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US Army Research Laboratory

Adapting My Weather Impacts Decision Aid (MyWIDA) to Additional Web Application Server Technologies

by Jacob C Randall and Jeffrey O Johnson

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Computational and Information Sciences Directorate, ARL

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14. ABSTRACT

My Weather Impacts Decision Aid (MyWIDA) is a software system that evaluates environmental impacts on air and surface combat systems using weather forecasts. The program ingests forecast data and references combat system environmental thresholds to determine and display the relevant impacts. MyWIDA is currently deployed on Oracle's Glassfish application server and uses Hyper Structured Query Language (SQL) Database (HSQLDB) for its database. The program is being converted to allow it to also be deployed on RedHat's JBoss application server while using Oracle's database system. One of the drivers of this conversion is that it would allow MyWIDA to be seamlessly integrated into the weather component of the Distributed Common Ground System – Army (DCGS–A), a multifaceted intelligence software suite that is a US Army program of record. All modules of MyWIDA were successfully deployed on the new application server, with modified build scripts and updated web.xml files implemented. Further, the database was created successfully in Oracle after extensive editing of the scripts used with HSQLDB. Finally, Oracle database was fully integrated into MyWIDA, enabling the program to run on any combination of application server (JBoss or Glassfish) and database (HSQLDB or Oracle).

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MyWIDA, JBoss, Oracle, Glassfish, DCGS–A

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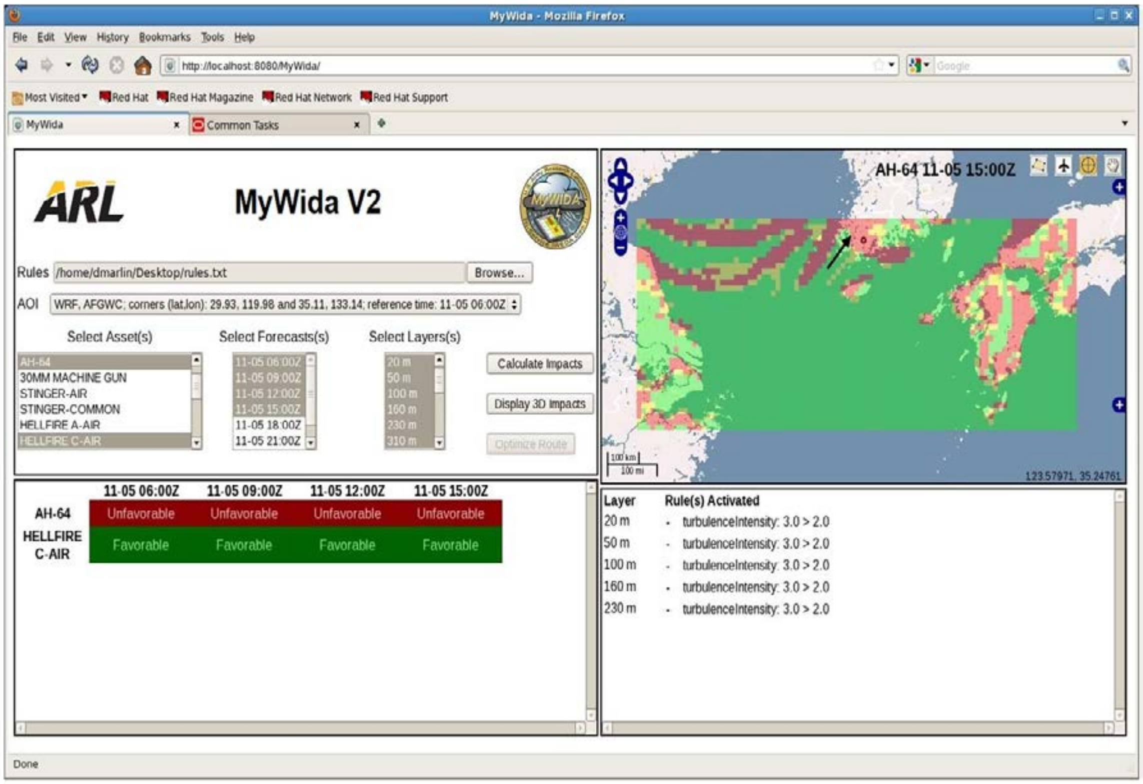
Student Biography

Jacob Randall is entering his senior year at Arizona State University, pursuing a major in Computer Systems Engineering and a minor in Biology. Additionally, he is a member of Barrett, the Honors College. This is Jacob’s first taste of industry experience, but he does have research experience with Hadoop applications in genetics. After graduating he hopes to find a way to combine his computer engineering knowledge, perhaps focusing on embedded systems, with his biology background.

1. Introduction/Background

My Weather Impacts Decision Aid (MyWIDA) is a program that uses forecast data to evaluate environmental impacts on given air and surface systems. The air and surface systems (i.e., assets), are imported from a set of rules provided by the user. These rules specify the various system engineering limitations on the asset, and are compared to the forecast data to determine the impacts on the asset. In addition to selecting the desired forecast model, which determines the area and resolution of the forecast, users can select the height layers and time periods to assess (Brandt et al. 2013).

As seen in Fig. 1, after importing the rules and selecting the desired parameters, the program outputs 3 separate windows of information. The window in the bottom left shows the overall impact for each asset at each time period assessed. The overall impact is determined by evaluating each layer over the entire area of interest (AOI) and retrieving the severity of the environmental condition's impact on the asset. Severity is split into 3 categories—Favorable, Marginal, and Unfavorable—shown by green, amber, and red, respectively. The overall severity of the impact for each forecast is given as the highest severity present at any point on any layer. Severity is determined by the percent degradation on the effectiveness of the asset. The boundaries of the impact levels, which were obtained from various US Army Field Manuals, are displayed in Fig. 2: 20%–25% or less degradation is considered favorable, 25%–30% to 70%–75% degradation is considered marginal, and 70%–75% or greater degradation is considered unfavorable.



Rules /home/dmarlin/Desktop/rules.txt

AOI WRF, AFGWC; corners (lat,lon): 29.93, 119.98 and 35.11, 133.14; reference time: 11-05 06:00Z

Select Asset(s)	Select Forecasts(s)	Select Layers(s)
AH-64	11-05 06:00Z	20 m
30MM MACHINE GUN	11-05 09:00Z	50 m
STINGER-AIR	11-05 12:00Z	100 m
STINGER-COMMON	11-05 15:00Z	160 m
HELLFIRE A-AIR	11-05 18:00Z	230 m
HELLFIRE C-AIR	11-05 21:00Z	310 m

	11-05 06:00Z	11-05 09:00Z	11-05 12:00Z	11-05 15:00Z
AH-64	Unfavorable	Unfavorable	Unfavorable	Unfavorable
HELLFIRE C-AIR	Favorable	Favorable	Favorable	Favorable

Layer	Rule(s) Activated
20 m	- turbulenceIntensity: 3.0 > 2.0
50 m	- turbulenceIntensity: 3.0 > 2.0
100 m	- turbulenceIntensity: 3.0 > 2.0
160 m	- turbulenceIntensity: 3.0 > 2.0
230 m	- turbulenceIntensity: 3.0 > 2.0

Fig. 1 MyWIDA Web application after calculating impacts

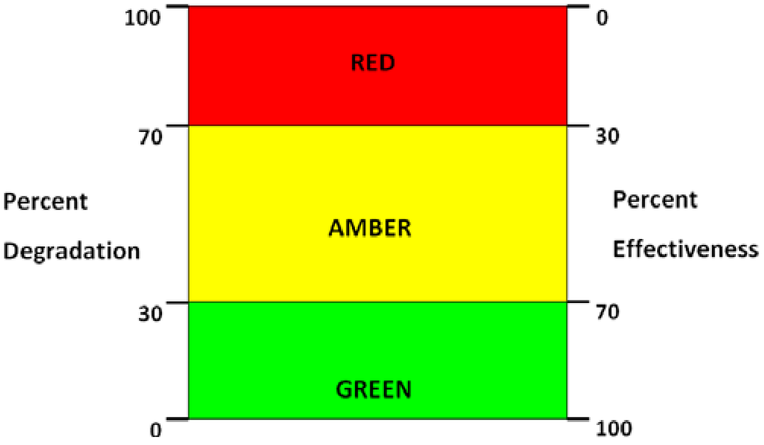


Fig. 2 Impact category ranges

The individual impact cells in the bottom left box of Fig. 1 bring up a grid overlay of the impacts on a map when selected via a left-mouse click. As seen in the upper right window of Fig. 1, the color of the determined impact level at the grid resolution of the forecast is shown in a 2-dimensional (2-D) map view. Each grid cell can be left-mouse clicked, and will enumerate the affected limitations for each layer in that location—if any—in the bottom right of the display. The overlay works in a similar way as the overall impact list. It evaluates the entire column of layers selected for each grid cell and displays the impact level of the most severe impact present. The impact columns can be visualized with the 3-dimensional (3-D) view of the output as represented in Fig. 3.

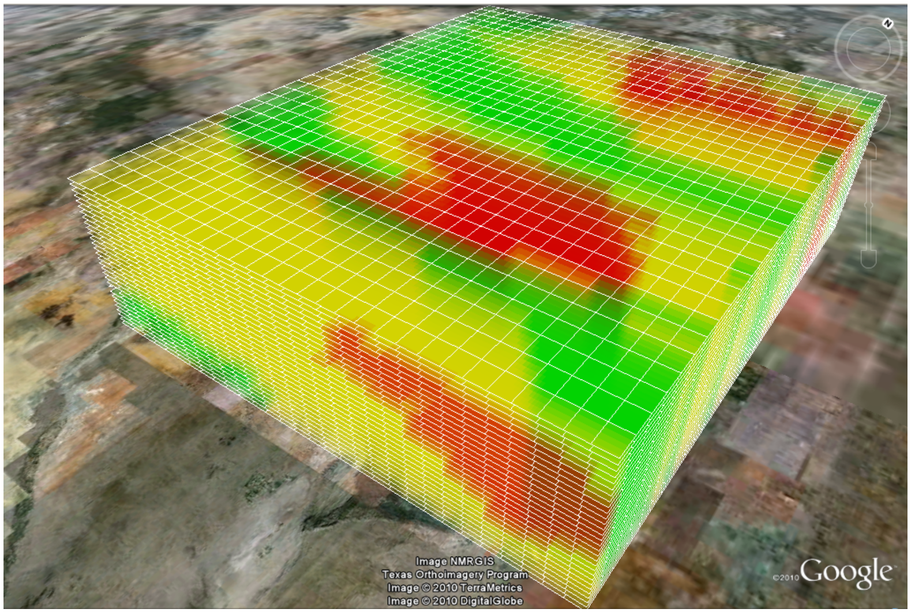


Image NMRGIS
Texas Orthoimagery Program
Image © 2010 TerraMetrics
Image © 2010 DigitalGlobe
©2010 Google

Fig. 3 3-D view of multiple impact grid layers

MyWIDA is comprised of 4 primary Web services, the Threshold Evaluation Service (TES), the Rule Evaluation Service (RES), the Impact Overlay Service (IOS), and the Area of Interest Service (AOIS). For routing through impacts, the optional Automated Impacts Routing (AIR) service may be called by MyWIDA using the MyWIDA Web application front-end. The AOIS manages the forecast models, the data requests, and the post processing of the returned information. The TES is responsible for analyzing the forecast data to determine which thresholds were exceeded for each asset. The RES manages the impact grids by assessing each rule for each asset and sending them to be evaluated by TES, and then returns the collection of impacts. The IOS takes the output from RES and creates the overlay as a keyhole markup language (kml) file. The AIR provides routing options with consideration for environmental factors (e.g., adverse weather) that may affect the assets (Johnson 2011). It provides multiple path options with varying levels of risk as seen in Fig. 4.

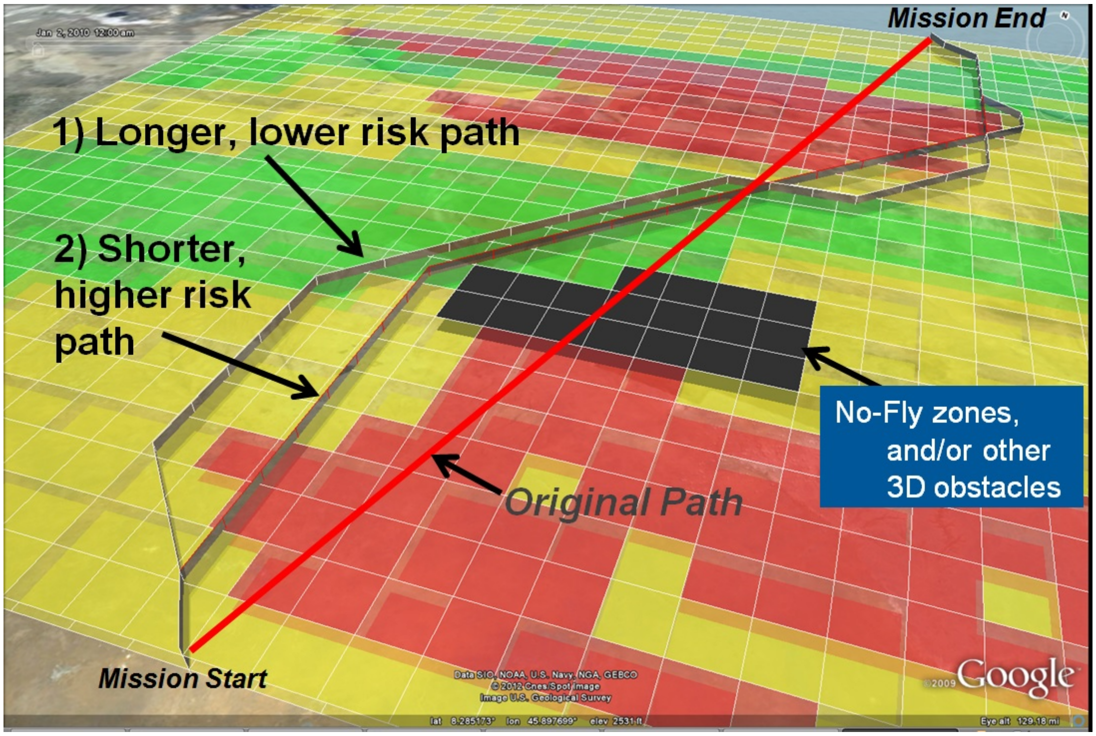

Jan 2, 2010 12:00 am
Mission End
1) Longer, lower risk path
2) Shorter, higher risk path
No-Fly zones, and/or other 3D obstacles
Original Path
Mission Start
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
Image U.S. Geological Survey
©2009 Google
lat 8.285173° lon 45.897699° elev 2531 ft
Eye alt 129.18 mi

Fig. 4 AIR mapping: Two AIR-generated paths of varying risk

MyWIDA was built for deployment on Oracle's (formerly Sun's) Glassfish application server with a Hyper Structured Query Language (SQL) Database (HSQLDB) and was written primarily in Java. It currently works with Java 6, but can be used with Java 5. Additionally, it can run on the latest stable version of Glassfish: 4.1, and the latest stable version of HSQLDB: 2.3—though it is shipped with 1.8. In an effort to increase the environments in which MyWIDA may be deployed and run, the program is being converted to run on Redhat's JBoss application server—EAP 6.4, and for use with Oracle's database—Oracle 12c. One of the specific drivers for this conversion was to allow MyWIDA to be used within the weather component of the Distributed Common Ground System–Army (DCGS–A). DCGS–A is a multifaceted intelligence system and a US Army program of record.

2. Experiment/Calculations

The conversion of MyWIDA consisted of 2 primary steps: making it functional on JBoss and making it compatible with Oracle's database. The most challenging aspect of the conversion however, was dissecting the program to determine how it functioned, from compilation to the actual computational processes. This inspection revealed that the major aspect of converting the program for use on

JBoss would be adjusting the build scripts. Further, allowing the program to function with Oracle would also require a large overhaul of the HSQLDB build scripts.

2.1 JBoss Functionality

MyWIDA build scripts were structured so that there was a primary bash script that essentially called all of the “Ant” build files for each module. Looking further into the build files revealed that they prepped all of the files and packaged them into .war files. Within each .war is a deployment descriptor file named web.xml, which is essential to any Web service. More importantly however, is that the content requirements of this file can vary depending on the application server used.

In the case of MyWIDA, the differences between the web.xml files for the 2 application servers was minute. JBoss simply required a specific declaration of the servlet and its mapping. To facilitate this change, the build files were rewritten to manage the folder structure and web.xml files based on the application server the service was built for. This was initially done for the TES service. After successfully altering and testing TES and RES with the new build, it was discovered that JBoss was able to deploy the remaining services without any further modifications. Additionally, the version of RES ported for JBoss was able to run on Glassfish, eliminating the need for separate build processes for all of the services except TES. Due to the way TES is programmed, it requires separate builds depending on the desired application server. This is likely a result of hardcoding the Web Service Definition Language (WSDL) file’s location parameters in the source code, but that avenue was not fruitful when explored.

2.2 Oracle Database Functionality

Converting the HSQLDB scripts to Oracle-compatible .sql files was less easily solved. While both technically use SQL syntax, Oracle has a different implementation of what users and schemas mean. This required a more intensive overhaul of how users are created and managed with Oracle. Further, some datatypes that are used with HSQLDB are not compatible with Oracle. Most notably, the VARBINARY datatype is not compatible with Oracle, and instead was replaced with the Binary Large Object (BLOB) datatype. Oracle additionally has a different implementation of primary keys in conjunction with other minor syntax differences. Due to length limitations when inserting strings into Oracle using SQL Plus (shipped with Oracle), a small Java program had to be written to facilitate the insertions. The final step was altering some properties files in MyWida, changing the database address, password, etc. With these changes, MyWida was up and running—on both application servers—with Oracle as its backend.

3. Results and Discussion

3.1 Application Server Benchmarking

The adjustment of the web.xml files and the minor build file modifications led to a successful deployment of the full program on both JBoss and Glassfish. For reference and benchmarking purposes, the startup times of JBoss and Glassfish were determined. Both had no services to deploy and were starting up with default parameters. On Debian 8, Glassfish took on average approximately 13 seconds (s) to start, with JBoss starting at an average of about 7 s (Table 1).

Table 1 Start times of the application servers and the database scripts' run times

App Server Start	**Glassfish**	**JBoss**
	13 s	7 s
Database Scripts	**Oracle**	**HSQLDB**
	30 min	9 s

3.2 Database Benchmarking

After the successful conversion of the HSQLDB scripts to .sql files that Oracle can use, the startup times between HSQLDB and OracleDB were tested. HSQLDB took substantially less time (in the half-hour range) to import the scripts than Oracle did. However, the vast majority of the data—and what took so long for Oracle to import—is not required to run the program right away. That data will be imported, deleted, and manipulated in general throughout the use of the program. Further, Oracle only needs to run the setup scripts once, as it is a persistent database. HSQLDB is an embedded database, thus everything must be created and filled from scratch if HSQLDB is stopped at any time.

Additional speed tests were performed to compare the databases on both application servers. The same 3 tests were run on the 4 possible database–application server pairings: the time it took to load MyWIDA, and 2 queries. The first query (Test 1 in Table 2) used the WRF model and ran 3 forecasts on 2 layers for 1 asset. The second query (Test 2) used the same model and asset, but ran all 17 possible forecasts on all 57 layers. Across the board, Oracle was slower than HSQLDB, most noticeably when loading MyWIDA and when performing a large request. Test 2 shows that the speed discrepancy is not a static overhead when using Oracle, as the difference is amplified with increased query volume. This is likely a result of writing to and reading from the disk rather than having everything stored in memory as HSQLDB does. It is possible to setup Oracle so that it stores select data in memory, though this feature is only available in Oracle 12c version 12.1.0.2 or newer. This avenue has not yet been thoroughly investigated with regards to MyWIDA, but at a cursory glance seems it will require more fine-tuning and optimization of the database scripts.

Table 2 MyWIDA load times and query run times

JBoss	**Load**	**Test 1**	**Test 2**
Oracle	8.2 s	4.1 s	309 s
HSQLDB	1.8 s	2.8 s	22.3 s
Glassfish	**Load**	**Test 1**	**Test 2**
Oracle	8.4 s	3.1 s	302 s
HSQLDB	2.2 s	1.8 s	19.4 s

Again, despite the slow performance, there are benefits to Oracle's method. In addition to its persistence, its size is virtually unlimited and can handle much larger sets of information as opposed to HSQLDB. However, the size benefits are mostly unseen with MyWIDA because its data falls within the limits for HSQLDB.

4. Summary and Conclusions

With the success of deploying MyWIDA on JBoss, all that remains to be done for the application server adaptation is to finalize the main build script and standardize the Ant build files. This standardization will allow the build script and the subsequent .war files to be server independent. It may be possible to further update the build script to allow for user selection of the database they intend to use. Initial testing of Oracle on JBoss and Glassfish indicate that there are no major issues, but it seems that investigating the in-memory option could provide improved performance. Further, there may be issues encountered with the specific versions of JBoss and Oracle that are being used in DCGS–A, or any other systems using older versions of JBoss or Oracle. Previously, older versions of JBoss have caused some problems. These issues were not addressed in this conversion due to the use of a newer version of JBoss, but are important considerations moving forward.

5. References

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List of Symbols, Abbreviations, and Acronyms

2-D	2-dimensional
3-D	3-dimensional
AIR	Automated Impacts Routing
AOI	area of interest
AOIS	Area of Interest Service
ARL	US Army Research Laboratory
BLOB	Binary Large Object
CISD	Computational and Information Sciences Directorate
DB	database
DCGS–A	Distributed Common Ground System–Army
HSQLDB	Hyper Structured Query Language (SQL) Database
IOS	Impact Overlay Service
kml	keyhole markup language
MyWIDA	My Weather Impacts Decision Aid
RES	Rule Evaluation Service
s	second(s)
SQL	Structured Query Language
TES	Threshold Evaluation Service
WSDL	Web Service Definition Language

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