# NYSE Pillar Stream Protocol Specification

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# Pillar Stream Protocol

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## 1 Architecture

The Pillar platform is a messaging system. All communications are implemented using messages; and each message has a 4-byte header with type and a length (See **MsgHeader**). This is a common header for all messages.

One particular message type, the **SeqMsg** is reserved for persisted application layer messages. Each **SeqMsg** has a **SeqMsgId**, a globally unique 128-bit identifier consisting of a 64-bit "stream ID" and a sequence number. The first message on a stream has sequence number 1. A stream is an append-only file consisting of a sequence of **SeqMsg**s. Once a message is added to a stream and assigned its unique ID, this action cannot be undone.

Clients use Pillar Client Gateways to read and write streams. Once a client authenticates with the gateway, the gateway continually informs the client of availability of various streams using the **StreamAvail** message (see section Connection below).

The same stream can be read from multiple gateways simultaneously. Only one connection is allowed to write a given stream at any given time. One gateway connection supports multiple open streams.

## 2 Connection/Reconnection

A client connects to the gateway using TCP/IP and authenticates by sending **Login** message. Gateway responds with **LoginResponse** message. Additionally, gateway may send unsolicited **LoginResponse** with an appropriate status code (see **Status**) to indicate client logout due to violation of protocol, heartbeat timeout or if there is a new login to the same destination by the user. Upon successful login, gateway advertises all the available streams user can access through this connection with one or more **StreamAvail** messages. As long as the connection is open, client and gateway exchange heartbeats. Client sends one **Heartbeat** per second. Gateway sends one **StreamAvail** per second for each stream that's available.

To read or write a stream, client sends **Open** message, specifying a stream id, message range and delivery options. For writing, `start_seq` of message range should be the `next_seq` provided by **StreamAvail**. Gateway responds with **OpenResponse** message. While satisfying the read request, gateway delivers requested messages via **SeqMsg**. Client may specify a large `end_seq` (e.g. `1ULL<<63`) to subscribe to future messages.

When writing to a stream, client posts new messages with **SeqMsg**, starting with the sequence number the client specified in the **Open** request that was accepted, and incrementing it after each messages. If the client attempts to write an out-of-sequence message to a stream, the gateway will close the stream by sending an unsolicited **CloseResponse** with an appropriate error code (see **Status**). Additionally gateway may send unsolicited **CloseResponse** to indicate change in access to the stream, which may happen when there is **Open** request on the same stream from a backup connection that affects the current access.

To close a stream, the client sends **Close** message, and gateway responds with a **CloseResponse**. The gateway will automatically close a stream by sending an unsolicited **CloseResponse** once the message range specified in the **Open** message has been satisfied. If the client sends an unknown or malformed session-level message, the gateway will drop the connection.

*Note:* When cancel-on-disconnect is enabled, it is automatically triggered when a **TG** (trader-to-gateway) stream is closed for writing. One use case is when client closes the **TG** stream while continuing to read from the **GT** stream for cancel messages. When a connection is closed, any open streams associated with the connection are automatically closed as well.

# 3 Data Formats

All binary fields are *little-endian*. All alphanumeric fields are left-justified and padded on the right with ascii NULs (0 byte value).

## 3.1 char

char(xx) - Fixed length string padded on the right with spaces

## 3.2 MsgHeader

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| type | u16 | 0 | 2 | Message type |
| length | u16 | 2 | 2 | Total message length, including this header |

## 3.3 StreamId

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| sess | u32 | 0 | 4 | 32-bit session Id |
| value | u32 | 4 | 4 | Id of stream within session |

| *Bit Field Name* | *Source* | *Offset* | *Bits* | *Comment* |
|---|---|---|---|---|
| env_id | sess | 24 | 8 | Environment id. e.g. `(sess_id >> 24) & 0xff` |
| sess_num | sess | 0 | 24 | Session number. e.g. `sess_id & 0xffffff` |
| stream_type | value | 24 | 8 | Type of stream. e.g. `(id >> 24) & 0xff` |
| user_id | value | 8 | 16 | User id. e.g. `(id >> 8) & 0xffff` |
| sub_id | value | 0 | 8 | Stream sub id. e.g. `id & 0xff` |

**StreamType** defines all the possible stream types.

## 3.4 SeqMsgId

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| stream_id | StreamId | 0 | 8 | Target stream |
| seq | u64 | 8 | 8 | Sequence number, starting from 1 |

## 3.5 StreamType

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| value | u8 | 0 | 1 | |

### 3.5.1 Stream Type Values

| *Value* | *Comment* |
|---|---|
| 15 | TG: Trader to Gateway |
| 13 | GT: Gateway to Trader |
| 33 | REF: Reference data from gateway to trader |
| 27 | XDP: Market Data (currently unavailable) |

## 3.6 Status

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| value | u8 | 0 | 1 | Status code |

### 3.6.1 Status Code Values

| *Value* | *Comment* |
|---|---|
| 0 | Request processed successfully |
| 18 | Not logged in |
| 24 | Invalid login details |
| 27 | Already logged in |
| 28 | Heartbeat timeout |
| 29 | Login timed out |
| 33 | Invalid message |
| 54 | No stream permission |
| 81 | Invalid protocol version |
| 82 | Message out of sequence |
| 84 | Invalid stream |
| 85 | Stream not open |
| 86 | Invalid timestamp |
| 89 | Denial of service |
| 90 | Write permission revoked |
| 93 | Invalid Multi-message |

# 4 Message Layouts

## 4.1 Login

Direction: client-to-gateway. Client must send Login before any other message. The protocol version applies for both the stream specification and binary application specification.

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0201`, length:`76` |
| username | char(16) | 4 | 16 | User name |
| password | char(32) | 20 | 32 | User password (plain text) |
| mic | char(4) | 52 | 4 | Market to login |
| version | char(20) | 56 | 20 | Protocol version, should be "1.1" |

## 4.2 LoginResponse

Direction: gateway-to-client.

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0202`, length:`21` |
| username | char(16) | 4 | 16 | User name |
| status | Status | 20 | 1 | Status of login attempt. Sucess, failure etc. |

## 4.3 StreamAvail

Direction: gateway-to-client. Pillar gateway sends this message immediately following **LoginResponse** and once per second for each of the streams that client can interact with. The message contains stream ID and sequence of next message on stream. This message provides heartbeat for the stream. The sequence number in the message can be used to learn the last message gateway has processed when the message was created.

| ***Name*** | ***Type*** | ***Offset*** | ***Size*** | ***Comment*** |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0203`, length:`21` |
| stream_id | StreamId | 4 | 8 | Target stream |
| next_seq | u64 | 12 | 8 | Next sequence number. First message is 1. |
| access | u8 | 20 | 1 | Available access on the stream, bit 0: Read, bit 1: Write, bit 2:Throttle Reject |

## 4.4 Heartbeat

Direction: client-to-gateway. Message must be sent once a second (whether other data has been sent or not). If no heartbeat is received within 5 seconds, Pillar gateway will close the connection.

| *Name* | *Type* | *Offset* | *Size* | *Comment* |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0204`, length:`4` |

## 4.5 Open

Direction: client-to-gateway. Request open a stream for reading or writing. **Open** can be called on an already open stream to upgrade the *access* on the stream, in which case the new set of access flags will be applied. Client needs to open streams upon login every time they connect or re-connect.

"Lossy" mode is an optional configuration that allows the gateway to drop messages whenever the client-facing TCP buffer is full. In addition, the gateway will not attempt to retrieve any messages from disk. This results in only recently-created messages being passed through to the client. All read-only streams can be opened in Lossy mode.

If "Throttle Reject" is set, when the input throttle is hit, instead of default behavior to queue messages until throttle is released, the New Orders are rejected with throttle reject code, Cancels are permitted and Cancel-Replaces are decomposed into Cancel and New Order and handled accordingly.

Opening the stream with a different range of messages than previously requested will override the previous range and new range of messages will be serviced. This can be used to re-request prior messages. Once all the prior messages are received, stream can be again opened with a new range to get the latest messages. The end_seq in the message is not inclusive. For example, to request messages from 1 to 10, Open request should be sent with start_seq 1 and end_seq 11.

| *Name* | *Type* | *Offset* | *Size* | *Comment* |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0205`, length:`30` |
| stream_id | StreamId | 4 | 8 | Target stream |
| start_seq | u64 | 12 | 8 | Start sequence, must be >=1 |
| end_seq | u64 | 20 | 8 | End sequence (ignored for write request) |
| access | u8 | 28 | 1 | Access requested, bit 0: Read, bit 1: Write, bit 2:Throttle Reject |
| mode | u8 | 29 | 1 | Mode requested, bit 0: Lossy |

## 4.6 OpenResponse

Direction: gateway-to-client. Response to **Open**

| *Name* | *Type* | *Offset* | *Size* | *Comment* |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0206`, length:`14` |
| stream_id | StreamId | 4 | 8 | Target stream |
| status | Status | 12 | 1 | Response status |
| access | u8 | 13 | 1 | Access granted |

## 4.7 Close

Direction: client-to-gateway. Request close stream.

| *Name* | *Type* | *Offset* | *Size* | *Comment* |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0207`, length:`12` |
| stream_id | StreamId | 4 | 8 | Target stream |

## 4.8 CloseResponse

Direction: gateway-to-client. Response to **Close**

| *Name* | *Type* | *Offset* | *Size* | *Comment* |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0208`, length:`13` |
| stream_id | StreamId | 4 | 8 | Target stream |
| status | Status | 12 | 1 | Response status |

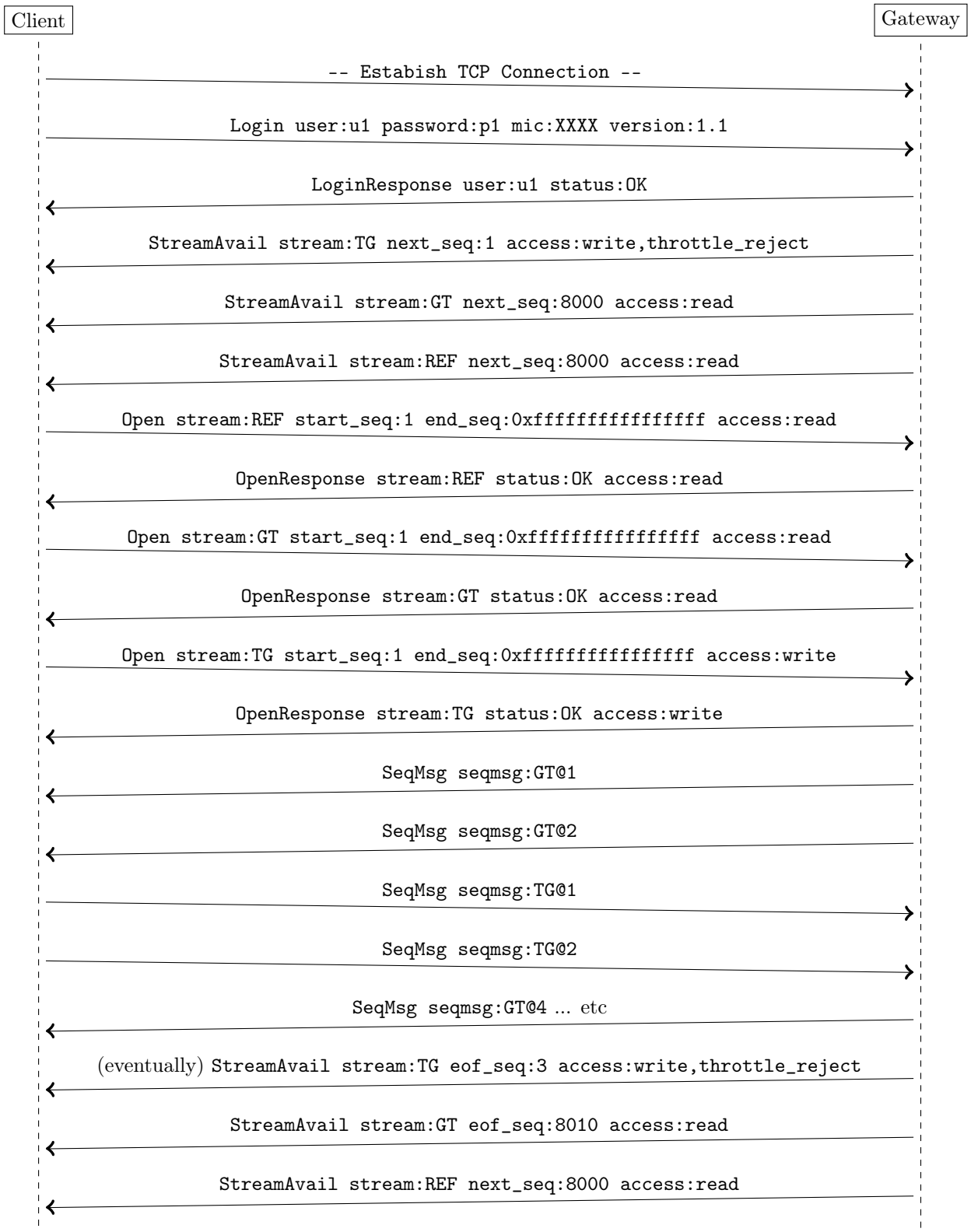
## 4.9 SeqMsg

Direction: both. Used to transmit a stream message.

| *Name* | *Type* | *Offset* | *Size* | *Comment* |
|---|---|---|---|---|
| msghdr | MsgHeader | 0 | 4 | type:`0x0905`, minimum length:`32` |
| seqmsg | SeqMsgId | 4 | 16 | Globally unique message id |
| reserved | u32 | 20 | 4 | Reserved field |
| timestamp | u64 | 24 | 8 | Message timestamp |
| payload | MsgHeader | 32 | 4 | Message header for the payload, present when $length - sizeof(SeqMsg) >= sizeof(MsgHeader)$ |

# 5 Examples

### 5.0.1 Stream Read/Write



# 6 Document History

| Date | Spec Version # | Change Summary |
|---|---|---|
| August 12, 2016 | 1.1.0 | Initial version of the specification. |
| October 28, 2016 | 1.1.1 | - Removed error code:<br>Permission denied<br>- Added error codes:<br>Not logged in<br>Invalid message<br>No stream permission<br>Invalid stream<br>Stream not open<br>Invalid timestamp<br>- Added mic field to Login message<br>- Removed mic field from LoginResponse message<br>- username field of Login/LoginResponse message changed from 32 to 16 bytes<br>- msghdr type for Heartbeat message changed from 0x0e01 to 0x0204<br>- writable field replaced by access in StreamAvail message<br>- timestamp in SeqMsg message changed from optional to non-optional for writing |
| January 5, 2017 | 1.1.2 | - Added error codes:<br>Denail of service<br>Write permission revoked |
| February 21, 2017 | 1.1.3 | - Added char type definition<br>- Update start_seq comment for Open |
| September 18, 2017 | 1.1.4 | - Update description for,<br>Connection/Reconnection<br>StreamAvail<br>Login<br>Open<br>Examples |
| April 19, 2018 | 1.1.5 | - Update Connection/Reconnection section with unsolicited CloseResponse on stream access change due to Open request from backup connection |
| August 26, 2019 | 1.1.6 | - Update Open Request desription<br>- Add new error code for Invalid multi-message |

Built on August 26, 2019