

EXHIBIT M

Network Working Group
Request for Comments: 3261
Obsoletes: 2543
Category: Standards Track

J. Rosenberg
dynamicsoft
H. Schulzrinne
Columbia U.
G. Camarillo
Ericsson
A. Johnston
WorldCom
J. Peterson
Neustar
R. Sparks
dynamicsoft
M. Handley
ICIR
E. Schooler
AT&T
June 2002

SIP: Session Initiation Protocol

Status of this Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

Copyright Notice

Copyright (C) The Internet Society (2002). All Rights Reserved.

Abstract

This document describes Session Initiation Protocol (SIP), an application-layer control (signaling) protocol for creating, modifying, and terminating sessions with one or more participants. These sessions include Internet telephone calls, multimedia distribution, and multimedia conferences.

SIP invitations used to create sessions carry session descriptions that allow participants to agree on a set of compatible media types. SIP makes use of elements called proxy servers to help route requests to the user's current location, authenticate and authorize users for services, implement provider call-routing policies, and provide features to users. SIP also provides a registration function that allows users to upload their current locations for use by proxy servers. SIP runs on top of several different transport protocols.

Table of Contents

1	Introduction	8
2	Overview of SIP Functionality	9
3	Terminology	10
4	Overview of Operation	10
5	Structure of the Protocol	18
6	Definitions	20
7	SIP Messages	26
7.1	Requests	27
7.2	Responses	28
7.3	Header Fields	29
7.3.1	Header Field Format	30
7.3.2	Header Field Classification	32
7.3.3	Compact Form	32
7.4	Bodies	33
7.4.1	Message Body Type	33
7.4.2	Message Body Length	33
7.5	Framing SIP Messages	34
8	General User Agent Behavior	34
8.1	UAC Behavior	35
8.1.1	Generating the Request	35
8.1.1.1	Request-URI	35
8.1.1.2	To	36
8.1.1.3	From	37
8.1.1.4	Call-ID	37
8.1.1.5	CSeq	38
8.1.1.6	Max-Forwards	38
8.1.1.7	Via	39
8.1.1.8	Contact	40
8.1.1.9	Supported and Require	40
8.1.1.10	Additional Message Components	41
8.1.2	Sending the Request	41
8.1.3	Processing Responses	42
8.1.3.1	Transaction Layer Errors	42
8.1.3.2	Unrecognized Responses	42
8.1.3.3	Vias	43
8.1.3.4	Processing 3xx Responses	43
8.1.3.5	Processing 4xx Responses	45
8.2	UAS Behavior	46
8.2.1	Method Inspection	46
8.2.2	Header Inspection	46
8.2.2.1	To and Request-URI	46
8.2.2.2	Merged Requests	47
8.2.2.3	Require	47
8.2.3	Content Processing	48
8.2.4	Applying Extensions	49
8.2.5	Processing the Request	49

8.2.6	Generating the Response	49
8.2.6.1	Sending a Provisional Response	49
8.2.6.2	Headers and Tags	50
8.2.7	Stateless UAS Behavior	50
8.3	Redirect Servers	51
9	Canceling a Request	53
9.1	Client Behavior	53
9.2	Server Behavior	55
10	Registrations	56
10.1	Overview	56
10.2	Constructing the REGISTER Request	57
10.2.1	Adding Bindings	59
10.2.1.1	Setting the Expiration Interval of Contact Addresses	60
10.2.1.2	Preferences among Contact Addresses	61
10.2.2	Removing Bindings	61
10.2.3	Fetching Bindings	61
10.2.4	Refreshing Bindings	61
10.2.5	Setting the Internal Clock	62
10.2.6	Discovering a Registrar	62
10.2.7	Transmitting a Request	62
10.2.8	Error Responses	63
10.3	Processing REGISTER Requests	63
11	Querying for Capabilities	66
11.1	Construction of OPTIONS Request	67
11.2	Processing of OPTIONS Request	68
12	Dialogs	69
12.1	Creation of a Dialog	70
12.1.1	UAS behavior	70
12.1.2	UAC Behavior	71
12.2	Requests within a Dialog	72
12.2.1	UAC Behavior	73
12.2.1.1	Generating the Request	73
12.2.1.2	Processing the Responses	75
12.2.2	UAS Behavior	76
12.3	Termination of a Dialog	77
13	Initiating a Session	77
13.1	Overview	77
13.2	UAC Processing	78
13.2.1	Creating the Initial INVITE	78
13.2.2	Processing INVITE Responses	81
13.2.2.1	1xx Responses	81
13.2.2.2	3xx Responses	81
13.2.2.3	4xx, 5xx and 6xx Responses	81
13.2.2.4	2xx Responses	82
13.3	UAS Processing	83
13.3.1	Processing of the INVITE	83
13.3.1.1	Progress	84
13.3.1.2	The INVITE is Redirected	84

13.3.1.3	The INVITE is Rejected	85
13.3.1.4	The INVITE is Accepted	85
14	Modifying an Existing Session	86
14.1	UAC Behavior	86
14.2	UAS Behavior	88
15	Terminating a Session	89
15.1	Terminating a Session with a BYE Request	90
15.1.1	UAC Behavior	90
15.1.2	UAS Behavior	91
16	Proxy Behavior	91
16.1	Overview	91
16.2	Stateful Proxy	92
16.3	Request Validation	94
16.4	Route Information Preprocessing	96
16.5	Determining Request Targets	97
16.6	Request Forwarding	99
16.7	Response Processing	107
16.8	Processing Timer C	114
16.9	Handling Transport Errors	115
16.10	CANCEL Processing	115
16.11	Stateless Proxy	116
16.12	Summary of Proxy Route Processing	118
16.12.1	Examples	118
16.12.1.1	Basic SIP Trapezoid	118
16.12.1.2	Traversing a Strict-Routing Proxy	120
16.12.1.3	Rewriting Record-Route Header Field Values	121
17	Transactions	122
17.1	Client Transaction	124
17.1.1	INVITE Client Transaction	125
17.1.1.1	Overview of INVITE Transaction	125
17.1.1.2	Formal Description	125
17.1.1.3	Construction of the ACK Request	129
17.1.2	Non-INVITE Client Transaction	130
17.1.2.1	Overview of the non-INVITE Transaction	130
17.1.2.2	Formal Description	131
17.1.3	Matching Responses to Client Transactions	132
17.1.4	Handling Transport Errors	133
17.2	Server Transaction	134
17.2.1	INVITE Server Transaction	134
17.2.2	Non-INVITE Server Transaction	137
17.2.3	Matching Requests to Server Transactions	138
17.2.4	Handling Transport Errors	141
18	Transport	141
18.1	Clients	142
18.1.1	Sending Requests	142
18.1.2	Receiving Responses	144
18.2	Servers	145
18.2.1	Receiving Requests	145

18.2.2	Sending Responses	146
18.3	Framing	147
18.4	Error Handling	147
19	Common Message Components	147
19.1	SIP and SIPS Uniform Resource Indicators	148
19.1.1	SIP and SIPS URI Components	148
19.1.2	Character Escaping Requirements	152
19.1.3	Example SIP and SIPS URIs	153
19.1.4	URI Comparison	153
19.1.5	Forming Requests from a URI	156
19.1.6	Relating SIP URIs and tel URLs	157
19.2	Option Tags	158
19.3	Tags	159
20	Header Fields	159
20.1	Accept	161
20.2	Accept-Encoding	163
20.3	Accept-Language	164
20.4	Alert-Info	164
20.5	Allow	165
20.6	Authentication-Info	165
20.7	Authorization	165
20.8	Call-ID	166
20.9	Call-Info	166
20.10	Contact	167
20.11	Content-Disposition	168
20.12	Content-Encoding	169
20.13	Content-Language	169
20.14	Content-Length	169
20.15	Content-Type	170
20.16	CSeq	170
20.17	Date	170
20.18	Error-Info	171
20.19	Expires	171
20.20	From	172
20.21	In-Reply-To	172
20.22	Max-Forwards	173
20.23	Min-Expires	173
20.24	MIME-Version	173
20.25	Organization	174
20.26	Priority	174
20.27	Proxy-Authenticate	174
20.28	Proxy-Authorization	175
20.29	Proxy-Require	175
20.30	Record-Route	175
20.31	Reply-To	176
20.32	Require	176
20.33	Retry-After	176
20.34	Route	177

20.35	Server	177
20.36	Subject	177
20.37	Supported	178
20.38	Timestamp	178
20.39	To	178
20.40	Unsupported	179
20.41	User-Agent	179
20.42	Via	179
20.43	Warning	180
20.44	WWW-Authenticate	182
21	Response Codes	182
21.1	Provisional 1xx	182
21.1.1	100 Trying	183
21.1.2	180 Ringing	183
21.1.3	181 Call Is Being Forwarded	183
21.1.4	182 Queued	183
21.1.5	183 Session Progress	183
21.2	Successful 2xx	183
21.2.1	200 OK	183
21.3	Redirection 3xx	184
21.3.1	300 Multiple Choices	184
21.3.2	301 Moved Permanently	184
21.3.3	302 Moved Temporarily	184
21.3.4	305 Use Proxy	185
21.3.5	380 Alternative Service	185
21.4	Request Failure 4xx	185
21.4.1	400 Bad Request	185
21.4.2	401 Unauthorized	185
21.4.3	402 Payment Required	186
21.4.4	403 Forbidden	186
21.4.5	404 Not Found	186
21.4.6	405 Method Not Allowed	186
21.4.7	406 Not Acceptable	186
21.4.8	407 Proxy Authentication Required	186
21.4.9	408 Request Timeout	186
21.4.10	410 Gone	187
21.4.11	413 Request Entity Too Large	187
21.4.12	414 Request-URI Too Long	187
21.4.13	415 Unsupported Media Type	187
21.4.14	416 Unsupported URI Scheme	187
21.4.15	420 Bad Extension	187
21.4.16	421 Extension Required	188
21.4.17	423 Interval Too Brief	188
21.4.18	480 Temporarily Unavailable	188
21.4.19	481 Call/Transaction Does Not Exist	188
21.4.20	482 Loop Detected	188
21.4.21	483 Too Many Hops	189
21.4.22	484 Address Incomplete	189

21.4.23	485 Ambiguous	189
21.4.24	486 Busy Here	189
21.4.25	487 Request Terminated	190
21.4.26	488 Not Acceptable Here	190
21.4.27	491 Request Pending	190
21.4.28	493 Undecipherable	190
21.5	Server Failure 5xx	190
21.5.1	500 Server Internal Error	190
21.5.2	501 Not Implemented	191
21.5.3	502 Bad Gateway	191
21.5.4	503 Service Unavailable	191
21.5.5	504 Server Time-out	191
21.5.6	505 Version Not Supported	192
21.5.7	513 Message Too Large	192
21.6	Global Failures 6xx	192
21.6.1	600 Busy Everywhere	192
21.6.2	603 Decline	192
21.6.3	604 Does Not Exist Anywhere	192
21.6.4	606 Not Acceptable	192
22	Usage of HTTP Authentication	193
22.1	Framework	193
22.2	User-to-User Authentication	195
22.3	Proxy-to-User Authentication	197
22.4	The Digest Authentication Scheme	199
23	S/MIME	201
23.1	S/MIME Certificates	201
23.2	S/MIME Key Exchange	202
23.3	Securing MIME bodies	205
23.4	SIP Header Privacy and Integrity using S/MIME: Tunneling SIP	207
23.4.1	Integrity and Confidentiality Properties of SIP Headers	207
23.4.1.1	Integrity	207
23.4.1.2	Confidentiality	208
23.4.2	Tunneling Integrity and Authentication	209
23.4.3	Tunneling Encryption	211
24	Examples	213
24.1	Registration	213
24.2	Session Setup	214
25	Augmented BNF for the SIP Protocol	219
25.1	Basic Rules	219
26	Security Considerations: Threat Model and Security Usage Recommendations	232
26.1	Attacks and Threat Models	233
26.1.1	Registration Hijacking	233
26.1.2	Impersonating a Server	234
26.1.3	Tampering with Message Bodies	235
26.1.4	Tearing Down Sessions	235

26.1.5	Denial of Service and Amplification	236
26.2	Security Mechanisms	237
26.2.1	Transport and Network Layer Security	238
26.2.2	SIPS URI Scheme	239
26.2.3	HTTP Authentication	240
26.2.4	S/MIME	240
26.3	Implementing Security Mechanisms	241
26.3.1	Requirements for Implementers of SIP	241
26.3.2	Security Solutions	242
26.3.2.1	Registration	242
26.3.2.2	Interdomain Requests	243
26.3.2.3	Peer-to-Peer Requests	245
26.3.2.4	DoS Protection	246
26.4	Limitations	247
26.4.1	HTTP Digest	247
26.4.2	S/MIME	248
26.4.3	TLS	249
26.4.4	SIPS URIs	249
26.5	Privacy	251
27	IANA Considerations	252
27.1	Option Tags	252
27.2	Warn-Codes	252
27.3	Header Field Names	253
27.4	Method and Response Codes	253
27.5	The "message/sip" MIME type.	254
27.6	New Content-Disposition Parameter Registrations	255
28	Changes From RFC 2543	255
28.1	Major Functional Changes	255
28.2	Minor Functional Changes	260
29	Normative References	261
30	Informative References	262
A	Table of Timer Values	265
	Acknowledgments	266
	Authors' Addresses	267
	Full Copyright Statement	269

1 Introduction

There are many applications of the Internet that require the creation and management of a session, where a session is considered an exchange of data between an association of participants. The implementation of these applications is complicated by the practices of participants: users may move between endpoints, they may be addressable by multiple names, and they may communicate in several different media - sometimes simultaneously. Numerous protocols have been authored that carry various forms of real-time multimedia session data such as voice, video, or text messages. The Session Initiation Protocol (SIP) works in concert with these protocols by

Certain other requests are sent within a dialog. A dialog is a peer-to-peer SIP relationship between two user agents that persists for some time. The dialog facilitates sequencing of messages and proper routing of requests between the user agents. The INVITE method is the only way defined in this specification to establish a dialog. When a UAC sends a request that is within the context of a dialog, it follows the common UAC rules as discussed in Section 8 but also the rules for mid-dialog requests. Section 12 discusses dialogs and presents the procedures for their construction and maintenance, in addition to construction of requests within a dialog.

The most important method in SIP is the INVITE method, which is used to establish a session between participants. A session is a collection of participants, and streams of media between them, for the purposes of communication. Section 13 discusses how sessions are initiated, resulting in one or more SIP dialogs. Section 14 discusses how characteristics of that session are modified through the use of an INVITE request within a dialog. Finally, section 15 discusses how a session is terminated.

The procedures of Sections 8, 10, 11, 12, 13, 14, and 15 deal entirely with the UA core (Section 9 describes cancellation, which applies to both UA core and proxy core). Section 16 discusses the proxy element, which facilitates routing of messages between user agents.

6 Definitions

The following terms have special significance for SIP.

Address-of-Record: An address-of-record (AOR) is a SIP or SIPS URI that points to a domain with a location service that can map the URI to another URI where the user might be available. Typically, the location service is populated through registrations. An AOR is frequently thought of as the "public address" of the user.

Back-to-Back User Agent: A back-to-back user agent (B2BUA) is a logical entity that receives a request and processes it as a user agent server (UAS). In order to determine how the request should be answered, it acts as a user agent client (UAC) and generates requests. Unlike a proxy server, it maintains dialog state and must participate in all requests sent on the dialogs it has established. Since it is a concatenation of a UAC and UAS, no explicit definitions are needed for its behavior.