CHAPTER 12

Bluetooth LE Communication Protocol

RANDALL MAAS

This chapter describes Vector's Bluetooth LE communication protocol.

- The kinds of activities that can be done thru communication channels
- The interaction sequences
- The communication protocol stack, including encryption, fragmentation and reassembly.

Note: communication with the Cube is simple reading and writing a characteristic, and covered in Appendix F.

1. COMMUNICATION PROTOCOL OVERVIEW

Vector advertises services on Bluetooth LE, with the Bluetooth LE peripheral name the same as his robot name (i.e. something that looks like "Vector-E5S6".)

Communication with Vector, once established, is structure as a request-response protocol. The request and responses are referred to as "C-Like Abstract Data structures" (CLAD) which are fields and values in a defined format, and interpretation. Several of these messages are used to maintain the link, setting up an encryption over the channel.

The application layer messages may be arbitrarily large. To support Bluetooth LE 4.1 (the version in Vector, and many mobile devices) the CLAD message must be broken up into small chunks to be sent, and then reassembled on receipt.

Combined with application-level encryption, the communication stack looks like:

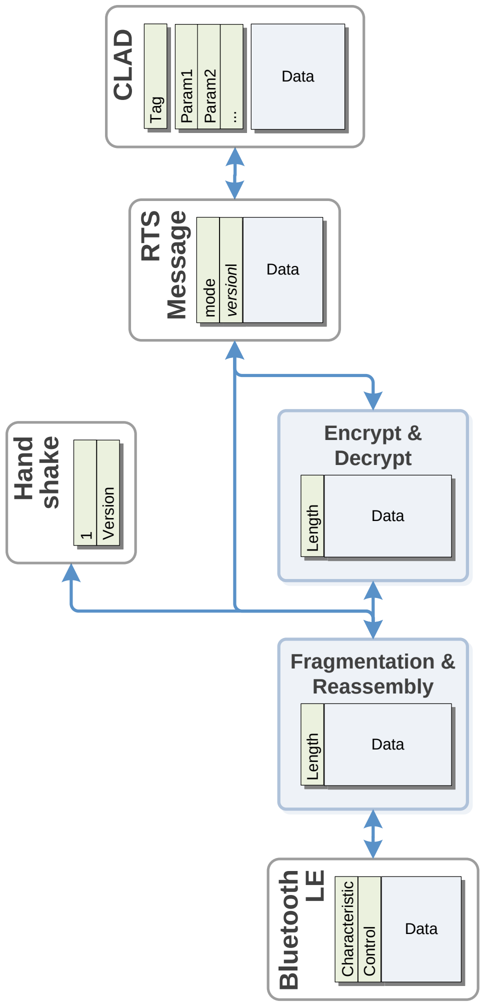


Figure 1: *Overview of encryption and fragmentation stack*

THE BLUETOOTH LE is the link/transport media. It handles the delivery, and low-level error detection of exchanging message frames. The frames are fragments of the overall message. The GUID's for the services and characteristics can be found in Appendix F.

THE FRAGMENTATION & REASSEMBLY is responsible for breaking up a message into multiple frames and reassembling them into a message.

THE ENCRYPTION & DECRYPTION LAYER is used to encrypt and decrypt the messages, after the communication channel has been set up.

THE RTS is extra framing information that identifies the kind of CLAD message, and the version of its format. The format changed with version, so this version code is embedded at this layer.

THE C-LIKE ABSTRACT DATA (CLAD) is the layer that decodes the messages into values for fields, and interprets them,

1.1. SETTING UP THE COMMUNICATION CHANNEL

It sometimes helps to start with the overall process. This section will walk thru the process, referring to later sections where detailed information resides.

If you use "first time" – or wish to re-pair with him – put him on the charger and press the backpack button twice quickly. He'll display a screen indicating he is getting ready to pair.

If you have already paired the application with Vector, the encryption keys can be reused.

The process to set up a Bluetooth LE communication with Vector is complex. The sequence has many steps:

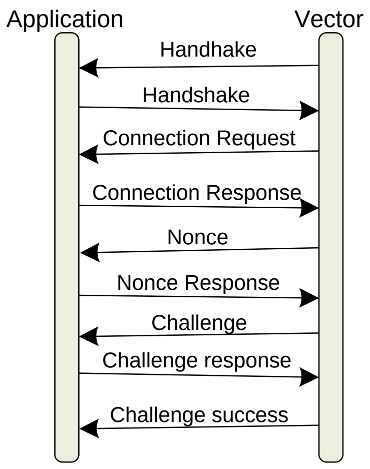


***Figure 2:** Sequence for initiating communication with Vector*

1. The application opens Bluetooth LE connection (retrieving the service and characteristics handles) and subscribes to the "read" characteristic (see Appendix F for the UUID).
2. Vector sends *handshake* message; which the application receives. The handshake message structure is given below. The handshake message includes the version of the protocol supported.

***Table 1:** Parameters for Handshake message*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*type*	?
1	4	uint32_t	*version*	The version of the protocol/messages to employ

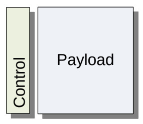
3. The application sends the handshake back
4. Then the Vector will send a *connection request*, consisting of the public key to use for the session. The application's response depends on whether this is a first-time pairing, or a reuse.
    a. First time pairing requires that Vector have already been placed into pairing mode prior to connecting to Vector. The application keys should be created (see section *1.3.1 First time pairing* above).
    b. Reconnection can reuse the public and secret keys, and the encryption and decryption keys from a prior pairing
5. The application should then send the publicKey in the response

6. If this is a first-time pairing, Vector will display a *pin code*. This is used to create the public and secret keys, and the encryption and decryption keys (see section *1.3.1 First time pairing* above). These can be saved for use in future reconnection.
7. Vector will send a *nonce* message. After the application has sent its response, the channel will now be encrypted.
8. Vector will send a *challenge* message. The application should increment the passed value and send it back as a challenge message.
9. Vector will send a *challenge success* message.
10. The application can now send other commands

If the user puts Vector on the charger, and double clicks the backpack button, Vector will usually send a *disconnect* request.

1.2. FRAGMENTATION AND REASSEMBLY

An individual frame sent over Bluetooth LE is limited to 20 bytes. (This preserves compatibility with Bluetooth LE 4.1) A frame looks like:



The control byte is used to tell the receiver how to *reassemble* the message using this frame.

- If the MSB bit (bit 7) is set, this is the start of a new message. The previous message should be discarded.
- If the 2nd MSB (bit 6) is set, this is the end of the message; there are no more frames.
- The 6 LSB bits (bits 0..5) are the number of payload bytes in the frame to use.

The receiver would append the payload onto the end of the message buffer. If there are no more frames to be received it will pass the buffer (and size count) on to the next stage. If encryption has been set up, the message buffer will be decrypted and then passed to the RTS and CLAD. If encryption has not been set up, it is passed directly to the RTS & CLAD.

Fragmenting reverses the process:

1. Set the MSB bit of the control byte, since this is the start of a message.
2. Copy up to 19 bytes to the payload.
3. Set the number of bytes in the 6 LSB bits of the control byte
4. If there are no more bytes remaining, set the 2nd MSB it of the control byte.
5. Send the frame to Vector
6. If there are bytes remaining, repeat from step 2.

1.3. ENCRYPTION SUPPORT

For the security layer, you will need the following:

```
uint8_t Vectors_publicKey[32];
uint8_t publicKey [crypto_kx_PUBLICKEYBYTES];
uint8_t secretKey [crypto_kx_SECRETKEYBYTES];
uint8_t encryptionKey[crypto_kx_SESSIONKEYBYTES];
uint8_t decryptionKey[crypto_kx_SESSIONKEYBYTES];
uint8_t encryptionNonce[24];
uint8_t decryptionNonce[24];
uint8_t pinCode[16];
```

Example 1: *Bluetooth LE encryption structures*

The variables mean:

Table 2: *The encryption variables*

Variable	Description
decryptionKey	The key used to decrypt each message from to Vector.
decryptionNonce	An extra bit that is added to each message. The initial nonce's to use are provided by Vector.
encryptionKey	The key used to encrypt each message sent to Vector.
encryptionNonce	An extra bit that is added to each message as it is encrypted. The initial nonce's to use are provided by Vector.
pinCode	6 digits that are displayed by Vector during an initial pairing.
Vectors_publicKey	The public key provided by Vector, used to create the encryption and decryption keys.

There are two different paths to setting up the encryption keys:

- First time pairing, and
- Reconnection

1.3.1 First time pairing

First time pairing requires that Vector be placed into pairing mode prior to the start of communication. This is done by placing Vector on the charger, and quickly double clicking the backpack button.

The application should generate its own internal *public* and *secret keys* at start.

```
crypto_kx_keypair(publicKey, secretKey);
```

Example 2: *Bluetooth LE key pair*

The application will send a *connection response* with first-time-pairing set, and the public key. After Vector receives the connection response, he will display the *pin code*. (See the steps in the next section for when this will occur.)

The session *encryption* and *decryption keys* can then created:

```
crypto_kx_client_session_keys(decryptionKey, encryptionKey, publicKey, secretKey,
      Vector_publicKey);
size_t pin_length = strlen(pin);

crypto_generichash(encryptionKey, sizeof(encryptionKey), encryptionKey,
      sizeof(encryptionKey), pin, pin_length);
crypto_generichash(decryptionKey, sizeof(decryptionKey), decryptionKey,
      sizeof(decryptionKey), pin, pin_length);
```

Example 3: *Bluetooth LE encryption & decryption keys*

1.3.2 Reconnecting

Reconnecting can reused the public and secret keys, and the encryption and decryption keys. It is not known how long these persist on Vector. {Next pairing? Next reboot? Indefinitely?}

1.3.3 Encrypting and decryption messages

Vector will send a *nonce* message with the *encryption* and *decryption nonces* to employ in encrypting and decrypting message.

Each received enciphered message can be decrypted from cipher text (cipher, and cipherLen) to the message buffer (message and messageLen) for further processing:

```
crypto_aead_xchacha20poly1305_ietf_decrypt(message, &messageLen, NULL, cipher,
      cipherLen,  NULL, 0L, decryptionNonce, decryptionKey);
sodium_increment(decryptionNonce, sizeof decryptionNonce);
```

Example 4: *Decrypting a Bluetooth LE message*

Note: the decryptionNonce is incremented each time a message is decrypted.

Each message to be sent can be encrypted from message buffer (message and messageLen) into cipher text (cipher, and cipherLen) that can be fragmented and sent:

```
crypto_aead_xchacha20poly1305_ietf_encrypt(cipher, &cipherLen, message,
     messageLen, NULL, 0L, NULL, encryptionNonce, encryptionKey);
sodium_increment(encryptionNonce, sizeof encryptionNonce);
```

Example 5: *Encrypting a Bluetooth LE message*

Note: the encryptionNonce is incremented each time a message is encrypted.

1.4. THE RTS LAYER

There is an extra, pragmatic layer before the messages can be interpreted by the application. The message has two to three bytes at the header:

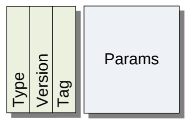


Figure 3: *The format of an RTS frame*

- The type byte is either 1 or 4. If it is 1 the version of the message format is 1.
- If type byte is 4, the version is held in the next byte. (If the type is 1, there is no version byte).
- The next byte is the tag – the value used to interpret the message.

The tag, parameter body, and version are passed to the CLAD layer for interpretation. This is described in the next section.

1.5. FETCHING A LOG

The process to set up a Bluetooth LE communication with Vector is complex. The sequence has many steps:

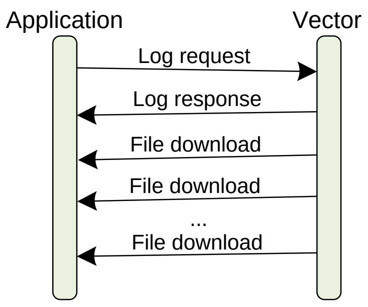


Figure 4: *Sequence for initiating communication with Vector*

The log request is sent to Vector. In principal this includes a list of the kinds of logs (called filter names) to be included. In practice, the "filter name" makes no difference.

Vector response, and if there will be a file sent, includes an affirmative and a 32-bit file identifier used for the file transfer.

Vector zips the log files up (as a tar.bz2 compressed archive) and sends the chunks to the application. Each chunk has this file identifier. (Conceptually there could be several files in transfer at a time.)

The file transfer is complete when the packet number matches the packet total.

2. MESSAGE FORMATS

This section describes the format and interpretation of the CLAD messages that go between the App and Vector. It describes the fields and how they are encoded, etc. Fields that do not have a fixed location, have no value for their offset. Some fields are only present in later versions of the protocol. They are marked with the version that they are present.

Except where otherwise stated:

- Requests are from the mobile application to Vector, and responses are Vector to the application
- All values in little endian order

Table 3: *Summary of the commands*

	Request	Response	Min Version
Application connection id	$1F_{16}$	20_{16}	4
Cancel pairing	10_{16}		0
Challenge	04_{16}	04_{16}	0
Challenge success	05_{16}		0
Connect	01_{16}	02_{16}	0
Cloud session	$1D_{16}$	$1E_{16}$	3
Disconnect	11_{16}		0
File download		$1a_{16}$	2
Log	18_{16}	19_{16}	2
Nonce	03_{16}	12_{16}	
OTA cancel	17_{16}		2
OTA update	$0E_{16}$	$0F_{16}$	0
SDK proxy	22_{16}	23_{16}	5
Response		21_{16}	4
SSH	15_{16}	16_{16}	0
Status	$0A_{16}$	$0B_{16}$	0
WiFi access point	13_{16}	14_{16}	0
WiFi connect	06_{16}	07_{16}	0
WiFi forget	$1B_{16}$	$1C_{16}$	3
WiFi IP	08_{16}	09_{16}	0
WiFi scan	$0C_{16}$	$0D_{16}$	0

2.1. APPLICATION CONNECTION ID

?

2.1.1 Request

The parameters of the request body are:

Offset	Size	Type	Parameter	Description
0	2	uint16_t	*name length*	The length of the application connection id; may be 0
2	*varies*	uint8_t[name length]	*name*	The application connection id

Table 4: *Parameters for Application Connection Id request*

2.1.2 Response

There is no response.

2.2. CANCEL PAIRING

Speculation: this is sent by the application to cancel the pairing process

2.2.1 Request

The command has no parameters.

2.2.2 Response

There is no response.

2.3. CHALLENGE

This is sent by Vector if he liked the response to a nonce message.

2.3.1 Request

The parameters of the request body are:

Table 5: *Parameters for challenge request*

Offset	Size	Type	Parameter	Description
0	4	uint8_t	*value*	The challenge value

The application, when it receives this message, should increment the value and send the response (a challenge message).

2.3.2 Response

The parameters of the response body are:

Table 6: *Parameters for challenge response*

Offset	Size	Type	Parameter	Description
0	4	uint8_t	*value*	The challenge value; this is 1 + the value that was received.

If Vector accepts the response, he will send a *challenge success.*

2.4. CHALLENGE SUCCESS

This is sent by Vector if the challenge response was accepted.

2.4.1 Request

The command has no parameters.

2.4.2 Response

There is no response.

2.5. CLOUD SESSION

This command is used to request a cloud session.

2.5.1 Command

The parameters of the request body are:

Offset	Size	Type	Parameter	Description
0	2	uint16_t	*session token length*	The number of bytes in the session token; may be 0
2	varies	uint8_t	*session token*	The session token, as received from the cloud server.[1]
	1	uint8_t	*client name length*	The number of bytes in the client name string; may be 0 version >= 5
	varies	uint8_t[]	*client name*	The client name string. Informational only. The mobile app uses the name of the mobile device. version >= 5
	1	uint8_t	*application id length*	The number of bytes in the application id string; may be 0; version >= 5
	varies	uint8_t[]	*application id*	The application id. Informational only. The mobile uses "companion-app". version >= 5

Table 7: *Parameters for Cloud Session request*

2.5.2 Response result

The parameters for the connection response message:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*success*	0 if failed, otherwise successful
1	1	uint8_t	*status*	See *Table 9: Cloud status enumeration*
2	1	uint16_t	*client token GUID length*	The number of bytes in the client token GUID; may be 0
	varies	uint8_t[]	*client token GUID*	The client token GUID. The client token GUID should be saved for future use.

Table 8: *Parameters for Cloud Session Response*

The cloud status types are:

Index	Meaning
0	unknown error
1	connection error
2	wrong account
3	invalid session token
4	authorized as primary
5	authorized as secondary

Table 9: *Cloud status enumeration*

[1]

6	reauthorization

2.6. CONNECT

The connect request *comes from Vector* at the start of a connection. The response is from the application.

2.6.1 Request

The parameters of the request body are:

Offset	Size	Type	Parameter	Description
0	32	uint8_t[32]	*publicKey*	The public key for the connection

Table 10: *Parameters for Connection request*

The application, when it receives this message, should use the public key for the session, and send a response back.

2.6.2 Response

The parameters for the connection response message:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*connectionType*	See *Table 12: Connection types enumeration*
1	32	uint8_t[32]	*publicKey*	The public key to use for the connection

Table 11: *Parameters for Connection Response*

The connection types are:

Index	Meaning
0	first time pairing (requests pin code to be displayed)
1	reconnection

Table 12: *Connection types enumeration*

The application sends the response, with its publicKey (see section *1.3 Encryption support*). A "first time pairing" connection type will cause Vector to display a pin code on the screen

If a first time pairing response is sent:

- If Vector is not in pairing mode – was not put on his charger and the backpack button pressed twice, quickly – Vector will respond. Attempting to enter pairing mode now will cause Vector to send a *disconnect* request.
- If Vector is in pairing mode, Vector will display a pin code on the screen, and send a nonce message, triggering the next steps of the conversation.

If a reconnection is sent, the application would employ the public and secret keys, and the encryption and decryption keys from a prior pairing.

2.7. DISCONNECT

This may be sent by Vector if there is an error, and it is ending communication. For instance, if Vector enters pairing mode, it will send a disconnect.

The application may send this to request Vector to close the connection.

2.7.1 Request

The command has no parameters.

2.7.2 Response

There is no response.

2.8. FILE DOWNLOAD

This command is used to pass chunks of a file to Vector. Files are broken up into chunks and sent.

2.8.1 Request

There is no direct request.

2.8.2 Response

The parameters of the response body are:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*status*	
1	4	uint32_t	*file id*	
5	4	uint32_t	*packet number*	The chunk within the download
9	4	uint32_t	*packet total*	The total number of packets to be sent for this file download
13	2	uint16_t	*length*	The number of bytes to follow (can be 0)
	varies	uint8_t[length]	*bytes*	The bytes of this file chunk

Table 13: *Parameters for File Download request*

2.9. LOG

This command is used to request the Vector send a compressed archive of the logs.

2.9.1 Request

The parameters of the request body are:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*mode*	
1	2	uint16_t	*num filters*	The number of filters in the array
3	varies	filter[num filters]	*filters*	The filter names

Table 14: *Parameters for Log request*

Each filter entry has the following structure:

Offset	Size	Type	Parameter	Description
0	2	uint16_t	*filter length*	The length of the filter name; may be 0
2	*varies*	uint8_t[filter length]	*filter name*	The filter name

Table 15: *Log filter*

2.9.2 Response

It can take several seconds for Vector to prepare the log archive file and send a response. The response will be a “log response” (below) and a series of “file download” responses.

The parameters for the response message:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*exit code*	
1	4	uint32_t	*file id*	A 32-bit identifier that will be used in the file download messages.

Table 16: *Parameters for Log Response*

2.10. NONCE

A nonce is sent by Vector after he has accepted your key, and the application sends a response

2.10.1 Request

The parameters for the nonce request message:

Table 17: *Parameters for Nonce request*

Offset	Size	Type	Parameter	Description
0	24	uint8_t[24]	*toVectorNonce*	The nonce to use for sending stuff to Vector
24	24	uint8_t[24]	*toAppNonce*	The nonce for receiving stuff from Vector

2.10.2 Response

After receiving a nonce, if the application is in first-time pairing the application should send a response, with a value of 3.

Table 18: *Parameters for Nonce response*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*connection tag*	This is always 3

After the response has been sent, the channel will now be encrypted. If vector likes the response, he will send a challenge message.

2.11. OTA UPDATE

This command is used to request the Vector download software from a given server

2.11.1 Request

The parameters of the request body are:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*length*	The length of the URL; may be 0
1	*varies*	uint8_t[length]	*URL*	The URL string

Table 19: *Parameters for OTA request*

2.11.2 Response

The response will be one or more "OTA response" indicating the status of the update, or errors. Status codes >= 200 indicate that the update process has completed. The update has completed the download when the current number of bytes match the expected number of bytes.

The parameters for the response message:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*status*	See *Table 21: OTA status enumeration*
1	8	uint64_t	*current*	The number of bytes downloaded
9	8	uint64_t	*expected*	The number of bytes expected to be downloaded

Table 20: *Parameters for OTA Response*

The OTA status codes are:

Status	Meaning
0	idle
1	unknown
2	in progress
3	complete
4	rebooting
5	error
200…	Status codes from the update-engine. See Appendix D, table {xlink OTA update-engine status codes} for these update-engine status codes.

Table 21: *OTA status enumeration*

Note: the status codes 200 and above are from the update-engine, and are given in Appendix D.

2.12. RESPONSE

This message will be sent on the event of an error. Primarily if the session is not cloud authorized and the command requires it.

Table 22: *Parameters for Response*

Offset	Size	Type	Parameter	Description
0	1	uint16_t	*code*	0 if not cloud authorized, otherwise authorized
1	1	uint8_t	*length*	The number of bytes in the string that follows.
	varies	uint8_t [length]	*text*	A text error message.

2.13. SDK PROXY

This command is used to pass the gRPC/protobufs messages to Vector over Bluetooth LE. It effectively wraps a HTTP request/response. Note: the HTTPS TLS certificate is not employed with this command.

2.13.1 Request

The parameters of the request body are:

Table 23: *Parameters for the SDK proxy request*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*GUID length*	The number of bytes in the GUID string; may be 0
2	*varies*	uint8_t[GUID length]	*GUID*	The GUID string
	1	uint8_t	*msg length*	The number of bytes in the message id string
	varies	uint8_t[msg id length]	*msg id*	The message id string
	1	uint8_t	*path length*	The number of bytes in the URL path string
	varies	uint8_t[path length]	*path*	The URL path string
	2	uint16_t	*JSON length*	The length of the JSON
	varies	uint8_t[JSON length]	*JSON*	The JSON (string)

2.13.2 Response

The parameters for the response message:

Table 24: *Parameters for the SDK proxy Response*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*msg id length*	The number of bytes in the message id string; may be 0
2	*varies*	uint8_t[msg id length]	*msg id*	The message id string
	2	uint16_t	*status code*	The HTTP-style status code that the SDK may return.
	1	uint8_t	*type length*	The number of bytes in the response type string
	varies	uint8_t[type length]	*type*	The response type string
	2	uint16_t	*body length*	The length of the response body
	varies	uint8_t[body length]	*body*	The response body (string)

2.14. SSH

This command is used to request the Vector allow SSH. It is reported that only the developer releases support SSH; it is not known which versions are applicable. It does not appear that SSH can be enabled in the production release software.

2.14.1 Request

The SSH keys command passes the authorization key by dividing it up into substrings and passing the list of substrings. The substrings are appended together by the recipient to make for the overall authorization key.

The parameters for the request message:

Table 25: Parameters for SSH request

Offset	Size	Type	Parameter	Description
0	2	uint16_t	*num substrings*	The number of SSH authorization key substrings; may be 0
2	*varies*	substring[num substrings]	*substrings*	The array of authorization key substrings (see below).

Each authorization key substring has the following structure:

Table 26: SSH authorization key substring

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*substring length*	The length of the substring; may be 0
1	*varies*	uint8_t[substringlength]	*substring*	UTF8 substring of the SSH authorization key

2.14.2 Response

The response has no parameters.

2.15. STATUS

This command is used to request basic info from Vector.

2.15.1 Request

The request has no parameters.

2.15.2 Response

The parameters for the response message:

Table 27: *Parameters for Status Response*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*SSID length*	The number of bytes in the SSID string; may be 0
2	*varies*	uint8_t[SSID length]	*SSID*	The WiFi SSID (hex string).
	1	uint8_t	*WiFi state*	See *Table 28: WiFi state enumeration*
	1	uint8_t	*access point*	0 not acting as an access point, otherwise acting as an access point
	1	uint8_t	*Bluetooth LE state*	0 if the Bluetooth
	1	uint8_t	*Battery state*	
	1	uint8_t	*version length*	The number of bytes in the version string; may be 0 version >= 2
	varies	uint8_t [version length]	*version*	The version string; version >= 2
	1	uint8_t	*ESN length*	The number of bytes in the ESN string; may be 0 version >= 4
	varies	uint8_t[ESN length]	*ESN*	The *electronic serial number* string; version >= 4
	1	uint8_t	*OTA in progress*	0 over the air update not in progress, otherwise in process of over the air update; version >= 2
	1	uint8_t	*has owner*	0 does not have an owner, otherwise has an owner; version >= 3
	1	uint8_t	*cloud authorized*	0 is not cloud authorized, otherwise is cloud authorized; version >= 5

Note: a *hex string* is a series of bytes with values 0-15. Every pair of bytes must be converted to a single byte to get the characters. Even bytes are the high nybble, odd bytes are the low nibble.

The WiFi states are:

Table 28: *WiFi state enumeration*

Index	Meaning
0	Unknown
1	Online
2	Connected
3	Disconnected

2.16. WIFI ACCESS POINT

This command is used to request that the Vector act as a WiFi access point. This command requires that a "cloud session" have been successfully started first (see section *2.5 Cloud session*).

If successful, Vector will provide a WiFi Access Point with an SSID that matches his robot name.

2.16.1 Request

The parameters of the request body are:

Table 29: *Parameters for WiFi Access Point request*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*enable*	0 to disable the WiFi access point, 1 to enable it

2.16.2 Response

If the Bluetooth LE session is not cloud authorized a "response" message will be sent with this error. Otherwise the WiFi Access Point response message will be sent.

The parameters for the response message:

Table 30: *Parameters for WiFi Access Point Response*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*enabled*	0 if the WiFi access point is disabled, otherwise enabled
1	1	uint8_t	*SSID length*	The number of bytes in the SSID string; may be 0
2	*varies*	uint8_t[SSID length]	*SSID*	The WiFi SSID (hex string)
	1	uint8_t	*password length*	The number of bytes in the password string; may be 0
	varies	uint8_t [password length]	*password*	The WiFi password

2.17. WIFI CONNECT

This command is used to request Vector to connect to a given WiFi SSID. Vector will retain this WiFi for future use.

2.17.1 Request

The parameters for the request message:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*SSID length*	The number of bytes in the SSID string; may be 0
1	*varies*	uint8_t[SSID length]	*SSID*	The WiFi SSID (hex string)
	1	uint8_t	*password length*	The number of bytes in the password string; may be 0
	varies	uint8_t [password length]	*password*	The WiFi password
	1	uint8_t	*timeout*	How long to given the connect attempt to succeed.
	1	uint8_t	*auth type*	The type of authentication to employ; see *Table 32: WiFi authentication types enumeration*
	1	uint8_t	*hidden*	0 the access point is not hidden; 1 it is hidden

Table 31: *Parameters for WiFi Connect request*

The WiFi authentication types are:

Index	Meaning
0	None, open
1	WEP
2	WEP shared
3	IEEE8021X
4	WPA PSK
5	WPA2 PSK
6	WPA2 EAP

Table 32: *WiFi authentication types enumeration*

2.17.2 Response

The parameters for the response message:

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*SSID length*	The length of the SSID that was deleted; may be 0
1	*varies*	uint8_t[SSID length]	*SSID*	The SSID (hex string) that was deleted
	1	uint8_t	*WiFi state*	See *Table 28: WiFi state enumeration*
	1	uint8_t	*connect result*	version >= 3

Table 33: *Parameters for WiFi Connect command*

2.18. WIFI FORGET

This command is used to request Vector to forget a WiFi SSID.

2.18.1 Request

The parameters for the request message:

Table 34: *Parameters for WiFi Forget request*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*delete all*	0 if Vector should delete only one SSID; otherwise Vector should delete all SSIDs
1	1	uint8_t	*SSID length*	The length of the SSID that to be deleted; may be 0
2	*varies*	uint8_t[SSID length]	*SSID*	The SSID (hex string) to be deleted

2.18.2 Response

The parameters for the response message:

Table 35: *Parameters for WiFi Forget response*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*did delete all*	0 if only one; otherwise Vector deleted all SSIDs
1	1	uint8_t	*SSID length*	The length of the SSID that was deleted; may be 0
2	*varies*	uint8_t[SSID length]	*SSID*	The SSID (hex string) that was deleted

2.19. WIFI IP ADDRESS

This command is used to request Vector’s WiFi IP address.

2.19.1 Request

The request has no parameters

2.19.2 Response

The parameters for the response message:

Table 36: *Parameters for WiFi IP Address response*

Offset	**Size**	**Type**	**Parameter**	**Description**
0	1	uint8_t	*has IPv4*	0 if Vector doesn’t have an IPv4 address; other it does
1	1	uint8_t	*has IPv6*	0 if Vector doesn’t have an IPv6 address; other it does
2	4	uint8_t[4]	*IPv4 address*	Vector’s IPv4 address
6	32	uint8_t[16]	*IPv6 address*	Vector’s IPv6 address

2.20. WIFI SCAN

This command is used to request Vector to scan for WiFi access points.

2.20.1 Request

The command has no parameters.

2.20.2 Response

The parameters for the response message:

Table 37: *Parameters for WiFi scan response*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*status code*	
1	1	uint8_t	*num entries*	The number of access points in the array below
2	*varies*	AP[num entries]	*access points*	The array of access points

Each access point has the following structure:

Table 38: *Parameters access point structure*

Offset	Size	Type	Parameter	Description
0	1	uint8_t	*auth type*	The type of authentication to employ; see *Table 32: WiFi authentication types enumeration*
1	1	uint8_t	*signal strength*	The number of bars, 0..4
2	1	uint8_t	*SSID length*	The length of the SSID string
3	*varies*	uint8_t[SSID length]	*SSID*	The SSID (hex string)
	1	uint8_t	*hidden*	0 not hidden, 1 hidden; version >= 2
	1	uint8_t	*provisioned*	0 not provisioned, 1 provisioned; version>= 3