Presence Interdomain Scaling Analysis for SIP/SIMPLE

draft-ietf-simple-interdomain-scaling-analysis-03.txt

Status of this Memo

By submitting this Internet-Draft, each author represents that any applicable patent or other IPR claims of which he or she is aware have been or will be disclosed, and any of which he or she becomes aware will be disclosed, in accordance with Section 6 of BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at http://www.ietf.org/ietf/1id-abstracts.txt.

The list of Internet-Draft Shadow Directories can be accessed at http://www.ietf.org/shadow.html.

This Internet-Draft will expire on May 21, 2008.

Copyright Notice

Copyright (C) The IETF Trust (2007).

Abstract

The document analyzes the traffic that is generated due to presence
subscriptions between domains. It is shown that the amount of traffic can be extremely big. In addition to the very large traffic the document also analyzes the affects of a large presence system on the memory footprint and the CPU load. Current approved and in work optimizations to the SIMPLE protocol are analyzed with the possible impact on the load. Separate documents contain the requirements for optimizations and suggestions for new optimizations.

Table of Contents

1. Introduction ................................................. 4
2. Message Load ............................................... 5
  2.1. Known Optimizations .................................... 5
  2.2. Assumptions ............................................. 6
  2.3. Analysis ................................................. 7
    2.3.1. Constants .......................................... 7
    2.3.2. Initial Messages .................................. 9
    2.3.3. Steady State Messages ............................... 10
    2.3.4. Termination Messages ................................. 11
    2.3.5. Bottom Line .......................................... 11
    2.3.6. Rush Hour Calculations ............................... 12
  2.4. SIMPLE with no optimizations ............................. 12
  2.5. SIMPLE with dialog optimization .......................... 14
  2.6. SIMPLE with NOTIFY optimization .......................... 16
  2.7. SIMPLE with Dialog & NOTIFY optimizations .................. 18
  2.8. Presence Federations .................................... 20
    2.8.1. Widely distributed inter-domain presence ............... 21
    2.8.2. Associated inter-domain presence ...................... 25
    2.8.3. Very large network peering ............................ 26
    2.8.4. Intra-domain peering .................................. 30
  2.9. Partial Notifications Optimization ....................... 35
  2.10. Other Protocols ........................................ 37
3. State Management ............................................ 39
  3.1. State Size Calculations .................................. 40
    3.1.1. Tiny System ......................................... 40
    3.1.2. Medium System ....................................... 41
    3.1.3. Large System ........................................ 41
    3.1.4. Very Large System .................................... 41
4. Processing complexities ......................................... 42
  4.1. Aggregation .............................................. 42
  4.2. Partial Publish and Notify ................................ 42
  4.3. Filtering ................................................ 43
  4.4. Authorization ............................................ 43
  4.5. Resource List Service ..................................... 43
5. Current Optimizations .......................................... 45
6. Summary ..................................................... 46
7. Conclusions .................................................. 51
8. Security Considerations ........................................ 53
9. Changes from Previous Versions ................................. 54
   9.1. Changes in version 03 .................................... 54
   9.2. Changes in version 02 .................................... 54
   9.3. Changes in version 01 .................................... 54
10. Acknowledgments ................................................. 54
11. References ..................................................... 55
   11.1. Normative References .................................... 55
   11.2. Informational References ................................. 55
Authors’ Addresses .................................................. 57
Intellectual Property and Copyright Statements .................. 59
1. Introduction

The document analyzes the traffic that is generated due to presence subscriptions between domains. It is shown that the number of messages and the amount of data sent can be extremely big. In addition to the very large traffic the document also analyzes the affects of a large presence system on the memory footprint and the CPU load. Current approved and in work optimizations to the SIMPLE protocol are analyzed with the possible impact on the load. Other documents contain the requirements for optimizations [21] and suggestions for new optimizations are included in the following documents: [22]. [24]

This document is intended to be drive work on possible solutions that will make the deployment of a presence server more reasonable task. Although a comparison to another protocol is given in the document, the intention of the document is not try to compare the SIP based presence protocol to other types of presence protocols but only to analyze the SIP based presence protocol. It is very likely that that the scalability issues are inherent to the deployment of presence systems and not to a certain protocol.

The document discusses the following areas. In each area we try to show the complexity and the load that the presence server has to handle in order to provide its service.

- Messages load - By computing the number of messages that are required for connecting presence systems the document shows that the number of messages is very big and it is quite obvious that some optimizations are needed. In addition we also show that the bandwidth required is also very big.
- State management - Due to the nature of the service that the presence server provides, the presence server has to manage a relatively big and complex state and some computations are provided in the document.
- Processing complexities - The presence server maintains many small objects and has to do frequent operations on these objects. We show that these operations and especially the optimizations that are intended to save on the amount of data that is being sent between watchers and presence servers, are not so simple and may create a very heavy processing load on the presence server.
- Groups - Resource List Servers [12] optimize the number of sessions that are created between the watchers and the presence server. On the other hand, this optimization may create an exponential size of subscription due to the unbearable ease of subscribing to large groups.

The term presence domain or presence system appears in the document.
several time. By this term we refer to a presence server that provides presence subscription and notification services to its users. The system can be a system that is deployed in a small enterprise or in a very large consumer network.

2. Message Load

Some optimizations are approved or are being defined for the SIP presence protocol, but even with these optimizations a very large number of messages & large bandwidth are needed in order to establish federation between presence systems of large communities. Further thinking is needed in order to make large deployment of presence systems less resource demanding.

Note that even though this document talks about inter domain traffic, the introduction of resource list servers (RLSs) [12] introduce very similar traffic pattern in intra-domain and in inter-domain. See detailed discussion on resource lists in Section 4.5.

2.1. Known Optimizations

The current optimizations that are approved or are approved as working group items in the SIMPLE working group can be divided into two categories:

- Dialogs saving optimization - Here we refer to optimizations as the resource list RFC [12] or to the URI list subscriptions draft [19]. These documents define ways to reduce the number of dialogs that are required between the subscriber and the presence system.

  Note that dialog optimization or RLS usage as it is used in this document refers to the usage of a URI that represents a list of a URI list between domains and not within the same domain. An example is a user Alice in domain example.org that subsides to URI of e.g. external-reps-list at example.com or uses a URI list to subscribe at on her watch list in example.com. Note also that when calculating the traffic that is due to RLS within a domain the traffic between the RLS and the presence agents should also be taken into account. However, since in this document we are mostly dealing with inter-domain traffic, the traffic between the RLS and the presence agents was not taken into account.

- Notification optimizations - Here we refer to the optimizations that are suggested in the subnot- etags draft [20]. This draft suggests ways to suppress the sending of unnecessary notifies when for example a subscription is refreshed. There are other drafts
that reduce the size of messages as partial notifications or filtering but in this document we mostly care about the amount of messages & bandwidth so the partial optimizations can help a bit in the bandwidth but will not help in the number of messages.

2.2. Assumptions

In the document we have several assumptions regarding size of messages, rate of presence change and more. It should be noted that these assumptions are not directly based on rigorous statistics that was done on actual SIP based deployments of presence systems but more from some experience on other types of presence based systems.

In a large consumer network we have seen the following patterns:

- Approximately 110 users in the watch list in average.
- There are approximately 12 billion status changes a day (139k/second) across the network. Of these, when a proprietary binary protocol is used to convey the status changes the average of the message is about 188 bytes. When SIP NOTIFY is used the average is about 1228 bytes for the message.
- The average of logins/logouts in the system is about 2000 logins per second and about 4000 logouts per second. When something happens - either a promotion, contest, or a network hiccup that causes many users to login and logout simultaneously, there are about 20,000 logins per second.
- The peak of the instant messages sent is about 50,000 messages per second.

In a deployment in enterprises we have seen the following patterns:

- Averages watch list size was 200 users.
- About half of the registered users were online at peak time
- Status change per hour was 2 changes per hour.
- The average logins/logouts in the system was about 5 logins per second with additional 15 logins/logouts during start/end of day rush hours.

Even though the assumptions in this document are not based on rigorous statistical data the target here is not to analyze specific system but show that even with VERY moderate assumptions (which are even less then the observations mentioned above), the number of messages, the network bandwidth, the required state management and the load on the CPU is very high. Real life systems should have a much bigger scalability requirements. for example the presence state change that we assumed (one presence state change per hour) is maybe one of the most moderate assumptions that we have taken. Experience from consumer networks show that the frequency here is much bigger.
and especially with the younger generation. In an environment where a user may have several devices and other resources for presence information as geographical location and calendar the frequency of presence state changes will be much higher.

It is very hard to measure presence load since the behavior of users is very different. Some users will have a very small number of presentities in their watch list while others may have hundreds. Some users will change their state a lot and have many sources of presence information while others may have very small number of changes during the day. In addition the "rush hour" calculations of when the day starts and ends were not included yet in this document. Rush hour differs between different enterprises and is still different in the consumer presence systems. It is very hard if not impossible to take into a static model all the possible combinations.

2.3. Analysis

The basic SIMPLE subscription dialog involves the following message-transfer:

- SUBSCRIBE/200
- Initial NOTIFY/200
- (j) NOTIFY/200 where ‘j’ is the number of presence changes seen by the watcher
- (k) SUBSCRIBE/200 where ‘k’ is the number of subscription dialog refresh periods
- SUBSCRIBE/200 with Expires = 0 to terminate the dialog
- NOTIFY/200 ending the dialog

An individual watcher will generate X number of SIMPLE subscription dialogs corresponding to the number of presentities it chooses to watch. The amount of traffic generated is significantly affected by several factors:

- Number of watchers connected to the system
- Number of presentities connected to the system
- Frequency of changes to presence information

This document contains several calculations that show the expected message rate and bandwidth between presence domains. The following sections explain the assumptions and methods behind the calculations.

2.3.1. Constants

The following are number of "constants" that we use in the calculations. Some of the constants are used throughout the calculation while other change between use cases
o  (C01) Subscription lifetime (hours) - The assumed lifetime of a
subscription in hours. We assume 8 hours for all calculations.

o  (C02) Presence state changes / hour - The average time that a
presentity changes his/hers status in one hour. We assumed 3
times per hour for most calculations. Note that for some users in
consumer messaging systems, the actual number of changes is likely
to be much higher.

o  (C03) Subscription refresh interval / hour - The duration of the
SUBSCRIBE session after which it needs to be refreshed. We
assumed that the duration is one hour.

o  (C04) Total federated presentities per watcher - The number of
presentities that the watcher is watching. The number here
changes in this document according to the type of the specific
deployment.

o  (C05) Number of dialogs to maintain per watcher - The number of
the SUBSCRIBE dialogs that are maintained per watcher. if a dialog
optimization is not assumed this number is equal to A04, otherwise
it is 1.

o  (C06) Total number of watchers in the federated presence domains.
The number here is the number of all watchers in all the federated
domains.

o  (C07) SUBSCRIBE message size in bytes. We assume 450 bytes in all
calculations. The size is based on a typical SUBSCRIBE taken from
RFCs.

o  (C08) 200 OK for SUBSCRIBE message size in bytes. We assume 370
bytes in all calculations. The size is based on a typical 200 OK
taken from RFCs.

o  (C09) NOTIFY message size not including the presence document.
The size of this message for a single presentity is assumed to be
500 bytes for the NOTIFY message itself (based on sizes from
examples in RFCs).

o  (C10) 200 OK for NOTIFY message size in bytes. We assume 370
bytes in all calculations. The size is based on a typical 200 OK
taken from RFCs.

o  (C11) Size of an average presence document. In the previous
version of this document we have used only the size of 3000 bytes
for a presence document. This number was calculated based on
examples of rich presence document in RFCs. Due to discussion in
the SIMPLE list where it was claimed that it may be too big and
due to the fact that we are talking here about federation between
communities where the rich presence document may be of less use,
we have done all the calculations with two sizes of presence
document. One size is the minimal size of the PIDF [6] document
which was taken to be 350 bytes based on examples from RFCs and
the other size is the 3000 bytes for rich presence document [8].
It should be noted that assuming 3000 bytes for presence document
is relatively modest if we take into account multiple devices and
location information.
o  (C12) The size of NOTIFY when partial [15] notification is being 
done. We have taken this size to be 200 bytes. The size is much 
smaller then the example that is given in [15] but the example 
given there assumes multiple changes in the presence document and 
here we assume a single change.

When dialog optimization [12] is used, an RLMI document is 
being sent and that document contains the presence documents 
for the users that are in the watch list. In previous version 
of this document we have omitted the overhead of the RLMI 
document. This "bug" was found by Victoria Beltran-Martinez 
and is being fixed in this document by adding the constants 
C13, C14 and C15 to the calculations

o  (C13) Item size per each contact in RLMI document, 160 bytes.

o  (C14) The size of the multipart boundary (per each contact) in 
RLMI notifications, 144 bytes.

o  (C15) The size of the XML root node in RLMI document (once per 
notification), 144 bytes.

2.3.2. Initial Messages

The following are the calculations for the messages in the initial 
phase of the establishment of the subscriptions. The calculations 
contain both number of messages and the number of bytes.

o  (I01) Number of initial SUBSCRIBE messages per watcher = C05.

o  (I02) Number of initial 200 OK messages for SUBSCRIBE messages per 
watcher = C05.

o  (I03) Number of initial NOTIFY messages per watcher = C05.

o  (I04) Number of initial 200 OK messages for NOTIFY messages per 
watcher = C05.

o  (I05) Total number and bytes of initial SUBSCRIBE messages for all 
watchers = Number - I01*C06, Bytes = I01*C06*C07.

o  (I06) Total number and bytes of initial 200 OK for SUBSCRIBE 
messages for all watchers = Number - I01*C06, Bytes = I01*C06*C08.

o  (I07) Total number and bytes of initial NOTIFY messages for all 
watchers = Number - I01*C06, The calculation for the number of 
bytes is different when dialog optimization is used or not. When 
dialog optimization is not applied the number of bytes will be 
calculated by: (I01*C06*C09)+(I01*C06*C11) and when dialog 
optimization is applied the number of bytes will be calculated by 
(I01*C06*(C09+C15))+(I01*C06*C04*(C11+C13+C14)).

o  (I08) Total number and bytes of initial 200 OK for NOTIFY messages 
for all watchers = Number - I04*C06, Bytes = I04*C06*C10.

o  (I09) Total number and bytes of initial messages per day = Number 
- numbers in I05+I06+I07+I08, Size -sizes in I05+I06+I07+I08.
2.3.3. Steady State Messages

Here we describe the calculations for the steady state messages. Steady state is the time between the initial subscription and the tear down of the subscription. It contains the notifies due to state change and the subscription refreshes.

- **(S01)** NOTIFY messages due to state change per watched presence entity per day (less 2 since the NOTIFY for initial and terminating state is calculated in the initial and terminating calculations) = \((C02*C01-2)\).

- **(S02)** 200 (for NOTIFY due to state change) messages per watched entity per day (less 2 since the NOTIFY for initial and terminating state is calculated in the initial and terminating calculations) = \((C02*C01-2)\).

- **(S03)** Total number and size of messages due to state change per day = Number - \((S01+S02)*C06*C04\). The calculation for the number of bytes is different when dialog optimization is used or not. When dialog optimization is not applied the number of bytes will be calculated by: \((C06*C04)*((S01*(C09+C11))+(S02*C10))\) and when dialog optimization is applied the number of bytes will be calculated by \((C06*C04)*((S01*(C09+C11+C13+C14+C15))+S02*C10))\). Note that for dialog optimization it is assumed that only a single presenceity is changed and partial state notification is used.

- **(S04)** Number of SUBSCRIBE messages for refreshes per watcher per day = \(((C01/C03)-1)*C05\). One is subtracted since the termination is calculated separately. For example if there are 8 hours in the day and a refresh should occur every hour, there are 7 refreshes during the day and not 8.

- **(S05)** Number of 200 OK messages for SUBSCRIBE messages for refreshes per watcher per day = \(((C01/C03)-1)*C05\). When NOTIFY optimization is used [20] there is no need to send NOTIFY for refreshes, so 06 will be zero.

- **(S06)** Number of NOTIFY messages for refreshes per watcher per day = \(((C01/C03)-1)*C05\). Since when NOTIFY optimization is used [20] there is no need to send NOTIFY for refreshes, so 07 will be zero when NOTIFY optimizations is used.

- **(S07)** Number of 200 OK messages for NOTIFY messages for refreshes per watcher per day = \(((C01/C03)-1)*C05\). When NOTIFY optimization is used [20] there is no need to send NOTIFY for refreshes, so 07 will be zero when NOTIFY optimizations is used.

- **(S08)** Total number and size of messages due to SUBSCRIBE refreshes per day = Number - \(((S04+S05+S06+S07)*C06\). The number of bytes is calculated by adding the SUBSCRIBE bytes \((S04*C06*C07)\), the OK for SUBSCRIBE bytes \((S05*C06*C08)\), the NOTIFY bytes \((S06*(C09+C15+C11+C13+C14))\) and the OK for NOTIFY \((S07*C06*C10)\). Note that the formula for the NOTIFY bytes is for the dialog optimization is not used and when it used the formula will be: \(C06*(S06*((C09+C15)+(C04*(C11+C13+C14))))\). Note that a full state should be given in SUBSCRIBE refreshes in resource lists. See section 4.5 in [12].
The fact that the full state needs to be returned in a NOTIFY response to refresh makes the NOTIFY optimization more efficient in conjunction with the dialog optimization.

- (S09) Total number and bytes of steady messages per day = Number - numbers in S03+S08, Bytes - sizes in S03+S08.

### 2.3.4. Termination Messages

The following are the calculations for the messages in the termination phase of the of the subscriptions. The calculations contain both number of messages and the number of bytes.

- (T01) Number of terminating SUBSCRIBE messages per watcher = C05.
- (T02) Number of terminating 200 OK messages for SUBSCRIBE messages per watcher = C05.
- (T03) Number of terminating NOTIFY messages per watcher = C05. Since when NOTIFY optimization is used [20] there is no need to send NOTIFY for terminations, T03 will be zero when NOTIFY optimization is used.
- (T04) Number of terminating 200 OK messages for NOTIFY messages per watcher = C05. Since when NOTIFY optimization is used [20] there is no need to send NOTIFY for terminations, T04 will be zero when NOTIFY optimization is used.
- (T05) Total number and bytes of terminating SUBSCRIBE messages for all watchers = Number - T01*C06, Bytes - T01*C06*C07.
- (T06) Total number and bytes of terminating 200 OK for SUBSCRIBE messages for all watchers = Number - T01*C06, Bytes - T01*C06*C08.
- (T07) Total number and bytes of terminating NOTIFY messages for all watchers = Number - T01*C06, The number of bytes is calculated to be: (T03*C06*(C09+C11)) when dialog optimization is not used and: (T03*C06*(C09+C11+C13+C14+C15)) when dialog optimization is used. Note that for dialog optimization it is assumed that only a single presentity is changed and partial state notification is used.
- (T08) Total number and bytes of terminating 200 OK for NOTIFY messages for all watchers = Number - T04*C06, Bytes - T04*C06*C10.
- (T09) Total number and bytes of terminating messages per day = Number - numbers in T05+T06+T07+T08, Size -sizes in T05+T06+T07+ T08.

### 2.3.5. Bottom Line

The following are the calculations of several totals that are based on the above calculations.

- (B01) Total number of messages and bytes during the day = Messages - Number of messages in I09+S09+T09, Bytes - Number of bytes in I09+S09+T09.
o (B02) Total number of messages and bytes per second = Messages - Number of messages in B01/(C01*3600) Bytes - Number of bytes in B01/(C01*3600).

o (B02) Total number of message and bytes per user per day = Messages - number of messages in B01/C06 Bytes - Number of bytes in B01/C06.

2.3.6. Rush Hour Calculations

The way that the calculations are built it is relatively easy to see the affect of rush hours at the beginning and the end of the day. for the beginning of the day we should look at the numbers of "(I09) Total number and bytes of initial messages per day" and for the end of the day we should look at the number of "(T09) Total number and bytes of terminating messages per day". Taking these numbers with some assumed percentage of the numbers of users that log in at the same hour should give good indication for the rush hour load.

2.4. SIMPLE with no optimizations

The following table uses some common presence characteristics to demonstrate the effect these factors have on state and message rate within a presence domain using base SIMPLE protocols without any proposed optimizations. In this example, there are two presence domains with total of 40,000 federating users with an average of 4 contacts in the peer domain. Note that the main calculation is done for a presence document size of 350 bytes which is the base PIDF [6] document size but the bottom line calculation is also given for a presence document size for rich presence [8] which is assumed to be 3000 bytes based on the examples given in the RFCs. This two folded calculation is done for every use case in this document.

** Constants
(C01) Subscription lifetime (hours)...........................8
(C02) Presence state changes / hour..............................3
(C03) Subscription refresh interval / hour.....................1
(C04) Total federated presentities per watcher.................4
(C05) Number of dialogs to maintain per watcher...............4
(C06) Total number of watchers in domains..................40,000
(C07) SUBSCRIBE message size in bytes.......................450
(C08) 200 OK for SUBSCRIBE message size in bytes...........370
(C09) NOTIFY message size not including presence doc........500
(C10) 200 OK for NOTIFY message size in bytes..............370
(C11) Size of an average presence document..................350

** Initial Messages
(I01) Initial SUBSCRIBE msgs per watcher.....................4
(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher...........4
(I03) Initial NOTIFY msgs per watcher..........................4
(I04) Initial 200 OK msgs (NOTIFY) per watcher...............4
(I05) Total number & bytes of initial SUBSCRIBE msgs
   Number of msgs for all watchers...............160,000
   Bytes for all watchers......................72,000,000
(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs
   Number of msgs for all watchers...............160,000
   Bytes for all watchers.......................59,200,000
(I07) Total number & bytes of initial NOTIFY msgs
   Number of msgs for all watchers...............160,000
   Bytes for all watchers......................136,000,000
(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs
   Number of msgs for all watchers...............160,000
   Bytes for all watchers.......................59,200,000
(I09) Total number & bytes of initial messages per day
   Number of msgs for all watchers..............640,000
   Bytes for all watchers.....................326,400,000

** Steady State Messages**
(S01) NOTIFY msgs due to state change
   per watched presentity per day................22
(S02) 200 (for NOTIFY due to state change) msgs
   per watched presentity per day................22
(S03) Total number and size of msgs due to state change per day
   Number of msgs for all watchers...............7,040,000
   Bytes for all watchers......................4,294,400,000
(S04) Number of SUBSCRIBE msgs for refreshes
   per watcher per day...........................28
(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
   per watcher per day...........................28
(S06) Number of NOTIFY msgs for refreshes
   per watcher per day...........................28
(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
   per watcher per day...........................28
(S08) Total number and size of msgs due to SUBSCRIBE refreshes
   Number of msgs for all watchers per day.....4,480,000
   Bytes for all watchers per day..............2,284,800,000
(S09) Total number & bytes of steady messages per day
   Number of msgs for all watchers.............11,520,000
   Bytes for all watchers.....................6,579,200,000

** Termination Messages**
(T01) Terminating SUBSCRIBE msgs per watcher...............4
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher........4
(T03) Terminating NOTIFY msgs per watcher....................4
(T04) Terminating 200 OK msgs (NOTIFY) per watcher...........4
(T05) Total number & bytes of Terminating SUBSCRIBE msgs
   Number of msgs for all watchers.............160,000
Bytes for all watchers.....................72,000,000  
(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
Number of msgs for all watchers...............160,000  
Bytes for all watchers.....................59,200,000
(T07) Total number & bytes of terminating NOTIFY msgs
Number of msgs for all watchers...............160,000  
Bytes for all watchers.....................136,000,000
(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
Number of msgs for all watchers...............160,000  
Bytes for all watchers.....................59,200,000
(T09) Total number & bytes of terminating messages per day
Number of msgs for all watchers...............640,000  
Bytes for all watchers.....................326,400,000

** Bottom Line
(B01) Total of messages between domains...............12,800,000
Total of bytes between domains (PD=350)......7,232,000,000
Total of bytes between domains (PD=3000)...20,376,000,000
(B02) Total number of messages / second................444
Total of bytes per second (PD=350)..............251,111
Total of bytes per second (PD=3000)..............707,500
(B03) Total number of by msgs per user/day...........320
Total number of bytes per user/day (PD=350).....180,800
Total number of bytes per user/day (PD=3000)....509,400

Figure 1: SIMPLE with no optimizations

2.5. SIMPLE with dialog optimization

The same analysis provided above is repeated here with the assumption that the dialog optimization is applied. Note that while the sign-in (ramp up) and sign-out messages flows are positively affected, the steady state rates are not.

** Constants
(C01) Subscription lifetime (hours).........................8
(C02) Presence state changes / hour......................3
(C03) Subscription refresh interval / hour..............1
(C04) Total federated presentities per watcher...........4
(C05) Number of dialogs to maintain per watcher.........1
(C06) Total number of watchers in domains..............40,000
(C07) SUBSCRIBE message size in bytes...................450
(C08) 200 OK for SUBSCRIBE message size in bytes.......370
(C09) NOTIFY message size not including presence doc....500
(C10) 200 OK for NOTIFY message size in bytes..........370
(C11) Size of an average presence document.............350
(C12) Additional data per document in RLMI..............160
(C13) Multiparty boundary in RLMI document.............144
** Initial Messages**

(I01) Initial SUBSCRIBE msgs per watcher......................1

(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher..............1

(I03) Initial NOTIFY msgs per watcher........................1

(I04) Initial 200 OK msgs (NOTIFY) per watcher................1

(I05) Total number & bytes of initial SUBSCRIBE msgs
     Number of msgs for all watchers......................40,000
     Bytes for all watchers.........................18,000,000

(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs
     Number of msgs for all watchers......................40,000
     Bytes for all watchers.........................14,800,000

(I07) Total number & bytes of initial NOTIFY msgs
     Number of msgs for all watchers......................40,000
     Bytes for all watchers.........................130,400,000

(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs
     Number of msgs for all watchers......................40,000
     Bytes for all watchers.........................14,800,000

(I09) Total number & bytes of initial messages per day
     Number of msgs for all watchers......................160,000
     Bytes for all watchers.........................178,000,000

** Steady State Messages**

(S01) NOTIFY msgs due to state change
     per watched presentity per day......................22

(S02) 200 (for NOTIFY due to state change) msgs
     per watched presentity per day......................22

(S03) Total number and size of msgs due to state change per day
     Number of msgs for all watchers...................7,040,000
     Bytes for all watchers.........................5,871,360,000

(S04) Number of SUBSCRIBE msgs for refreshes
     per watcher per day..............................7

(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
     per watcher per day..............................7

(S06) Number of NOTIFY msgs for refreshes
     per watcher per day..............................7

(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
     per watcher per day..............................7

(S08) Total number and size of msgs due to SUBSCRIBE refreshes
     Number of msgs for all watchers per day........1,120,000
     Bytes for all watchers per day...............1,246,000,000

(S09) Total number & bytes of steady messages per day
     Number of msgs for all watchers.................8,160,000
     Bytes for all watchers.........................7,117,360,000

** Termination Messages**
(T01) Terminating SUBSCRIBE msgs per watcher................. 1
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher......... 1
(T03) Terminating NOTIFY msgs per watcher..................... 1
(T04) Terminating 200 OK msgs (NOTIFY) per watcher............ 1
(T05) Total number & bytes of Terminating SUBSCRIBE msgs
    Number of msgs for all watchers......................40,000
    Bytes for all watchers.........................18,000,000
(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
    Number of msgs for all watchers......................40,000
    Bytes for all watchers.........................14,800,000
(T07) Total number & bytes of terminating NOTIFY msgs
    Number of msgs for all watchers......................40,000
    Bytes for all watchers.........................51,920,000
(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
    Number of msgs for all watchers......................40,000
    Bytes for all watchers.........................14,800,000
(T09) Total number & bytes of terminating messages per day
    Number of msgs for all watchers.....................160,000
    Bytes for all watchers...........................99,520,000

** Bottom Line
(B01) Total of messages between domains..............8,480,000
    Total of bytes between domains (PD=350)........7,394,880,000
    Total of bytes between domains (PD=3000)........20,220,880,000
(B02) Total number of messages / second..................294
    Total of bytes per second (PD=350)................256,767
    Total of bytes per second (PD=3000)..............702,114
(B03) Total number of by msgs per user/day...............212
    Total number of bytes per user/day (PD=350)........184,872
    Total number of bytes per user/day (PD=3000)......505,522

Figure 2: SIMPLE with Dialog optimizations

2.6. SIMPLE with NOTIFY optimization

The initial analysis of analysis provided in Figure 1 is repeated
here with the assumption that the notify optimization is applied. The
optimization saves the need for NOTIFY upon refreshing a
SUBSCRIBE if there was no change since the last NOTIFY. It is
assumed here that there will be no NOTIFY message for a SUBSCRIBE
refreshes and terminations. As should be expected this optimization
affects the steady and termination state and does not affect the
initial state.

** Constants
(C01) Subscription lifetime (hours)......................8
(C02) Presence state changes / hour......................3
(C03) Subscription refresh interval / hour................1
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(C04)</td>
<td>Total federated presentities per watcher</td>
</tr>
<tr>
<td>(C05)</td>
<td>Number of dialogs to maintain per watcher</td>
</tr>
<tr>
<td>(C06)</td>
<td>Total number of watchers in domains</td>
</tr>
<tr>
<td>(C07)</td>
<td>SUBSCRIBE message size in bytes</td>
</tr>
<tr>
<td>(C08)</td>
<td>200 OK for SUBSCRIBE message size in bytes</td>
</tr>
<tr>
<td>(C09)</td>
<td>NOTIFY message size not including presence doc</td>
</tr>
<tr>
<td>(C10)</td>
<td>200 OK for NOTIFY message size in bytes</td>
</tr>
<tr>
<td>(C11)</td>
<td>Size of an average presence document</td>
</tr>
</tbody>
</table>

** Initial Messages**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(I01)</td>
<td>Initial SUBSCRIBE msgs per watcher</td>
</tr>
<tr>
<td>(I02)</td>
<td>Initial 200 OK msgs (SUBSCRIBE) per watcher</td>
</tr>
<tr>
<td>(I03)</td>
<td>Initial NOTIFY msgs per watcher</td>
</tr>
<tr>
<td>(I04)</td>
<td>Initial 200 OK msgs (NOTIFY) per watcher</td>
</tr>
<tr>
<td>(I05)</td>
<td>Total number &amp; bytes of initial SUBSCRIBE msgs</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
</tr>
<tr>
<td></td>
<td>Bytes for all watchers</td>
</tr>
<tr>
<td>(I06)</td>
<td>Total number &amp; bytes of initial 200 OK (SUBSCRIBE) msgs</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
</tr>
<tr>
<td></td>
<td>Bytes for all watchers</td>
</tr>
<tr>
<td>(I07)</td>
<td>Total number &amp; bytes of initial NOTIFY msgs</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
</tr>
<tr>
<td></td>
<td>Bytes for all watchers</td>
</tr>
<tr>
<td>(I08)</td>
<td>Total number &amp; bytes of initial 200 OK (NOTIFY) msgs</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
</tr>
<tr>
<td></td>
<td>Bytes for all watchers</td>
</tr>
<tr>
<td>(I09)</td>
<td>Total number &amp; bytes of initial messages per day</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
</tr>
<tr>
<td></td>
<td>Bytes for all watchers</td>
</tr>
</tbody>
</table>

** Steady State Messages**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(S01)</td>
<td>NOTIFY msgs due to state change per watched presentity per day</td>
</tr>
<tr>
<td>(S02)</td>
<td>200 (for NOTIFY due to state change) msgs per watched presentity per day</td>
</tr>
<tr>
<td>(S03)</td>
<td>Total number and size of msgs due to state change per day</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
</tr>
<tr>
<td></td>
<td>Bytes for all watchers</td>
</tr>
<tr>
<td>(S04)</td>
<td>Number of SUBSCRIBE msgs for refreshes per watcher per day</td>
</tr>
<tr>
<td>(S05)</td>
<td>Number of 200 OK msgs for SUBSCRIBE msgs for refreshes per watcher per day</td>
</tr>
<tr>
<td>(S06)</td>
<td>Number of NOTIFY msgs for refreshes per watcher per day</td>
</tr>
<tr>
<td>(S07)</td>
<td>Number of 200 OK msgs for NOTIFY msgs for refreshes per watcher per day</td>
</tr>
<tr>
<td>(S08)</td>
<td>Total number and size of msgs due to SUBSCRIBE refreshes</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers per day</td>
</tr>
</tbody>
</table>
Bytes for all watchers per day............918,400,000
(S09) Total number & bytes of steady messages per day
Number of msgs for all watchers.............9,280,000
Bytes for all watchers..................5,212,800,000

** Termination Messages

(T01) Terminating SUBSCRIBE msgs per watcher.................4
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher.........4
(T03) Terminating NOTIFY msgs per watcher....................0
(T04) Terminating 200 OK msgs (NOTIFY) per watcher.............0
(T05) Total number & bytes of Terminating SUBSCRIBE msgs
Number of msgs for all watchers.............160,000
Bytes for all watchers..................72,000,000

(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
Number of msgs for all watchers.............160,000
Bytes for all watchers..................59,200,000

(T07) Total number & bytes of terminating NOTIFY msgs
Number of msgs for all watchers.............0
Bytes for all watchers..................0

(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
Number of msgs for all watchers.............0
Bytes for all watchers..................0

(T09) Total number & bytes of terminating messages per day
Number of msgs for all watchers.............320,000
Bytes for all watchers..................131,200,000

** Bottom Line

(B01) Total of messages between domains..............10,240,000
Total of bytes between domains (PD=350).....5,670,400,000
Total of bytes between domains (PD=3000)...15,422,400,000

(B02) Total number of messages / second....................356
Total of bytes per second (PD=350)............196,889
Total of bytes per second (PD=3000).........535,500

(B03) Total number of by msgs per user/day............256
Total number of bytes per user/day (PD=350)....141,760
Total number of bytes per user/day (PD=3000)....385,560

Figure 3: SIMPLE with NOTIFY optimizations

2.7. SIMPLE with Dialog & NOTIFY optimizations

Here both optimizations are combined. In all the subsequent use cases we will show only the analysis with no optimizations and with both optimizations combined.

** Constants

(C01) Subscription lifetime (hours).........................8
(C02) Presence state changes / hour........................3
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C03)</td>
<td>Subscription refresh interval / hour</td>
<td>1</td>
</tr>
<tr>
<td>(C04)</td>
<td>Total federated presentities per watcher</td>
<td>4</td>
</tr>
<tr>
<td>(C05)</td>
<td>Number of dialogs to maintain per watcher</td>
<td>1</td>
</tr>
<tr>
<td>(C06)</td>
<td>Total number of watchers in domains</td>
<td>40,000</td>
</tr>
<tr>
<td>(C07)</td>
<td>SUBSCRIBE message size in bytes</td>
<td>450</td>
</tr>
<tr>
<td>(C08)</td>
<td>200 OK for SUBSCRIBE message size in bytes</td>
<td>370</td>
</tr>
<tr>
<td>(C09)</td>
<td>NOTIFY message size not including presence doc</td>
<td>500</td>
</tr>
<tr>
<td>(C10)</td>
<td>200 OK for NOTIFY message size in bytes</td>
<td>370</td>
</tr>
<tr>
<td>(C11)</td>
<td>Size of an average presence document</td>
<td>350</td>
</tr>
<tr>
<td>(C13)</td>
<td>Additional data per document in RLMI</td>
<td>160</td>
</tr>
<tr>
<td>(C14)</td>
<td>Multiparty boundary in RLMI document</td>
<td>144</td>
</tr>
<tr>
<td>(C15)</td>
<td>XML root node in RLMI document</td>
<td>144</td>
</tr>
</tbody>
</table>

** Initial Messages **

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I01)</td>
<td>Initial SUBSCRIBE msgs per watcher</td>
<td>1</td>
</tr>
<tr>
<td>(I02)</td>
<td>Initial 200 OK msgs (SUBSCRIBE) per watcher</td>
<td>1</td>
</tr>
<tr>
<td>(I03)</td>
<td>Initial NOTIFY msgs per watcher</td>
<td>1</td>
</tr>
<tr>
<td>(I04)</td>
<td>Initial 200 OK msgs (NOTIFY) per watcher</td>
<td>1</td>
</tr>
<tr>
<td>(I05)</td>
<td>Total number &amp; bytes of initial SUBSCRIBE msgs</td>
<td>40,000</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
<td>18,000,000</td>
</tr>
<tr>
<td>(I06)</td>
<td>Total number &amp; bytes of initial 200 OK (SUBSCRIBE) msgs</td>
<td>40,000</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
<td>14,800,000</td>
</tr>
<tr>
<td>(I07)</td>
<td>Total number &amp; bytes of initial NOTIFY msgs</td>
<td>40,000</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
<td>130,400,000</td>
</tr>
<tr>
<td>(I08)</td>
<td>Total number &amp; bytes of initial 200 OK (NOTIFY) msgs</td>
<td>40,000</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
<td>14,800,000</td>
</tr>
<tr>
<td>(I09)</td>
<td>Total number &amp; bytes of initial messages per day</td>
<td>160,000</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
<td>178,000,000</td>
</tr>
</tbody>
</table>

** Steady State Messages **

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(S01)</td>
<td>NOTIFY msgs due to state change per watched presentity per day</td>
<td>22</td>
</tr>
<tr>
<td>(S02)</td>
<td>200 (for NOTIFY due to state change) msgs per watched presentity per day</td>
<td>22</td>
</tr>
<tr>
<td>(S03)</td>
<td>Total number and size of msgs due to state change per day</td>
<td>7,040,000,000</td>
</tr>
<tr>
<td></td>
<td>Number of msgs for all watchers</td>
<td>5,871,360,000</td>
</tr>
<tr>
<td>(S04)</td>
<td>Number of SUBSCRIBE msgs for refreshes per watcher per day</td>
<td>7</td>
</tr>
<tr>
<td>(S05)</td>
<td>Number of 200 OK msgs for SUBSCRIBE msgs for refreshes per watcher per day</td>
<td>7</td>
</tr>
<tr>
<td>(S06)</td>
<td>Number of NOTIFY msgs for refreshes per watcher per day</td>
<td>0</td>
</tr>
</tbody>
</table>
(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes per watcher per day.............................................. 0
(S08) Total number and size of msgs due to SUBSCRIBE refreshes
Number of msgs for all watchers per day........560,000
Bytes for all watchers per day............229,600,000
(S09) Total number & bytes of steady messages per day
Number of msgs for all watchers.............7,600,000
Bytes for all watchers..................6,100,960,000

** Termination Messages
(T01) Terminating SUBSCRIBE msgs per watcher..................1
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher.........1
(T03) Terminating NOTIFY msgs per watcher........................0
(T04) Terminating 200 OK msgs (NOTIFY) per watcher............0
(T05) Total number & bytes of Terminating SUBSCRIBE msgs
Number of msgs for all watchers...............40,000
Bytes for all watchers......................18,000,000
(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
Number of msgs for all watchers...............40,000
Bytes for all watchers......................14,800,000
(T07) Total number & bytes of terminating NOTIFY msgs
Number of msgs for all watchers................0
Bytes for all watchers..........................0
(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
Number of msgs for all watchers...............0
Bytes for all watchers..........................0
(T09) Total number & bytes of terminating messages per day
Number of msgs for all watchers...............80,000
Bytes for all watchers......................32,800,000

** Bottom Line
(B01) Total of messages between domains....................7,840,000
Total of bytes between domains (PD=350)......6,311,760,000
Total of bytes between domains (PD=3000)....16,063,760,000
(B02) Total number of messages / second......................272
Total of bytes per second (PD=350)............219,158
Total of bytes per second (PD=3000)............557,769
(B03) Total number of by msgs per user/day..............196
Total number of bytes per user/day (PD=350).....157,794
Total number of bytes per user/day (PD=3000)......401,594

Figure 4: SIMPLE with Dialog & NOTIFY optimizations

2.8. Presence Federations

While scalability issues exist in any large deployment, certain characteristics make the deployment conducive to the existing resource-list optimizations, and others have characteristics that
cannot be exploited with the existing SIMPLE model. Following is a list of federation relationships that have varying usage characteristics. For each, a message rate and bandwidth table is provided reflecting typical changes message rates. Those characteristics can alter the overall effectiveness of existing optimizations.

2.8.1. Widely distributed inter-domain presence

In some environments presence federation may be very common, perhaps even more common than intra-domain presence. An example of this type of environment is a small ISV or public server. Users in that small ISV are not likely to subscribe to the presence of other users in their server since they do not necessarily have any relationship with each other aside from receiving service from the same provider. They are much more likely to be subscribed to the presence of users in one of the federated domains (whether in consumer domains, academic, other ISVs, etc). Common characteristics of this deployment are:

- Federated subscriptions are the majority of subscription traffic
- Individual users are likely to subscribe to multiple users in any one domain
- The intersection of users in the deployment watching the same presentity is quite small (i.e., probability that watchers in the domain subscribe to the same presentity is low)

To account for the extraordinarily high percentage of federation traffic, the number of federated presentities is increased to 20. The number of watchers in the domain could also be adjusted to account for an expected larger community of users being peered with, it is omitted here for simplification

The first table below provides the calculations without optimizations the second table provides the calculations with optimization.

** Constants
(C01) Subscription lifetime (hours)...............................8
(C02) Presence state changes / hour.............................3
(C03) Subscription refresh interval / hour.....................1
(C04) Total federated presentities per watcher..............20
(C05) Number of dialogs to maintain per watcher..........20
(C06) Total number of watchers in domains...............40,000
(C07) SUBSCRIBE message size in bytes......................450
(C08) 200 OK for SUBSCRIBE message size in bytes.......370
(C09) NOTIFY message size not including presence doc.....500
(C10) 200 OK for NOTIFY message size in bytes..........370
(C11) Size of an average presence document..............350
** Initial Messages
(I01) Initial SUBSCRIBE msgs per watcher.................... 20
(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher........ 20
(I03) Initial NOTIFY msgs per watcher....................... 20
(I04) Initial 200 OK msgs (NOTIFY) per watcher............ 20
(I05) Total number & bytes of initial SUBSCRIBE msgs
   Number of msgs for all watchers..................800,000
   Bytes for all watchers.......................360,000,000
(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs
   Number of msgs for all watchers...............800,000
   Bytes for all watchers.......................296,000,000
(I07) Total number & bytes of initial NOTIFY msgs
   Number of msgs for all watchers...............800,000
   Bytes for all watchers.......................680,000,000
(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs
   Number of msgs for all watchers...............800,000
   Bytes for all watchers.......................296,000,000
(I09) Total number & bytes of initial messages per day
   Number of msgs for all watchers.............3,200,000
   Bytes for all watchers..................1,632,000,000

** Steady State Messages
(S01) NOTIFY msgs due to state change
   per watched presentity per day.................... 22
(S02) 200 (for NOTIFY due to state change) msgs
   per watched presentity per day.................... 22
(S03) Total number and size of msgs due to state change per day
   Number of msgs for all watchers...............35,200,000
   Bytes for all watchers...................21,472,000,000
(S04) Number of SUBSCRIBE msgs for refreshes
   per watcher per day.............................140
(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
   per watcher per day.............................140
(S06) Number of NOTIFY msgs for refreshes
   per watcher per day.............................140
(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
   per watcher per day.............................140
(S08) Total number and size of msgs due to SUBSCRIBE refreshes
   Number of msgs for all watchers per day........22,400,000
   Bytes for all watchers per day..............11,424,000,000
(S09) Total number & bytes of steady messages per day
   Number of msgs for all watchers.............57,600,000
   Bytes for all watchers..................32,896,000,000

** Termination Messages
(T01) Terminating SUBSCRIBE msgs per watcher.............. 20
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher..... 20
(T03) Terminating NOTIFY msgs per watcher................... 20
(T04) Terminating 200 OK msgs (NOTIFY) per watcher...........20
(T05) Total number & bytes of Terminating SUBSCRIBE msgs
  Number of msgs for all watchers.................800,000
  Bytes for all watchers......................360,000,000
(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
  Number of msgs for all watchers...............800,000
  Bytes for all watchers......................296,000,000
(T07) Total number & bytes of terminating NOTIFY msgs
  Number of msgs for all watchers...............800,000
  Bytes for all watchers......................680,000,000
(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
  Number of msgs for all watchers...............800,000
  Bytes for all watchers......................296,000,000
(T09) Total number & bytes of terminating messages per day
  Number of msgs for all watchers..............3,200,000
  Bytes for all watchers.....................1,632,000,000

** Bottom Line

B01 Total of messages between domains..............64,000,000
  Total of bytes between domains (PD=350)........36,160,000,000
  Total of bytes between domains (PD=3000).....101,880,000,000
B02 Total number of messages / second................2,222
  Total of bytes per second (PD=350)...........1,255,556
  Total of bytes per second (PD=3000)..........3,537,500
B03 Total number of by msgs per user/day...........1,600
  Total number of bytes per user/day (PD=350)....904,000
  Total number of bytes per user/day (PD=3000)....2,547,000

(B01) Total of messages between domains..............64,000,000
  Total of bytes between domains (PD=350)........36,160,000,000
  Total of bytes between domains (PD=3000)....101,880,000,000
(B02) Total number of messages / second..............2,222
  Total of bytes per second (PD=350)............1,255,556
  Total of bytes per second (PD=3000)..........3,537,500
(B03) Total number of by msgs per user/day...........1,600
  Total number of bytes per user/day (PD=350)....904,000
  Total number of bytes per user/day (PD=3000)....2,547,000

Figure 5: Widely distributed inter-domain with no optimizations

** Constants
(C01) Subscription lifetime (hours)...................8
(C02) Presence state changes / hour................3
(C03) Subscription refresh interval / hour..........1
(C04) Total federated presentities per watcher......20
**Initial Messages**

(I01) Initial SUBSCRIBE msgs per watcher

(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher

(I03) Initial NOTIFY msgs per watcher

(I04) Initial 200 OK msgs (NOTIFY) per watcher

(I05) Total number & bytes of initial SUBSCRIBE msgs

   Number of msgs for all watchers.................. 40,000
   Bytes for all watchers............................ 18,000,000

(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs

   Number of msgs for all watchers.................. 40,000
   Bytes for all watchers............................ 14,800,000

(I07) Total number & bytes of initial NOTIFY msgs

   Number of msgs for all watchers.................. 40,000
   Bytes for all watchers............................ 548,960,000

(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs

   Number of msgs for all watchers.................. 40,000
   Bytes for all watchers............................ 14,800,000

(I09) Total number & bytes of initial messages per day

   Number of msgs for all watchers.................. 160,000
   Bytes for all watchers............................ 596,560,000

**Steady State Messages**

(S01) NOTIFY msgs due to state change per watched presentity per day

(S02) 200 (for NOTIFY due to state change) msgs per watched presentity per day

(S03) Total number and size of msgs due to state change per day

   Number of msgs for all watchers.................. 35,200,000
   Bytes for all watchers............................ 29,356,800,000

(S04) Number of SUBSCRIBE msgs for refreshes per watcher per day

(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes per watcher per day

(S06) Number of NOTIFY msgs for refreshes per watcher per day

(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes per watcher per day
### (S08) Total number and size of msgs due to SUBSCRIBE refreshes

- Number of msgs for all watchers per day: 560,000
- Bytes for all watchers per day: 229,600,000

### (S09) Total number & bytes of steady messages per day

- Number of msgs for all watchers: 35,760,000
- Bytes for all watchers: 29,586,400,000

### Termination Messages

- **(T01)** Terminating SUBSCRIBE msgs per watcher: 1
- **(T02)** Terminating 200 OK msgs (SUBSCRIBE) per watcher: 1
- **(T03)** Terminating NOTIFY msgs per watcher: 0
- **(T04)** Terminating 200 OK msgs (NOTIFY) per watcher: 0

### Total number & bytes of Terminating SUBSCRIBE msgs

- Number of msgs for all watchers: 40,000
- Bytes for all watchers: 18,000,000

### Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs

- Number of msgs for all watchers: 40,000
- Bytes for all watchers: 14,800,000

### Total number & bytes of terminating NOTIFY msgs

- Number of msgs for all watchers: 0
- Bytes for all watchers: 0

### Total number & bytes of terminating 200 OK (NOTIFY) msgs

- Number of msgs for all watchers: 0
- Bytes for all watchers: 0

### Total number & bytes of terminating messages per day

- Number of msgs for all watchers: 80,000
- Bytes for all watchers: 32,800,000

### Bottom Line

- **(B01)** Total of messages between domains: 36,000,000
- Total of bytes between domains (PD=350): 30,215,760,000
- Total of bytes between domains (PD=3000): 78,975,760,000

- **(B02)** Total number of messages / second: 1,250
- Total of bytes per second (PD=350): 1,049,158
- Total of bytes per second (PD=3000): 2,742,214

- **(B03)** Total number of by msgs per user/day: 900
- Total number of bytes per user/day (PD=350): 755,394
- Total number of bytes per user/day (PD=3000): 1,974,394

**Figure 6:** Widely distributed inter-domain with optimizations

### 2.8.2. Associated inter-domain presence

In this type of environment, the domain is a collection of associated users such as an enterprise. Here, federation is once again very common. However, there is also a strong association between some users in the deployment. These associations make it somewhat more likely that users in that domain will be watchers of the same
presentity. This can occur because of business relationships (e.g. two co-workers on a project federating with a partner company).

Common characteristics of this deployment are:

- Federated subscriptions are large minority or small majority of subscription traffic
- Individual users are likely to subscribe to multiple users in any one domain, especially their own
- The intersection of users in the deployment watching the same presentities increases

This federation type has traffic rates similar to the previous examples but with different levels of association of the users.

2.8.3. Very large network peering

In this environment, two or more very large networks create a peering relationship allowing their users to subscribe to presence in the other domains. Where as the number of users in other deployment types ranges from hundreds to several hundred thousand, these large networks host up to hundreds of millions of users. Examples of these networks are large wireless carriers and consumer IM networks.

Common characteristics of this deployment are:

- As users become accustomed to network boundaries disappearing, federated subscriptions become as common as subscriptions within the same domain
- Individual users are highly likely to want to see presence of multiple presentities in the peer network
- The intersection of users in the deployment watching the same presentities is very high (i.e., two or more users in network A are extremely likely to be watching a same user in network B)
- Status changes increase greatly due to typical observed consumer behavior

The first table below provides the calculations without optimizations the second table provides the calculations with optimizations. Even though the optimizations help a lot (almost cut the number of messages by half), the numbers are still very high. Note also that the bandwidth required is very high.

** Constants

(C01) Subscription lifetime (hours) .........................8
(C02) Presence state changes / hour .......................6
(C03) Subscription refresh interval / hour ...............1
(C04) Total federated presentities per watcher ..........10
(C05) Number of dialogs to maintain per watcher..............10
(C06) Total number of watchers in domains...................20,000,000
(C07) SUBSCRIBE message size in bytes..........................450
(C08) 200 OK for SUBSCRIBE message size in bytes.............370
(C09) NOTIFY message size not including presence doc...........500
(C10) 200 OK for NOTIFY message size in bytes................370
(C11) Size of an average presence document....................350

** Initial Messages
(I01) Initial SUBSCRIBE msgs per watcher.......................10
(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher...............10
(I03) Initial NOTIFY msgs per watcher..........................10
(I04) Initial 200 OK msgs (NOTIFY) per watcher..................10
(I05) Total number & bytes of initial SUBSCRIBE msgs
      Number of msgs for all watchers..................200,000,000
      Bytes for all watchers......................90,000,000,000
(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs
      Number of msgs for all watchers..................200,000,000
      Bytes for all watchers......................74,000,000,000
(I07) Total number & bytes of initial NOTIFY msgs
      Number of msgs for all watchers..................200,000,000
      Bytes for all watchers......................170,000,000,000
(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs
      Number of msgs for all watchers..................200,000,000
      Bytes for all watchers......................74,000,000,000
(I09) Total number & bytes of initial messages per day
      Number of msgs for all watchers.................800,000,000
      Bytes for all watchers..................408,000,000,000

** Steady State Messages
(S01) NOTIFY msgs due to state change
      per watched presentity per day.....................46
(S02) 200 (for NOTIFY due to state change) msgs
      per watched presentity per day.....................46
(S03) Total number and size of msgs due to state change per day
      Number of msgs for all watchers.............18,400,000,000
      Bytes for all watchers..................11,224,000,000,000
(S04) Number of SUBSCRIBE msgs for refreshes
      per watcher per day............................70
(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
      per watcher per day............................70
(S06) Number of NOTIFY msgs for refreshes
      per watcher per day............................70
(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
      per watcher per day............................70
(S08) Total number and size of msgs due to SUBSCRIBE refreshes
      Number of msgs for all watchers per day........5,600,000,000
      Bytes for all watchers per day...............2,856,000,000,000
(S09) Total number & bytes of steady messages per day
   Number of msgs for all watchers........24,000,000,000
   Bytes for all watchers..............14,080,000,000,000

** Termination Messages
(T01) Terminating SUBSCRIBE msgs per watcher.................10
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher........10
(T03) Terminating NOTIFY msgs per watcher.....................10
(T04) Terminating 200 OK msgs (NOTIFY) per watcher...........10
(T05) Total number & bytes of Terminating SUBSCRIBE msgs
   Number of msgs for all watchers........200,000,000
   Bytes for all watchers..............90,000,000,000
(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
   Number of msgs for all watchers........200,000,000
   Bytes for all watchers..............74,000,000,000
(T07) Total number & bytes of terminating NOTIFY msgs
   Number of msgs for all watchers........200,000,000
   Bytes for all watchers..............170,000,000,000
(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
   Number of msgs for all watchers........200,000,000
   Bytes for all watchers..............74,000,000,000
(T09) Total number & bytes of terminating messages per day
   Number of msgs for all watchers........800,000,000
   Bytes for all watchers.............408,000,000,000

** Bottom Line
(B01) Total of messages between domains..........25,600,000,000
   Total of bytes bet. domains (PD=350)...14,896,000,000,000
   Total of bytes bet. domains (PD=3000)...44,046,000,000,000
(B02) Total number of messages / second..............888,889
   Total of bytes per second (PD=350)...........517,222,222
   Total of bytes per second (PD=3000)..........1,529,375,000
(B03) Total number of by msgs per user/day..............1,280
   Total number of bytes per user/day (PD=350)....744,800
   Total number of bytes per user/day (PD=3000)...2,202,300

Figure 7: Very large network peering with no optimizations

** Constants
(C01) Subscription lifetime (hours).........................8
(C02) Presence state changes / hour.......................6
(C03) Subscription refresh interval / hour.............1
(C04) Total federated presenties per watcher..........10
(C05) Number of dialogs to maintain per watcher........1
(C06) Total number of watchers in domains............20,000,000
(C07) SUBSCRIBE message size in bytes.................450
(C08) 200 OK for SUBSCRIBE message size in bytes....370
### Initial Messages

<table>
<thead>
<tr>
<th>Message Type</th>
<th>Number of Messages</th>
<th>Bytes of Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial SUBSCRIBE msgs per watcher</td>
<td>1</td>
<td>9,000,000</td>
</tr>
<tr>
<td>Initial 200 OK msgs (SUBSCRIBE) per watcher</td>
<td>1</td>
<td>7,400,000</td>
</tr>
<tr>
<td>Initial NOTIFY msgs per watcher</td>
<td>1</td>
<td>143,680,000</td>
</tr>
<tr>
<td>Initial 200 OK msgs (NOTIFY) per watcher</td>
<td>1</td>
<td>7,400,000</td>
</tr>
<tr>
<td>Total number of initial SUBSCRIBE msgs</td>
<td>20,000,000</td>
<td>9,000,000</td>
</tr>
<tr>
<td>Total number of initial 200 OK (SUBSCRIBE) msgs</td>
<td>20,000,000</td>
<td>7,400,000</td>
</tr>
<tr>
<td>Total number of initial NOTIFY msgs</td>
<td>20,000,000</td>
<td>143,680,000</td>
</tr>
<tr>
<td>Total number of initial 200 OK (NOTIFY) msgs</td>
<td>20,000,000</td>
<td>7,400,000</td>
</tr>
</tbody>
</table>

### Steady State Messages

<table>
<thead>
<tr>
<th>Message Type</th>
<th>Number of Messages</th>
<th>Bytes of Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOTIFY msgs due to state change per watched presentity per day</td>
<td>46</td>
<td>15,345,600,000</td>
</tr>
<tr>
<td>200 (for NOTIFY due to state change) msgs per watched presentity per day</td>
<td>46</td>
<td>15,345,600,000</td>
</tr>
<tr>
<td>Total number and size of msgs due to state change per day</td>
<td>18,400,000,000</td>
<td>15,345,600,000</td>
</tr>
<tr>
<td>Number of.Subscribe msgs for refreshes per watcher per day</td>
<td>7</td>
<td>114,800,000</td>
</tr>
<tr>
<td>Number of 200 OK msgs for SUBSCRIBE msgs for refreshes per watcher per day</td>
<td>7</td>
<td>114,800,000</td>
</tr>
<tr>
<td>Number of NOTIFY msgs for refreshes per watcher per day</td>
<td>0</td>
<td>114,800,000</td>
</tr>
<tr>
<td>Number of 200 OK msgs for NOTIFY msgs for refreshes per watcher per day</td>
<td>0</td>
<td>114,800,000</td>
</tr>
<tr>
<td>Total number and size of msgs due to SUBSCRIBE refreshes</td>
<td>280,000,000</td>
<td>114,800,000</td>
</tr>
<tr>
<td>Total number &amp; bytes of steady messages per day</td>
<td>167,480,000,000</td>
<td>114,800,000</td>
</tr>
</tbody>
</table>
** Termination Messages**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(T01) Terminating SUBSCRIBE msgs per watcher</td>
<td>1</td>
</tr>
<tr>
<td>(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher</td>
<td>1</td>
</tr>
<tr>
<td>(T03) Terminating NOTIFY msgs per watcher</td>
<td>0</td>
</tr>
<tr>
<td>(T04) Terminating 200 OK msgs (NOTIFY) per watcher</td>
<td>0</td>
</tr>
<tr>
<td>(T05) Total number &amp; bytes of Terminating SUBSCRIBE msgs</td>
<td>Number of msgs for all watchers............20,000,000 Bytes for all watchers...9,000,000,000</td>
</tr>
<tr>
<td>(T06) Total number &amp; bytes of terminating 200 OK (SUBSCRIBE) msgs</td>
<td>Number of msgs for all watchers............20,000,000 Bytes for all watchers...7,400,000,000</td>
</tr>
<tr>
<td>(T07) Total number &amp; bytes of terminating NOTIFY msgs</td>
<td>Number of msgs for all watchers............0 Bytes for all watchers...0</td>
</tr>
<tr>
<td>(T08) Total number &amp; bytes of terminating 200 OK (NOTIFY) msgs</td>
<td>Number of msgs for all watchers............0 Bytes for all watchers...0</td>
</tr>
<tr>
<td>(T09) Total number &amp; bytes of terminating messages per day</td>
<td>Number of msgs for all watchers............40,000,000 Bytes for all watchers...16,400,000,000</td>
</tr>
</tbody>
</table>

** Bottom Line**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(B01) Total of messages between domains</td>
<td>18,800,000,000</td>
</tr>
<tr>
<td>(B02) Total number of messages / second</td>
<td>652,778</td>
</tr>
<tr>
<td>(B03) Total number of bytes per second</td>
<td>543,208,333</td>
</tr>
<tr>
<td>(B04) Total number of bytes between domains</td>
<td>15,644,400,000,000</td>
</tr>
<tr>
<td>(B05) Total number of bytes per second (PD=350)</td>
<td>543,208,333</td>
</tr>
<tr>
<td>(B06) Total number of bytes between domains (PD=350)</td>
<td>40,554,280,000</td>
</tr>
<tr>
<td>(B07) Total number of bytes per second (PD=3000)</td>
<td>1,408,134,722</td>
</tr>
<tr>
<td>(B08) Total number of bytes between domains (PD=3000)</td>
<td>782,220</td>
</tr>
<tr>
<td>(B09) Total number of bytes per user/day</td>
<td>940</td>
</tr>
<tr>
<td>(B10) Total number of bytes per user/day (PD=350)</td>
<td>782,220</td>
</tr>
<tr>
<td>(B11) Total number of bytes per user/day (PD=3000)</td>
<td>2,027,714</td>
</tr>
</tbody>
</table>

**Figure 8:** Very large network peering with optimizations

2.8.4. Intra-domain peering

Within a particular domain, multiple presence infrastructures are deployed with users split between the two. This scenario is unique in that federated messages do not pass outside the administrative domain’s network. The two infrastructures peer directly inside the domain. A common example of this is an enterprise IT system with multiple independent vendor presence solutions deployed (e.g., a presence solution for desktop messaging deployed alongside a presence solution for IP telephony).
Common characteristics of this deployment are

- The difference between subscriptions to presentities in one system vs. the other are completely arbitrary. Any one presentity is as likely to be homed on one infrastructure as the other.
- Active users are almost guaranteed of subscribing to many users in the peer infrastructure.
- The level of intersection of presentities is extremely high.

The first table below provides the calculations without optimizations the second table provides the calculations with optimization. Even though the relatively conservative numbers are used, the amount of messages is still very high even though optimization may cut the traffic by more then half

**Constants**

| (C01) Subscription lifetime (hours) | 8 |
| (C02) Presence state changes / hour | 3 |
| (C03) Subscription refresh interval / hour | 1 |
| (C04) Total federated presentities per watcher | 10 |
| (C05) Number of dialogs to maintain per watcher | 10 |
| (C06) Total number of watchers in domains | 120,000 |
| (C07) SUBSCRIBE message size in bytes | 450 |
| (C08) 200 OK for SUBSCRIBE message size in bytes | 370 |
| (C09) NOTIFY message size not including presence doc | 500 |
| (C10) 200 OK for NOTIFY message size in bytes | 370 |
| (C11) Size of an average presence document | 350 |

**Initial Messages**

| (I01) Initial SUBSCRIBE msgs per watcher | 10 |
| (I02) Initial 200 OK msgs (SUBSCRIBE) per watcher | 10 |
| (I03) Initial NOTIFY msgs per watcher | 10 |
| (I04) Initial 200 OK msgs (NOTIFY) per watcher | 10 |
| (I05) Total number & bytes of initial SUBSCRIBE msgs | 1,200,000 |
| Number of msgs for all watchers | 1,200,000 |
| Bytes for all watchers | 540,000,000 |
| (I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs | 1,200,000 |
| Number of msgs for all watchers | 1,200,000 |
| Bytes for all watchers | 444,000,000 |
| (I07) Total number & bytes of initial NOTIFY msgs | 1,200,000 |
| Number of msgs for all watchers | 1,200,000 |
| Bytes for all watchers | 1,020,000,000 |
| (I08) Total number & bytes of initial 200 OK (NOTIFY) msgs | 1,200,000 |
| Number of msgs for all watchers | 1,200,000 |
| Bytes for all watchers | 444,000,000 |
| (I09) Total number & bytes of initial messages per day | 4,800,000 |
| Number of msgs for all watchers | 4,800,000 |
| Bytes for all watchers | 2,448,000,000 |
** Steady State Messages
(S01) NOTIFY msgs due to state change
    per watched presentity per day........................22
(S02) 200 (for NOTIFY due to state change) msgs
    per watched presentity per day........................22
(S03) Total number and size of msgs due to state change per day
    Number of msgs for all watchers.............52,800,000
    Bytes for all watchers..................32,208,000,000
(S04) Number of SUBSCRIBE msgs for refreshes
    per watcher per day................................70
(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
    per watcher per day................................70
(S06) Number of NOTIFY msgs for refreshes
    per watcher per day................................70
(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
    per watcher per day................................70
(S08) Total number and size of msgs due to SUBSCRIBE refreshes
    Number of msgs for all watchers per day....33,600,000
    Bytes for all watchers per day........17,136,000,000
(S09) Total number & bytes of steady messages per day
    Number of msgs for all watchers...........86,400,000
    Bytes for all watchers................49,344,000,000

** Termination Messages
(T01) Terminating SUBSCRIBE msgs per watcher..................10
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher..........10
(T03) Terminating NOTIFY msgs per watcher........................10
(T04) Terminating 200 OK msgs (NOTIFY) per watcher...............10
(T05) Total number & bytes of Terminating SUBSCRIBE msgs
    Number of msgs for all watchers............1,200,000
    Bytes for all watchers....................540,000,000
(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
    Number of msgs for all watchers............1,200,000
    Bytes for all watchers....................444,000,000
(T07) Total number & bytes of terminating NOTIFY msgs
    Number of msgs for all watchers............1,200,000
    Bytes for all watchers....................1,020,000,000
(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
    Number of msgs for all watchers............1,200,000
    Bytes for all watchers....................444,000,000
(T09) Total number & bytes of terminating messages per day
    Number of msgs for all watchers............4,800,000
    Bytes for all watchers....................2,448,000,000

** Bottom Line
(B01) Total of messages between domains...............96,000,000
    Total of bytes between domains (PD=350)......54,240,000,000
    Total of bytes between domains (PD=3000).....152,820,000,000
Figure 9: Intra-domain peering with no optimizations

**Constants**

(C01) Subscription lifetime (hours)...........................8
(C02) Presence state changes / hour...........................3
(C03) Subscription refresh interval / hour......................1
(C04) Total federated presentities per watcher................10
(C05) Number of dialogs to maintain per watcher..............1
(C06) Total number of watchers in domains...............120,000
(C07) SUBSCRIBE message size in bytes.....................450
(C08) 200 OK for SUBSCRIBE message size in bytes..........370
(C09) NOTIFY message size not including presence doc.......500
(C10) 200 OK for NOTIFY message size in bytes............370
(C11) Size of an average presence document..................350
(C12) Additional data per document in RLMI...............160
(C13) Multiparty boundary in RLMI document.................144
(C14) XML root node in RLMI document.......................144

**Initial Messages**

(I01) Initial SUBSCRIBE msgs per watcher......................1
(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher.............1
(I03) Initial NOTIFY msgs per watcher.........................1
(I04) Initial 200 OK msgs (NOTIFY) per watcher...............1
(I05) Total number & bytes of initial SUBSCRIBE msgs
    Number of msgs for all watchers...............120,000
    Bytes for all watchers..................54,000,000
(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs
    Number of msgs for all watchers...............120,000
    Bytes for all watchers..................44,400,000
(I07) Total number & bytes of initial NOTIFY msgs
    Number of msgs for all watchers...............120,000
    Bytes for all watchers..................862,080,000
(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs
    Number of msgs for all watchers...............120,000
    Bytes for all watchers..................44,400,000
(I09) Total number & bytes of initial messages per day
    Number of msgs for all watchers...............480,000
    Bytes for all watchers..................1,004,880,000

**Steady State Messages**
(S01) NOTIFY msgs due to state change
   per watched presentity per day....................22
(S02) 200 (for NOTIFY due to state change) msgs
   per watched presentity per day....................22
(S03) Total number and size of msgs due to state change per day
   Number of msgs for all watchers.............52,800,000
   Bytes for all watchers..................44,035,200,000
(S04) Number of SUBSCRIBE msgs for refreshes
   per watcher per day.............................7
(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
   per watcher per day.............................7
(S06) Number of NOTIFY msgs for refreshes
   per watcher per day..............................0
(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
   per watcher per day..............................0
(S08) Total number and size of msgs due to SUBSCRIBE refreshes
   Number of msgs for all watchers per day.....1,680,000
   Bytes for all watchers....................688,800,000
(S09) Total number & bytes of steady messages per day
   Number of msgs for all watchers...........54,480,000
   Bytes for all watchers...................44,724,000,000

** Termination Messages
(T01) Terminating SUBSCRIBE msgs per watcher...............1
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher.......1
(T03) Terminating NOTIFY msgs per watcher....................1
(T04) Terminating 200 OK msgs (NOTIFY) per watcher..........1
(T05) Total number & bytes of terminating SUBSCRIBE msgs
   Number of msgs for all watchers............120,000
   Bytes for all watchers...................54,000,000
(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
   Number of msgs for all watchers............120,000
   Bytes for all watchers...................44,400,000
(T07) Total number & bytes of terminating NOTIFY msgs
   Number of msgs for all watchers...............0
   Bytes for all watchers.......................0
(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
   Number of msgs for all watchers............120,000
   Bytes for all watchers...................44,400,000
(T09) Total number & bytes of terminating messages per day
   Number of msgs for all watchers...........240,000
   Bytes for all watchers...................98,400,000

** Bottom Line
(B01) Total of messages between domains...........55,200,000
   Total of bytes between domains (PD=350)......45,827,280,000
   Total of bytes between domains (PD=3000)....118,967,280,000
(B02) Total number of messages / second............1,917
Partial Notifications Optimization

Draft [15] define a way for the watcher to request getting only what was changed in the presence document. The following is a calculation of the bandwidth that is saved in the very large peering network case, when we add the partial notification optimization to the dialog and NOTIFY optimization. It is assumed that except for the initial NOTIFY all the other NOTIFY messages will be partial. It is also assumed that only a single attribute in the presence document will be changed each time, thus the size of the partial presence document is assumed to be 200 bytes.

** Constants
(C01) Subscription lifetime (hours)..........................8
(C02) Presence state changes / hour..........................6
(C03) Subscription refresh interval / hour....................1
(C04) Total federated presentities per watcher..............10
(C05) Number of dialogs to maintain per watcher............10
(C06) Total number of watchers in domains...............20,000,000
(C07) SUBSCRIBE message size in bytes.......................450
(C08) 200 OK for SUBSCRIBE message size in bytes.........370
(C09) NOTIFY message size not including presence doc.....500
(C10) 200 OK for NOTIFY message size in bytes............370
(C11) Size of an average presence document...............350
(C12) Size of an average partial presence document........200

** Initial Messages
(I01) Initial SUBSCRIBE msgs per watcher..................10
(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher........10
(I03) Initial NOTIFY msgs per watcher......................10
(I04) Initial 200 OK msgs (NOTIFY) per watcher............10
(I05) Total number & bytes of initial SUBSCRIBE msgs
    Number of msgs for all watchers..................200,000,000
    Bytes for all watchers......................90,000,000,000
(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs
    Number of msgs for all watchers...........200,000,000
    Bytes for all watchers..................74,00,000,000
(I07) Total number & bytes of initial NOTIFY msgs
    Number of msgs for all watchers............200,000,000
    Bytes for all watchers................170,000,000,000
(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs
Number of msgs for all watchers...........200,000,000
Bytes for all watchers....................74,000,000,000

(I09) Total number & bytes of initial messages per day
Number of msgs for all watchers...........800,000,000
Bytes for all watchers....................408,000,000,000

** Steady State Messages

(S01) NOTIFY msgs due to state change
per watched presentity per day.............46

(S02) 200 (for NOTIFY due to state change) msgs
per watched presentity per day.............46

(S03) Total number and size of msgs due to state change per day
Number of msgs for all watchers........18,400,000,000
Bytes for all watchers...............9,844,000,000,000

(S04) Number of SUBSCRIBE msgs for refreshes
per watcher per day.........................70

(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
per watcher per day.........................70

(S06) Number of NOTIFY msgs for refreshes
per watcher per day.........................0

(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
per watcher per day.........................0

(S08) Total number and size of msgs due to SUBSCRIBE refreshes
Number of msgs for all watchers per day.2,800,000,000
Bytes for all watchers........1,148,000,000,000

(S09) Total number & bytes of steady messages per day
Number of msgs for all watchers........21,200,000,000
Bytes for all watchers...............10,992,000,000,000

** Termination Messages

(T01) Terminating SUBSCRIBE msgs per watcher............10

(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher......10

(T03) Terminating NOTIFY msgs per watcher..................0

(T04) Terminating 200 OK msgs (NOTIFY) per watcher..........0

(T05) Total number & bytes of Terminating SUBSCRIBE msgs
Number of msgs for all watchers...........200,000,000
Bytes for all watchers...................90,000,000,000

(T06) Total number & bytes of terminating 200 OK (SUBSCRIBE) msgs
Number of msgs for all watchers...........200,000,000
Bytes for all watchers...................74,000,000,000

(T07) Total number & bytes of terminating NOTIFY msgs
Number of msgs for all watchers...............0
Bytes for all watchers........................0

(T08) Total number & bytes of terminating 200 OK (NOTIFY) msgs
Number of msgs for all watchers...............0
Bytes for all watchers........................0

(T09) Total number & bytes of terminating messages per day
Number of msgs for all watchers ........... 400,000,000
Bytes for all watchers ................ 164,000,000,000

** Bottom Line

(B01) Total of messages between domains .......... 22,400,000,000
Total of bytes bet. domains (PD=350) ........... 11,564,000,000,000
Total of bytes bet. domains (PD=3000) ........... 12,094,000,000,000

(B02) Total number of messages / second ............ 777,778
Total of bytes per second (PD=350) ............... 401,527,778
Total of bytes per second (PD=3000) ............... 419,930,556

(B03) Total number of by msgs per user/day .......... 1,120
Total number of bytes per user/day (PD=350) ....... 578,200
Total number of bytes per user/day (PD=3000) ...... 604,700

Figure 11: Very large networks peering with NOTIFY and partial optimizations

2.10. Other Protocols

In SIP there are several differences from other protocols of presence as XMPP [7] and the proprietary protocols of the consumer domains. The differences are:

- There is no 200 OK for each message. These protocols support only TCP and they do not compensate for network issues.
- There is no refresh for subscription.
- There is no NOTIFY upon termination of SUBSCRIPTION.
- The size of each message of these protocol is smaller since they are either binary and/or there is no need for the various headers that SIP uses for routing etc. So we need to assume smaller message sizes while we will keep the size of the presence document the same.

The following is an analysis of the very large networks peering assuming all the changes in other protocols with respect to SIP.

** Constants

(C01) Subscription lifetime (hours) .................. 8
(C02) Presence state changes / hour .................. 6
(C03) Subscription refresh interval / hour .......... 0
(C04) Total federated presentities per watcher .... 10
(C05) Number of dialogs to maintain per watcher .... 10
(C06) Total number of watchers in domains ........ 20,000,000
(C07) SUBSCRIBE message size in bytes ............ 150
(C08) 200 OK for SUBSCRIBE message size in bytes .... 0
(C09) NOTIFY message size not including presence doc .... 150
(C10) 200 OK for NOTIFY message size in bytes .... 0
(C11) Size of an average presence document ......... 350
** Initial Messages

(I01) Initial SUBSCRIBE msgs per watcher.........................10
(I02) Initial 200 OK msgs (SUBSCRIBE) per watcher..............0
(I03) Initial NOTIFY msgs per watcher..........................10
(I04) Initial 200 OK msgs (NOTIFY) per watcher..................0
(I05) Total number & bytes of initial SUBSCRIBE msgs
    Number of msgs for all watchers...........200,000,000
    Bytes for all watchers...................30,000,000,000
(I06) Total number & bytes of initial 200 OK (SUBSCRIBE) msgs
    Number of msgs for all watchers...........0
    Bytes for all watchers....................0
(I07) Total number & bytes of initial NOTIFY msgs
    Number of msgs for all watchers...........200,000,000
    Bytes for all watchers...................100,000,000,000
(I08) Total number & bytes of initial 200 OK (NOTIFY) msgs
    Number of msgs for all watchers...........0
    Bytes for all watchers....................0
(I09) Total number & bytes of initial messages per day
    Number of msgs for all watchers...........400,000,000
    Bytes for all watchers...................130,000,000,000

** Steady State Messages

(S01) NOTIFY msgs due to state change
    per watched presentity per day..................46
(S02) 200 (for NOTIFY due to state change) msgs
    per watched presentity per day..................0
(S03) Total number and size of msgs due to state change per day
    Number of msgs for all watchers...........9,200,000,000
    Bytes for all watchers....................4,600,000,000,000
(S04) Number of SUBSCRIBE msgs for refreshes
    per watcher per day............................0
(S05) Number of 200 OK msgs for SUBSCRIBE msgs for refreshes
    per watcher per day............................0
(S06) Number of NOTIFY msgs for refreshes
    per watcher per day............................0
(S07) Number of 200 OK msgs for NOTIFY msgs for refreshes
    per watcher per day............................0
(S08) Total number and size of msgs due to SUBSCRIBE refreshes
    Number of msgs for all watchers per day........0
    Bytes for all watchers per day................0
(S09) Total number & bytes of steady messages per day
    Number of msgs for all watchers............9,200,480,000
    Bytes for all watchers....................4,600,000,000,000

** Termination Messages

(T01) Terminating SUBSCRIBE msgs per watcher..................10
(T02) Terminating 200 OK msgs (SUBSCRIBE) per watcher.........0
(T03) Terminating NOTIFY msgs per watcher....................0
3. State Management

In previous sections we have discussed the big amount of messages that need to be sent to/from a presence server. In this section, the state that needs to be maintained by a presence server will be analyzed and shown to be far from trivial.

The presence server has two parallel tasks.

1. Maintain the state of the presentities to which watchers subscribe.
2. Maintain the state of the subscriptions of watchers and provide timely updates to the watchers.
For a single subscription from a single watcher on a presentity, the presence server has to maintain the following state:

- Subscription state including all the parameters that are needed in order to maintain the subscription as timers.
- Optional filtering information that was requested by the watcher. This includes enough information that is needed for doing the filtering. In addition, additional information has to be maintained if partial notification is being supported for the subscription.
- Optional rate management information as throttling.
- Watcher information that is the result of the subscription in order to enable watched presentities to see who is watching them.

For each presentity that has been subscribed to in the presence server, the presence server has to maintain the following state:

- A list of the subscriptions for the presentity. Note that this is already taken care of from the size calculation point of view by the subscription state above.
- Authorization information for the presentity.

For each presentity for which there was any publication and the presentity has a state other than a default value, the presence server has to maintain the current value of the presentity.

### 3.1. State Size Calculations

Let's assume the following sizes:

- Subscription size - 2K bytes. This includes watcher information that need to be created by the presence server for each subscription.
- Subscribed resource - 1K bytes (for privacy information and other management info). The subscriptions themselves are already calculated in the previous bullet.
- Resource with a state - 6K bytes. This is a moderate assumption if we take into account the amount of data that is being put in a presence document as multiple devices, calendar and geographical information.

#### 3.1.1. Tiny System

- 10K subscriptions = 19M bytes.
- 5K subscribed to presentities = 5M bytes.
10K presentities with state = 58M bytes.
Total is 82M bytes.

3.1.2. Medium System
- 100K subscriptions = 195M bytes.
- 50K subscribed to presentities = 49M bytes.
- 100K presentities with state = 586M bytes.
Total is 830M bytes.

3.1.3. Large System
- 6M subscriptions = 11,718M bytes.
- 3M subscribed to presentities = 2,929M bytes.
- 4M presentities with state = 23437M bytes.
Total is 38G bytes.

3.1.4. Very Large System
- 150M subscriptions = 292,969M bytes.
- 75M subscribed to presentities = 73,242M bytes.
- 100M presentities with state = 585,937M bytes.
Total is 952G bytes which is a very big number for a very dynamic storage as needed by the presence server.

Although the numbers above may seem moderate enough for the sizes that the presence server is handling we should consider the following:

- Dynamic state - Although the state may seem not so big for databases even for the very large system, we need to remember that this state is a very dynamic state. Subscriptions come and go all the time, the status of presentities is being updated and so forth. This means that the presence server has to manage its state in a medium that is very dynamic and for such large sizes this task is not trivial.
- Interlinked state - The subscriptions and the subscribed to presentities are dependent on each other. There needs to be a link from the presentity to the subscriptions and vice versa. See Section 4.5 about the interlinkage that is created due to resource lists.
- Moderate assumptions - The size assumptions that were made above are quite moderate. As presence is becoming more a core middleware functionality that holds a lot of data on the user. In
real-life the numbers above may be even higher and the presence server can have additional overhead as managing the SIP sessions, networking and more.

Although the calculations above do not show that there is a real issue with state management of presence in medium systems or even in big systems since it should be possible to divide the state between different machines, the state size is still very big. A bigger issue with the state is more when resource lists are involved and create an interlinked state between many servers. In that case the division of very big state to multiple servers becomes less trivial...

4. Processing complexities

The basic presence paradigm consists from a watcher and a presentity to which the watcher watches. It sounds simple enough but there are many additions and extensions that the presence server has to manage that make the processing of the presence server very complex.

In this section we show that in addition to the large amount of messages and the big state that the presence server has to handle, it has also to handle quite intensive processing for aggregation, partial notify and publish, filtering and privacy. This adds another complexity to the presence server in the CPU front in addition to the network and memory fronts that were described before.

4.1. Aggregation

A presence document may contain multiple resources. These resources can be devices of the presentity, information that is received form external providers of presence information for the presentity as geographical and calendar information and more.

The presence server needs to be able to get the updates from all the resources and aggregate them correctly into a single presence document. Although this is just "XML processing" task, the amount of updates that the presence server may get, the need to keep the presence document aligned with its schema and the need to notify the users as soon as possible create a significant processing burden on the presence server

4.2. Partial Publish and Notify

Drafts [15], [16] define a way for the watcher to request getting only what was changed in the presence document and for the publisher of presence information to publish only what was changed in the presence document since the last publish. Although these
optimizations help in reducing the amount of the data that is sent from/to the presence server, these optimizations create additional processing burden on the presence server.

When a partial publish is arriving to the presence server, the presence server has to be able to process the partial publish, change only what is indicated in the partial publish while keeping the presence document in a well formed shape according to the schema.

In partial notify the processing is even more complex since each watcher needs to get the partial update based on the last update that was received by that watcher. Therefore [15] specifies a versioning mechanism that enables the watcher to get the updates based on the previous state that it has seen. This versioning mechanism has to be maintained by the presence server for each watcher that is subscribed to a presentity and requires partial notify.

4.3. Filtering

Filtering as defined in RFCs [10], [11] enables a watcher to request to be notified only when the presence document fulfills certain conditions. Although this is a very convenient feature for watchers, the burden that is put on the presence server is quite big. For each change in the presence document, the presence server needs to compute the filtering expressions which can be very complex, decide whether and what to send to the watcher that have requested filtering.

4.4. Authorization

Draft [17] defines presence authorization rules that can be used by presentities to define who can see what from their presence documents. The processing that the presence server has to do here is very similar to filtering. When there is a change to any presence document that has privacy defined for it, the presence server needs to create different notification for different watchers according to what is defined in the authorization rules.

4.5. Resource List Service

RFC [12] defines a way to subscribe on a single URI while that URI is actually a list of resources that are being subscribed to by a single subscription. Although this is quite useful mechanism and it significantly saves on the number of sessions between the watcher and the presence server (as we show in the calculations of messages), this feature has the potential to make the scalability issue of presence systems harder and more complex.

The reasons that resource lists may make the scalability problem of
the presence server even more complex are:

- Subscriptions and state - The resource list may contain reference to many other presence servers in many other domains. This requires the RLS to create subscriptions to other presence servers and buffer the state of all presentities in order to be able to provide the full state of the presentities in the list when needed. So in the overall system, the subscriptions that were saved between the watcher and the presence server are moved to the backend system while state has been duplicated between the various presence servers that serve the various presentities and the RLSs. This issue could have been mitigated if there was a way for the RLS to retrieve the presence information for many watchers while adhering to privacy when sending the actual notifications to the watchers.

- Interlinkage - The resource list subscription will reach one RLS that will open it and send it to many presence servers and to other RLSs (if there is a subgroup inside the list). This way a complex linkage between the state of many components is created. This linkage makes state management and other maintenance of a presence systems quite complex.

- Big lists are easy - There are two types of groups that may be used with this feature, private groups that are defined by/for each watcher and public groups that are defined in the system and can be used by any watcher. Although we should expect IT administrators to take caution when creating public groups, this may be not the case in real life. The connection between the size of the public group and the load on the presence server system may not apparent to everyone. Furthermore many public groups that are used in presence systems may have been created for other purposes as email systems (where the size of the lists was not so important) and are taken as they are to presence systems. So for example we may very easily find that a public group that actually covers all the users in the enterprise are used by many users in the enterprise thus creating unbearable load on the presence server. Note that this issue is not a protocol or design issue but more a usage issue that may have a real impact on the presence system.

- Stopping notifications - A watcher may accidentally subscribe to a very big list and be overwhelmed by the amount of notifies that it receives from the presence server. There is no current way to stop this stream of notifies and even canceling the subscription may take time until being affective.

The issues mentioned above are one example of an optimization that helps in one part of the system but creates even bigger problems in the overall system. There is a need to think about the problems listed above but more then that there is a need to make sure that
when an optimization is introduced it does not create issues in other places.

5. Current Optimizations

This section lists and discusses several optimizations that are either already part of the SIP protocol or they have been suggested in various drafts. Several other optimizations that have been suggested but have not been discussed in any working group yet are summarized in [22] and in [24]. Note that trials with batched notifies optimization that is describes in [22], showed an improvement of 117% in the whole throughput of presence traffic.

- Subnot-etag - Draft [20]. This draft suggests ways to suppress the sending of unnecessary notifies when for example a subscription is refreshed. This suggestion seems to be an efficient optimization since it saves both the number of messages sent and on the processing time of the presence server.

- Resource List Service - [12] enable creating a single subscription session between the watcher and the presence server for subscribing on a list of users. This saves the amount of sessions that are created between watchers and presence servers. On the other hand, this mechanism enables creating very large amount of subscriptions in the presence server/RLS system thus enabling the creation of a very large number of subscriptions between presence servers and RLSs with relatively few clients especially if large public groups are used. It seems that in order to really optimize in this area, the usage of large public groups should not be considered as BCP and there should be a way for an RLS to create a single subscription for multiple occurrences of the same resource in resource lists. See consolidates subscriptions below.

- Partial notify/publish - Drafts [15], [16] define a way for the subscriber to request getting only what was changed in the presence document and for the publisher of presence information to publish only what was changed in the presence document since the last publish. Although these optimizations help in reducing the amount of actual data that is sent from/to the presence server, these optimizations create additional processing burden on the presence server as was discussed above.

- Filtering as defined in RFCs [10], [11] enables a watcher to request to be notified only when the presence document fulfills certain conditions. Although this optimization enables saving on the amount of messages that are sent from the presence server to the watcher, this optimization puts more burden on the processing time of the presence server as was discussed above.
Throttling [23] defines a mechanism in which a watcher requires to be updated only in certain intervals. Although this mechanism may give some extra load on the processing time of the presence server, that load is negligible and the reduction on the amount of messages sent from the presence server to the watchers is significant. This optimization is even more important with resource lists where there can be many resources in the resource lists and if the traffic of updates on resource list is not regulated, the watcher may get very large amount of notifications.

- Presence specific sigcomp dictionary [18] defines a SIGCOMP [3] dictionary for presence. This optimization will enable to reduce the number of bytes that are transferred in presence systems by compressing the textual SIP messages and using the specialized presence dictionary the compression may be more significant then just using SIGCOMP as is. Note that number of actual messages will remain the same and a calculation of the amount of bytes that will be saved may be useful here.

- Content Indirection [9] enables sending only the URI of the presence document to the watcher thus offloading the presence server from sending the presence document to the watcher. This optimization may be useful in some cases especially where there is a big number of users that get the same presence document.

6. Summary

Following is a summary of the various calculations. This is repeated here in order to ease the understanding of the conclusions that are listed below.

The following table summarizes the various constants that are used in ALL calculations.
(C01) Subscription lifetime (hours)...........................8
(C03) Subscription refresh interval / hour....................1
(C05) Number of dialogs to maintain per watcher = Number of federated presentities when dialog optimization is not used and to 1 when dialog optimization is used.
(C07) SUBSCRIBE message size in bytes.......................450
(C08) 200 OK for SUBSCRIBE message size in bytes..........370
(C09) NOTIFY message size not including presence doc........500
(C10) 200 OK for NOTIFY message size in bytes.............370
(C11) Size of an average presence document............350 or 3000
Calculations are done for both sizes
(C12) Size of an average partial presence document.........200
(C13) Additional data per document in RLMI................160
(C14) Multiparty boundary in RLMI document...............144
(C15) XML root node in RLMI document....................144

Figure 13: Constants in ALL calculations

The following table summarizes the results of various optimization factors for the basic use case.

C02 Presence state changes / hour...........................3
C04 Total federated presentities per watcher...............4
C06 Total # of watchers in the federated domains........40,000

No optimizations are applied

B01 Total of messages between domains......................12,800,000
  Total of bytes between domains (PD=350).................7,232,000,000
  Total of bytes between domains (PD=3000).............20,376,000,000
B02 Total number of messages / second......................444
  Total of bytes per second (PD=350)......................251,111
  Total of bytes per second (PD=3000)....................707,500
B03 Total number of by msgs per user/day..................320
  Total number of bytes per user/day (PD=350)...........180,800
  Total number of bytes per user/day (PD=3000)...........509,400

Dialog optimization is applied

B01 Total of messages between domains......................8,480,000
  Total of bytes between domains (PD=350).................7,394,880,000
  Total of bytes between domains (PD=3000).............20,220,880,000
B02 Total number of messages / second......................294
  Total of bytes per second (PD=350)......................256,767
  Total of bytes per second (PD=3000)....................702,114
B03 Total number of by msgs per user/day..................212
  Total number of bytes per user/day (PD=350)...........184,872
  Total number of bytes per user/day (PD=3000)...........505,522
Notify optimization is applied

B01 Total of messages between domains...............10,240,000
    Total of bytes between domains (PD=350)........5,670,400,000
    Total of bytes between domains (PD=3000)........15,422,400,000
B02 Total number of messages / second................356
    Total of bytes per second (PD=350)...............196,889
    Total of bytes per second (PD=3000).............535,500
B03 Total number of by msgs per user/day...............256
    Total number of bytes per user/day (PD=350).......141,760
    Total number of bytes per user/day (PD=3000)......385,560

Dialog and notify optimizations are applied

B01 Total of messages between domains...............7,840,000
    Total of bytes between domains (PD=350)........6,311,760,000
    Total of bytes between domains (PD=3000)........16,063,760,000
B02 Total number of messages / second................272
    Total of bytes per second (PD=350)...............219,158
    Total of bytes per second (PD=3000).............557,769
B03 Total number of by msgs per user/day...............196
    Total number of bytes per user/day (PD=350).......157,794
    Total number of bytes per user/day (PD=3000)......401,594

Figure 14: Basic use case

The following table summarizes the results of various optimization factors for the widely distributed inter domain use case.
C02 Presence state changes / hour..........................3
C04 Total federated presentities per watcher..............20
C06 Total # of watchers in the federated domains........40,000

No optimizations are applied

B01 Total of messages between domains......................64,000,000
  Total of bytes between domains (PD=350)..............36,160,000,000
  Total of bytes between domains (PD=3000)............101,880,000,000
B02 Total number of messages / second.....................2,222
  Total of bytes per second (PD=350)...................1,255,556
  Total of bytes per second (PD=3000)...................3,537,500
B03 Total number of by msgs per user/day...................1,600
  Total number of bytes per user/day (PD=350).........904,000
  Total number of bytes per user/day (PD=3000)........2,547,000

Dialog and notify optimizations are applied

B01 Total of messages between domains......................36,000,000
  Total of bytes between domains (PD=350)..............30,215,760,000
  Total of bytes between domains (PD=3000)............78,975,760,000
B02 Total number of messages / second.....................1,250
  Total of bytes per second (PD=350)...................1,049,158
  Total of bytes per second (PD=3000)...................2,742,214
B03 Total number of by msgs per user/day...................900
  Total number of bytes per user/day (PD=350).........755,394
  Total number of bytes per user/day (PD=3000)........1,974,394

Figure 15: Widely distributed inter-domain

The following table summarizes the results of various optimization factors for the intra-domain peering use case.
No optimizations are applied

B01 Total of messages between domains ................. 96,000,000
   Total of bytes between domains (PD=350) ......... 54,240,000,000
   Total of bytes between domains (PD=3000) ...... 152,820,000,000
B02 Total number of messages / second ................... 3,333
   Total of bytes per second (PD=350) .......... 1,883,333
   Total of bytes per second (PD=3000) ......... 5,306,250
B03 Total number of by msgs per user/day .............. 800
   Total number of bytes per user/day (PD=350) .. 452,000
   Total number of bytes per user/day (PD=3000) .. 1,273,500

Dialog and notify optimizations are applied

B01 Total of messages between domains ................. 55,200,000
   Total of bytes between domains (PD=350) ......... 45,827,280,000
   Total of bytes between domains (PD=3000) ...... 118,967,280,000
B02 Total number of messages / second ................... 1,917
   Total of bytes per second (PD=350) .......... 1,591,225
   Total of bytes per second (PD=3000) ......... 4,130,808
B03 Total number of by msgs per user/day .............. 460
   Total number of bytes per user/day (PD=350) .. 381,894
   Total number of bytes per user/day (PD=3000) .. 991,394

The following table summarizes the results of various optimization
factors for the very large scale peering networks use case.

C02 Presence state changes / hour ...................... 3
C04 Total federated presentities per watcher .......... 10
C06 Total # of watchers in the federated domains .... 120,000

No optimizations are applied

B01 Total of messages between domains ................. 25,600,000,000
   Total of bytes between domains (PD=350) ......... 14,896,000,000,000
   Total of bytes between domains (PD=3000) ...... 44,046,000,000,000
B02 Total number of messages / second ................... 888,889
   Total of bytes per second (PD=350) .......... 517,222,222
   Total of bytes per second (PD=3000) ......... 1,529,375,000
B03 Total number of by msgs per user/day .............. 1,280
   Total number of bytes per user/day (PD=350) .. 744,800
   Total number of bytes per user/day (PD=3000) .. 2,202,300
Dialog and notify optimizations are applied

B01 Total of messages between domains............18,800,000,000
        Total of bytes between domains (PD=350)....15,644,400,000,000
        Total of bytes between domains (PD=3000)....40,554,280,000,000
B02 Total number of messages / second...............652,778
        Total of bytes per second (PD=350)............543,208,333
        Total of bytes per second (PD=3000)............1,408,134,722
B03 Total number of by msgs per user/day.............940
        Total number of bytes per user/day (PD=350).........782,220
        Total number of bytes per user/day (PD=3000).......2,027,714

Partial and notify optimizations are applied

B01 Total of messages between domains............22,400,000,000
        Total of bytes between domains (PD=350)....11,564,000,000,000
        Total of bytes between domains (PD=3000)....12,094,000,000,000
B02 Total number of messages / second...............777,778
        Total of bytes per second (PD=350)............401,527,778
        Total of bytes per second (PD=3000)............419,930,556
B03 Total number of by msgs per user/day.............1,120
        Total number of bytes per user/day (PD=350).........578,200
        Total number of bytes per user/day (PD=3000)..........604,700

Calculation for other protocols

B01 Total of messages between domains.............9,800,000,000
        Total of bytes between domains (PD=50)........1,940,000,000,000
        Total of bytes between domains (PD=350)........4,760,000,000,000
        Total of bytes between domains (PD=3000)........29,670,000,000,000
B02 Total number of messages / second...............340,278
        Total of bytes per second (PD=50)..............67,361,111
        Total of bytes per second (PD=350)...............165,277,778
        Total of bytes per second (PD=3000).............1,030,208,333
B03 Total number of by msgs per user/day.............490
        Total number of bytes per user/day (PD=50).........97,000
        Total number of bytes per user/day (PD=350).........238,000
        Total number of bytes per user/day (PD=3000).......1,483,500

Figure 17: Very large scale peering networks

7. Conclusions

The following conclusions can be drawn from the above numbers:
Due to the overhead of RLMI (that was not included in the previous version of this document), the dialog optimization does not help in reducing the number of bytes nor in the number of the messages. It seems to be more important from the point of view of the convenience of the user since it enables the user to manage his/hers watch list.

The notify optimization optimizes both the number of messages and the number of bytes.

Partial notification saves a lot in the number of bytes especially when the presence document is a rich presence document which is relatively big.

Comparing to protocols that do not have the overhead of SIP (e.g. XMPP) shows that the number of messages is less by about a half. The number of bytes is also reduced by about a half. It is interesting to see that when the presence document is big (3000 bytes) and partial and notify optimizations are applied, the number of bytes is smaller in SIP!

When looking at the numbers from the perspective of the number of bytes that a user "consumes" per day the numbers may not look so big. Nevertheless, we should remember that the overall affect on the network may be quite big since the network will have to convey dozens of Giga bytes per day for the modest use cases that are described in this document for presence traffic only. Recalling that presence is only an enabler for other media these numbers are not so easy to handle.

The document analyzes the scalability of presence systems and of the SIP based in particular. It is apparent that the scalability of these systems is far from being trivial from several perspectives: number of messages, network bandwidth, state management and CPU load.

As part of the analysis we have analyzed several optimizations and showed the effect of these optimizations on the number of messages and the number of bytes that are sent between the federating domains.

We have also computed the number of messages and bytes for a very large scale peering network while assuming a protocol that has much less overhead then SIP. Even in that protocol we got relatively high numbers.

It is very possible that the issues that are described in this document are inherent to presence systems in general and not specific to the SIMPLE protocol. Organizations need to be prepared to invest a lot in network and hardware in order to create real big systems. However, it is apparent that not all the possible optimizations were done yet and further work is needed in the IETF in order to provide better scalability.
Nevertheless, we should remember that SIP was originally designed for end to end session creation and number and size of messages are of secondary importance for end to end session negotiation. For large scale and especially for very large scale presence the number of messages that are needed and the size of each message are of extreme importance. It seems that we need to think about the problem in a different way. We need to think about scalability as part of the protocol design. The IETF tends not to think about actual deployments when designing a protocol but in this case it seems that if we do not think about scalability with the protocol design it will be very hard to scale.

We should also consider whether using the same protocol between clients and servers and between servers is a good choice with this problem? It may be that in interdomain or even between servers in the same domain (as between RLSs and presence servers) there is a need to have a different protocol that will be very optimized for the load and can assume some assumptions about the network (e.g. do not use unreliable protocol as UDP but only TCP).

When servers is connecting to another server using current protocol, there will be an extreme number of redundant messages due to the overhead of supporting UDP and to the need to send multiple presence documents for the same watched user due to privacy issue. A server to server protocol will have to address these issues. Some initial work to address these issues can be found in: \[22\], \[24\] and \[25\].

Another issue that is more concerning protocol design is whether NOTIFY messages should not be considered as media as audio, video and even text messaging are considered? The SUBSCRIBE can be extended to do similar three way handshake as INVITE and negotiate where the notify messages should go, rate and other parameters. This way the load can be offloaded to a specialized NOTIFY “relays" thus not loading the control path of SIP. One of the possible ideas (Marc Willekens) is to use the SIP stack for the client/server NOTIFY but make use of a more optimized and controllable protocol for the server-to-server interface. Another possibility is to use the MSRP \[13\], \[14\]protocol for the notifies.

8. Security Considerations

This document discusses scalability issues with the existing SIP/SIMPLE presence protocol and model. Therefore, there are no security considerations to be considered for this document. However, a lot of the possible optimizations that should emerge as a result of this document will have security implications that will need to be solved.
9. Changes from Previous Versions

9.1. Changes in version 03

- Added some input from real life deployments and input on a test with batched notifies.
- Added Calculations of messages and bytes per user.
- Calculations are now done both for minimal size of presence document and for an average size of rich presence document.
- Comparison with other protocol is now done using small, tiny and rich presence document sizes.
- Removed dialog optimization with partial notification since it is not relevant.
- Fixed a few issues in calculations that were found by Victoria Beltran-Martinez.
  * Added overhead for RLMI for dialog optimizations (list subscription). This calculation fix actually shows that dialog optimization is not a real optimization from the point of view of bytes and number of messages.
  * When NOTIFY optimizations are applied no need for final NOTIFY
  * The usage of RLS between domains was clarified.
- Significantly enhanced the conclusions section
- Several typo fixes

9.2. Changes in version 02

- Fixed a bug in the calculations. Thanks to Marc Willekens for finding the bug.

9.3. Changes in version 01

- Clarifications and corrections of the computation model and the computations.
- Added several more computations to show the influence of different optimizations.
- The requirements were moved to [21]
- The new suggestions for optimizations were moved to [22]

10. Acknowledgments

We would like to thank Jonathan Rosenberg, Ben Campbell, Markus Isomaki, Piotr Boni, David Viamonte and Aki Niemi for ideas and input. Special thanks to Marc Willekens and Victoria Beltran-Martinez for finding issues in the calculations.

11. References
11.1.  Normative References


11.2.  Informational References


Federated Presence with View Sharing”,
draft-rosenberg-simple-view-sharing-00 (work in progress),
November 2007.

draft-rosenberg-simple-intradomain-federation-00 (work in progress), November 2007.

Authors’ Addresses

Avshalom Houri
IBM
Science Park Building 18/D
Rehovot,
Israel

Email: avshalom@il.ibm.com

Edwin Aoki
AOL LLC
360 W. Caribbean Drive
Sunnyvale, CA 94089
USA

Email: aoki@aol.net

Sriram Parameswar
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052
USA

Email: Sriram.Parameswar@microsoft.com

Tim Rang
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052
USA

Email: timrang@microsoft.com