Network Working Group
Request for Comments: 2920
STD: 60
Obsoletes: 2197
Category: Standards Track

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September 2000

SMTP Service Extension for Command Pipelining

Status of this Memo

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Abstract

This memo defines an extension to the Simple Mail Transfer Protocol (SMTP) service whereby a server can indicate the extent of its ability to accept multiple commands in a single Transmission Control Protocol (TCP) send operation. Using a single TCP send operation for multiple commands can improve SMTP performance significantly.

1. Introduction

Although SMTP is widely and robustly deployed, certain extensions may nevertheless prove useful. In particular, many parts of the Internet make use of high latency network links. SMTP's intrinsic one command-one response structure is significantly penalized by high latency links, often to the point where the factors contributing to overall connection time are dominated by the time spent waiting for responses to individual commands (turnaround time).

In the best of all worlds it would be possible to simply deploy SMTP client software that makes use of command pipelining: batching up multiple commands into single TCP send operations. Unfortunately, the original SMTP specification [RFC-821] did not explicitly state that SMTP servers must support this. As a result a non-trivial number of Internet SMTP servers cannot adequately handle command pipelining. Flaws known to exist in deployed servers include:

(1) Connection handoff and buffer flushes in the middle of the SMTP dialogue. Creation of server processes for incoming SMTP connections is a useful, obvious, and harmless implementation technique. However, some SMTP servers defer process forking and connection handoff until some intermediate point in the SMTP dialogue. When this is done material read from the TCP connection and kept in process buffers can be lost.

(2) Flushing the TCP input buffer when an SMTP command fails. SMTP commands often fail but there is no reason to flush the TCP input buffer when this happens. Nevertheless, some SMTP servers do this.

(3) Improper processing and promulgation of SMTP command failures. For example, some SMTP servers will refuse to accept a DATA command if the last RCPT TO command fails, paying no attention to the success or failure of prior RCPT TO command results. Other servers will accept a DATA command even when all previous RCPT TO commands have failed. Although it is possible to accommodate this sort of behavior in a client that employs command pipelining, it does complicate the construction of the client unnecessarily.

This memo uses the mechanism described in [RFC-1869] to define an extension to the SMTP service whereby an SMTP server can declare that it is capable of handling pipelined commands. The SMTP client can then check for this declaration and use pipelining only when the server declares itself capable of handling it.

1.1. Requirements Notation

This document occasionally uses terms that appear in capital letters. When the terms "MUST", "MUST NOT", "SHOULD", "SHOULD NOT", and "MAY" appear capitalized, they are being used to indicate particular requirements of this specification. A discussion of the meanings of the terms "MUST", "SHOULD", and "MAY" appears in [RFC-1123]; the terms "MUST NOT" and "SHOULD NOT" are logical extensions of this usage.

2. Framework for the Command Pipelining Extension

The Command Pipelining extension is defined as follows:

(1) the name of the SMTP service extension is Pipelining;

(2) the EHLO keyword value associated with the extension is PIPELINING;

(3) no parameter is used with the PIPELINING EHLO keyword;

(4) no additional parameters are added to either the MAIL FROM or RCPT TO commands.

(5) no additional SMTP verbs are defined by this extension; and,

(6) the next section specifies how support for the extension affects the behavior of a server and client SMTP.

3. The Pipelining Service Extension

When a client SMTP wishes to employ command pipelining, it first issues the EHLO command to the server SMTP. If the server SMTP responds with code 250 to the EHLO command, and the response includes the EHLO keyword value PIPELINING, then the server SMTP has indicated that it can accommodate SMTP command pipelining.

3.1. Client use of pipelining

Once the client SMTP has confirmed that support exists for the pipelining extension, the client SMTP may then elect to transmit groups of SMTP commands in batches without waiting for a response to each individual command. In particular, the commands RSET, MAIL FROM, SEND FROM, SOML FROM, SAML FROM, and RCPT TO can all appear anywhere in a pipelined command group. The EHLO, DATA, VRFY, EXPN, TURN, QUIT, and NOOP commands can only appear as the last command in a group since their success or failure produces a change of state which the client SMTP must accommodate. (NOOP is included in this group so it can be used as a synchronization point.)

Additional commands added by other SMTP extensions may only appear as the last command in a group unless otherwise specified by the extensions that define the commands.

The actual transfer of message content is explicitly allowed to be the first "command" in a group. That is, a RSET/MAIL FROM sequence used to initiate a new message transaction can be placed in the same group as the final transfer of the headers and body of the previous message.

Client SMTP implementations that employ pipelining MUST check ALL statuses associated with each command in a group. For example, if none of the RCPT TO recipient addresses were accepted the client must then check the response to the DATA command -- the client cannot assume that the DATA command will be rejected just because none of the RCPT TO commands worked. If the DATA command was properly rejected the client SMTP can just issue RSET, but if the DATA command

was accepted the client SMTP should send a single dot.

Command statuses MUST be coordinated with responses by counting each separate response and correlating that count with the number of commands known to have been issued. Multiline responses MUST be supported. Matching on the basis of either the error code value or associated text is expressly forbidden.

Client SMTP implementations MAY elect to operate in a nonblocking fashion, processing server responses immediately upon receipt, even if there is still data pending transmission from the client's previous TCP send operation. If nonblocking operation is not supported, however, client SMTP implementations MUST also check the TCP window size and make sure that each group of commands fits entirely within the window. The window size is usually, but not always, 4K octets. Failure to perform this check can lead to deadlock conditions.

Clients MUST NOT confuse responses to multiple commands with multiline responses. Each command requires one or more lines of response, the last line not containing a dash between the response code and the response string.

3.2. Server support of pipelining

A server SMTP implementation that offers the pipelining extension:

(1) MUST respond to commands in the order they are received from the client.

(2) SHOULD elect to store responses to grouped RSET, MAIL FROM, SEND FROM, SOML FROM, SAML FROM, and RCPT TO commands in an internal buffer so they can sent as a unit.

(3) SHOULD issue a positive response to the DATA command if and only if one or more valid RCPT TO addresses have been previously received.

(4) MUST NOT, after issuing a positive response to a DATA command with no valid recipients and subsequently receiving an empty message, send any message whatsoever to anybody.

(5) MUST NOT buffer responses to EHLO, DATA, VRFY, EXPN, TURN, QUIT, and NOOP.

(6) MUST NOT buffer responses to unrecognized commands.

(7) MUST send all pending responses immediately whenever the local TCP input buffer is emptied.

(8) MUST NOT make assumptions about commands that are yet to be received.

(9) MUST NOT flush or otherwise lose the contents of the TCP input buffer under any circumstances whatsoever.

(10) SHOULD issue response text that indicates, either implicitly or explicitly, what command the response matches.

The overriding intent of these server requirements is to make it as easy as possible for servers to conform to these pipelining extensions.

4. Examples

Consider the following SMTP dialogue that does not use pipelining:

```
S: <wait for open connection>
C: <open connection to server>
S: 220 Innosoft.com SMTP service ready
C: HELO dbc.mtview.ca.us
S: 250 Innosoft.com
C: MAIL FROM:<mrose@dbc.mtview.ca.us>
S: 250 sender <mrose@dbc.mtview.ca.us> OK
C: RCPT TO:<ned@innosoft.com>
S: 250 recipient <ned@innosoft.com> OK
C: RCPT TO:<dan@innosoft.com>
S: 250 recipient <dan@innosoft.com> OK
C: RCPT TO:<kvc@innosoft.com>
S: 250 recipient <kvc@innosoft.com> OK
C: DATA
S: 354 enter mail, end with line containing only "."
 ...
C: .
S: 250 message sent
C: QUIT
S: 221 goodbye
```

The client waits for a server response a total of 9 times in this simple example. But if pipelining is employed the following dialogue is possible:

```
S: <wait for open connection>
C: <open connection to server>
S: 220 innosoft.com SMTP service ready
```

```
C: EHLO dbc.mtview.ca.us
S: 250-innosoft.com
S: 250 PIPELINING
C: MAIL FROM:<mrose@dbc.mtview.ca.us>
C: RCPT TO:<ned@innosoft.com>
C: RCPT TO:<dan@innosoft.com>
C: RCPT TO:<kvc@innosoft.com>
C: DATA
S: 250 sender <mrose@dbc.mtview.ca.us> OK
S: 250 recipient <ned@innosoft.com> OK
S: 250 recipient <dan@innosoft.com> OK
S: 250 recipient <kvc@innosoft.com> OK
S: 354 enter mail, end with line containing only "."
 ...
C: .
C: QUIT
S: 250 message sent
S: 221 goodbye
```

The total number of turnarounds has been reduced from 9 to 4.

The next example illustrates one possible form of behavior when pipelining is used and all recipients are rejected:

```
S: <wait for open connection>
C: <open connection to server>
S: 220 innosoft.com SMTP service ready
C: EHLO dbc.mtview.ca.us
S: 250-innosoft.com
S: 250 PIPELINING
C: MAIL FROM:<mrose@dbc.mtview.ca.us>
C: RCPT TO:<nsb@thumper.bellcore.com>
C: RCPT TO:<galvin@tis.com>
C: DATA
S: 250 sender <mrose@dbc.mtview.ca.us> OK
S: 550 remote mail to <nsb@thumper.bellore.com> not allowed
S: 550 remote mail to <galvin@tis.com> not allowed
S: 554 no valid recipients given
C: QUIT
S: 221 goodbye
```

The client SMTP waits for the server 4 times here as well. If the server SMTP does not check for at least one valid recipient prior to accepting the DATA command, the following dialogue would result:

```
S: <wait for open connection>
C: <open connection to server>
S: 220 innosoft.com SMTP service ready
```

```
C: EHLO dbc.mtview.ca.us
S: 250-innosoft.com
S: 250 PIPELINING
C: MAIL FROM:<mrose@dbc.mtview.ca.us>
C: RCPT TO:<nsb@thumper.bellcore.com>
C: RCPT TO:<galvin@tis.com>
C: DATA
S: 250 sender <mrose@dbc.mtview.ca.us> OK
S: 550 remote mail to <nsb@thumper.bellore.com> not allowed
S: 550 remote mail to <galvin@tis.com> not allowed
S: 354 enter mail, end with line containing only "."
C: .
C: QUIT
S: 554 no valid recipients
S: 221 goodbye
```

5. Security Considerations

This RFC does not discuss security issues and is not believed to raise any security issues not endemic in electronic mail and present in fully conforming implementations of [RFC-821].

6. Acknowledgements

This document is based on the SMTP service extension model presented in RFC 1425. Marshall Rose’s description of SMTP command pipelining in his book "The Internet Message" also served as a source of inspiration for this extension.

7. References

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This document is a product of work done by the Internet Engineering Task Force Working Group on Messaging Extensions, Alan Cargille, chair.

9. Full Copyright Statement

Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.