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Differential GPS and System Integration of the Low Visibility Landing and Surface Operations (LVLASO) Demonstration

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The LVLASO Flight Demonstration of ASTA concepts (FDAC) integrates NASA-Langley's electronic moving map display and Transport Systems Research Vehicle (TSRV) (a modified Boeing 737 aircraft); ARINC's VHF data link, GPS ground station, and automated controller workstation; and Norden's surface radar/airport movement safety system. Aircraft location is shown on the electronic map display in the cockpit. An approved taxi route as well as other aircraft and surface traffic are also displayed.

An Ashtech Z12 Global Positioning System (GPS) receiver on the TSRV estimates the aircraft's position. In Differential mode (DGPS), the Ashtech receiver accepts differential C/A code pseudorange corrections from a GPS ground station. The GPS ground station provides corrections for up to ten satellites. The corrections are transmitted on a VHF data link at a 1 Hz. rate using the RTCM-104 format. DGPS position estimates will be within 5 meters of actual aircraft position.

DGPS position estimates are blended with position, velocity, acceleration, and heading data from the TSRV Air Data/Inertial Reference System (ADIRS). The ADIRS data is accurate in the short-term, but drifts over time. The DGPS data is used to keep the ADIRS position accurate. Ownship position, velocity, heading, and turn rate are sent at a 20 Hz. rate to the electronic map display.

Airport traffic is detected by the airport surface radar system. Aircraft and vehicles such as fuel trucks and baggage carts are detected. The traffic's location, velocity, and heading are sent to the TSRV. To prevent traffic symbology from jumping each second when a location update arrives, velocity and heading are used to predict a new traffic location for each display update. Possible runway incursions and collisions can be shown on the electronic map

Integrating the different systems used in the FDAC requires attention to the underlying coordinate systems. The airport diagram displayed on the electronic map is obtained from published navigational charts. The charts reference the North American Datum of 1927 (NAD27) or a local state-plane coordinate system. GPS uses the World Geodetic Standard of 1984 (WGS84). Both NAD27 and WGS84 model the Earth as an ellipsoid, however, they use a different origin and different size ellipsoids. Latitudes and longitudes given in these systems can be converted to a Cartesian system with the origin at the Earth's center. The surface radar detects traffic in a locally-level, rho-theta coordinate system.

The electronic airport diagram is stored using a flat XY coordinate system. The map origin is at the tower and is referenced as True North up. All ownship and other traffic positions must be converted to the electronic map's frame of reference for display.