VPDARS: An Invaluable Enterprise NAS Performance Monitoring Asset During COVID-19

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In today's National Airspace System, being able to monitor and provide a holistic picture of the operational situation is vital. With the ability to produce millions of flight events per day and compute hundreds of metrics continuously, Performance Data Analysis and Reporting System (PDARS) is critical to ensuring data-driven decision making.

DUE TO THE current pandemic in which FAA staff are maintaining remote working posture, Virtual PDARS has "come to the rescue" by providing uninterrupted access to PDARS data and applications. When asked about the subject, Vern Payne (who has had a long association with the PDARS system as TMO at ZDC and now as the QC Manager at ATCSCC) states:

"PDARS has long been a go to tool for post event analysis as well as airspace design and trend analysis. With the introduction recently of Virtual PDARS the flexibility of usage has been enhanced and the infrastructure modernized. Of great benefit to me has been the ability to be away from my home facility while visiting other FAA locations or other stakeholders and still being able to access the previous day's data, load data in GRADE and create replays of different types of events. The visualization ability of GRADE to see the aircraft tracks and animate the replay is a tremendous tool for education as well as analysis. With the current pandemic environment in which we find ourselves, having the ability to access virtual PDARS has allowed much of the post event analysis to continue uninterrupted. Additionally, the ability to see aircraft tracks has assisted in evaluating routes and altitudes used in response to facility cleaning events, and in at least one case helped improve the plan for a facility shutdown when that facility was cleaned a second time."

Beginning in the late 1990s, the Federal Aviation Administration (FAA) collaborated with the National Aeronautics and Space Administration (NASA) to develop a brand-new system that aggregated FAA aviation data onto a single platform for aviation performance monitoring and analysis. This system, known as PDARS, began with a small number of strategic Terminal Radar Approach Control (TRACONs) and Air Route Traffic Control Centers (ARTCCs) and has grown to incorporate data from facilities across the NAS.

PDARS has been successfully supporting a broad range of data-driven operational decision-making across the FAA for decades. However, the fast pace of technology advancement and critically needed tech refresh, as a side-benefit, enabled PDARS to take a quantum technological leap forward.

Virtual PDARS — A Tech Refresh Reducing Operating Costs and Delivering High Quality Data

The tech refresh dramatically reduced operating costs and put the FAA's highest quality data directly in the hands of any FAA user, via desktop, laptop or mobile device to enable data-driven decisions. This evolved aviation performance system platform is known as "Virtual PDARS" or "VPDARS."

Since the beginning of the PDARS program, the ATAC Corporation, headquartered in Santa Clara, California, has been the developer/integrator of PDARS. ATAC's roles include systems engineering, software development and deployment, system monitoring, operations, maintenance, training, and user support.

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PDARS is a program managed by the FAA's Office of Performance Analysis (AJR-G) supporting over 75 FAA offices and lines of business, including offices within System Operations Services (AJR), Mission Support Services (AJV), NextGen (ANG), Environment and Energy (AEE), Investment Planning and Analysis (AFI), Office of Safety and Technical Training (AJI), and Terminal Services (AJT).

It aligns perfectly with AJR-G's objectives of being responsible for the reporting and analysis of NAS operational performance, conducting delay and capacity impact analysis, identifying trends in air traffic management and the aviation industry, and establishing benchmark performance.

AJR-G also provides operational engagement for Plan, Execute, Review, Train and Improve (PERTI) initiatives. ATAC's deep experience and usage of FAA on-staff air traffic management Subject Matter Experts comprise the basis for its understanding of the needs and requirements of users across the FAA, including operational staff at FAA ATCSCC, ARTCCs, TRACONs, and ATCTs; research and management staff at FAA Headquarters and the WJHTC; with additional staff at the Service Centers.

Graphical Airspace Design Environment (GRADE)

ATAC has designed, developed, and enhanced the Graphical Airspace Design Environment (GRADE) for use with PDARS. GRADE, when developed, was one of the first tools of its kind with the ability to visualize a full day's worth of traffic for an ATC facility. Over the years, GRADE has become a foundational element of PDARS and provides a way for FAA facility personnel to analyze and review operational data at the highest levels of fidelity (**Figure 1**).

Another PDARS tool the users extensively rely on is the BirdWatch Reporting System (BWRS). The BWRS provides the PDARS reporting capability to extract data from multiple, uncorrelated, distributed data sources, then intelligently combine the results that support data-driven FAA decision making.

One example, using separate databases for weather data and flight data, the BWRS can determine which flights were impacted by specific weather conditions. For example, BWRS can compute the average in-trail separation for flights landing at SFO from 7:00-9:00 a.m. when visibility was below 5 NM. Drilling down through the BWRS report tables, one can find the individual flights from which the average was calculated.

Due to the interoperability of PDARS applications, the user can quickly view the same flights in GRADE. The tracks for those flights can be displayed and even animated — then with a few simple mouse clicks, one can take a snapshot and insert either a picture or an animation to a PowerPoint presentation.

PDARS has traditionally been a "distributed" system, meaning that access to its data and applications was limited to dedicated, standalone terminals called Analysis (ANA) machines. When such a system grows large, the scale-up problems are not always linear; there is often a significant increase in complexity, and things that are trivial when dealing with a smaller network of machines suddenly become significant.

FIGURE 1: GRADE provides the ability to analyze historical NAS-wide air traffic data at its highest resolution.

Distributed systems are important, but must overcome scalability and extensibility issues in order to achieve performance objectives and fault-tolerance standards. Some of the most common issues encountered by PDARS users that were addressed by VPDARS include:

- Ability to access PDARS from their FAA-issued desktops and laptops.
- Availability of PDARS resources using remote access over FAA VPN. Users don't need to be physically present in the FAA facility and specific office where the ANA machines are installed, sometimes behind locked doors.
- Users could easily access the PDARS data archive to perform analysis on historical data stretching back more than a decade.
- Mobile access to the PDARS system which includes tablets and cell phones, using both Android and iOS.
- Concurrency was enabled in the new system. In certain facilities, the users far outnumbered the ANA machines, which impacted day-to-day work.
- Cost of technical refresh of the hardware and software required at the facilities went down dramatically by using VPDARS. This was an important consideration in the maintenance of a distributed system is the cost of technical refresh of the hardware and software required at the facilities.
- From the PDARS Information Technology (IT) standpoint, supporting a growing network of ANA machines is a difficult, time-consuming, and costly effort. The challenge of delivering 1000+ daily reports, supporting expensive hardware in diverse environments, and fulfilling hardware-related user requirements proved to be an ongoing challenge.

ATAC worked with the FAA to address the challenges stated above, investing in internal research and development for software alternatives to overcome the obstacles encountered. This effort resulted in a Proof of Concept of a new system that fulfilled all the required PDARS requirements and use cases such as safety, operational, environmental, business, and others. Thereafter, we worked closely with AJR-G to develop and deploy VPDARS in less than 12 months. This is a giant leap forward in terms of modernization and value for the FAA.

*"VPDARS reduces the technical footprint by centralizing functional capabilities of PDARS into an enterprise server cluster. Consolidating the capabilities of dedicated workstations into a virtualized environment will reduce the cost-inefficient technical refresh cycles of the legacy system, as well as the logistical overhead for components throughout the NAS. Another key characteristic of VPDARS is that system's security posture is hardened by removing legacy vulnerabilities from the system and transitioning to a consolidated secure portal." — **Bryan Baszczewski***

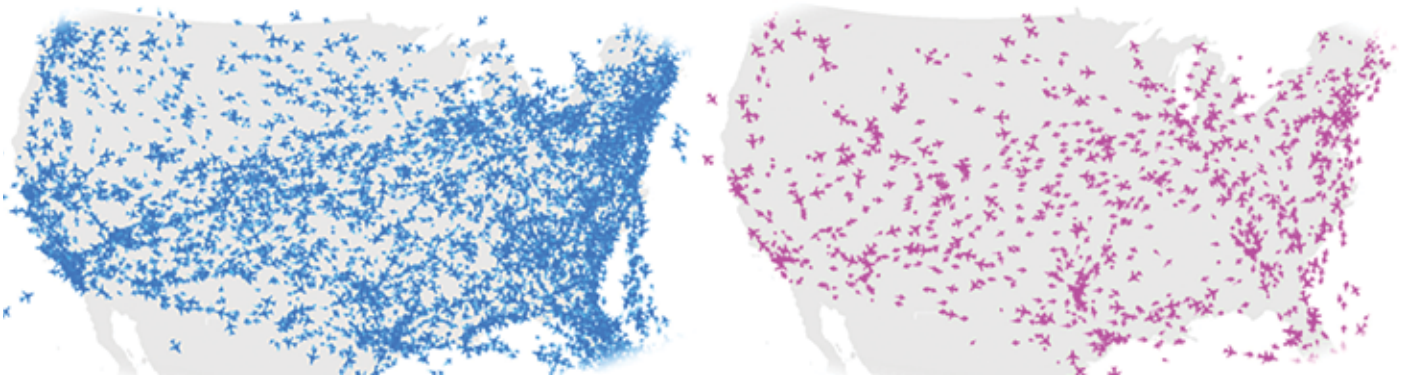

FIGURE 2: Peak NAS traffic before and during COVID-19, visualized in GRADE

In the words of Bryan Baszczewski, Manager, System Data and Infrastructure in AJR-G,

"The legacy PDARS system maintains 147 dedicated analytical workstations at various facilities throughout the National Airspace System. Users must be physically co-located with the workstation at their facility for access to the system, whereas facilities without a workstation rely upon support from AJR-G for special requests. VPDARS provides access to the facility data regardless of the users' remote location, and allows multiple concurrent user sessions. VPDARS also expands user access to data generated from multiple facilities, promoting common situational awareness of facilities' interdependencies of traffic flow. VPDARS reduces the technical footprint by centralizing functional capabilities of PDARS into a enterprise server cluster. Consolidating the capabilities of dedicated workstations into a virtualized environment will reduce the cost-inefficient technical refresh cycles of the legacy system, as well as the logistical overhead for components throughout the NAS. Another key characteristic of VPDARS is that system's security posture is hardened by removing legacy vulnerabilities from the system and transitioning to a consolidated secure portal."

Designed for Scalability and Compatibility With the Cloud

VPDARS is a cloud-based capability that provides access to high fidelity PDARS data and visualization as a service from any platform connected to the FAA mission support network (e.g., desktop, laptop, mobile devices); therefore, there is no designated workstation required. Its open architecture-based solution provides a high degree of scalability by modularizing the applications and allowing them to be run in virtual environments.

From the network storage to the processing power of servers, the entire system is designed for scalability and compatibility with the cloud. VPDARS provides a robust and reliable platform, which is built like an App Store that can house software addressing a multitude of additional aviation-related use cases.

The evolution to VPDARS enhances user access and experience. Access to this capability is available to all FAA users via the PDARS Enterprise Website (PEW) at ***pdars.tc.faa.gov***. PEW is built using portal technology which is inherently modular and makes adding new functionality fairly simple.

Another important aspect is delivery of key information for informed decision making for various levels of aviation stakeholders in the FAA. In their interaction with the FAA over the years, ATAC has learned that the need for information changes at different levels of the FAA organization. VPDARS is designed to provide role-based access for performance, safety, and efficiency monitoring — the cornerstones of the PDARS program.

Laura Stensland, Deputy Director System Operations, East-North says:

"VPDARS is an invaluable resource that provides historic flight tracks to compare reroutes to originally filed flight plans, assess volume for mile-in-trail restrictions, portray airspace complexity, review weather impacts, provide holding information and review surface saturation. The web-based tool provided data and analysis that would not have been available to our office during the current COVID-19 crisis."

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> ***— Laura Stensland***

VPDARS is built on web portal technology. It is a web-based system that provides the functions and features to authenticate and identify users using Single Sign On (SSO) technology and provide them with an easy, intuitive, personalized, and user-customizable web-interface which is a 'one stop shop' for everything PDARS. This access control allows role-based authentication and authorization.

The system provides versatile functions for the organization to catalogue or organize collections of different and multiple sources of information and service resources for dissemination to many users according to their specific roles in the organization which define their needs and interests.

VPDARS is the perfect starting point for everyday aviation and reporting tasks that usually would require disparate types and sources of information and tools. The ability to gather all necessary information and tools in one environment is a huge time-saver. According to Diana Maguire, Management & Program Analyst at the New York TRACON and a PDARS power user,

"The new VPDARS system has continued to demonstrate consistency and accuracy since its early stages of implementation. New York TRACON's mission is to move air traffic as efficiently and safely as possible through airspace with incomparable complexities. We are pleased to see ATAC maintain the GRADE platform through a web-based environment without compromising speed and performance. Daily scenarios are generated within GRADE to provide a visual perspective of volume in concentrated areas, as well as merged track data over larger areas within the NAS. Fix usage and re-routes are reviewed and monitored regularly to ensure appropriate distribution of aircraft. Arrival and departure procedures are examined to determine separation compliance. In addition, reporting capabilities within the program have continued to expand, often being tailored to our specific needs. As always, the level of professionalism and knowledge demonstrated by AJR-G and the customer support team remains dedicated and consistent."

Predefined custom reports are an important analysis product provided by PDARS. In VPDARS predefined reports are delivered through a web-based interface allowing users to quickly search, find, and access the reporting information relevant to their task.

Examples of predefined reports include: OPSNET holding, turn-to-final, go-arounds, diversions, and RNP conformance. These reports consist of individual sets of business rules developed through extensive FAA/ATAC SME workgroup meetings and commonly agreed-to parameters, often requiring complex algorithmic coding, which have formed the baseline for measurement in these performance areas.

VPDARS Dashboard

Another core component of VPDARS is the dashboard. By using dashboards, you don't have to be an analyst to harness the power of PDARS data. Dashboards are made available in the form of apps, as on a smartphone. VPDARS dashboards are tailored for specific purposes. They're extremely user friendly and can be used readily by any layperson to see what's happening operationally.

You have the ability to quickly drill down into the data to gain new insight that combines business intelligence systems and browser-based applications to summarize the status of a complex enterprise for FAA decision-makers. These dashboards use software that enables the building and deployment of web-based dashboards, reports, and interactive analytics using various data sources.

Users can view, build, save, and manage their own views of the data. Dashboards make decision-making faster and easier allowing a wide variety of business users to interpret and interact with them. Users are immediately able to see if targets are being met, understand performance discrepancies, identify opportunities and threats, and drill down on issues that require further analysis. Dashboards integrate a variety of content and functionality.

VPDARS enables training delivery in a more efficient and cost-effective manner. It reduces the cost per class by about 40%. PDARS Basic Training, which is a three-day, in-person class, is popular among new and returning PDARS users.

FIGURE 3: Accessible from any device connected to the FAA Mission Support network, VPDARS enables the hosting and customization of operational data-driven dashboards such as this Go Around Dashboard.

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The class is comprised of up to 18 trainees being taught by two trainers who travel to the facility for instruction. Due to COVID-19-induced telecommuting across the FAA, in-person classes are not possible. The VPDARS platform enables ATAC to deliver classes online effectively. ATAC also hosts and delivers other training options such as:

- **Knowledgebase/Wiki Site:** a host of articles/reference documents based on inquiries from users across the FAA. This is searchable content, organized with cross-references to related topics. These references can be in the form of more articles/information or links to videos and tutorials.
- **How-To Videos**: short video recordings that demonstrate basic functions in PDARS Tools. These videos can complement or supplement information provided in the Knowledgebase articles
- **Tutorials:** web-based walk-throughs of complex PDARS topics ranging from basic to intermediate usage. They are used to break down complex topics by introducing them in step-by-step instruction videos.
- **Webinars:** a video workshop/seminar. These are longer video presentations, about 45 minutes - 1 hour in duration, delivered to the end users over a web broadcast. This methodology of training is used to demonstrate a particular functionality, address a common use case or demonstrate multiple concepts on a single topic. Webinars are delivered live the first time and later become a part of the video archive on PEW for the users. During the live webinar, the instructor is available for Q&A towards the end of the session.
- **One-on-one training:** highly customized, web-based, live training covering intermediate to advanced usage. This method can supply training focused to user's specific needs/facility specific use case.

Another capability now available via a virtualized platform to enable remote training is ISIM, Kongsberg's human-in-the-loop simulator, which uses PDARS data to capture the realism of the real-world environment. The marriage of ISIM and PDARS/GRADE technologies provides unparalleled realism in aircraft trajectories and behaviors.

Controllers often comment that it's like working a real TRACON or Center position. ISIM is capable of emulating ERAM, STARS, and ARTS displays with a high degree of fidelity and provides very fast scenario generation. Saving countless hours of simulation setup time for FAA projects.

One of ATAC's biggest strengths is their top-tier Air Traffic Control SMEs combined with Aviation Data Analysts who provide outstanding analytical support. They have extensive air traffic control and air traffic management experience and aviation analysis capabilities covering all the air traffic domains. The SMEs and Analysts provide support to users by assisting in the preparation of evaluations and cost benefit analyses, designing new reports and metrics utilizing PDARS data.

They also assist users by improving and streamlining processes, defining new flight events, and creating new reports or dashboards. The SMEs working alongside the development team enable synergistic analytical support that is efficient and effective.

ATAC continues to make investments in internal research and development of cutting-edge aviation technologies, including real-time data and analytics, explainable artificial intelligence-based anomaly detection, Big Data predictive and prescriptive tools, machine learning analytics provided by "what if" decision support tools, and visualization improvements based on several years of internal and NASA-sponsored research and development to support commercial data analytics products and services.

A Flexible, Multi-Dimensional Performance Monitoring Tool

During this unprecedented time with impacts from COVID-19, VPDARS has proven itself to deliver highly-accessible NAS performance monitoring applications while significantly reducing operational costs and increasing the level of security. As a flexible, multi-dimensional performance monitoring tool in the FAA's toolbox, VPDARS is ready to be additionally customized to serve future FAA operational performance-related use cases across the FAA's enterprise.

Where Can You Find Out More?

- By visiting *pdars.tc.faa.gov*
- Nidhi Khatri at *nok@atac.com*
- Bryon Li at *bjl@atac.com*
- Jeff Browder at *jmb@atac.com*