GPS Solut (2013) 17:175–198
DOI 10.1007/s10291-012-0270-z

ORIGINAL ARTICLE

A modeling language to support the interoperability of global navigation satellite systems

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Received: 5 July 2011 / Accepted: 17 May 2012 / Published online: 12 June 2012

Abstract The availability of multiple *Global Navigation Satellite Systems (GNSS)* will offer the opportunity to provide seamless navigation services and improved positioning performance. However, before this opportunity can be exploited, a number of issues need to be solved to ensure the compatibility and interoperability of existing *GNSS*. In particular, the *GNSS interoperability* can be technically defined as the capability of receivers to compute their global position using two or more *GNSS* signals. This capability can be more effectively achieved if *Signal-In-Space interface* specifications are available in a consistent, unambiguous, and possibly standard format, which can support engineers to design interoperable receivers. We aim to support the design of interoperable receivers with the introduction of the *Interface Communication Modeling Language (ICML)*, a graphical language for the formal specification of *Signal-In-Space interfaces*. The ICML language enables receiver engineers to specify these interfaces at different levels of abstraction, such as analog signal or binary data. In addition, the *ICML* language also supports the specification of conversion routines between adjacent levels, for the representation of the dynamic aspects—e.g., convolution and encryption processes—of the interface specification. As such, the *ICML* language proposes an alternative format to textual-based interface specifications and can possibly integrate with the ongoing trend of the Model-based Systems Engineering approaches. We present the structure of the framework implementing the language and an example *ICML*-based specification for a simplified and reduced version of the *Galileo Freely Accessible Navigation (F/NAV)* message. The language metamodel is also attached for technical reference. An important caveat: no endorsement is made for the use of the *ICML* language for the official *Galileo Signal-In-Space interface specification*.

Keywords GNSS interoperability · Signal-In-Space · Interface specification · Model-based systems engineering · Receiver design

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Introduction

The coexistence and the integration of *Global Navigation Satellite Systems (GNSSs)* have been arguably identified as two strategic future issues; and an international working group has been established to address the future political challenges and to seize the upcoming technical opportunities (http://www.oosa.unvienna.org/oosa/SAP/gnss/icg.html). Among the notable technical opportunities, there is a visionary seamless global navigation and a common belief that the use of more *GNSS* signals can increase positioning performance in terms of availability, integrity, and accuracy, for example (Wang et al. 2001). However, before