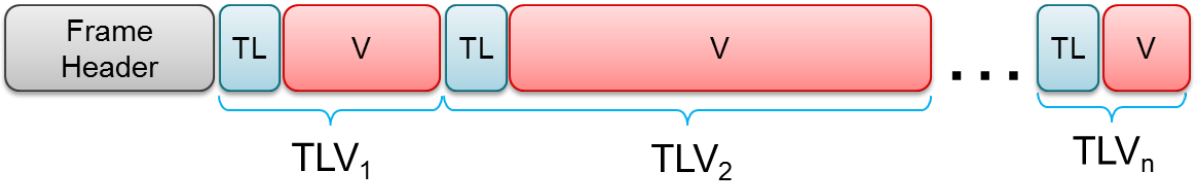
Data Formats

A TLV(type-length-value) encoding scheme is used with little endian byte order. For every frame, a packet is sent consisting of a fixed sized **Frame Header** and then a variable number of TLVs depending on what was detected in that scene. The TLVs can be of types representing the 2D point cloud, target list object, and associated points.



Frame Header

Size: 52 bytes

Select text

```
frameHeaderStructType = struct(...
    'sync',             {'uint64', 8}, ... % syncPattern in hex is: '02 01 04 03 06 05 08 07'
    'version',          {'uint32', 4}, ... % 0xA1642 or 0xA1443
    'platform',         {'uint32', 4}, ... % See description below
    'timestamp',        {'uint32', 4}, ... % 600MHz free running clocks
    'packetLength',     {'uint32', 4}, ... % In bytes, including header
    'frameNumber',      {'uint32', 4}, ... % Starting from 1
    'subframeNumber',   {'uint32', 4}, ...
    'chirpMargin',      {'uint32', 4}, ... % Chirp Processing margin, in ms
    'frameMargin',      {'uint32', 4}, ... % Frame Processing margin, in ms
    'uartSentTime' ,    {'uint32', 4}, ... % Time spent to send data, in ms
    'trackProcessTime', {'uint32', 4}, ... % Tracking Processing time, in ms
    'numTLVs' ,         {'uint16', 2}, ... % Number of TLVs in thins frame
    'checksum',         {'uint16', 2});    % Header checksum
```

Frame Header Structure in MATLAB syntax for name, type, length

Select text

```
% Input: frameheader is a 52x1 double array, each index represents a byte of the frame header
% Output: CS is checksum indicator. If CS is 0, checksum is valid.

function CS = validateChecksum(frameheader)
    h = typecast(uint8(header),'uint16');
    a = uint32(sum(h));
    b = uint16(sum(typecast(a,'uint16')));
    CS = uint16(bitcmp(b));
end
```

validateChecksum(frameheader) in MATLAB syntax

TLVs

The TLVs can be of type **POINT_CLOUD_2D**, **TARGET_LIST_2D**, or **TARGET_INDEX**.

TLV Header

Size: 8 bytes

Select text

```
% TLV Type: 06 = Point cloud, 07 = Target object list, 08 = Target index
tlvHeaderStruct = struct(...
    'type',             {'uint32', 4}, ... % TLV object
    'length',           {'uint32', 4});    % TLV object Length, in bytes, including TLV header
```

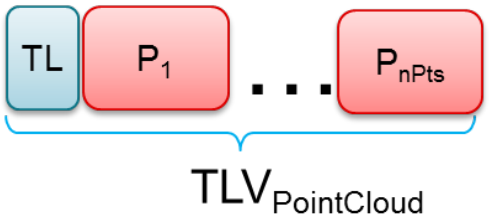
TLV header in MATLAB syntax

Following the header, is the the TLV-type specific payload

Point Cloud TLV

Type: POINT_CLOUD_2D

Size: sizeof (tlvHeaderStruct) + sizeof (pointStruct2D) x numberOfPoints



Each Point Cloud TLV consists of an array of points. Each point is defined in 16 bytes.

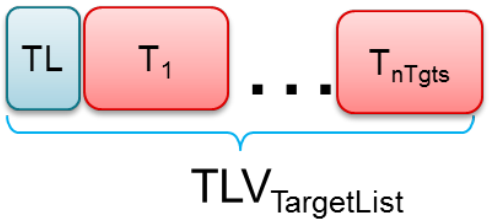
Select text

```
pointStruct2D = struct(...
    'range',            {'float', 4}, ... % Range, in m
    'azimuth',          {'float', 4}, ... % Angle, in rad
    'doppler',          {'float', 4}, ... % Doppler, in m/s
    'snr',              {'float', 4});    % SNR, ratio
```

Point Structure in MATLAB syntax

Target Object TLV

Type: TARGET_LIST_2D
Size: sizeof (tlvHeaderStruct) + sizeof (targetStruct2D) x numberOfTargets



Each Target List TLV consists of an array of targets. Each target is defined in 68 bytes.

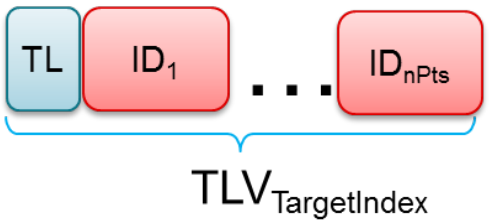
Select text

```
targetStruct2D = struct(...
    'tid',              {'uint32', 4}, ... % Track ID
    'posX',             {'float', 4}, ... % Target position in X dimension, m
    'posY',             {'float', 4}, ... % Target position in Y dimension, m
    'velX',             {'float', 4}, ... % Target velocity in X dimension, m/s
    'velY',             {'float', 4}, ... % Target velocity in Y dimension, m/s
    'accX',             {'float', 4}, ... % Target acceleration in X dimension, m/s2
    'accY',             {'float', 4}, ... % Target acceleration in Y dimension, m/s
    'EC',               {'float', 9*4}, ... % Error covariance matrix, [3x3], in range/angle/doppler
 coordinates
    'G',                {'float', 4});    % Gating function gain
```

Target Structure in MATLAB syntax

Target Index TLV

Type: TARGET_INDEX Size: sizeof (tlvHeaderStruct) + numberOfPoints (NOTE: here the number of points are for frame n-1)



Each Target List TLV consists of an array of target IDs. A targetID at index ***i*** is the target to which point ***i*** of the previous frame's point cloud was associated. Valid IDs range from 0-249.

Select text

```
targetIndex = struct(...
'targetID',         {'uint8', 1});    % Track ID
```

Target ID Structure in MATLAB syntax

Other Target ID values:

Value	Meaning
253	Point not associated, SNR too weak
254	Point not associated, located outside boundary of interest
255	Point not associated, considered as noise

Example Parsing

Example UART stream with annotation of Frame Header and TLVs.

02 01 04 03 06 05 08 07 02 00 01 01 42 16 0A 00 47 48 31 6B 4A 01 00 00 8D 5E 00 00 00 00 00 00 4E 00 00 00 9D 50 00 00 53 00 00 00 0B 0E 00 00 03 00 00 66 06 00 00 00 38 00 00 00 6C D6 8F 3F DB 0F C9 3D B3 15 A6 3D 1B 30 0A 41 59 99 A2 3F 92 0A 86 3D B3 15 A6 BD 49 6D 18 41 52 DA A8 3F 92 0A 86 3D B3 15 A6 BD 38 26 02 41 07 00 00 00 D4 00 00 00 00 00 00 00 7B BA A3 3D 83 4F 98 3F FE 47 0A BE 00 B0 77 38 1E 9F D9 BE 80 BB B0 3A A7 EE 2F 41 FC C8 3D 3D 25 87 C7 BD FE C8 3D 3D E2 E6 6A 41 77 1C 18 3D 25 87 C7 BD 75 1C 18 3D D7 7E 5A 3F C8 79 A0 40 01 00 00 00 9F 41 11 3E 90 64 08 40 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0A AE 0D 41 50 3B D0 BE 68 BD AC BE 51 3B D0 BE 69 AE E4 41 2A CE 2C 3D 68 BD AC BE 29 CE 2C 3D A3 C0 20 3F 00 00 80 3F 02 00 00 00 D8 6F 90 BF C4 0B 36 40 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 B0 67 2D 41 78 6D 4E BD AD AF 93 BE 7E 6D 4E BD 8C CD 8E 42 92 4F 91 3D AD AF 93 BE 7C 4F 91 3D AA 3F 31 3F 00 00 80 3F 08 00 00 00 0A 00 00 00 00 00 02 01 04 03 06 05 08 07 02 00 01 01 42 16 0A 00 62 11 CA 6B 8B 01 00 00 8E 5E 00 00 00 00 00 00 4E 00 00 00 84 50 00 00 58 00 00 00 7B 0E 00 00 03 00 AE 9B 06 00 00 00 78 00 00 00 6C D6 8F 3F DB 0F C9 3D B3 15 A6 3D 51 FA 0A 41 66 17 96 3F DB 0F C9 3D B3 15 A6 3D A1 F4 D0 41 59 99 A2 3F DB 0F C9 3D B3 15 A6 BD A4 A9 24 41 6C D6 8F 3F 92 0A 86 3D B3 15 A6 3D E7 87 FA 40 66 17 96 3F 92 0A 86 3D B3 15 A6 3D E2 69 0A 42 5F 58 9C 3F 92 0A 86 3D B3 15 A6 3D CA E5 A4 41 59 99 A2 3F 92 0A 86 3D B3 15 A6 BD 58 47 8D 41 07 00 00 00 D4 00 00 00 00 00 00 00 5D 0B A5 3D D1 B1 98 3F 08 27 CA BD 1B 12 8E 3B 4A BC 5B BE 5A FB 82 BC 7D 7F 2E 41 31 D7 2E 3D 55 B0 2C BE 31 D7 2E 3D CC AA 58 41 91 5A 14 3D 55 B0 2C BE 95 5A 14 3D 74 A1 48 3F 14 46 A0 40 01 00 00 00 9F 41 11 3E 90 64 08 40 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0A AE 0D 41 50 3B D0 BE 68 BD AC BE 51 3B D0 BE 69 AE E4 41 2A CE 2C 3D 68 BD AC BE 29 CE 2C 3D A3 C0 20 3F 00 00 80 3F 02 00 00 00 D8 6F 90 BF C4 0B 36 40 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 B0 67 2D 41 78 6D 4E BD AD AF 93 BE 7E 6D 4E BD 8C CD 8E 42 92 4F 91 3D AD AF 93 BE 7C 4F 91 3D AA 3F 31 3F 00 00 80 3F 08 00 00 00 0B 00 00 00 00 00 00

Frame Header
Point Cloud TLV
Target List TLV
Target Index TLV
Type Length Header