GPS Civil/Commercial Receivers

Compliance & Certification

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Outline

- **Review NCO tasking to Advisory Board (October 2010)**
  - Action Item #1 from 3 Feb 2010 GPS Civil Focus Day:
    "PNT Safety & Compliance Body"

- **Relevant GPS compliance documents**

- **GPS receiver performance overview**

- **Notional certification content & process options**

Non-ICD Compliant Civil/Commercial Receivers

> **Evaluate the implications of user non-compliance with GPS ICD specifications and potential solutions.**

- Recent events revealed some legacy receiver equipment may not be compliant with ICDs (both civil and military)
  - Issues cause USAF to expend resources to investigate disruptions or outages to ensure issues are/are not U.S. Government induced

- ICDs are published and intended to give receiver manufacturers design guidance and ensure backward compatibility
  - Is this enough or do we need a receiver certification process?
  - What are the implications to receiver manufacturing industry?
  - Should this be a U.S. Government or private sector activity?

Slide from NCO Director brief to NPEC Advisory Board, Oct 2010
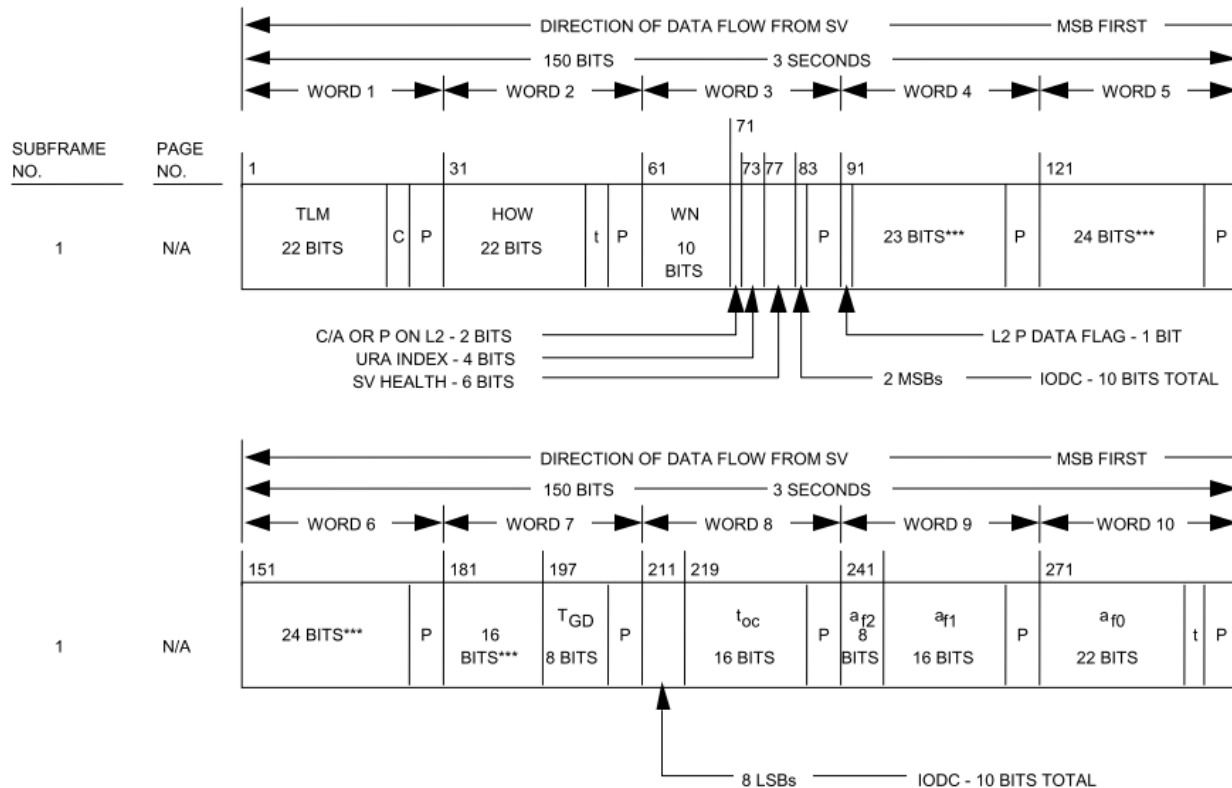
Specifications & Standards

- **GPS Interface Specifications (IS - formerly Interface Control Documents (ICDs))**
  - Public process (Interface Control Working Group – ICWG)
  - IS-GPS-200E (Receiver interface requirements for L1 & L2)
    - C/A-code, P(Y)-Code, L2C-Code
  - IS-GPS-705A (Receiver interface requirements for L5)
  - IS-GPS-800A (Receiver interface requirements for L1C)
- **GPS Application Performance Standards/Criteria**
  - Aviation, Maritime, Timing/Synchronization, etc.

- *GPS SPS Performance Standard* **– NOT a receiver standard**
  - *Defines levels of signal-in-space performance from SPS*
  - *Establishes minimum performance level <u>for GPS constellation</u>*
  - *Assumes notional receiver design (NOT a receiver requirement)*

GPS Receiver Performance Elements

- **Signal reception**
  - Antenna, RF front end parameters (includes filtering)
- **Signal demodulation/down-conversion**
  - Synchronize receiver internal code with received data stream
  - Perform signal down-conversion, A/D detection
  - Recover transmitted navigation message data stream
  - Conduct code/carrier tracking, data detection (phase changes) & data demodulation – read navigation message
- **Signal processing**
  - Calculate pseudoranges and timing parameters
  - Apply correction factors (clock offsets, relativistic factors, ionospheric effects, aiding information, differential corrections, etc.)
  - Calculate navigation solution (Position, Velocity, Time)
- **Applications**

Navigation Message Detail (Example)

25 frames, 1500 bits/frame (5 sub-frames, 300 bits/subframe [10 words, 30 bits/word])

Figure 20-1.   Data Format (sheet 1 of 11)

Notional Receiver Certification Categories

- **Technical Certification**
  - Receiver engineering design IAW relevant Interface Specification(s)
    - Signal & navigation data stream reception
    - Demodulation & detection of navigation message data
    - Application of all navigation message data bits as specified
  - Calculation of navigation solution

- **Performance Certification**
  - Receiver data processing IAW application performance requirements
    - Fidelity of data detection processing (phase change/code transition)
    - Application of correction factors
    - Precision/accuracy/integrity of navigation solution calculations
  - Resiliency in the presence of interference

- **Security Certification (if applicable)**
  - Receiver processing of security information in navigation message
    - Detection, decryption, application
  - Protection of security features from unauthorized access

Sources of Receiver Certification Metrics

- **Code tracking process**
  - Performance relative to detection/refinement of code transitions
    - Position accuracy
    - Resilience

- **Carrier tracking process**
  - Performance relative to signal reception & tracking
    - Velocity (first order)
    - High precision

- **Data demodulation and interpretation**
  - Performance relative to navigation message application
    - Navigation solution in 4 dimensions
    - Seamless adaptation to control segment modifications

Issues to Consider

- **Certification Scope**
  - IS provide technical parameters for GPS receivers
  - Definition of receiver/application performance categories?
  - Consensus on common certification criteria?
    - System-level v Component level
- **Certification process model examples**
  - Government conducted/government oversight
    - Safety certification for aviation receivers
      - Approvals for design/manufacture (IAW FAA Orders)
    - DoD GPS receiver certification (military receivers only)
      - Planning stages at present
      - Process may be applicable to civil problem (separate funding)
  - Industry conducted
    - Independent laboratory (U/L model)
    - Individual self-certification (maritime compliance w/ IMO standards)

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