Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of		
Wireless E911 Location Accuracy Requirements	)	PS Docket No. 07-114
E911 Requirements for IP-Enabled Service Providers	)	WC Docket No. 05-196

To: The Commission

COMMENTS OF THE BOEING COMPANY

Audrey Allison
Director, Frequency Management Services
The Boeing Company
1200 Wilson Boulevard
Arlington, VA 22209
(703) 465-3215

Barry Martin
Business Development & Strategy
Boeing Timing & Location
Advanced Network & Space Systems
The Boeing Company
P.O. Box 516 M/C S306-4160
St. Louis, MO 63042
(314) 234-5257

October 3, 2011

SUMMARY

The Commission has taken important steps in the *Second and Third Report and Orders* to advance the goals of better location accuracy of wireless 911 callers. There are still, however, numerous situations where first responders will be unable to locate citizens making emergency calls from a wireless devices—outdoors and indoors. Network-based location technologies may be adequate in urban areas, but in rural areas, accuracies suffer where there is a lower tower density, poor tower geometry, or rugged terrain. Handset-based location technologies, such as Assisted-GPS (A-GPS) are adequate in open spaces, but suffer in urban canyons and forested regions. In the *Further Notice and Second Further Notice of Proposed Rulemaking*, the Commission seeks "new prospective location" technologies that can provide location in challenging environments, including indoors. The Commission notes that with an increasing use of wireless inside buildings, and with many citizens dropping their land-line in favor of only a wireless service, an indoor location capability will be crucial to public safety.

The Boeing Company ("Boeing") has developed a "new prospective location" technology that can provide location in challenging environments, including indoors, as well as speed time to compliance, and increase the percentage of counties in compliance under the current *Second R&O* requirements (counties excluded in rural or heavy forestation areas). The new technology is a high performance satellite-based technology called the *Boeing Timing & Location (BTL)* technology. *BTL* modifies the current Iridium Communications, Inc. (NASDAQ: IRDM) ("Iridium") Low Earth Orbit (LEO) satellite constellation to enable location in challenging environments by either 1) assisting GPS receivers, 2) providing an Iridium-only Ranging ("IOR") capability, or 3) determining position from a hybrid of Iridium and GPS signals when fewer than four GPS satellites are in view. IOR enables positions to be obtained deep indoors by geo-locating off the Iridium *BTL* signal without the use of GPS.

Boeing has been collaborating with several leading cellular connectivity integrated circuit ("chip") manufacturers of both multi-sensor connectivity chips and stand-alone chips that receive only the Iridium *BTL* signal. All the *BTL* positioning modes can be implemented on a multi-sensor chip that receives both Iridium and GPS signals. The much simpler, low power *BTL*-only chips can implement the IOR mode and be embedded in Subscriber Identity Module (SIM) cards, allowing for a retrofit capability on GSM/3G phones. Boeing expects our chipmaker partner's decision to enter into full-scale chip production late in 2011. Given the close proximity of Iridium L-band spectrum to the GPS spectrum, the multi-sensor *BTL* chip can share the front-end RF electronics (antenna, etc.), thereby reducing cost and complexity of the chip. Given that the Iridium constellation is already modified to enable the broadcast of an operational *BTL* Signal-In-Space (SIS), combined with the availability of inexpensive chips, the *BTL* System can be made available at a low cost across the entire United States by 2012.

Boeing developed *BTL* to allow wireless carriers to speed time to compliance and reduce exclusions under the Commission's recently revised E911 location accuracy requirements (*Second R&O)*. In addition, in response to the *Further Notice,* the *BTL* technology is designed to be able to provide location indoors or in challenging environments. Handsets incorporating *BTL* technology will permit first responders to locate citizens *outdoors* in both cities and rural areas at the current handset-based requirements of the *Second R&O* within a year as well as provide an *indoor* location capability. Boeing's ultimate goal, shared by the Commission, is to ensure that public safety officials are able to locate wireless 911 callers as accurately and rapidly as possible wherever they are—indoors, rural counties, rugged terrain—with high integrity and no roaming issues. The public benefits resulting from achieving this goal would be considerable.

TABLE OF CONTENTS

I. INTRODUCTION 2

II. THE *BOEING TIMING & LOCATION* TECHNOLOGY 7

III. THE COMMISION'S REVISED E911 RULES IN THE *SECOND AND THIRD REPORT & ORDER* 13

A. THE *SECOND R&O* RELAXED THE E911 TIMEFRAME FOR COMPLIANCE BASED ON COMPROMISE AMONGST STAKEHOLDERS 13

B. THE COMMISSION ESTABLISHED A PSAP OR COUNTY-LEVEL GEOGRAPHIC AREA FOR LOCATION ACCURACY COMPLIANCE WITH EXCLUSIONS OF UP TO 15% OF COUNTIES 14

C. THE THIRD R&O ESTABLISHED A UNITARY LOCATION ACCURACY STANDARD 17

IV. THE COMMISSION'S *FURTHER NOTICE* AND *SECOND FURTHER NOTICE* SEEKS NEW PROSPECTIVE LOCATION TECHNOLOGIES WITH CAPABILITIES IN CHALLENGING ENVIRONMENTS 18

V. THE *BOEING TIMING & LOCATION (BTL)* TECHNOLOGY IS A *"NEW PROSPECTIVE TECHNOLOGY"* THAT CAN GREATLY IMPROVE WIRELESS E911 CAPABILITIES AND IMPROVE PUBLIC SAFETY 20

A. *BTL* TEST RESULTS EXCEED THE COMMISSION'S HANDSET-BASED LOCATION ACCURACY REQUIREMENTS 21

B. *BTL* CAN IMPROVE CARRIERS *TIME TO COMPLIANCE* UNDER THE CURRENT *SECOND R&O* 22

C. *BTL* CAN PROVIDE EMERGENCY CALL LOCATIONS WITH MINIMAL COUNTY *EXCLUSIONS* UNDER THE CURRENT *SECOND R&O* 23

D. *BTL* CAN LOCATE EMERGENCY CALLERS IN CHALLENGING ENVIRONMENTS 26

E. *BTL* CAN PROVIDE CONFIDENCE AND UNCERTAINTY DATA 28

F. *BTL* CAN PROVIDE VERTICAL Z-AXIS LOCATION INFORMATION 28

G. *BTL* IS NOT AFFECTED BY ROAMING 29

H. *BTL* CAN WORK IN VOIP PHONES AND EMERGING NETWORK DEVICES 29

I. *BTL* IS COMMERCIALLY FEASIBLE AND CAN BE ROLLED OUT ACROSS THE ENTIRE U.S. WITHIN ONE YEAR 32

J. *BTL* CAN BE MADE AVAILABLE AT LOW COST 33

VI. IRIDIUM "NEXT" CONSTELLATION IS SCHEDULED FOR LAUNCH IN 2015 34

VII. CONCLUSION 35

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of		
Wireless E911 Location Accuracy Requirements	)	PS Docket No. 07-114
E911 Requirements for IP-Enabled Service Providers	)	WC Docket No. 05-196

To: The Commission

COMMENTS OF THE BOEING COMPANY

The Boeing Company ("Boeing"), in accordance with Section 1.415 of the Commission's rules, 47 C.F.R. §1.415, hereby submits its comments in response to the Federal Communications Commission's ("FCC" or "Commission") Further Notice of Proposed Rulemaking ("FNPRM") and Notice of Inquiry ("NOI") (together, *"Further Notice"* (FCC 10-177)) [1] and the *Second Further Notice of Proposed Rulemaking* ("*Second Further Notice*" FCC 11-107)[2] in the above-referenced proceeding. The *Further Notice* was released in conjunction with the *Second Report and Order* (FCC 10-176)) ("*Second R&O*") on September 23rd, 2010. [3]

[1] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, E911 Requirements for IP-Enabled Service Providers, WC Docket No. 05-196, Further Notice of Proposed Rulemaking and Notice of Inquiry, FCC 10-177 (Sept. 23, 2010) ("*Further Notice*").

[2] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, E911 Requirements for IP-Enabled Service Providers, WC Docket No. 05-196, Amending the Definition of Interconnected VoIP Service in Section 9.3 of the Commission's Rules, GN Docket No. 11-117, Second Further Notice of Proposed Rulemaking, FCC 11-107 (July 13, 2011) ("*Second Further Notice*").

[3] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, Second Report and Order, FCC 10-176 (Sept. 23, 2010) ("*Second R&O*").

The *Second Further Notice* was released in conjunction with the *Third Report and Order* (FCC 11-107)) ("*Third R&O*") on July 13th, 2011.[4]

I. INTRODUCTION

The Commission's efforts to enhance E911 service and location accuracy rules recently adopted in the *Second Report and Order* and the *Third Report and Order* will enhance the goal of ensuring that public safety organizations are able to locate wireless 911 calls as accurately as possible. The Commission is also seeking comment via the *Further Notice of Proposed Rulemaking and Notice of Inquiry* and the *Second Further Notice of Proposed Rulemaking* regarding any "new prospective location technologies" which can provide improved location information in more challenging environments, including indoor settings, urban canyons, high rise buildings, and rural environments characteristic of heavy forestation, mountainous terrain, or sparsely located wireless towers. The Commission also seeks comment on whether a framework should be developed to ensure all covered VoIP service providers can provide automatic location information (ALI) for VoIP 911 calls versus the current capability of manually registering the physical location of their phones with their VoIP service providers.

The wireless industry has predominantly relied on two technologies to meet location accuracy requirements—handset-based Assisted-GPS (A-GPS) and network-based multilateration. Even when the wireless carriers comply fully with the requirements of the *Second Report and Order*, emergency personnel may still be unable to locate a wireless 911 call. In urban canyons or from inside a building, where the GPS signals do not reach, handset-based A-GPS may not obtain a position fix. Similarly, wireless 911 calls placed in rural areas may not

[4] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, Third Report and Order, FCC 11-107 (July 13, 2011) ("*Third R&O*").

obtain a position fix where network-based location multilateration technologies struggle in counties with low tower densities, poor tower geometries, or rough terrain. Further, users of indoor VoIP devices or indoor Emerging Network Devices (Femtocells) may not have any E911 location capability if the user failed to register the location of a device that has been moved.

Boeing is a recognized leader in providing and supporting large-scale systems that combine sophisticated communications networks with air-, land-, sea- and space-based platforms for military, government and commercial customers around the world. Boeing is introducing a "new prospective location technology" to the Commission that can provide location in such challenging environments. Boeing has developed a high performance satellite-based timing & location technology called *Boeing Timing & Location ("BTL").* *BTL* modifies the current Iridium Low Earth Orbit (LEO) constellation signal via software, and modifies a chipset architecture to enable location in challenging environments by three different modes: 1) assisting GPS receivers, 2) providing an Iridium-only Ranging ("IOR") capability, or 3) determining position from a hybrid of Iridium and GPS signals when fewer than four GPS satellites are in view. IOR enables positions to be obtained deep indoors by geo-locating off the Iridium *BTL* signal without the use of GPS.

Boeing has been collaborating with several leading cellular connectivity integrated circuit ("chip") manufacturers to develop both multi-sensor connectivity "combo-chips" (*BTL,* GPS, Wi-Fi, Bluetooth, etc) and chips that are designed to receive the *BTL* signal only. All the *BTL* positioning modes can be implemented on a multi-sensor chip that receives both Iridium and GPS signals. The much simpler, low power *BTL*-only chips can implement the IOR mode and be embedded in Subscriber Identity Module (SIM) cards, allowing for a retrofit capability on GSM and 3G phones. Boeing expects a decision by our chipmaker partners to enter into

production late in 2011. Boeing expects service to start next year, combined with inexpensive chips; the *BTL* System can be made available at a low cost across the entire United States.

Boeing, through an exclusive teaming arrangement with Iridium Communications, Inc (NASDAQ: IRDM) to provide the signal-in-space (SIS), has had operational *BTL* software installed on Iridium satellites since 2009 and has conducted extensive testing and evaluation of the *BTL* System in many indoor and other challenging environments. The *BTL* A-GPS mode yields typical A-GPS accuracies, but with additional penetration capability over typical A-GPS chips as depicted in Figure 5 below. The *BTL* IOR mode has demonstrated the following performance, for outdoor and indoor environments:[5]

FCC Rules	**Outdoors**	**Indoors**
Current **Requirement** under *Second Report & Order*[6]	Handset-Based Location Technology: • < 50 meters for 67 percent of calls • < 150 meters for 90 percent of calls Network-Based Location Technology: • < 100 meters for 67 percent of calls • < 300 meters for 90 percent of calls	No current indoor requirements. Subject of the *Further Notice (FCC 10-177A1)* and *Second Further Notice (FCC 11-107)*
***BTL* Mode**	**2013 Outdoor Performance**	**2013 Indoor Performance**
Iridium Only Ranging (IOR) Performance	Established a location result 95 percent of the time, and located target devices within 50 meters for 67 percent of calls and within 100 meters for 90 percent of calls made outdoors in both urban and suburban conditions.	Established a location result 95 percent of the time, and located target devices within 100 meters for 67 percent of calls and within 150 meters for 90 percent of calls made indoors in both urban and suburban conditions.

[5] Performance results are based on over 4000 actual test points with representative outdoor and indoor locations and with both single and dual SV coverage. The position estimate is recorded at 29 seconds after each test initialization. Accuracies listed assume knowledge of demonstration receiver clock time and drift values (which will be available when an actual integrated BTL chip becomes available). Actual averages for 67%/90% of calls were 36/73 meters and 42/93 meters, for outdoor and indoor, respectively, but allocations for multipath error sources are included.

[6] Requirements quoted are end-state, fully phased in requirements after 8 years. The 90% requirement is phased in from 80% over the 8 years. The *Third R&O* provides for phasing out the network-based standard over time to the handset-based standard.

There are several unique advantages of the *BTL* satellite-based location technology:

1. **Ubiquitous Coverage** – The Iridium satellite constellation has global coverage, unlike local infrastructure-based solutions or Wi-Fi Positioning Systems (WPS).[7] Figure 1 below shows the ubiquitous coverage of the *BTL* Iridium signal across the entire United States (coverage of only two satellite vehicles' (SV) depicted). And, given the signal originates from a dynamic, LEO space-based vehicle, horizontal blockage from rough terrain or urban canyons is minimized. This provides consistent performance (yield) and minimizes county exclusions across all environments (rural, urban canyon, mountainous terrain, forested regions, etc).

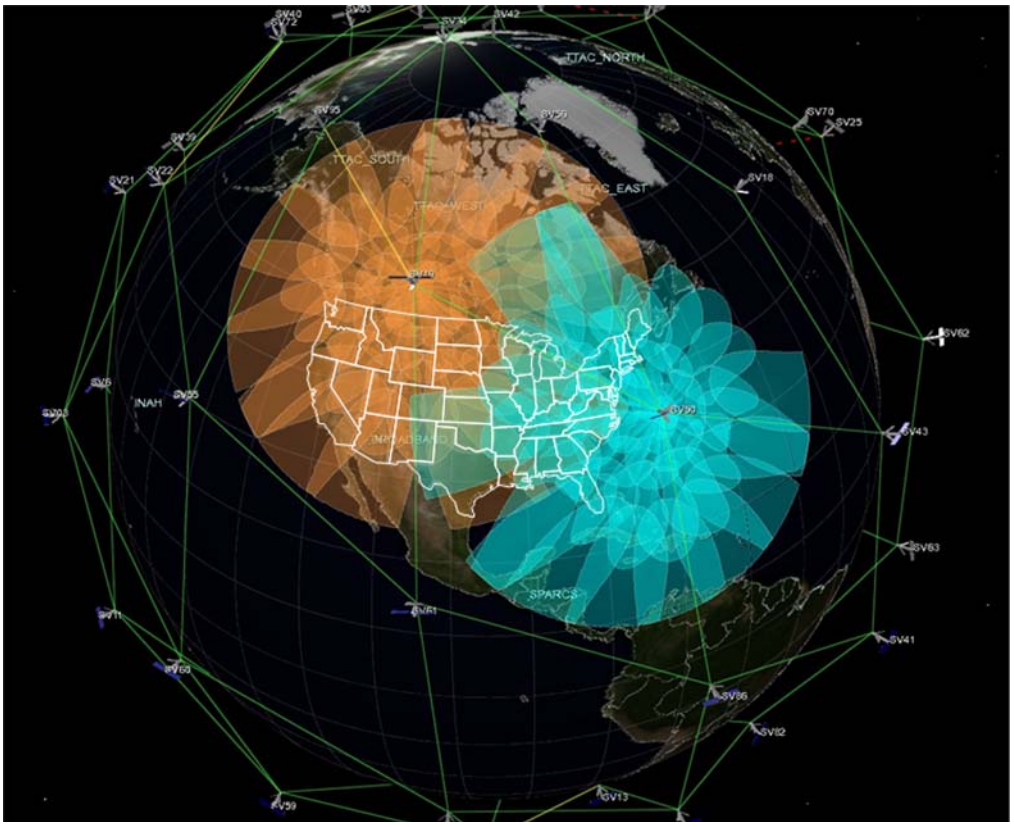


Figure 1 – Iridium satellite coverage over the United States (two SV footprints)

[7] Wi-Fi Positioning also has reliability issues. *See* Verizon Notice of Ex Parte, May 18, 2011 at page 2. *Verizon Wireless does not currently use WiFi-based positioning for 9-1-1 call location given concerns for the accuracy and reliability of information in vendors' databases.*

2. **Higher Power than GPS** – Boeing has worked with Iridium to design a signal much stronger than GPS. This additional power has successfully demonstrated location in high-rise office buildings, parking structures, shopping malls, shipping containers, and other indoor locations. Figure 5 depicts the additional penetration capability of the *BTL* signal.

3. **No Additional Infrastructure costs required by Wireless Carriers** – *BTL* is a handset-based solution that requires no additions to a carrier's infrastructure to implement.

4. **A handset "retrofit" capability –** A SIM card implementation would allow, through an updated SIM card, an immediate capability through a "retrofit" of currently owned cell phones versus waiting for cell phone turnover (in GSM-based networks for GSM/3G handsets) to penetrate a significant portion of subscribers, thereby reducing time to compliance.

BTL is a viable location technology solution that can facilitate efforts by wireless carriers to exceed the Commission's revised E911 location accuracy requirements in the *Second Report & Order* as well as address the Commission's interest in new indoor location technologies.

BTL, even without GPS, can consistently and precisely, provide a high yield positioning capability to locate wireless cell phones, VoIP devices, or Emerging Network Devices (Femtocells) anywhere in the United States, including inside commercial buildings, parking structures, and in urban canyons as soon as the device is equipped. A high yield solution can exceed the Commissions 90% of calls requirement and improve the percentage of counties compliant with the new requirements. The public safety benefits resulting from the widespread availability of the *Boeing Timing & Location* technology would be substantial.

II. THE *BOEING TIMING & LOCATION* TECHNOLOGY

Boeing is a recognized leader in providing and supporting large-scale systems that combine sophisticated communications networks with air-, land-, sea- and space-based platforms for military, government and commercial customers around the world. Boeing has a deep history and capability in GPS navigation systems. Boeing developed the first GPS System (circa 1978) and the current constellation – GPS IIA. Boeing also developed the latest replacement constellation, GPS IIF, being placed into service now. Boeing has also provided Operations & Maintenance of the Iridium constellation since 2000.

The Boeing team is focused on developing and bringing to market innovative next generation location technologies for hand-held wireless devices, Voice over IP (VoIP) phones, Femtocells, vehicles and other mobile assets. Boeing has spent the last three and a half years developing the *BTL* system, and has been developing innovative applications for Iridium's space-based LEO network since 2003.[8] The *BTL* system provides a specially coded RF signal which is broadcast from the Iridium Satellite Constellation to users located in any location on the Earth. This broadcast provides an extremely accurate time and frequency reference transfer capability to properly equipped users.

Users gain three advantages from the *BTL* broadcast. First, the accurate time and frequency transfer greatly increases the sensitivity of a Global Navigation Satellite System (GNSS)[9] chipset in the user equipment, enabling signal reception in attenuated areas, such as a short distance indoors where GNSS signals can still be detected by the aided chip with the

[8] Boeing received a $164 Million dollar contract from the Naval Research Laboratory in 2007 for the *High Integrity Global Positioning System* program to demonstrate a robust GPS anti-jam and time synchronization capability. The program has successfully met all objectives.

[9] GNSS is used here versus GPS because *BTL* can work with any GNSS system, to include GPS, GLONASS, or Galileo.

increased sensitivity. Secondly, the accuracy and power of the *BTL* broadcast enables geo-location, or Iridium-Only Ranging ("IOR"), of the user in areas deep indoors where GNSS signals do not penetrate or are not adequate to provide a position estimate alone. And thirdly, in situations where less than four GNSS satellites are visible due to occlusions such as urban canyons, a hybrid *BTL* mode can still take advantage of those GNSS satellites that are visible, and combine that information with Iridium positioning to obtain a location solution better than IOR.

The hybrid mode leverages the dynamic nature of the Iridium LEO satellites. Because the *BTL* signal originates from space with a constantly changing geometry, the signal is less likely to be blocked by mountainous terrain or urban canyons. Figure 2 below depicts how the Iridium LEO's rapid motion helps ensure visibility of Iridium SVs in urban canyons.

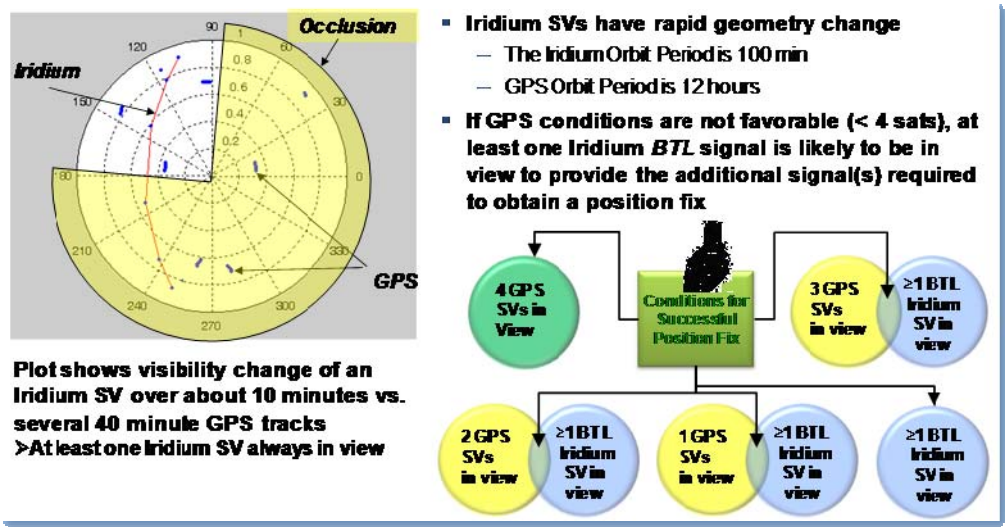


Figure 2 –Iridium satellite rapid motion improves availability in urban canyons

Although the geo-location IOR capability of *BTL* is not as accurate as a GNSS receiver operating outdoors, it still is adequate to meet the handset-based requirements of E911 and has the significant advantages of requiring no additional ground based infrastructure added to the

carrier's network to operate, the ability to penetrate deep indoors, and ubiquitous coverage across the entire United States.

The Iridium satellite constellation of Low Earth Orbiting satellites was chosen as the broadcast medium of *BTL*. Iridium's relative frequency proximity to GPS L1C, global coverage, high power, individually programmable spot beams, signal architecture, and rapid and stable orbit makes it the perfect platform to broadcast *BTL*. Iridium is a mobile voice and data satellite communications network that spans the entire globe. Iridium enables connections between people, organizations and assets to and from anywhere, in real time. Together with its ever-expanding ecosystem of partner companies, Iridium delivers an innovative and rich portfolio of reliable solutions for markets that require truly global communications. Iridium owns and operates its constellation, and sells equipment and access to its services. Boeing has entered into an exclusive relationship with Iridium as the sole provider of BTL worldwide.

The Iridium constellation has 66 active satellites in orbit to complete its constellation and additional spare satellites are kept in-orbit to serve in case of failure. Satellites are in low Earth orbit at a height of approximately 485 mi (781 km) and inclination of 86.4°. The orbital velocity of the satellites is approximately 17,000 mph (27,000 km/h). The satellites orbit from pole to pole with an orbit time of roughly 100 minutes. The satellite's communication look down antenna has 48 spot beams arranged as 16 beams in three sectors. Each Iridium SV includes a very stable internal clock that is monitored and maintained to within several micro-seconds (μSecs) of UTC time.

Figure 3 below provides a high level overview of the *BTL* concept. The basic premise is to provide users with precise time and frequency indoors by leveraging the higher power Iridium LEO signal. The unique *BTL* waveform developed by Boeing and transmitted via a spare

Iridium "paging" channel, transfers the highly accurate and stable oscillator (clock) to the user equipment. *BTL* leverages the Iridium constellation to deliver very accurate time and frequency to a *BTL* enabled device in an occluded environment (45dB+ of attenuation). Providing precise time to the user device quickly—even deep indoors—means the user device does not waste battery energy attempting to receive time of day from GPS. This significantly extends battery life, and allows the GPS chip to search a much smaller time/frequency 'space' looking for the correct GPS signals, thereby increasing the sensitivity of the GPS receiver.

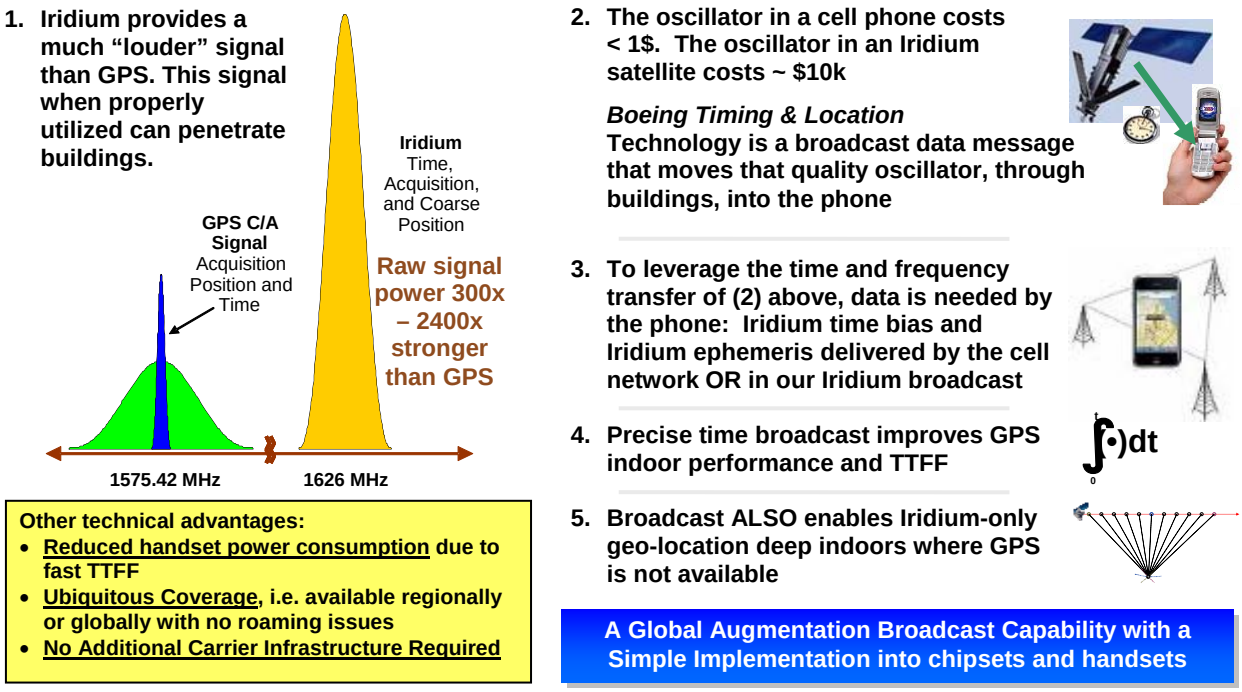


Figure 3 – *BTL* Overview

Figure 4 below presents the *BTL* operational architecture. The *BTL* Operations Server (BTLOS) sends broadcast requests to the Iridium Control Center which include the desired broadcast location, duration, and power level. Iridium SV ephemeris data is sent back to the BTLOS which is forwarded to the user either within the *BTL* broadcast (for unconnected users) or as a data transfer (transfer for users connected to a cell network). The broadcast is initiated when the tasked SV spot beam flies over the service region. The user equipment receives the

broadcast through as much as 45 dB of attenuation. When combined with ephemeris and clock bias data, the received broadcast calibrates the user equipment clock, "hot starting" the GNSS receiver chip and/or *BTL* IOR geo-location algorithms.

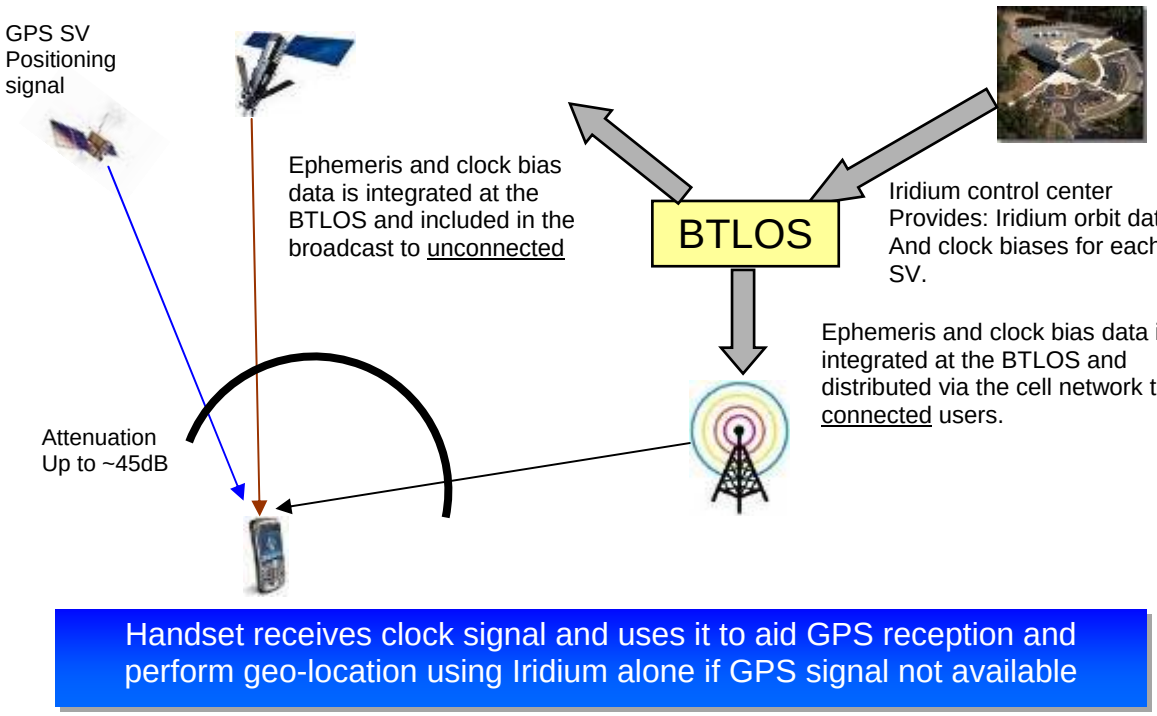


Figure 4 – *BTL* Broadcast to Occluded User Operational Architecture

Figure 5 below summarizes the *BTL* attenuation performance versus other aiding architectures. A standard GPS receiver can tolerate approximately 12-14 dB of attenuation as seen in a typical 1 story home. GPS aiding architectures (A-GPS) can increase this attenuation tolerance by 10 dB to ~25 dB. By providing a more precise time and frequency transfer using the *BTL* aiding signal, the A-GPS receiver increases attenuation performance by 2 – 4 dB over other GPS aiding architectures (CDMA vs. GSM). The *BTL* Iridium signal can tolerate 45 dB of attenuation, enabling time/frequency transfer and geo-location in nearly any location above ground worldwide. The *BTL* broadcast has been specifically designed to penetrate high levels of attenuation to enable signal reception deep indoors. This performance is enabled by a

combination of high broadcast power from the satellite using an Iridium "paging" channel and spread spectrum signal processing techniques. The power and processing techniques on the much simpler receive-only *BTL* data broadcast are different than those employed for an Iridium telephone call, which is bi-directional. The receive-only broadcast, power and processing techniques combined with the close proximity of our *BTL* frequency to the GPS frequency allows us to share the same antenna as the GPS receiver, or similarly in the case of *BTL-Only* reception, use a much smaller antenna than an Iridium phone.

Boeing has performed tests in multiple challenging deep indoor environments. The stronger signal power and variable and dynamic geometries of the Iridium LEO constellation has allowed our prototype *BTL* receiver to get position in multi-story office buildings, urban canyons, shopping malls, and even multi-story parking lots.

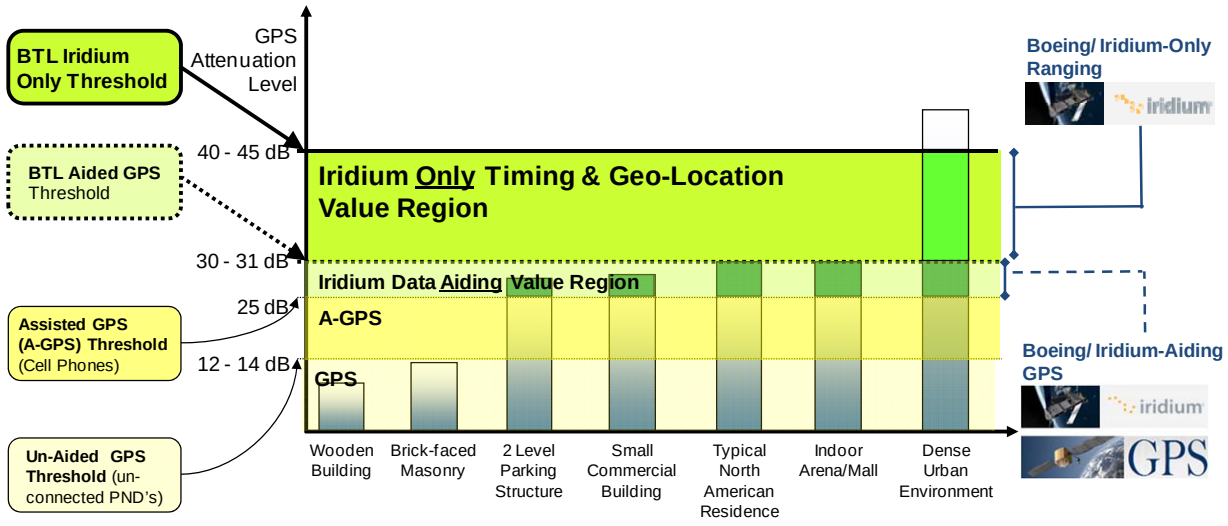


Figure 5 – *BTL* Provides Superior Dual Mode Positioning as GPS Aid or Stand-Alone

Boeing's planned operations would broadcast 24/7/365 *BTL* service coverage for the entire United States. The unique capability of *BTL* to individually task Iridium SV spot beams enables areas as small in diameter as 400 km or as large as continents to be provided with

broadcasts at the required power and duration to respond to public safety needs for operations with no advanced planning.

III. THE COMMISION'S REVISED E911 RULES IN THE *SECOND AND THIRD REPORT & ORDER*

In the *Second R&O*, the Commission revised the E911 location accuracy requirements contained in Section 20.18(h) of its rules in several important respects. The revised rules: 1) make adjustments to both the network-based and handset-based location accuracy requirements and deadlines; 2) establish the PSAP or county region as the geographic area for compliance; 3) confirm that the accuracy measurements are for outdoor calls only;[10] 4) adjusted the E911 deadlines and phased in the percentage of counties and population in compliance over time; and 5) deferred addressing emergency calls made from indoors given limitations of existing technologies.

In the *Third R&O,* the Commission continues to strengthen the existing Enhanced 911 (E911) location accuracy regime for wireless carriers by retaining the existing handset-based and network-based location accuracy standards and the eight-year implementation period established in the *Second R&O,* but provide for the phasing out the network-based standard over time.

A. The *Second R&O* Relaxed the E911 Timeframe for Compliance Based on Compromise Amongst Stakeholders

Based on compromises between the public safety community and wireless carriers, in the *Second R&O* the Commission relaxed the timeframe and percentage of call rules adopted in the 2007 First Report and Order. The Commission concluded that it's *Second R&O* "effectively

[10] *See* Second R&O, ¶ 29, 48, 56.

relaxed"[11] its requirements, adjusting the compliance deadlines by approximately six years and five percent of emergency calls, from 95% to 90%. As discussed in further detail in Section V.B below, *BTL* would allow carriers to improve significantly both their E911 timeframe for compliance and could exceed the Commission's requirements for percentage of calls that can meet the accuracy requirements, currently at 90%.

B. The Commission Established a PSAP or County-Level Geographic Area for Location Accuracy Compliance with Exclusions of up to 15% of Counties

In the *Second R&O*, the Commission resolved any ambiguity regarding the geographic area over which wireless carriers must establish compliance with the location accuracy requirements.[12] Some had argued in favor of a state, regional or even larger geographic area for compliance.[13] The Commission concluded that such an approach would have resulted in failure to meet the accuracy requirements in substantial segments of each carrier's service area.[14] Those segments could have included rural areas without a dense cellular tower infrastructure, but they could have also included urban canyons for handset-based carriers, leading to inadequate E911 coverage for thousands or millions of city dwellers.

The primary concern raised, as referenced in the *First R&O*, was that "carriers may achieve acceptable levels of location accuracy in urban areas of a given state, yet provide location information of limited or no use to first responders in rural areas."[15] Although this would likely be true for network-based technologies, for which density of cellular towers is the

---

[11] *Id.*, ¶ 25.

[12] *Id.*, ¶ 16.

[13] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, Notice of Proposed Rulemaking, FCC 07-108, ¶ 6 (2007) ("NPRM") and First R&O, ¶ 9.

[14] *See* NPRM, ¶ 5 and Second R&O, ¶ 12.

[15] *See* First R&O, ¶ 11.

primary concern, handset-based carriers using GPS are more likely to be concerned about locating E911 callers in urban canyons.

The Commission implicitly addressed the concern for performance of handset-based carriers in urban canyons. Motorola argued that rather than excluding from compliance fifteen percent of counties due to heavy forestation, the Commission should have favored the overall 85 percent compliance standard afforded to network-based carriers so that handset-based carriers could take into account factors such as urban canyons.[16] The Commission rejected this proposal, stating, "we agree with [the National Emergency Number Association ("NENA")] and [Association of Public-Safety Communications Officials ("APCO")] that any expansion of this exclusion, whether to an increased percentage or based on factors in addition to forestation, would excuse compliance to an unacceptable level of risk to public safety."[17] The "factors in addition to forestation" would certainly include location difficulties in urban canyons. Therefore, the Commission appears to have concluded that a lack of E911 coverage in urban centers would impose a substantial risk to public safety.

There was also great concern exhibited in the comments regarding the *feasibility* and *cost* of meeting the new *accuracy requirements in rural areas*, primarily by network-based carriers.[18] Corr Wireless Communications, LLC (Corr) advocates using the Metropolitan Statistical Area as

[16] *See* Second R&O, ¶ 24. In the revised rules, handset-based carriers are allowed to exclude from compliance up to fifteen percent of counties or PSAPs due to heavy forestation. Network-based carriers, on the other hand, are only required to comply with the location accuracy requirements in 85 percent of counties or PSAPs at their final benchmark. Therefore, network-based carriers have more options to exclude counties based on various considerations other than heavy forestation, such as building obstructions.

[17] *Id.*, ¶ 27

[18] *Id.*, ¶15

a "more useful measuring stick for this kind of service."[19] Corr, however, indicates that it would support a county-based metric provided that the Commission "*make an exception in its accuracy requirement to account for the impossibility or extreme difficulty in meeting that standard in rural areas*."[20] Furthermore, a number of commenters argue that complying with the county-level standard would be prohibitively expensive.[21] For example, the National Telecommunications Cooperative Association (NTCA) argues that "*it is expected that the new standards will impose prohibitive costs on many rural wireless carriers, if compliance is even possible*."[22] The Rural Telecommunications Group (RTG), citing to its August 20, 2007 comments, notes that rural carriers "*may need to construct an extraordinary number of additional antenna sites*," and that, "*with fewer customers than large carriers serving urban areas, RTG members and other rural wireless carriers are unable to recover the substantial cost of constructing a large number of additional cell sites solely to triangulate location data*."[23] GCI argues that the county-based metric does "*not take into account the technological and economic realities of providing service to low-density, topographically challenged service areas, like Alaska*," adding that "*strict adherence to the proposed metrics would have the perverse*

[19] Corr Wireless Comments to Bureau Public Notice at 2.

[20] *Id*. at 2-3.

[21] *See e.g.* NTCA Comments to *Bureau Public Notice* at 2; NTCA Reply Comments to *Second Bureau Public Notice* at 2; Blooston Rural Carriers Comments to *Bureau Public Notice* at 2; Blooston Rural Carriers Reply Comments to *Second Bureau Public Notice* at 2; SouthernLINC Reply Comments to *Second Bureau Public Notice* at 4; RTG Comments to *Bureau Public Notice* at 3, Andrews LLC Comments to *Bureau Public Notice* at 2 (citing Andrews LLC August 2007 Comments); Nokia Reply Comments to *Bureau Public Notice* at 2.

[22] *See* NTCA Comments to *Bureau Public Notice* at 2.

[23] RTG Comments to *Bureau Public Notice*, attaching and incorporating by reference RTG Comments to *Notice at* 4-5 (filed Aug. 20, 2007 in response to *Notice*, Part III.B).

result of stifling deployments to areas most in need of wireless infrastructure investment."[24] NENA and APCO favor "*a waiver process to the wholesale 'exceptions' for rural carriers proposed by Corr Wireless which would essentially only require Phase I [no location information] in many parts of the country*."[25]

The Commission took important steps to improve the accuracy reporting of 911 calls for all citizens, urban and rural, while achieving a reasonable compromise amongst carriers and public safety officials. But both the current network-based and handset-based location technologies still struggle in challenging environments, such as urban canyons and rural areas. As described in Section V.C below, *BTL* can help reduce the percentage of counties excluded from the new rules, and improve the accuracy and yield for a greater percentage of calls to improve public safety without prohibitive costs of additional infrastructure in rural areas.

C. The Third R&O Established a Unitary Location Accuracy Standard

In the Third R&O, the Commission struck a balance between cost and capability by adopting the unitary, more stringent, handset-based location accuracy standard at the end of the eight year phase-in established in the *Second Report & Order*. [26]

Verizon supports a unitary standard, as they are already subject to the more stringent handset-based requirements given the CDMA user base has a large percentage of A-GPS handsets.[27] Other GSM carriers, such as AT&T and T-Mobile, oppose adoption of a unitary

---

[24] GCI Comments to *Second Bureau Public Notice* at 3-4.

[25] NENA/APCO Reply Comments to *Bureau Public Notice* at 5.

[26] *See* Third R&O, ¶ 19 - 21

[27] Verizon and Verizon Wireless Comments at 1-2. See generally Qualcomm Comments at 1 (stating that the Commission "may be able to implement a single location accuracy standard" as 3G and 4G-capable networks "become ubiquitous").

location accuracy standard. For instance, T-Mobile asserts that "[f]or carriers using network-based E911 solutions . . . the [E911 Location Accuracy Second Report and Order] establishes a migration path from those technologies to the handset-based A-GPS solution."[28] T-Mobile further submits that the "[Second Report and Order] already contemplates *a handset change out* for all non-A-GPS capable handsets" and urges the Commission to be "reluctant to order *another handset change out*, especially before it can fully evaluate the results of the [Second Report and Order]."[29] T-Mobile contends that "[d]oing so would likely impose significant additional unnecessary *costs* on consumers and providers without an ascertainable benefit."

Boeing postulates the opposition by GSM carriers to the handset-based standard results from the time it will take to transition to 3G and 4G capable handsets, since GSM carriers did not initially start to address the E911 location requirement with A-GPS in 2G handsets, but rather pursued network-based location technologies.

It is precisely because the low-power *BTL-Only* chip can be implemented in a SIM card, and a SIM card is used in GSM carrier phones, that Boeing believes the more stringent accuracy requirement can be met sooner by replacing SIM cards, without the need for an expensive handset turnover. This is discussed further in Section V.A and V.B below.

IV. THE COMMISSION'S *FURTHER NOTICE* AND *SECOND FURTHER NOTICE* SEEKS NEW PROSPECTIVE LOCATION TECHNOLOGIES WITH CAPABILITIES IN CHALLENGING ENVIRONMENTS

In the *Further Notice*, the Commission seeks to develop a full understanding of the capabilities and limitations of existing location technologies, as well as seeks comment on any

[28] See AT&T Comments at 5-7; T-Mobile Comments at 5.

[29] T-Mobile Comments at 6

"new prospective location technologies"[30] which can provide improved location information in more challenging environments,[31] including indoor settings, urban canyons, high rise buildings, and rural environments characteristic of heavy forestation, mountainous terrain, or sparsely located wireless towers. Also, the Commission seeks to understand how any new technology can address issues such as providing confidence and uncertainty data,[32] vertical or z-axis location information,[33] roaming issues,[34] and providing automatic location information (ALI) on VoIP devices[35] or emerging network devices such as Femtocells.[36] The Commission specifically requests quantitative analysis be provided for assessing the potential to incorporate newer technologies into wireless networks and their relative performance capabilities and commercial feasibility. It inquires whether certain technologies are better suited for particular environments.

In the *Second Further Notice*, the Commission seeks comment on whether E911 Rules should be applied to VoIP devices other than fully "Interconnected" VoIP phones, such as Outbound-Only Interconnected VoIP devices. The Commission also seeks comment on whether a framework should be developed to ensure all covered VoIP service providers can provide automatic location information (ALI) for VoIP 911 calls versus the current capability of manually registering the physical location of their phones with their VoIP service providers.[37] In

[30] *See* Further Notice ¶ 15.

[31] *Id*., ¶ 22.

[32] *Id*., ¶ 16.

[33] *Id*., ¶ 23.

[34] *Id*., ¶ 24.

[35] *Id*., ¶ 29, 30. And Second Further Notice Section IV. B.

[36] *Id*., ¶ 40, 41.

[37] *See* Second Further Notice ¶ 3.

addition, the Commission seeks comment on technological approaches to improve location accuracy for 911 communications originating from **indoor environments.**

V. THE *BOEING TIMING & LOCATION (BTL)* TECHNOLOGY IS A *"NEW PROSPECTIVE TECHNOLOGY"* THAT CAN GREATLY IMPROVE WIRELESS E911 CAPABILITIES AND IMPROVE PUBLIC SAFETY

Boeing wishes to introduce to the Commission a "new prospective location" technology: the *Boeing Timing & Location* technology, as described in Section 0 herein. *BTL* is a systems approach to solving the indoor location challenge by leveraging the global coverage of the Iridium Satellite LEO constellation, as well as modifications at the chip level to allow many devices—handsets, VOIP phones, Femtocells, etc.—to calculate position based on received signals-in-space, similar to A-GPS. It is therefore considered a handset-based location technology.

Boeing does not believe the Commission should implement rules to mandate a specific technology or standard; rather, we are introducing our technology to industry to show the potential for a ubiquitous indoor E911 capability with a potential for a quick time to compliance via a retrofit and forward fit deployment using SIM Cards in GSM/3G networks, or multi-radio combo chips in CDMA or GSM/3G networks. This capability combined with the ability to scale infinitely because the technology is enabled via a *broadcast* satellite signal, analogous to GPS, would allow for a fast implementation. Further, *BTL* would allow carriers to locate emergency callers in particularly challenging environments, is not affected by roaming concerns and can be rolled out across the entire United States as soon as *BTL* chipsets are ready. This technology would allow first responders to more accurately locate emergency callers in a greater percentage of counties and for a greater proportion of calls. Sections A through J below describe how *BTL*

can address issues with E911 automatic location information for both the *Second and Third R&O* and comments on requests documented in the *Further Notice* and *Second Further Notice.*

A. *BTL* Test Results Exceed the Commission's Handset-Based Location Accuracy Requirements

BTL offers the capability for wireless carriers to exceed the eight-year location accuracy standards as soon as their handsets are equipped with the *BTL* capable chip. *BTL* technology has undergone extensive testing in several challenging environments[38] over the last year, with a significant amount of data captured under the actual operational signal-in-space (SIS) broadcast from Iridium. Analysis of the test data resulted in the following *BTL* performance: [39]

FCC Rules	**Outdoors**	**Indoors**
Current **Requirement** under *Second Report & Order*[40]	Handset-Based Location Technology: • < 50 meters for 67 percent of calls • < 150 meters for 90 percent of calls Network-Based Location Technology: • < 100 meters for 67 percent of calls • < 300 meters for 90 percent of calls	No current indoor requirements. Subject of the *Further Notice (FCC 10-177A1)* and *Second Further Notice (FCC 11-107)*
***BTL* Mode**	**2013 Outdoor Performance**	**2013 Indoor Performance**
Iridium Only Ranging (IOR) Performance	Established a location result 95 percent of the time, and located target devices within 50 meters for 67 percent of calls and within 100 meters for 90 percent of calls made outdoors in both urban and suburban conditions.	Established a location result 95 percent of the time, and located target devices within 100 meters for 67 percent of calls and within 150 meters for 90 percent of calls made indoors in both urban and suburban conditions.

[38] Test locations include a 7 - story office building, 7 - story hotel, a shopping mall, a shipping container, and a typical 2-story home residence

[39] Performance results are based on over 4000 actual test points with representative outdoor and indoor locations and with both single and dual SV coverage. The position estimate is recorded at 29 seconds after each test initialization. Accuracies listed assume knowledge of demonstration receiver clock time and drift values (which will be available when an actual integrated BTL chip becomes available). Actual averages for 67%/90% of calls were 36/73 meters and 42/93 meters, for outdoor and indoor, respectively, but allocations for multipath error sources are included.

[40] Requirements quoted are end-state, fully phased in requirements after 8 years. The 90% requirement is phased in from 80% over the 8 years. The *Third R&O* provides for phasing out the network-based standard over time to the handset-based standard.

Therefore, assuming *BTL* is deployed; *BTL*-equipped handsets could meet the *Second and Third R&O* outdoor location accuracy requirements for handset-based technologies (i.e., 50M for 67% of calls) in the toughest outdoor locations, such as urban canyons and could provide a new capability in challenging environments (indoors) where no requirement has been established.

B. *BTL* Can Improve Carriers *Time to Compliance* under the Current *Second R&O*

The *Boeing Timing & Location (BTL)* technology has three modes: 1) assisting GPS receivers, 2) providing an Iridium-only Ranging ("IOR") capability, or 3) determining position from a hybrid of Iridium and GPS signals when fewer than four GPS satellites are in view. IOR enables positions to be obtained deep indoors by geo-locating off the Iridium *BTL* signal without the use of GPS. The A-GPS or Hybrid mode would require an integrated circuit chip that could receive both GPS and Iridium signals; the IOR mode would require receiving only the Iridium *BTL* signal. A chip that receives both signals could implement all positioning modes, obtaining the precise accuracy of GPS when available, and benefit from the deep indoor positioning from Iridium when GPS is not available.

Boeing has been in partnering discussions with several leading cellular connectivity integrated circuit ("chip") manufacturers, both multi-sensor connectivity "combo-chips" (GPS, Wi-Fi, Bluetooth, etc, applicable to both CDMA and GSM/3G carriers) and chips that can be embedded in Subscriber Identity Module (SIM) cards (applicable to GSM/3G carriers). Many new handset-based technologies require a completely new chip, thereby requiring handset turnover to penetrate a large percentage of the subscriber base. By retrofitting current GSM/3G cell phones with a *BTL* Iridium-Only Ranging (IOR) SIM card, a carrier could upgrade many existing non A-GPS phones in rapid fashion for the price of a low cost *BTL* SIM Card. A carrier

could also upgrade legacy A-GPS phones with a *BTL* SIM card to provide enhanced positioning capabilities to cover challenging environments, such as indoor and urban canyons, where A-GPS often fails. The BTL SIM card could also be forward fit on new GSM/3G cell phones that already have an A-GPS chip, or forward fit into new 3G or CDMA cell phones with a multi-sensor connectivity "combo-chip" that includes the BTL capability. A SIM card implementation would also consume much less power than an A-GPS chip, primarily because the *BTL* signal is very simple compared to GPS, conserving battery lifetime.

All the *BTL* modes can operate either "connected" or "unconnected" to a carrier's network as described in Figure 4. The unconnected mode would not require any distribution of the assistance data by the carrier's network, but may cause slight delays in the time to required accuracy. The connected mode would require integration on the carrier's network or could use existing proprietary servers providing assistance data operated by various A-GPS chipset manufacturers. It is envisioned that much of the current interface standards for A-GPS could be leveraged for the *BTL* data transfer.

Once a chip is available, and any integration on a carrier's network for the connected user is accomplished, the *BTL* System can be made available at a low cost across the United States. Speeding time to compliance will provide public safety organizations and first responders with better location information sooner and ultimately save more lives over the next six years.

C. *BTL* Can Provide Emergency Call Locations with Minimal County *Exclusions* under the Current *Second R&O*

The technologies that currently provide the majority of wireless location fixes include: handset-based location technologies, primarily A-GPS; and network-based location technologies, primarily Uplink Time Difference of Arrival (U-TDOA), Advanced Forward Link Trilateration

(AFLT); and also include several fallback technologies with lesser accuracies, such as CGI + Timing Advance, Round Trip Timing,[41] cell sector with timing, mixed cell sector, cell sector,[42] as well as hybrids of handset and network based technologies.

As noted in Section III.B, handset-based location technologies perform well in environments where there is an unobstructed view of the sky, but do not perform well in challenging environments (urban canyons, mountainous regions, heavy forestation, indoors).[43] Network-based location technologies generally perform well in counties where there is sufficient tower density and good tower geometry such as urban and suburban areas, but network-based technologies are challenged in rural areas.[44]

As such, handset-based carriers are allowed to exclude from compliance up to fifteen percent of counties or PSAPs due to heavy forestation. Network-based carriers, on the other hand have more options to exclude counties based on various considerations other than heavy forestation. This is primarily because network-based technologies work sufficiently well in urban areas and therefore would not exclude urban areas with a large percentage of populations,

[41] *See* AT&T Notice of Ex Parte, May 4, 2011 at page 6

[42] *See* Verizon Notice of Ex Parte, May 18, 2011 at page 2

[43] *See* Comments of Verizon and Verizon Wireless at pages 4-5, PS Docket 07-114 (January 19, 2010). "Despite the success of GPS for accurately locating most wireless E911 calls, the basic attributes of the technology are unchanged from 2007…. Obstacles to the device "seeing" a sufficient number of GPS satellites include: multipath delays when radio transmissions reflect off buildings; the limited search window, in seconds, for acquiring satellite signals; weak signal strength or penetration of GPS signals in challenged environments (GPS satellite transmissions operating at 1.5 GHz are low power and do not penetrate structures well); and inherent difficulties posed by calls placed from indoor locations because the most advanced GPS techniques only provide an extra six to ten feet of penetration within a building."

[44] *See* TruePosition, Inc. Comment, Jan. 19, 2011 at p. 8

but do need more relief in rural areas for considerations other than forestation.[45] For example, AT&T—a network-based carrier—lists exclusions for the following reasons:[46]

1) Stand Alone Sites: The county contains an isolated stand-alone site that preclude triangulation
2) String of Pearls: There are multiple sites located in a linear string that do not allow for triangulation
3) Terrain: The terrain, including, but not limited to mountainous areas, prevents a sufficient number of LMUs from contributing to location attempts
4) Distance: There are multiple sites but the distance between them is too great for LMUs to contribute with each other

The *BTL* system is based on the ubiquitous coverage, high power signal of the Iridium LEO constellation emanating from space, with a constantly moving geometry. Therefore the performance is uniform over the entire continent outdoors, and is not dependent on terrestrial infrastructure density or geometry, and is less affected by mountainous terrain or urban canyons given the dynamic nature of the LEO space-based signal (availability). Also, the higher power means the *BTL* system can penetrate forestation, urban canyons, and indoors. *BTL* works well in the areas most likely to be excluded for either handset-based technologies—forestation—or network-based technologies—rural and mountainous areas. Therefore, with a more uniform and consistent performance across the entire country, *BTL* can help reduce the percentage of counties excluded from the new rules, for both network-based and handset-based carriers. *BTL* can also improve the yield of location performance by improving the accuracy for a greater percentage of calls and thus improve public safety in even the most challenging environments.

[45] *See* Second R&O ¶ 45. The Commission will permit network-based carriers to exclude from compliance particular counties, or portions of counties, where triangulation is not technically possible, such as locations where at least three cell sites are not sufficiently visible to a handset.

[46] *See* Comment to Second R&O, AT&T Mobility E911 County Exclusions List July 15, 2011

The Commission has also helped network-based carriers meet the increased accuracy requirements with a compromise to use a blend of network-based and handset-based location technologies. NENA, APCO and AT&T (a network-based technology carrier) stated in their joint proposal that handset-based approaches are preferable to network-based approaches.[47] The parties proposed to employ a "blended" approach that would include "A-GPS" handsets for many customers.[48] The *Second R&O* permits this "blended" approach which will certainly help in rural areas.[49] Because *BTL* is a handset-based location technology, deployment of *BTL* enabled handsets could also be used in the blended approach to meet the new accuracy requirements.

D. *BTL* Can Locate Emergency Callers in Challenging Environments

In the *Further Notice*, the Commission seeks to refresh the record on how location information and accuracy can be improved in more challenging environments, including indoor settings, urban canyons, buildings including high-rises, rural environments characteristic of heavy forestation, mountainous terrain, or sparsely located wireless towers.[50] One of the most challenging environments for wireless carriers to trace emergency callers is indoors. This is especially true for handset-based carriers using GPS technology, but even network-based carriers

---

[47] *See* APCO/NENA/AT&T Aug. 25 Ex Parte at 1. As network-based providers will be unable to meet the new proposed county-level accuracy standards in all areas relying solely upon current network-based technology solutions, carriers who employ network-based location solutions may be expected to deploy handset-based solutions as an overlay to existing network-based solutions in order to meet the more stringent county-level requirements … To encourage the improvements in location accuracy that may be achieved using both network and handset based solutions, this proposal provides that network-based carriers may elect to use a system of blended reporting for accuracy measurements

[48] *See* Second R&O, ¶ 33.

[49] *Id*., ¶ 47.

[50] *See* Further Notice, ¶ 22.

are *relying more and more on GPS as a supplement to their network-based technologies* to meet the Commission's requirements.[51] The Commission clarified in the *Second R&O* that its revised location accuracy requirements apply only to outdoor measurements, giving as its reasons the inherent technological challenges and the cooperative efforts being undertaken by the public safety and industry communities.[52]

In the *Further Notice*, the Commission also requests comment on the trends reflecting "the growing number of indoor 911 calls."[53] State officials (Alabama, Texas, Virginia, Washington, Massachusetts, Delaware, and Michigan) report that percentage of wireless calls range from 52% to 72% of all 911 calls received by PSAPs.[54] A J.D. Power 2009 study also shows that 52% of all wireless calls are made indoors.[55]

Unfortunately from a public safety perspective, given the ever growing number of wireless emergency calls[56], including wireless calls made from indoors, a solution to this

---

[51] *See* Section V.C.

[52] *See* Second R&O, ¶ 29.

[53] *See* Further Notice, ¶ 20, *see also* Second R&O, Appendix A. Chairman Julius Genachowski comments: When Americans call 9-1-1- from their landlines, first responders receive location information that's accurate more than 98% of the time. When Americans call 9-1-1 from their mobile phones, first responders are about 50% less likely to receive precise information about your location. Fifty percent…The inaccuracy is not just a few feet, but up to one or two miles—and sometimes no location information at all. Meanwhile, more and more 9-1-1- calls are being made from mobile phones – over 425,000 mobile 9-1-1- calls every day, and rising.

[54] *See* Comments of Intrado, Inc. and Intrado Communications on National Broadband Plan Public Notice #8, GN Docket No. 09-47, at 4 (Nov. 12,2009) (noting that the States of Alabama, Texas, Virginia, Washington, Massachusetts, Delaware, and Michigan report that the percentage of wireless calls in those states ranges from 52% to 72% of all calls received by PSAPs).

[55] The J.D. Power and Associates 2009 Wireless Call Quality Stud/M-Volume, http://www.jdpower.com/telecom/articles/2009-Wireless-Call-Quality-Volume-l

[56] *See* Communications Security, Reliability and Interoperability Council Working Group 4C "Technical Options for E9-1-1 Location Accuracy" FINAL Report, March 14, 2011. *As more and more of the population moves away from landline service and relies solely on mobile*

problem must be found quickly. As discussed in Section. V.C above, as a result of *BTL*'s ability to broadcast over the entire United States and the enhanced sensitivity of a cellular device equipped with *BTL* receivers when receiving the low bit rate, high power Iridium signal, *BTL* can penetrate indoors and in urban canyons to locate emergency callers, no matter where the caller is located. These capabilities would allow emergency responders to precisely locate wireless 911 callers throughout the entire United States, including inside buildings and downtown in major cities with no roaming issues, and no additional infrastructure costs for the wireless carriers.

E. *BTL* Can Provide Confidence and Uncertainty Data

The Kalman filter used by the *BTL* position engine routinely outputs a covariance estimate which is a statistical estimate of position uncertainty and confidence level. The methods used are similar to the positioning algorithms used in GPS receivers.

F. *BTL* Can Provide Vertical Z-Axis Location Information

Boeing has performed preliminary analysis and measurements that supports the ability of *BTL* technology to be able to determine a vertical position as well as a horizontal position. This is possible because the near polar orbits rise and set with varying elevations in the sky, as the earth rotates. Those orbits that have an inclination greater than 45 degrees allow a vertical positioning vector to be estimated similar to the horizontal position. This technology has not been studied in detail and no performance claims are forthcoming at this time, but Boeing has a clear roadmap to additional research and development to improve accuracies, and to add a vertical capability.

---

telephony devices, a larger percentage of E9-1-1 calls are being made via mobile telephony. This growth in wireless 9-1-1 calls has reached or is approaching 70% in many urban 9-1-1 Centers

G. *BTL* is Not Affected by Roaming

The Commission's *Further Notice* seeks comment on location accuracy while roaming.[57] The Commission is concerned that a wireless caller whose carrier employs one type of location technology may not be provided Phase II service at all when roaming on the network of another carrier that relies on a different technology, or when there is no roaming agreement between carriers using compatible technologies

Although roaming is a potential concern for handsets relying on network-based location technologies, any handset outfitted with a *BTL* enabled chip can locate itself regardless of whether it is roaming on another network.

BTL can allow carriers to meet the tighter location accuracy standards discussed above whether the emergency caller is on the carrier's home network or roaming on another network. Because *BTL* is a separate, space-based global overlay network from the Iridium LEO constellation, handsets using *BTL* do not depend on cellular networks to identify their location. Therefore, just like with GPS, as long as the *BTL* Iridium network is available, the system is independent of the carrier's network in establishing position location. Therefore, BTL can provide accurate location information, independent of any carrier network assistance to determine that location. Of course the network is needed to communicate the location information to the PSAP.

H. *BTL* Can Work in VoIP phones and Emerging Network Devices

The Commission requests comment regarding what advanced technologies, if any, permit interconnected VoIP service providers to provide Automatic Location Information.[58] Also, in

[57] *See* Further Notice, ¶24.

[58] *See* NOI ¶ 29

the *Second Further Notice*, the Commission seeks comment on whether E911 Rules should be applied to VoIP devices other than fully "Interconnected" VoIP phones, such as Outbound-Only Interconnected VoIP devices.

BTL can also be available for VoIP handsets or Emerging Network Devices, such as femtocells/picocells/microcells, with the addition of an inexpensive *BTL* receiver chip. The Commission has concluded that the existing method for establishing the location of an interconnected VoIP device (i.e., the registered location requirement) is inadequate.[59] The Commission therefore tentatively concluded that it should require that portable or nomadic VoIP services employ an automatic location technology.[60]

By 2013, VoIP enabled devices could incorporate *BTL* technology by integrating a *BTL* chipset and antenna to give a handset the ability to automatically locate itself to within 100 to 150 meters indoors, with a clear roadmap to better accuracy performance. This solution would allow the Commission to avoid the difficult decision regarding whether and how to regulate various potentially small local providers of broadband Internet connections to customers such as coffee shops, hotels, airports and municipalities.[61] Rather, the location capability would be built into the VoIP device. AT&T supports this approach, but cautions about reliance on GPS indoors.[62] As mentioned throughout this paper, *BTL* can overcome the indoor shortfall of GPS.

---

[59] *See id.*, ¶ 27 (*citing* NPRM, ¶ 18).

[60] *See id*.

[61] *See id.*, ¶ 28.

[62] *See* AT&T Comments at 19, 20. *According to AT&T, one possible technological solution that warrants further consideration would be "to include integrated ALI capabilities in the design of terminal adapters or other user devices employed in the provision of portable VoIP services." AT&T states that "these devices could include A-GPS, passive CMRS wireless receivers, or both, for use in trilateration and identification of the user's location." Nevertheless, AT&T cautions that GPS-based automatic location information poses technical limitations, as many*

Boeing takes no position on whether the Commission should extend E911 location accuracy requirements to interconnected VoIP providers, or other VoIP providers. Any VoIP device, however, can be outfitted with *BTL* technology and would therefore be able to exceed the Commission's E911 location accuracy requirements. Of course, as noted by Nokia, standards must be developed for delivering location technology over the Internet when a wireless VoIP 911 call is made.[63]

Similarly, *BTL* receivers can be installed in Emerging Network devices, such as Femtocells, Picocells, or Microcells. Carriers are increasing deployments of Emerging Network Devices to fill in coverage gaps as well as to offload data intensive requests through a broadband backhaul connection. Depending on the service provider, femtocells must be used either at the registered civic address or in an area where it can acquire geodetic coordinates (GPS or network location measurements) that are within the carrier's licensed area. At least one service provider requires both geodetic coordinates and a registered civic address. When a customer moves a femtocell, or it loses power, the carrier performs the same location validation process that is used for initial activation. Also, carriers do not allow femtocells to remain active unless the location of the cell can be regularly confirmed through a ping for the GPS location of the femtocell. In cases where GPS is used to determine the femtocell location, the accuracy may be degraded if

---

interconnected VoIP subscribers use their service indoors or in urban environments, making GPS less effective if satellite transmissions are reflected off buildings and other obstructions or satellite connectivity is lost when VoIP users are deeper indoors.164

[63] Nokia Comments at 6. Nokia stated that interconnected VoIP services "should not be subject to the Commission's CMRS E911 location requirements without ensuring that time is taken to study location technologies that can be used when a wireless 911 call is made using VoIP, standards are developed for delivering location technology over the Internet when a wireless VoIP 911 call is made, and technologies to be utilized for location are tested and finally deployed."

the femtocell is located deep inside a building where GPS signals are weak. Often, an external antenna located in a clear view of the sky is employed.

Therefore, *BTL* can allow a VoIP device or Femtocell to determine accuracy deep indoors sufficient to determine if the device is not at the registered Master Street Address Guide (MSAG). If there is a high confidence in the femtocells location, and given the small coverage area, then any mobile phone making a 911 call through that device can be routed to the MSAG address that has been correlated with the BTL location.

I. *BTL* is Commercially Feasible and Can Be Rolled Out Across the Entire U.S. Within One Year

A persistent concern when new technologies are introduced is when each capability can be made available.[64] *BTL* will allow wireless carriers to significantly improve E911 location accuracy, and expand location coverage indoors, in urban canyons and high-rises, on a much shorter schedule than required by the Commission in the *Second R&O*. New handset-based technologies are typically criticized as taking a long time to penetrate a substantial portion of the subscriber base. For GSM/3G carriers, Boeing has described a retrofit capability using a SIM card implementation that can significantly speed the deployment time.[65] For CDMA carriers, a new multi-radio combo chip that includes the *BTL* capability can be installed on new phones going forward. The *BTL* service, including all the capabilities described above, can achieve coverage across the entire United States as soon as the handsets are capable of receiving the *BTL*

[64] *See e.g.*, Further Notice, ¶ 19-24.

[65] *See* Section V.B

signal, including Alaska and Hawaii. Boeing's chip partners expect to have chipsets ready in 2012.[66]

J. *BTL* Can Be Made Available at Low Cost

Another matter of concern to the Commission and to carriers (and potentially interconnected VoIP providers) subject to the E911 location accuracy requirements, is, of course, cost. It is worth noting that, other technologies such as GPS and network-based technologies cannot economically provide the same capabilities as *BTL*, such as providing accurate location information in urban canyons, indoors, or over vast rural areas for network-based technologies. This is primarily because many network-based location technologies require expensive infrastructure (additional towers, position determining equipment, mobile location centers, etc) to improve accuracies in rural areas.

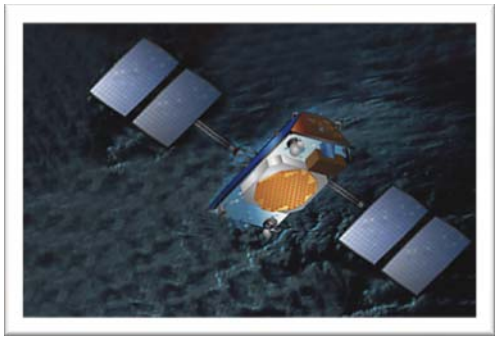
Because *BTL* is a broadcast signal capable of covering the entire United States, it can be made available to an unlimited number of carriers and other service providers, with no additional infrastructure costs.[67] As a result, the operating costs can be incrementally shared by many entities at a remarkably reasonable cost. Also, given our SIM Card implementation, many handsets can be retrofitted for the price of a low cost SIM chip with *BTL* embedded. For these reasons, *BTL* is a viable and economical solution to the current E911 limitations outlined in the *Further Notice* and *Second Further Notice.* In addition, *BTL* can help carriers reach current milestones under the *Second R&O* sooner. Boeing has been meeting with the major wireless carriers; handset and multiple chipset manufacturers, as well as the Commission, APCO, and

[66] Any modifications required to the carrier's network to integrate data transfers for connected users would also have to be incorporated into the initial operational capability start date. See discussion about "connected" vs. "unconnected" users on page 20.

[67] Integration and test activities may be required by the carriers for the "connected" data transfers

NENA to discuss the *BTL* capabilities and costs. The results of these meetings have been very promising.

VI. IRIDIUM NEXT CONSTELLATION IS SCHEDULED TO BEGIN LAUNCHING IN 2015



Another matter of interest to the Commission, wireless carriers, handset providers, and chipset providers is the long-term plan for the Iridium constellation. Iridium Communications, Inc secured $1.8B in financing from the French Export Credit Agency, Coface, in June 2010 and a nine-bank syndicate financing deal was finalized in October 2010. Thales Alenia Space (TAS) won the contract to design and build the new Iridium NEXT constellation, is in the process of finalizing its Preliminary Design Review ("PDR") in 2011, and has a Critical Design Review ("CDR") scheduled for 2012. Approximately 40% of the subcontract work will be performed by U.S. firms. Orbital Sciences was selected to serve as satellite integrator and to test hosted payloads, and agreed to buy excess hosted payload capability.

Boeing will continue to provide operations and maintenance of Iridium NEXT, and will provide system integration and testing support to Thales. The first launch is scheduled to occur in the first quarter of 2015 and the constellation will be completely re-capitalized by the end of 2017. SpaceX was awarded the launch contract and Iridium awarded ISC Kosmotras a secondary launch contract. Given these developments, the Commission can be confident that the *BTL* capabilities that can be made available by Boeing using the existing Iridium constellation

will continue to be available into the future through the launch of the Iridium NEXT constellation.

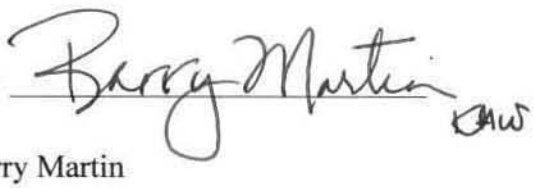
VII. CONCLUSION

As discussed herein, Boeing has developed a new location technology that can exceed the Commission's location accuracy requirements, speed time to compliance, minimize exclusions in rural areas with poor tower density/geometry or rugged terrain, and locate emergency callers in urban canyons and indoors. *BTL* is not impacted by customer roaming, requires no "local infrastructure" installation, can be made available at a very low cost to carriers via a simple SIM card retrofit, or forward fit of a new SIM Card or new multi-radio AGPS/*BTL* chip. *BTL* technology could also be used to automatically locate VoIP devices and Emerging Network Devices (Femtocells). The *BTL* Signal-In-Space has already been developed by Boeing and operational tests have been occurring for the last year. Boeing is also in discussions with several of the leading GPS chipset and SIM card manufacturers and expects a decision on incorporation of the *BTL* capability later this year. With the ability to scale quickly with retrofit and forward fit chip options, combined with the ubiquitous coverage of the space-based Iridium signal, Boeing believes that its *BTL* service can be an important (but not the sole) contributor to advance

the E911 goals established by the Commission in the *Second and Third R&O* and the *Further and Second Further Notices*.

Respectfully submitted,

THE BOEING COMPANY

By: 

Barry Martin

Audrey Allison
Director, Frequency Management Services
The Boeing Company
1200 Wilson Boulevard
Arlington, VA 22209
(703) 465-3215

Barry Martin
Business Development & Strategy
Boeing Timing & Location
Advanced Network & Space Systems
The Boeing Company
P.O. Box 516 M/C S306-4160
St. Louis, MO 63042
(314) 234-5257