

GPS & Selective Availability Q&A

GPS

Q. Last year, the Vice President announced that two new civil signals would be added to Global Positioning System (GPS) satellites. What is the current implementation plan?

A: Our current plan for modernizing GPS includes the addition of two new civil signals and additional military capabilities to protect our military use of GPS. The new civil signals will improve the robustness, accuracy and availability of GPS for civil and commercial users and will enable the civil community to develop a broad range of new and improved GPS applications. The civil and military capabilities will be incorporated into the next two generations of GPS satellites with the capabilities being phased in beginning in 2003. Exact dates of availability will depend on several factors, including funding and the health of the existing satellites, which will govern our launch schedule.

Q. When will the new capabilities be available? Have the new capabilities been accelerated or delayed?

A. It is difficult to predict with certainty when a useable capability will be available, because this date will depend, among other things, on when replacement satellites are needed to maintain the 24 satellite constellation and required backups to provide worldwide coverage. However, based on our current projections, the dates we announced last year are still good – a satellite with the second civil signal will likely be launched in 2003, and the first satellite with the third civil signal will likely be launched in 2005.

Q. How much is in the President's budget for GPS?

A. The fiscal 2001 President's budget includes about \$2.7 billion over the next five years (FY01-05) to operate, maintain and modernize GPS. This includes about \$2.5 billion for research, development, and procurement of satellites and ground systems.

Q. How much have costs increased since last year's budget?

A. The FY 2001 budget includes an increase of about \$800 million over five years. We will add new civil signals to more satellites and will enhance military GPS capabilities to satisfy the needs of our armed forces.

Q. Press reports have indicated that DoD plans a substantial change to the modernization program. Can you elaborate? How will these plans affect the program you just described?

- A. Its true that some aspects of the modernization program are still being defined, because we want to be very sure we can sustain the constellation while we modernize, and that we bring the new military capabilities into GPS in the smartest way. However, we do not expect near term changes to the strategy for implementing the new civil signals.

Q. Is the Department of Transportation still planning to fund civil modernization? If not, why not. How much does civil modernization cost?

- A. No, the Department of Transportation is no longer requesting funding for GPS. For two years, Congress did not provide the funding the Administration requested in the Transportation budget. This year the Administration is proposing that new funding be included in the Department of Defense budget to cover civil modernization. Civil unique costs – those associated with adding the third civil signal – are under \$100 million over the next five years.

Q. If the Department of Defense is paying for GPS modernization, will civil users still have a voice in GPS management?

- A. Absolutely. The Interagency GPS Executive Board, which is jointly chaired by the Departments of Defense and Transportation, will continue to manage GPS and U.S. Government augmentations. The Department of Transportation is lead for all Federal civil GPS matters. A memorandum of agreement between DOD and DOT is being developed to assure that civil interests (and responsibilities) are fully recognized in GPS funding and acquisition decisions.

Q. Will the current GPS receivers continue to work as these services come on line?

- A. Yes. Backward compatibility is a fundamental requirement of the signal changes. However, users who wish to capitalize on the new capabilities will need to reinvest in order to take advantage of the new enhanced features. On the other hand, reception of the current civil signal without SA will require no changes in hardware or software.

Q. What is the status of WAAS and how much are we spending?

- A. We are working hard to implement WAAS in order to provide improved area navigation capability and precision approaches to every runway end as soon as possible. The Presidents 2001 budget contains \$85m, but this level is currently under review. The WAAS contractor recently encountered a problem during the final stability testing of the system. FAA, the contractor and a panel of technical experts are currently reviewing options for solving the problem.

Q: Why doesn't the U.S. charge for GPS?

A: Many years ago we evaluated charging for the civil signal. The more we looked at it, the more convinced we became that by providing the signal free of direct user fees we would encourage technological development and industrial growth. The benefits from that, the new jobs created, and the increased safety and efficiency for services more than outweighed the money we would get from charging – especially when you consider the additional bureaucracy that would be needed to manage cost recovery. We think that judgement has proven valid, as the world-wide market for GPS applications and services now exceeds \$8B annually.

Q: Why do we provide it free to the rest of the world?

A: Following the Korean Airline disaster, President Reagan offered GPS free to promote increased safety for civil aviation. Many major U.S. industries now operate on a global basis, and many Americans travel internationally. Their safety and economic efficiency are maximized by having open worldwide availability of GPS.

Q: Does the U.S. intend to charge for civil GPS in the future?

A: We consider GPS a global utility that is vital for safety and the national infrastructure. We have no plans to charge for the service.

Selective Availability

Q. What is Selective Availability (SA)?

A. SA was a technique to reduce the accuracy of unaugmented, single-receiver GPS measurements. This was accomplished by altering (or "dithering") the GPS satellite clock signals, and by modifying orbital elements of the broadcast navigation message. These alterations were done in a coded fashion, and could be removed by authorized users. This alteration caused horizontal positional errors on the order of 100 meters (95%), and varied in a manner that prevented rapid averaging of positional data.

Q. Why was SA necessary?

A. SA was used to protect the security interests of the U.S. and its allies by globally denying the full accuracy of the civil system to potential adversaries.

Q. When was SA implemented?

- A. SA was implemented on 25 March 1990 on all GPS Block II satellites. The level of SA is adjustable. SA was discontinued in September 1990 in support of Operation Desert Storm, and was returned to standard level on 1 July 1991. With minor exceptions, SA has been in place since these dates.

Q. Why are you turning it off?

- A. The decision to end the degradation of civil accuracy on a global level was made by the President based on a Secretary of Defense recommendation coordinated with all applicable departments and agencies. This decision is based on the U.S. military commitment to develop and employ technologies to deny the civil services of GPS on a regional basis. Under this approach, it will be possible to deny GPS to potential adversaries in areas of operations while preserving the peaceful use of GPS services outside those areas. Another factor in the decision to discontinue the use of SA is the awareness that there is a widespread growth of differential GPS services, designed to improve civil accuracy performances and essentially work to eliminate the advantages that SA previously provided.

Q. With the discontinuation of GPS SA, will DPGS systems continue to be required?

- A. DGPS systems, such as the U.S. Coast Guard's maritime beacon system and the FAA's Wide Area Augmentation System (WAAS), will continue to provide accuracy enhancements to the civil GPS services which will exceed the performances available from the basic GPS civil service without SA. These DGPS systems also provide other enhancements to the basic GPS such as warnings of system interruptions or interference.

Q. When will SA be turned off?

- A. SA will be turned off beginning at midnight GMT on May 1, 2000.

Q. How will it be turned off?

- A. Commanding the satellites to set a value of zero will turn off SA, thus eliminating any intentional error in the GPS signal.

Q. Will SA ever be turned back on?

- A. It is not the intent of the US to ever use SA again. To ensure that potential adversaries do not use GPS, the military is dedicated to the development and deployment of regional denial capabilities in lieu of global degradation through SA.

Q. Will SA be on the new satellites?

A. Since the satellites were designed and built before this decision was made, the SA capability will be on the new satellites, but SA will be set to zero.

Q. What if the U.S. discovers that adversaries are equipping to use the GPS capability against you or your allies?

A. Presidential Decision Directive (PDD) NTSC-6 states that we plan to discontinue the use of SA within a decade, *in a manner that allows adequate time and resources for our military to prepare fully for operations without SA*. The directive also requires that the DoD develop measures to prevent the hostile use of GPS and its augmentations to ensure that the U.S. retains a military advantage without unduly disrupting or degrading civilian uses. The DoD has an active Navigation Warfare (Navwar) Program fulfilling these requirements. The decision to discontinue SA was supported by the commitment being made by the US in the development and deployment of capabilities to selectively deny civil radionavigation signals on a regional basis when our national security is threatened. This regional approach to preventing adversaries from using radionavigation services against us circumvents the need to degrade the civil GPS system globally through the SA technique.

Q. Who benefits from termination of SA?

A. Many civilian applications will immediately benefit from termination of SA. Among them are car navigation, fleet management, aviation, highway and waterway maintenance, emergency response, resource management, forestry, precision timing, and recreational uses.

Q. What is the performance of GPS receivers with SA terminated?

A. One may immediately expect better than 20 meter horizontal accuracy on the ground. The performance will vary depending upon the particular receiver and the level of solar disturbance of the ionosphere.

Q. Can GPS accuracy be improved beyond discontinuation of SA?

A. With the removal of SA, distortion of the GPS signal as it travels through the ionosphere will be the largest error source. An ionosphere correction model is broadcast over the navigation message. However, that model is only partially successful in correcting the ionosphere sensed by a GPS receiver at a given location. As additional GPS frequencies are added as part of our GPS modernization program there will be increased demand for multi frequency receivers, so that the local ionospheric error can be directly measured and eliminated. If ionospheric error is eliminated, the next largest error source is the orbital parameters broadcast on the navigation message. Currently, the broadcast

orbit is accurate to around 5 meters. If a readily available, precise, real-time/predicted orbit were obtained, then one may be able to achieve around 1-3 meter positioning. This figure would be a combination of signal multipath error, and tropospheric error.

Q. What is DGPS (Differential GPS)?

- A. DGPS is a technique used to improve GPS accuracy by incorporating error corrections provided by a GPS monitoring station. The monitoring station calculates the corrections by comparing its known location with that reported by GPS. The difference between the two represents an “differential correction” that can be applied either in real-time or during post-processing.

Q. Is DGPS still needed now that SA is terminated?

- A. The discontinuation of Selective Availability will not eliminate the need for DGPS systems. The decision whether to use unaugmented GPS or DGPS depends upon an individual user’s application and requirements for positioning and navigational services. For example, Federally-operated DGPS systems provide integrity monitoring and alerts, and support many applications involving safety of life, such as aviation transportation.

Q. It is anticipated that setting the Selective Availability (SA) feature of the GPS signal to zero will improve the basic accuracy of position determinations utilizing the GPS signal. Will this expose the GPS signal provider, the United States government, to any additional risk of liability for positioning mishaps?

- A. No. Under the Federal Tort Claims Act, the U.S. government has been held liable for negligence in activities comparable to its provision of radionavigation signals, such as GPS alone or GPS as augmented by other positioning systems the government may also directly provide. Establishing negligence on the part of the U.S. government would require a claimant to prove that, in providing the GPS signal, the government had failed to carry out reasonably what it had undertaken to do, which is to provide a GPS signal operating within its design capabilities for use under proper procedures. Under the statute and international law. Legal causation between the negligence and the damage would also have to be proven. Improving the accuracy of the basic signal has no significance in itself for government liability exposure under U.S. and international law.

Q. If turning off SA dramatically improves the accuracy of the basic GPS, what impact would this improved accuracy have on commercial DGPS service providers? Would eliminating SA drive them out of business?

- A. Although eliminating SA will dramatically improve the accuracy of GPS, the majority of users relying on commercial providers need accuracies an order of magnitude better than unaugmented GPS can provide, even with SA terminated

and would therefore continue to use the services. One major provider has stated on its Internet [page that turning off SA will not suffice for commercial applications. Many of its customers are asking for accuracies well below one meter. It notes that "Accuracy is addictive."

Q. What is the impact of the decision to terminate GPS selective availability on the plans of the Department of Transportation to continue operating the Loran-C navigation system?

A. We will continue to evaluate the need for Loran-C as a complement or backup to GPS.