Genesis – The Dawn of a New Era in Airspace Management

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Abstract – *The effective utilization of our national airspace requires that military and civilian airspace managers have accurate, timely and reliable airspace information. The current methods for determining airspace utilization include: counting flight strips, watching radar tapes, using scheduled flight plans and corporate memory. These decades-old airspace utilization methods are best guesses at what is actually occurring in the airspace. Thus, a more effective method for determining airspace utilization is needed. This paper describes Genesis, a computer based system that has demonstrated its ability to accurately, timely and reliably generate actual airspace utilization reports. Genesis facilitates more accurate and timely decisions by automatically generating and printing daily reports based upon actual Air Traffic Control radar track and flight data.*

Keywords: airspace management, air traffic control, Genesis, Airspace Utilization Reporting System.

1 Introduction

It is becoming apparent to the most casual observer that the phrase "Big Sky Little Airplane" no longer applies. What once seemed an unlimited resource is now rapidly becoming a scarce commodity? The competing demands of commercial, military and general aviation aircraft require that the agencies responsible for airspace and traffic flow know what took place in their airspace five hours ago, five days ago, five months ago or five years ago at an instance notice.

Commercial airlines expressing their desire to fly through Special Use Airspace to save fuel and time have spearheaded the Free Flight concept, i.e., a concept on which the National Aeronautics and Space Administration and the Federal Aviation Administration are spending millions of research and technology development dollars. Increased environmental awareness and concerns from the Bureau of Land Management and National Parks have in the past years created an airspace nightmare. Noise complaints, sonic boom damage reports and air quality have become major encroachment issues. These issues and concerns have emphasized the need for better airspace management techniques and tools [1-4].

2 Current Methods for Determining Airspace Utilization

The need for accurate, timely and reliable airspace data is essential for any airspace analysis and management decision. The current methods for collecting and analyzing airspace data and reporting airspace utilization involves counting flight strips, watching radar tapes, using scheduled flight plan information as actual utilization, and estimating airspace utilization based upon corporate memory. Counting flight strips is the time-honored method for determining actual airspace utilization. This method relies upon sorting the air traffic controller's flight strips by the selected airspace areas of interest. This "stubby pencil" method for determining airspace utilization is not always accurate and subject to human errors.

Another method for determining airspace utilization is using scheduled flight plan information as actual utilization. Since the major airlines keep detailed schedules of aircraft arrivals and departures, most major airports rely on the airlines to estimate Class B and C airspace utilization. While this method appears to provide reasonable airspace utilization information, flights are often cancelled, diverted, or have different arrival and departure times.

Another method is watching radar tapes to determine if an aircraft violated airspace restrictions. The Federal Aviation Administration's policy is to save the radar data for approximately two weeks. After two weeks the data is erased and the tapes are reused. Thus, replaying radar tapes to evaluate an incident is only applicable if the data is available. In addition, watching radar tapes often involves two airspace managers and is a very time consuming process.

Another method is estimating airspace utilization based upon corporate memory. This method uses the experience and memory of the most senior airspace manager to gauge actual airspace utilization and the most probable cause for an airspace incident. Experience is a valuable asset and should definitely be considered, however relying on memory of what normally occurs is not an accurate method for determining actual airspace utilization. Thus, a better method of determining and reporting actual airspace utilization is needed. This new method is called Genesis.

3 Genesis - What Is It?

Genesis is a high performance computer system that operates twenty-four hours per day, seven days per week with less than four hours of weekly system administration. Genesis was designed as a tool to assist Operations Directors, Facility Managers, Flow Controllers and Airspace Managers in making more accurate airspace utilization management decisions. Genesis does this by automatically generating and printing daily airspace utilization reports based upon actual Air Traffic Control radar track and flight data collected from Class A, B, C, D and Restricted Special Use Airspace.

Class A airspace is the airspace from 18,000 to 60,000 feet. All pilots flying in Class A airspace shall file an Instrument Flight Rules (IFR) flight plan and receive an appropriate air traffic control clearance. Class B airspace is generally the airspace from the surface to 10,000 feet which includes all major airports such as Los Angeles International. Class C airspace is the airspace from the surface to 4,000 feet above the airport elevation. An example of Class C airspace is the Santa Barbara airport in Santa Barbara, California. Class D airspace is generally that airspace from the surface to 2,500 feet above the airport elevation. Class D airspace is generally used for general aviation. Fox Field in Lancaster, California is an example of Class D airspace. Restricted Special Use Airspace is controlled by the military. An example of Restricted Special Use Airspace is the R-2508 airspace surrounding Edwards Air Force Base. Figure 1 depicts each airspace class.

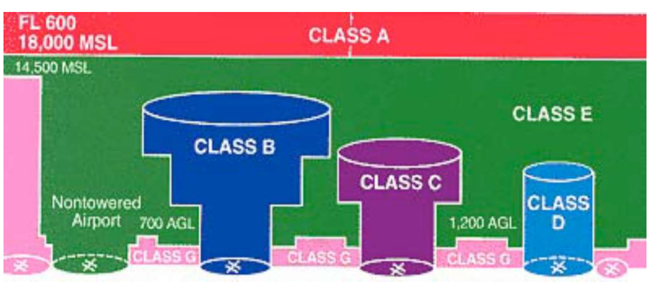


Figure 1. Classification of airspace.

Genesis, which employs Intel Pentium based computers and commercial-off-the-shelf software, incorporates a modular building block design. For example, *Genesis S1* is the core system and its primary function is airspace utilization. *Genesis S2* functions include airspace utilization and airspace scheduling. In addition, *Genesis S2* incorporates a remote system alert notification and monitoring to Informational Database Solutions or any designated agency. *Genesis S3* functions include airspace utilization, airspace scheduling and airspace modeling and trending. In addition, *Genesis S3* incorporates a Geographical Informational System user interface and a Standby Server. The Standby Server automatically activates if the Database Server fails. The Standby Server is also used for user-defined reports, and forms development. Therefore, depending upon customer requirements and budget, the user can select the system that meets his/her needs.

4 Genesis - How Does It Work?

The air traffic control system continuously broadcasts a subset of the digital radar track and flight plan data to the System Interface Unit (SIU). The track data consists of current date, current time, reporting aircraft transponder code, altitude, groundspeed, latitude and longitude. The flight plan data consists of current date, current time, the aircraft call sign and aircraft type.

The purpose of the SIU-2100 Network Universal Input/Output is to provide a serial link between the Federal Aviation Administration radar Common Digitizer Two (CD-2) data and the Genesis Hub. The System Interface Unit also converts the CD-2 radar data format to Sensis Generic Format (SGF) format and sends the SGF formatted data through the Hub to the Genesis Database Server for collection.

The purpose of the Hub is to provide connectivity from the air traffic control system to the Genesis Database Server, Genesis Application Server (GAS), Client Workstation and printer. Once through the Hub, the data is transmitted to the Genesis Database Server.

The purpose of the Genesis Database Server is to collect, pre-process and store the track and flight plan data for twenty-four hours. These data can range from less than one million records to one and one-half million records per day. The Genesis Database Server data is stored for one week.

At a pre-determined time, the Genesis Database Server automatically loads the stored data into a single database table. After the data is loaded into the specified table, the data is processed and filtered into multiple database tables depending on the type of information desired. For example, Genesis derives the aircraft entry and exit times in the various airspaces. It also calculates the total time spent in the airspace.

Other derived parameters include: minimum and maximum altitude, and minimum and maximum groundspeed. The data are then formatted into user specified reports that are generated and printed automatically every day. Figure 2 shows a functional block diagram illustrating the flow of data in the *Genesis S1* configuration.

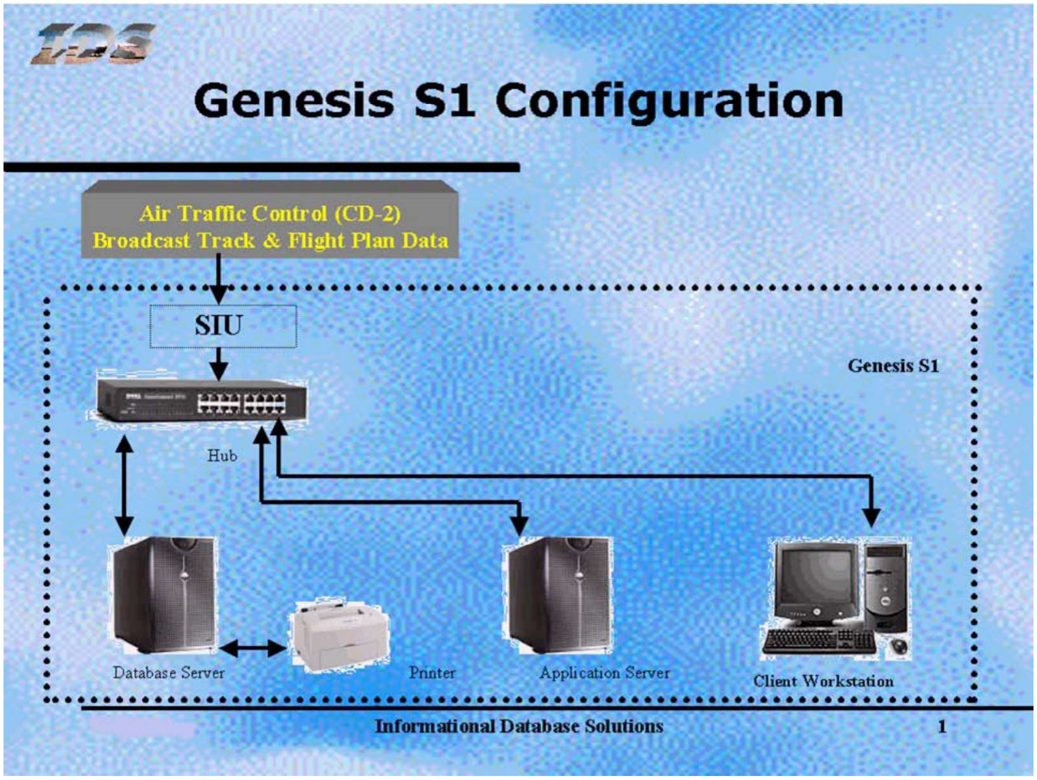


Figure 2. *Genesis S1* functional flow block diagram.

The purpose of the Genesis Application Server is to provide the Airspace Manager with easy access to the Genesis standard reports and forms.

In addition, the user can perform ad hoc database queries using the Client Workstation. The Client Workstation is connected either through the Genesis Hub or through the military's Local Area Network (LAN).

5 Genesis - What Are Its Products

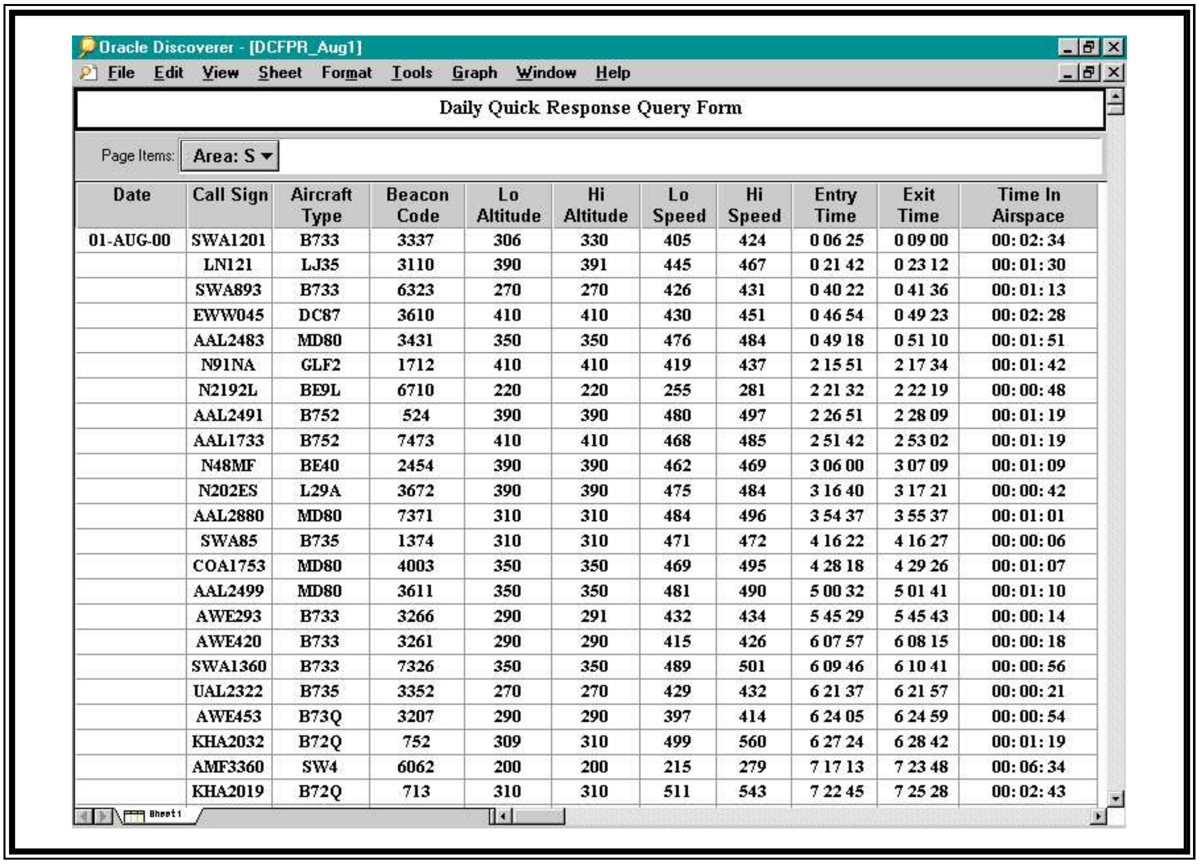
Genesis standard user products consist of reports, forms and graphs. Highlighted below are examples of the Airspace Utilization Report, Altitude Band Report, and Quick Response Query Form.

The *Airspace Utilization Report* displays the number of aircraft and total amount of time the various airspaces were actually utilized. This report can be automatically generated and printed every day, every week or every month. This report gives the Operations Director a clear indication of which airspace is under-utilized or over-utilized.

The *Altitude Band Report* displays all aircraft flying within user specified altitude bands in the airspace. This report also displays the following parameters: aircraft type, airspace, call sign, entry and exit times, minimum and maximum groundspeed, time in altitude band per aircraft and total time in altitude band by all aircraft. Likewise, this report can be automatically generated and printed every day, every week or every month. Environmental Managers, who want to incorporate actual airspace utilization data into their Environmental Baseline Studies, can use this report to derive aircraft noise levels based upon various altitude bands.

The *Quick Response Query Form* is used to perform ad hoc airspace utilization queries and analysis. This form displays the following parameters: date, call sign, aircraft type, transponder code, airspace, minimum and maximum altitude, minimum and maximum groundspeed, airspace entry time, airspace exit time and the amount of time the aircraft was in the airspace. This powerful form allows the Facility Manager to respond to airspace violation and noise complaints within minutes instead of hours or days! An example of this form is shown in Figure 3.

All the above reports and forms are archived on the Database Server and can be later viewed and printed using the Client Workstation or e-mailed to anyone in spreadsheet or word-processor format.



Date	Call Sign	Aircraft Type	Beacon Code	Lo Altitude	Hi Altitude	Lo Speed	Hi Speed	Entry Time	Exit Time	Time In Airspace
01-AUG-00	SWA1201	B733	3337	306	330	405	424	0 06 25	0 09 00	00: 02: 34
	LN121	LJ35	3110	390	391	445	467	0 21 42	0 23 12	00: 01: 30
	SWA893	B733	6323	270	270	426	431	0 40 22	0 41 36	00: 01: 13
	EWW045	DC87	3610	410	410	430	451	0 46 54	0 49 23	00: 02: 28
	AAL2483	MD80	3431	350	350	476	484	0 49 18	0 51 10	00: 01: 51
	N91NA	GLF2	1712	410	410	419	437	2 15 51	2 17 34	00: 01: 42
	N2192L	BE9L	6710	220	220	255	281	2 21 32	2 22 19	00: 00: 48
	AAL2491	B752	524	390	390	480	497	2 26 51	2 28 09	00: 01: 19
	AAL1733	B752	7473	410	410	468	485	2 51 42	2 53 02	00: 01: 19
	N48MF	BE40	2454	390	390	462	469	3 06 00	3 07 09	00: 01: 09
	N202ES	L29A	3672	390	390	475	484	3 16 40	3 17 21	00: 00: 42
	AAL2880	MD80	7371	310	310	484	496	3 54 37	3 55 37	00: 01: 01
	SWA85	B735	1374	310	310	471	472	4 16 22	4 16 27	00: 00: 06
	COA1753	MD80	4003	350	350	469	495	4 28 18	4 29 26	00: 01: 07
	AAL2499	MD80	3611	350	350	481	490	5 00 32	5 01 41	00: 01: 10
	AWE293	B733	3266	290	291	432	434	5 45 29	5 45 43	00: 00: 14
	AWE420	B733	3261	290	290	415	426	6 07 57	6 08 15	00: 00: 18
	SWA1360	B733	7326	350	350	489	501	6 09 46	6 10 41	00: 00: 56
	UAL2322	B735	3352	270	270	429	432	6 21 37	6 21 57	00: 00: 21
	AWE453	B73Q	3207	290	290	397	414	6 24 05	6 24 59	00: 00: 54
	KHA2032	B72Q	752	309	310	499	560	6 27 24	6 28 42	00: 01: 19
	AMF3360	SW4	6062	200	200	215	279	7 17 13	7 23 48	00: 06: 34
	KHA2019	B72Q	713	310	310	511	543	7 22 45	7 25 28	00: 02: 43

Figure 3. Daily Quick Response Query Form.

6 Summary and Conclusions

The effectiveness of national airspace utilization by military and civilian airspace managers can be improved using methods and tools that are more effective at determining actual airspace utilization than current methods such as counting flight strips, watching radar tapes, using scheduled flight plans and corporate memory. The Genesis computer system serves this purpose and is described in the paper with a focus on how the system works and the products it generates.

Genesis offers a high performance computer system that operates continuously as a tool to assist Operations Directors, Facility Managers, Flow Controllers and Airspace Managers in making more accurate and timely Class A, B, C, D and Special Use Airspace utilization management decisions. Genesis has demonstrated its ability to accurately, timely and reliably generate actual airspace utilization reports based upon actual air traffic control radar track and flight data. This is an advancement beyond methods that, in recent decades, have only provided guesses at what is actually occurring in the airspace.

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