JTLS-2021-15460 Link 16 Air PPLIs Report Selves as Tracks

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1.0 Summary of Model Change Request

JTLS-GO represents the setting of a Special Interest Flag for Link-16 tracks. The Special Interest Indicator exists in Link 16 only on J3.2 messages, or air tracks. This flag is not available on the J2.2 message, known as a self-reporting mission or PPLI. In JTLS-GO, PPLIs only generate J2.2 messages for themselves and not a J3.2 message. Thus there is no way for PPLIs to be marked with a Special Interest Indicator by an operator.

The request is for PPLIs be able to maintain a Link 16 Special Interest Indicator. In addition, the Link 16 Message Service (L16MS) must be able to indicate to the user that the Link 16 Special Interest Indicator is active for a track.

2.0 Design Summary

This design will allow operators to set Special Interest Indicators on PPLI missions by introducing the option for PPLIs to generate a J2.2 and J3.2 message for itself simultaneously. This setting will be available as a "Self-Tracking Air PPLIs" check box on the message Configuration panel. This check box will be deselected by default to match the current behavior.

For a PPLI to send both a J2.2 and J3.2 message for itself, the Combat Events Program (CEP) must fill all of the required JU numbers to produce those messages. The L16MS will perform this check when processing Air Missions to determine if the object is eligible to be sent as both types of messages. This functionality will apply only to Air objects and not Ground or Naval.

3.0 Detailed Design

3.1 Activating The Dual Link-16 Message Capability

In order to activate this Dual Link-16 message capability for Air Missions two flags must be set:

- Link-16 Module Flag - The Link-16 Module manager will need to set the flag on the Link-16 Module panel. It is a simple check-box button labeled as: "Self-Tracking Air PPLIs". The check-box, buy default, will be unselected. The status of the check-box will be part of the configuration save capability of the Link-16 Module panel.

- **CEP Flag** - The CEP must be told to have self-reporting Air Missions, with an assigned track block, allocate a track number for itself. The Design Team discussed this planned improvement with operational personnel from the US Pacific Air Command (US-PACAF). US-PACAF indicated they had never heard of this problem and wanted the Design Team to ensure that no one could accidentally set JTLS-GO up to activate this behavior during US INDO-PACOM exercises.

  For this reason, the CEP Flag that needs to be set to activate this behavior will work in the same manner currently handled for the ATO LITE FLAG. The ATO LITE FLAG also has some serious consequences, and requires Technical Control to confirm the setting of the flag on the CEP Terminal. To make this process clearer for Technical Control, a new Order will be created called the CONTROLLED DEBUG FLAG Order. The ATO LITE FLAG will be moved from the current DEBUG.FLAG Order panel to this new panel and the new flag, named DUAL LINK16 AIR FLAG, will be added to this new panel

Table 1.summarizes the process that will be followed for all flags being set through the new CONTROLLED DEBUG FLAG Order

Table 1. Technical Control Verification Of CEP Dual Link-16 Message Flag

STEP	EXPLANATION ATO LITE FLAG	EXPLANATION DUAL LINK16 FLAG
1	Using the current Controlled Debug Flag Order, set the desired flag.	
2	The order is sent to the CEP and when received the model determines whether the flag is being set to On (Yes) or Off (No).	
Set To On		
3	Message written to CEP window asking for confirmation that the flag should be set.	
4	The Controller is required to approve or disapprove the change. If disapproved, the flag is not changed. If approved the flag is changed.	
Set To Off		
5	The User is informed that the flag cannot be turned off. Once off, it cannot be changed back.	The flag is turned off. No confirmation will be required,

This new DUAL LINK16 AIR FLAG will default to off when the game start. Unlike the ATO LITE FLAG which is not saved as part of an ASCII checkpoint, the new DUAL LINK16 AIR FLAG will be added to Modeling Parameter ASCII file when a checkpoint is executed. On a restore, the flag will be restored to the value held by the flag when the checkpoint was taken.

3.2 L16MS Message Checks and Handling

The L16MS receives all track data from the JTLS Object Data Authority (JODA), which is updated by the Combat Events Program (CEP). The L16MS currently determines what message type to send for an object based on several fields. These fields are described in Table 2.

Table 2. Description of JU Attributes

ATTRIBUTE	MESSAGE	DESCRIPTION
ju_number	J2.2 (PPLI)	A unique number used to identify a specific entity such as a ship, Air Mission, or ground unit. A PPLI reports itself in the J2.2 message using this number.
source_ju_number	J3.2 (Track)	Identifies the source PPLI that currently owns the track.
track_ju_number	J3.2 (Track)	A unique value used to identify the track.

For an Air Mission to be considered a PPLI by the L16MS and send a J2.2 message, the CEP must fill the **ju_number** field on the object. The L16MS does not inspect or consider the **source_ju_number** or **track_ju_number** of the object if the **ju_number** field is filled and valid.

For an Air Mission to be considered a track by the L16MS and send a J3.2 message, the CEP must fill both the **source_ju_number** and **track_ju_number** fields. In addition, the **ju_number** field must not be filled. Otherwise the object would be qualify as a J2.2 message.

In the new implementation, if Self-tracking Air PPLIs is enabled and an Air Mission has all three fields filled by the CEP, then the L16MS will generate both a J2.2 and J3.2 message for that object.

3.3 Simultaneous Production of J2.2 and J3.2 Messages

There are important design decisions to be made to determine how the L16MS will send both a J2.2 and J3.2 message for a single object. In the current implementation, an object only ever sends one core message type. While there are instances where an object will send additional message types that act as amplifications of the core message, these are special cases. For example:

- An Air Mission PPLI can send a J13.2 Platform Status message. These 13.2 messages are invisible to the user and cannot be filtered off. They automatically are generated when a capable J2.2 message is sent.

- The same concept exists for J3.6 Space Track messages. There are associated J3.0 Reference Point messages that are produced at regular intervals associated with the J3.6 message. These are also invisible to the user and cannot be filtered.

The behavior for these examples varies from the behavior required for sending multiple core message types for a single object, so a new methodology is needed.

Currently, the logic for generating messages is based on the assignment of a **message_type** attribute to an object. For example, an Air Mission object can be assigned a **message_type** of AIR PPLI or AIR TRACK. Based on that value, the L16MS knows what message type to build. In order for one object to generate multiple message types, there are a few options that can be pursued.

1. The object can be duplicated. This would allow one version of the object to hold one **message_type**, and the other version to hold another **message_type.** Managing these two separate objects may become confusing, especially when updates are involved. All versions of the object would also have to be synchronized, and keeping the multiple versions of the object distinct may become difficult. This would make filtering of the separate objects simple because each object would hold a distinct **message_type** and so each object and therefore **message_type** could be filtered separately.

2. The **message_type** attribute of an object will be changed to become a list. This will keep the object a singular entity, making JODA update handling simple when compared to option 1. When processing an object, the L16MS will get the object's list of **message_type**s and generate a message for each **message_type.** Any existing code that checks for an object's **message_type** can be safely modified to support the new list type.

    The L16MS publishes tracks to the L16 WHIP module, which are displayed in the track summary table. To support a single Air Mission that is publishing multiple message types, there are two options for filtering:

    a. The Air Mission will be represented as a single row in the table. Each message type filter will require its own column. This option will require structural changes to the track summary table.

Table 3. Option 2A Track Summary Table

JTLS Short Name	JU Number	Source JU Number	Track JU Number	Message Type	J2.2 (PPLI) Send	J3.2 (Track) Send
RECCE_0001	00123	00123	AA001	J2.2 + J3.2	Yes	No

    b. The Air Mission will be represented by as many rows as message types it implements. Only one filter column will be required. This option will not require any structural changes to the track summary table. Depending on the type of message, only the

related JU numbers will be filled. For example, for a PPLI only the JU Number cell will be filled. For a track, only the Source JU Number and Track JU Number cells will be filled.

Table 4. Option 2B Track Summary Table

JTLS Short Name	JU Number	Source JU Number	Track JU Number	Message Type	Send
RECCE_0001	00123			J2.2	Yes
RECCE_0001		00123	AA001	J3.2	No

The design team has decided to implement option 2B as it will provide the most flexibility for all object types in the event that similar changes need to occur in the future. This option has the added benefit of not requiring that the new extra column be explained to non-NATO organizations, such as US PACAF. The second line will only be displayed when the Dual Link16 Air Track is checked. Furthermore, this option is a generic change that affects all objects, whereas option 1 would require special handling code for only the object types that will require duplication.

3.4 Filtering Considerations

The impact of this ECP on the new filters being developed for the associated ECP, JTLS-2021-15458 Link 16 J-Message Filters must be considered.

In the current implementation design for JTLS-2021-15458 Link 16 J-Message Filters, each object was envisioned to have a single filter setting. This is because each object was only responsible for one message type. This planned filter setting will need to be expanded in the new implementation. The **message_type** data structure will become a key-value pair list, where the key is the message type and the value is that message type's filter setting.

Using the data in Table 4 as an example, RECCE_0001's **message_type** data structure would be held by the L16MS as follows under the following circumstances:

Table 5. Message Type Data Structure

L16 Module Action	Key (Message Type)	Value (Filter Setting)
The module starts up. The Self Tracking PPLI flag has a default value of unchecked meaning that only the PPLI Message Type should be sent.	J2.2	Yes
	J3.2	No
The Link 16 Module Manager sets the Self Tracking PPLI flag on the module panel. The J3.2 filter value goes to Yes indicating that is should be sent.	J2.2	Yes
	J3.2	Yes

Table 5. Message Type Data Structure

L16 MODULE ACTION	KEY (MESSAGE TYPE)	VALUE (FILTER SETTING)
The Link 16 Module Manager sets the J3.2 filter to off. Note that this is a inconsistency. The Self Tracking PPLI flag indicates J 3.2 messages should be sent out for self-reporters, but the J 3.2 filter has indicated they should not be sent. There will be no check for this situation. It is inconsistent, but it is up to the Link 16 Module Manager to decide on how to manage the flag and the filters.	J2.2	Yes
This approach was taken to ensure flexibility for the Module Manager in that actions do not need to be accomplished in a certain order.	J3.2	No
Assume the Link 16 Module Manager now clears the Filter J 3.2 messages box indicating that J 3.2 messages should be sent. Now assume the Link 16 Module Manager checks the box to filter J 2.2 Air PPLI messages. The result of the filter flag would be as shown.	J2.2	No
As mentioned in the filtering design, it is unclear how the Link-16 capable Command, Control, Communication, and Computer Information (C4I) system will react when a J 3.2 messages is received for a JU source number that does not exist since the source's J 2.2 message will not be sent. The situation	J3.2	Yes
The manual setting of a specific missions message types will be feasible. This means the user, for a specific Air Mission can set the Message Types filters in any combination desired without impact any other Air Missions. So technically it could be possible to only send the J3.2 messages for a mission in which the Special Interest flag is needed.	J2.2	Yes
	J3.2	No

3.5 Module to Service Communication - Toggling Filters

When modifying filter or configuration settings, the L16 WHIP module communicate over HTTP. To toggle the filter for a specific object, the WHIP module sends a command containing the object's JTLS Short Name and its new filter setting. This will no longer be possible for objects that implement multiple message types. In the new implementation, the module will send a command containing the object's JTLS Short Name, message type, and new filter setting.

3.6 Special Interest Indicator Display

The L16MS currently monitors the Link 16 Special Interest Indicator for Air Missions; however, this data is not available to users. The Air Mission track summary table of the L16 WHIP Module will be modified to provide an indication that an Air Mission has an active Special Interest

Indicator. The JTLS Short Name will be painted with a yellow background for any missions that have an active Special Interest Indicator.

3.7 CEP Management of Track Numbers for PPLIs

Consideration must be made for PPLI missions and how they will be assigned a **track_ju_number**. In the current implementation, when a PPLI tags a track, that track is assigned a **source_ju_number** equal to the PPLI's **ju_number**. The track is also assigned **track_ju_number** from the PPLI mission's Mission Link Block (MLB). MLBs belonging to the mission consist of a block of track JU numbers and a JU number used by a mission as its PPLI identifier.

JU Track numbers will only be assigned to a self-reporter when the CEP DUAL LINK16 FLAG is set. If it is not set, the model will not attempt to assign a track number to the self-reporter. Consider the following MLB definition for an Air Mission:

- JU Number: 00123

- Track Block: AA001 - AA777

Table 6 follows the CEP JU Track assignment logic for various situations.

Table 6. Assigning a Self Report A JU Track Number By CEP

SITUATION	RESULT
Assume the DUAL LINK16 AIR Flag is set to YES. When the example Self Reporter launches, it will assign itself the JU Number from its track block and set its Source JU number to its own JU number and take the first Track JU Number from its MLB Block	• JU Number: 00123 • Source JU Number: 00123 • Track JU Number: AA001
Assume the DUAL LINK16 AIR Flag is set to NO. When the example Self Reporter launches, it will assign itself only its JU Number from its assigned MLB.	• JU Number: 00123 • Source JU Number: • Track JU Number:
Assume while the mission is flying, the DUAL LINK16 AIR Flag is set from NO to YES. In this case, when the flag is set, the next time the air mission moves, the model will assign the Track JU Number and set the JU Source to its own JU Number. When it does this, the model will take the next Track number in the missions list. A recent change to the CEO results in all Track numbers be used prior to cycling back and reusing numbers.	• JU Number: 00123 • Source JU Number: 00123 • Track JU Number:AA144
Assume that while the mission is flying the DUAL LINK16 AIR Flag is set from YES to NO. The model will cycle through all Air Missions and clear the Source JU Number setting and the Track JU Number setting. The model will not wait for the mission's next move. This is done to make the handling of cycling through available JU Track Numbers more consistently managed.	• JU Number: 00123 • Source JU Number: • Track JU Number:

Table 6. Assigning a Self Report A JU Track Number By CEP

SITUATION	RESULT
This leaves one last situation that needs to be considered. Assume that the DUAL LINK16 AIR Flag is set to Yes while a Self-Reporter is flying and although it has a Track Block specified, it is already holding the maximum number of tracks and has no available Track numbers to assign for its own use. The Design Team considered the obvious two options: • Option 1: Take an existing track number away from an existing track. • Option 2: Do not give a Track number to the mission. The Design Team selected Option 2 for the following reasons: • The entire reason for the Self Reporter track is to set the Special Interest flag. This is probably not going to happen often because if all mission are set to Special Interest - it is not very "Special" • The idea of dropping a perfectly good foreign track and instantaneously converting it into a Self Reporter track would more than likely confuse the exercise audience or anyone watching the C4I COP feed. Therefore the final decision is to implement the following logic: • The next time the Air Mission moves, the model executes the detection algorithm including the assignment and release of track numbers for foreign missions. • After this is done, the model will determine if the DUAL LINK16 FLAG is set and if the mission does not already have an assigned JU TRACK NUMBER, the model will allocated a track number and properly update the JODA. • If no track numbers are available, the model will attempt again on its next move, • Once a Track number is assigned, the only way the mission will give up its own Track number is if it lands or if Technical Control turns off the DUAL LINK16 FLAG.	• JU Number: 00123 • Source JU Number: • Track JU Number: When a track number is available, it will be assigned • JU Number: 00123 • Source JU Number: 00123 • Track JU Number:AA252

3.8 Link 16 Module Interface

The Link 16 Module, accessible though the Web Hosted Interface Program, will be updated to include a new check box to toggle the Self-tracking Air PPLIs setting. The updated Configuration panel and check box can be seen in Figure 1.
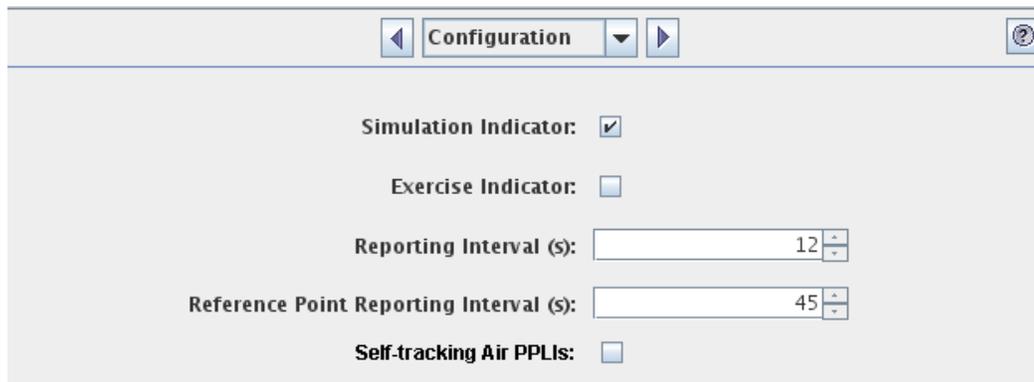
Figure 1. Link 16 Module - Configuration Panel

4.0 Data Changes

None

or

A flag will be added to the Global Values table that determines if Self-tracking Air PPLIs will be used in the scenario. If enabled, the CEP will automatically reserve and assign the first item in each mission's MLB track block to associated mission.

5.0 Order Changes

None

or

An order will be modified (one in the Modeling Parameters category?) that will toggle the reservation of the first item in MLB track blocks for use by Self-tracking Air PPLIs.

6.0 JODA Changes

None

7.0 Test Plan

If a real-world Link-16 capable C4I system is not available, use either the jtlsserver or jtlsclient program to serve as a virtual C4I device in order that Link-16 messages can be generated and checked. At times it may be necessary to directly look at the JODA attributes to determine if the Air Mission settings are appropriated set or cleared.

7.1 Test Basic Capability

Purpose: The purpose of this test is to ensure that the basic described capabilities in the model are properly executing.

Step 1: Turn on the "Self-Tracking Air PPLIs" check-box within the Link-16 Module.

Step 2: Turn on the DUAL LINK16 AIR Flag in the CEP.

Step 3: At the CEP Terminal, when asked if the flag should be turned on, answer No.

Expected Results: A message should be generated and sent to the sending WHIP indicating the flag was not turned on.

Step 4: Turn on the DUAL LINK16 AIR Flag in the CEP.

Step 5: At the CEP terminal, when asked if the flag should be turned on, answer Yes.

Expected Results: A message should be generated and sent to the sending WHIP indicating the flag was turned on

Step 6: Using Table 6, create the described situations. It is suggested that a smaller Track Block than specified for the example be used. This will make it easier to run out of track numbers to assign needed for the last test described in Table 6.

Expected Results: The results are provided in Table 6.

Step 7: Take a Stop checkpoint.

Step 8: Restart from the Stop checkpoint.

Step 9: Using a new Self Reporting Air Mission, rerun the tests in Table 6.

Expected Results: The results should be the same,

Step 10:Have one of the Self Reporter mission land for fuel.

Expected Results: The mission should land and all held tracks should be dropped including the Self Reporters Track Number. It is possible that the dropped tracks may be picked up by the remaining Self Reporter.

Step 11:When the mission takes off again after rearming and refueling. i

Expected Results: The mission should again assign itself a Track Number.

Step 12:Have the WHIP module turn off the "Self-Tracking Air PPLIs" Flag.

Expected Results: The two self reporters should do nothing, but J 3.2 messages should not be sent out for the Self Reported.

Step 13:Close the WHIP being used by the WHIP Module.

Step 14:Start a different WHIP and open the Link-16 Module

Expected Results: The "Self-Tracking Air PPLIs" Flag should still be off.

Step 15:Take another Stop Checkpoint

Step 16:Restart from this Stop Checkpoint.

Step 17:The missions should still have their JU numbers, Source JU Numbers and Track Numbers, but the Link-16 Message service should not send out the J 3.2 messages for the Self Reporters.

Step 18:Have the other Self Reporter land to rearm and refuel.

Step 19:While it is on the ground, reset the "Self-Tracking Air PPLIs" Flag so it is on.

Expected Results: When the mission takes off again, its J 3.2 message should start to be generated.

Step 20:Stop the WHIP from which the Link-16 Module is executing.

Step 21:Go back to the first WHIP and bring up the Link-16 Module.

Expected Results: The "Self-Tracking Air PPLIs" Flag should still be set to on. Make sure that the Dual Track is being sent out for the Self Reporters.

Step 22:Enter a CEP Order to turn off the DUAL LINK16 AIR Flag.

Expected Results: The flag should be turned off without any need for interaction with the CEP terminal. The Track J 3.2 messages should stop being generated by the Link-16 Message Service.

Step 23:Have both missions fly to completion.

Expected Results: The missions should complete without incident.

7.2 Test Filtering Capability Within This Design

Purpose: The purpose of this test is to ensure that filtering implemented as part of JTLS-2021-15458 Link 16 J-Message Filters works within this design.

Step 1: Implement the filtering options described in Table 5.

Expected Results: The results should match the description in Table 5.