

May 21, 2010

STI-909029-3876-TM

To: Mr. John Cissel, Program Manager, Joint Fire Science Program

From: Ms. Tami Funk

Re: Interagency Fuels Treatment Decision Support System Proof-of-Concept System

This technical memorandum describes the requirements and functionality of the Interagency Fuels Treatment Decision Support System (IFT-DSS) proof-of-concept (POC) system released in May 2010 (IFT-DSS version 0.3.0). The IFT-DSS POC system was developed from May 2009 through May 2010 using an agile software development approach. This approach employs an iterative development cycle where initial goals are identified, system components are rapidly engineered, user feedback is acquired, and modifications are made to the system based on user feedback and evolving developments.

An important element of the agile development process is working closely with a test user community to obtain feedback as development occurs. Early during the development process, feedback from the test user community directed the team to focus efforts on implementing two of the most common fuels treatment planning workflow scenarios¹: prescribed burn planning and strategic planning. Developing these workflow scenarios required manual entry of data, use of Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) data, and use of a fire behavior model to estimate fire behavior variables for both a point location and across a landscape. During the initial thought process for the IFT-DSS POC system, we had planned on implementing both the LANDFIRE data and the Field Sampled Vegetation (FSVeg) treelist data. It became clear during implementation that (1) the FSVeg treelist data were not going to be available in time for use in the POC development, and (2) the fire behavior model choices were narrowed to FlamMap because the developers of the fire behavior calculator, BEHAVE, were not yet prepared to release the source code for implementation in the IFT-DSS. However, FlamMap uses the same fire behavior equations as BEHAVE; therefore, we were able to use it to support both of the workflow scenarios the users wanted implemented first.

Additionally, it is worth noting that other considerations suggested that the Fuels Characteristics and Classification System (FCCS) and the Forest Vegetation Simulator (FVS) not be implemented during this first year of software development. The Fire and Environmental Research Applications (FERA) team recognized the need to re-engineer the FCCS application to

¹ Refer to *Refined Work Flow Scenarios and Proposed Proof of Concept System Functionality for the Interagency Fuels Treatment Decision Support System*; Drury et al., 2009 for complete descriptions of the workflow scenarios to be implemented in the IFT-DSS.

be more modular and more appropriate for use in service-oriented architecture systems (SOAs). That effort is currently underway; when completed, the FCCS will be incorporated into the IFT-DSS. The FVS is also currently under re-engineering to make the FVS run on multiple processors, thereby increasing the speed of project runs.

The two key strategic objectives of the IFT-DSS POC system were (1) to quickly develop a POC system that could immediately serve a subset of the needs of the fuels treatment planning community, and (2) to demonstrate that a well-designed SOA framework approach was practical. One of the strategic visions forming in the fire and fuels community is the desire for the larger service-oriented systems such as the Wildland Fire Decision Support System (WFDSS), BlueSky Smoke Modeling Framework (BlueSky), and Fire and Fuels Application (FFA) to share software services and information with IFT-DSS. The IFT-DSS POC explores an initial connection to BlueSky. BlueSky was recently expanded to provide access to its processes through web services. IFT-DSS currently runs the FERA team's Consume 3.0 Natural Consumption Algorithm utilizing a web service call to BlueSky. In addition, throughout the development of the IFT-DSS POC, the IFT-DSS development team collaborated with the WFDSS development team to share technological information, map layers, and map symbology. There is an overlap in functionality between the two systems, and IFT-DSS developers will continue to collaborate with the WFDSS team to connect IFT-DSS to WFDSS to the maximum practical extent. In turn, as IFT-DSS is developed, it will make its services available to BlueSky, WFDSS, and other interoperable systems in the fire and fuels domain.

While we refer to the current system as a proof-of-concept, it should be noted that the system is functional and stable, and that most of its programming code and system components engineered to date will be used as the foundation for the fully functional system. This document does not contain software architecture or design specifications; however, this information can be found in Funk et al., 2008 and Wheeler et al., 2009² available on the Software Tools and System (STS) Study website.

Sections 1 through 3 of this document describe the high-level requirements, technical functionality, and integration of models into the IFT-DSS POC.

² Funk T.H., Rauscher M., Raffuse S.M., and Chinkin L.R. (2008) *Findings of the current practices and needs assessment for the Interagency Fuels Treatment Decision Support System (IFT-DSS) project. Technical memorandum prepared for the Interagency Fuels Treatment Work Group (IFTWG), by Sonoma Technology, Inc., Petaluma, CA, and the Air Fire Science Team, Seattle, WA, STI-908038.01-3504, December.*

Wheeler N.J.M., Reed J.E., Unger K., Raffuse S.M., Ludewig S.A., Funk T.H., and Gray E.A. (2009) *Interagency Fuels Treatment Decision Support System software design specifications. Software specifications prepared for the Joint Fire Science Program, Boise, ID, by Sonoma Technology, Inc., Petaluma, CA, STI-909029.03-3664-SS, August 18.*

1. IFT-DSS POC REQUIREMENTS

Eight general objectives were established for the IFT-DSS. These requirements and a brief description of how they were realized in the POC are summarized in **Table 1-1**.

Table 1-1. The IFT-DSS objectives and how they were realized in the POC.

Objective	POC Realization
1. Support the decision support process, analysis steps, and software tools commonly used for fuels treatment planning	Implemented two of the most common workflow scenarios to varying degrees: <ol style="list-style-type: none"> 1. Prescribed burn planning 2. Strategic planning
2. Provide users with software model choices within workflow scenarios	Implemented FlamMap as one choice for fire behavior modeling. Future development will support the addition of more model choices.
3. Provide data choices	Implemented three data input options: <ol style="list-style-type: none"> 1. User-supplied local data in .lcp file format 2. User-supplied manual entry of data for single-unit fire behavior modeling 3. User-supplied LANDFIRE data (as the default)
4. Support visualization of spatial and tabular data, data editing, and user interaction at each processing step	Implemented an interactive GIS map viewer and editing tool, and the ability to export and view data in Google Earth
5. Have a quality control, documentation, and audit-trail mechanism to support regulatory requirements	Implemented initial reporting tools that support the first two workflow scenarios, including maps, graphs, and data tables
6. Support analytical collaboration so that the system provides a mechanism for fuels treatment analysts to publish and share methods and algorithms with other system users via a central system library	Implemented a user profile system that lets users establish profiles within the system and save their work to a system database. Future versions will allow users to publish their methods and results for other users to view.
7. Support scientific collaboration so that the system is able to incorporate via an authorship and publishing mechanism new models and tools as they become available	Implemented two fire and fuels applications: FlamMap and Consume 3.0. Developed software guidelines for integrating new models into the system.
8. Provide an easily accessible and straightforward user interface to all models and applications	Implemented a web-based, easy-to-use GUI

2. IFT-DSS POC FUNCTIONALITY

The IFT-DSS POC version 0.3.0 includes a subset of the required fuels treatment planning workflow scenarios and functions. The goal for the IFT-DSS POC at the end of the first year of development (May 2010) was to deliver a proof-of-concept product that is useful for the fuels treatment planning community. Based on feedback from the fuels treatment planning community, we implemented two of the most common workflow scenarios to some extent in the POC: prescribed burn planning and strategic planning.

2.1 DATA AND MODEL IMPLEMENTATION

The software applications and data listed in **Figure 2-1** were implemented because (1) they have been identified as widely adopted and used by the fire and fuels community; and (2) they are likely to be the most technologically feasible to incorporate into the system during the first year of development.

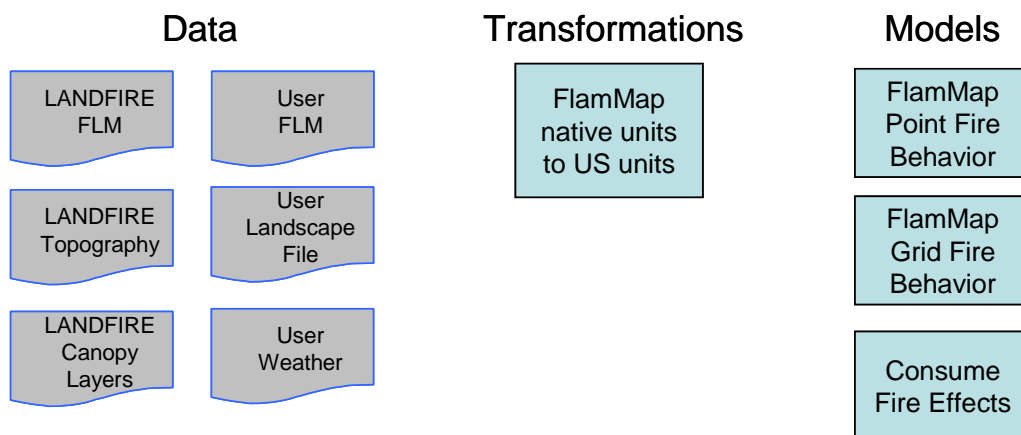


Figure 2-1. Data and models implemented in the IFT-DSS POC system.

2.2 IFT-DSS POC WORKFLOW SCENARIOS

This section describes the input data options and the fuels treatment planning workflow scenarios that have been implemented in the IFT-DSS POC: prescribed burn planning and strategic planning.

Input Data Options

The IFT-DSS POC provides three options for entering data into the system: (1) manually entering the data needed for prescribed burn planning (i.e., fuel model, fuel loadings, and wind speed) into a form via the user interface; (2) uploading local data in Landscape File (.lcp) format; and (3) accessing LANDFIRE national data. As the IFT-DSS is developed further, other functionality will be added, such as the ability to upload treelist data and edit input data files for local conditions. **Figure 2-2** illustrates the workflow process for data acquisition and preparation

as it is implemented in the IFT-DSS POC. The IFT-DSS will eventually have a comprehensive data acquisition and preparation workflow scenario that will help the fuels treatment planner acquire, prepare, and quality-assure vegetation data for use in fuels treatment planning.

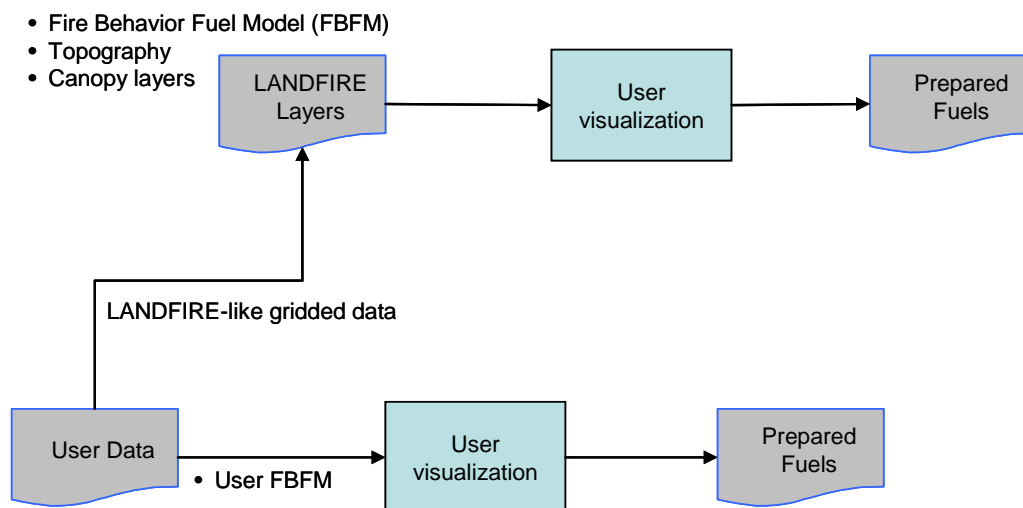


Figure 2-2. Process diagram for the data acquisition and preparation workflow scenario implemented in the IFT-DSS POC.

Prescribed Burn Planning Workflow Scenario

The objective of the prescribed burn planning workflow scenario is to provide the information needed to plan, document, and conduct a prescribed fire. The IFT-DSS POC currently provides one pathway for fire behavior simulations: running FlamMap for a single point location. However, future versions of the IFT-DSS will provide multiple options for prescribed burn planning (i.e., FCCS, NEXUS). To run FlamMap for a point location, users can manually input data parameters such as wind, fuel models, fuel moisture, and fuel loadings. The FlamMap application functions behind the scenes on a point location. Simulations of possible fire behaviors provide essential information for describing the burn plan prescription (Element 7), the ignition plan (Element 15), and the holding plan (Element 16).³

FlamMap Pathway

Using the FlamMap pathway in the POC, the user inputs data parameters required by FlamMap. As described in the strategic planning scenario, FlamMap's outputs include fireline intensity, flame length, rate of spread, heat per unit area, horizontal movement rate, midflame wind speed, spread vectors, and crown fire activity. This information is crucial in determining how and when a prescribed burn should be conducted to meet specific objectives. **Figure 2-3** summarizes the process steps in this pathway.

³ U.S. Department of Agriculture and U. S. Department of the Interior (2008) Interagency prescribed fire planning and implementation procedures guide. Available at <http://www.nifc.gov/fire_policy/rx/rxfireguide.pdf>.

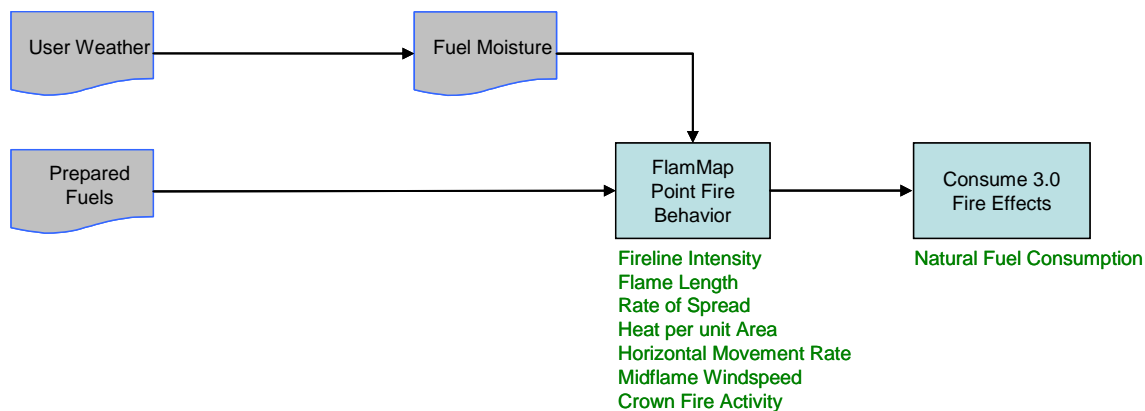


Figure 2-3. Process diagram for the prescribed burn planning workflow scenario using the FlamMap pathway in the IFT-DSS POC.

The Consume 3.0 fuel consumption model has been implemented in the IFT-DSS POC to calculate fuel consumption for natural fuels. Consume's fire-effects outputs are fuel consumption, smoke emissions, and heat release. The IFT-DSS POC has limited Consume functionality; however, future versions of the IFT-DSS POC will incorporate all of the consumption algorithms within Consume. The IFT-DSS POC runs the Consume model via a web-service call to the BlueSky Smoke Modeling Framework. This demonstrates the IFT-DSS's ability to communicate with other fire, fuels, and smoke systems.

Strategic Planning Workflow Scenario

The objective of the strategic planning workflow scenario is to identify high fire hazard areas within an area of interest. The focus of this workflow scenario is to identify locations where the potential fire hazard may warrant further analysis. High fire hazard is expressed by high potential fire behavior and/or undesirable fire effects.

In the IFT-DSS POC, FlamMap has been implemented to perform fire behavior simulations across a landscape. FlamMap fire behavior outputs include fireline intensity, flame length, rate of spread, heat per unit area, horizontal movement rate, midflame wind speed, spread vectors, and crown fire activity. **Figure 2-4** summarizes the strategic analysis workflow scenario as it is implemented in the POC.

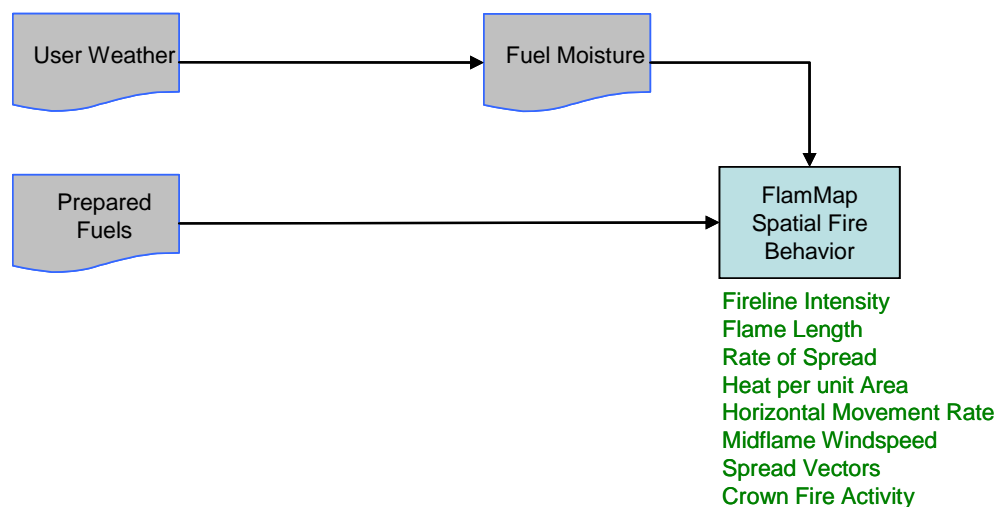


Figure 2-4. Process diagram for the strategic planning workflow scenario as it is implemented in the IFT-DSS POC.

3. IFT-DSS POC MODEL INTEGRATION

The various data and software applications used in the fire and fuels community differ in many ways, including their manner of invocation, robustness, generality, types of modeling, and execution platform. Integrating these applications in the early stages of IFT-DSS development poses both technical and structural challenges because the applications are not in standard formats for integration. However, an important community development goal is to adopt over time simple software development protocols and guidelines that facilitate the integration of scientific applications into the various SOA systems in the fire and fuels domain (e.g., IFT-DSS, BlueSky, and WFDSS).

Developers of individual applications are likely to have little or no time to integrate their products with the proposed framework. Therefore, tools and guidance will be developed to facilitate collaboration:

- Software tools will simplify and streamline the process of integrating new models into the IFT-DSS;
- Technical assistance will be offered to application developers, including software application programming interface (API) documentation and email/phone support;
- It will be easier to register components and deliver applications and updates to users; and
- Clear specifications will be available for data standards and the required APIs that the software applications are expected to support.

In some cases, the original developers of key applications that are necessary for integration with the IFT-DSS may be unable to modify their software. In these cases, assuming

the source code is available in the public domain and can be decoded, the IFT-DSS development team will integrate the application by:

- Obtaining the source code, making necessary modifications, and integrating the application into the IFT-DSS;
- “Wrapping” the original software application in a wrapper application that is itself integrated into the framework;
- Re-engineering the application so that it can be integrated directly into the framework; or
- Providing access to a model through the IFT-DSS via a web-service call to another system.

In the early stages of IFT-DSS POC development, the software applications require integration into the IFT-DSS by one of the methods described above. Once a sufficient number of key applications support the new framework, it is likely that users will pressure the developers of remaining applications (and those creating new applications) to provide voluntary support for the framework.

The STI development team is currently working with the FERA team to use the FERA tools (FCCS, Consume, and FEPS) as a test case of how best to integrate existing and new software applications. The result of this collaboration will be a best practices guide for application developers to follow as they devise new products to facilitate integration of models into the IFT-DSS. The STI development team is also seeking input from the stewards of BlueSky and WFDSS for the development of best practices guidelines.

As part of the IFT-DSS POC development effort, the Control Database Loader (CDL) administrative software tool was developed to simplify and streamline the process of integrating new models into the IFT-DSS. The CDL allows a system administrator to manage models, input data formats, and output data formats within the system framework. **Figure 3-1** shows a screen shot of the administrative the CDL tool.

Figure 3-1. The Control Database Loader tool within the IFT-DSS.

IFT-DSS POC uses the approaches described above to integrate three models: FlamMap, Consume, and a unit conversion module. These applications have been integrated into the IFT-DSS POC in the following ways:

- **FlamMap** was converted by obtaining and modifying the source code and dynamic link library (.dll) files necessary for integration with the IFT-DSS. The IFT-DSS development team communicated with the developers of FlamMap, who agreed to provide FlamMap .dll files and supported the team's modifications to the FlamMap source code so that it could be integrated into the IFT-DSS POC. It should be noted that the .dll files currently used in the WFDSS are also used in the IFT-DSS POC. This is an example of the “wrapping” method described above.
- **Consume 3.0** was implemented by using a web-service call to the BlueSky Playground, which is the web-service version of the BlueSky Smoke Modeling Framework. The IFT-DSS currently offers the natural fuel consumption algorithms in Consume, which are the same algorithms that have been implemented in the BlueSky Playground.

- The **unit conversion tool** is programming code that converts the fire behavior units from FlamMap to U.S. standard units. This tool was developed and implemented directly within the IFT-DSS using the CDL. The unit conversion tool was developed in response to users who requested that the FlamMap output be available in U.S. standard units.

The three applications were integrated into IFT-DSS using three separate, unique approaches. This diversity of approaches provided the opportunity to develop protocols, guidelines, and an integration toolkit for the IFT-DSS. The protocols, guidelines, and toolkit developed during the first year of POC development will be tested and refined early in the second year of IFT-DSS development as new applications are integrated.

In the IFT-DSS POC, applications added to the system are available within the system and are documented in a resource library that contains information about the application, its intended use, and authorship.