RAPID ACCESS PLANNING SYSTEM (RAPS) WEB APPLICATION FOR COLLECTION PLANNING

Ella Herz\(^a\), Nick Schlatter\(^b\)*, Benjamin Sapp\(^c\), Alex Herz\(^d\)

\(^a\) Chief Operating Officer, Orbit Logic, Inc., Greenbelt, MD 20770, USA
\(^b\) Systems Engineer, Orbit Logic, Inc., Greenbelt, MD 20770, USA
\(^c\) Senior Systems Engineer, Orbit Logic, Inc., Greenbelt, MD 20770, USA
\(^d\) President, Orbit Logic, Inc., Greenbelt, MD 20770, USA
* Corresponding Author

Abstract

Orbit Logic will present the system architecture and web-based interface for the Rapid Access Planning System (RAPS), a web-based GUI supported on the backend by Direct Access Facility (DAF) Collection Planning System (CPS). RAPS provides users with a simplified, straightforward approach to Satellite Imagery Order Management and Collection Planning; thus innovating on the workstation based client approach. RAPS has transformed the longstanding DAF desktop client into a light-weight web GUI. The RAPS system utilizes a web GUI connected on the backend to a DAF CPS client. This approach was taken to not only give DAF CPS a much-needed facelift but also the web architecture makes the client more easily accessible. In addition, this brings DAF CPS into the cloud making it more easily upgradable and extensible in the future. The RAPS interface integrates with DAF CPS’s API calls as well as its shared order database. With DAF CPS serving as the backend processing, the GUI can be solely responsible for providing a high-end visual user experience. RAPS development capitalized on the success of DAF CPS with a web GUI that’s easy to learn, understand, and utilize. The simplicity of RAPS is in the web page layout and functionality. Order Management and Collection Planning pages provide text tables, Gantt charts, and 2D and 3D map visualization to aid the operator in their tasking. Each page has been specially designed to reduce clutter and focus on the main goal of the corresponding page. At first glance, the Order Management page provides the operator with a view of all Orders and their respective locations. While the amount of data displayed is enormous, the page doesn’t feel overloaded nor confusing. The Collection Planning page provides useful tools to aid the operators in tasking. Ground track and field-of-regard visuals help define the area of coverage of each satellite. The RAPS Dashboard page displays useful metrics to give authorized users a quick view into the state of the DAF. Overall, the RAPS GUI provides a candid approach to user operation in providing only the necessary tools and information while offering visualization aid for each facet.

Keywords: Design, Architecture, Planning

Acronyms/Abbreviations

- APS - Autonomous Planning System
- CMPC – Central Messaging Processing Component
- CONOPS – Concept Of Operations
- CPAW – Constellation Planning and Analysis Workstation
- CPS – Collection Planning System
- DAF – Direct Access Facility
- GUI – Graphical User Interface
- RAPS – Rapid Access Planning System
- SAW – Satellite Access Window

1. Introduction

This paper presents the rationale behind and design of the Rapid Access Planning System as an evolution from the preexisting Collection Planning System. It first discusses the driving requirement of a simplified user system and how Orbit Logic was able to create a new GUI to fit customer needs.

1.1 Orbit Logic

Orbit Logic is a software company that specializes in software for satellite planning, scheduling and space situational awareness. Orbit Logic has many flagship products, including, Constellation Planning and Analysis Workstation (CPAW), STK Scheduler, Order Logic, Autonomous Planning System (APS), SpyMeSat, UAV Planner etc. These products help to create better plans faster with fewer resources and more insight for all mission phases.

1.2 Partnership

Orbit Logic contracted with Maxar (formerly DigitalGlobe) to develop Direct Access Facility Collection Planning System (DAF CPS) in 2004. Since 2004, this partnership expanded to support 14 global customers and counting. In 2017 DigitalGlobe and Orbit Logic worked together to develop the idea of Rapid Access Planning System (RAPS). RAPS isn’t just a weibified Graphical User Interface (GUI) for DAF CPS, but the entrance into a broader marketplace with appeal to more customers. With the consideration of a
broader market, it was required to examine multiple categories of enhancements.

1.3 DAF CPS

DAF CPS is a satellite image collection planning system. The desktop application provides the operator with the means to create/edit tasking orders, schedule Satellite Access Windows (SAW) and transmit plans for the Maxar satellite constellation which includes the WorldView-I, WorldView-II, WorldView-III, and GeoEye-I satellites. The software provides many features and capabilities to specify order constraints and optimize the SAW plan. It is a multi-user application that allows for collaboration of several different planners to jointly define tasking requests and collect imagery. Automated algorithms consider both agility and scoring to optimize generated collection plans. DAF CPS considers satellite constraints, agility, ephemeris, as well as recorder capacity to make sure that all plans are valid for tasking.

1.3.1 System Architecture

DAF CPS is broken into two software applications, CPS and Central Messaging Processing Component (CMPC). CPS is the main operating software used by the operators to perform tasking and scheduling. CPS utilizes a visualization display to allow users to see orders and the plan on the globe with an optional weather forecast. Fig. 1 displays the system architecture.

The Target Handling System provides an additional interface to create and modify targets, execute target feasibility and browse imagery and related metadata.

Basemap services provides the user with multiple basemaps to display on the geographical viewer. The CPS user has the option to select either High Res Raster, Low Res Raster or Vector basemaps to display.

The Weather service provides Cloud Cover Forecast and Cloud Cover imagery data. This is a subscription service and provides regular global updates to CPS. The operator and CPS system can utilize this data to optimize their scheduling.

The Ground Segment component supplies DAF CPS with updated contact and predicted ephemeris data, to keep planning and orbit modelling current. This interface also deconflicts SAW requests based on a number of parameters.

CMPC is operated by administrative users and controls the configurable parameters including file locations, satellite customizable parameters and archiving constraints, as well as CPS user management. CMPC is responsible for processing all incoming messages via dropboxes. CMPC will receive and process incoming messages, update the database accordingly, and send the updates out to the DAF CPS workstations.

CPS provides a two-application setup where the CPS GUI and the geographical visualization work together to provide real-time feedback to the operator during planning and scheduling. Fig. 2 and 3 display an example of this two-application setup of a planned SAW.

![Fig. 1. DAF CPS System Architecture](image)

![Fig. 2. CPS Planning Window](image)

![Fig. 3. Geographic Visualization](image)

1.4 The need for RAPS

In order to broaden the customer base and simplify the induction into satellite imagery, a new system architecture was needed. First and foremost, RAPS needed to be in the cloud. This opens up the opportunities for ease of access, lessened hardware requirements and familiarity with web-based software that everyone has become so accustomed to. Following the model of large tech giants such as Netflix, Facebook and Yahoo!, RAPS utilizes the ReactJS (created by Facebook) framework to deliver its simplistic, yet
elaborate, front-end GUI. The RAPS design focuses on improving user experience, streamlining workflows and delivering only the necessary information to the user. See Fig. 4. RAPS - SAW Planning page for an example of the updated interface.

Fig. 4. RAPS - SAW Planning page

2. Broadening the Customer Base

The wide success of DAF CPS brought in many interested customers. Additionally, it brought to light the fact that the DAF CPS architecture is not suited for all customers and there exist gaps in the market for enhancement. There also exist barriers that slow down the access to the Direct Access program, where streamlining these barriers would aid the customer in a more timely and beneficial induction.

2.1 Investment

DAF CPS requires the investment into a ground system, facility and the personnel required to run that facility. Additionally, the amount of time to procure the location, land, titles, permits etc. may occur over a prolonged period. This investment provides the customer with direct access and ownership of the facilities, grounds, overhead and any maintenance and management for the equipment therein.

The operating structure for DAF CPS is on a per seat basis. Therefore, each workstation setup for planning and scheduling has an assigned cost. Typically, most customers pay for two licenses, which equates to two operators simultaneously executing the software. This allows the operators to be in charge of the entire workflow. Also, the operators become familiar with the system and all of its intricacies.

In order to appeal to a larger customer base, the pricing on the facilities, personnel, equipment, time to stand-up operations, etc. needs to be reduced. RAPS aims to lessen the cost for these items by adjusting their overall necessity in the Concept Of Operations (CONOPS). Making earth observations cheaper opens up the market greatly to more interested parties.

2.2 Reduce Complexity

The DAF CPS software is designed to accommodate experienced constellation planning and scheduling operators. An abundance of information is supplied via the GUI to inform the operator of upcoming contacts, parameters regarding other potential contacts and additional activities that can be executed. While this information is pertinent it is not laid out or presented in the most ideal manner. The ability to view all the data all at once can be very helpful but in some cases it can seem overwhelming.

In the DAF CPS application, certain useful features and functionality can only be found within drop-down menus and subsections within menu dialogs, making them difficult to find for inexperienced users. Additionally, all the features are laid out for the operators use even though they may not be at the correct/opportune stage in the CONOPS to use them. This can be distracting and potentially confusing for in-experienced operators.

The GUI is laid out such that many workflows are possible. With all the capabilities provided to the operator, they are in charge of knowing the specific workflow to execute. The software gives the operator free-reign of numerous configuration items and a large degree of control to perform the many tasks available.

As mentioned earlier, this system is designed for experienced operators who not only have industry expertise but expertise and training with the system. The existing users of this system have endless tools, buttons and knobs to tweak to improve and optimize their satellite collection plans to achieve the most desirable outcome.

2.3 Software Re-architecture

DAF CPS was designed over a decade and a half ago and looking at the GUI styling and layout, it shows. The GUI is fairly monotone with colors only used to grab the operator’s attention. Fig. 5 shows a snapshot of the SAW table which is the main landing page.

Fig. 5. DAF CPS software

Also designed 15+ years ago, was the system architecture. The software utilizes dropboxes strictly, to ingest supporting files like ephemeris, contacts and weather data. There are currently more useful and efficient methods of data transfer that can be used at a less costly expense.
The system supports multiple service interfaces that are all required for the successful operation of the software. Each of these services need to be managed and maintained by the operators to assure optimal operation. See Error! Reference source not found. for the System diagram, where ‘**’ denotes what needs to be maintained and managed by the operator.

Referring to Fig. 1, each of the services are only semi-handled by the Orbit Logic delivered software. In most instances, the operators are responsible for standing up the infrastructure to support the services, denoted by ‘**’ in the figure.

A major component of the 15-year-old design is the desktop application. With new age applications moving to the cloud, DAF CPS becomes less accessible. Of course, virtual machines exist to make this software more accessible, but typically requires additional support.

3. RAPS was Born

RAPS was designed in 2017 with the goal of extending the DAF CPS capabilities to a web application. The system architecture is based on Orbit Logic’s pre-existing software, Order Logic. The RAPS application was branched off to create a custom design for Digital Globe. Creation of the front-facing web application would make it possible to expand the user basis by reducing cost, simplifying the system and making it more modern and more accessible.

3.1 Cost Savings

The RAPS web application is powered on the backend by DAF CPS, with the DAF CPS software running on servers owned and operated by Maxar. After satellites scan and record earth imaging, they downlink to Maxar owned ground stations which disseminate the data and deliver to the end user. This updated CONOPS is highly advantageous for cost savings. The web application gives customers the ability to utilize the full fidelity, proven DAF CPS algorithms and capabilities, ground antenna and hardware, to schedule and receive satellite imagery without having to pay for the respective equipment.

The biggest cost savings with RAPS when compared to DAF CPS is the facility and hardware requirements. RAPS does not require a ground antenna or any of the supporting hardware. The facility itself can be stationed wherever desired and doesn’t need to be concerned with zoning, obscura or licensing. As long as the customer facility has internet access, they have the ability to schedule and receive satellite imagery. Taking this one more step, the customer doesn’t technically need a facility. Customers can utilize the RAPS system from the field if desired. The accessibility is incredibly flexible for the customer to use as they so choose.

Additional cost savings comes from the lessened personnel size required to operate the facility. Ground antenna personnel aren’t needed since there is no antenna. The amount of personnel in general isn’t needed because the system is much less complex. DAF CPS requires multiple servers/VMs, a software infrastructure to stand up directories, users, permissions, firewalls etc., but RAPS does not require any of that.

The last cost savings also comes with an added bonus. The licensing fee is not only smaller but it is only applied to the active planning. Therefore, each license applies to the number of active planning sessions allowed for each customer. A customer could employ 100 users, all registered in RAPS and all active on the system at once, but with only one user utilizing the planning session. RAPS allows target creation/editing, target feasibility, SAW analysis, metrics collection, SAW forecasting, weather analysis etc. to be performed by all users in addition to a single user planning session, all for the cost of one license.

In total, RAPS has pushed to redefine the cost of constellation planning and earth observation, by lowering costs significantly, to open up the market for additional customers.

3.2 Simplification

Simplifying DAF CPS was an important task in the development of RAPS. This desire was to appeal to users without the experience or expertise of the constellation planning and scheduling industry. It follows the theme of broadening the Customer base by making the software easier and more discernible to use.

User management is a great way to enforce simplicity by setting up permissions, roles, data sets and view modes. These completely customizable parameters allow admins to setup specific roles for the users to limit their permissions and visibility to the data. Not only does it focus the user on only the pertinent information but it lessens the chance for error. These roles also assist in the execution of a successful workflow. While one user may have permissions to create a target observation and its constraints, another will have permissions to approve and push it to the upcoming plan. The configurability within these data sets, roles and permissions allows infinite parameters sets to be adjusted to give the optimal settings to each user. With RAPS simplifying yet improving user management, the customer can more easily perform their task at hand. Not only was it easier to plan but it was faster as well, since less time was spent planning a schedule.

The RAPS GUI was defined with user experience and improved workflows in mind. Color scheme, button placement and usability of the system was analyzed to create an efficient and functioning web application. Additionally, embedding a map within the
application gives the user immediate feedback to their operations and gives them another tool to analyze their decisions.

RAPS was developed in ReactJS, following the success of tech giants like Netflix, Yahoo! and Facebook. The ReactJS framework is touted by being fast, scalable and simple to use and has enabled Orbit Logic to develop a successful constellation planning system.

Most important to the simplification of constellation planning and scheduling is to define easy to use and efficient workflows. RAPS has three defined workflows that each stem from the three main pages of the web application, SAW Management, Order Management and Dashboard. Additional capabilities for Administration and account management exist but aren’t as relevant to the Earth Sensing topic.

The Order Management workflow begins with a list of previous orders which allows you to review, edit, delete and create orders. During order creation and editing, the user updates target constraints and executes Feasibility. Feasibility informs the user if the order they have edited is possible to be collected given the constraints and the upcoming SAWs. If the user is happy with the order, they can save any edits or create the order. User management plays a role to set the order into the proper state, either requiring approval of the order or if the user has permissions, automatically approving the order. Once the order deck has been updated to the desired state, the user can execute Opportunities, where they select their desired targets and receive a report back on which SAWs can be used to fulfill their selected orders. Fig. 6 displays a snapshot of the Order Management page.

At this stage the SAW Management workflow takes over. It’s possible the user already knows which SAW they want to plan so they are able to start with that or use the recommendation from Opportunities. With the desired SAW, the user begins SAW planning. SAW Planning considers only orders that pass the order filter (based on the constraints of the target and satellite). The orders are broken into strips (sections of the order that can be scanned by the satellite). The user can update individual strips with a priority and a select status. The select status is a modifier to the strip that allows the user to ignore strips, force them to be included, hide them all together or lock them in place if they are already included. Once these parameters are set, the user can generate a plan. After the plan is returned, the user can review, make adjustments and re-plan if desired.

Additional capabilities can be used to further configure the plan. SAW Snap is used to shorten the satellite window by removing unused time at the front and back of the window, so that the user is responsible for only the time required to image their targets. Max Area can be run on individual or many scans to take advantage of additional gaps in the satellite schedule to maximize the area scanned.

Once planning is finished, the user can request the SAW window. If the SAW is approved via Maxar’s arbitration, the user can transmit the plan which finalizes the plan for upload to the vehicle. At this stage the vehicles scan the desired targets, downlink the data and the user is delivered the satellite imagery.

3.3 Software Re-architecture

The Software Re-Architecture helped appeal to the new age of software with the GUI being accessible via the World Wide Web and taking advantage of the already successful DAF CPS software.

With DAF CPS globally available to anyone with internet access, accessibility is no longer a concern for potential customers. Web applications are on the rise and definitely the staple for any new software; RAPS is no exception to that matter.

RAPS development consisted of utilizing the previously successful DAF CPS as the underlying engine with RAPS as the front-end GUI. RAPS users have access to the DAF CPS engine through the RAPS web server hosted by Maxar, allowing them access to functionality from any location. Fig. 7 displays a high-level diagram of the RAPS System Architecture.

![Fig. 6. Order Management Page](image_url)

At this stage the SAW Management workflow takes over. It’s possible the user already knows which SAW they want to plan so they are able to start with that or use the recommendation from Opportunities. With the desired SAW, the user begins SAW planning. SAW Planning considers only orders that pass the order filter (based on the constraints of the target and satellite). The orders are broken into strips (sections of the order that can be scanned by the satellite). The user can update individual strips with a priority and a select status. The select status is a modifier to the strip that allows the user to ignore strips, force them to be included, hide them all together or lock them in place if they are already included. Once these parameters are set, the user can generate a plan. After the plan is returned, the user can review, make adjustments and re-plan if desired.

Additional capabilities can be used to further configure the plan. SAW Snap is used to shorten the satellite window by removing unused time at the front and back of the window, so that the user is responsible for only the time required to image their targets. Max Area can be run on individual or many scans to take advantage of additional gaps in the satellite schedule to maximize the area scanned.

Once planning is finished, the user can request the SAW window. If the SAW is approved via Maxar’s arbitration, the user can transmit the plan which finalizes the plan for upload to the vehicle. At this stage the vehicles scan the desired targets, downlink the data and the user is delivered the satellite imagery.

3.3 Software Re-architecture

The Software Re-Architecture helped appeal to the new age of software with the GUI being accessible via the World Wide Web and taking advantage of the already successful DAF CPS software.

With DAF CPS globally available to anyone with internet access, accessibility is no longer a concern for potential customers. Web applications are on the rise and definitely the staple for any new software; RAPS is no exception to that matter.

RAPS development consisted of utilizing the previously successful DAF CPS as the underlying engine with RAPS as the front-end GUI. RAPS users have access to the DAF CPS engine through the RAPS web server hosted by Maxar, allowing them access to functionality from any location. Fig. 7 displays a high-level diagram of the RAPS System Architecture.

![Fig. 7. RAPS System Architecture](image_url)
The design had to allow for rapid development in order to be operational for the first customer. By leveraging and expanding the existing DAF CPS API the web application was able to leverage the proven DAF CPS planning features. However, the design is not constrained to only utilize DAF CPS functionality. Wherever possible, the RAPS application directly interfaces with the database and external systems instead of relying on DAF CPS to relay information.

A large concern for the aerospace industry is complying to ITAR. DAF CPS is regulated under ITAR, disallowing its use to unapproved foreign customers. By hosting all ITAR restricted data solely on the MAXAR hosted machines, foreign customers can be added without completing the lengthy TAA process.

The RAPS architecture adopts many agile practices. Maxar and Orbit Logic work side-by-side to provide daily support of bug tracking, maintenance, resolution and feature development. RAPS allows the customer to generate bug reports directly from the web application to package necessary logs and data to aid in investigation and resolution. Agile practices extend to the software development cycle as well with the daily stand-ups, scrum-based development cycle, etc.

3.4 Innovative Features

In order to create a more accessible web product simplification as described by section 3.2 above, the granularity of control had to be decreased. The user cannot explicitly define imaging times. To ensure the user still had some direct input into the plan generation, a new feature was added to the interface and planning algorithms: Flexlock. Whereas previously, the user could only lock a specific scan at a single time of inclusion, Flexlock allows the user to specify that the scan should be included, but allows for the inclusion time to change throughout the plan generation process.

This feature was found to be convenient and effective for even advanced planners and was thusly incorporated into the desktop application itself for the existing customer base to use as well.

3.5 Current Operations

RAPS currently supports two active imagery customers with more turning on in the near future. These customers have delivered high accolades to the use and management of the software. All parties are in constant communication to not only troubleshoot issues that arise but also to foster software enhancements and capabilities that benefit the customer.

4. Possible Applications

The re-architecture solution that is RAPS, has many applications within the Earth Observation and Sensing field, but also extends into other industries as well.

4.1 Direct Application – Ground Facilities

The aerospace industry is known for being associated to high price tags. By reducing the cost for such a high-end service, customers who could not previously afford satellite imagery, are now able to specify and collect their own images. The software architecture that is reviewed in this paper takes a new approach to collection planning and scheduling by hosting the software for their customers to access remotely. This model is perfect for Ground Facilities because it follows the model of giving users access to the expensive architecture for just a fraction of the costs. Additionally, the customer never has to fully invest in the system, they are able to walk away as soon as their contract has ended.

4.2 Broadening the Customer Base

The bigger picture to note, in terms of potential applications, is broadening the customer base. By changing up the software architecture, the customer user base was broadened to allow for more potential customers due to cost, simplicity and accessibility. This idea can be applied to many different applications. This applies to companies that develop a web interface to connect to their expensive system architecture and sell that as a service.

More specific to this paper, creating a web front-end GUI that connects to the pre-existing backend engine, allows for an improved product. Its more efficient to develop a web application that connects to the pre-existing software than it is to re-develop that software to begin with. In addition, you are able to market accessibility, which is a significant feature in today’s world.

5. Conclusion

RAPS created a new business model of selling satellite imagery through the use of their own equipment. Users are able to schedule and plan target collections themselves through the use of Maxar’s hosted software, facilities and equipment. The user only requires access to the internet to take advantage of the cost-savings.

Improving the accessibility also aids in the expansion of the customer user base. Something that was previously only available to a single user on a single workstation is now available through web browser with many users. This new work style is more appealing due to the ease of access, updated user management and improved GUI.

The simplistic design and re-designed workflows give the customer a better user experience. Not only is this advantageous for appealing to a wider user base, but it makes the software powerful and efficient to use.
Broadening the customer base starts with knowing the customer. The reasonings behind why the product is too expensive, complicated, unnecessary, inefficient etc. should help drive a narrative in software re-architecture. In the case of DAF CPS and RAPS, that narrative pointed towards a less expensive, more accessible and more simplistic approach.