Transforming Aeronautical NAV/PLAN Charts: Enterprise Product on Demand Service (ePODS

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TRANSFORMING AERONAUTICAL NAV/PLAN CHARTS: Enterprise Product on Demand Service (ePODS)

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ABSTRACT

Historically, NGA's aeronautical NAV/PLAN charts were created and maintained using labor intensive and obsolete methods. Enterprise Product on Demand Service (ePODS) is a means to use technology to transform legacy methods into an automated process. This server-based application utilizes web service architecture and relies on the concept of leveraging NGA data stores to produce customer generated charts.

An ePODS application can be hosted in any browser that supports current web standards. The browser will access web services built specifically for ePODS based on ESRI's ArcGIS to generate the chart. Because ePODS was designed for open consumption, other applications would also be able to use ePODS in their own client. This paper will discuss the technology and the resulting improvements in product quality and labor efficiencies.

INTRODUCTION

Since the early years of aviation, man has relied on the use of known reference points on the ground for spatial and situational orientation. Spatial as defined by Macquarie Dictionary, means "pertaining to space" This term is often used instead of "geographic". However, geographic means "pertaining to geography (the study of the surface of the earth)" and "referring to or characteristic of a certain locality, especially in reference to its location in relation to other places". Spatial has a broader meaning, encompassing the term geographic. Situational is defined by Webster's New World Dictionary as the "manner in which

things are situated in relation to its surroundings: location; position.” Understanding the meaning of these two terms is essential to understanding the importance of transforming the Navigation/Planning Chart series.

NAVIGATON/PLANNING CHARTS

In the early years of aviation navigation from point A to point B was pretty much an acquired art commonly referred to as “barn storming” or “dead reckoning”. It was called barn storming because the names of towns were painted on the roofs of buildings and water towers to provide the pilot with a means of fixing their location. The phrase “dead reckoning” referred to the fact that if you didn’t reckon your course accurately then you were going to be dead.

After World War I, charting requirements grew as the complexity of the aircraft and the emergence of a National Airspace System (NAS) changed the face of aviation. The Army recognized the need for a charting service and in 1943 established the Aeronautical Chart Plant in St. Louis, Missouri. It was during this time period that the use of imagery became an integral part in the production of aeronautical charts. Imagery provided the cartographer with a more detailed view of the features and their spatial relationship. The Aeronautical Chart Plant was the first of a number of legacy organizations leading to what is today known as the National Geospatial-Intelligence Agency (NGA).

The Navigation/Planning (NAV/PLAN) Chart Program evolved from early charting programs of the 1950’s and 1960’s. The NAV/PLAN Charts consisted of a series of small and medium scale charts (JOG-A, TPC, ONC, JNC, GNC, and Specials). JOG products were compiled using imagery as a primary source. TPC, ONC, and the smaller scales used imagery only when there was a question in the depiction of a feature.

Joint Operations Graphic (JOG)

Tactical Pilotage Chart (TPC)

Operational Navigation Chart (ONC)

Jet Navigation Chart (JNC)

Global Navigation and Planning Chart (GNC)

Figure 1 Navigation/Planning Chart Series

The charts were designed to meet the pilots and aircrews needs in medium and low enroute navigation by visual and other techniques. The charts were also designed to support military operational planning, intelligence briefings, preparation of visual cockpit displays, and other uses. Medium altitude was defined as 2,000 to 25,000 feet Above Ground Level (AGL) and low altitude was defined as 500 feet to 2,000 feet AGL.

NAV/PLAN charts were originally produced according to line item resource availability. These resources were laid out each fiscal year in the Program Objective Memorandum (POM). The charts were very labor intensive requiring a large work force to support the program.

Figure 2 Cartographer manually producing a small scale chart.

At the height of the program over 200 work years were allocated to chart production. During the mid to late 90's the in-house charting program was reduced in favor of outsourcing. In FY98 approximately 90 work years (120 people) were resourced for the NAV/PLAN program. The resources applied against the program continued to dwindle to where in FY 2005 there were only a handful of charts produced or revised.

Today there is no longer an active maintenance program as it existed during the Defense Mapping Agency-Aerospace Center (DMAAC) and early National Imagery and Mapping Agency (NIMA) years. As a result, many of the 6,166 NAV/PLAN products are significantly out of date with an average age of over 17 years.

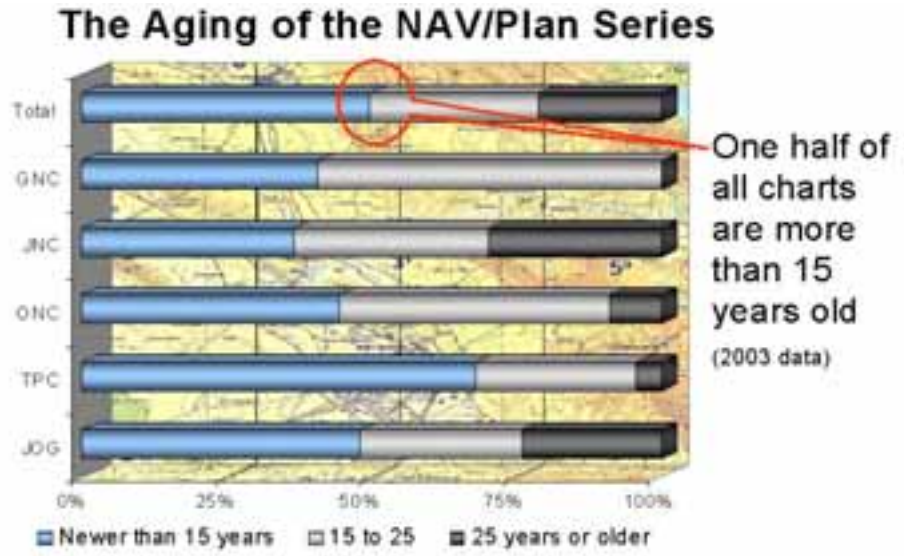


Figure 3 chart depicting the age of the different NAV/PLAN charts.

The Chart Updating Manual (CHUM) was initially created as a means to update the charts in between maintenance cycles. The CHUM books, produced monthly, were only a few pages thick because of the frequency of chart updates. When maintenance of the charts ceased, the CHUM book grew proportionally as the Digital Vertical Obstruction File (DVOF) database increased. The last paper CHUM printed in March 2004 was a three volume set over seven inches thick.

With the development of flight mission planning systems capable of ingesting the data electronically the paper CHUM was replaced with an electronic CHUM (ECHUM) that became the preferred method of updating the NAV/PLAN charts.

These systems were capable of importing the aeronautical data contained in the Digital Aeronautical Flight Information File (DAFIF)™; however nothing was done to address the aging of the base detail. Accurate portrayal of the base detail is important to the aircrews' spatial and situational awareness. The growth of an urban area, a new lake, or major highway can all lead to confusion if not depicted correctly on the chart.

THE NEED FOR CHANGE

The National Geospatial-Intelligence Agency (NGA) will never again see a manual compilation effort of NAV/PLAN charts to the scale performed in the 1960's through 1990's. National policy changes and advancements in technology have led to the reprioritization of resources within the agency.

NGA's stated goal is to transform from a product-centric to data-centric environment. As the Agency's former Director, General Clapper, has stated, "We currently face growing complexity in the world's security situation, an increasing array of sources, and an ever-present demand for both speed and accuracy. Geospatial Intelligence can help meet these challenges."

The Department of Defense's ability to consume digital data is reshaping how NGA is doing business. Over 66 million individual maps were produced in support of Operation Desert Storm. While this effort was very admirable, it was neither speedy nor actionable. Support provided during Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) on the other hand saw a dramatic increase in the use of digital support either pushed or pulled into theater that provided both actionable and timely geospatial intelligence.

Through a collaborative effort with ESRI, NGA created a GIS-based aeronautical charting process. The early transformation successes of NGA's Aeronautical Division in the production and dissemination of Flight Information Publications (FLIP) served as an impetus for the digital replication of the NAV/PLAN charts.

ENTERPRISE PRODUCT ON DEMAND SERVICE (ePODS)

Enterprise Product on Demand Service (ePODS) is a an early NGA adapter of Web Services construct that enables the production and dissemination of both digital and hard copy charts to the customer. It enables access to the "best available" NGA data to build on-demand NAV/PLAN chart products.

"Best available" data is defined in this case as the most current production data available from legacy databases. These production data holdings are now stored in a mix of databases and product suites (see figure 4). Geospatial Intelligence Database Integration (GIDI)/ Geospatial Intelligence Feature Database (GIFD) and WebDVOF already exist and are maintained at the Gateway. GIDI/GIFD contains the country feature data necessary to produce a chart, while WebDVOF contains the vertical Obstructions data to include powerline data.

To make ePODS fully functional, a geodatabase that contains derived Shuttle Radar Topography Mission (SRTM) contours, Grids, and VMAP0 will need to be created. In addition, Aeronautical Digital Data Environment (ADDE)data will be required to portray airspace, navigational aids (NAVAIDS), and airfield information.

ESRI will convert the interferometric synthetic aperture radar (SAR) data derived from the Shuttle mission STS-99 launched on 11 FEB 00 for a one time standup that will provide hill shading and contour data. A script will be run to fill as NGA fills the gaps that currently exist in the SRTM data in order to update the hill shading and contour data.

Until such time as an ADDE database can be stood up at the Gateway, a "Super Digital Aeronautical Flight Information File (DAFIF)™" will be created and provided to the Gateway once every 28 days. "Super DAFIF™" will contain a superset of airfield information (NAVAIDS, airspace and all the worlds airports) in a DAFIF format.

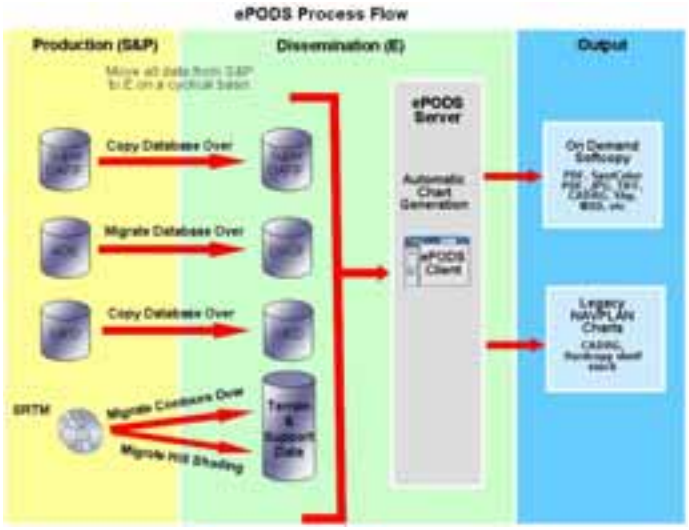


Figure 4 Representation of databases supporting ePODS

Since ePODS generates the charts without human intervention, placement of the data does not follow the legacy specifications. The charts produced using ePODS will essentially be new charts that will require the generation new e-specifications to describe them. The new charts will be identified by placing an “e” before the chart name (e-JOG-A, e-TPC, e-ONC, etc.).

ARCHITECTURE

ePODS is based on an N-Tier Service Oriented Architecture using NGA data holdings and ESRI commercial off-the-shelf (COTS) software. An ePODS application (thin client) can be hosted in any browser that supports current web standards. There is no special hardware necessary on the user’s end. The browser will access web services built specifically for ePODS based on ArcGIS to generate the chart.

Tier 1 consists of NGA and ePODS data servers that feed the map/application servers in tier 2. The map servers contain ArcMap sessions with cartographic rules, as well as, the processing and program logic. Clients access the ePODS web service through the Web server, tier 3. Users can produce a chart digitally, print a hardcopy or download to a file to perform analysis, make a customized finished product or convert into other file types. The user selects what format and how they want to get the file. Once they

have the file on their machine, they can then choose to print it or not.

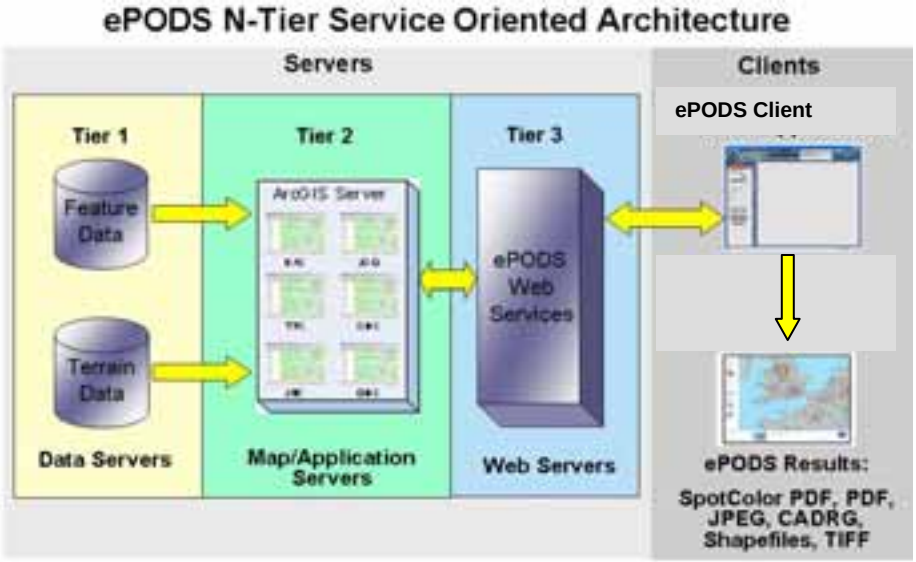


Figure 5 ePODS Architecture

BENEFITS

EPODS provides a unique opportunity to update, revise, and maintain a legacy product with the best available data. The digital generation of the NAV/PLAN charts means the customer will have the ability to customize their chart based on the mission.

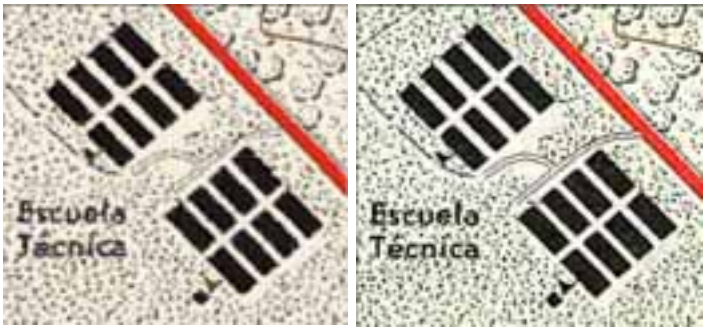
Unlike the legacy NAV/PLAN charts, ePODS offers the user the ability to select their Minimum Bounding Rectangle (MBR). This option solves one of the most frustrating problems with the legacy charts, that being the tendency for every flight to fall within the corners of four charts.

Figure 6 NAV/PLAN charts used during OIF

NGA intends to utilize ePODS to generate the standard legacy/heritage set of NAV/PLAN products to replace outdated shelf stock at the Defense Logistics Agency (DLA) within a three to five year time frame. While lacking the aesthetics of a chart produced by an analyst utilizing their "cartographic license", the new charts will have 100% of the current data necessary for safety of navigation.

Customers will have the option to download several different formats to include: SpotColor PDF, PDF, TIFF, ECRG, CADRG, Shape, and MXD with Geodatabase. SpotColor is a great new format that has better control of print colors and reduces low light readability issues.

One of the most promising options is the Enhanced Compressed Raster Graphic (ECRG) format option. Currently, NAV/PLAN charts are scanned into a digital version in a Compressed ARC Digitized Raster Graphics (CADRG) format. ECRG provides a much sharper resolution than the legacy CADRG and will eventually replace the latter.



CADRG Simulated ECRG

Figure 7 CADRG/ECRG comparison

The fielding of ePODS will substantially reduce the customers' dependency on ECHUM as a means of updating their charts. Since ePODS draws from the most current data available it is feasible that ECHUM could be retired. Because obstruction data will come from WebDVOF the customer will have the option of displaying all of the obstruction data including powerlines instead of being limited to the 150/200 foot and above criteria used by ECHUM.

CONCLUSIONS

EPODS is just the start of how business will be conducted in the future. The focus within NGA is providing accurate, timely data through a web service via the NGA Portal that allows the customer to pull the information they need rather than the legacy one product fits all.

The potential is there for NGA to apply the successes of ePODS to other legacy products. However, the benefits don't stop with the legacy products, but opens the door to new and exciting applications that will better serve NGA's customers. The capabilities developed through ePODS will support future technological advancements in how data is digitally displayed.

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