

Capabilities of TARGETS

The Terminal Area Route Generation and Traffic Simulation (TARGETS) tool offers a unique combination of capabilities for the design, analysis, and operational assessment of procedures and airspace. Developed by The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) under sponsorship of the Federal Aviation Administration (FAA), the tool is being used by a variety of FAA and non-government users supporting the implementation of area navigation (RNAV) and required navigation performance (RNP) operations within the United States and internationally.

TARGETS incorporates data visualization capabilities with readily accessible design elements to enable procedure designers to rapidly and easily develop procedures. The integrated capabilities of TARGETS enable quick assessment of alternative design concepts, leading to robust solutions that satisfy operational needs and comply with design constraints. Using TARGETS significantly reduces the time to capture requirements and expedites the overall design process. TARGETS integrates with standard office applications making it easy to prepare presentations or document procedure design and the data output is formatted to support operational, certification and charting needs. Information that took weeks to generate can now be done in hours!

Features of TARGETS include:

- Integration of essential capabilities into a single desktop application, featuring multi-platform compatibility
- An easy-to-learn user-tested interface utilizing a comprehensive geographic information system (GIS) to display information that expedites procedure development
- Easy capture of route/procedure design information in project files and distribution packages, for dissemination to dispersed stakeholders
- Automated evaluation of key procedure areas to ensure compliance with FAA, noise and operational requirements
- Data export capabilities that include seamless exchange with standard office applications, auto-population of regulatory forms, electronic data exchange using web services and flat files.
- Java-based software with object oriented design that runs on a variety of platforms, including most desktop PC systems. Platform requirements that are within the normal range of office automation systems and no Computer-aided design (CAD) engine is required
- Plug-in architecture, which provides user controlled modularity and extensibility



GIS Capabilities

Procedure stakeholders need a way of merging geographic airspace and airport information (waypoints, navigation aids [NAVAIDS], routes, etc.) with flight procedure and path information based upon aircraft performance. TARGETS provides a GIS tailored to support procedure design, flyability assessment, airspace/procedure surface generation, obstacle assessment, noise assessment, seamless data exchange with centralized databases or other applications, and simulation of the operational environment.

TARGETS combines layers of information relevant to procedure development and airspace analysis. Fundamental data sources are navigation and airspace data. This data includes NAVAIDS, waypoints, Standard Terminal Arrivals (STARs), Standard Instrument Departures (SIDs), Special Aircraft and Aircrew Authorization Required (SAAAR) procedures, airways, runways, airports, radars, radios, Instrument Landing Systems (ILS), Special Use Airspace (SUA), sector boundaries, terminal airspace, obstructions, terrain points and holding patterns.

TARGETS supports the import and display of many image and map data formats for the visualization of topography, terrain, and urban areas. Formats supported include geo-referenced sectional charts, air traffic controller video maps, ESRI® shape files as well as non-geo-referenced images. For geo-referenced files such as sectional charts, TARGETS will align the image according to the files associated data. For non-referenced files users can interact with images by modifying the center, size, and orientation as needed to visually align as required. For noise assessments TARGETS can load detailed community and census data. The community data is available in the form of Topologically Integrated Geographic Encoding and Referencing (TIGER®) system data and the population density data is obtained from the United States Census Bureau.

TARGETS has extensive capabilities for visualizing, manipulating, and analyzing recorded radar tracks. Having historical track data available supports several key development and evaluation functions including: lateral and vertical track reference during the development of RNAV and RNP procedures, creating before and after

operational assessment scenarios and for performing before and after noise assessments. Recorded terminal and en route track data can be imported from several systems including Automated Radar Terminal System (ARTS), Standard Terminal Automation Replacement System and Enhanced Traffic Management System (ETMS). TARGETS can combine ARTS data with ETMS data to provide the user with all of the information required (i.e., runway assignment, aircraft type, city-pair information) for procedure development, analysis and to provide a more complete picture of the operation being examined.

TARGETS provides users the ability to modify the display styles of the data through layering, color customization, changing line styles, and varying image transparency. A filtering feature helps users manage the information displayed, avoid visual overload and reduce screen clutter. Filtering capabilities include the use of multiple filters for altitudes, airspace, radar tracks, obstacles, and simulation profiles.

Procedure Design

The manual procedure design process can be a complex and time consuming process involving multiple and often dispersed stakeholders. TARGETS provides stakeholders with an automated tool that allows them to work collaboratively to examine the many constraints that must be considered and evaluated during the development of a procedure. By providing a modern design tool that takes advantage of a vast array of data and design capabilities a procedure designer can rapidly develop, evaluate, modify and assess a procedure thereby enabling a much quicker and higher quality design. Many constraints that historically were not addressed until late in the development process are now checked earlier and in a fraction of the time. The workload is reduced significantly and changes are completed with a few keystrokes or mouse clicks. TARGETS users follow a straightforward process to develop new arrival, departure and approach procedures as follows:

Step 1 – Import supporting data. All of the needed reference and visualization data (i.e., airport information, runways, waypoints, obstructions, terrain, etc.) are imported into a project.

Step 2 – Build route/ procedure / approach. Using a graphical point-and-click interface, the user places waypoints that define the two-dimensional path including enroute



transitions, common routes, and runway transitions, final approach segments, missed approach segment, etc.

Step 3 – Add speed and altitude constraints. After placing the waypoints the user then can specify altitude and speed constraints as needed. The constraints can be at-or-above, at-or-below, or at.

Step 4 – Modify leg types and transitions. The user can also specify ARINC 424 leg types (all are defaulted to track-to-fix [TF] except for the first point on a transition which are initial fix [IF] legs.) If the user changes the leg type, TARGETS will verify that the new leg type is valid and prompt the user for any additional parameters needed. Leg validity is checked against ARINC 424 and FAA rules that restrict the leg types based on procedure type and leg sequencing requirements. Only valid types and sequences are allowed. A user preference will allow only leg types used by the FAA for RNAV STAR, SID and RNP SAAAR procedure development.

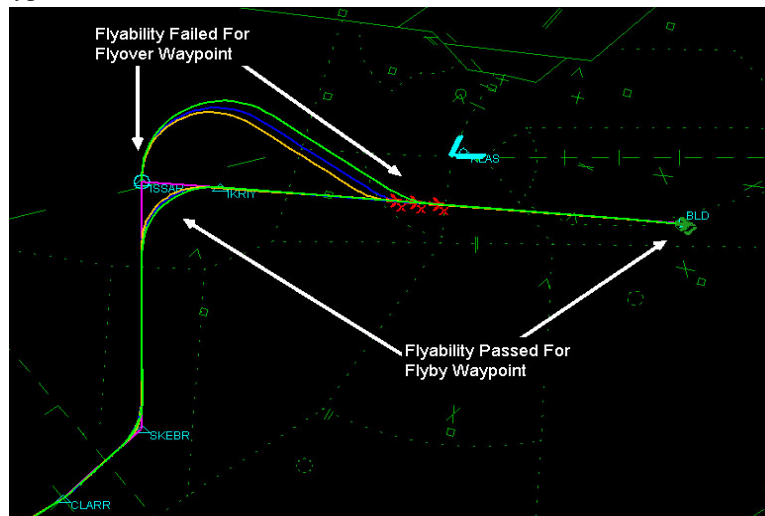
Step 5 – Complete evaluations. An extensive set of evaluations are conducted in TARGETS including: include:

- Flyability assessment for user/default aircraft performance sets
- FAA criteria compliance (including minimum segment length, climb/descent rates, etc.)
- FAA obstruction surfaces and minimum altitudes
- Noise screening
- Communication, Navigation and Surveillance (CNS) Coverage Assessment

Based on the results of the evaluations the procedure designer has many options to modify the procedure including changing waypoint locations, modifying altitudes/speeds, modifying decision altitudes and changing climb/descent rates.

Step 6 – Document procedure. Once the procedure design is complete and all evaluations are satisfactory, a stakeholder distribution package containing design information, graphics and evaluation results is generated and distributed.

TARGETS also auto-populates and revises the appropriate FAA forms as the design phase nears completion.



Flyability Assessment

Flyability assessment is an integral part of the design process. Early identification of flyability problems reduces the risk of encountering flyability issues later when a proposed route is flown in a costly high fidelity simulator or when the route undergoes flight checks during

certification. Features of the flyability capability include:

- Assignment of speeds and altitudes to waypoints
- Evaluation of ARINC 424 coding
- Assessment of multiple user defined aircraft performance sets. Aircraft performance sets allow the user to assign weights, speeds, acceleration/ deceleration rates, climb/ descent rates, bank angles, etc. for each performance set
- Impact of wind. Wind can be defined as a globally applied vertical profile or as an along-track constant speed wind component
- Identification and feedback on problem segments allows the user to complete modification/ optimization of routes as required



Data Exchange

Obstacle Evaluation Surfaces

The path flown by an aircraft differs from the ideal or desired path due to a variety of errors such as the navigation system error (NSE) or flight technical error (FTE). Given those and other errors, an obstacle evaluation area (OEA) surface is generated based on FAA criteria for later evaluation against man-made and terrain obstacles. The size, shape and number of surfaces both laterally and vertically vary depending on the type of procedures built. RNP SAAAR procedures require an additional evaluation of the vertical error budget (VEB) when developing the final segment obstacle clearance surfaces (OCS). Historically these evaluations were not conducted until late in the design process.

The TARGETS user can easily add RNAV and/or RNP OEA's and OCS's to STARs, SIDs and approaches. When the user chooses to add these surfaces, TARGETS automatically calculates and draws them according to FAA criteria. To simplify the process of surface generation for procedures TARGETS provides the user with the minimum required parameters, which are initially set to default values. Following standard design methods, approaches are built from the runway back (final, intermediate, and initial segments) and forward from the runway for the missed approach segments and have a mixture of level and sloped surfaces as appropriate.

Both RNAV and RNP surfaces can be displayed at the same time, allowing the user to view where an obstruction intersects with a procedure surface and assess the impact of the procedure on airspace usage, especially for turns. Any time a change to the procedure is made, perhaps to comply with FAA criteria, flyability or airspace requirements, TARGETS will re-compute, re-draw and re-evaluate the containment surfaces to allow for further refinement.

Obstacle Assessment

Critical to determining the safety of a proposed operation is the evaluation of obstructions. TARGETS functionality evaluates man-made obstructions, natural terrain points and user-defined obstructions to determine if they are within a specific OEA or OCS and then evaluate if a penetration has occurred. The results of evaluations (both

area and procedure based) are provided to the user visually and textually. This allows the user to rapidly modify and/or optimize the flight path (laterally and/or vertically) to avoid the obstruction.

For terrain assessments, different resolutions of the data are allowed in two different formats: either digital terrain elevation data (DTED) or digital elevation model (DEM) data. Man-made obstacles formats supported include the digital obstacle file (DOF), Universal Data Delivery Format (UDDF), Digital vertical obstruction file (DVOF), and Aviation System Standards (AVN) Inspection System (AVNIS) obstacles. TARGETS also allows the user to create user defined obstacles (UDO) for evaluation.

Noise Screening

Facilities proposing new procedures are required to evaluate and understand the impact of the changes on the current noise footprint early in the development process. Using GIS visualization, track data processing, and simulation capabilities in conjunction with an embedded FAA Integrated Noise Model (INM) capability the TARGETS application allows noise screenings to occur in the early phase of the procedure design process.

For Air Traffic users to see the impact in the noise footprint for a new RNAV procedure, TARGETS allows the user to identify a group of tracks and perform before and after noise calculations for a defined geographic area. The dispersion of the tracks along with a mapping of the aircraft IDs to engine types are done for the user. Algorithms have been developed which automatically create a backbone structure based upon the spatial average of the selected tracks along with a spatial dispersion. Additional algorithms and tables that map aircraft IDs (found in ARTS data) to aircraft type and then to specific engines with their associated noise characteristics have also been developed. New flight paths are generated within TARGETS based on the ARINC 424 coding and any imposed ATC speed or altitude constraints. TARGETS creates all the needed input files required by the INM noise computation engine. The output generated by the noise computation engine is used by TARGETS to create visual products that indicate areas of significant noise change.

CNS Coverage Assessment

For new procedures or sector boundary changes, it is important to check whether there is adequate radio and radar coverage. CNS coverage computed by TARGETS is based upon a line-of-sight model that takes into account atmospheric refraction and terrain blockage. In cases where the standard FAA service volume coverage is not adequate, an extended service volume (ESV) analysis can be done to determine if there would be adequate coverage using the ESV of selected NAVAIDs.

TARGETS allows the user to define a coverage group consisting of the specific CNS elements to use (e.g., NAVAIDs, radar, etc). The user can add or subtract from a coverage group or select from different coverage evaluations. Evaluation options include mean sea level (MSL) and above ground level (AGL) where the user sets a particular altitude, and then

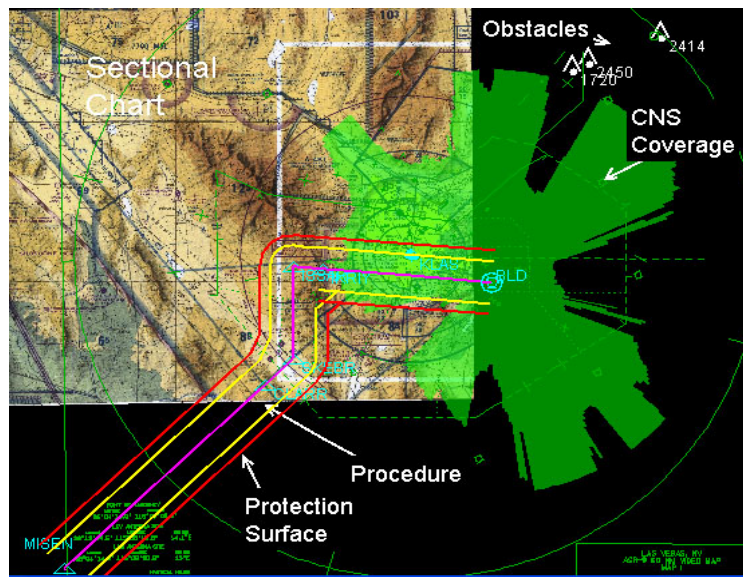
TARGETS checks the coverage at that fixed altitude with all the elements in the coverage group. Another evaluation option provides the user with a coverage count (i.e., number of signals available) at different altitudes. Procedures can be evaluated for the coverage available at different altitudes within the identified airspace or OEA surfaces for a specific procedure. The CNS coverage tool also allows users to selectively remove elements from the available signals to assess the impact of an outage on an area or procedure.

Operational Assessment

An operational assessment of a procedure is needed to assess dynamic issues such as mixed equipage, controller workload, and traffic sequencing and merging. TARGETS provides an interactive simulation environment in which scenarios can be developed based on procedures and processes either currently in use or proposed for future operations. TARGETS operational assessment capability equips the user with mechanisms for assigning aircraft to fly procedures, vector aircraft dynamically and collect metrics.

There are two ways a user interacts with aircraft in the simulation; indirectly through control lines and directly through selection of a specific aircraft. A control line

allows the user to define a line that when crossed provides a control input such as “join procedure” or “turn right to 270.” Users can continue to add control lines as necessary to customize the simulation and provide additional levels of realism. Control lines can also collect metrics for later analysis. Several control line filtering options are provided that can be applied to aircraft crossing a control line that limit the action to only aircraft meeting the filter criteria. To add realism, control lines can be hidden so the display will match what the controller actually sees.



TARGETS operational assessment capability provides a powerful and portable platform for performing simplified human-in-the-loop experiments. Multiple TARGETS sessions running on different computers may be networked to form a single simulation, allowing participants to play the roles of pilots and air traffic controllers. Popular flight and flight management system (FMS) desktop simulators networked with

the central TARGETS simulation allow for more complex human-in-the-loop scenarios to be developed.

Scenario Building

The scenario building capability allows the user to build traffic samples with variations in navigation equipage levels, aircraft type, and separation distances to support the systematic and parametric evaluation of operational issues under different equipage mix levels and demand conditions. The user can select from probability distributions that include uniform, normal, and Poisson.

Metrics Collection

When developing new procedures and assessing their operational impact prior to their implementation into the National Airspace System (NAS), quantification of potential benefits is desirable. Collection of metric data is accomplished using the extended functionality of a control line. This functionality allows the user to perform metric collection at a number of points of interest in a specific airspace. For terminal airspace, metrics collection can be accomplished: at the TRACON entry fixes to confirm the flow rates; before and after merge points; at the hand-off points between feeder and final controllers; on the final approach; at the runway threshold or at any other user defined location.

The metrics control line allows the user to collect aircraft separation information for leading or following aircraft. The user can also create dependencies between metrics lines where data is collected only if an aircraft crossed the first line. This capability could examine aircraft separations when they are staggered on approach to parallel runways. The aircraft identification and state information are written to data files for post-simulation analysis.

Plugin Architecture

The plugin architecture of TARGETS accommodates specialized functions that are of interest only to certain users. A plugin is a particular set of functionality that may be optionally added to enhance TARGETS capabilities. TARGETS plugins address a range of functionality including: importing and exporting unique data formats; importing and displaying terrain elevation data; and facilitating data exchange with other tools.

The plugin architecture provides modularity of the software and avoids user interface complexity. Users are not distracted by extraneous menu choices and buttons because they can tailor TARGETS to include only the plugins that they need.

Data Exchange

Data exchange is supported in TARGETS via ASCII data files, XML files, and Web services. Data file exchange is supported between TARGETS and the Total Airspace and Airport Modeler (TAAM[®]), the Sector Design and Analysis Tool (SDAT), RNAV Pro[™], and MapInfo[®]. Web service data exchange is used for the FAA's Flyability Service and their various database query services. For example, airspace designers use TARGETS to design RNAV routes then exported to TAAM[®] to simulate detailed operational impacts of the designs. TAAM[®] simulations can then be exported for TARGETS for additional procedure design work.

Quality Assurance

Multiple navigation databases can be imported for use in TARGETS. These include the National Flight Data Center (NFDC), FMS databases from avionics manufacturers, Digital Aeronautical Flight Information File (DAFIF), ARINC 424, National Flight Database (NFD), and AVNIS web service. The user can query all of the databases or set a priority for querying the databases. Items that are in common to the databases are checked for consistency with differing items highlighted. Elements such as NAVAIDs, waypoints, STARs, SIDs and approaches are also displayed for a visual check.

Consistency checks across different versions of the same database can also be done by loading multiple versions of the database. Discrepancy reports and edit logs are kept to track changes. A batch mode is available to compare the entire contents of databases.

TAAM[®] Plugin

The Total Airspace and Airport Modeler (TAAM[®]) Plugin enables users to design RNAV SIDs and STARs in TARGETS, then export them to TAAM[®] for further analysis and modeling. This capability provides significant time savings by allowing TARGETS users to quickly develop and export procedures to TAAM[®] for further analysis. The ability for users to import the airspace model built in TAAM[®] and then play it back using TARGETS simulation capability makes it easy for controllers to validate the design. Conversely, controllers can use TARGETS to capture operational constraints during a facilitated discussion that reduces the time for TAAM[®] modelers to build a high quality airspace model. TAAM[®] import and export capability is provided through a plugin that allows database records for fixes and NAVAIDs from TARGETS to be exported to TAAM[®].

For More Information Contact:

[The MITRE Corporation](http://www.mitreaasd.org)
7515 Colshire Drive
McLean, VA 22102-7508
703.983.6053
www.mitreaasd.org