RESULTS OF A BLOCK II GPS USERS SURVEY

Thomas R. Bartholomew
The Analytic Sciences Corporation (TASC)
1190 Winterson Road
Linthicum, MD 21090
and
Stephen M. Bloor
Department of Defense
Ft. Meade, MD

Abstract

As part of a system development the authors were required to select appropriate standards and cost–effective techniques for time recovery and frequency control. It quickly became apparent that GPS offered a good across–the–board solution to the system requirements for:

- time recovery
- synchrony
- frequency control
- syntony
- precise positioning.

It was also apparent, with the advent of Block II, selective availability (SA) and anti–spoofing (AS), that the performance of presently available time recovery receivers would potentially be inadequate to meet our system requirements. It was further evident that readily available, cost–effective receivers were not in the near–term plans of any of the contacted manufacturers. We therefore undertook to encourage the development and competitive availability of "authorized user" receivers capable of achieving the full time and frequency performance capabilities of GPS within the Block II environment. As part of that effort we reviewed our requirements with a representative set of receiver manufacturers. In addition, we distributed a questionnaire to over 1300 projected "authorized users". This was an attempt to determine:

1. the range of user requirements;
2. the size of the potential market; and
3. the degree of user interest in establishing an "authorized user" users group (AUUG).

This paper presents the results of the survey, reports on our progress in organizing the user/working group and briefly describes some of the concepts proposed to provide cost–effective solutions to the problem.

APPROACH

The initiative for the questionnaire was a direct result of an action item proposed at the May 11, 1989 USNO GPS Workshop.

The mailing list for the questionnaire was derived from the registration lists for the 1988 and 1989 Annual PTTI meetings, and the "Publication Series 4" mailing list provided by the USNO. The final list of 1100 names was assembled and culled to remove duplicates, foreign addresses and blunders.

The questionnaire was designed to be as simple as possible and was provided with a cover letter which contained essentially the same material as the above abstract. The seven questions posed in the questionnaire asked the user to:

1. Compare the users requirements to the attainable accuracy estimates of Table I. Table I was obtained from the USNO and is their estimate of the one sigma time recovery accuracy obtainable with SA and AS in Block II;
2. Provide estimates of required time and frequency accuracies if "authorized user" performance levels are required;
3. Estimate the number of "authorized user" GPS receivers required immediately and over the next 5 years;
4. Express interest in a "survey" option (probably a software option or addition) which would allow the timing receiver to be used as the reference end of a relative positioning system;
5. Provide any comments regarding SA and AS;
6. Express interest in an "authorized user" users group; and
7. State any restrictions on use of the responses.

The questionnaire, which is presented in its entirety in the following section, suffered from at least two major deficiencies. The three words "SPS (Standard Positioning Service) 'unauthorized user' " were omitted from the first question in the first mailing. This caused some "authorized users" to ignore the second question on specific requirements. Respondents in this category will be contacted by telephone as time and resources permit. The second difficulty occurred in questions 2) and 3) in that the time, frequency, and quantity categories were broken down into rather broad and unequal ranges. This caused some difficulty in our analysis in assigning specific values to the responses.

RESULTS

At this writing (November 22, 1989) responses are still coming in. We have received a total of about 175 replies with several classified as "non–responsive". Non–responsive was defined as follows:

1. not in time/frequency business at all;
2. total lack of understanding – "what is GPS?"; and
3. not now using and/or no future plans to use GPS.

There seemed to be a significant secondary distribution in that we received more than 20 responses from individuals in organizations who were not on our original mailing list. We had restricted our distribution to the USA and some of these came from other countries.

The data was entered into a simple data base and analyzed for "frequency of occurrence" in each of the question areas. There was no attempt to project the results of the survey to the total user population.

The following section presents the questions exactly as stated and shows the actual number of responses to each along with computed percentages from the 124 "responsive" questionnaires analyzed to date.

Q1. Will your (or your customers') time and frequency requirements be met by the projected Block II GPS SPS "unauthorized user" performance levels as estimated in Table I?

Yes 34 27% No 90 73%

[All of the 90 negative responses were found to be at least potentially eligible for AU status.]

Q2. If the answer to Q1. above is No, please indicate the required performance level:

Time		Frequency		Number
< 100 ns	19	1×10^{-10}	3	
< 50 ns	5	1×10^{-11}	4	
< 25 ns	15	1×10^{-12}	25	
Other (1 ns to 15 ns)	16	Other (1×10^{-13} to 1×10^{-14})	10	
Total	56	Total	42	

[Of the 56 AU time requirement responses 31 (55%) need time recovery to 25 Ns or better. Of the 42 frequency requirement responses 35 (83%) need frequency to a part in 1×10^{-12} or better. Note that not all of the 90 potential "authorized users" responded to one or both elements of the requirements question.]

Q3. Please estimate the number of "authorized user" Block II GPS receivers equipped with security modules (PPS–SM's) which would be necessary to satisfy your (or your customers) requirements.

Immediate		Total over 5 years	
> 100	5	>100	14
50–99	3	50–99	1
20–49	4	20–49	12
10–19	6	10–19	9
01–09	59	01–09	59

[For the 90 AU responses only:

1. Estimated immediate requirement = 800–1000 receivers; and
2. Estimated total requirement over 5 years = 1600–2000 receivers.]

Q4. Would you (or your customers) be interested in a "survey" option which would allow centimeter level relative positioning?

Yes 63 *[51% of all responses]* No 49 *[40% of all]*

[Totals less than 100% because not all respondents replied to this question]

Q5. Please provide any other comments which you may have regarding SA–AS as it impacts your time, frequency, and positioning requirements.

[58% of all respondents provided comments. Several of these fell into 4 general areas as follows:

1. Hostility towards SA;
2. Questions and misconceptions regarding SA;
3. Questions and statements regarding alternative time recovery/time transfer methods including LORAN–C, two way communications via commercial COMSAT using spread spectrum modems, and similar schemes; and
4. Questions on the requirements for becoming an authorized user and participation in the planned users group.

Q6. If you are an "authorized user" would you be interested in participating in an "authorized user" users group (AUUG)?

Yes 66 *[73% of the AU responses]* No 24

Q7. Please detail any security, proprietary, or attribution restrictions you wish us to observe regarding your responses.

[Less than 2% had any sort of restrictions.]

PLANS

Where do we go from here? The time and frequency standards and requirements mentioned in Section I. have been determined and specified. The improvement of current systems and the development of future systems will require a series of steps with the following specific activities underway:

1. Propose the implementation/development of time recovery/frequency control receivers equipped with the necessary hardware (PPS–SM's and AOC's) to provide full access to GPS Block II performance capabilities for AU. It will be suggested that the initial acquisition be conducted such that 2 receivers are procured from each of 2 different manufacturers. The contracts could be written such that procurement options for 20 – 50 more receivers can be exercised.

2. Authorized User Users Group. This activity has been somewhat overtaken by events in that there is now an organized DoD PTTI AU Planning Group. They are in the first steps of planning, requirements definition and generating a receiver specification. This group is established under the auspices of the Superintendent of the USNO. The NRL will act as the technical coordinator.

3. Future activities with respect to this survey. We plan to analyze the remaining 40–50 responses received after our cutoff date. We will then total the results and provide a summary to all the respondents. We will further provide the survey in its entirety to the DoD PTTI AU Planning Group.

TABLE I

ESTIMATED ONE SIGMA TIME RECOVERY INCLUDING

THE EFFECTS OF S/A AND A/S

WITH A/S		UNAUTHORIZED USER NO KEYS	AUTHORIZED USER KEYS
NO S/A	SPA	40 ns.	40 ns.
	PPS	?	15 ns.
S/A	SPS	300 ns.	40 ns.
	PPS	?	15 ns.

QUESTIONS AND ANSWERS

UNIDENTIFIED QUESTIONER: Did the questionnaire go to people who had geodetic requirements, or were they excluded in principle?

MR. BLOOR: No, they weren't excluded at all. The questionnaires went to people who had always been on the PTTI mailing list or the PUB–4 mailing list. If there are geodetic users that were not surveyed, we are certainly interested in their responses.

SAME PERSON: I think that there are people that are not currently using GPS for geodetic purposes but who might benefit from it. I think that you have missed a significant number of folks. I am not not an authorized user, in your sense of the word, but I think that you have missed a large number of people that have a much stiffer requirement than you talked about.

MR. BLOOR: Stiffer time transfer requirements?

SAME PERSON: No, geodetic requirement.

MR. BLOOR: Yes, our geodetic requirements were very minor. I am mainly interested in time and frequency control.

UNIDENTIFIED QUESTIONER AND INDECIPHERABLE QUESTION:

MR. BLOOR: No, I am not the right person to state DoD policy. The term 'authorized user' has not been defined. Certainly, any military user could be an authorized user, however, that does not preclude others from being authorized users. Even, under certain interpretations of the draft policy, members of the civilian community. The keys are designed such that some keys are good for days and some are good for years. There has been discussion that certain civilian users might be authorized access via short term keys. I am not in the authorized user policy business.