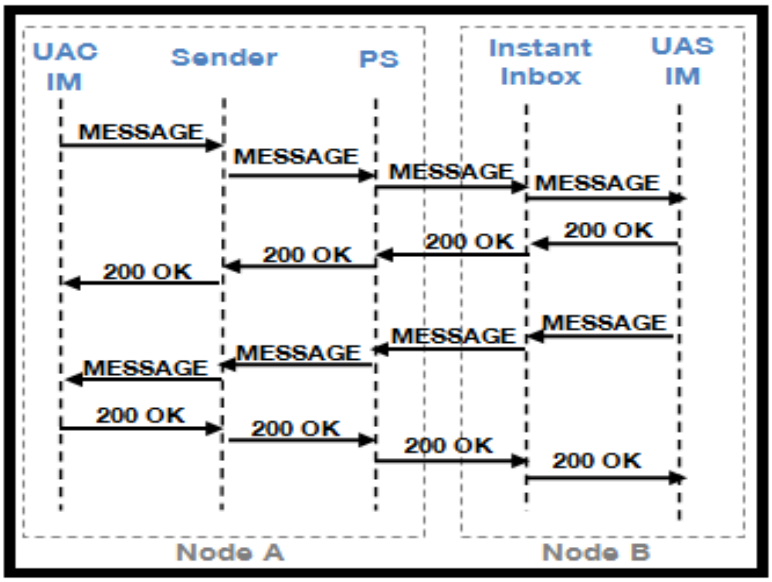

Figure 8 Example of IM call flow using VNSIP, when the PS of Node A knows location of Node B

When a Node A decides to establish a subscription for the purpose of receiving notifications from Node B, the same treatment is achieved as IM communication algorithm seen above. The figure 9 shown here, describes the call flow of Presence, when requests are forwarded between several nodes.

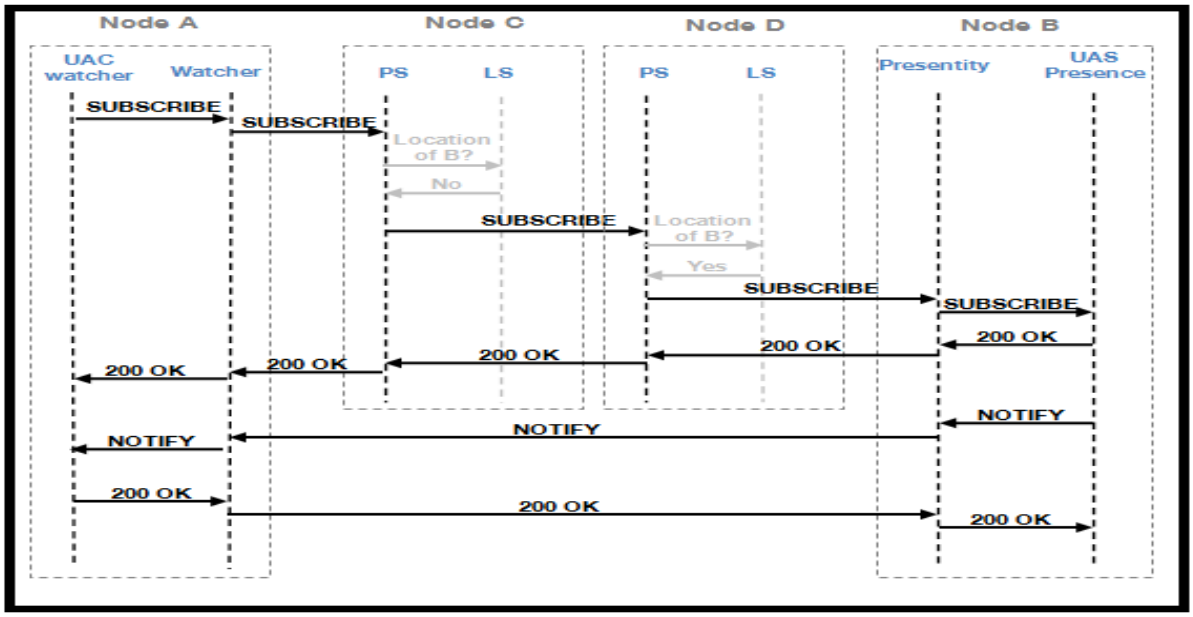

Figure 9 Example of Presence call flow using VNSIP, when the PS of Node C doesn't know location of Node B

Modifications achieved above, to support Presence and IM services, enable VNSIP approach to be used by UCIAN project to provide those services to University teachers under an Ad Hoc Network. Figure 10 shown here, gives an example of deployment of UCIAN in IT department of university. VNSIP approach is installed on each teacher computer, which considered as a node in the ad hoc network. Using this architecture, teachers can exchange messages and information using SIP protocol without using any pre-existed infrastructure. This figure presents also an example of communication between "teacher1" and "teacher4" using SIP protocol (using Message method).

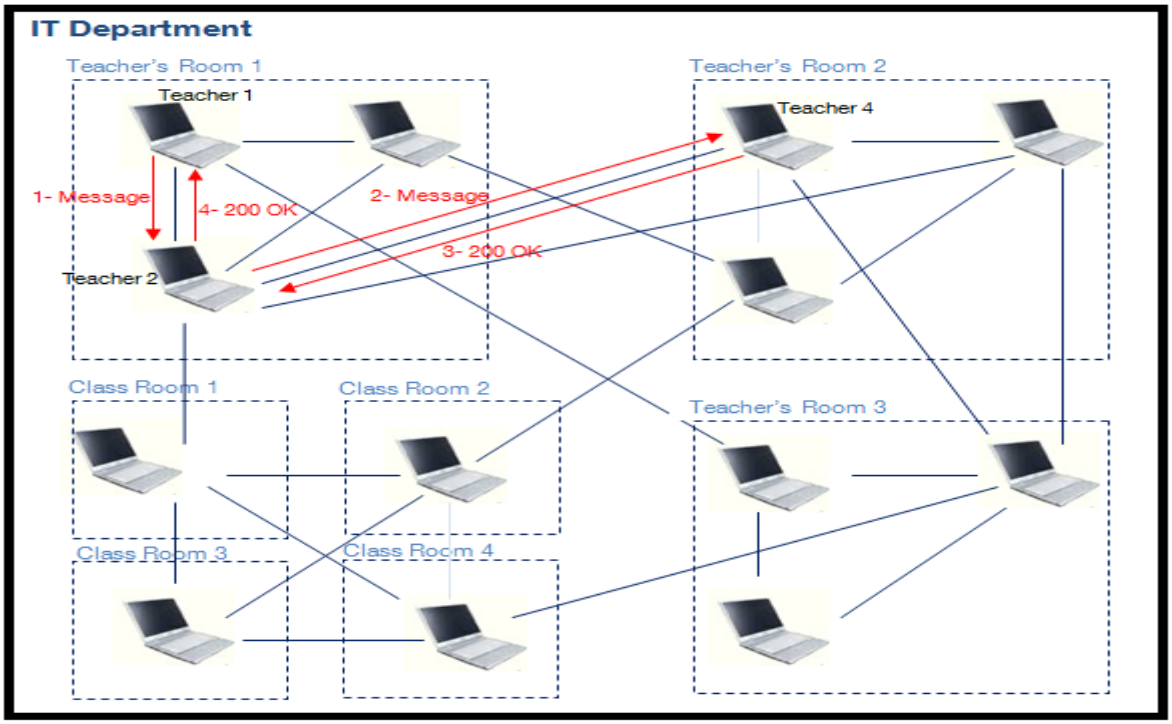

Figure 10 Deployment of UCIAN in an IT department

5. Simulations and Evaluation of performances

Simulations scenarios were achieved using the network simulator NS2 [7]. The simulation area was 1000m by 1000m. The node number was between 10 and 50 nodes. The movement speed of nodes was between 0 and 18 m/s, and times of simulations were 180 seconds.

To define differences between utilization of Instant Messaging and Presence using VNSIP, we achieved many types of simulations, and we analyzed behaviors when node speeds and node numbers are increased.

5.1. Failure rates

The figure 11 shown here illustrates the failure rates of session setting according to nodes mobility for Instant Messaging and Presence services

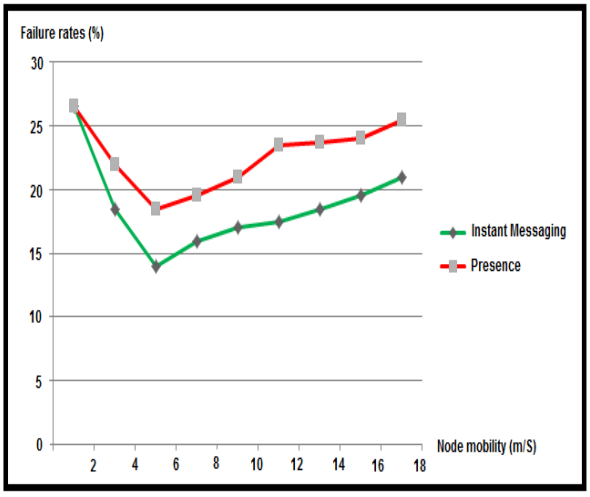

Figure 11 Failure rates by mobility of nodes for IM and Presence services

We observe good results of both services when mobility of nodes is not important. However when the mobility is higher the failure rate increases. Fortunately concerning the UCIAN project, we will not be faced with this problem on a large scale, because mobility of teacher is not very important in the area of department in the university (see figure 10).

The figure 12 shown here illustrates the failure rates of session setting according to number of nodes for Instant Messaging and Presence services

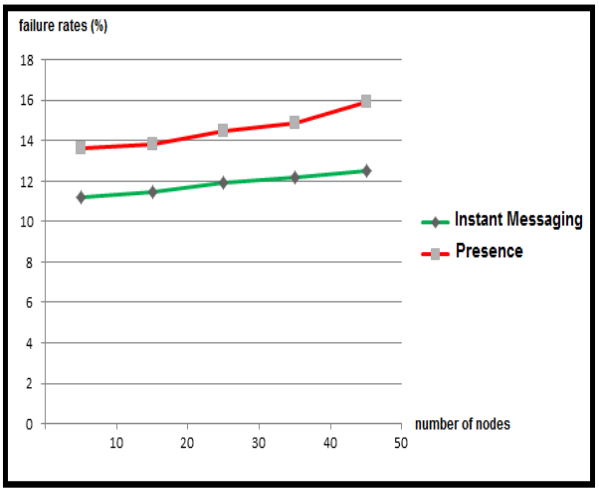

Figure 12 Failure rates by number of nodes for IM and Presence services

In this case, both services perform good results as we considered that nodes are immobile. When the number of nodes increases, the failure rate slightly increases also.

5.2. Bandwidth consumption

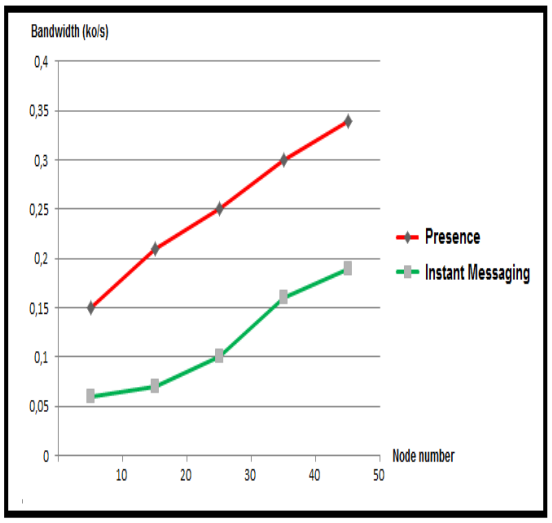

Figure 13 Bandwidth consumption by number of nodes for IM and Presence services

IM service presents better performances than Presence service in term of bandwidth consumption. We can explain this behavior by the fact that presence service uses two types of SIP request (SUBSCRIBE and NOTIFY), while IM service uses only MESSAGE request.

6. Conclusion

In this paper we have presented UCIAN project, which is a solution to propose a smart environment to university teacher, to communicate between them by exploring Instant Messaging and Presence service without using any preexisted infrastructure. We have shown as well how we have modified our solution VNSIP to support IM and Presence services, and deployment of VNSIP under UCIAN architecture. For future work, we will be focused on the security inside UCIAN. An algorithm will be designed to manage users inside the environment of UCIAN.

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