JEPP'S BRIEFING

The Chart Clinic – Database Series

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When you first learned how to fly, most likely you learned to navigate using the Sectional Chart (scale of 1:500,000) and then gradually moved through the 1:1,000,000 charts and then learned how to use the IFR charts which had a number of different scales. After learning pilotage and dead reckoning, your instructor probably showed you the "magic" of the VOR that lets you know your azimuth to or from the station. And if you were lucky, the airplane had a DME so you could tell how far you were away from the VORTAC.

Well, that "magic" turned into something even better with the introduction of GPS. Now you can enter the airport identifier for wherever you wish to go and the GPS receiver will take you there via the shortest distance — a great circle route (or geodesic line for the perfectionists). But — did you ever think that the only way you could shoot an approach would be to have a current database on board your airplane? And — the FAA TSO-C129 document which approves your GPS requires you to use that database for approaches without hand entering any of the fixes.

Databases — What are They?

Databases are a collection of information. This collection of data could be in paper form, but for our discussion, we'll consider only computer databases. Also, there is a major difference between software and databases. When referring to software, people sometimes include databases in that definition. For the purposes of our discussion, software is the application that gives the ability to access and use the database. And databases include only information — they do not include the software to manipulate the databases.

One of the basic principles of databases is that information can be entered only once and then used again many, many times. A good example of this is the Mile High VORTAC (DVV) near Denver which is used on seven airways, three SIDs, four STARs, five ILS approaches, one VOR DME RNAV approach, the formation facility for 25 intersections, and numerous company routes or flight plans.

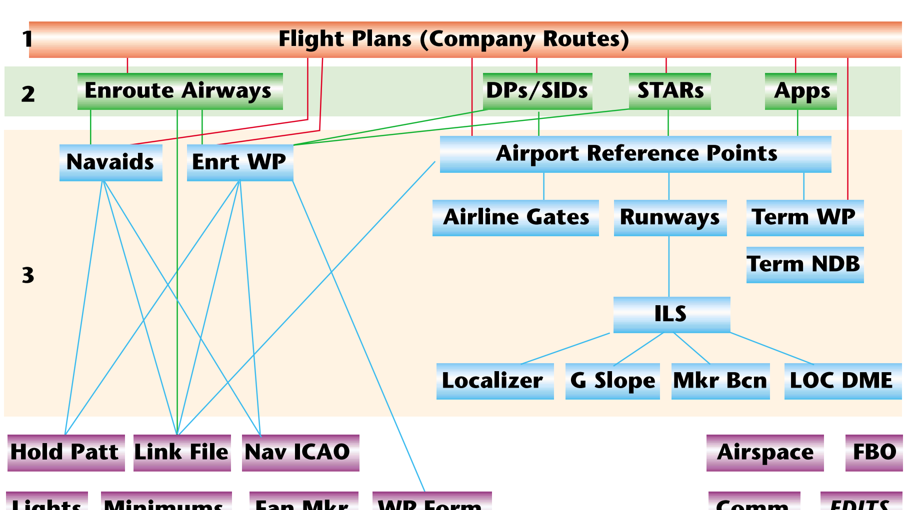
Look at the illustration titled *Navigation Database Structure* and you can see three large levels of horizontal rectangles, each with different types of information. The highest level (1) includes Flight Plans (also called Company Routes). The flight plans are at the highest level since they are a collection of all kinds of data specified in a unique sequence. The next level down (2) includes route information such as airways, SIDs, STARs, and approaches. The next level down (3) includes geographical fixes and navaids on the earth's surface, and all have coordinates expressed with latitude and longitude.

At the bottom of the illustration are a number of individual database elements, each with a different type of function.

Fix Location

For discussion purposes, let's start with the largest rectangle that includes all the database geographic locations. And — let's begin the discussion with the VOR which is one of the most common elements in the database. Each VOR is entered with its two- or three-letter identifier, frequency, latitude, longitude, ICAO identifier, navaid class (specifies if there is DME, the navaid service volume, weather broadcast, and whether or not the DME is collocated with the VOR), DME latitude and longitude, DME identifier (when different), DME elevation, Datum Code (whether or not the coordinates are WGS-84), station declination (magnetic variation at date of commissioning or last realignment), VOR name, and date of last revision. Additionally, if the VOR is a terminal VOR, the associated airport's identifier is included with the VOR record.

Navigation Database Structure



As can be seen, it is best to enter the information about a VOR once so it can be changed only once when revisions come from all the 200 plus governmental authorities around the world. If the VOR information was included with each item where it had an association, the amount of revision activity would be multiplied by the number of times it was used. And the most important part of the activity is that the number of mistakes are reduced substantially.

The most common elements found in the database are the fixes which include intersections, waypoints, turning points, and mileage breaks. Because of the way airborne databases are designed and the way the avionics work that include those databases, **every geographical aeronautical location in the world needs to be included in the database with a unique, five-character identifier**. When using only VOR navigation and you flew an airway that had a bend in it, you would fly out on one radial, tune the second VOR receiver to the next VOR and set the next inbound course on the second VOR head. When both needles were centered, you could say that you were at the bend in the airway and then make the turn to the next VOR. With GPSs and FMSs, it just doesn't work that way. GPS receivers and FMS systems need to have a fix at the bend — then fly from the first VOR and to the bend as a waypoint and *then* make the turn and proceed to the next VOR.

As you can imagine, *not all governments in the world recognize the needs of airborne databases* so each fix must have an identifier created if the government does not assign a unique, five-character identifier to their locations. So, now you ask, "What if a government doesn't assign the appropriate identifier?" In order to provide standards for the industry so everyone could make waypoint assignments using the same methods when not established by the individual countries, the ARINC 424 Navigation Database Standards committee established rules by which identifiers would be created. We will discuss these later in the article.

Route Records

The rectangle (2) next to the top includes the route records. The importance of the route records is that they string together all the airway segments, SID, STAR, and approach segments in the proper sequence with the appropriate information so that there is a continuity of where an airway goes when you use it in your airborne database.

Looking closely at the illustration, you will see a number of lines extending from each type of route down to the different types of fix records in the large rectangle below. As an example, Victor 8 near Denver is described with the following fixes: RIL, TRUEL, RLG, PENEY, DVV, HOYTT, AKO,... In the airway record for Victor 8, there are a number of fields including information such as the airway identifier (V-8), altitude information (minimum and maximum when appropriate), magnetic course (inbound and outbound), leg distance, latest date of revision, and sequence number.

Why is a sequence number required? It is not something that is supplied by any country, but it is critical to keep all the fixes on an airway in the proper sequence. For example, the fixes mentioned above are all in the right order, but if there was no way in the database to ensure they were strung together properly, you might end up making a 180° turn back to a fix you actually crossed before. For a bit of trivia, all the airways are sequenced from the west going to the east or starting from the south going to the north for north/south airways.

For the V-8 example above, the first route record would include the identifier of RIL. When the airborne database encounters the letters RIL as you request V-8, the software knows you need coordinates for the fix on V-8 to successfully fly the airway. The software uses the letters RIL to search the files that include the fixes. Just the letters RIL are not good enough because there could be an NDB with that identifier, there could be a waypoint (in some countries) with that identifier, and there could be a VOR with that identifier. To make matters worse, there could be numerous VORs with the letters RIL as their identifiers.

To help the software identify the correct fix file in which to look, there is a pointer in the enroute airway record that identifies the letters RIL as a VOR so the computer will look into the navaid file for the correct coordinates. To ensure the correct VOR with the identifier RIL is found, the ICAO identifier is included in the enroute airway record *and* in the VOR record to get the correct coordinates.

ARINC 424 — Navigation Database Standards

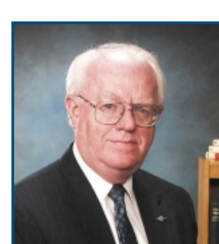
The first use of databases in commercial airline service in the United States was in June 1973 when National Airlines installed and flew the Collins ANS-70 and AINS-70 RNAV systems in their DC-10s. Because this was the first installation of an airborne database, Jeppesen produced the database in a way that was very oriented to solving the needs of the Collins systems. The next airborne database was used in Delta Airlines L-1011s with a system manufactured by ARMA corporation. The database requirements for the ARMA system were significantly different than those needed for the Collins system. The third avionics manufacturer wanted yet a different format.

Every avionics system is built with different features and capabilities and the way in which they implement the functions of database structures and inter relationships between airways, navaids, waypoints, etc. In order to bring economics of volume to databases, a committee first met in Los Angeles in September 1973 under the sponsorship of Aeronautical Radio, Inc. (ARINC) to begin work on aeronautical databases. After meetings every other month, the first standard was published in July 1975.

One of the principle standards that pilots see every day in airborne databases (and on charts) came out of those committee meetings. It was decided that all fixes would have five characters and that is what led to all the intersection and waypoint names in the world having five characters.

When a country does not specify a five-character name, *one is made up according to the ARINC rules*. The first rule is to use the identifier of the forming navaid followed by the nautical mile distance. As an example, an unnamed intersection 45 NM away from Denver would have the identifier of DEN45. That worked well until there were unnamed fixes on a DME ring associated with an approach. It's obvious that on an 11 DME arc, you couldn't have five or six fixes all with the same identifier of DEN11 (databases just don't like duplicates.) The solution for that problem was to create an identifier starting with the letter D to indicate DME followed by the radial of the forming VOR. After the radial, a letter would follow. The letter to follow starts with "A" meaning 1 DME. Therefore, a fix on the 11 DME arc at the 305° radial would get the identifier D305K.

Many more standards exist in the ARINC 424 specification. Some of these will be covered in future articles plus we will discuss how approach routes are coded into the database.



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