Branch of Joint Stock Company «United Rocket Space Corporation» - «INSTITUTE OF SPACE DEVICE ENGINEERING» (Branch of JSC «URSC» - «ISDE»)

Refinement of TTFF Methodology

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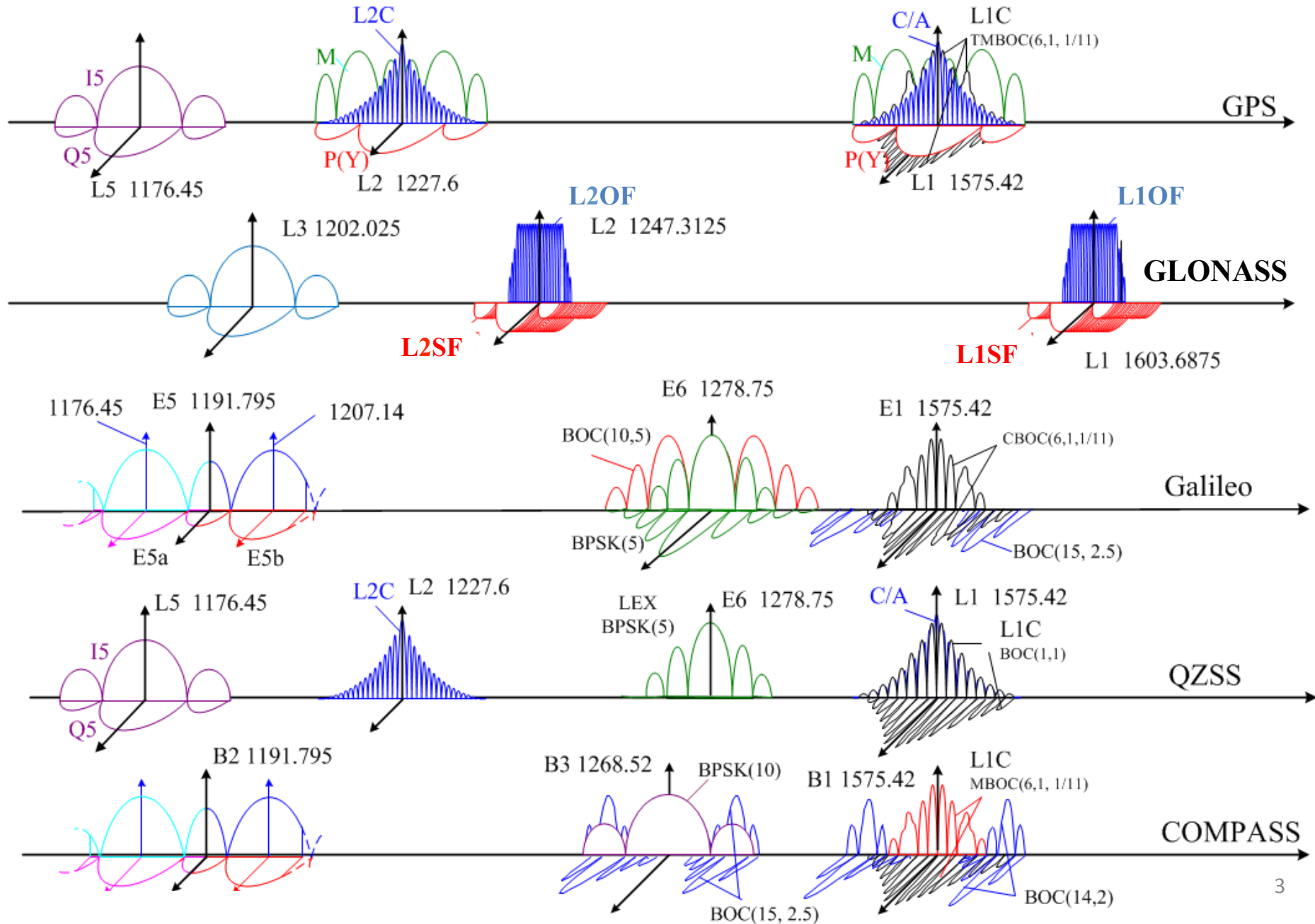
The Time To First Fix (TTFF)

TTFF: system characteristic?

TTFF: receiver characteristic?

TTFF: characteristic of system and receiver?

Could the TTFF serve as criterion for receivers comparison?

Navigation signal characteristics

	GPS				GLONASS		GALILEO			QZSS				COMPASS	
	C/A	L1C	L2C	L5	L1OF	L2OF	E1	E5a	E5b	L1C/A	L1C	L2C	L5	B1	B2
1. Received power level, dBW	-158,5	-157,0	-160,0	-157,9	-161.0	-161.0	-157,0	-155,0	-155,0	-158.5	-157,0	-160.0	-154,9	-163,0	-163,0
2. Chip rate, Mcps	1.023	1.023	0.5115 0.5115	10.23	0.511	0.511	1.023 6.138	10.23	10.23	1.023	1.023	0.5115 0.5115	10.23	2.046	2.046
3. Data rate, bit/s	50	100	25	50	50	50	250	50	250	50	100	25	50	50	500
4. Data duration, s	750	18	168	84	150	150	720	600	720	750	18	168	84	720	360
5. Data signal	+	+		+	+	+	+	+	+	+	+		+	+	+
6. Pilot signal	-	+		+	-	-	+	+	+	-	+		+	+	+

TTFF definition problems

Different GNSS:
- different signals;
- different number of visible satellites;
- SBAS, GBAS, assisted information

Different signals :
- different power levels;
- different chip rates;
- different data rates;
- different message duration;
- pilot or data signals

Different navigation receivers:
- single- or multi- systems;
- channel number;
- different applications (mass consumption, high-precision equipment, aviation, etc.)

Do we need TTFF parameter?

TTFF definition:
1. **Is the TTFF the time from switch-on to the first coordinate determination ?**
   Or
2. **Is the TTFF the time from switch-on to coordinate determination with given accuracy?**

Russian specialists consider that the first definition is more correct because the complex statistical processing is required for the second TTFF definition.
Only the first TTFF definition is discussed below.

Is it useful the TTFF parameter when a wide variety of GNSS, their navigation signals and messages as well as different navigation receivers are available?

Russian specialists consider that TTFF parameter is useful. It is only necessary to fix the initial conditions, for example:

- GNSS used in receiver;
- used signals;
- received power level;
- number of receiver channels;
- use/no use SBAS;
- use/no use assistance service, etc.

Refinement of TTFF Methodology (1)

In our opinion the method of determining TTFF is necessary to clarify:

Starting conditions (see previous slides)

Receiver operating conditions:

- stationary;
- mobile;
- with initial data (S, VS) from object computer system;
- without initial data (S, VS)

The signal level correspond to ICD

Some Russian experts believe that the concept of a warm start is useless, because of large quantity of various starting conditions

Refinement of TTFF Methodology (2)

In our opinion cold start definition (proposed by M. Paonni in his paper) are completely correct. It is necessary to add T_{pvt} parameter in hot start definition.

$$TTFF_{cold} = T_{warm-up} + T^c_{acq} + T_{track} + T_{CED+GST} + T^c_{PVT}$$

$$TTFF_{hot} = T^h_{acq} + T_{track} + T_{pvt}$$

GLONASS typical values:

$T_{warm-up} = 2\text{-}3 \text{ s};$ $T^c_{acq} \leq 20 \text{ s}$ $T^c_{pvt} \cong 0.1 \text{ s}$

$T^h_{acq} = 2 \text{-} 5 \text{ s}$ $T_{trac} = 3 \text{-} 5 \text{ s}$ $T_{CED+GST} = 8 \text{-} 30 \text{ s}$

In our opinion statistical TTFF data processing has to include mean value and rms deviation at identical starting conditions for each test.

The Time To First Track (TTFT)

One more parameter – Time To First Track (TTFT) - is proposed to discuss.

In our view TTFT parameter is useful, it does not depend on information and defines own receiver parameters more completely.

TTFT parameter can be especially useful for estimation of pilot signal processing.

It is necessary to fix TTFT from switch-on time to time of lock loop work beginning (mainly frequency lock loop). In this case cold and hot starts also are available.

The cold start: almanac and coordinates are not known and pseudorange and pseudorange rate forecast is impossible;

The hot start: almanac and approximate coordinates are known, pseudorange and pseudorange rate forecast is possible.

SUMMARY (1)

TTFF is the system and receiver characteristic

The proposed methodology can be used as the basis for cold and hot start TTFF definition.

Some Russian experts believe that the concept of a warm start is useless, because of large quantity of various starting conditions

The TTFF measurement   should be performed   at well-defined starting conditions (number of GNSS, signals, receiver channels, power level, etc).

Under these conditions it is possible   to compare different receiver types according to TTFF parameter.

SUMMARY (2)

One more parameter – Time to First Track (TTFT) was proposed to discuss

TTFT describes itself receiver especially in pilot signal processing.

Also the cold and hot starts can be retained in TTFT definition.

Thank you for your attention