ISSUE DOCUMENTATION – RTCA SC-186

ASA / ASAS

Tracking Information (committee secretary only)	
Change Issue Number	18
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Short Title for Change Issue:	Velocity Vector Issues for CDTI

Topic:	X	ASA		High-level		ASAS		STP		ASSAP	X	CDTI
Document Reference: RTCA DO-289							Originator Information:					
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Table/Figure number(s)							Other					

Proposed Rationale for Consideration (originator should check all that apply):	
	Item needed to coordinate with other documents
X	ASA MASPS
	1090 MHz Link MOPS
	UAT Link MOPS
	TIS-B MASPS
	Previously written CDTI MOPS
	Other (include document title):
	Item needed for harmonization with international requirements
	Item identified during recent ADS-B development activities and operational evaluations
	MOPS clarifications and correction item
	Validation/modification of questioned MOPS requirement item
	Military use provision item
	New requirement item

Nature of Issue:		Editorial		Clarity		Performance	X	Functional

Issue Description:

RTCA DO289 (Minimum Aviation System Performance Standards for Aircraft Surveillance Applications) requires CDTI installations that support the intermediate or above ASA Capability Level shall be capable of depicting the magnitude and direction of the horizontal velocity of traffic. It also states that it is desirable that CDTI installations that support ASSA, FAROA and CD applications should be capable of displaying the horizontal velocity of the traffic.

Horizontal Velocity Vector is a straight line emanating from the nose of each traffic airplane(s)/ground vehicle(s) symbol indicating instantaneous direction and magnitude of speed with respect to the surface of the earth. The tip of the line indicates the future position of the traffic at the end of the vector time selected by the pilot or set by other means.

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Issue Description (*continued*):

Velocity Vector Usage:

The display of horizontal velocity vector on the CDTI for airplanes has many operational usages on the airport surface for applications like ASSA and FAROA. At relatively low speeds during surface operations, it provides accurate traffic information about the changes in speed and direction with respect to the runways and taxiways that can be used by the aircrew for better situational awareness during take-off and landing roll. A rapidly lengthening or shortening velocity vector is a useful indication that an airplane is either taking off or is slowing down after landing.

Limitations:

The display of horizontal velocity vector on the CDTI in flight (Figure I), however, has some limitations and shortcomings as described below:

Instantaneous Nature: The velocity vector presents correct airplane short-term intent information only when it is maintaining a constant heading/track either in the air or on the surface. It provides only instantaneous direction, which results in the display of an implied future position of the traffic airplane(s). Because velocity vector does not reflect the trend for traffic airplanes that are maneuvering, information provided by it can be misleading to the flight crew. Display of velocity vector does not provide the complete picture to the flight crew as to which traffic airplanes are turning and which ones are flying straight.

Due to its instantaneous characteristic, the flight crew may not be able to use velocity vector symbol correctly for applications like conflict detection and conflict management without a significant amount of heads down time.

Large Update Lags: To further compound the issue of reliable data, there are several sources of ADS-B/TIS-B data that do not measure velocity vector directly. In such cases, the velocity is estimated from the past measurements of the position data. Depending upon the source of the airplane position/state data, velocity vector could be highly misleading for display systems that have large update lags during maneuvering.

Display of Trend Vector and Velocity Vector on Integrated Display: Airplane position trend vector is used on the Navigation Display of most current transport airplanes to indicate the future position of "ownship" at different time intervals. The trend vector is an accurate presentation of the airplane trend during maneuvering or during wings level flight. The position trend vector varies (curves) to reflect the changes in future airplane position due to changes in the angle of bank. It essentially provides visual cue to the flight crew that the traffic airplane(s) are maneuvering (Figure II) and the crew must pay closer attention if it is a target of significance. The velocity vector on the other hand, represents the future traffic position only when it is flying a constant heading as mentioned above. Depicting the future position of the traffic airplane(s) by velocity vector and future position of the own-ship by trend vector on an integrated display unit may provide visually misleading information to the flight crew in a high workload environment i.e. two similar symbols on a display carrying two different interpretations. At lower range scale, graphical representation of trend vector and velocity vector are identical when ownship is maintaining a constant heading (Figure I). A quick glance at the Navigation Display for traffic awareness could lead the flight crew into making a wrong decision for conflict management,

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Issue Description (*continued*):

particularly in a system that provides conflict detection but no resolution and prevention function. Future position provided by the velocity vector is only valid when the traffic is in wings level state and does not provide accurate information during maneuvering, unless the pilot continuously monitors the velocity vector for trend information.

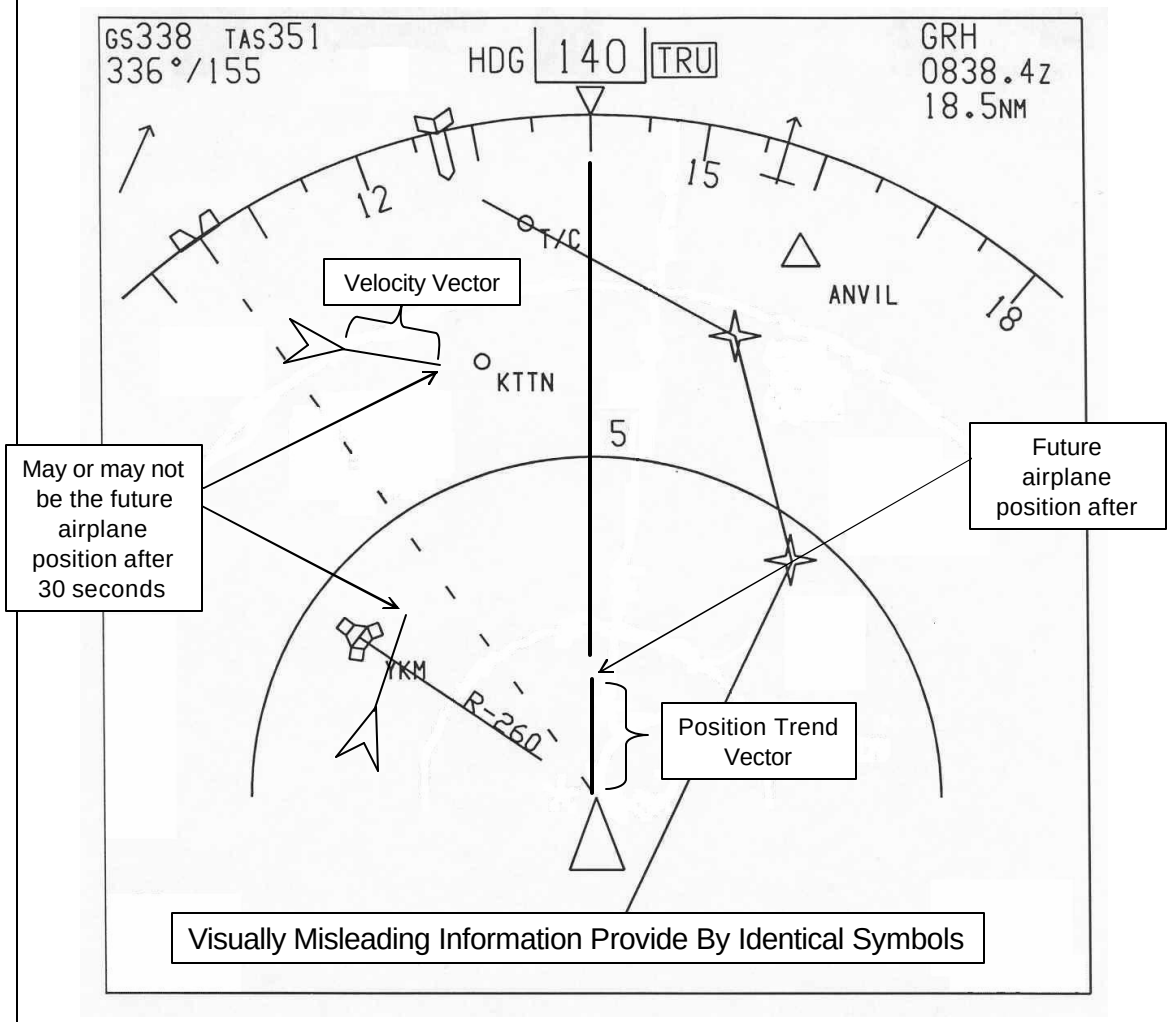

Figure I, At lower range scale, velocity vector and the position trend vector are graphically identical symbols – both provide different set of information.

Flight Crew Training: The flight crew is currently trained to rely on the position trend vector for their future position regardless of the airplane state. Due to the lack of trend information in the current requirement the pilots should not rely on traffic velocity vector to provide them accurate information about the turning performance of other airplanes in vicinity. Additional workload required to obtain trend information should not be levied on the pilots. Also, pilots are likely to be more prone to make errors if velocity vector and position trend vector are displayed on the same display.

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Issue Description (*continued*):

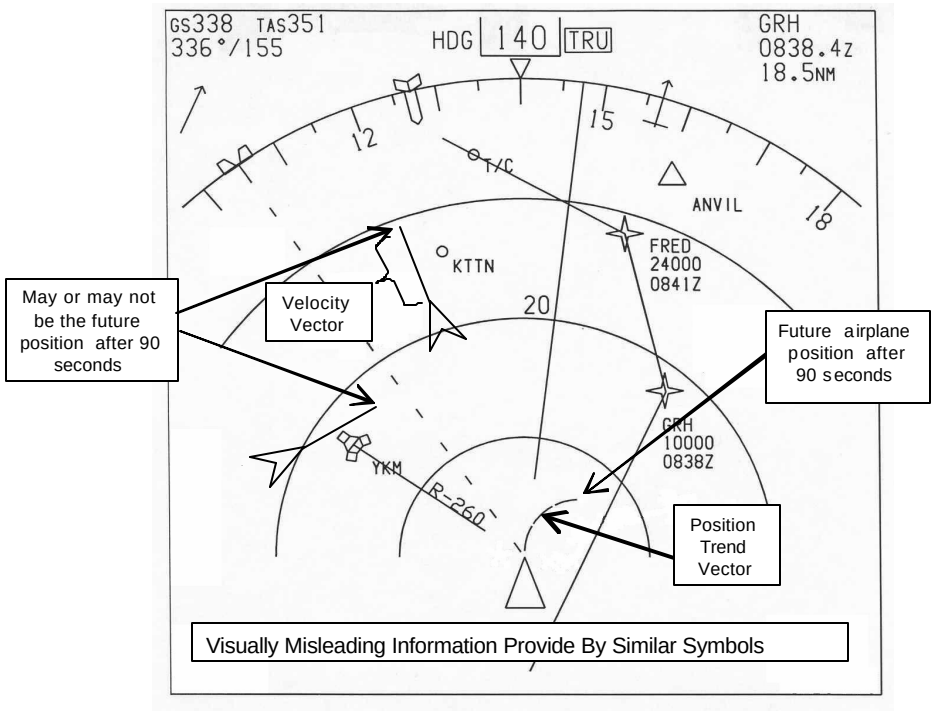

Figure II, During maneuvering, position trend vector provides accurate future ownship position. Velocity vector does not provide accurate future position if the traffic is maneuvering.

Originator's proposed resolution:

To validate the above mentioned operational human factors issues, it is necessary to evaluate the symbology and implementation of the velocity vector on an integrated display in the laboratory and simulator under various scenarios.

Since the velocity vector inherently has built in limitations, a better means of providing instantaneously-derived, short-term intent information to the flight crew would be to display a trend vector on the traffic as well as for the own-ship airplane symbol. A trend vector makes the crew aware that the traffic aircraft are maneuvering at a glance.
For now, directionality provided by the directional traffic symbols is sufficient for traffic awareness. The display of velocity vector with the traffic symbols should be decided by the manufacturer for different applications after a thorough evaluation is performed for their flight deck.

It is suggested that the requirement for capability of displaying traffic velocity vector in RTCA DO-289 be changed to a suggestion/recommendation and should not be included in the CDTI

MOPS.

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Originator's proposed resolution (*continued*):

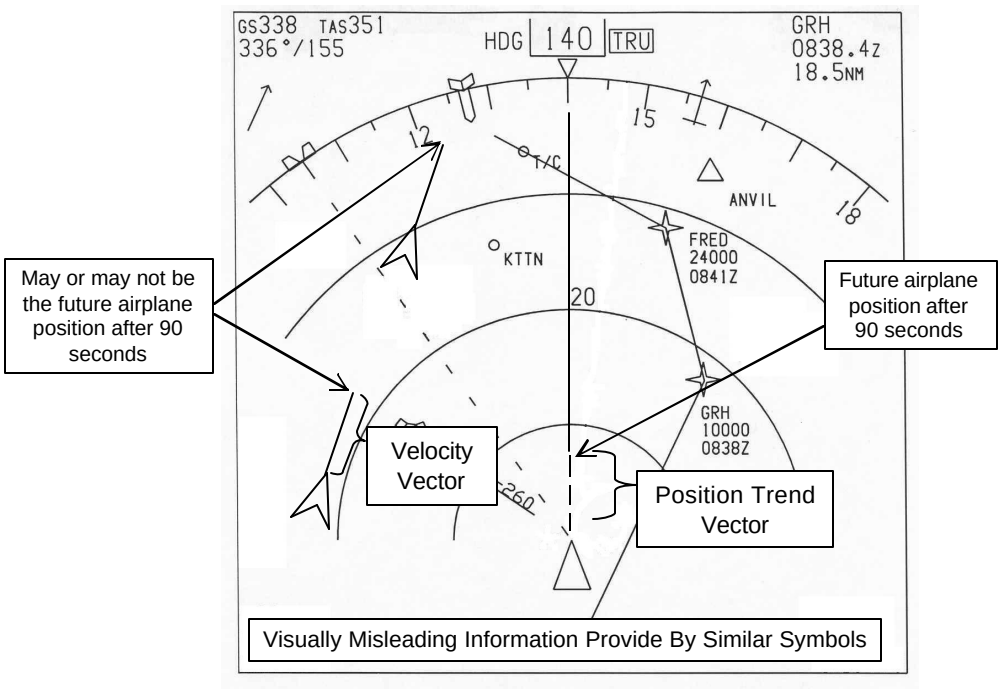

Figure III, At higher range scale, velocity vector and position trend vector symbols are very similar.

CDTI Subgroup Deliberations:

November 2, 2004: The paper was discussed at the CDTI subgroup meeting of November 2004. [See CDTI meeting notes 110204.doc for more detailed notes.]

The group **agreed** that there should not be mixed use of trend vectors (noodles) and horizontal velocity vectors on the same display. A note discussing the issue will be included in the CDTI section of the ASAS MOPS.