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Author: Dr. Giovanni Mattei
Northrop Grumman Aerospace Systems, Italy

# ARCHITECTURE DESIGN OF AN ITAR-FREE ALTERNATIVE-TO-GNSS NAVIGATION SYSTEM FOR ASSURED PNT

**Abstract**

The architecture of a new, ITAR-free, Alternative-to-GNSS Navigation System (ANS) for Assured Positioning, Navigation and Timing (A-PNT), designed and developed by Northrop Grumman Italia, is presented. The central element of the system is an Inertial Navigation Core (INC), which can be augmented with additional navigation instruments. The INC provides position, velocity, attitude, heading, body rates and accelerations, with navigation-grade accuracy. Moreover, it ensures continuity of reference time using high precision oscillators . The INC great advantage is that it cannot be spoofed or jammed. In what follows, we describe an open architecture based on INC, with emphasis on integration of GNSS receivers, air-data systems, terrain reference augmentation systems, sun-sensors, magnetic field sensors and star-trackers. An architecture is "the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution" (ISO/IEC/IEEE 42010). The novel system architecture is conceived to be modular and flexible, in order to allow easy integration of different sensors and components, as well as guaranteeing maximum code re-usability and paving the way to model-based design. The final objective of this architecture is to enable and provide means to a future plug-and-play core structure, to which it should be possible to add/remove software and hardware modules without redesign effort and drastically reducing the feedback loops in the V-cycle. System high and low level testability is also improved: changes at hardware level should not have relevant impact at software level, and vice versa. The core of the INC software is a flexible structure Unscented Kalman Filter (UKF), whose reliability has been tested throughout extensive Monte Carlo simulations. Simulations and Hardware-in-the-Loop tests show that the UKF outperforms the classical Extended Kalman Filter (EKF) in capturing high-dynamics/aggressive maneuvers of the host vehicle, since they stimulate significantly the nonlinear flight dynamics.