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Full Length Research Paper

Presence enabled conditional call setup model for IP multimedia subsystem

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IP multimedia subsystem (IMS) provides the architectural framework for next generation networks. Presence is considered as the most important service of IMS. Currently, a user needs to subscribe for the presence service of the receiver before deciding whether to call that particular receiver or not. This mechanism increases the network traffic and may result in more delay in call setup. To handle this problem, we proposed a new presence enabled call setup model in this paper.

Key words: IP multimedia subsystem, presence, call setup.

INTRODUCTION

In future it is planned that all the telecommunication core and access networks will use Internet Protocol (IP) for the transportation. The kind of network in which traffic of all access networks will be transported through IP packet encapsulation is known as Next Generation Networks (NGN). NGN provides Service Delivery Platform (SDP) for integration of telecommunication, Information Technology (IT) and creation of new services ranges above the boundaries of network and technology. SDP implementtation facilitates the development and deployment of new multimedia services. IP Multimedia Subsystem (IMS) provides architecture for fixed mobile convergence that includes variety of protocols. Session Initiation Protocol (SIP) is one of the main protocols of the IMS.

IMS ARCHITECTURE

IMS can be divided into three layers. The lower layer is called as user plan and it accommodates all the users who want to use different IMS services. In order to obtain services a user contacts the layer two known as IMS core where authentication and authorization takes place. IMS core mainly consists of Call Session Control Functions (CSCFs) and databases. The upper layer contains the application servers to provide different kind of services.

Third generation partnership project (3GPP) launches the IMS release 5, to add the SIP based multimedia services (ITU). After that, release 6 was launched that provides internetworking with the wireless local area networks (WLAN). Release 7 is launched in cooperation with TISPAN to add the support for fixed networks. Third Generation Partnership Project 2 (3GPP2) is a separate body that is working on a project which is very similar to IMS, known as multimedia domain (MMD). Figure 1 describes the IMS based 3GPP NGN architecture.

IMS ENTITIES

IMS entities can be broadly classified into 6 main categories (Poikselka et al., 2006)

(a) Call session control functions (CSCFs): CSCFs are further divided into 3 types

(i) Proxy call session control function (P-CSCF): user's request is received by the PCSCF in the IMS core. So P-CSCF acts as an entry point for the user.
(ii) Interrogating call session control function (I-CSCF): I-CSCF is the contact point in the provider's IMS. It obtains the name of the next hope and route the information towards next hop. In release 5 and 6 topology hiding was also the duty of I-CSCF.
(iii) Serving call session control function (S-CSCF): it is one of the main entities of the IMS. S-CSCF is responsible for user registration, session setup, routing and maintenance of the user's profiles.
(b) Databases: IMS has two types of databases

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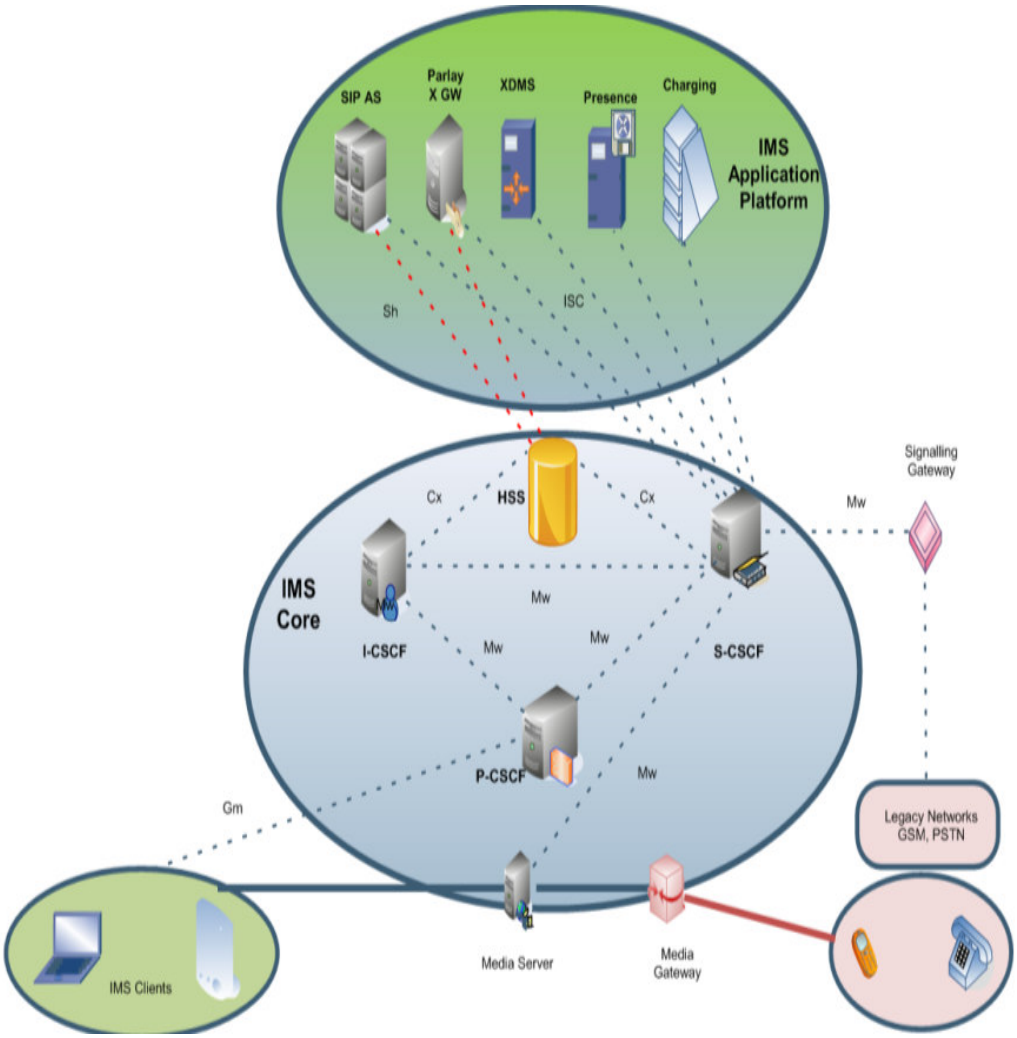

Figure 1. IMS architecture.

(i) Home subscriber station (HSS): user registration data, user identities, access parameters and triggering information is stored at HSS.
(ii) Subscription location function (SLF): helps the S-CSCF and I-CSCF etc. to find the address of HSS.
(c) Service functions: Service function includes Media Resource Function Controller (MRFC), Media Resource Function Processor (MRFP) and Application Servers (AS).
(d) Internetworking functions: The internetworking functions are required to exchange signaling and media between IMS and Circuit Switched Computer Networks (CS CN). These functions include Border Gateway Control Function (BGCF), Media Gateway Control Function (MGCF), Signaling Gateway (SGW) etc.
(e) Support function: Functions like Policy Decision Function (PDF) is known as support function.
(f) Charging entities: To charge a user against the services use, different charging functions play their role.

Presence

To communicate the current status of a user to other users is known as presence service. The status may contain information like the current location of the user, the available devices; preferred means of communication, currently supported applications etc. Presence service contributes to change of the current communication paradigm. You have information about a particular person before contacting him /her. The components of the presence service include Personal User Agent or Publisher, Watcher and Presence Server. The publisher provides the information to presence server who stores it and provides it to the subscribed watchers. Subscription can be made to more than one presentities at a time known as subscription to presentity list. Presentity can set different information for different watchers at different levels. Figure 2 explains the subscription of presence service while the Figure 3 describes the publication of

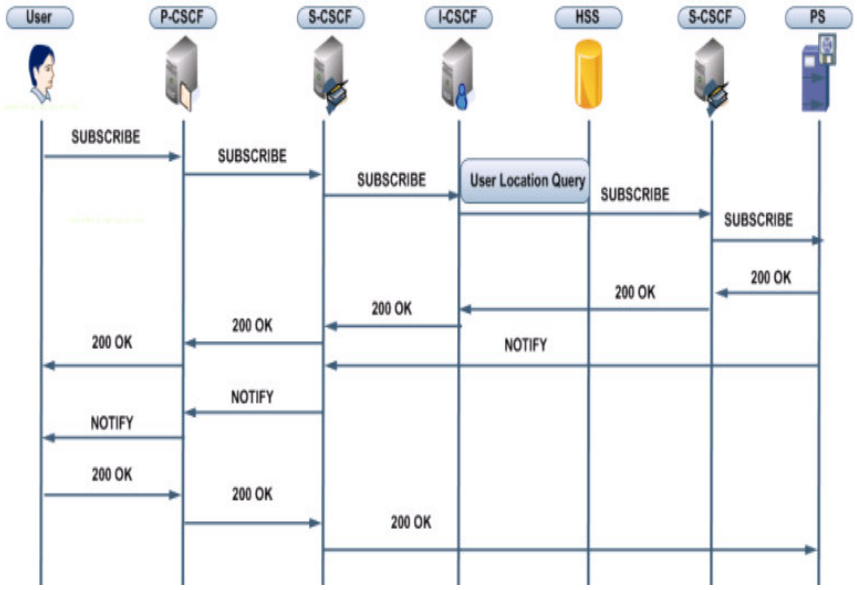

Figure 2. Presence subscription.

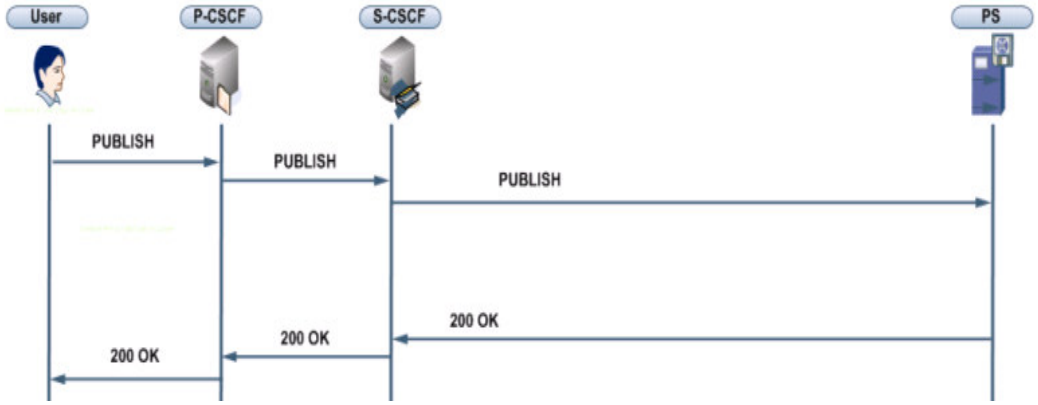

Figure 3. Presence publication.

presence service.

RELATED WORK

Rahman et al. (2004) described the architecture and protocols of the mobile multimedia instant messaging and presence service (Rahman et al., 2004). The author emphasize on the relationship between SIP and wireless village framework. The major focus was on analyzing the protocol standards for Instant Messaging and Presence Service (IMPS).

Jin et al. (2004) proposed the use of SIMPLE for instant messaging and presence and highlights the advantages of using SIP for presence (Jin et al., 2004). The author also analyzed the IM and P architecture. Huh et al. (2005) discussed the different design considerations related to the presence service. The authors explained the design consideration of presence agent when it is supporting multiple presence packages and design consideration of presence agent supporting for user authentication function (Huh et al., 2005). Jiang et al. (2005) proposed a three layer for presence service. Layer one provides network services, layer two is responsible for basic services to all users and layer three contains the policies related to personalization service. The authors proposed to add location, line status, role and availability in the presence information. To extend Call Processing Language (CPL) for presence authors defined four top level actions, five operations and a presence switch. The major focus of the authors is on presence service and call control (Jiang et al., 2005).

Igor (2004) conducted the detailed analysis of the presence subscription when the underlying access network is UMTS. According to the author periodic subscriptions to presence by a user after a short interval of time utilizes more bandwidth at the air interface of the UMTS. Author proposed a modified technique to reduce this load from the UMTS air interface (Igor, 2004). Rishi et al. (2005) analyzed the effect of presence service over network. PULL and PUSH based communication mechanisms for presence service are discussed and compared. The authors pointed out that since the presence service is not point to point service so it adds a significant load of traffic over the network because every change in the presence information of a presentity is communicated to all of its subscribers. Privacy issues are also discussed by the authors (Rishi et al., 2005). Alam and Zheng da (2005) analyzed the cost of presence service. According to them, it is essential to reduce the load of the traffic in order to make the presence service more attractive. In the paper they provided an analytical framework to measure the performance of the IMS presence service (Alam and Zheng da, 2005). Buford et al., (2005) described that Instant Messaging and presence service supports different protocols those do not provide dynamic roaming. First they emphasized on need of the client and server dependent roaming aware mechanism and then to enable roaming they described and analyzed a technique for handoff (Buford et al., 2005). Huh et al. (2006) described the basic call flow for interoperability in presence service based on SIP (Huh et al., 2006). SIP is classified into registration func-tion and subscription and notification function. Author also presented the detailed explanation of each of the message exchanged during the registration, subscription and notification procedure. Yang (2006) presented distributed presence service middle-ware architecture to cope with the problems like service provisioning, Quality of Service (QoS), bandwidth provisioning (Yang, 2006).

Florian et al. (2006) described that instead of subscribing to presence service individually, subscription should be allowed to a Resource List Server (RLS). RLS collects the information and sends it in bundles. It reduced the number of messages thus results in efficient utilization of resources. Author also proposed that instead of providing information to subscriber after every change, the RLS should collect the information and provide it to the watcher only on demand (Florian et al., 2006). Vishal et al. (2006) presented a survey on security issues in presence and proposed few solutions to solve these security issues. Authors emphasized on authentication of the watcher and presentity, authorization and access control over presence information and the integrity and confidentiality of the presence information. For authentication author proposed asserted identity, cryptographically verified identity and certificate based authentication. For data integrity and confidentiality of the presence information the author proposed the use of private and public key (Vishal et al., 2006). Beltran and Paradells (2008) presented the fully distributed platform to deploy presence service. They proposed middleware architecture consists of two layers. First layers takes the intelligent decision to process and manage the presence information and the second layer is responsible for sending and receiving messages like subscribe and notify. The major emphasis of the authors is on the management of the presence information in order to make it more efficient. RA rules defined by the authors restrict a user to communicate with other user (Beltran and Paradells, 2008).

Alam and Zheng da (2007) proposed Weighted Class Based Queuing (WCBQ) in order to reduce the load at presence server. According to the authors a watcher who is subscribed for a list of 100 presentities will receive a notification message after every change in any of the 100 presentities. So it will result in consumption of resources at client side that is equipped with low processing devices. The WCBQ drop the low priority pre-existing messages in order to reduce the load. The results showed that during the heavy traffic load this mechanism works well. The graphs showed that WCBQ only works well when there is a scenario of heavy traffic load (Alam and Zheng da, 2007). Salinas in 2007 described the advantages and disadvantages of using presence service. Author described that on one side presence service facilitates many other services, makes the communication easy, reduces the unnecessary traffic etc and on the other side it has privacy concerns. An intelligent user can guess the routine of other user by seeing his presence history. The author's presence service also involves the end user, so it requires that the end user must be aware of how to use presence service (Salinas, 2007). Sedlar et al. (2007) proposed the use of presence information in an enter-prise environment. According to authors, if the presence information is collected from different sources and provided to the subscribers after aggregation then it can help the employees to organize themselves more efficiently (Sedlar et al., 2007).

Jae et al. (2007) described the technologies that have been developed or being developed by IETF IMPP WG and SIMPLE WG. The purpose of the author is to update the readers about presence and instant messaging (Jae et al., 2007). Wang et al. (2007) presented the idea of PoC session setup using rich presence information. All the group members are invited without knowing the presence information. The server retrieved and compared the presence information and only those users whose presence information matches with the request are invited. It decreased the session setup delay and reduced the presence related SIP signaling traffic (Wang et al., 2007). Peternel et al. (2008) describes the mechanism for enterprises to collect presence information from multiple presentities and to distribute among the consumers. The author focuses on the basic and extended system of the

presence service (Peternal et al., 2008). Loreto and Eriksson (2008) uses the idea of presence network agent to improve the performance of the presence service by minimizing the load from radio access network. The author discussed few open issues those need to be resolved in order to improve the performance of the presence service (Loreto et al., 2008). Mckeon (2008) studies the effect of presence service over the latency and throughput of the network. The authors analyzed that the presence service can put a great load over the network by issuing too much traffic (Mckeon, 2008).

PROBLEM STATEMENT

Receiver can deny calls by not answering or by making the status busy or unavailable. But from caller point of view no such mechanism exists that can provide the opportunity to make a conditional call. An employee who wants to call his boss only if the boss is in office must require subscribing the presence information of his boss. There is no mechanism which allows the users to send a conditional 'Invite' request (based on receiver's presence information) without subscribing the presence information of the receiver. Conditional call means the call from caller side will only be connected if a particular condition becomes true else the call will be dropped. If a user wants to call another user only if the receiver is in Washington D.C. then first he/she has to subscribe for the presence information of the receiver and after that he/she will decide whether to make a call or not. Subscription to presence service requires exchange of subscribe and notify messages.

Now if a user A needs to call another user B if and only if the status of the user B is according to the expectation of the user A then it must need to subscribe the presence information before establishing the call if it does not already subscribe the presence information of user B. Exchange of the 4 messages of the subscription process shown in the Figure 3 causes a significant delay in the call establishment and also increases the load on the radio access network. If a user A wants to call user B occasionally or once in a month then the user A does not require the presence information of user B all the time. Therefore if the user A subscribe for the presence information of the user B only to decide whether to establish a call or not then user A has to unsubscribe the presence information immediately after making the call in order to avoid the unnecessary notification messages. Un-subscription also puts load on the network. So currently there exists no mechanism which allows the user to make a call on the basis of the receiver's presence status without subscribing the presence information.

PRESENCE ENABLED CONDITIONAL CALL SETUP

If a user wants to make a call on the basis of the presence information of the receiver it must require subscribing for the presence information. Our proposed presence enabled conditional call setup allows the caller to send a conditional invite request to the receiver without subscribing the presence information of the receiver. The presence information is verified during the call setup. A user inserts condition inside the 'Invite' request of the call. When this invite request arrives at the S-CSCF, it checks whether it contains some condition or not. If it contains no condition the call is routed according to the normal procedures. But if it contains a presence based condition the S-CSCF extract that condition and forward it to the presence server. Now the presence server verifies that whether this caller is authorized to view this information or not. If the caller is not authorized on that specific presence information then the presence server returns an error message and upon receiving the error message the S-CSCF immediately dropped the call. The scenario is described in the Figure 4.

If the user is authorized for that presence information then presence server retrieve that attribute of the presence information and returns it to the S-CSCF. Upon receiving that presence information, S-CSCF matches it with the condition. If it does not match with the condition then S-CSCF drops the call and returns the current presence information to the caller. The details are shown in the Figure 5.

If the condition becomes true then S-CSCF removes the presence condition from the invite request and forwards it towards the receiver and the remaining procedure of call setup works according the standard procedures. In this scenario there is no need to return the presence information to the caller because if the call is established then it can automatically be concluded that the value of the presence information is the same as the condition specifies. Figure 6 specifies the details.

VALIDATION AND TESTING

To evaluate the performance of our proposed conditional call mechanism we compare it with the existing "subscribe before call mechanism". We find that the conditional call mechanism reduces the delay significantly. Moreover the numbers of messages exchanged at the radio access network are also decreased. In case of subscribe before call the number of messages exchanged for presence service subscription are not required for conditional call. Figure 7 shows that the number of messages exchanged for different number of calls require far more messages in the traditional mechanism as compared to our conditional call mechanism.

The presence subscription process requires exchange of 4 messages as shown in the Figure 3. Therefore the traditional subscribe before call mechanism requires total exchange of 5 messages to send a presence based call setup request 'Invite' (4 messages for presence

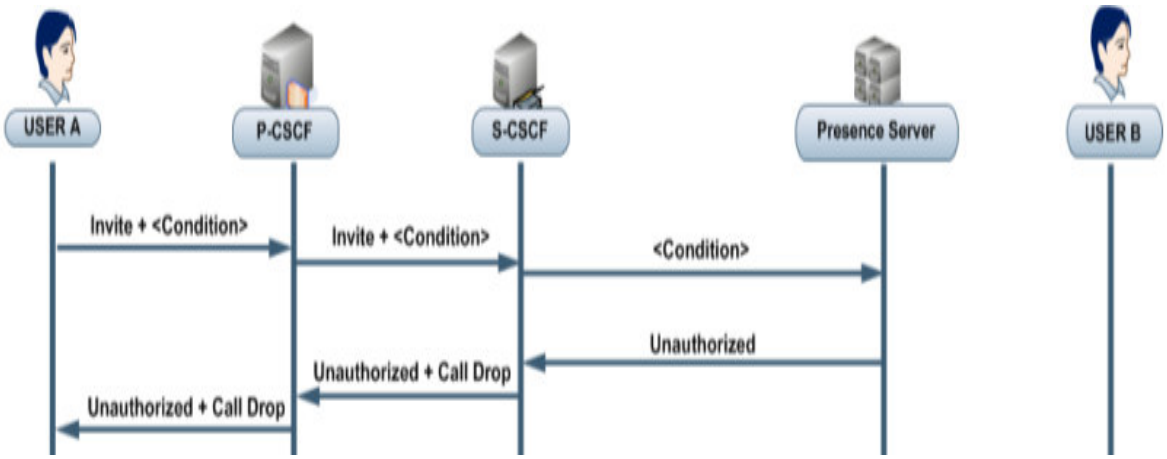

Figure 4. Conditional call scenario when condition contain unauthorized presence attribute.

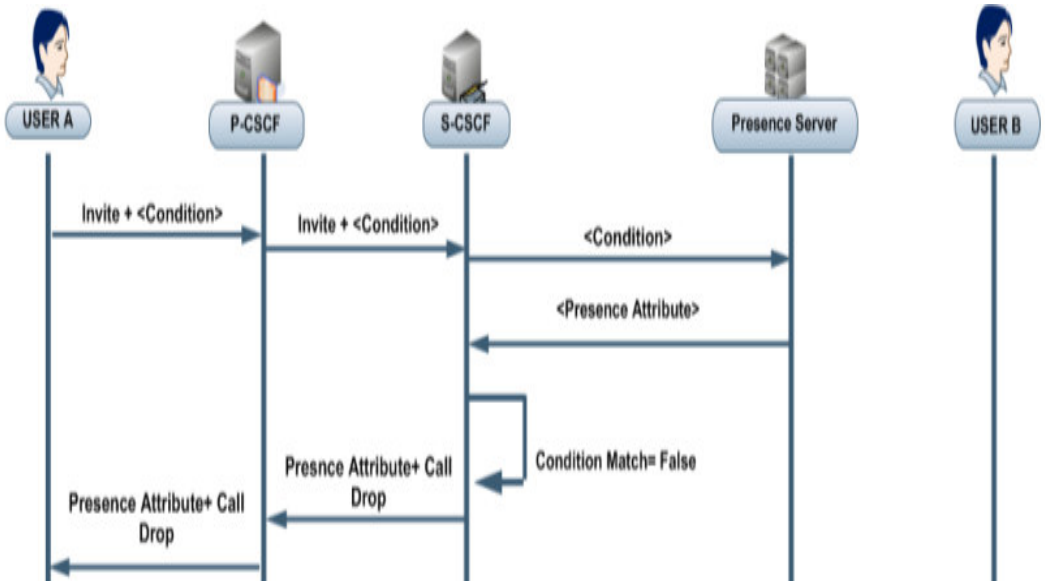

Figure 5. Conditional call scenario when condition becomes false.

subscription and one for SIP Invite request). While in our presence enabled conditional call mechanism only one request is exchanged at the air interface of the watcher. (Presence condition enabled SIP Invite request). The procedure of Un-subscribing the presence service is very much similar to the subscription procedure. The only difference is that instead of sending the 'Subscribe' request, a watcher sends a 'Un-subscribe' request. Since presence notifications are generated after every change in the presence information of the subscribed attributes so it puts high load on the network as well as on watcher's device. If the only purpose of the watcher is to get presence information to route a call then in traditional process first it needs to subscribe for the presence information and after making the call it needs to be unsubscribe the presence information in order to avoid unnecessary notifications.

In our presence enabled conditional call mechanism a watcher needs not to subscribe for the presence information nor did he require unsubscribing it. The difference in number of messages exchanged on the air interface of the watcher in traditional mechanism and in presence enabled conditional mechanism is shown in the Figure 8. The presence subscription process requires exchange of 4 messages and un-subscription also requires exchange of 4 messages. Therefore in this case the traditional subscribe before call mechanism requires total exchange of 9 messages (4 messages for presence subscription, 1 for SIP Invite request and 4 for presence un-subscription) to send a presence based call setup

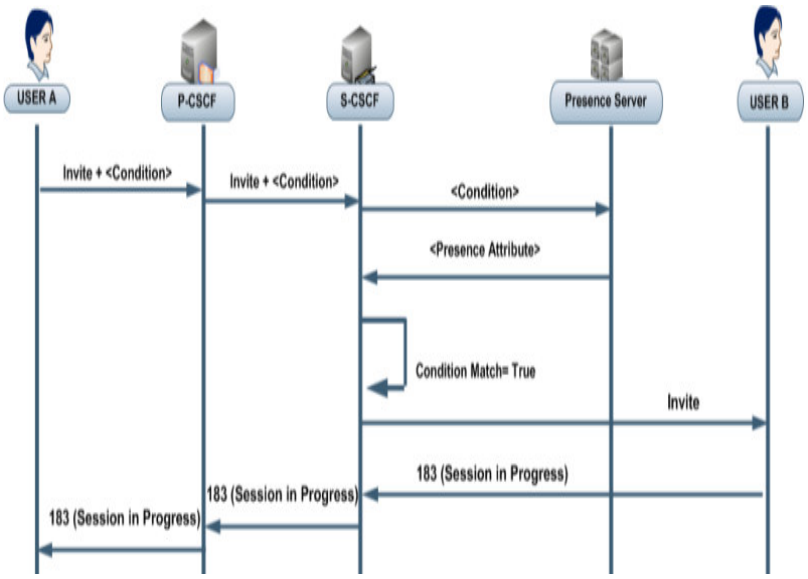

Figure 6. Conditional call scenario when condition becomes true.

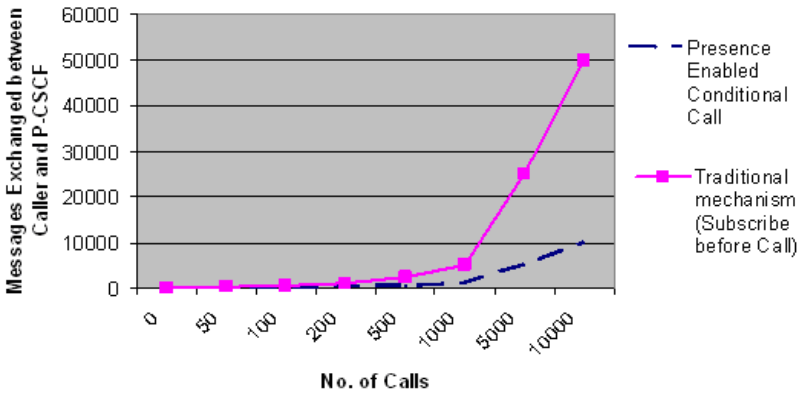

Figure 7. Performance evaluation of presence enabled conditional call without un-subscription.

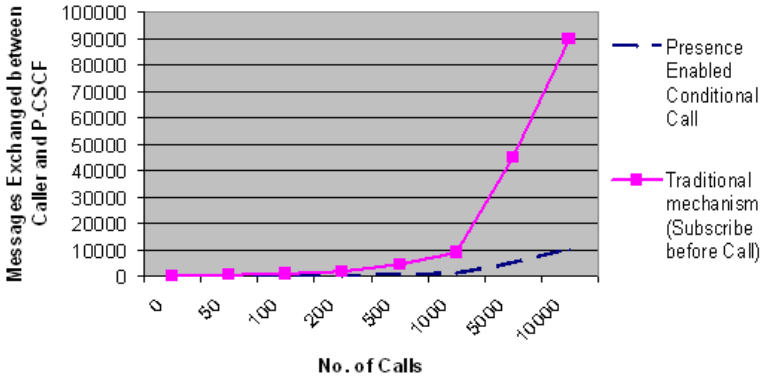

Figure 8. Performance evaluation of presence enabled conditional call with un-subscription.

request 'Invite' if the caller does not require presence information after the call. In our presence enabled conditional call mechanism since there is no presence subscription so un-subscription is also not required. Therefore only one message is exchanged between caller and P-CSCF (presence condition enabled SIP Invite request).

Conclusion

Presence enabled conditional call setup models not only facilitate the users to route call without subscribing the presence information but also reduces the network traffic up to great extent. Disturbance at the time of meeting or sleeping hours may also be reduced by using this mechanism. This mechanism also informs the sender that why receiver is not willing to pick the phone.

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