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Volumetrically-Derived Global Navigation Satellite System Performance Assessment From the Earth's Surface Through the Terrestrial Service Volume and the Space Service Volume

Bryan W. Welch
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November 2016

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Abstract

NASA is participating in the International Committee on Global Navigation Satellite Systems (GNSS) (ICG)'s efforts towards demonstrating the benefits to the space user from the Earth's surface through the Terrestrial Service Volume (TSV) to the edge of the Space Service Volume (SSV), when a multi-GNSS solution space approach is utilized. The ICG Working Group: Enhancement of GNSS Performance, New Services and Capabilities has started a three phase analysis initiative as an outcome of recommendations at the ICG-10 meeting, in preparation for the ICG-11 meeting. The first phase of that increasing complexity and fidelity analysis initiative was recently expanded to compare nadir-facing and zenith-facing user hemispherical antenna coverage with omnidirectional antenna coverage at different distances of 8,000 km altitude and 36,000 km altitude. This report summarizes the performance using these antenna coverage techniques at distances ranging from 100 km altitude to 36,000 km to be all encompassing, as well as the volumetrically-derived system availability metrics.

Introduction

The region of space nearby the Earth is divided into two specific regions, defined as the Terrestrial Service Volume (TSV) and the Space Service Volume (SSV) (Ref. 1). The TSV is defined from the Earth's surface up to an altitude of 3,000 km, while the SSV is defined from the altitude of 3,000 km to the geostationary altitude of roughly 36,000 km. These two regions of space are illustrated in Figure 1. Navigation system performance is vastly different in these two regions of space, as many of the GNSS constellations operate in Medium Earth Orbit (MEO) at an altitude around 20,000 km. Space users in the TSV can expect to observe GNSS satellites with a zenith-facing antenna just as a ground user on the Earth's surface, though a nadir-facing antenna can also provide comparable performance above specific minimum altitudes, such that Earth blockage effects are minimized. However, space users in the SSV will observe dramatically different numbers of GNSS satellites, both dependent on the space user altitude but also its antenna location. At the maximum altitude within the SSV at 36,000 km, space users will not be able to observe MEO GNSS satellites with a zenith-facing antenna, but rather, will be required to observe GNSS satellites with a nadir-facing antenna which have signals crossing over the Earth's limb (Ref. 2).

Analysis (Ref. 3) previously reported the geometrical coverage performance of four global and two regional GNSS constellations, solely using a nadir-facing antenna at the altitude of 36,000 km altitude. The trade space of the global GNSS constellation includes the United States' Global Position System (GPS) (Refs. 4 and 5), European Galileo (Ref. 6), Russian Global Navigation Satellite System (GLONASS) (Ref. 7), and Chinese BeiDou (Ref. 8). The trade space of the regional GNSS constellations include Indian Regional Navigation Satellite System (IRNSS) (Ref. 9) and the Japanese Quasi-Zenith Satellite System (QZSS) (Ref. 10). Due to the nature of the main antenna beam of those GNSS constellations being directed nadir, along with the fact that side-lobe antenna performance is unspecified, visibility is restricted to the portion of the antenna beam that extends beyond the Earth blockage, as seen in Figure 2.

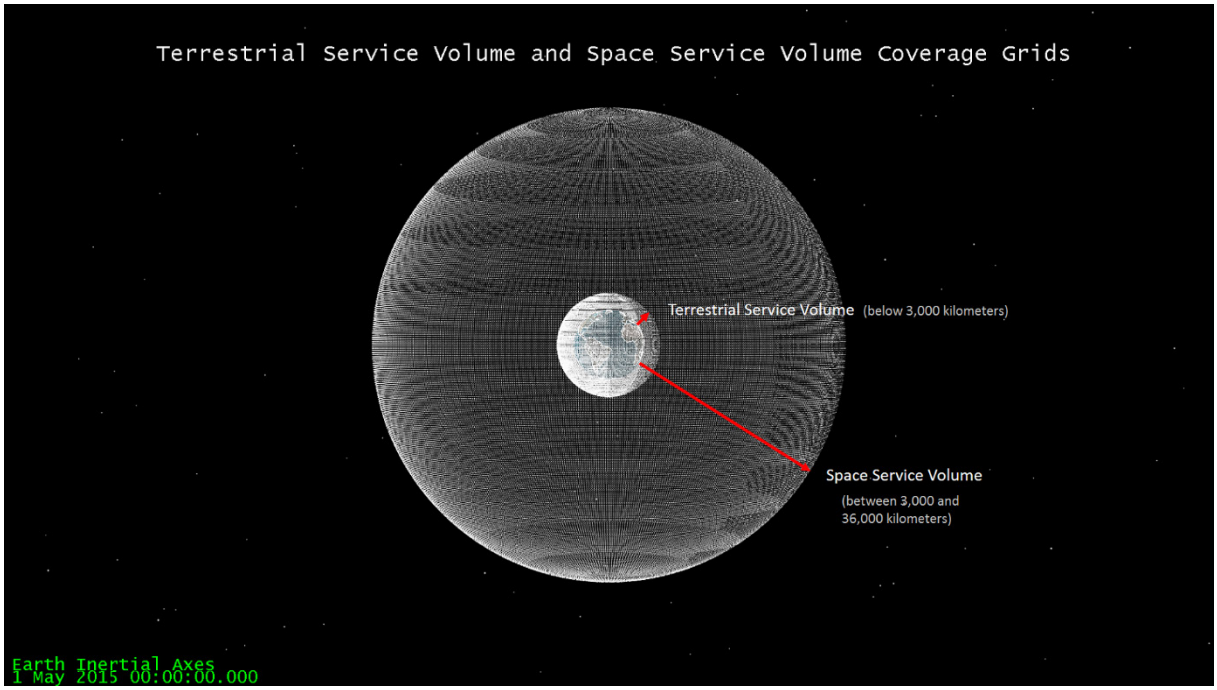

Figure 1.—Earth Terrestrial and Space Service Volume Regions

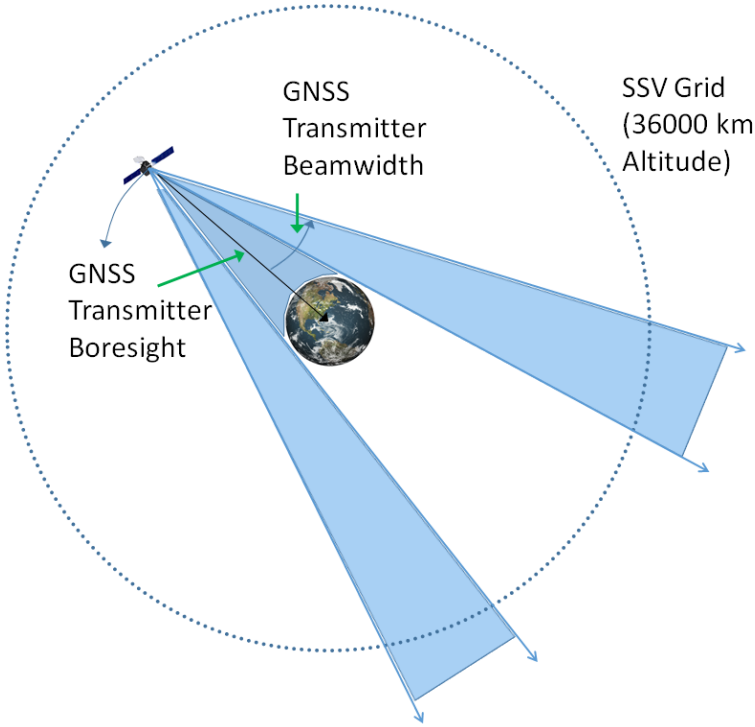

Figure 2.—GNSS Visibility Limitations

That ultimately limits the visible number of GNSS spacecraft that can be in view of the space users at all altitudes. The results of this paper utilize previously developed analytical techniques (Ref. 3) for deriving the visibility Figures of Merit with the concept of analyzing individual GNSS constellations separate from the combined multi-GNSS system. However, this work extends that capability by performing those analyses at distances ranging from above the Earth's surface through the edge of the SSV, using nadir-facing, zenith-facing, and omnidirectional user antenna constraints, as well as calculating a volumetrically-derived system availability metric, as a means to combine the performance characteristics over the various altitudes analyzed.

Analysis Methodology and Assumptions

This paper is an expanded effort of the results reported previously (Ref. 3), where the antenna constraint was limited to a nadir-facing hemispherical coverage at a distance of only 36,000 km altitude. These efforts build on those same Keplarian orbital simulation assumptions, equal area-based grid of points and beamwidths to assess the full distance range from the Earth's surface using additional user antenna constraints of zenith-facing hemispherical coverage and omnidirectional coverage. All orbital simulation assumptions and orbital Keplarian parameters can be found in Reference 3.

The table of the GNSS transmit beamwidths is provided in Table 1 for both the L1 (1575.42 MHz) and L5 (1176.45 MHz) frequency bands that this study also analyzes against. Note that for the BeiDou constellation, the beamwidth is defined separately for the satellites in MEO or Geostationary (GEO) / Inclined Geosynchronous Orbit (IGSO). Also, for IRNSS, L1 beamwidth is not applicable, as IRNSS does not transmit the L1 frequency band. It is also important to note that all L5 beamwidths are larger than their constellation's L1 beamwidth, as that will directly impact performance results.

Similarly to the previous study (Ref. 3), access is derived and limited from purely geometrical limitations from two perspectives. The space user in the SSV grid needs to be within the specified beamwidth angle of the GNSS transmitter beam, which may preclude access due to Earth blockage, as seen in Figure 3. Also, the GNSS transmitter needs to be within the space user's antenna field of view, which is now defined to either be nadir-facing hemispherical, zenith-facing hemispherical, or omnidirectional. These three space user fields of view considerations are shown in Figure 4 through Figure 6, respectively. Previous specialized definitions for the IRNSS pointing vector (Ref. 3) also apply in this analysis effort, as that is an artifact of that constellation design and implementation.

TABLE 1.—GNSS TRANSMITTER BEAMWIDTHS

GNSS Constellation	L1 Beamwidth, degree	L5 Beamwidth, degree
BeiDou	25 (MEO) 19 (GEO/IGSO)	28 (MEO) 22 (GEO/IGSO)
Galileo	20.5	23.5
GLONASS	20	28
GPS	23.5	26
IRNSS	Not Applicable	16
QZSS	22	24

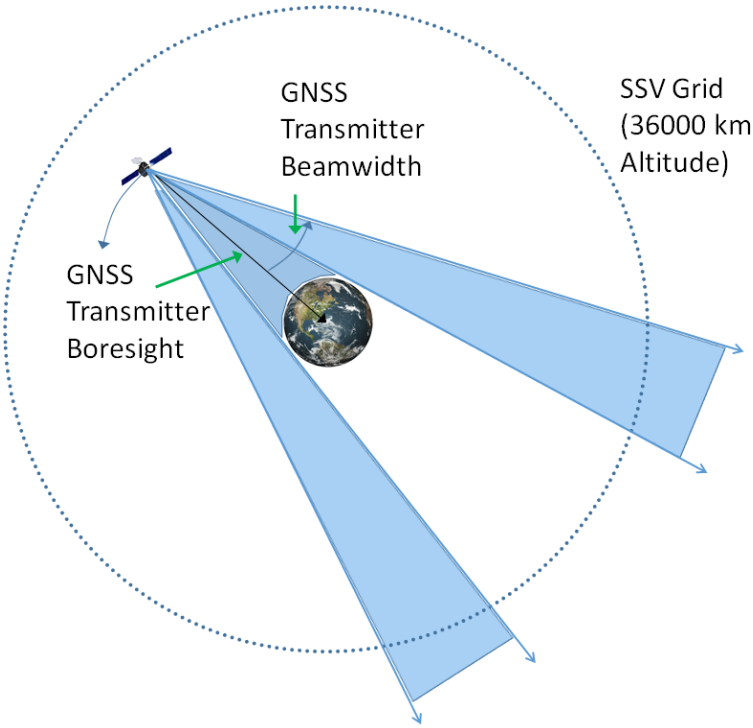

Figure 3.—GNSS Transmitter Geometrical Access Considerations

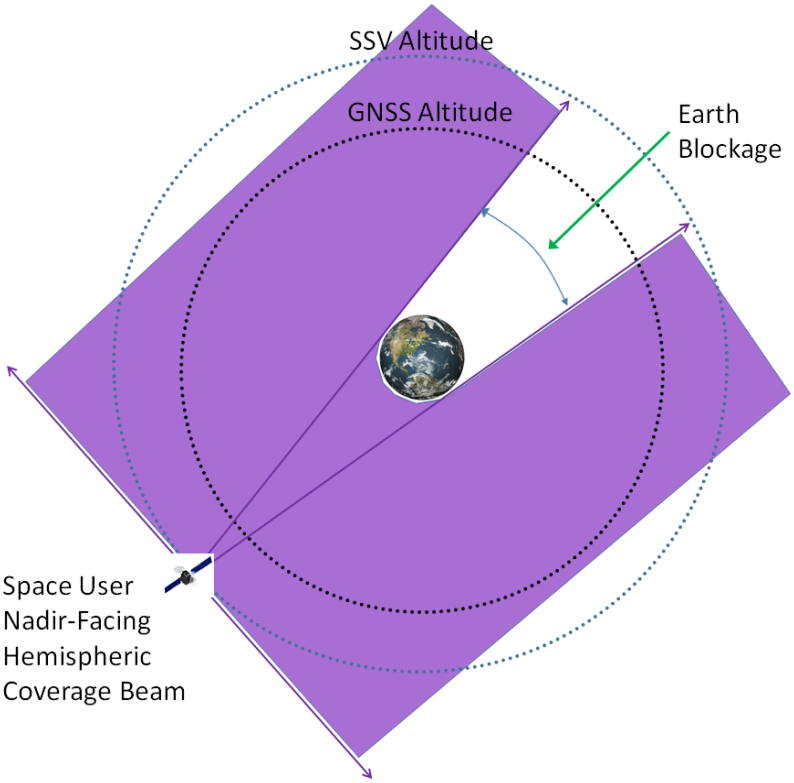

Figure 4.—Space User Nadir-Facing Antenna Geometrical Access Considerations

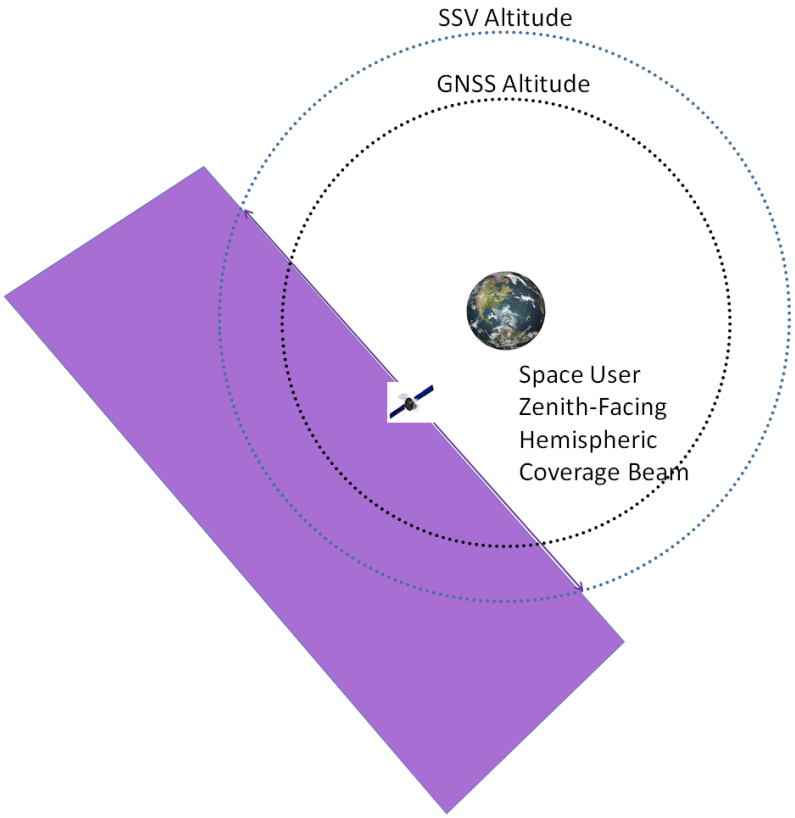

Figure 5.—Space User Zenith-Facing Antenna Geometrical Access Considerations

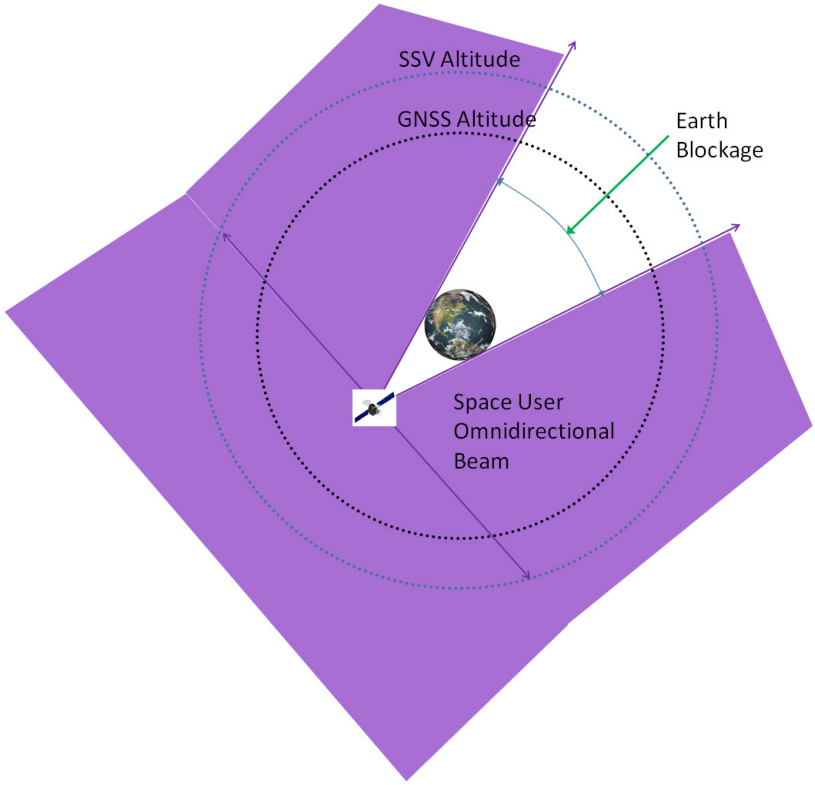

Figure 6.—Space User Omnidirectional Antenna Geometrical Access Considerations

The overall simulation methodology is performed in multiple steps, which are listed below, to derive the Figures of Merit for a particular altitude:

1. Propagate orbit position vectors into Earth-Centered Earth-Fixed frame coordinates over scenario time instances.
2. Calculate angle off GNSS boresight vector to all SSV grid points over scenario time instances.
3. Calculate angle off SSV nadir boresight vector to all GNSS orbit positions over scenario time instances.
4. Determine yes/no access using maximum GNSS beamwidth consideration, Earth blockage consideration, and SSV hemispherical/omnidirectional beamwidth consideration over scenario time instances for all SSV grid points.
5. Calculate Figures of Merit from access determination over scenario time instances over all SSV grid points.

Following the calculation of the System Availability (SA) metric over a matrix of data X that spans the range of time instants N_T by the range of grid points N_P containing the number of available satellites in view at individual grid-time points, as shown below in Equations (1) and (2), the set of SA metrics for a particular minimum number of satellites in view are utilized together to derive the Volumetric System Availability parameter.

$$SA(N_{\min}) = \frac{1}{N_T N_P} \sum_{i=1}^{N_T} \sum_{j=1}^{N_P} Y(i, j, N_{\min}) \tag{1}$$

$$Y(i, j, N_{\min}) = \begin{cases} 1, & X(i, j) \geq N_{\min} \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

The Volumetric System Availability (VSA) is defined as the weighted average of the various SA terms, where the weighting is proportional to the slice of the volume in the TSV or SSV that the SA represents using sequential altitudes Alt_{k-1} and Alt_k for a range of altitudes N_A, compared to the overall volume of the SSV. This is defined in Equation (3), where the weighting term is defined in Equation (4), using the definition of R_E as utilized in the orbital propagation routines.

$$VSA(N_{\min}) = \sum_{k=1}^{N_A} SA(N_{\min}, Alt_k) W(Alt_k, Alt_{k-1}) \tag{3}$$

$$W(Alt_k, Alt_{k-1}) = \frac{(R_E + Alt_k)^3 - (R_E + Alt_{k-1})^3}{(R_E + 36{,}000)^3 - (R_E)^3} \tag{4}$$

This additional term can only be derived in this type of analysis, where results are compared not only over a spherical surface, but over a range of spherical surfaces defined to represent the volume of space, which is an additional metric not previously available to be defined in Reference 3.

Access Results

The simulation results that are analyzed for this study are the various Figures of Merit (FoM) as defined in Reference 3, with the additional computation of the new VSA metrics. The Figures of Merit are defined as System Availability and Maximum Outage time, with the minimum number of satellites under consideration being either one or four satellites for each FoM. Since the grid points are defined as having equal area pertaining to each grid point, averaging of performance over the grid points can be done using a pure mean calculation, without additional weighting factors needing to be applied pertaining to the area of the spherical surface that corresponds to each grid point. For the Volumetric System Availability, weighting factors do need to be applied, as the weighting for each grid point over the Earth's surface corresponds to a different volume of space at different altitudes. As stated, the constellations being considered are the six individual constellations, as well as a combined multi-GNSS constellation consisting of all individual constellations, at either the L1 or L5 frequency bands, independently. Therefore, a system performance assessment is not, for example, of using the L1 frequency band performance of BeiDou, Galileo, GLONASS, GPS and QZSS combined with the L5 frequency band performance of IRNSS. Finally, for the purpose of IRNSS, which does not support the L1 frequency band, tabulated SA results are shown as 0, while Maximum Outage times are reported as the duration of the simulations, in minutes, with a value of 20160 minutes.

Summary tables of the Volumetric System Availability parameters for the two frequency bands, each reporting the three antenna field of view considerations, are provided in Table 2 and Table 3, for the L1 frequency band and L5 frequency band respectively. Visualizations of the SA metrics, as well as the maximum outage time metrics are provided in Appendix A, while the tabulated data used in those plots are provided in Appendix B. It should also be noted that the tabulated data uses a rounding down scheme to the tenth's decimal place, such that 100 percent System Availability does not mean 99.9999 percent System Availability, which would be reported as 99.9 percent System Availability.

TABLE 2.—L1 VOLUMETRIC SYSTEM AVAILABILITY RESULTS

Satellites in view	Antenna configuration	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
1	Nadir-facing	99.3	88.8	70.4	95.1	0	37.1	99.9
1	Zenith-facing	11.5	7.1	4.2	6.4	0	5.9	15
1	Omnidirectional	99.3	88.9	70.5	95.1	0	41.2	99.9
4	Nadir-facing	46.2	9.2	3.5	20.6	0	3.3	98.1
4	Zenith-facing	3.4	1.5	0.8	1.6	0	0.8	5.8
4	Omnidirectional	47.5	10.6	4.6	21.2	0	5.7	98.2

TABLE 3.—L5 VOLUMETRIC SYSTEM AVAILABILITY RESULTS

Satellites in view	Antenna configuration	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
1	Nadir-facing	99.9	97.9	99.2	98.7	48.5	41.9	99.9
1	Zenith-facing	13.5	8.4	6.3	7.2	5.4	6.8	18.2
1	Omnidirectional	99.9	97.9	99.2	98.7	52.4	46.4	100
4	Nadir-facing	68.6	21.9	38	39.1	4	5	99.9
4	Zenith-facing	4.6	2.3	2.2	2.1	1.5	1	7.8
4	Omnidirectional	69.4	22.8	38.2	39.3	5.4	8.1	99.9

Results in Table 2 and Table 3 summarize the Volumetric System Availability findings, which are comprised of data illustrated in plots in Appendix A and tabulated in Appendix B. Several key findings are observed in these data. For any given antenna configuration, the larger L5 beamwidth, compared to the L1 beamwidth, provides higher performance capabilities. Also, the omnidirectional antenna provides the combination of zenith-facing and nadir-facing hemispherical coverage capabilities, and can be considered an upper bound on the performance of that particular constellation using the specified beamwidths. The nadir-facing antenna orientation is shown to have a reduction in performance for low altitudes within the typical TSV region of space, which is due to the Earth blockage accounting for a larger percentage of the field of view of that sensor. Finally, the zenith-facing antenna orientation is shown to have its performance reduce as a function of the user orbital altitude, due to the reduced portion of its field of view which intersects the nominal GNSS beamwidth. In that case, altitudes above the GNSS altitude will not see any System Availability due to the geometrical constraints completely blocking the intersection of those signals, which is the primary reason why the VSA for the zenith-facing antenna is so low. If the VSA term had been calculated solely for the TSV, then the data in Appendix B shows that it would be a much higher value than what is was calculated for in the TSV/SSV spatial region combination.

Conclusions and Next Steps

The analysis presented in this paper documents the navigation performance at many altitude levels within the TSV and SSV using individual GNSS constellations and a combined multi-GNSS constellation at the individual L1 and L5 frequency bands. This data is also calculated for three different space user antenna orientations, those being nadir-facing, zenith-facing, and omnidirectional, where the nadir-facing and zenith-facing configurations only provided hemispherical coverage. This paper also derives a new metric which illustrates the weighted-average performance over the TSV and SSV altitudes. The results show that no individual constellation can provide the nominal four satellite coverage at all points in time over all altitudes. The combination of the six GNSS platforms shows that with the use of the L5 frequency band, 100 percent volumetric coverage is possible for a single satellite, while global four satellite volumetric coverage is nearly possible, at 99.9 percent, given the constraint that the space user has an omnidirectional or nadir-facing antenna. Performance with a zenith-facing antenna is severely degraded in altitudes near and above that of the GNSS orbit. The results are very promising towards meeting the needs of space users in the TSV and SSV.

It is important to note that this study was limited to geometrical access considerations, which does not take into account aspects of access pertaining to received signal to noise ratios at the space user, which is also dependent on the space user receiver antenna gain pattern. Future work will need to take into account minimum signal to noise ratio thresholds to determine if a GNSS spacecraft is visible, which should ideally be derived in terms of both initial acquisition signal levels and tracking signal levels, where the tracking signal levels are lower than what is required for initial acquisition. Future work should also recognize the differences in modulation and coding formats of the various GNSS constellation signals, where a specific signal to noise threshold value of one constellation does not mean the same signal to noise threshold value for another constellation. Future work should also take advantage of the transmitter side lobe signals, which requires that the GNSS transmitter antenna pattern is known, to increase the number of potential spacecraft in view of the SSV user. Finally, it is important to note that the methodologies created and reported in this document can be utilized beyond the scope of navigation system coverage analysis, such as for space communication architecture analysis, though for that particular application, the minimum number of satellites in view would nominally be 1 satellite, aside from the use case of launch vehicle tracking, which may require even more signals in view than what is desired for navigation purposes.

Appendix A.—Figure of Merit Performance Plots

A.1 L1 Nadir-Facing Antenna Performance

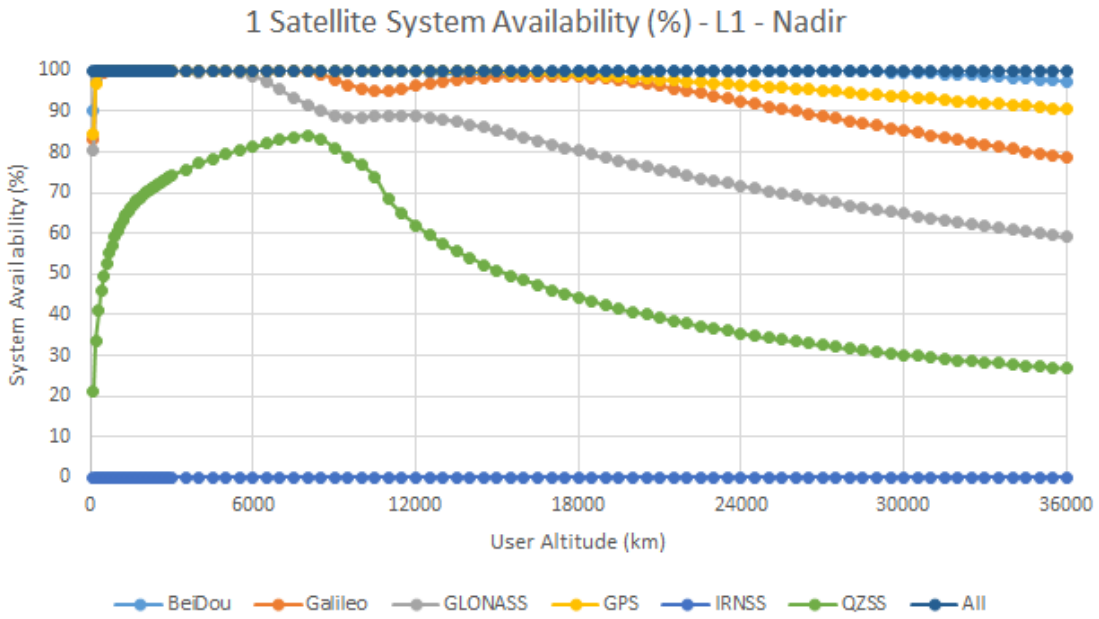

Figure 7.—L1 Frequency Band Nadir-Facing 1 Satellite System Availability Performance

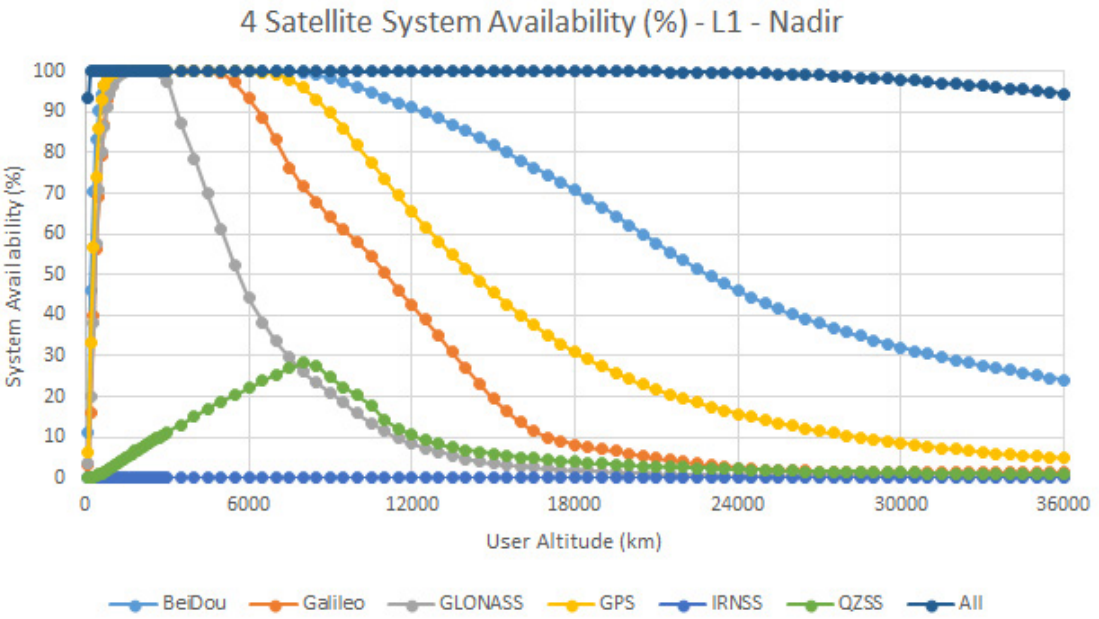

Figure 8.—L1 Frequency Band Nadir-Facing 4 Satellite System Availability Performance

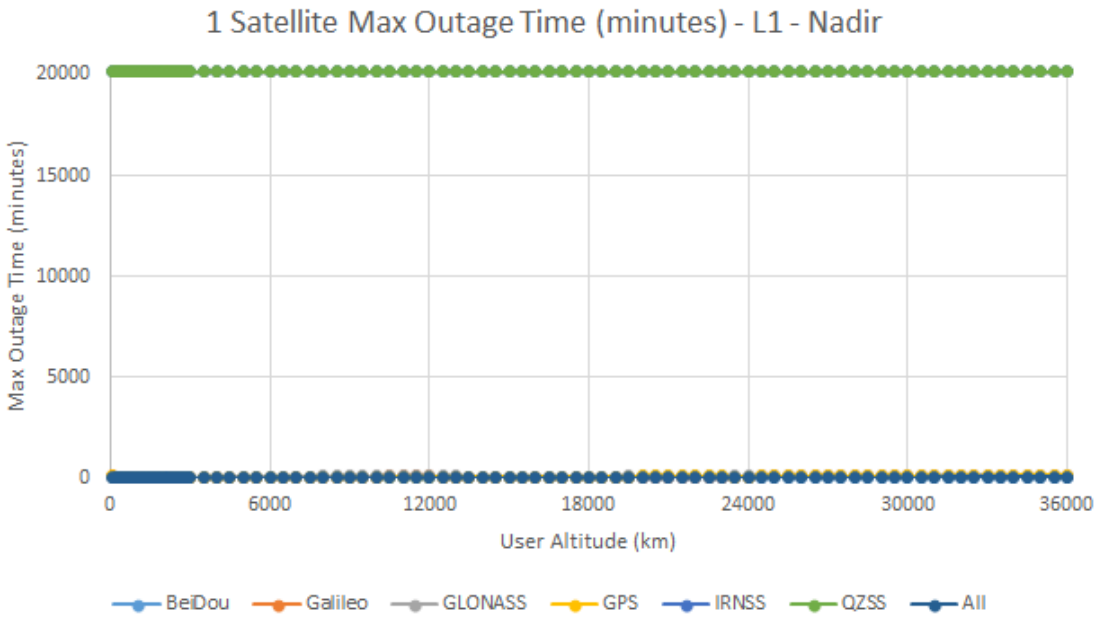

Figure 9.—L1 Frequency Band Nadir-Facing 1 Satellite Maximum Outage Performance

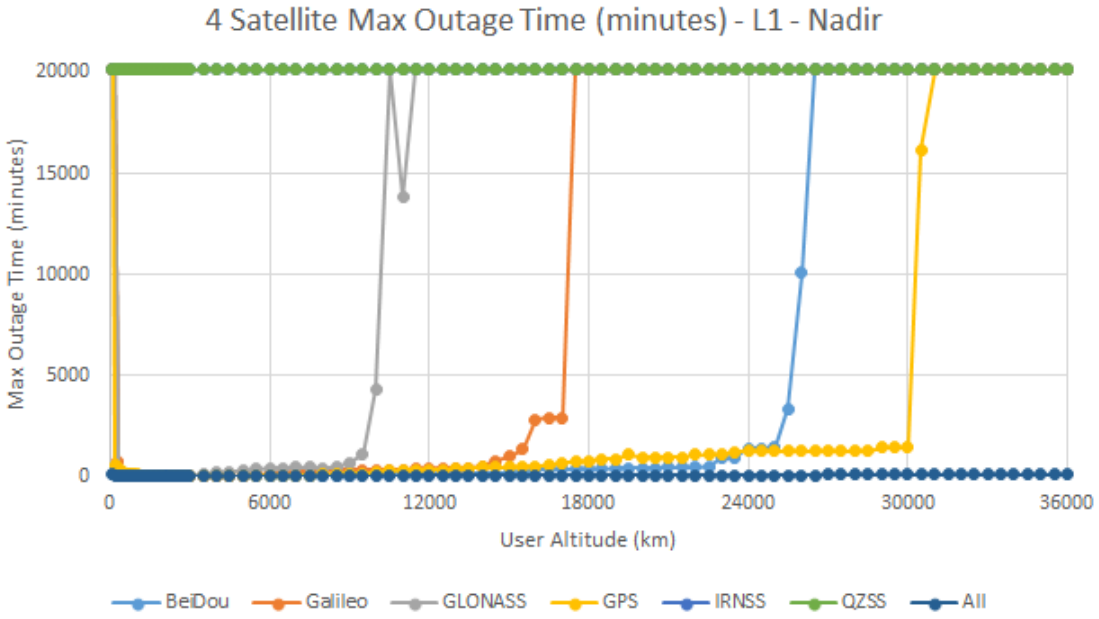

Figure 10.—L1 Frequency Band Nadir-Facing 4 Satellite Maximum Outage Performance

A.2 L1 Zenith-Facing Antenna Performance

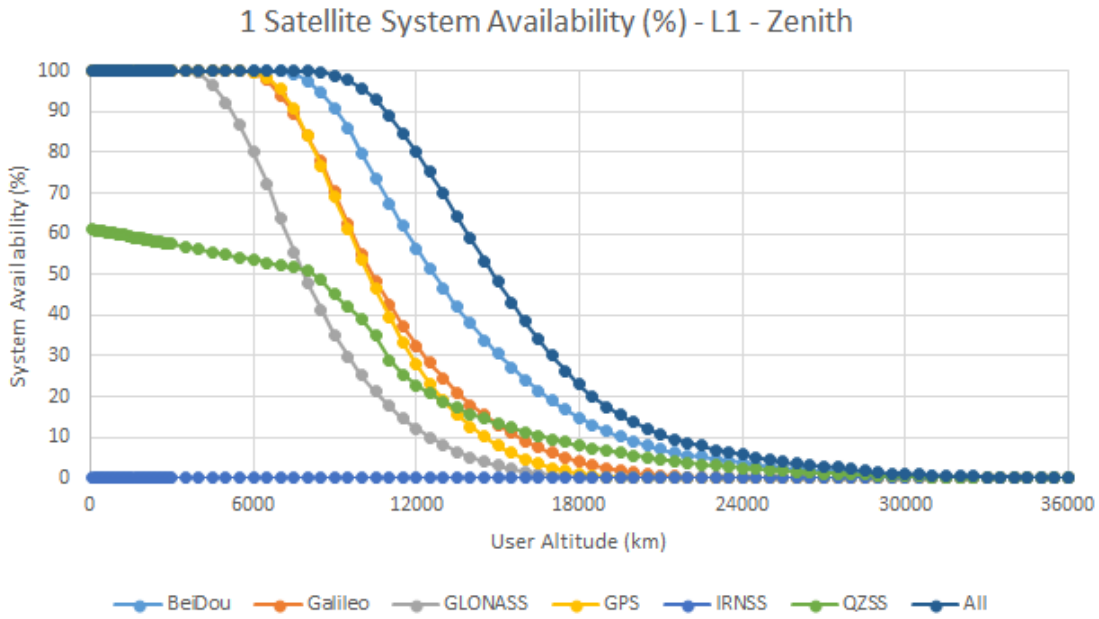

Figure 11.—L1 Frequency Band Zenith-Facing 1 Satellite System Availability Performance

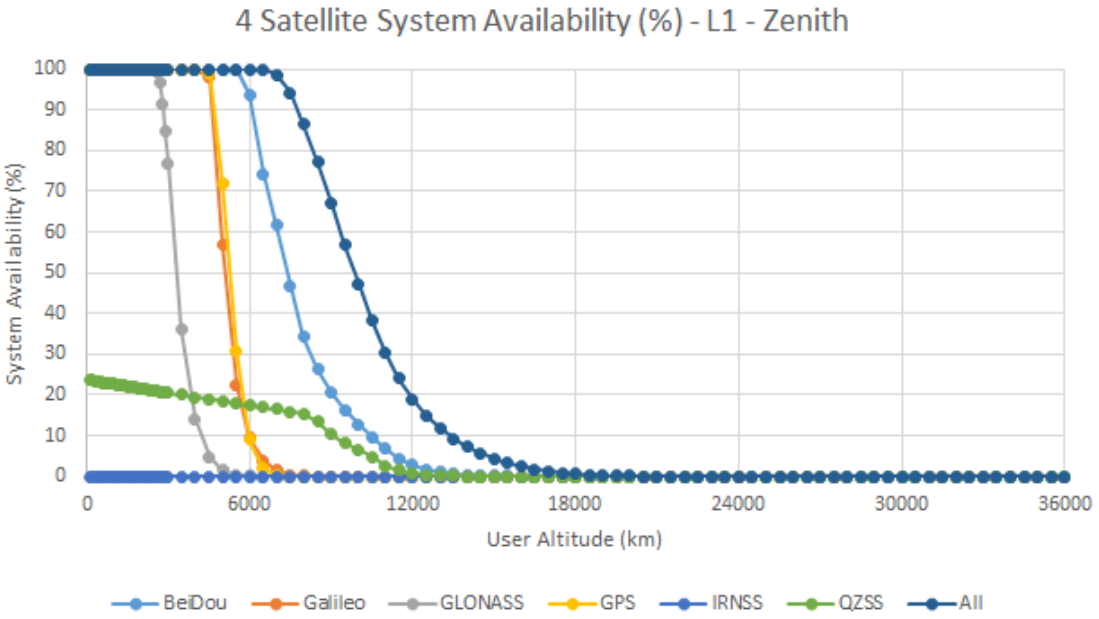

Figure 12.—L1 Frequency Band Zenith-Facing 4 Satellite System Availability Performance

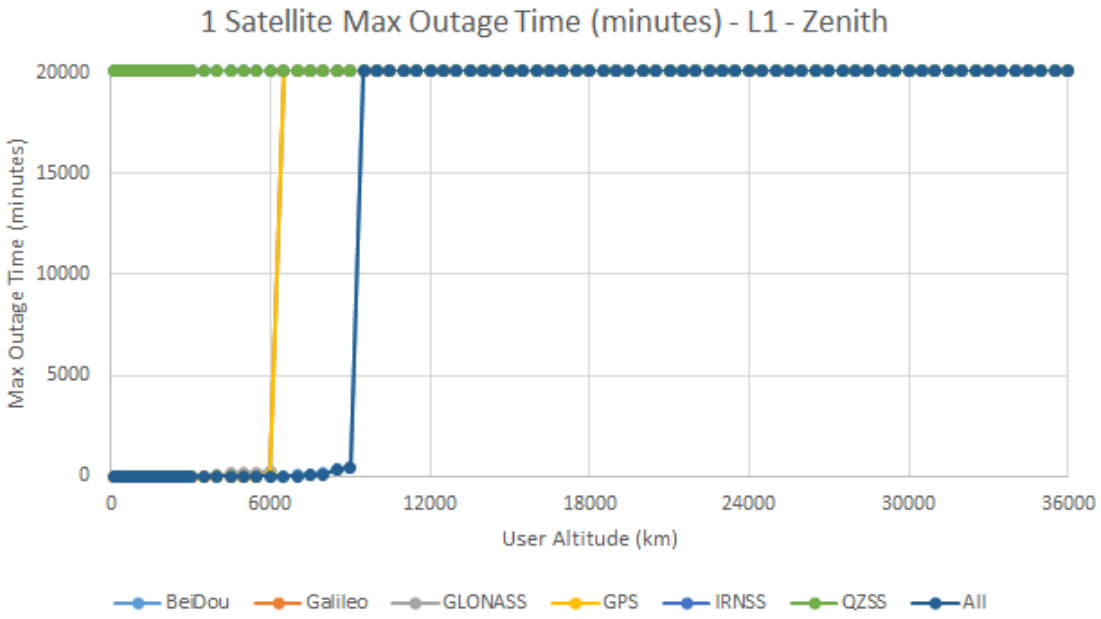

Figure 13.—L1 Frequency Band Zenith-Facing 1 Satellite Maximum Outage Performance

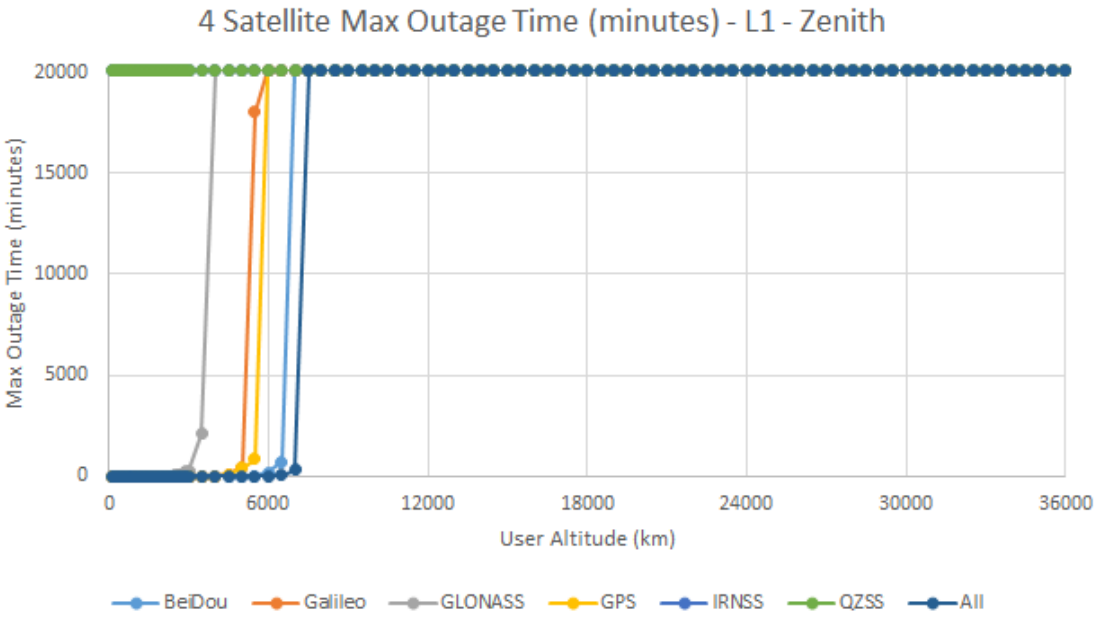

Figure 14.—L1 Frequency Band Zenith-Facing 4 Satellite Maximum Outage Performance

A.3 L1 Omnidirectional Antenna Performance

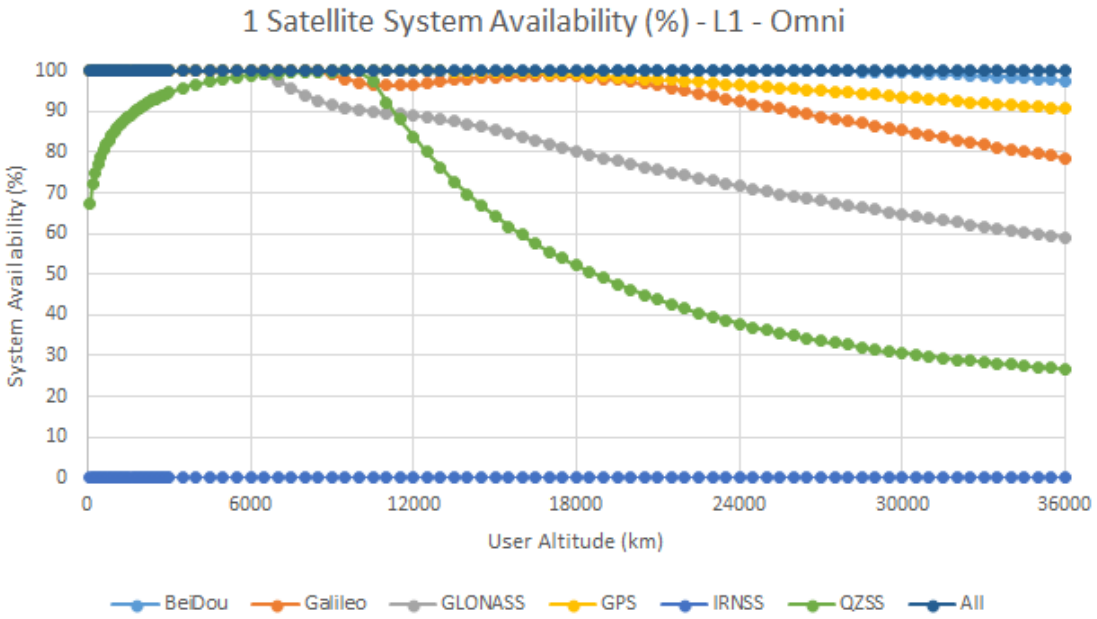

Figure 15.—L1 Frequency Band Omnidirectional 1 Satellite System Availability Performance

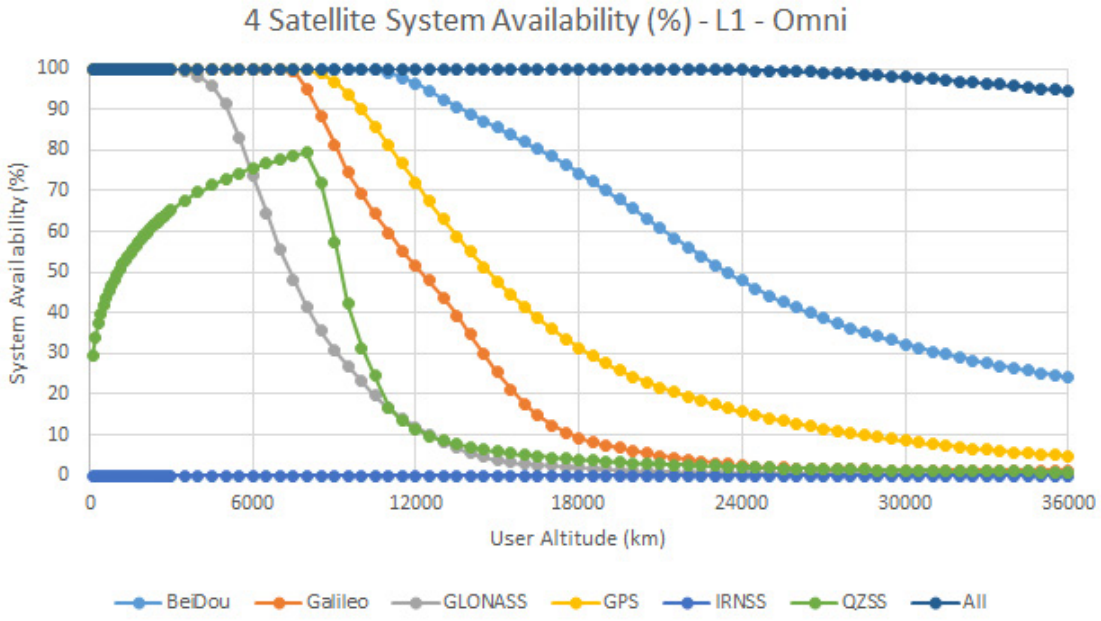

Figure 16.—L1 Frequency Band Omnidirectional 4 Satellite System Availability Performance

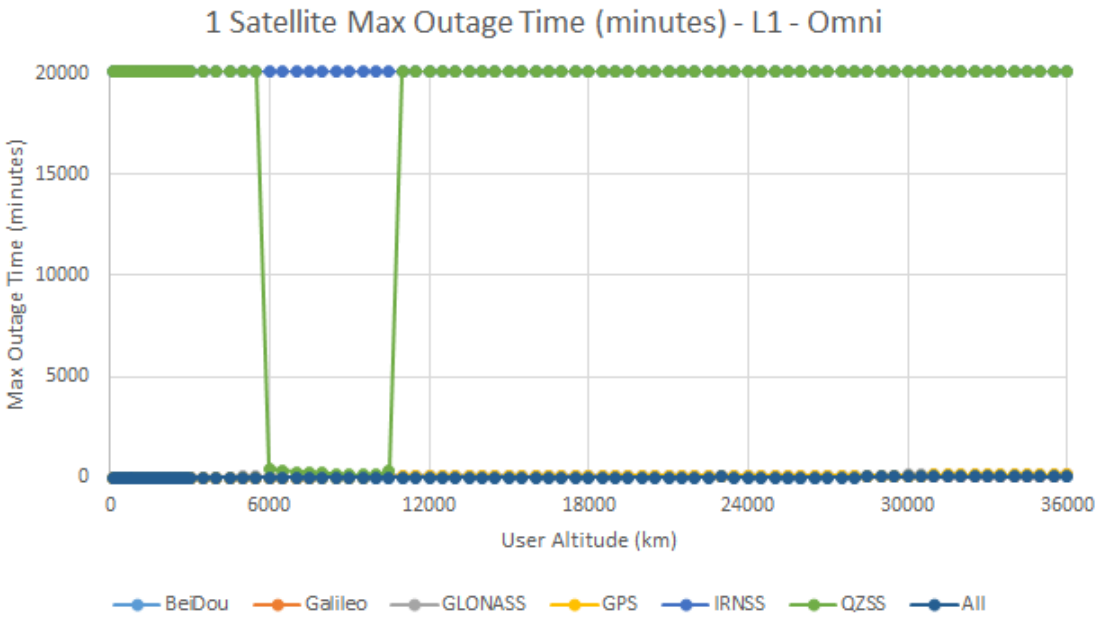

Figure 17.—L1 Frequency Band Omnidirectional 1 Satellite Maximum Outage Performance

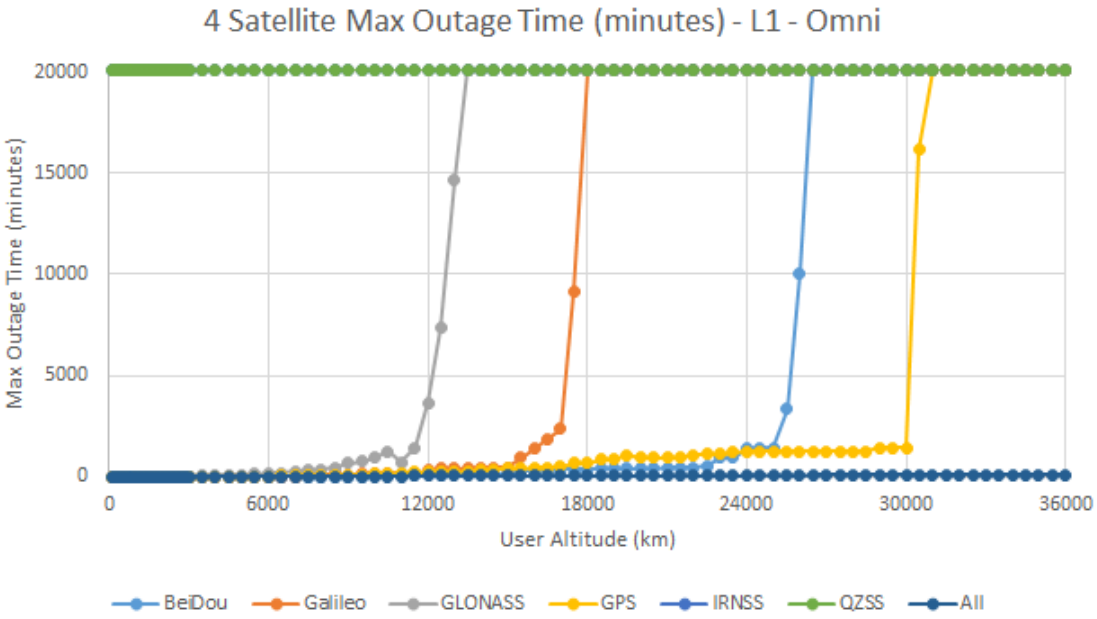

Figure 18.—L1 Frequency Band Omnidirectional 4 Satellite Maximum Outage Performance

A.4 L5 Nadir-Facing Antenna Performance

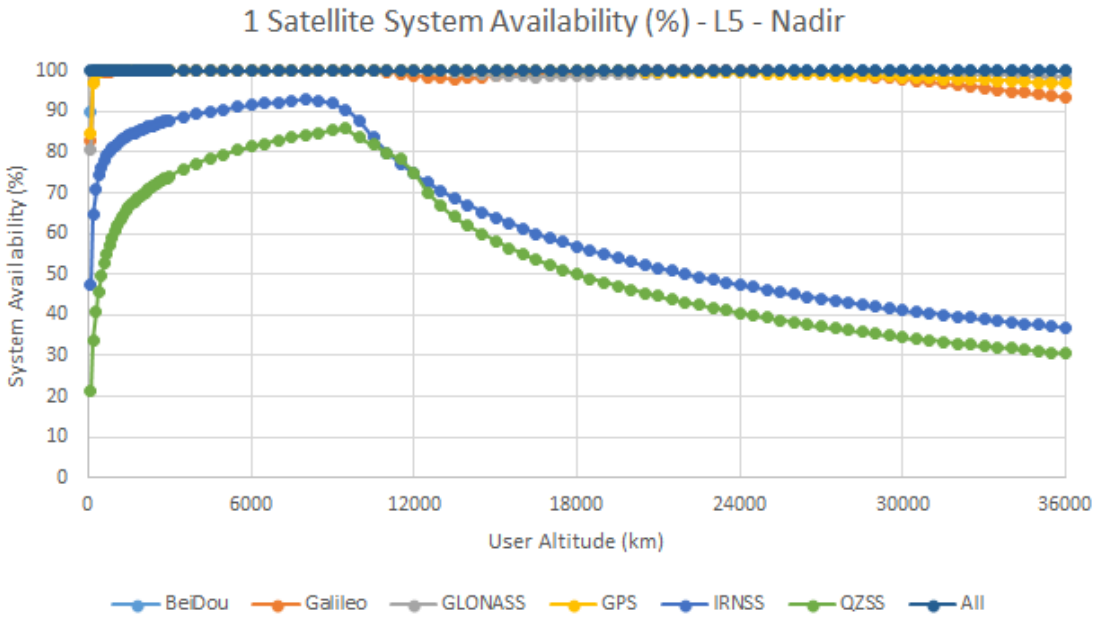

Figure 19.—L5 Frequency Band Nadir-Facing 1 Satellite System Availability Performance

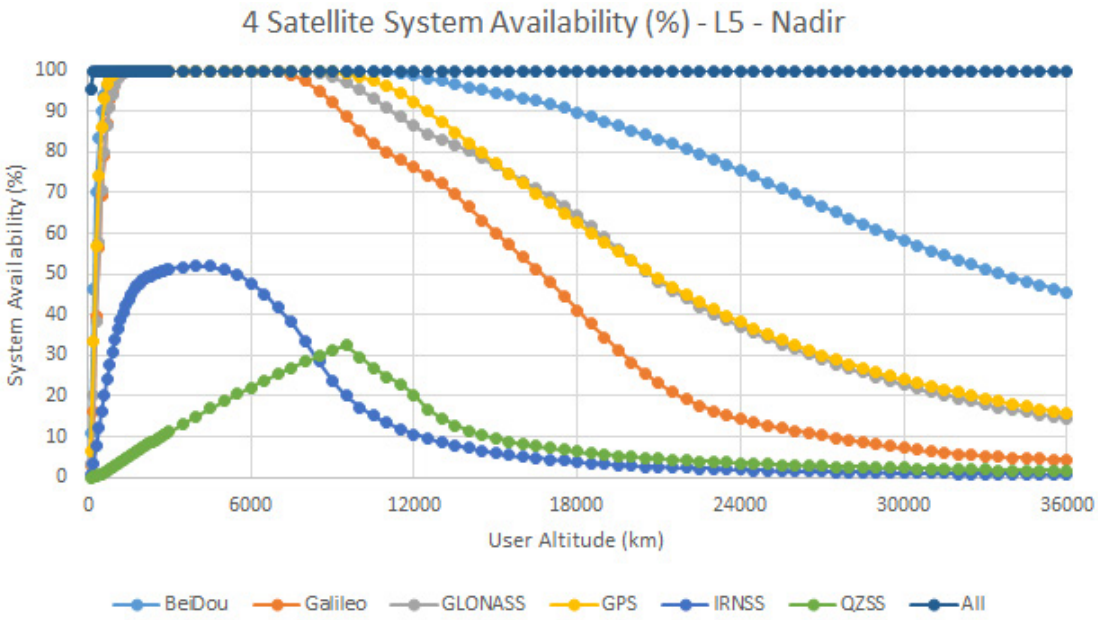

Figure 20.—L5 Frequency Band Nadir-Facing 4 Satellite System Availability Performance

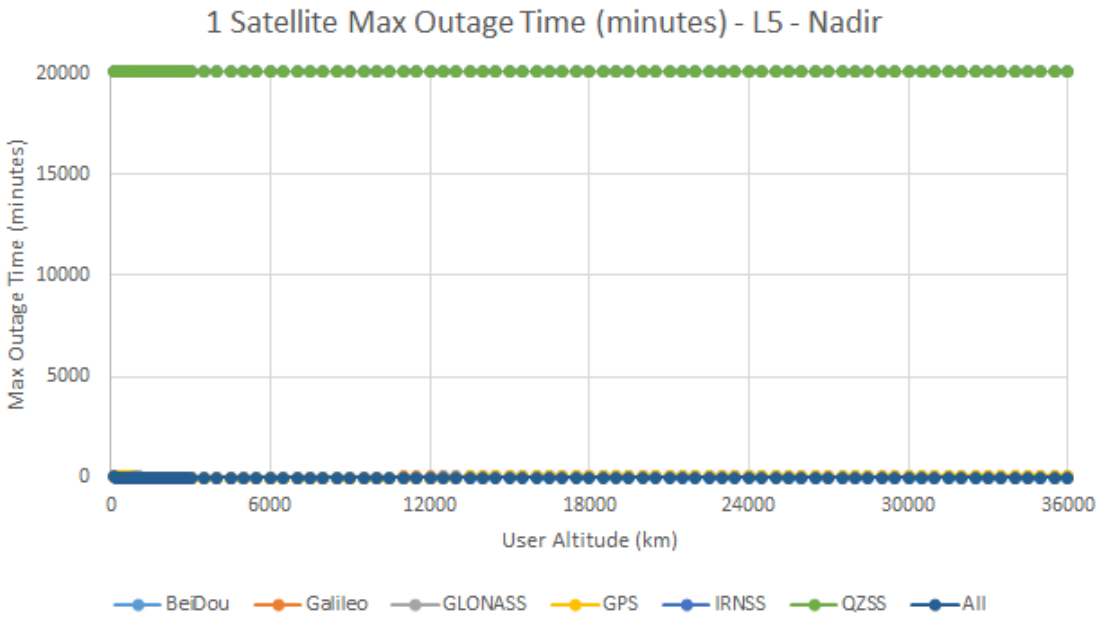

Figure 21.—L5 Frequency Band Nadir-Facing 1 Satellite Maximum Outage Performance

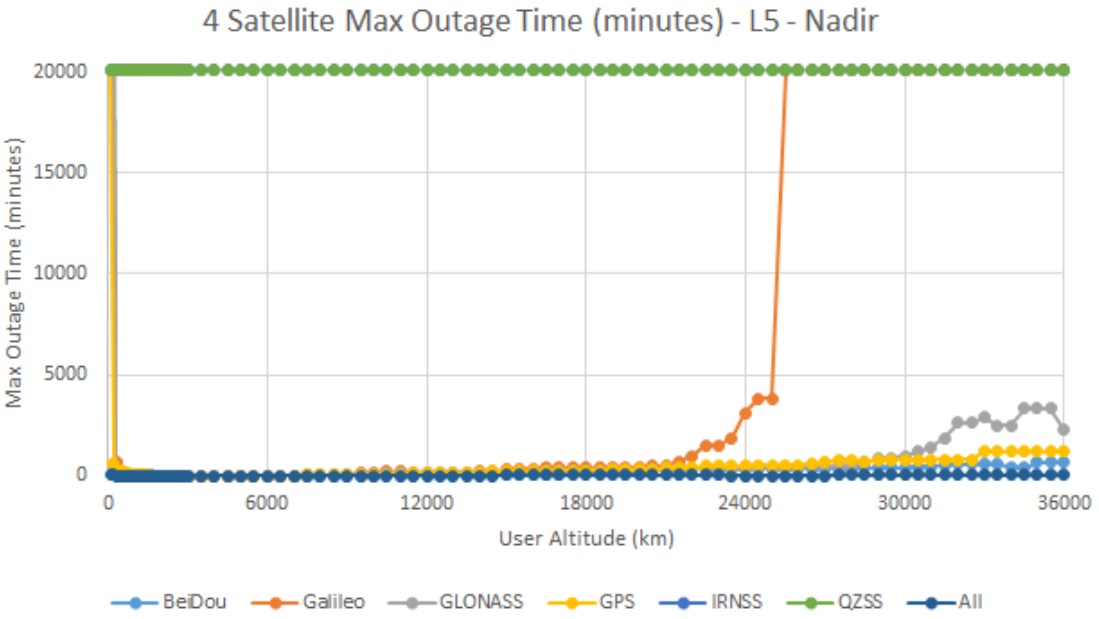

Figure 22.—L5 Frequency Band Nadir-Facing 4 Satellite Maximum Outage Performance

A.5 L5 Zenith-Facing Antenna Performance

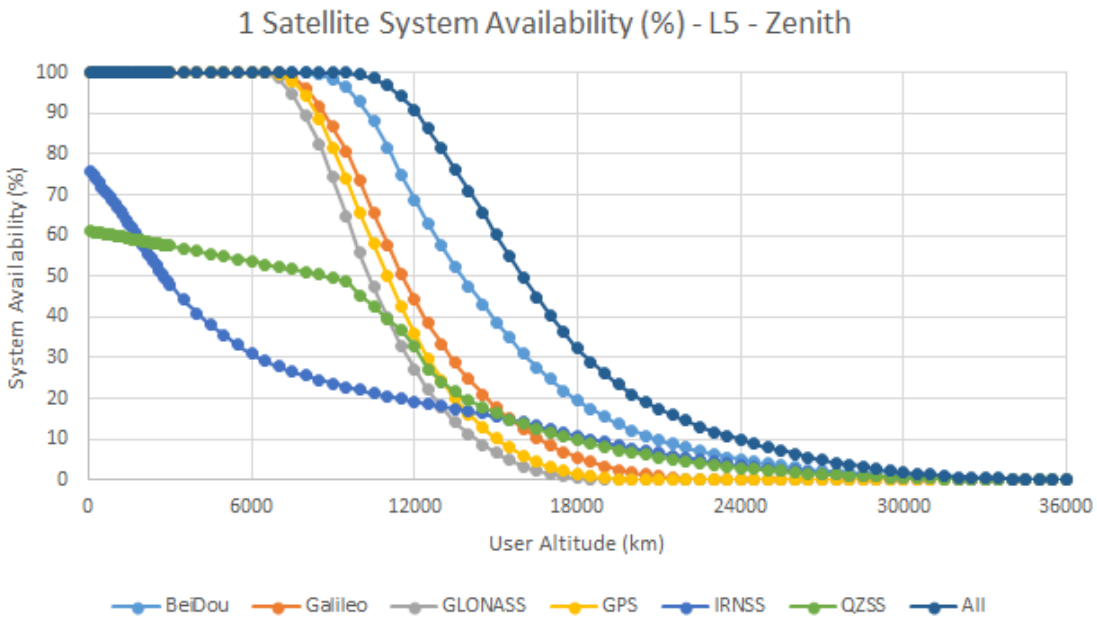

Figure 23.—L5 Frequency Band Zenith-Facing 1 Satellite System Availability Performance

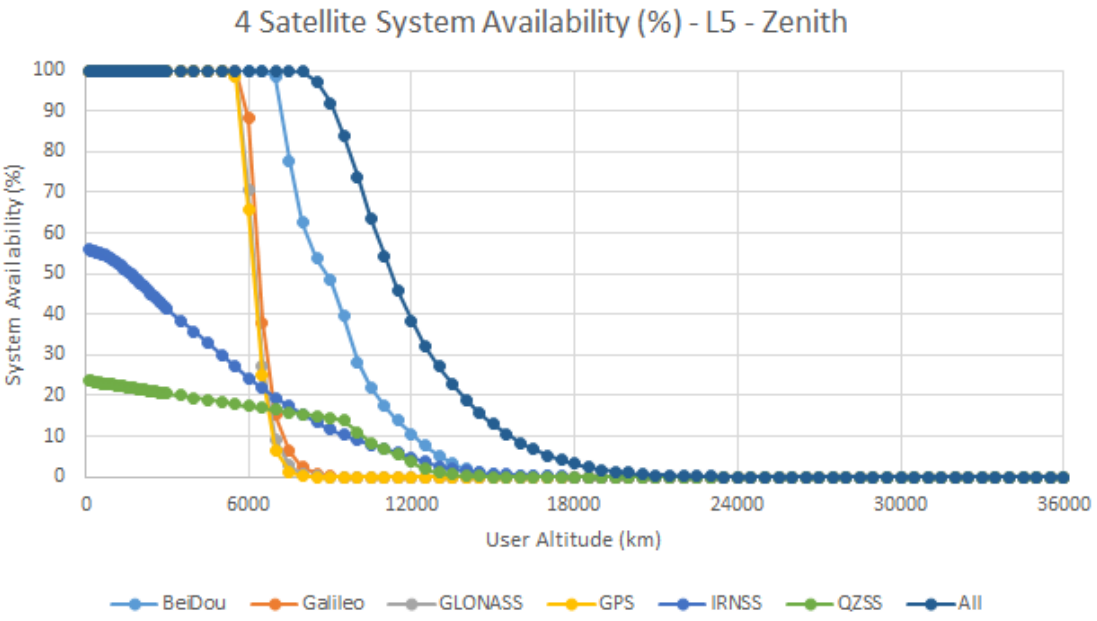

Figure 24.—L5 Frequency Band Zenith-Facing 4 Satellite System Availability Performance

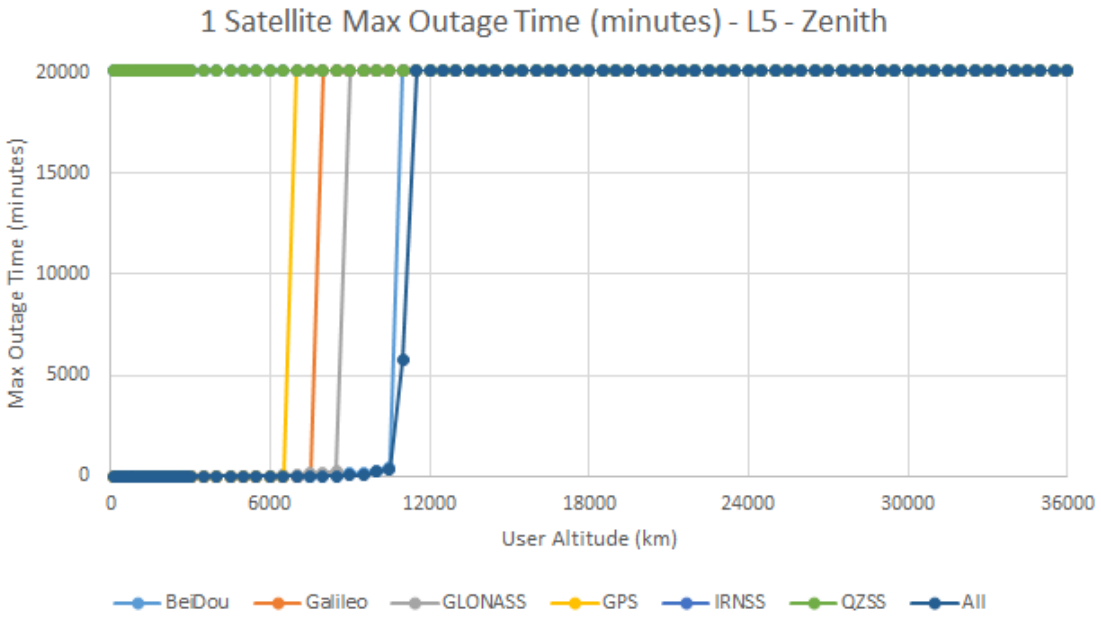

Figure 25.—L5 Frequency Band Zenith-Facing 1 Satellite Maximum Outage Performance

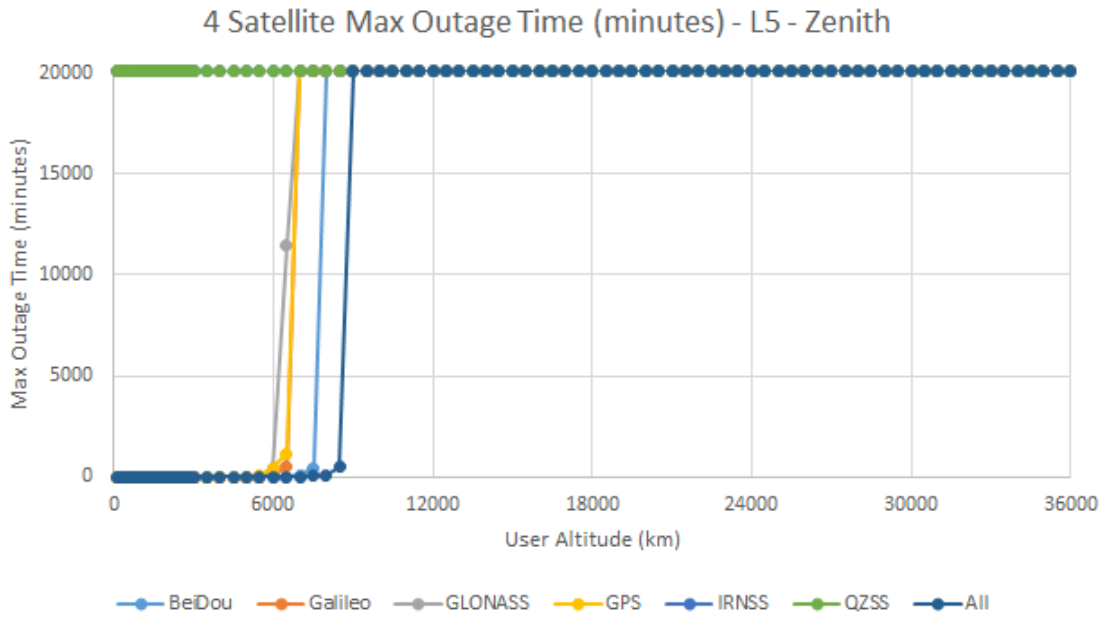

Figure 26.—L5 Frequency Band Zenith-Facing 4 Satellite Maximum Outage Performance

A.6 L5 Omnidirectional Antenna Performance

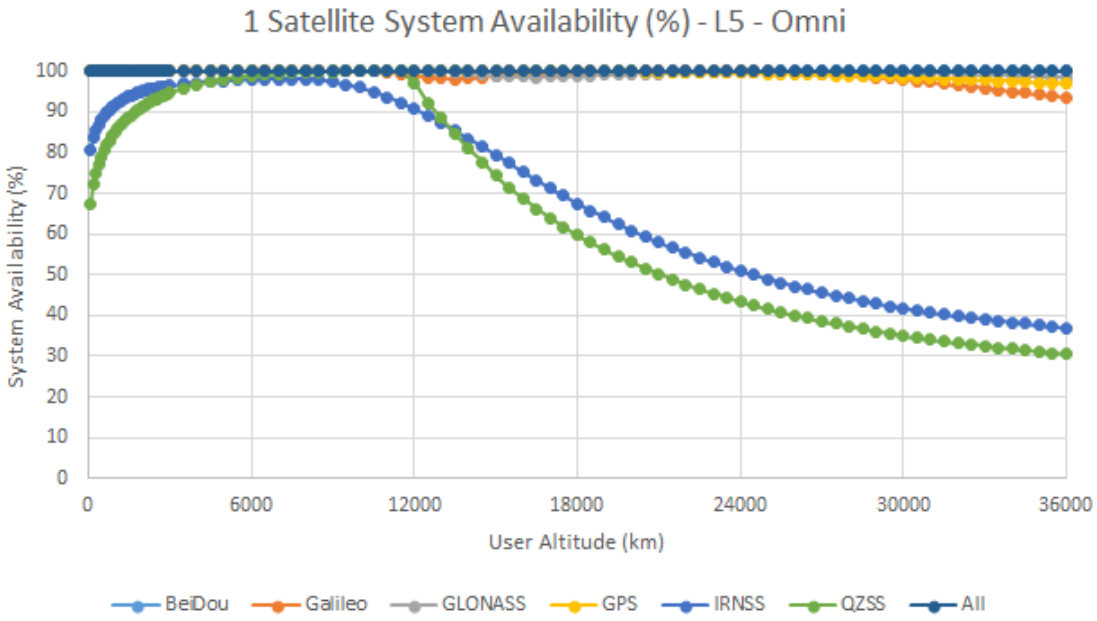

Figure 27.—L5 Frequency Band Omnidirectional 1 Satellite System Availability Performance

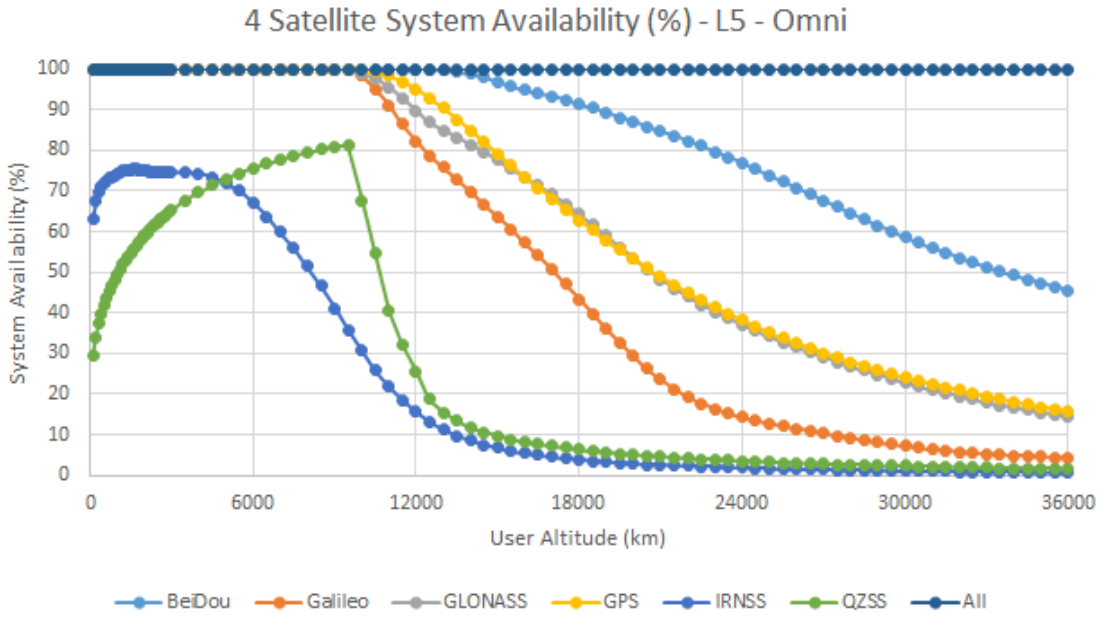

Figure 28.—L5 Frequency Band Omnidirectional 4 Satellite System Availability Performance

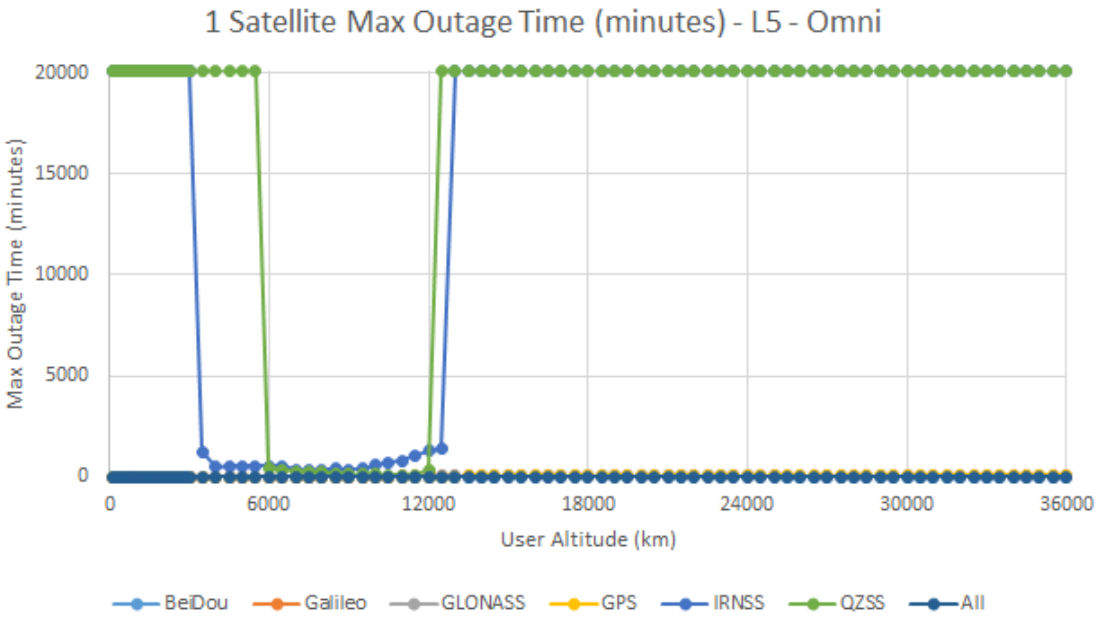

Figure 29.—L5 Frequency Band Omnidirectional 1 Satellite Maximum Outage Performance

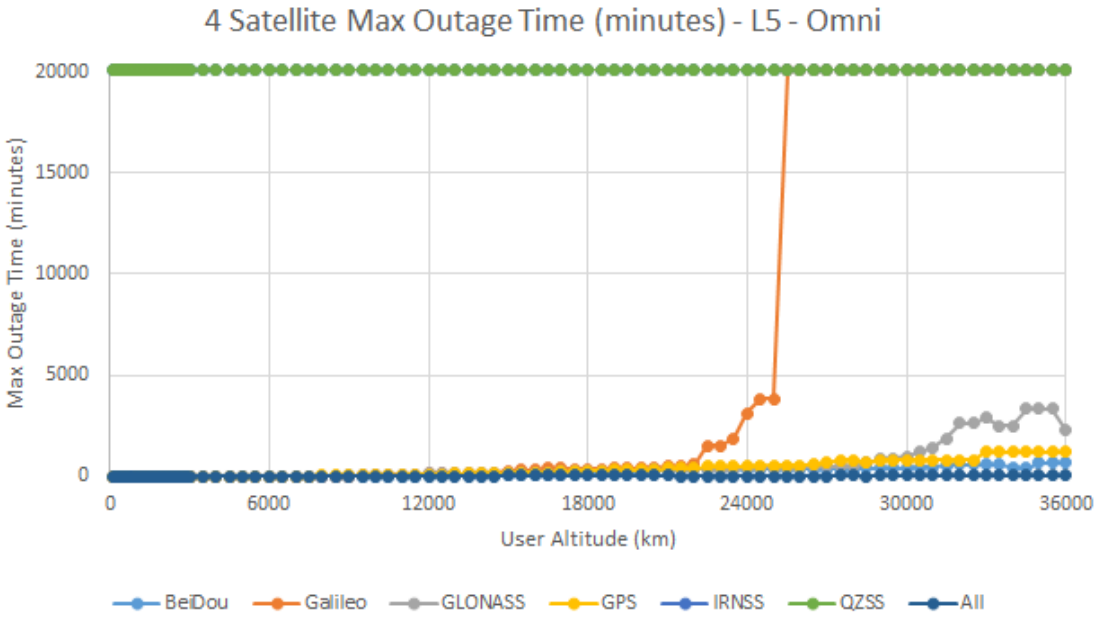

Figure 30.—L5 Frequency Band Omnidirectional 4 Satellite Maximum Outage Performance

Appendix B.—Tabulated Figure of Merit Performance Data

B.1 L1 Nadir-Facing Antenna Performance

TABLE 4.—L1 FREQUENCY BAND NADIR-FACING 1 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	89.9	83	80.5	84.3	0	21.1	99.9	12,500	99.5	96.8	88.5	99.8	0	59.5	100
200	99.4	99	97.5	96.9	0	33.7	100	13,000	99.4	97.3	88	99.8	0	57.4	99.9
300	99.9	99.5	99.8	99.2	0	40.9	100	13,500	99.2	97.7	87.4	99.8	0	55.5	99.9
400	99.9	99.6	99.8	99.8	0	45.8	100	14,000	99.2	98	86.7	99.7	0	53.9	99.9
500	99.9	99.6	99.8	99.9	0	49.5	100	14,500	99.2	98.3	85.9	99.7	0	52.2	99.9
600	99.9	99.7	99.9	99.9	0	52.6	100	15,000	99.2	98.5	85.2	99.7	0	50.9	99.9
700	99.9	99.7	99.9	99.9	0	55.1	100	15,500	99.3	98.6	84.3	99.6	0	49.5	99.9
800	99.9	99.8	99.9	99.9	0	57.1	100	16,000	99.4	98.7	83.5	99.5	0	48.3	99.9
900	99.9	99.9	99.9	100	0	59	100	16,500	99.5	98.7	82.7	99.4	0	47.2	99.9
1,000	100	100	99.9	100	0	60.5	100	17,000	99.6	98.7	81.9	99.2	0	46	99.9
1,100	100	100	99.9	100	0	62	100	17,500	99.6	98.6	81	99.1	0	45.1	99.9
1,200	100	100	99.9	100	0	63.3	100	18,000	99.7	98.5	80.2	98.9	0	44.2	99.9
1,300	100	100	99.9	100	0	64.4	100	18,500	99.7	98.3	79.4	98.7	0	43.2	99.9
1,400	100	100	100	100	0	65.4	100	19,000	99.8	97.9	78.6	98.6	0	42.3	99.9
1,500	100	100	100	100	0	66.3	100	19,500	99.8	97.6	77.8	98.4	0	41.4	99.9
1,600	100	100	100	100	0	67.1	100	20,000	99.8	97.2	77	98.2	0	40.7	99.9
1,700	100	100	100	100	0	67.8	100	20,500	99.8	96.7	76.3	98	0	39.9	99.9
1,800	100	100	100	100	0	68.5	100	21,000	99.9	96.2	75.6	97.8	0	39.2	99.9
1,900	100	100	100	100	0	69.1	100	21,500	99.9	95.6	74.9	97.6	0	38.4	99.9
2,000	100	100	100	100	0	69.6	100	22,000	99.9	95	74.2	97.4	0	37.8	99.9
2,100	100	100	100	100	0	70.2	100	22,500	99.9	94.4	73.5	97.2	0	37.2	99.9
2,200	100	100	100	100	0	70.7	100	23,000	99.9	93.7	72.8	96.9	0	36.6	99.9
2,300	100	100	100	100	0	71.2	100	23,500	99.9	93.1	72.2	96.7	0	35.9	99.9
2,400	100	100	100	100	0	71.6	100	24,000	99.9	92.4	71.6	96.5	0	35.4	99.9
2,500	100	100	100	100	0	72.1	100	24,500	99.9	91.8	70.9	96.2	0	34.8	99.9
2,600	100	100	100	100	0	72.5	100	25,000	99.9	91.2	70.3	96	0	34.3	99.9
2,700	100	100	100	100	0	72.9	100	25,500	99.9	90.5	69.7	95.7	0	33.8	99.9
2,800	100	100	100	100	0	73.3	100	26,000	99.9	89.9	69.1	95.5	0	33.4	99.9
2,900	100	100	99.9	100	0	73.7	100	26,500	99.9	89.3	68.5	95.3	0	32.9	99.9
3,000	100	100	99.9	100	0	74	100	27,000	99.9	88.7	68	95	0	32.5	99.9
3,500	100	100	99.7	100	0	75.7	100	27,500	99.9	88.1	67.4	94.8	0	32.1	99.9
4,000	100	100	99.5	100	0	77.1	100	28,000	99.8	87.6	66.8	94.5	0	31.6	99.9
4,500	100	100	99.7	100	0	78.4	100	28,500	99.8	87	66.3	94.3	0	31.2	99.9
5,000	100	100	99.8	100	0	79.4	100	29,000	99.7	86.4	65.7	94	0	30.8	99.9
5,500	100	100	99.5	100	0	80.4	100	29,500	99.6	85.9	65.2	93.8	0	30.5	99.9
6,000	100	100	98.7	100	0	81.3	100	30,000	99.5	85.3	64.7	93.5	0	30.2	99.9
6,500	100	100	97.3	100	0	82.1	100	30,500	99.4	84.7	64.1	93.3	0	29.7	99.9
7,000	100	100	95.3	100	0	82.8	100	31,000	99.3	84.1	63.6	93	0	29.4	99.9
7,500	100	100	93.3	100	0	83.5	100	31,500	99.1	83.5	63.1	92.8	0	29.1	99.9
8,000	100	99.8	91.5	100	0	84.1	100	32,000	99	82.9	62.6	92.5	0	28.8	99.9
8,500	100	99.1	90	100	0	83.1	100	32,500	98.8	82.3	62.2	92.3	0	28.5	99.9
9,000	100	97.8	89	99.9	0	80.9	100	33,000	98.6	81.8	61.7	92	0	28.3	99.9
9,500	100	96.5	88.5	99.9	0	78.8	100	33,500	98.5	81.2	61.2	91.8	0	28	99.9
10,000	100	95.5	88.5	99.9	0	77	100	34,000	98.3	80.6	60.8	91.5	0	27.7	99.9
10,500	100	95	88.7	99.9	0	73.9	100	34,500	98.1	80.1	60.3	91.3	0	27.4	99.9
11,000	99.9	94.9	88.9	99.9	0	68.2	100	35,000	97.8	79.6	59.9	91	0	27.1	99.9
11,500	99.9	95.4	89	99.9	0	64.7	100	35,500	97.6	79.1	59.5	90.8	0	26.9	99.9
12,000	99.7	96.1	88.8	99.8	0	61.9	100	36,000	97.4	78.5	59.1	90.5	0	26.7	99.9

TABLE 5.—L1 FREQUENCY BAND NADIR-FACING 4 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	10.9	3	3.5	6.4	0	0	93.2	12,500	89.7	38.8	7.3	61.6	0	9.3	99.9
200	46.3	16.1	20.1	33.4	0	0	99.9	13,000	88.3	34.9	6.3	58	0	8.3	99.9
300	70.3	39.7	38.1	56.7	0	0.2	99.9	13,500	86.9	31	5.4	54.7	0	7.5	99.9
400	83.2	56.4	57.5	74	0	0.4	99.9	14,000	85.4	27	4.6	51.5	0	6.9	99.9
500	90.2	69.3	70.6	85.9	0	0.8	100	14,500	83.6	23	4	48.4	0	6.3	99.9
600	94.2	79.1	79.9	92.9	0	1.1	100	15,000	81.8	19.4	3.5	45.5	0	5.8	99.9
700	96.4	86.8	86.4	96.5	0	1.5	100	15,500	79.9	16.3	3.1	42.7	0	5.4	99.9
800	97.7	92.8	91	98.2	0	2	100	16,000	78.1	13.6	2.8	40	0	5	99.9
900	98.5	94.6	94.1	99.1	0	2.4	100	16,500	76.2	11.5	2.5	37.5	0	4.7	99.9
1,000	99.2	96.7	96.3	99.5	0	2.8	100	17,000	74.5	9.9	2.2	35.1	0	4.4	99.9
1,100	99.7	98.5	97.8	99.8	0	3.3	100	17,500	72.6	8.9	2	32.9	0	4.1	99.9
1,200	99.9	99.5	98.7	99.9	0	3.7	100	18,000	70.7	8.1	1.8	31	0	3.8	99.9
1,300	99.9	99.9	99.3	99.9	0	4.1	100	18,500	68.6	7.5	1.6	29.1	0	3.6	99.9
1,400	99.9	99.9	99.7	99.9	0	4.7	100	19,000	66.4	7	1.4	27.3	0	3.4	99.9
1,500	100	100	99.8	99.9	0	5	100	19,500	64.3	6.5	1.2	25.7	0	3.2	99.9
1,600	100	100	99.9	99.9	0	5.6	100	20,000	62.1	5.9	1.1	24.3	0	3	99.9
1,700	100	100	99.9	99.9	0	5.9	100	20,500	59.9	5.3	0.9	22.9	0	2.9	99.8
1,800	100	100	99.9	99.9	0	6.5	100	21,000	57.6	4.8	0.8	21.7	0	2.7	99.8
1,900	100	100	99.9	100	0	6.8	100	21,500	55.4	4.3	0.7	20.5	0	2.6	99.8
2,000	100	100	100	100	0	7.2	100	22,000	53.4	3.8	0.6	19.4	0	2.5	99.8
2,100	100	100	100	100	0	7.6	100	22,500	51.4	3.4	0.6	18.4	0	2.4	99.7
2,200	100	100	100	100	0	8	100	23,000	49.4	3.1	0.5	17.5	0	2.3	99.7
2,300	100	100	100	100	0	8.4	100	23,500	47.7	2.7	0.5	16.6	0	2.1	99.6
2,400	100	100	100	100	0	8.8	100	24,000	46	2.4	0.5	15.7	0	2.1	99.5
2,500	100	100	99.9	100	0	9.2	100	24,500	44.4	2.2	0.5	14.9	0	1.9	99.5
2,600	100	100	99.9	100	0	9.6	100	25,000	42.9	2	0.5	14.1	0	1.9	99.4
2,700	100	100	99.9	100	0	10	100	25,500	41.4	1.8	0.5	13.4	0	1.8	99.3
2,800	100	100	99.8	100	0	10.4	100	26,000	40.3	1.7	0.5	12.7	0	1.7	99.2
2,900	100	100	99.1	100	0	10.8	100	26,500	39.1	1.6	0.5	12.1	0	1.6	99.1
3,000	100	100	97.5	100	0	11.2	100	27,000	37.9	1.5	0.5	11.5	0	1.6	98.9
3,500	100	100	87.3	100	0	13	100	27,500	36.8	1.4	0.6	10.9	0	1.5	98.8
4,000	100	100	78.5	100	0	15	100	28,000	35.8	1.4	0.6	10.4	0	1.4	98.6
4,500	100	100	69.8	100	0	16.9	100	28,500	34.8	1.3	0.6	9.8	0	1.4	98.4
5,000	100	99.6	61	100	0	18.6	100	29,000	33.8	1.3	0.6	9.4	0	1.3	98.3
5,500	100	97.2	52.3	99.9	0	20.4	100	29,500	33	1.3	0.6	8.9	0	1.3	98
6,000	100	93.3	44.2	99.9	0	22.1	100	30,000	32	1.3	0.6	8.5	0	1.2	97.8
6,500	100	88.6	38.2	99.6	0	23.8	100	30,500	31.1	1.2	0.6	8.1	0	1.2	97.6
7,000	99.9	83	33.6	99.1	0	25.4	100	31,000	30.3	1.2	0.6	7.7	0	1.1	97.3
7,500	99.9	76.3	29.5	98	0	26.9	100	31,500	29.7	1.2	0.6	7.3	0	1.1	97.1
8,000	99.6	71.5	26.1	95.9	0	28.3	100	32,000	28.9	1.2	0.6	7	0	1	96.8
8,500	99.1	67.8	23.4	93.1	0	27.5	100	32,500	28.2	1.2	0.6	6.6	0	1	96.6
9,000	98.4	64.1	21	89.8	0	24.8	100	33,000	27.6	1.2	0.6	6.3	0	0.9	96.3
9,500	97.3	61.1	18.6	85.9	0	22.3	99.9	33,500	26.9	1.2	0.6	6	0	0.9	96
10,000	96.1	58.1	16	81.7	0	20.3	99.9	34,000	26.4	1.2	0.6	5.7	0	0.9	95.7
10,500	94.8	54.5	13.4	77.5	0	17.8	99.9	34,500	25.8	1.2	0.6	5.5	0	0.9	95.4
11,000	93.4	50.4	11.4	73.4	0	14.1	99.9	35,000	25.2	1.2	0.5	5.2	0	0.9	95.1
11,500	92.3	46.3	9.7	69.4	0	12	99.9	35,500	24.6	1.2	0.5	5	0	0.8	94.8
12,000	91	42.4	8.4	65.4	0	10.5	99.9	36,000	24.1	1.2	0.5	4.8	0	0.8	94.4

TABLE 6.—L1 FREQUENCY BAND NADIR-FACING 1 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	57	70	51	76	20160	20160	29	12,500	33	62	63	29	20160	20160	0
200	55	36	34	59	20160	20160	0	13,000	37	58	63	28	20160	20160	1
300	13	32	20	45	20160	20160	0	13,500	40	55	62	26	20160	20160	1
400	9	31	19	33	20160	20160	0	14,000	42	51	61	30	20160	20160	1
500	8	29	17	26	20160	20160	0	14,500	45	48	59	33	20160	20160	2
600	7	28	16	20	20160	20160	0	15,000	44	45	57	33	20160	20160	2
700	5	26	15	12	20160	20160	0	15,500	42	43	55	34	20160	20160	2
800	4	24	13	5	20160	20160	0	16,000	40	40	53	33	20160	20160	4
900	3	12	12	0	20160	20160	0	16,500	37	38	55	34	20160	20160	5
1,000	0	0	11	0	20160	20160	0	17,000	35	35	56	35	20160	20160	5
1,100	0	0	9	0	20160	20160	0	17,500	33	33	56	36	20160	20160	6
1,200	0	0	5	0	20160	20160	0	18,000	31	31	58	39	20160	20160	8
1,300	0	0	2	0	20160	20160	0	18,500	29	33	60	51	20160	20160	8
1,400	0	0	0	0	20160	20160	0	19,000	27	36	61	56	20160	20160	6
1,500	0	0	0	0	20160	20160	0	19,500	26	36	63	61	20160	20160	8
1,600	0	0	0	0	20160	20160	0	20,000	24	35	63	64	20160	20160	8
1,700	0	0	0	0	20160	20160	0	20,500	22	34	65	66	20160	20160	3
1,800	0	0	0	0	20160	20160	0	21,000	21	38	67	68	20160	20160	4
1,900	0	0	0	0	20160	20160	0	21,500	20	42	68	69	20160	20160	6
2,000	0	0	0	0	20160	20160	0	22,000	18	46	68	68	20160	20160	8
2,100	0	0	0	0	20160	20160	0	22,500	16	51	70	66	20160	20160	8
2,200	0	0	0	0	20160	20160	0	23,000	15	56	72	64	20160	20160	10
2,300	0	0	0	0	20160	20160	0	23,500	14	60	73	62	20160	20160	8
2,400	0	0	0	0	20160	20160	0	24,000	12	62	73	62	20160	20160	6
2,500	0	0	0	0	20160	20160	0	24,500	11	63	74	63	20160	20160	6
2,600	0	0	0	0	20160	20160	0	25,000	10	63	75	63	20160	20160	4
2,700	0	0	0	0	20160	20160	0	25,500	8	63	76	66	20160	20160	5
2,800	0	0	0	0	20160	20160	0	26,000	7	64	76	72	20160	20160	5
2,900	0	0	2	0	20160	20160	0	26,500	8	65	77	75	20160	20160	4
3,000	0	0	7	0	20160	20160	0	27,000	9	67	78	76	20160	20160	4
3,500	0	0	41	0	20160	20160	0	27,500	11	68	79	78	20160	20160	6
4,000	0	0	37	0	20160	20160	0	28,000	13	69	86	84	20160	20160	7
4,500	0	0	26	0	20160	20160	0	28,500	15	70	87	89	20160	20160	10
5,000	0	0	25	0	20160	20160	0	29,000	18	71	88	92	20160	20160	11
5,500	0	0	28	0	20160	20160	0	29,500	20	73	91	94	20160	20160	13
6,000	0	0	28	0	20160	20160	0	30,000	23	75	101	95	20160	20160	15
6,500	0	0	40	0	20160	20160	0	30,500	25	77	105	97	20160	20160	17
7,000	0	0	51	0	20160	20160	0	31,000	26	79	112	99	20160	20160	20
7,500	0	0	59	0	20160	20160	0	31,500	29	82	112	100	20160	20160	22
8,000	0	13	64	0	20160	20160	0	32,000	30	84	113	102	20160	20160	23
8,500	0	30	68	0	20160	20160	0	32,500	32	86	120	103	20160	20160	26
9,000	0	45	70	2	20160	20160	0	33,000	34	87	124	105	20160	20160	28
9,500	0	58	73	7	20160	20160	0	33,500	36	90	126	106	20160	20160	30
10,000	0	61	73	15	20160	20160	0	34,000	39	92	127	107	20160	20160	33
10,500	0	64	72	23	20160	20160	0	34,500	41	94	127	109	20160	20160	34
11,000	4	68	69	20	20160	20160	0	35,000	43	95	129	110	20160	20160	36
11,500	14	69	67	21	20160	20160	0	35,500	44	97	131	111	20160	20160	37
12,000	24	65	64	26	20160	20160	0	36,000	45	98	134	111	20160	20160	39

TABLE 7.—L1 FREQUENCY BAND NADIR-FACING 4 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	20160	20160	20160	20160	20160	20160	89	12,500	127	385	20160	318	20160	20160	27
200	20160	20160	20160	577	20160	20160	33	13,000	122	394	20160	330	20160	20160	31
300	259	693	313	342	20160	20160	9	13,500	126	412	20160	410	20160	20160	36
400	187	231	147	261	20160	20160	2	14,000	132	466	20160	424	20160	20160	35
500	116	141	104	209	20160	20160	0	14,500	143	748	20160	429	20160	20160	39
600	78	98	76	141	20160	20160	0	15,000	173	965	20160	438	20160	20160	40
700	60	74	68	116	20160	20160	0	15,500	240	1351	20160	465	20160	20160	40
800	54	61	56	77	20160	20160	0	16,000	291	2818	20160	493	20160	20160	34
900	48	51	46	69	20160	20160	0	16,500	336	2880	20160	549	20160	20160	32
1,000	40	43	38	63	20160	20160	0	17,000	346	2893	20160	660	20160	20160	29
1,100	32	32	30	21	20160	20160	0	17,500	356	20160	20160	698	20160	20160	28
1,200	22	21	25	18	20160	20160	0	18,000	364	20160	20160	744	20160	20160	29
1,300	8	11	21	14	20160	20160	0	18,500	373	20160	20160	845	20160	20160	28
1,400	1	2	19	13	20160	20160	0	19,000	381	20160	20160	849	20160	20160	29
1,500	0	0	16	10	20160	20160	0	19,500	389	20160	20160	1070	20160	20160	33
1,600	0	0	12	7	20160	20160	0	20,000	395	20160	20160	917	20160	20160	36
1,700	0	0	8	5	20160	20160	0	20,500	409	20160	20160	915	20160	20160	38
1,800	0	0	4	2	20160	20160	0	21,000	423	20160	20160	912	20160	20160	38
1,900	0	0	1	0	20160	20160	0	21,500	442	20160	20160	911	20160	20160	39
2,000	0	0	0	0	20160	20160	0	22,000	452	20160	20160	1077	20160	20160	42
2,100	0	0	0	0	20160	20160	0	22,500	503	20160	20160	1079	20160	20160	43
2,200	0	0	0	0	20160	20160	0	23,000	909	20160	20160	1082	20160	20160	45
2,300	0	0	0	0	20160	20160	0	23,500	914	20160	20160	1178	20160	20160	47
2,400	0	0	0	0	20160	20160	0	24,000	1390	20160	20160	1237	20160	20160	49
2,500	0	0	6	0	20160	20160	0	24,500	1394	20160	20160	1238	20160	20160	54
2,600	0	0	10	0	20160	20160	0	25,000	1423	20160	20160	1238	20160	20160	53
2,700	0	0	13	0	20160	20160	0	25,500	3349	20160	20160	1238	20160	20160	52
2,800	0	0	16	0	20160	20160	0	26,000	10051	20160	20160	1238	20160	20160	52
2,900	0	0	25	0	20160	20160	0	26,500	20160	20160	20160	1239	20160	20160	61
3,000	0	0	35	0	20160	20160	0	27,000	20160	20160	20160	1248	20160	20160	64
3,500	0	0	94	0	20160	20160	0	27,500	20160	20160	20160	1247	20160	20160	65
4,000	0	0	160	0	20160	20160	0	28,000	20160	20160	20160	1246	20160	20160	66
4,500	0	0	215	0	20160	20160	0	28,500	20160	20160	20160	1254	20160	20160	75
5,000	0	28	258	0	20160	20160	0	29,000	20160	20160	20160	1411	20160	20160	87
5,500	0	89	357	20	20160	20160	0	29,500	20160	20160	20160	1433	20160	20160	73
6,000	0	124	394	28	20160	20160	0	30,000	20160	20160	20160	1435	20160	20160	73
6,500	0	168	417	37	20160	20160	0	30,500	20160	20160	20160	16165	20160	20160	74
7,000	3	209	438	46	20160	20160	0	31,000	20160	20160	20160	20160	20160	20160	77
7,500	17	250	429	56	20160	20160	0	31,500	20160	20160	20160	20160	20160	20160	78
8,000	31	262	417	93	20160	20160	0	32,000	20160	20160	20160	20160	20160	20160	79
8,500	42	288	443	110	20160	20160	0	32,500	20160	20160	20160	20160	20160	20160	81
9,000	52	292	674	127	20160	20160	0	33,000	20160	20160	20160	20160	20160	20160	85
9,500	82	296	1074	134	20160	20160	5	33,500	20160	20160	20160	20160	20160	20160	93
10,000	107	291	4305	176	20160	20160	12	34,000	20160	20160	20160	20160	20160	20160	94
10,500	106	301	20160	276	20160	20160	13	34,500	20160	20160	20160	20160	20160	20160	97
11,000	225	312	13807	297	20160	20160	16	35,000	20160	20160	20160	20160	20160	20160	96
11,500	236	364	20160	295	20160	20160	20	35,500	20160	20160	20160	20160	20160	20160	96
12,000	135	378	20160	315	20160	20160	27	36,000	20160	20160	20160	20160	20160	20160	97

B.2 L1 Zenith-Facing Antenna Performance

TABLE 8.—L1 FREQUENCY BAND ZENITH-FACING 1 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	0	61	100	12,500	51.5	28.2	9.9	23.1	0	20.7	75.1
200	100	100	100	100	0	60.9	100	13,000	46.5	24.4	8	19	0	18.8	69.8
300	100	100	100	100	0	60.7	100	13,500	42.1	21	6.4	15.5	0	17.2	64.3
400	100	100	100	100	0	60.6	100	14,000	38	17.9	5	12.6	0	15.7	58.8
500	100	100	100	100	0	60.5	100	14,500	33.8	15.3	3.9	10	0	14.5	53.3
600	100	100	100	100	0	60.4	100	15,000	30.4	13	3	7.9	0	13.3	48.2
700	100	100	100	100	0	60.2	100	15,500	27.2	10.9	2.2	6.1	0	12.2	43.1
800	100	100	100	100	0	60.1	100	16,000	24	9.1	1.5	4.6	0	11.3	38.3
900	100	100	100	100	0	60	100	16,500	21.4	7.5	1	3.4	0	10.3	33.9
1,000	100	100	100	100	0	59.9	100	17,000	19	6.2	0.6	2.4	0	9.5	29.9
1,100	100	100	100	100	0	59.8	100	17,500	16.8	5	0.3	1.6	0	8.8	26.3
1,200	100	100	100	100	0	59.7	100	18,000	14.8	4	0.1	1	0	8	22.9
1,300	100	100	100	100	0	59.5	100	18,500	13	3.1	0	0.5	0	7.2	19.9
1,400	100	100	100	100	0	59.4	100	19,000	11.5	2.3	0	0.2	0	6.7	17.5
1,500	100	100	100	100	0	59.2	100	19,500	10.1	1.7	0	0	0	6	15.4
1,600	100	100	100	100	0	59	100	20,000	9	1.2	0	0	0	5.5	13.6
1,700	100	100	100	100	0	58.9	100	20,500	8	0.8	0	0	0	4.9	12
1,800	100	100	100	100	0	58.8	100	21,000	7	0.5	0	0	0	4.5	10.6
1,900	100	100	100	100	0	58.7	100	21,500	6.2	0.3	0	0	0	4.1	9.5
2,000	100	100	100	100	0	58.6	100	22,000	5.6	0.1	0	0	0	3.7	8.6
2,100	100	100	100	100	0	58.4	100	22,500	5.2	0	0	0	0	3.3	7.8
2,200	100	100	100	100	0	58.3	100	23,000	4.5	0	0	0	0	2.9	6.8
2,300	100	100	100	100	0	58.2	100	23,500	4.1	0	0	0	0	2.7	6.3
2,400	100	100	100	100	0	58.1	100	24,000	3.6	0	0	0	0	2.4	5.7
2,500	100	100	100	100	0	58	100	24,500	3.1	0	0	0	0	2.1	5.1
2,600	100	100	100	100	0	57.8	100	25,000	2.6	0	0	0	0	1.9	4.4
2,700	100	100	100	100	0	57.7	100	25,500	2.4	0	0	0	0	1.6	3.9
2,800	100	100	100	100	0	57.6	100	26,000	2.1	0	0	0	0	1.5	3.5
2,900	100	100	100	100	0	57.5	100	26,500	1.8	0	0	0	0	1.2	3
3,000	100	100	100	100	0	57.3	100	27,000	1.6	0	0	0	0	1.1	2.8
3,500	100	100	99.9	100	0	56.8	100	27,500	1.4	0	0	0	0	1	2.5
4,000	100	100	99.5	100	0	56	100	28,000	1.2	0	0	0	0	0.9	2.1
4,500	100	100	96.6	100	0	55.4	100	28,500	0.9	0	0	0	0	0.7	1.7
5,000	100	100	92.2	100	0	54.8	100	29,000	0.8	0	0	0	0	0.5	1.3
5,500	100	100	86.9	100	0	54.2	100	29,500	0.6	0	0	0	0	0.5	1.1
6,000	100	99.7	80.1	99.8	0	53.6	100	30,000	0.6	0	0	0	0	0.4	1
6,500	100	97.7	72.2	98.5	0	52.8	100	30,500	0.5	0	0	0	0	0.3	0.9
7,000	99.9	94	63.5	95.5	0	52.2	100	31,000	0.4	0	0	0	0	0.2	0.6
7,500	99.3	89.4	55.4	90.5	0	51.6	99.9	31,500	0.2	0	0	0	0	0.2	0.4
8,000	97.5	84	47.9	84	0	51	99.9	32,000	0.1	0	0	0	0	0.1	0.3
8,500	94.7	77.8	41.2	76.7	0	48.5	99.7	32,500	0.1	0	0	0	0	0.1	0.3
9,000	90.9	70.3	35.2	68.9	0	45.1	98.9	33,000	0.1	0	0	0	0	0.1	0.2
9,500	86	62.4	29.8	61.2	0	42	97.6	33,500	0.1	0	0	0	0	0.1	0.2
10,000	79.8	55.1	25.1	53.7	0	39.1	95.8	34,000	0	0	0	0	0	0	0.1
10,500	73.5	48.5	21.1	46.4	0	35	93	34,500	0	0	0	0	0	0	0.1
11,000	67.4	42.6	17.6	39.5	0	28.9	88.9	35,000	0	0	0	0	0	0	0
11,500	61.8	37.2	14.6	33.3	0	25.4	84.6	35,500	0	0	0	0	0	0	0
12,000	56.3	32.5	12.1	27.9	0	22.8	80	36,000	0	0	0	0	0	0	0

TABLE 9.—L1 FREQUENCY BAND ZENITH-FACING 4 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	0	23.6	100	12,500	1.6	0	0	0	0	0.3	15
200	100	100	100	100	0	23.4	100	13,000	0.9	0	0	0	0	0.1	11.7
300	100	100	100	100	0	23.3	100	13,500	0.5	0	0	0	0	0	9.3
400	100	100	100	100	0	23.2	100	14,000	0.3	0	0	0	0	0	7.2
500	100	100	100	100	0	23.1	100	14,500	0.1	0	0	0	0	0	5.6
600	100	100	100	100	0	23	100	15,000	0	0	0	0	0	0	4.3
700	100	100	100	100	0	22.9	100	15,500	0	0	0	0	0	0	3.2
800	100	100	100	100	0	22.8	100	16,000	0	0	0	0	0	0	2.5
900	100	100	100	100	0	22.7	100	16,500	0	0	0	0	0	0	1.7
1,000	100	100	100	100	0	22.6	100	17,000	0	0	0	0	0	0	1.2
1,100	100	100	100	100	0	22.5	100	17,500	0	0	0	0	0	0	0.8
1,200	100	100	100	100	0	22.3	100	18,000	0	0	0	0	0	0	0.5
1,300	100	100	100	100	0	22.2	100	18,500	0	0	0	0	0	0	0.3
1,400	100	100	100	100	0	22.1	100	19,000	0	0	0	0	0	0	0.1
1,500	100	100	100	100	0	22	100	19,500	0	0	0	0	0	0	0
1,600	100	100	100	100	0	21.9	100	20,000	0	0	0	0	0	0	0
1,700	100	100	100	100	0	21.8	100	20,500	0	0	0	0	0	0	0
1,800	100	100	100	100	0	21.7	100	21,000	0	0	0	0	0	0	0
1,900	100	100	100	100	0	21.6	100	21,500	0	0	0	0	0	0	0
2,000	100	100	100	100	0	21.5	100	22,000	0	0	0	0	0	0	0
2,100	100	100	100	100	0	21.4	100	22,500	0	0	0	0	0	0	0
2,200	100	100	100	100	0	21.3	100	23,000	0	0	0	0	0	0	0
2,300	100	100	100	100	0	21.1	100	23,500	0	0	0	0	0	0	0
2,400	100	100	100	100	0	21.1	100	24,000	0	0	0	0	0	0	0
2,500	100	100	99.9	100	0	21	100	24,500	0	0	0	0	0	0	0
2,600	100	100	99.3	100	0	20.8	100	25,000	0	0	0	0	0	0	0
2,700	100	100	96.8	100	0	20.7	100	25,500	0	0	0	0	0	0	0
2,800	100	100	91.5	100	0	20.6	100	26,000	0	0	0	0	0	0	0
2,900	100	100	84.8	100	0	20.5	100	26,500	0	0	0	0	0	0	0
3,000	100	100	76.8	100	0	20.4	100	27,000	0	0	0	0	0	0	0
3,500	100	100	36.2	100	0	19.9	100	27,500	0	0	0	0	0	0	0
4,000	100	100	14.1	100	0	19.4	100	28,000	0	0	0	0	0	0	0
4,500	100	97.9	4.8	99	0	18.9	100	28,500	0	0	0	0	0	0	0
5,000	100	57	1.4	72	0	18.4	100	29,000	0	0	0	0	0	0	0
5,500	100	22.3	0.3	30.6	0	17.9	100	29,500	0	0	0	0	0	0	0
6,000	93.6	9.5	0	8.9	0	17.4	99.9	30,000	0	0	0	0	0	0	0
6,500	74.2	3.9	0	1.8	0	16.9	99.9	30,500	0	0	0	0	0	0	0
7,000	61.6	1.3	0	0.2	0	16.4	98.6	31,000	0	0	0	0	0	0	0
7,500	46.8	0.3	0	0	0	15.9	94.1	31,500	0	0	0	0	0	0	0
8,000	34.2	0	0	0	0	15.4	86.4	32,000	0	0	0	0	0	0	0
8,500	26.2	0	0	0	0	13.3	77.1	32,500	0	0	0	0	0	0	0
9,000	20.5	0	0	0	0	10.2	67	33,000	0	0	0	0	0	0	0
9,500	16.2	0	0	0	0	8	56.8	33,500	0	0	0	0	0	0	0
10,000	12.8	0	0	0	0	6.5	47.1	34,000	0	0	0	0	0	0	0
10,500	9.5	0	0	0	0	4.7	38.3	34,500	0	0	0	0	0	0	0
11,000	6.7	0	0	0	0	2.5	30.1	35,000	0	0	0	0	0	0	0
11,500	4.4	0	0	0	0	1.4	24.1	35,500	0	0	0	0	0	0	0
12,000	2.7	0	0	0	0	0.7	18.9	36,000	0	0	0	0	0	0	0

TABLE 10.—L1 FREQUENCY BAND ZENITH-FACING 1 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	20160	20160	20160	20160	20160	20160	20160
200	0	0	0	0	20160	20160	0	13,000	20160	20160	20160	20160	20160	20160	20160
300	0	0	0	0	20160	20160	0	13,500	20160	20160	20160	20160	20160	20160	20160
400	0	0	0	0	20160	20160	0	14,000	20160	20160	20160	20160	20160	20160	20160
500	0	0	0	0	20160	20160	0	14,500	20160	20160	20160	20160	20160	20160	20160
600	0	0	0	0	20160	20160	0	15,000	20160	20160	20160	20160	20160	20160	20160
700	0	0	0	0	20160	20160	0	15,500	20160	20160	20160	20160	20160	20160	20160
800	0	0	0	0	20160	20160	0	16,000	20160	20160	20160	20160	20160	20160	20160
900	0	0	0	0	20160	20160	0	16,500	20160	20160	20160	20160	20160	20160	20160
1,000	0	0	0	0	20160	20160	0	17,000	20160	20160	20160	20160	20160	20160	20160
1,100	0	0	0	0	20160	20160	0	17,500	20160	20160	20160	20160	20160	20160	20160
1,200	0	0	0	0	20160	20160	0	18,000	20160	20160	20160	20160	20160	20160	20160
1,300	0	0	0	0	20160	20160	0	18,500	20160	20160	20160	20160	20160	20160	20160
1,400	0	0	0	0	20160	20160	0	19,000	20160	20160	20160	20160	20160	20160	20160
1,500	0	0	0	0	20160	20160	0	19,500	20160	20160	20160	20160	20160	20160	20160
1,600	0	0	0	0	20160	20160	0	20,000	20160	20160	20160	20160	20160	20160	20160
1,700	0	0	0	0	20160	20160	0	20,500	20160	20160	20160	20160	20160	20160	20160
1,800	0	0	0	0	20160	20160	0	21,000	20160	20160	20160	20160	20160	20160	20160
1,900	0	0	0	0	20160	20160	0	21,500	20160	20160	20160	20160	20160	20160	20160
2,000	0	0	0	0	20160	20160	0	22,000	20160	20160	20160	20160	20160	20160	20160
2,100	0	0	0	0	20160	20160	0	22,500	20160	20160	20160	20160	20160	20160	20160
2,200	0	0	0	0	20160	20160	0	23,000	20160	20160	20160	20160	20160	20160	20160
2,300	0	0	0	0	20160	20160	0	23,500	20160	20160	20160	20160	20160	20160	20160
2,400	0	0	0	0	20160	20160	0	24,000	20160	20160	20160	20160	20160	20160	20160
2,500	0	0	0	0	20160	20160	0	24,500	20160	20160	20160	20160	20160	20160	20160
2,600	0	0	0	0	20160	20160	0	25,000	20160	20160	20160	20160	20160	20160	20160
2,700	0	0	0	0	20160	20160	0	25,500	20160	20160	20160	20160	20160	20160	20160
2,800	0	0	0	0	20160	20160	0	26,000	20160	20160	20160	20160	20160	20160	20160
2,900	0	0	0	0	20160	20160	0	26,500	20160	20160	20160	20160	20160	20160	20160
3,000	0	0	0	0	20160	20160	0	27,000	20160	20160	20160	20160	20160	20160	20160
3,500	0	0	7	0	20160	20160	0	27,500	20160	20160	20160	20160	20160	20160	20160
4,000	0	0	46	0	20160	20160	0	28,000	20160	20160	20160	20160	20160	20160	20160
4,500	0	0	113	0	20160	20160	0	28,500	20160	20160	20160	20160	20160	20160	20160
5,000	0	0	155	0	20160	20160	0	29,000	20160	20160	20160	20160	20160	20160	20160
5,500	0	0	178	0	20160	20160	0	29,500	20160	20160	20160	20160	20160	20160	20160
6,000	0	55	241	49	20160	20160	0	30,000	20160	20160	20160	20160	20160	20160	20160
6,500	0	20160	20160	20160	20160	20160	0	30,500	20160	20160	20160	20160	20160	20160	20160
7,000	42	20160	20160	20160	20160	20160	0	31,000	20160	20160	20160	20160	20160	20160	20160
7,500	82	20160	20160	20160	20160	20160	21	31,500	20160	20160	20160	20160	20160	20160	20160
8,000	181	20160	20160	20160	20160	20160	88	32,000	20160	20160	20160	20160	20160	20160	20160
8,500	310	20160	20160	20160	20160	20160	310	32,500	20160	20160	20160	20160	20160	20160	20160
9,000	440	20160	20160	20160	20160	20160	440	33,000	20160	20160	20160	20160	20160	20160	20160
9,500	20160	20160	20160	20160	20160	20160	20160	33,500	20160	20160	20160	20160	20160	20160	20160
10,000	20160	20160	20160	20160	20160	20160	20160	34,000	20160	20160	20160	20160	20160	20160	20160
10,500	20160	20160	20160	20160	20160	20160	20160	34,500	20160	20160	20160	20160	20160	20160	20160
11,000	20160	20160	20160	20160	20160	20160	20160	35,000	20160	20160	20160	20160	20160	20160	20160
11,500	20160	20160	20160	20160	20160	20160	20160	35,500	20160	20160	20160	20160	20160	20160	20160
12,000	20160	20160	20160	20160	20160	20160	20160	36,000	20160	20160	20160	20160	20160	20160	20160

TABLE 11.—L1 FREQUENCY BAND ZENITH-FACING 4 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	20160	20160	20160	20160	20160	20160	20160
200	0	0	0	0	20160	20160	0	13,000	20160	20160	20160	20160	20160	20160	20160
300	0	0	0	0	20160	20160	0	13,500	20160	20160	20160	20160	20160	20160	20160
400	0	0	0	0	20160	20160	0	14,000	20160	20160	20160	20160	20160	20160	20160
500	0	0	0	0	20160	20160	0	14,500	20160	20160	20160	20160	20160	20160	20160
600	0	0	0	0	20160	20160	0	15,000	20160	20160	20160	20160	20160	20160	20160
700	0	0	0	0	20160	20160	0	15,500	20160	20160	20160	20160	20160	20160	20160
800	0	0	0	0	20160	20160	0	16,000	20160	20160	20160	20160	20160	20160	20160
900	0	0	0	0	20160	20160	0	16,500	20160	20160	20160	20160	20160	20160	20160
1,000	0	0	0	0	20160	20160	0	17,000	20160	20160	20160	20160	20160	20160	20160
1,100	0	0	0	0	20160	20160	0	17,500	20160	20160	20160	20160	20160	20160	20160
1,200	0	0	0	0	20160	20160	0	18,000	20160	20160	20160	20160	20160	20160	20160
1,300	0	0	0	0	20160	20160	0	18,500	20160	20160	20160	20160	20160	20160	20160
1,400	0	0	0	0	20160	20160	0	19,000	20160	20160	20160	20160	20160	20160	20160
1,500	0	0	0	0	20160	20160	0	19,500	20160	20160	20160	20160	20160	20160	20160
1,600	0	0	0	0	20160	20160	0	20,000	20160	20160	20160	20160	20160	20160	20160
1,700	0	0	0	0	20160	20160	0	20,500	20160	20160	20160	20160	20160	20160	20160
1,800	0	0	0	0	20160	20160	0	21,000	20160	20160	20160	20160	20160	20160	20160
1,900	0	0	0	0	20160	20160	0	21,500	20160	20160	20160	20160	20160	20160	20160
2,000	0	0	0	0	20160	20160	0	22,000	20160	20160	20160	20160	20160	20160	20160
2,100	0	0	0	0	20160	20160	0	22,500	20160	20160	20160	20160	20160	20160	20160
2,200	0	0	0	0	20160	20160	0	23,000	20160	20160	20160	20160	20160	20160	20160
2,300	0	0	0	0	20160	20160	0	23,500	20160	20160	20160	20160	20160	20160	20160
2,400	0	0	0	0	20160	20160	0	24,000	20160	20160	20160	20160	20160	20160	20160
2,500	0	0	18	0	20160	20160	0	24,500	20160	20160	20160	20160	20160	20160	20160
2,600	0	0	59	0	20160	20160	0	25,000	20160	20160	20160	20160	20160	20160	20160
2,700	0	0	86	0	20160	20160	0	25,500	20160	20160	20160	20160	20160	20160	20160
2,800	0	0	175	0	20160	20160	0	26,000	20160	20160	20160	20160	20160	20160	20160
2,900	0	0	202	0	20160	20160	0	26,500	20160	20160	20160	20160	20160	20160	20160
3,000	0	0	246	0	20160	20160	0	27,000	20160	20160	20160	20160	20160	20160	20160
3,500	0	0	2068	0	20160	20160	0	27,500	20160	20160	20160	20160	20160	20160	20160
4,000	0	0	20160	0	20160	20160	0	28,000	20160	20160	20160	20160	20160	20160	20160
4,500	0	63	20160	57	20160	20160	0	28,500	20160	20160	20160	20160	20160	20160	20160
5,000	0	446	20160	391	20160	20160	0	29,000	20160	20160	20160	20160	20160	20160	20160
5,500	0	18057	20160	851	20160	20160	0	29,500	20160	20160	20160	20160	20160	20160	20160
6,000	154	20160	20160	20160	20160	20160	1	30,000	20160	20160	20160	20160	20160	20160	20160
6,500	722	20160	20160	20160	20160	20160	47	30,500	20160	20160	20160	20160	20160	20160	20160
7,000	20160	20160	20160	20160	20160	20160	285	31,000	20160	20160	20160	20160	20160	20160	20160
7,500	20160	20160	20160	20160	20160	20160	20160	31,500	20160	20160	20160	20160	20160	20160	20160
8,000	20160	20160	20160	20160	20160	20160	20160	32,000	20160	20160	20160	20160	20160	20160	20160
8,500	20160	20160	20160	20160	20160	20160	20160	32,500	20160	20160	20160	20160	20160	20160	20160
9,000	20160	20160	20160	20160	20160	20160	20160	33,000	20160	20160	20160	20160	20160	20160	20160
9,500	20160	20160	20160	20160	20160	20160	20160	33,500	20160	20160	20160	20160	20160	20160	20160
10,000	20160	20160	20160	20160	20160	20160	20160	34,000	20160	20160	20160	20160	20160	20160	20160
10,500	20160	20160	20160	20160	20160	20160	20160	34,500	20160	20160	20160	20160	20160	20160	20160
11,000	20160	20160	20160	20160	20160	20160	20160	35,000	20160	20160	20160	20160	20160	20160	20160
11,500	20160	20160	20160	20160	20160	20160	20160	35,500	20160	20160	20160	20160	20160	20160	20160
12,000	20160	20160	20160	20160	20160	20160	20160	36,000	20160	20160	20160	20160	20160	20160	20160

B.3 L1 Omnidirectional Antenna Performance

TABLE 12.—L1 FREQUENCY BAND OMNIDIRECTIONAL 1 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	0	67.4	100	12,500	99.8	96.8	88.5	99.8	0	79.9	100
200	100	100	100	100	0	71.9	100	13,000	99.7	97.3	88.1	99.8	0	76.3	100
300	100	100	100	100	0	74.8	100	13,500	99.6	97.7	87.5	99.8	0	72.7	100
400	100	100	100	100	0	77	100	14,000	99.5	98	86.8	99.7	0	69.6	100
500	100	100	100	100	0	78.8	100	14,500	99.5	98.3	86.2	99.7	0	66.8	100
600	100	100	100	100	0	80.4	100	15,000	99.5	98.5	85.4	99.7	0	64.2	100
700	100	100	100	100	0	81.7	100	15,500	99.5	98.6	84.6	99.6	0	61.7	100
800	100	100	100	100	0	82.9	100	16,000	99.6	98.7	83.8	99.5	0	59.7	100
900	100	100	100	100	0	83.9	100	16,500	99.6	98.7	82.9	99.4	0	57.5	100
1,000	100	100	100	100	0	84.9	100	17,000	99.6	98.7	82.1	99.2	0	55.5	100
1,100	100	100	100	100	0	85.7	100	17,500	99.7	98.6	81.1	99.1	0	53.9	99.9
1,200	100	100	100	100	0	86.5	100	18,000	99.7	98.5	80.2	98.9	0	52.2	99.9
1,300	100	100	100	100	0	87.2	100	18,500	99.7	98.3	79.4	98.7	0	50.5	99.9
1,400	100	100	100	100	0	87.9	100	19,000	99.8	98	78.6	98.6	0	49	99.9
1,500	100	100	100	100	0	88.6	100	19,500	99.8	97.7	77.8	98.4	0	47.5	99.9
1,600	100	100	100	100	0	89.1	100	20,000	99.8	97.3	77	98.2	0	46.3	99.9
1,700	100	100	100	100	0	89.7	100	20,500	99.8	96.9	76.3	98	0	44.9	99.9
1,800	100	100	100	100	0	90.2	100	21,000	99.9	96.3	75.6	97.8	0	43.7	99.9
1,900	100	100	100	100	0	90.7	100	21,500	99.9	95.7	74.9	97.6	0	42.6	99.9
2,000	100	100	100	100	0	91.1	100	22,000	99.9	95.1	74.2	97.4	0	41.5	99.9
2,100	100	100	100	100	0	91.6	100	22,500	99.9	94.4	73.5	97.2	0	40.5	99.9
2,200	100	100	100	100	0	92	100	23,000	99.9	93.7	72.8	96.9	0	39.6	99.9
2,300	100	100	100	100	0	92.4	100	23,500	99.9	93.1	72.2	96.7	0	38.7	99.9
2,400	100	100	100	100	0	92.7	100	24,000	99.9	92.4	71.6	96.5	0	37.8	99.9
2,500	100	100	100	100	0	93.1	100	24,500	99.9	91.8	70.9	96.2	0	37	99.9
2,600	100	100	100	100	0	93.4	100	25,000	99.9	91.2	70.3	96	0	36.2	99.9
2,700	100	100	100	100	0	93.7	100	25,500	99.9	90.5	69.7	95.7	0	35.5	99.9
2,800	100	100	100	100	0	94	100	26,000	99.9	89.9	69.1	95.5	0	34.9	99.9
2,900	100	100	100	100	0	94.3	100	26,500	99.9	89.3	68.5	95.3	0	34.1	99.9
3,000	100	100	100	100	0	94.5	100	27,000	99.9	88.7	68	95	0	33.6	99.9
3,500	100	100	100	100	0	95.7	100	27,500	99.9	88.1	67.4	94.8	0	33.2	99.9
4,000	100	100	100	100	0	96.5	100	28,000	99.9	87.6	66.8	94.5	0	32.6	99.9
4,500	100	100	100	100	0	97.3	100	28,500	99.8	87	66.3	94.3	0	32	99.9
5,000	100	100	99.9	100	0	97.8	100	29,000	99.7	86.4	65.7	94	0	31.4	99.9
5,500	100	100	99.8	100	0	98.3	100	29,500	99.6	85.9	65.2	93.8	0	31	99.9
6,000	100	100	99.7	100	0	98.7	100	30,000	99.5	85.3	64.7	93.5	0	30.6	99.9
6,500	100	100	99	100	0	99	100	30,500	99.4	84.7	64.1	93.3	0	30.1	99.9
7,000	100	100	97.5	100	0	99.3	100	31,000	99.3	84.1	63.6	93	0	29.7	99.9
7,500	100	100	95.7	100	0	99.4	100	31,500	99.1	83.5	63.1	92.8	0	29.4	99.9
8,000	100	99.9	94	100	0	99.6	100	32,000	99	82.9	62.6	92.5	0	29	99.9
8,500	100	99.8	92.6	100	0	99.7	100	32,500	98.8	82.3	62.2	92.3	0	28.7	99.9
9,000	100	99.1	91.6	100	0	99.8	100	33,000	98.6	81.8	61.7	92	0	28.4	99.9
9,500	100	98	90.9	99.9	0	99.8	100	33,500	98.5	81.2	61.2	91.8	0	28.1	99.9
10,000	100	97	90.4	99.9	0	99.9	100	34,000	98.3	80.6	60.8	91.5	0	27.7	99.9
10,500	100	96.5	89.9	99.9	0	97.5	100	34,500	98.1	80.1	60.3	91.3	0	27.4	99.9
11,000	100	96.3	89.5	99.9	0	92.2	100	35,000	97.8	79.6	59.9	91	0	27.1	99.9
11,500	99.9	96.3	89.2	99.9	0	87.9	100	35,500	97.6	79.1	59.5	90.8	0	26.9	99.9
12,000	99.9	96.5	88.9	99.9	0	83.8	100	36,000	97.4	78.5	59.1	90.5	0	26.7	99.9

TABLE 13.—L1 FREQUENCY BAND OMNIDIRECTIONAL 4 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	0	29.5	100	12,500	94.5	47.9	10	67.3	0	9.7	99.9
200	100	100	100	100	0	34	100	13,000	92.3	43.7	8.2	62.9	0	8.5	99.9
300	100	100	100	100	0	37.2	100	13,500	90.5	39.3	6.7	58.8	0	7.6	99.9
400	100	100	100	100	0	39.7	100	14,000	88.8	34.6	5.4	54.9	0	6.9	99.9
500	100	100	100	100	0	41.8	100	14,500	87.1	29.8	4.4	51.2	0	6.3	99.9
600	100	100	100	100	0	43.7	100	15,000	85.6	25.3	3.7	47.7	0	5.8	99.9
700	100	100	100	100	0	45.3	100	15,500	83.8	21.2	3.2	44.4	0	5.4	99.9
800	100	100	100	100	0	46.9	100	16,000	82	17.6	2.8	41.4	0	5	99.9
900	100	100	100	100	0	48.2	100	16,500	80.1	14.7	2.5	38.5	0	4.7	99.9
1,000	100	100	100	100	0	49.5	100	17,000	78.3	12.3	2.2	35.9	0	4.4	99.9
1,100	100	100	100	100	0	50.7	100	17,500	76.3	10.5	2	33.5	0	4.1	99.9
1,200	100	100	100	100	0	51.8	100	18,000	74.3	9.1	1.8	31.3	0	3.8	99.9
1,300	100	100	100	100	0	52.8	100	18,500	72.2	8.1	1.6	29.3	0	3.6	99.9
1,400	100	100	100	100	0	53.9	100	19,000	70	7.3	1.4	27.5	0	3.4	99.9
1,500	100	100	100	100	0	54.8	100	19,500	67.8	6.7	1.2	25.8	0	3.2	99.9
1,600	100	100	100	100	0	55.7	100	20,000	65.5	6	1.1	24.3	0	3	99.9
1,700	100	100	100	100	0	56.6	100	20,500	63.2	5.4	0.9	22.9	0	2.9	99.9
1,800	100	100	100	100	0	57.5	100	21,000	60.7	4.8	0.8	21.7	0	2.7	99.8
1,900	100	100	100	100	0	58.2	100	21,500	58.3	4.3	0.7	20.5	0	2.6	99.8
2,000	100	100	100	100	0	58.9	100	22,000	56.1	3.8	0.6	19.4	0	2.5	99.8
2,100	100	100	100	100	0	59.7	100	22,500	53.9	3.4	0.6	18.4	0	2.4	99.7
2,200	100	100	100	100	0	60.4	100	23,000	51.7	3.1	0.5	17.5	0	2.3	99.7
2,300	100	100	100	100	0	61.1	100	23,500	49.7	2.7	0.5	16.6	0	2.1	99.7
2,400	100	100	100	100	0	61.7	100	24,000	47.8	2.4	0.5	15.7	0	2.1	99.6
2,500	100	100	100	100	0	62.4	100	24,500	45.9	2.2	0.5	14.9	0	1.9	99.5
2,600	100	100	100	100	0	62.9	100	25,000	44.1	2	0.5	14.1	0	1.9	99.4
2,700	100	100	100	100	0	63.5	100	25,500	42.5	1.8	0.5	13.4	0	1.8	99.4
2,800	100	100	100	100	0	64.1	100	26,000	41.1	1.7	0.5	12.7	0	1.7	99.3
2,900	100	100	100	100	0	64.7	100	26,500	39.8	1.6	0.5	12.1	0	1.6	99.1
3,000	100	100	99.9	100	0	65.2	100	27,000	38.6	1.5	0.5	11.5	0	1.6	99
3,500	100	100	99.5	100	0	67.5	100	27,500	37.3	1.4	0.6	10.9	0	1.5	98.9
4,000	100	100	98.1	100	0	69.6	100	28,000	36.2	1.4	0.6	10.4	0	1.4	98.7
4,500	100	100	95.8	100	0	71.4	100	28,500	35.1	1.3	0.6	9.8	0	1.4	98.5
5,000	100	100	91.3	100	0	72.9	100	29,000	34.1	1.3	0.6	9.4	0	1.3	98.3
5,500	100	99.9	82.8	100	0	74.2	100	29,500	33.2	1.3	0.6	8.9	0	1.3	98.1
6,000	100	100	73.8	99.9	0	75.5	100	30,000	32.2	1.3	0.6	8.5	0	1.2	97.9
6,500	100	100	64.4	99.9	0	76.6	100	30,500	31.3	1.2	0.6	8.1	0	1.2	97.6
7,000	100	99.9	55.7	99.9	0	77.6	100	31,000	30.5	1.2	0.6	7.7	0	1.1	97.4
7,500	100	99.3	48.1	99.9	0	78.6	100	31,500	29.7	1.2	0.6	7.3	0	1.1	97.1
8,000	100	95	41.4	99.6	0	79.4	100	32,000	29	1.2	0.6	7	0	1	96.8
8,500	100	88.4	35.5	98.7	0	71.9	100	32,500	28.3	1.2	0.6	6.6	0	1	96.6
9,000	100	81.3	30.7	96.8	0	57.4	100	33,000	27.6	1.2	0.6	6.3	0	0.9	96.3
9,500	99.9	74.4	26.8	93.7	0	42.1	100	33,500	27	1.2	0.6	6	0	0.9	96
10,000	99.9	69	23.1	89.9	0	31.4	100	34,000	26.4	1.2	0.6	5.7	0	0.9	95.7
10,500	99.6	64.2	19.5	85.6	0	24.5	100	34,500	25.8	1.2	0.6	5.5	0	0.9	95.4
11,000	98.9	59.6	16.4	81.1	0	16.7	99.9	35,000	25.2	1.2	0.5	5.2	0	0.9	95.1
11,500	97.8	55.3	14	76.6	0	13.5	99.9	35,500	24.6	1.2	0.5	5	0	0.8	94.8
12,000	96.2	51.5	11.9	71.9	0	11.3	99.9	36,000	24.1	1.2	0.5	4.8	0	0.8	94.4

TABLE 14.—L1 FREQUENCY BAND OMNIDIRECTIONAL 1 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	26	61	63	29	20160	20160	0
200	0	0	0	0	20160	20160	0	13,000	32	58	63	28	20160	20160	0
300	0	0	0	0	20160	20160	0	13,500	37	55	62	26	20160	20160	0
400	0	0	0	0	20160	20160	0	14,000	42	51	61	30	20160	20160	0
500	0	0	0	0	20160	20160	0	14,500	45	48	59	33	20160	20160	0
600	0	0	0	0	20160	20160	0	15,000	44	45	57	33	20160	20160	0
700	0	0	0	0	20160	20160	0	15,500	41	43	55	34	20160	20160	0
800	0	0	0	0	20160	20160	0	16,000	39	40	53	33	20160	20160	0
900	0	0	0	0	20160	20160	0	16,500	37	38	55	34	20160	20160	0
1,000	0	0	0	0	20160	20160	0	17,000	35	35	56	35	20160	20160	0
1,100	0	0	0	0	20160	20160	0	17,500	33	33	56	36	20160	20160	1
1,200	0	0	0	0	20160	20160	0	18,000	31	31	58	39	20160	20160	3
1,300	0	0	0	0	20160	20160	0	18,500	29	33	60	51	20160	20160	3
1,400	0	0	0	0	20160	20160	0	19,000	27	36	61	56	20160	20160	6
1,500	0	0	0	0	20160	20160	0	19,500	26	36	63	61	20160	20160	8
1,600	0	0	0	0	20160	20160	0	20,000	24	35	63	64	20160	20160	8
1,700	0	0	0	0	20160	20160	0	20,500	22	34	65	66	20160	20160	3
1,800	0	0	0	0	20160	20160	0	21,000	21	38	67	68	20160	20160	4
1,900	0	0	0	0	20160	20160	0	21,500	20	42	68	69	20160	20160	6
2,000	0	0	0	0	20160	20160	0	22,000	18	46	68	68	20160	20160	8
2,100	0	0	0	0	20160	20160	0	22,500	16	51	70	66	20160	20160	8
2,200	0	0	0	0	20160	20160	0	23,000	15	56	72	64	20160	20160	10
2,300	0	0	0	0	20160	20160	0	23,500	14	60	73	62	20160	20160	8
2,400	0	0	0	0	20160	20160	0	24,000	12	62	73	62	20160	20160	6
2,500	0	0	0	0	20160	20160	0	24,500	11	63	74	63	20160	20160	6
2,600	0	0	0	0	20160	20160	0	25,000	10	63	75	63	20160	20160	4
2,700	0	0	0	0	20160	20160	0	25,500	8	63	76	66	20160	20160	5
2,800	0	0	0	0	20160	20160	0	26,000	7	64	76	72	20160	20160	5
2,900	0	0	0	0	20160	20160	0	26,500	8	65	77	75	20160	20160	4
3,000	0	0	0	0	20160	20160	0	27,000	9	67	78	76	20160	20160	4
3,500	0	0	0	0	20160	20160	0	27,500	11	68	79	78	20160	20160	6
4,000	0	0	0	0	20160	20160	0	28,000	13	69	86	84	20160	20160	7
4,500	0	0	0	0	20160	20160	0	28,500	15	70	87	89	20160	20160	10
5,000	0	0	15	0	20160	20160	0	29,000	18	71	88	92	20160	20160	11
5,500	0	0	28	0	20160	20160	0	29,500	20	73	91	94	20160	20160	13
6,000	0	0	27	0	20160	437	0	30,000	23	75	101	95	20160	20160	15
6,500	0	0	38	0	20160	354	0	30,500	25	77	105	97	20160	20160	17
7,000	0	0	50	0	20160	275	0	31,000	26	79	112	99	20160	20160	20
7,500	0	0	57	0	20160	253	0	31,500	29	82	112	100	20160	20160	22
8,000	0	11	60	0	20160	197	0	32,000	30	84	113	102	20160	20160	23
8,500	0	27	63	0	20160	182	0	32,500	32	86	120	103	20160	20160	26
9,000	0	40	63	0	20160	138	0	33,000	34	87	124	105	20160	20160	28
9,500	0	52	65	6	20160	127	0	33,500	36	90	126	106	20160	20160	30
10,000	0	55	65	13	20160	116	0	34,000	39	92	127	107	20160	20160	33
10,500	0	57	65	16	20160	306	0	34,500	41	94	127	109	20160	20160	34
11,000	0	59	65	19	20160	20160	0	35,000	43	95	129	110	20160	20160	36
11,500	11	61	65	21	20160	20160	0	35,500	44	97	131	111	20160	20160	37
12,000	19	59	63	26	20160	20160	0	36,000	45	98	134	111	20160	20160	39

TABLE 15.—L1 FREQUENCY BAND OMNIDIRECTIONAL 4 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	95	374	7339	230	20160	20160	23
200	0	0	0	0	20160	20160	0	13,000	100	384	14716	227	20160	20160	28
300	0	0	0	0	20160	20160	0	13,500	111	408	20160	258	20160	20160	36
400	0	0	0	0	20160	20160	0	14,000	123	411	20160	280	20160	20160	35
500	0	0	0	0	20160	20160	0	14,500	142	423	20160	365	20160	20160	39
600	0	0	0	0	20160	20160	0	15,000	162	450	20160	374	20160	20160	37
700	0	0	0	0	20160	20160	0	15,500	240	904	20160	381	20160	20160	40
800	0	0	0	0	20160	20160	0	16,000	245	1377	20160	424	20160	20160	34
900	0	0	0	0	20160	20160	0	16,500	336	1841	20160	453	20160	20160	32
1,000	0	0	0	0	20160	20160	0	17,000	346	2341	20160	475	20160	20160	29
1,100	0	0	0	0	20160	20160	0	17,500	355	9143	20160	662	20160	20160	27
1,200	0	0	0	0	20160	20160	0	18,000	363	20160	20160	663	20160	20160	29
1,300	0	0	0	0	20160	20160	0	18,500	373	20160	20160	845	20160	20160	28
1,400	0	0	0	0	20160	20160	0	19,000	381	20160	20160	849	20160	20160	29
1,500	0	0	0	0	20160	20160	0	19,500	388	20160	20160	1070	20160	20160	33
1,600	0	0	0	0	20160	20160	0	20,000	394	20160	20160	917	20160	20160	36
1,700	0	0	0	0	20160	20160	0	20,500	409	20160	20160	915	20160	20160	38
1,800	0	0	0	0	20160	20160	0	21,000	423	20160	20160	912	20160	20160	38
1,900	0	0	0	0	20160	20160	0	21,500	442	20160	20160	911	20160	20160	39
2,000	0	0	0	0	20160	20160	0	22,000	449	20160	20160	1077	20160	20160	42
2,100	0	0	0	0	20160	20160	0	22,500	503	20160	20160	1079	20160	20160	43
2,200	0	0	0	0	20160	20160	0	23,000	909	20160	20160	1082	20160	20160	45
2,300	0	0	0	0	20160	20160	0	23,500	913	20160	20160	1178	20160	20160	47
2,400	0	0	0	0	20160	20160	0	24,000	1390	20160	20160	1237	20160	20160	49
2,500	0	0	0	0	20160	20160	0	24,500	1394	20160	20160	1238	20160	20160	54
2,600	0	0	0	0	20160	20160	0	25,000	1423	20160	20160	1238	20160	20160	53
2,700	0	0	0	0	20160	20160	0	25,500	3349	20160	20160	1238	20160	20160	52
2,800	0	0	0	0	20160	20160	0	26,000	10051	20160	20160	1238	20160	20160	52
2,900	0	0	0	0	20160	20160	0	26,500	20160	20160	20160	1239	20160	20160	61
3,000	0	0	6	0	20160	20160	0	27,000	20160	20160	20160	1248	20160	20160	64
3,500	0	0	40	0	20160	20160	0	27,500	20160	20160	20160	1247	20160	20160	65
4,000	0	0	58	0	20160	20160	0	28,000	20160	20160	20160	1246	20160	20160	66
4,500	0	0	55	0	20160	20160	0	28,500	20160	20160	20160	1254	20160	20160	71
5,000	0	0	62	0	20160	20160	0	29,000	20160	20160	20160	1411	20160	20160	87
5,500	0	2	120	0	20160	20160	0	29,500	20160	20160	20160	1433	20160	20160	73
6,000	0	0	149	3	20160	20160	0	30,000	20160	20160	20160	1435	20160	20160	73
6,500	0	0	186	28	20160	20160	0	30,500	20160	20160	20160	16165	20160	20160	74
7,000	0	3	260	33	20160	20160	0	31,000	20160	20160	20160	20160	20160	20160	77
7,500	0	32	318	41	20160	20160	0	31,500	20160	20160	20160	20160	20160	20160	78
8,000	0	60	345	45	20160	20160	0	32,000	20160	20160	20160	20160	20160	20160	79
8,500	0	98	443	49	20160	20160	0	32,500	20160	20160	20160	20160	20160	20160	81
9,000	0	97	674	73	20160	20160	0	33,000	20160	20160	20160	20160	20160	20160	85
9,500	6	116	733	84	20160	20160	0	33,500	20160	20160	20160	20160	20160	20160	93
10,000	21	135	943	102	20160	20160	0	34,000	20160	20160	20160	20160	20160	20160	94
10,500	46	168	1232	115	20160	20160	0	34,500	20160	20160	20160	20160	20160	20160	97
11,000	58	153	714	151	20160	20160	6	35,000	20160	20160	20160	20160	20160	20160	96
11,500	85	182	1417	205	20160	20160	9	35,500	20160	20160	20160	20160	20160	20160	96
12,000	98	292	3655	209	20160	20160	20	36,000	20160	20160	20160	20160	20160	20160	97

B.4 L5 Nadir-Facing Antenna Performance

TABLE 16.—L5 FREQUENCY BAND NADIR-FACING 1 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	89.9	83	80.5	84.3	47.4	21.1	99.9	12,500	100	98.3	99.9	99.9	72.5	69.9	100
200	99.4	99	97.5	96.9	64.6	33.7	100	13,000	100	98.1	99.8	99.9	70.4	66.7	100
300	99.9	99.5	99.8	99.2	70.8	40.9	100	13,500	100	98	99.6	99.9	68.6	64.1	100
400	99.9	99.6	99.8	99.8	74.2	45.8	100	14,000	99.9	98.1	99.4	99.9	66.9	61.8	100
500	99.9	99.6	99.8	99.9	76.3	49.5	100	14,500	99.9	98.4	99.1	99.9	65.2	59.9	100
600	99.9	99.7	99.9	99.9	77.8	52.6	100	15,000	99.9	98.7	98.8	99.9	63.8	58	100
700	99.9	99.7	99.9	99.9	79.2	55.1	100	15,500	99.8	98.9	98.6	99.9	62.4	56.3	100
800	99.9	99.8	99.9	99.9	80.1	57.1	100	16,000	99.8	99.1	98.5	99.9	61.2	54.9	100
900	99.9	99.9	99.9	100	80.9	59	100	16,500	99.7	99.3	98.5	99.9	59.9	53.5	100
1,000	100	100	99.9	100	81.6	60.5	100	17,000	99.7	99.4	98.5	99.9	58.9	52.2	100
1,100	100	100	99.9	100	82.1	62	100	17,500	99.7	99.5	98.6	99.9	57.8	51.1	100
1,200	100	100	99.9	100	82.7	63.3	100	18,000	99.7	99.6	98.7	99.9	56.7	49.9	100
1,300	100	100	99.9	100	83.2	64.4	100	18,500	99.8	99.6	98.9	99.9	55.8	48.9	100
1,400	100	100	100	100	83.5	65.4	100	19,000	99.8	99.7	99	99.9	54.9	48	100
1,500	100	100	100	100	83.9	66.3	100	19,500	99.8	99.7	99.1	99.9	53.9	47.1	100
1,600	100	100	100	100	84.4	67.1	100	20,000	99.8	99.8	99.2	99.8	53	46.1	100
1,700	100	100	100	100	84.7	67.8	100	20,500	99.9	99.8	99.3	99.8	52.2	45.3	100
1,800	100	100	100	100	85	68.5	100	21,000	99.9	99.8	99.3	99.7	51.4	44.6	100
1,900	100	100	100	100	85.2	69.1	100	21,500	99.9	99.8	99.4	99.7	50.7	43.8	100
2,000	100	100	100	100	85.6	69.6	100	22,000	99.9	99.9	99.4	99.7	50	43.1	100
2,100	100	100	100	100	85.9	70.2	100	22,500	99.9	99.9	99.5	99.6	49.3	42.3	100
2,200	100	100	100	100	86.2	70.7	100	23,000	99.9	99.9	99.5	99.5	48.6	41.6	100
2,300	100	100	100	100	86.3	71.2	100	23,500	99.9	99.9	99.5	99.5	47.9	41.1	100
2,400	100	100	100	100	86.5	71.6	100	24,000	99.9	99.9	99.5	99.4	47.4	40.4	100
2,500	100	100	100	100	86.7	72.1	100	24,500	99.9	99.9	99.5	99.4	46.7	39.8	100
2,600	100	100	100	100	87.1	72.5	100	25,000	99.9	99.8	99.5	99.3	46.1	39.2	100
2,700	100	100	100	100	87.3	72.9	100	25,500	99.9	99.8	99.5	99.2	45.6	38.6	100
2,800	100	100	100	100	87.5	73.3	100	26,000	99.9	99.6	99.5	99.1	45	38.1	100
2,900	100	100	100	100	87.6	73.7	100	26,500	99.9	99.5	99.5	99.1	44.5	37.6	100
3,000	100	100	100	100	87.8	74	100	27,000	99.9	99.3	99.5	99	44	37.1	100
3,500	100	100	100	100	88.7	75.7	100	27,500	99.9	99.1	99.5	98.9	43.5	36.7	100
4,000	100	100	100	100	89.3	77.1	100	28,000	99.9	98.9	99.5	98.8	43	36.2	100
4,500	100	100	100	100	89.9	78.4	100	28,500	100	98.7	99.4	98.7	42.5	35.7	100
5,000	100	100	100	100	90.4	79.4	100	29,000	100	98.4	99.4	98.6	42	35.3	100
5,500	100	100	100	100	91.1	80.4	100	29,500	100	98.1	99.4	98.5	41.5	34.8	100
6,000	100	100	100	100	91.5	81.3	100	30,000	100	97.8	99.4	98.4	41.1	34.5	100
6,500	100	100	100	100	91.8	82.1	100	30,500	100	97.5	99.3	98.2	40.7	34	100
7,000	100	100	100	100	92.1	82.8	100	31,000	100	97.2	99.3	98.1	40.3	33.7	100
7,500	100	100	100	100	92.5	83.5	100	31,500	100	96.8	99.2	98	39.9	33.3	100
8,000	100	100	100	100	92.8	84.1	100	32,000	100	96.4	99.2	97.9	39.6	32.9	100
8,500	100	100	100	100	92.7	84.7	100	32,500	100	96	99.1	97.8	39.2	32.6	100
9,000	100	100	100	100	92	85.3	100	33,000	100	95.7	99	97.6	38.9	32.3	100
9,500	100	100	100	100	90.4	85.7	100	33,500	100	95.3	98.9	97.5	38.5	31.9	100
10,000	100	100	100	100	87.7	83.6	100	34,000	100	94.9	98.8	97.4	38.2	31.7	100
10,500	100	99.9	100	100	83.5	81.8	100	34,500	100	94.5	98.7	97.3	37.8	31.4	100
11,000	100	99.7	100	100	79.9	79.7	100	35,000	99.9	94.2	98.6	97.1	37.5	31	100
11,500	100	99.3	100	100	77.1	78.3	100	35,500	99.9	93.8	98.5	97	37.2	30.8	100
12,000	100	98.8	99.9	99.9	74.6	75	100	36,000	99.9	93.4	98.3	96.9	36.9	30.5	100

TABLE 17.—L5 FREQUENCY BAND NADIR-FACING 4 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	10.9	3	3.5	6.4	0.4	0	95.5	12,500	98.1	74.3	84.4	89.9	9.5	16.6	100
200	46.3	16.1	20.1	33.4	3.5	0	99.9	13,000	97.4	72.2	83.1	87.4	8.6	14.4	100
300	70.3	39.7	38.1	56.7	7.7	0.2	99.9	13,500	96.6	69.6	81.7	84.8	7.8	12.8	100
400	83.2	56.4	57.5	74	12.1	0.4	100	14,000	95.9	66.5	80.2	82.2	7.1	11.5	99.9
500	90.2	69.3	70.6	85.9	16.3	0.8	100	14,500	95.2	63.1	78.5	79.6	6.5	10.4	99.9
600	94.2	79.1	79.9	92.9	20.3	1.1	100	15,000	94.5	60.1	76.7	77.1	5.9	9.5	99.9
700	96.4	86.8	86.4	96.5	24.1	1.5	100	15,500	93.9	57.1	74.7	74.5	5.5	8.8	99.9
800	97.7	92.8	91	98.2	27.6	2	100	16,000	93.2	54.1	72.8	72.1	5	8.2	99.9
900	98.5	94.6	94.1	99.1	30.8	2.4	100	16,500	92.5	51.1	70.9	69.7	4.6	7.7	99.9
1,000	99.2	96.7	96.3	99.5	33.8	2.8	100	17,000	91.7	47.9	68.8	67.3	4.3	7.1	99.9
1,100	99.7	98.5	97.8	99.8	36.4	3.3	100	17,500	90.8	44.5	66.6	64.9	4	6.6	99.9
1,200	99.9	99.5	98.7	99.9	38.6	3.7	100	18,000	89.8	41.1	64.2	62.4	3.7	6.2	99.9
1,300	99.9	99.9	99.3	99.9	40.6	4.1	100	18,500	88.7	37.8	61.6	60	3.5	5.8	99.9
1,400	99.9	99.9	99.7	99.9	42.3	4.7	100	19,000	87.5	34.5	58.9	57.6	3.2	5.5	99.9
1,500	100	100	99.8	99.9	43.7	5	100	19,500	86.4	31.3	56.1	55.3	3	5.3	99.9
1,600	100	100	99.9	99.9	45	5.6	100	20,000	85.3	28.3	53.4	53.1	2.8	4.9	99.9
1,700	100	100	99.9	99.9	46.1	5.9	100	20,500	84.2	25.5	50.7	50.9	2.6	4.7	99.9
1,800	100	100	99.9	99.9	47	6.5	100	21,000	83.1	23.1	48.2	48.8	2.5	4.5	99.9
1,900	100	100	99.9	100	47.7	6.8	100	21,500	81.9	20.9	45.9	46.7	2.3	4.3	99.9
2,000	100	100	100	100	48.2	7.2	100	22,000	80.7	19.1	43.8	44.8	2.2	4.2	99.9
2,100	100	100	100	100	48.7	7.6	100	22,500	79.5	17.5	41.9	43	2.1	4	99.9
2,200	100	100	100	100	49.1	8	100	23,000	78.1	16.2	40.2	41.2	2	3.8	99.9
2,300	100	100	100	100	49.5	8.4	100	23,500	76.8	15.1	38.5	39.6	1.9	3.6	99.9
2,400	100	100	100	100	49.8	8.8	100	24,000	75.3	14.2	37	38	1.8	3.5	99.9
2,500	100	100	100	100	50.1	9.2	100	24,500	73.9	13.4	35.5	36.5	1.7	3.3	99.9
2,600	100	100	100	100	50.3	9.6	100	25,000	72.4	12.7	34.1	35.1	1.6	3.2	99.9
2,700	100	100	100	100	50.5	10	100	25,500	70.9	12.1	32.7	33.7	1.5	3	99.9
2,800	100	100	100	100	50.7	10.4	100	26,000	69.5	11.5	31.4	32.4	1.4	2.9	99.9
2,900	100	100	100	100	50.9	10.8	100	26,500	68.1	10.9	30.2	31.2	1.4	2.8	99.9
3,000	100	100	100	100	51.1	11.2	100	27,000	66.6	10.3	29	30	1.3	2.7	99.9
3,500	100	100	100	100	51.7	13	100	27,500	65.1	9.7	27.8	28.9	1.3	2.6	99.9
4,000	100	100	100	100	52	15	100	28,000	63.6	9.1	26.7	27.8	1.2	2.5	99.9
4,500	100	100	100	100	51.8	16.9	100	28,500	62.2	8.6	25.7	26.8	1.2	2.4	99.9
5,000	100	100	100	100	50.9	18.6	100	29,000	60.8	8	24.7	25.9	1.1	2.3	99.9
5,500	100	100	100	100	49.8	20.4	100	29,500	59.5	7.5	23.7	24.9	1.1	2.2	99.9
6,000	100	100	100	100	47.8	22.1	100	30,000	58.2	7.1	22.7	24.1	1	2.2	99.9
6,500	100	100	100	100	45	23.8	100	30,500	56.9	6.7	21.8	23.2	1	2.1	99.9
7,000	100	99.9	100	100	41.8	25.4	100	31,000	55.6	6.3	21	22.4	0.9	2.1	99.9
7,500	100	99.1	99.9	99.9	38	26.9	100	31,500	54.4	6	20.2	21.6	0.9	2	99.9
8,000	100	97.4	99.8	99.9	33.5	28.3	100	32,000	53.3	5.7	19.4	20.8	0.8	1.9	99.9
8,500	100	95.1	99.3	99.9	28.4	29.8	100	32,500	52.2	5.5	18.6	20.1	0.8	1.8	99.9
9,000	100	92.1	98.4	99.7	23.6	31.3	100	33,000	51.1	5.2	17.9	19.3	0.8	1.8	99.9
9,500	100	88.6	97.1	99.2	19.9	32.4	100	33,500	50.1	5	17.2	18.7	0.7	1.7	99.9
10,000	99.9	85.2	95.3	98.5	17.2	29.6	100	34,000	49.1	4.8	16.6	18	0.7	1.7	99.9
10,500	99.8	82	93.2	97.4	15.1	26.9	100	34,500	48.1	4.6	16	17.4	0.7	1.7	99.9
11,000	99.6	79.9	90.9	96.1	13.3	24.7	100	35,000	47.2	4.5	15.5	16.8	0.7	1.6	99.9
11,500	99.2	78	88.6	94.5	11.9	22.8	100	35,500	46.3	4.4	15	16.2	0.6	1.6	99.9
12,000	98.7	76.3	86.3	92.3	10.6	20.1	100	36,000	45.4	4.2	14.5	15.6	0.6	1.5	99.9

TABLE 18.—L5 FREQUENCY BAND NADIR-FACING 1 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	57	70	51	76	20160	20160	29	12,500	0	41	13	8	20160	20160	0
200	55	36	34	59	20160	20160	0	13,000	0	44	19	7	20160	20160	0
300	13	32	20	45	20160	20160	0	13,500	0	50	25	10	20160	20160	0
400	9	31	19	33	20160	20160	0	14,000	2	51	28	14	20160	20160	0
500	8	29	17	26	20160	20160	0	14,500	10	48	32	14	20160	20160	0
600	7	28	16	20	20160	20160	0	15,000	18	45	34	13	20160	20160	0
700	5	26	15	12	20160	20160	0	15,500	22	43	37	13	20160	20160	0
800	4	24	13	5	20160	20160	0	16,000	25	40	39	16	20160	20160	0
900	3	12	12	0	20160	20160	0	16,500	27	38	40	19	20160	20160	0
1,000	0	0	11	0	20160	20160	0	17,000	31	35	40	22	20160	20160	0
1,100	0	0	9	0	20160	20160	0	17,500	33	33	40	21	20160	20160	0
1,200	0	0	5	0	20160	20160	0	18,000	31	31	39	22	20160	20160	0
1,300	0	0	2	0	20160	20160	0	18,500	29	29	38	20	20160	20160	0
1,400	0	0	0	0	20160	20160	0	19,000	27	27	36	20	20160	20160	0
1,500	0	0	0	0	20160	20160	0	19,500	26	25	35	22	20160	20160	0
1,600	0	0	0	0	20160	20160	0	20,000	24	23	34	23	20160	20160	0
1,700	0	0	0	0	20160	20160	0	20,500	22	21	32	24	20160	20160	0
1,800	0	0	0	0	20160	20160	0	21,000	21	19	31	25	20160	20160	0
1,900	0	0	0	0	20160	20160	0	21,500	20	18	30	29	20160	20160	0
2,000	0	0	0	0	20160	20160	0	22,000	18	16	29	32	20160	20160	0
2,100	0	0	0	0	20160	20160	0	22,500	16	15	28	34	20160	20160	0
2,200	0	0	0	0	20160	20160	0	23,000	15	13	27	38	20160	20160	0
2,300	0	0	0	0	20160	20160	0	23,500	14	11	26	41	20160	20160	0
2,400	0	0	0	0	20160	20160	0	24,000	12	10	26	47	20160	20160	0
2,500	0	0	0	0	20160	20160	0	24,500	11	12	26	50	20160	20160	0
2,600	0	0	0	0	20160	20160	0	25,000	10	15	27	55	20160	20160	0
2,700	0	0	0	0	20160	20160	0	25,500	8	15	26	53	20160	20160	0
2,800	0	0	0	0	20160	20160	0	26,000	7	18	28	51	20160	20160	0
2,900	0	0	0	0	20160	20160	0	26,500	6	20	27	49	20160	20160	0
3,000	0	0	0	0	20160	20160	0	27,000	5	23	27	47	20160	20160	0
3,500	0	0	0	0	20160	20160	0	27,500	4	27	28	45	20160	20160	0
4,000	0	0	0	0	20160	20160	0	28,000	2	30	27	44	20160	20160	0
4,500	0	0	0	0	20160	20160	0	28,500	1	33	27	46	20160	20160	0
5,000	0	0	0	0	20160	20160	0	29,000	0	36	26	48	20160	20160	0
5,500	0	0	0	0	20160	20160	0	29,500	0	39	26	50	20160	20160	0
6,000	0	0	0	0	20160	20160	0	30,000	0	41	25	50	20160	20160	0
6,500	0	0	0	0	20160	20160	0	30,500	0	43	25	52	20160	20160	0
7,000	0	0	0	0	20160	20160	0	31,000	0	45	26	54	20160	20160	0
7,500	0	0	0	0	20160	20160	0	31,500	0	47	27	56	20160	20160	0
8,000	0	0	0	0	20160	20160	0	32,000	0	48	28	57	20160	20160	0
8,500	0	0	0	0	20160	20160	0	32,500	0	50	27	59	20160	20160	0
9,000	0	0	0	0	20160	20160	0	33,000	0	50	29	62	20160	20160	0
9,500	0	0	0	0	20160	20160	0	33,500	0	51	30	65	20160	20160	0
10,000	0	0	0	0	20160	20160	0	34,000	0	52	31	69	20160	20160	0
10,500	0	3	0	0	20160	20160	0	34,500	0	52	32	73	20160	20160	0
11,000	0	16	0	0	20160	20160	0	35,000	2	53	33	74	20160	20160	0
11,500	0	29	0	0	20160	20160	0	35,500	4	54	34	75	20160	20160	0
12,000	0	38	6	6	20160	20160	0	36,000	7	55	35	77	20160	20160	0

TABLE 19.—L5 FREQUENCY BAND NADIR-FACING 4 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	20160	20160	20160	20160	20160	20160	89	12,500	41	137	185	129	20160	20160	0
200	20160	20160	20160	577	20160	20160	33	13,000	75	142	185	130	20160	20160	0
300	259	693	313	342	20160	20160	1	13,500	75	149	151	123	20160	20160	0
400	187	231	147	261	20160	20160	0	14,000	97	191	115	127	20160	20160	4
500	116	141	104	209	20160	20160	0	14,500	103	223	143	226	20160	20160	4
600	78	98	76	141	20160	20160	0	15,000	97	309	143	231	20160	20160	12
700	60	74	68	116	20160	20160	0	15,500	92	324	148	232	20160	20160	15
800	54	61	56	77	20160	20160	0	16,000	90	345	156	216	20160	20160	19
900	48	51	46	69	20160	20160	0	16,500	95	370	199	226	20160	20160	20
1,000	40	43	38	63	20160	20160	0	17,000	96	380	208	232	20160	20160	25
1,100	32	32	30	21	20160	20160	0	17,500	103	369	220	249	20160	20160	24
1,200	22	21	25	18	20160	20160	0	18,000	114	366	241	245	20160	20160	22
1,300	8	11	21	14	20160	20160	0	18,500	122	372	244	254	20160	20160	20
1,400	1	2	19	13	20160	20160	0	19,000	132	383	255	284	20160	20160	18
1,500	0	0	16	10	20160	20160	0	19,500	165	395	257	285	20160	20160	16
1,600	0	0	12	7	20160	20160	0	20,000	202	410	260	290	20160	20160	13
1,700	0	0	8	5	20160	20160	0	20,500	284	468	317	293	20160	20160	11
1,800	0	0	4	2	20160	20160	0	21,000	310	486	325	375	20160	20160	10
1,900	0	0	1	0	20160	20160	0	21,500	317	681	330	380	20160	20160	12
2,000	0	0	0	0	20160	20160	0	22,000	325	984	345	384	20160	20160	11
2,100	0	0	0	0	20160	20160	0	22,500	334	1490	348	459	20160	20160	11
2,200	0	0	0	0	20160	20160	0	23,000	334	1494	358	462	20160	20160	10
2,300	0	0	0	0	20160	20160	0	23,500	298	1874	363	464	20160	20160	8
2,400	0	0	0	0	20160	20160	0	24,000	322	3086	393	466	20160	20160	7
2,500	0	0	0	0	20160	20160	0	24,500	330	3837	429	514	20160	20160	6
2,600	0	0	0	0	20160	20160	0	25,000	332	3838	427	515	20160	20160	6
2,700	0	0	0	0	20160	20160	0	25,500	332	20160	429	516	20160	20160	7
2,800	0	0	0	0	20160	20160	0	26,000	332	20160	442	517	20160	20160	7
2,900	0	0	0	0	20160	20160	0	26,500	333	20160	458	588	20160	20160	7
3,000	0	0	0	0	20160	20160	0	27,000	340	20160	460	662	20160	20160	8
3,500	0	0	0	0	20160	20160	0	27,500	357	20160	464	787	20160	20160	9
4,000	0	0	0	0	20160	20160	0	28,000	355	20160	467	789	20160	20160	9
4,500	0	0	0	0	20160	20160	0	28,500	375	20160	647	667	20160	20160	11
5,000	0	0	0	0	20160	20160	0	29,000	373	20160	855	802	20160	20160	13
5,500	0	0	0	0	20160	20160	0	29,500	372	20160	884	802	20160	20160	20
6,000	0	0	0	0	20160	20160	0	30,000	372	20160	979	802	20160	20160	20
6,500	0	0	0	0	20160	20160	0	30,500	413	20160	1175	803	20160	20160	18
7,000	0	3	0	0	20160	20160	0	31,000	419	20160	1426	803	20160	20160	20
7,500	0	24	16	18	20160	20160	0	31,500	501	20160	1837	803	20160	20160	21
8,000	0	40	26	25	20160	20160	0	32,000	566	20160	2605	803	20160	20160	21
8,500	0	52	40	27	20160	20160	0	32,500	573	20160	2606	799	20160	20160	20
9,000	0	64	48	33	20160	20160	0	33,000	573	20160	2868	1171	20160	20160	21
9,500	0	119	55	50	20160	20160	0	33,500	570	20160	2504	1174	20160	20160	23
10,000	3	117	77	64	20160	20160	0	34,000	422	20160	2504	1176	20160	20160	24
10,500	12	228	99	72	20160	20160	0	34,500	402	20160	3350	1177	20160	20160	26
11,000	20	208	105	87	20160	20160	0	35,000	639	20160	3349	1178	20160	20160	27
11,500	27	147	130	113	20160	20160	0	35,500	642	20160	3349	1179	20160	20160	35
12,000	34	139	173	116	20160	20160	0	36,000	644	20160	2252	1180	20160	20160	35

B.5 L5 Zenith-Facing Antenna Performance

TABLE 20.—L5 FREQUENCY BAND ZENITH-FACING 1 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	75.6	61	100	12,500	62.9	38.4	22	29.7	18.6	27.1	86.2
200	100	100	100	100	74.8	60.9	100	13,000	57.4	33.3	17.7	24.4	18	24	81.4
300	100	100	100	100	73.8	60.7	100	13,500	52.3	28.7	14.1	19.9	17.4	21.5	76.3
400	100	100	100	100	72.8	60.6	100	14,000	47.4	24.6	11.1	16.1	16.8	19.4	70.9
500	100	100	100	100	71.9	60.5	100	14,500	43	20.9	8.6	12.8	16.2	17.7	65.6
600	100	100	100	100	71	60.4	100	15,000	38.6	17.7	6.5	10.1	15.5	16.2	60
700	100	100	100	100	70.2	60.2	100	15,500	34.8	14.9	4.7	7.8	14.8	14.8	54.8
800	100	100	100	100	69.4	60.1	100	16,000	31	12.5	3.3	5.9	14	13.7	49.7
900	100	100	100	100	68.6	60	100	16,500	27.6	10.3	2.2	4.3	13.2	12.5	44.8
1,000	100	100	100	100	67.8	59.9	100	17,000	24.7	8.4	1.4	3.1	12.3	11.5	40.3
1,100	100	100	100	100	66.9	59.8	100	17,500	21.9	6.8	0.8	2.1	11.5	10.5	36.2
1,200	100	100	100	100	65.9	59.7	100	18,000	19.5	5.4	0.3	1.3	10.7	9.6	32.3
1,300	100	100	100	100	64.9	59.5	100	18,500	17.3	4.2	0.1	0.7	9.9	8.9	29
1,400	100	100	100	100	63.9	59.4	100	19,000	15.4	3.2	0	0.3	9.1	8.1	26
1,500	100	100	100	100	62.9	59.2	100	19,500	13.6	2.4	0	0.1	8.4	7.3	23.4
1,600	100	100	100	100	61.8	59	100	20,000	12.1	1.7	0	0	7.7	6.8	21
1,700	100	100	100	100	60.8	58.9	100	20,500	10.8	1.1	0	0	7.1	6.1	19
1,800	100	100	100	100	59.7	58.8	100	21,000	9.6	0.7	0	0	6.5	5.5	17.4
1,900	100	100	100	100	58.6	58.7	100	21,500	8.8	0.4	0	0	5.9	4.9	15.8
2,000	100	100	100	100	57.6	58.6	100	22,000	7.9	0.2	0	0	5.4	4.4	14.4
2,100	100	100	100	100	56.5	58.4	100	22,500	7	0	0	0	4.8	4.1	13
2,200	100	100	100	100	55.4	58.3	100	23,000	6.2	0	0	0	4.3	3.6	11.7
2,300	100	100	100	100	54.4	58.2	100	23,500	5.5	0	0	0	3.9	3.2	10.7
2,400	100	100	100	100	53.4	58.1	100	24,000	5.1	0	0	0	3.5	2.9	9.8
2,500	100	100	100	100	52.5	58	100	24,500	4.4	0	0	0	3.1	2.6	8.8
2,600	100	100	100	100	51.5	57.8	100	25,000	3.9	0	0	0	2.7	2.3	7.9
2,700	100	100	100	100	50.6	57.7	100	25,500	3.5	0	0	0	2.4	2	7.1
2,800	100	100	100	100	49.7	57.6	100	26,000	3	0	0	0	2.1	1.8	6.3
2,900	100	100	100	100	48.8	57.5	100	26,500	2.5	0	0	0	1.8	1.6	5.4
3,000	100	100	100	100	48	57.3	100	27,000	2.2	0	0	0	1.5	1.3	4.7
3,500	100	100	100	100	44.1	56.8	100	27,500	1.9	0	0	0	1.3	1.2	4.2
4,000	100	100	100	100	40.9	56	100	28,000	1.7	0	0	0	1.1	1	3.7
4,500	100	100	100	100	38	55.4	100	28,500	1.5	0	0	0	1	0.9	3.2
5,000	100	100	100	100	35.6	54.8	100	29,000	1.2	0	0	0	0.8	0.7	2.7
5,500	100	100	100	100	33	54.2	100	29,500	0.9	0	0	0	0.6	0.6	2.1
6,000	100	100	100	100	30.9	53.6	100	30,000	0.7	0	0	0	0.5	0.5	1.7
6,500	100	100	99.9	99.9	29.1	52.8	100	30,500	0.6	0	0	0	0.4	0.4	1.5
7,000	100	99.9	98.6	99.6	27.7	52.2	100	31,000	0.5	0	0	0	0.3	0.3	1.3
7,500	100	99.1	94.6	97.9	26.6	51.6	100	31,500	0.4	0	0	0	0.3	0.2	1
8,000	99.9	96	89.3	94.3	25.5	51	100	32,000	0.2	0	0	0	0.2	0.2	0.6
8,500	99.5	91.8	82.5	88.7	24.5	50.3	100	32,500	0.1	0	0	0	0.1	0.1	0.5
9,000	98.4	86.7	74.2	81.6	23.6	49.6	99.9	33,000	0.1	0	0	0	0.1	0.1	0.4
9,500	96.4	80.7	64.7	73.8	22.7	48.8	99.9	33,500	0.1	0	0	0	0	0.1	0.3
10,000	92.7	73.7	55.6	65.7	22	45.4	99.5	34,000	0.1	0	0	0	0	0	0.2
10,500	87.9	65.4	47.2	57.8	21.2	42.7	98.5	34,500	0	0	0	0	0	0	0.1
11,000	81.5	57.6	39.7	50	20.5	39.3	96.7	35,000	0	0	0	0	0	0	0
11,500	75	50.5	32.9	42.6	19.8	36.9	94.2	35,500	0	0	0	0	0	0	0
12,000	68.7	44.1	27	35.7	19.2	32.6	90.8	36,000	0	0	0	0	0	0	0

TABLE 21.—L5 FREQUENCY BAND ZENITH-FACING 4 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	55.7	23.6	100	12,500	7.5	0	0	0	3.6	1.9	32.2
200	100	100	100	100	55.6	23.4	100	13,000	5.1	0	0	0	2.6	1	27
300	100	100	100	100	55.4	23.3	100	13,500	3.2	0	0	0	1.9	0.5	22.7
400	100	100	100	100	55.2	23.2	100	14,000	1.9	0	0	0	1.4	0.2	18.9
500	100	100	100	100	55	23.1	100	14,500	1	0	0	0	1	0.1	15.6
600	100	100	100	100	54.8	23	100	15,000	0.6	0	0	0	0.7	0	12.9
700	100	100	100	100	54.4	22.9	100	15,500	0.3	0	0	0	0.4	0	10.5
800	100	100	100	100	54.1	22.8	100	16,000	0.2	0	0	0	0.3	0	8.3
900	100	100	100	100	53.7	22.7	100	16,500	0	0	0	0	0.2	0	6.7
1,000	100	100	100	100	53.2	22.6	100	17,000	0	0	0	0	0.1	0	5.2
1,100	100	100	100	100	52.8	22.5	100	17,500	0	0	0	0	0	0	4
1,200	100	100	100	100	52.3	22.3	100	18,000	0	0	0	0	0	0	3.1
1,300	100	100	100	100	51.8	22.2	100	18,500	0	0	0	0	0	0	2.2
1,400	100	100	100	100	51.3	22.1	100	19,000	0	0	0	0	0	0	1.7
1,500	100	100	100	100	50.7	22	100	19,500	0	0	0	0	0	0	1.2
1,600	100	100	100	100	50.1	21.9	100	20,000	0	0	0	0	0	0	0.9
1,700	100	100	100	100	49.6	21.8	100	20,500	0	0	0	0	0	0	0.6
1,800	100	100	100	100	49	21.7	100	21,000	0	0	0	0	0	0	0.4
1,900	100	100	100	100	48.3	21.6	100	21,500	0	0	0	0	0	0	0.3
2,000	100	100	100	100	47.8	21.5	100	22,000	0	0	0	0	0	0	0.2
2,100	100	100	100	100	47	21.4	100	22,500	0	0	0	0	0	0	0.1
2,200	100	100	100	100	46.5	21.3	100	23,000	0	0	0	0	0	0	0
2,300	100	100	100	100	45.8	21.1	100	23,500	0	0	0	0	0	0	0
2,400	100	100	100	100	45.1	21.1	100	24,000	0	0	0	0	0	0	0
2,500	100	100	100	100	44.5	21	100	24,500	0	0	0	0	0	0	0
2,600	100	100	100	100	43.8	20.8	100	25,000	0	0	0	0	0	0	0
2,700	100	100	100	100	43.2	20.7	100	25,500	0	0	0	0	0	0	0
2,800	100	100	100	100	42.5	20.6	100	26,000	0	0	0	0	0	0	0
2,900	100	100	100	100	41.9	20.5	100	26,500	0	0	0	0	0	0	0
3,000	100	100	100	100	41.2	20.4	100	27,000	0	0	0	0	0	0	0
3,500	100	100	100	100	38.3	19.9	100	27,500	0	0	0	0	0	0	0
4,000	100	100	100	100	35.7	19.4	100	28,000	0	0	0	0	0	0	0
4,500	100	100	100	100	32.8	18.9	100	28,500	0	0	0	0	0	0	0
5,000	100	100	100	100	30	18.4	100	29,000	0	0	0	0	0	0	0
5,500	100	100	100	98.5	27	17.9	100	29,500	0	0	0	0	0	0	0
6,000	100	88.1	70.5	65.6	24.3	17.4	100	30,000	0	0	0	0	0	0	0
6,500	100	38	27.3	24.8	21.7	16.9	100	30,500	0	0	0	0	0	0	0
7,000	98.4	15.1	9.3	6.5	19.4	16.4	100	31,000	0	0	0	0	0	0	0
7,500	77.9	6.3	2.7	1.1	17.3	15.9	99.9	31,500	0	0	0	0	0	0	0
8,000	62.4	2.4	0.6	0.1	15.3	15.4	99.6	32,000	0	0	0	0	0	0	0
8,500	53.7	0.7	0.1	0	13.3	14.9	97.1	32,500	0	0	0	0	0	0	0
9,000	48.3	0.1	0	0	11.6	14.4	91.9	33,000	0	0	0	0	0	0	0
9,500	39.4	0	0	0	10.2	13.9	84	33,500	0	0	0	0	0	0	0
10,000	28.2	0	0	0	9	10.8	73.7	34,000	0	0	0	0	0	0	0
10,500	22	0	0	0	7.9	8.3	63.6	34,500	0	0	0	0	0	0	0
11,000	17.4	0	0	0	6.8	6.7	54.3	35,000	0	0	0	0	0	0	0
11,500	13.8	0	0	0	5.9	5.3	45.9	35,500	0	0	0	0	0	0	0
12,000	10.5	0	0	0	4.8	3.7	38.4	36,000	0	0	0	0	0	0	0

TABLE 22.—L5 FREQUENCY BAND ZENITH-FACING 1 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	20160	20160	20160	20160	20160	20160	20160
200	0	0	0	0	20160	20160	0	13,000	20160	20160	20160	20160	20160	20160	20160
300	0	0	0	0	20160	20160	0	13,500	20160	20160	20160	20160	20160	20160	20160
400	0	0	0	0	20160	20160	0	14,000	20160	20160	20160	20160	20160	20160	20160
500	0	0	0	0	20160	20160	0	14,500	20160	20160	20160	20160	20160	20160	20160
600	0	0	0	0	20160	20160	0	15,000	20160	20160	20160	20160	20160	20160	20160
700	0	0	0	0	20160	20160	0	15,500	20160	20160	20160	20160	20160	20160	20160
800	0	0	0	0	20160	20160	0	16,000	20160	20160	20160	20160	20160	20160	20160
900	0	0	0	0	20160	20160	0	16,500	20160	20160	20160	20160	20160	20160	20160
1,000	0	0	0	0	20160	20160	0	17,000	20160	20160	20160	20160	20160	20160	20160
1,100	0	0	0	0	20160	20160	0	17,500	20160	20160	20160	20160	20160	20160	20160
1,200	0	0	0	0	20160	20160	0	18,000	20160	20160	20160	20160	20160	20160	20160
1,300	0	0	0	0	20160	20160	0	18,500	20160	20160	20160	20160	20160	20160	20160
1,400	0	0	0	0	20160	20160	0	19,000	20160	20160	20160	20160	20160	20160	20160
1,500	0	0	0	0	20160	20160	0	19,500	20160	20160	20160	20160	20160	20160	20160
1,600	0	0	0	0	20160	20160	0	20,000	20160	20160	20160	20160	20160	20160	20160
1,700	0	0	0	0	20160	20160	0	20,500	20160	20160	20160	20160	20160	20160	20160
1,800	0	0	0	0	20160	20160	0	21,000	20160	20160	20160	20160	20160	20160	20160
1,900	0	0	0	0	20160	20160	0	21,500	20160	20160	20160	20160	20160	20160	20160
2,000	0	0	0	0	20160	20160	0	22,000	20160	20160	20160	20160	20160	20160	20160
2,100	0	0	0	0	20160	20160	0	22,500	20160	20160	20160	20160	20160	20160	20160
2,200	0	0	0	0	20160	20160	0	23,000	20160	20160	20160	20160	20160	20160	20160
2,300	0	0	0	0	20160	20160	0	23,500	20160	20160	20160	20160	20160	20160	20160
2,400	0	0	0	0	20160	20160	0	24,000	20160	20160	20160	20160	20160	20160	20160
2,500	0	0	0	0	20160	20160	0	24,500	20160	20160	20160	20160	20160	20160	20160
2,600	0	0	0	0	20160	20160	0	25,000	20160	20160	20160	20160	20160	20160	20160
2,700	0	0	0	0	20160	20160	0	25,500	20160	20160	20160	20160	20160	20160	20160
2,800	0	0	0	0	20160	20160	0	26,000	20160	20160	20160	20160	20160	20160	20160
2,900	0	0	0	0	20160	20160	0	26,500	20160	20160	20160	20160	20160	20160	20160
3,000	0	0	0	0	20160	20160	0	27,000	20160	20160	20160	20160	20160	20160	20160
3,500	0	0	0	0	20160	20160	0	27,500	20160	20160	20160	20160	20160	20160	20160
4,000	0	0	0	0	20160	20160	0	28,000	20160	20160	20160	20160	20160	20160	20160
4,500	0	0	0	0	20160	20160	0	28,500	20160	20160	20160	20160	20160	20160	20160
5,000	0	0	0	0	20160	20160	0	29,000	20160	20160	20160	20160	20160	20160	20160
5,500	0	0	0	0	20160	20160	0	29,500	20160	20160	20160	20160	20160	20160	20160
6,000	0	0	0	0	20160	20160	0	30,000	20160	20160	20160	20160	20160	20160	20160
6,500	0	0	23	4	20160	20160	0	30,500	20160	20160	20160	20160	20160	20160	20160
7,000	0	4	65	20160	20160	20160	0	31,000	20160	20160	20160	20160	20160	20160	20160
7,500	0	72	137	20160	20160	20160	0	31,500	20160	20160	20160	20160	20160	20160	20160
8,000	10	20160	169	20160	20160	20160	0	32,000	20160	20160	20160	20160	20160	20160	20160
8,500	76	20160	192	20160	20160	20160	0	32,500	20160	20160	20160	20160	20160	20160	20160
9,000	115	20160	20160	20160	20160	20160	16	33,000	20160	20160	20160	20160	20160	20160	20160
9,500	145	20160	20160	20160	20160	20160	47	33,500	20160	20160	20160	20160	20160	20160	20160
10,000	276	20160	20160	20160	20160	20160	224	34,000	20160	20160	20160	20160	20160	20160	20160
10,500	410	20160	20160	20160	20160	20160	303	34,500	20160	20160	20160	20160	20160	20160	20160
11,000	20160	20160	20160	20160	20160	20160	5738	35,000	20160	20160	20160	20160	20160	20160	20160
11,500	20160	20160	20160	20160	20160	20160	20160	35,500	20160	20160	20160	20160	20160	20160	20160
12,000	20160	20160	20160	20160	20160	20160	20160	36,000	20160	20160	20160	20160	20160	20160	20160

TABLE 23.—L5 FREQUENCY BAND ZENITH-FACING 4 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	20160	20160	20160	20160	20160	20160	20160
200	0	0	0	0	20160	20160	0	13,000	20160	20160	20160	20160	20160	20160	20160
300	0	0	0	0	20160	20160	0	13,500	20160	20160	20160	20160	20160	20160	20160
400	0	0	0	0	20160	20160	0	14,000	20160	20160	20160	20160	20160	20160	20160
500	0	0	0	0	20160	20160	0	14,500	20160	20160	20160	20160	20160	20160	20160
600	0	0	0	0	20160	20160	0	15,000	20160	20160	20160	20160	20160	20160	20160
700	0	0	0	0	20160	20160	0	15,500	20160	20160	20160	20160	20160	20160	20160
800	0	0	0	0	20160	20160	0	16,000	20160	20160	20160	20160	20160	20160	20160
900	0	0	0	0	20160	20160	0	16,500	20160	20160	20160	20160	20160	20160	20160
1,000	0	0	0	0	20160	20160	0	17,000	20160	20160	20160	20160	20160	20160	20160
1,100	0	0	0	0	20160	20160	0	17,500	20160	20160	20160	20160	20160	20160	20160
1,200	0	0	0	0	20160	20160	0	18,000	20160	20160	20160	20160	20160	20160	20160
1,300	0	0	0	0	20160	20160	0	18,500	20160	20160	20160	20160	20160	20160	20160
1,400	0	0	0	0	20160	20160	0	19,000	20160	20160	20160	20160	20160	20160	20160
1,500	0	0	0	0	20160	20160	0	19,500	20160	20160	20160	20160	20160	20160	20160
1,600	0	0	0	0	20160	20160	0	20,000	20160	20160	20160	20160	20160	20160	20160
1,700	0	0	0	0	20160	20160	0	20,500	20160	20160	20160	20160	20160	20160	20160
1,800	0	0	0	0	20160	20160	0	21,000	20160	20160	20160	20160	20160	20160	20160
1,900	0	0	0	0	20160	20160	0	21,500	20160	20160	20160	20160	20160	20160	20160
2,000	0	0	0	0	20160	20160	0	22,000	20160	20160	20160	20160	20160	20160	20160
2,100	0	0	0	0	20160	20160	0	22,500	20160	20160	20160	20160	20160	20160	20160
2,200	0	0	0	0	20160	20160	0	23,000	20160	20160	20160	20160	20160	20160	20160
2,300	0	0	0	0	20160	20160	0	23,500	20160	20160	20160	20160	20160	20160	20160
2,400	0	0	0	0	20160	20160	0	24,000	20160	20160	20160	20160	20160	20160	20160
2,500	0	0	0	0	20160	20160	0	24,500	20160	20160	20160	20160	20160	20160	20160
2,600	0	0	0	0	20160	20160	0	25,000	20160	20160	20160	20160	20160	20160	20160
2,700	0	0	0	0	20160	20160	0	25,500	20160	20160	20160	20160	20160	20160	20160
2,800	0	0	0	0	20160	20160	0	26,000	20160	20160	20160	20160	20160	20160	20160
2,900	0	0	0	0	20160	20160	0	26,500	20160	20160	20160	20160	20160	20160	20160
3,000	0	0	0	0	20160	20160	0	27,000	20160	20160	20160	20160	20160	20160	20160
3,500	0	0	0	0	20160	20160	0	27,500	20160	20160	20160	20160	20160	20160	20160
4,000	0	0	0	0	20160	20160	0	28,000	20160	20160	20160	20160	20160	20160	20160
4,500	0	0	0	0	20160	20160	0	28,500	20160	20160	20160	20160	20160	20160	20160
5,000	0	0	0	0	20160	20160	0	29,000	20160	20160	20160	20160	20160	20160	20160
5,500	0	0	0	64	20160	20160	0	29,500	20160	20160	20160	20160	20160	20160	20160
6,000	0	120	398	426	20160	20160	0	30,000	20160	20160	20160	20160	20160	20160	20160
6,500	0	473	11480	1128	20160	20160	0	30,500	20160	20160	20160	20160	20160	20160	20160
7,000	66	20160	20160	20160	20160	20160	0	31,000	20160	20160	20160	20160	20160	20160	20160
7,500	426	20160	20160	20160	20160	20160	32	31,500	20160	20160	20160	20160	20160	20160	20160
8,000	20160	20160	20160	20160	20160	20160	70	32,000	20160	20160	20160	20160	20160	20160	20160
8,500	20160	20160	20160	20160	20160	20160	468	32,500	20160	20160	20160	20160	20160	20160	20160
9,000	20160	20160	20160	20160	20160	20160	20160	33,000	20160	20160	20160	20160	20160	20160	20160
9,500	20160	20160	20160	20160	20160	20160	20160	33,500	20160	20160	20160	20160	20160	20160	20160
10,000	20160	20160	20160	20160	20160	20160	20160	34,000	20160	20160	20160	20160	20160	20160	20160
10,500	20160	20160	20160	20160	20160	20160	20160	34,500	20160	20160	20160	20160	20160	20160	20160
11,000	20160	20160	20160	20160	20160	20160	20160	35,000	20160	20160	20160	20160	20160	20160	20160
11,500	20160	20160	20160	20160	20160	20160	20160	35,500	20160	20160	20160	20160	20160	20160	20160
12,000	20160	20160	20160	20160	20160	20160	20160	36,000	20160	20160	20160	20160	20160	20160	20160

B.6 L5 Omnidirectional Antenna Performance

TABLE 24.—L5 FREQUENCY BAND OMNIDIRECTIONAL 1 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	80.4	67.4	100	12,500	100	98.3	99.9	99.9	89	92.2	100
200	100	100	100	100	83.4	71.9	100	13,000	100	98.1	99.8	99.9	87.2	88.4	100
300	100	100	100	100	85.3	74.8	100	13,500	100	98	99.6	99.9	85.3	84.7	100
400	100	100	100	100	86.8	77	100	14,000	100	98.1	99.4	99.9	83.4	80.9	100
500	100	100	100	100	87.9	78.8	100	14,500	99.9	98.4	99.1	99.9	81.4	77.6	100
600	100	100	100	100	88.8	80.4	100	15,000	99.9	98.7	98.8	99.9	79.4	74.3	100
700	100	100	100	100	89.7	81.7	100	15,500	99.9	98.9	98.6	99.9	77.3	71.2	100
800	100	100	100	100	90.4	82.9	100	16,000	99.9	99.1	98.5	99.9	75.2	68.6	100
900	100	100	100	100	91.1	83.9	100	16,500	99.8	99.3	98.5	99.9	73.1	66.1	100
1,000	100	100	100	100	91.6	84.9	100	17,000	99.8	99.4	98.5	99.9	71.2	63.8	100
1,100	100	100	100	100	92	85.7	100	17,500	99.8	99.5	98.6	99.9	69.3	61.7	100
1,200	100	100	100	100	92.6	86.5	100	18,000	99.8	99.6	98.7	99.9	67.5	59.6	100
1,300	100	100	100	100	93	87.2	100	18,500	99.8	99.6	98.9	99.9	65.7	57.8	100
1,400	100	100	100	100	93.3	87.9	100	19,000	99.8	99.7	99	99.9	64.1	56.1	100
1,500	100	100	100	100	93.6	88.6	100	19,500	99.8	99.7	99.1	99.9	62.4	54.4	100
1,600	100	100	100	100	94	89.1	100	20,000	99.9	99.8	99.2	99.8	60.8	52.9	100
1,700	100	100	100	100	94.3	89.7	100	20,500	99.9	99.8	99.3	99.8	59.3	51.4	100
1,800	100	100	100	100	94.5	90.2	100	21,000	99.9	99.8	99.3	99.7	58	50.1	100
1,900	100	100	100	100	94.7	90.7	100	21,500	99.9	99.8	99.4	99.7	56.6	48.8	100
2,000	100	100	100	100	94.9	91.1	100	22,000	99.9	99.9	99.4	99.7	55.4	47.5	100
2,100	100	100	100	100	95.2	91.6	100	22,500	99.9	99.9	99.5	99.6	54.1	46.4	100
2,200	100	100	100	100	95.4	92	100	23,000	99.9	99.9	99.5	99.5	52.9	45.3	100
2,300	100	100	100	100	95.5	92.4	100	23,500	99.9	99.9	99.5	99.5	51.9	44.3	100
2,400	100	100	100	100	95.6	92.7	100	24,000	99.9	99.9	99.5	99.4	50.9	43.4	100
2,500	100	100	100	100	95.7	93.1	100	24,500	99.9	99.9	99.5	99.4	49.9	42.4	100
2,600	100	100	100	100	96	93.4	100	25,000	99.9	99.8	99.5	99.3	48.9	41.5	100
2,700	100	100	100	100	96.1	93.7	100	25,500	99.9	99.8	99.5	99.2	48	40.7	100
2,800	100	100	100	100	96.2	94	100	26,000	99.9	99.6	99.5	99.1	47.1	39.9	100
2,900	100	100	100	100	96.2	94.3	100	26,500	99.9	99.5	99.5	99.1	46.3	39.2	100
3,000	100	100	100	100	96.3	94.5	100	27,000	99.9	99.3	99.5	99	45.6	38.4	100
3,500	100	100	100	100	96.8	95.7	100	27,500	99.9	99.1	99.5	98.9	44.9	37.9	100
4,000	100	100	100	100	97.1	96.5	100	28,000	99.9	98.9	99.5	98.8	44.2	37.3	100
4,500	100	100	100	100	97.4	97.3	100	28,500	100	98.7	99.4	98.7	43.5	36.7	100
5,000	100	100	100	100	97.6	97.8	100	29,000	100	98.4	99.4	98.6	42.8	36.1	100
5,500	100	100	100	100	97.8	98.3	100	29,500	100	98.1	99.4	98.5	42.2	35.4	100
6,000	100	100	100	100	97.9	98.7	100	30,000	100	97.8	99.4	98.4	41.7	35	100
6,500	100	100	100	100	97.9	99	100	30,500	100	97.5	99.3	98.2	41.2	34.5	100
7,000	100	100	100	100	97.9	99.3	100	31,000	100	97.2	99.3	98.1	40.7	34.1	100
7,500	100	100	100	100	98	99.4	100	31,500	100	96.8	99.2	98	40.3	33.6	100
8,000	100	100	100	100	98	99.6	100	32,000	100	96.4	99.2	97.9	39.8	33.2	100
8,500	100	100	100	100	97.8	99.7	100	32,500	100	96	99.1	97.8	39.4	32.8	100
9,000	100	100	100	100	97.3	99.8	100	33,000	100	95.7	99	97.6	39	32.5	100
9,500	100	100	100	100	96.7	99.8	100	33,500	100	95.3	98.9	97.5	38.6	32.1	100
10,000	100	100	100	100	95.9	99.9	100	34,000	100	94.9	98.8	97.4	38.2	31.8	100
10,500	100	99.9	100	100	94.8	99.9	100	34,500	100	94.5	98.7	97.3	37.9	31.4	100
11,000	100	99.7	100	100	93.5	99.9	100	35,000	99.9	94.2	98.6	97.1	37.5	31.1	100
11,500	100	99.3	100	100	92.1	99.8	100	35,500	99.9	93.8	98.5	97	37.2	30.8	100
12,000	100	98.8	99.9	99.9	90.6	97.1	100	36,000	99.9	93.4	98.3	96.9	36.9	30.5	100

TABLE 25.—L5 FREQUENCY BAND OMNIDIRECTIONAL 4 SATELLITE SYSTEM AVAILABILITY PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	100	100	100	100	62.9	29.5	100	12,500	99.8	78.7	86.9	92.7	13.2	18.6	100
200	100	100	100	100	67.4	34	100	13,000	99.5	75.7	84.8	90.3	11.2	15.4	100
300	100	100	100	100	69.7	37.2	100	13,500	99.2	72.8	83	87.5	9.7	13.3	100
400	100	100	100	100	70.9	39.7	100	14,000	98.7	69.8	81.3	84.8	8.5	11.7	100
500	100	100	100	100	71.9	41.8	100	14,500	97.8	66.6	79.4	81.9	7.5	10.5	99.9
600	100	100	100	100	72.5	43.7	100	15,000	96.8	63.5	77.5	79	6.6	9.6	99.9
700	100	100	100	100	73	45.3	100	15,500	95.7	60.4	75.4	76.1	5.9	8.8	99.9
800	100	100	100	100	73.4	46.9	100	16,000	94.8	57.2	73.3	73.3	5.4	8.2	99.9
900	100	100	100	100	73.8	48.2	100	16,500	94	54	71.3	70.7	4.9	7.7	99.9
1,000	100	100	100	100	74.2	49.5	100	17,000	93.2	50.6	69.1	68	4.4	7.1	99.9
1,100	100	100	100	100	74.6	50.7	100	17,500	92.3	46.9	66.8	65.3	4.1	6.6	99.9
1,200	100	100	100	100	74.8	51.8	100	18,000	91.3	43.3	64.3	62.7	3.8	6.2	99.9
1,300	100	100	100	100	74.9	52.8	100	18,500	90.3	39.6	61.6	60.2	3.5	5.8	99.9
1,400	100	100	100	100	75.1	53.9	100	19,000	89.1	36	58.9	57.7	3.3	5.5	99.9
1,500	100	100	100	100	75.2	54.8	100	19,500	88	32.5	56.1	55.4	3	5.3	99.9
1,600	100	100	100	100	75.2	55.7	100	20,000	86.9	29.3	53.4	53.1	2.8	4.9	99.9
1,700	100	100	100	100	75.2	56.6	100	20,500	85.8	26.3	50.7	50.9	2.6	4.7	99.9
1,800	100	100	100	100	75.1	57.5	100	21,000	84.7	23.6	48.2	48.8	2.5	4.5	99.9
1,900	100	100	100	100	75	58.2	100	21,500	83.5	21.2	45.9	46.7	2.3	4.3	99.9
2,000	100	100	100	100	74.8	58.9	100	22,000	82.2	19.2	43.8	44.8	2.2	4.2	99.9
2,100	100	100	100	100	74.8	59.7	100	22,500	81	17.6	41.9	43	2.1	4	99.9
2,200	100	100	100	100	74.7	60.4	100	23,000	79.6	16.2	40.2	41.2	2	3.8	99.9
2,300	100	100	100	100	74.6	61.1	100	23,500	78.2	15.1	38.5	39.6	1.9	3.6	99.9
2,400	100	100	100	100	74.6	61.7	100	24,000	76.8	14.2	37	38	1.8	3.5	99.9
2,500	100	100	100	100	74.6	62.4	100	24,500	75.2	13.4	35.5	36.5	1.7	3.3	99.9
2,600	100	100	100	100	74.5	62.9	100	25,000	73.7	12.7	34.1	35.1	1.6	3.2	99.9
2,700	100	100	100	100	74.6	63.5	100	25,500	72.2	12.1	32.7	33.7	1.5	3	99.9
2,800	100	100	100	100	74.6	64.1	100	26,000	70.6	11.5	31.4	32.4	1.4	2.9	99.9
2,900	100	100	100	100	74.6	64.7	100	26,500	69	10.9	30.2	31.2	1.4	2.8	99.9
3,000	100	100	100	100	74.6	65.2	100	27,000	67.5	10.3	29	30	1.3	2.7	99.9
3,500	100	100	100	100	74.5	67.5	100	27,500	66	9.7	27.8	28.9	1.3	2.6	99.9
4,000	100	100	100	100	74.2	69.6	100	28,000	64.4	9.1	26.7	27.8	1.2	2.5	99.9
4,500	100	100	100	100	73.4	71.4	100	28,500	62.9	8.6	25.7	26.8	1.2	2.4	99.9
5,000	100	100	100	100	71.7	72.9	100	29,000	61.4	8	24.7	25.9	1.1	2.3	99.9
5,500	100	100	100	100	69.9	74.2	100	29,500	60	7.5	23.7	24.9	1.1	2.2	99.9
6,000	100	100	100	100	67	75.5	100	30,000	58.6	7.1	22.7	24.1	1	2.2	99.9
6,500	100	100	100	100	63.6	76.6	100	30,500	57.2	6.7	21.8	23.2	1	2.1	99.9
7,000	100	100	100	100	59.9	77.6	100	31,000	55.9	6.3	21	22.4	0.9	2.1	99.9
7,500	100	100	100	100	55.9	78.6	100	31,500	54.7	6	20.2	21.6	0.9	2	99.9
8,000	100	100	100	99.9	51.4	79.4	100	32,000	53.4	5.7	19.4	20.8	0.8	1.9	99.9
8,500	100	100	99.9	99.9	46.5	80.1	100	32,500	52.3	5.5	18.6	20.1	0.8	1.8	99.9
9,000	100	100	99.9	99.9	41	80.9	100	33,000	51.2	5.2	17.9	19.3	0.8	1.8	99.9
9,500	100	99.8	99.7	99.9	35.7	81.1	100	33,500	50.2	5	17.2	18.7	0.7	1.7	99.9
10,000	100	98.3	98.9	99.7	30.6	67.6	100	34,000	49.1	4.8	16.6	18	0.7	1.7	99.9
10,500	100	94.9	97.6	99.2	25.8	54.7	100	34,500	48.1	4.6	16	17.4	0.7	1.7	99.9
11,000	100	90.9	95.5	98.3	21.7	40.4	100	35,000	47.2	4.5	15.5	16.8	0.7	1.6	99.9
11,500	99.9	86.3	92.7	96.9	18.4	32.1	100	35,500	46.3	4.4	15	16.2	0.6	1.6	99.9
12,000	99.9	82.1	89.7	94.9	15.6	25.6	100	36,000	45.4	4.2	14.5	15.6	0.6	1.5	99.9

TABLE 26.—L5 FREQUENCY BAND OMNIDIRECTIONAL 1 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	0	41	13	8	1364	20160	0
200	0	0	0	0	20160	20160	0	13,000	0	44	19	7	20160	20160	0
300	0	0	0	0	20160	20160	0	13,500	0	50	25	10	20160	20160	0
400	0	0	0	0	20160	20160	0	14,000	0	51	28	14	20160	20160	0
500	0	0	0	0	20160	20160	0	14,500	6	48	32	14	20160	20160	0
600	0	0	0	0	20160	20160	0	15,000	13	45	34	13	20160	20160	0
700	0	0	0	0	20160	20160	0	15,500	18	43	37	13	20160	20160	0
800	0	0	0	0	20160	20160	0	16,000	22	40	39	16	20160	20160	0
900	0	0	0	0	20160	20160	0	16,500	27	38	40	19	20160	20160	0
1,000	0	0	0	0	20160	20160	0	17,000	31	35	40	22	20160	20160	0
1,100	0	0	0	0	20160	20160	0	17,500	33	33	40	21	20160	20160	0
1,200	0	0	0	0	20160	20160	0	18,000	31	31	39	22	20160	20160	0
1,300	0	0	0	0	20160	20160	0	18,500	29	29	38	20	20160	20160	0
1,400	0	0	0	0	20160	20160	0	19,000	27	27	36	20	20160	20160	0
1,500	0	0	0	0	20160	20160	0	19,500	26	25	35	22	20160	20160	0
1,600	0	0	0	0	20160	20160	0	20,000	24	23	34	23	20160	20160	0
1,700	0	0	0	0	20160	20160	0	20,500	22	21	32	24	20160	20160	0
1,800	0	0	0	0	20160	20160	0	21,000	21	19	31	25	20160	20160	0
1,900	0	0	0	0	20160	20160	0	21,500	20	18	30	29	20160	20160	0
2,000	0	0	0	0	20160	20160	0	22,000	18	16	29	32	20160	20160	0
2,100	0	0	0	0	20160	20160	0	22,500	16	15	28	34	20160	20160	0
2,200	0	0	0	0	20160	20160	0	23,000	15	13	27	38	20160	20160	0
2,300	0	0	0	0	20160	20160	0	23,500	14	11	26	41	20160	20160	0
2,400	0	0	0	0	20160	20160	0	24,000	12	10	26	47	20160	20160	0
2,500	0	0	0	0	20160	20160	0	24,500	11	12	26	50	20160	20160	0
2,600	0	0	0	0	20160	20160	0	25,000	10	15	27	55	20160	20160	0
2,700	0	0	0	0	20160	20160	0	25,500	8	15	26	53	20160	20160	0
2,800	0	0	0	0	20160	20160	0	26,000	7	18	28	51	20160	20160	0
2,900	0	0	0	0	20160	20160	0	26,500	6	20	27	49	20160	20160	0
3,000	0	0	0	0	20160	20160	0	27,000	5	23	27	47	20160	20160	0
3,500	0	0	0	0	1241	20160	0	27,500	4	27	28	45	20160	20160	0
4,000	0	0	0	0	491	20160	0	28,000	2	30	27	44	20160	20160	0
4,500	0	0	0	0	508	20160	0	28,500	1	33	27	46	20160	20160	0
5,000	0	0	0	0	522	20160	0	29,000	0	36	26	48	20160	20160	0
5,500	0	0	0	0	513	20160	0	29,500	0	39	26	50	20160	20160	0
6,000	0	0	0	0	540	437	0	30,000	0	41	25	50	20160	20160	0
6,500	0	0	0	0	514	354	0	30,500	0	43	25	52	20160	20160	0
7,000	0	0	0	0	363	275	0	31,000	0	45	26	54	20160	20160	0
7,500	0	0	0	0	317	253	0	31,500	0	47	27	56	20160	20160	0
8,000	0	0	0	0	348	197	0	32,000	0	48	28	57	20160	20160	0
8,500	0	0	0	0	368	182	0	32,500	0	50	27	59	20160	20160	0
9,000	0	0	0	0	341	138	0	33,000	0	50	29	62	20160	20160	0
9,500	0	0	0	0	401	127	0	33,500	0	51	30	65	20160	20160	0
10,000	0	0	0	0	571	116	0	34,000	0	52	31	69	20160	20160	0
10,500	0	3	0	0	697	88	0	34,500	0	52	32	73	20160	20160	0
11,000	0	16	0	0	806	76	0	35,000	2	53	33	74	20160	20160	0
11,500	0	29	0	0	1061	67	0	35,500	4	54	34	75	20160	20160	0
12,000	0	38	6	4	1281	362	0	36,000	7	55	35	77	20160	20160	0

TABLE 27.—L5 FREQUENCY BAND OMNIDIRECTIONAL 4 SATELLITE MAXIMUM OUTAGE PERFORMANCE

Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All	Altitude, km	BeiDou	Galileo	GLONASS	GPS	IRNSS	QZSS	All
100	0	0	0	0	20160	20160	0	12,500	29	108	112	96	20160	20160	0
200	0	0	0	0	20160	20160	0	13,000	49	112	115	107	20160	20160	0
300	0	0	0	0	20160	20160	0	13,500	66	125	116	106	20160	20160	0
400	0	0	0	0	20160	20160	0	14,000	72	133	115	119	20160	20160	0
500	0	0	0	0	20160	20160	0	14,500	75	169	110	135	20160	20160	4
600	0	0	0	0	20160	20160	0	15,000	71	274	108	172	20160	20160	12
700	0	0	0	0	20160	20160	0	15,500	76	279	108	180	20160	20160	15
800	0	0	0	0	20160	20160	0	16,000	77	294	148	184	20160	20160	19
900	0	0	0	0	20160	20160	0	16,500	94	370	151	184	20160	20160	20
1,000	0	0	0	0	20160	20160	0	17,000	96	380	199	224	20160	20160	25
1,100	0	0	0	0	20160	20160	0	17,500	103	353	220	249	20160	20160	24
1,200	0	0	0	0	20160	20160	0	18,000	114	357	241	245	20160	20160	22
1,300	0	0	0	0	20160	20160	0	18,500	122	365	244	254	20160	20160	20
1,400	0	0	0	0	20160	20160	0	19,000	132	380	255	284	20160	20160	18
1,500	0	0	0	0	20160	20160	0	19,500	165	389	257	285	20160	20160	16
1,600	0	0	0	0	20160	20160	0	20,000	178	392	260	290	20160	20160	13
1,700	0	0	0	0	20160	20160	0	20,500	284	427	317	293	20160	20160	11
1,800	0	0	0	0	20160	20160	0	21,000	309	467	325	375	20160	20160	9
1,900	0	0	0	0	20160	20160	0	21,500	317	492	330	380	20160	20160	7
2,000	0	0	0	0	20160	20160	0	22,000	325	551	345	384	20160	20160	7
2,100	0	0	0	0	20160	20160	0	22,500	334	1490	348	459	20160	20160	7
2,200	0	0	0	0	20160	20160	0	23,000	326	1494	358	462	20160	20160	5
2,300	0	0	0	0	20160	20160	0	23,500	288	1874	363	464	20160	20160	6
2,400	0	0	0	0	20160	20160	0	24,000	322	3086	393	466	20160	20160	7
2,500	0	0	0	0	20160	20160	0	24,500	330	3837	429	514	20160	20160	6
2,600	0	0	0	0	20160	20160	0	25,000	332	3838	427	515	20160	20160	6
2,700	0	0	0	0	20160	20160	0	25,500	332	20160	429	516	20160	20160	7
2,800	0	0	0	0	20160	20160	0	26,000	332	20160	442	517	20160	20160	7
2,900	0	0	0	0	20160	20160	0	26,500	333	20160	458	588	20160	20160	7
3,000	0	0	0	0	20160	20160	0	27,000	340	20160	460	662	20160	20160	8
3,500	0	0	0	0	20160	20160	0	27,500	357	20160	464	787	20160	20160	9
4,000	0	0	0	0	20160	20160	0	28,000	355	20160	467	789	20160	20160	9
4,500	0	0	0	0	20160	20160	0	28,500	375	20160	647	667	20160	20160	8
5,000	0	0	0	0	20160	20160	0	29,000	373	20160	855	802	20160	20160	10
5,500	0	0	0	0	20160	20160	0	29,500	372	20160	884	802	20160	20160	12
6,000	0	0	0	0	20160	20160	0	30,000	372	20160	979	802	20160	20160	13
6,500	0	0	0	0	20160	20160	0	30,500	413	20160	1175	803	20160	20160	14
7,000	0	0	0	0	20160	20160	0	31,000	419	20160	1426	803	20160	20160	18
7,500	0	0	0	0	20160	20160	0	31,500	501	20160	1837	803	20160	20160	18
8,000	0	0	0	16	20160	20160	0	32,000	566	20160	2605	803	20160	20160	19
8,500	0	0	5	24	20160	20160	0	32,500	573	20160	2606	799	20160	20160	20
9,000	0	0	15	27	20160	20160	0	33,000	573	20160	2868	1171	20160	20160	21
9,500	0	19	31	30	20160	20160	0	33,500	570	20160	2504	1174	20160	20160	23
10,000	0	44	48	39	20160	20160	0	34,000	422	20160	2504	1176	20160	20160	24
10,500	0	73	53	47	20160	20160	0	34,500	402	20160	3350	1177	20160	20160	26
11,000	0	71	71	76	20160	20160	0	35,000	639	20160	3349	1178	20160	20160	27
11,500	5	87	83	81	20160	20160	0	35,500	642	20160	3349	1179	20160	20160	35
12,000	12	102	100	87	20160	20160	0	36,000	644	20160	2252	1180	20160	20160	35

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