WxDE-VDT Integration Design

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| This document describes the features of the VDT integration with the WxDE. |

# Background

The VDT is designed to combine a variety of weather observations, including data collected from vehicles, to produce a variety of weather-related outputs. Integrating the VDT with the WxDE will provide the WxDE with new capabilities that have the potential to meet the needs of additional WxDE users. For example, USDOT is producing a “local situation database” to collect and distribute information about road conditions in Southeast Michigan to support demonstrations during the 2014 ITS World Congress. The statistical summaries of observations over pre-defined road segments would fit naturally into this Connected Vehicle demonstration database.

# Summary of How the VDT Works

The VDT 3.0 is a batch process that reads a set of input files that include (a) weather observation and forecast data (including probe data observations) and (b) definitions for road segments of interest. The VDT performs quality checks on this data and outputs quality checked probe data. It also uses the quality checked probe data to produce statistics summarizing various input parameters for (a) the defined road segments and (b) grid elements on a pre-defined grid. Lastly, the VDT produces road condition summaries for the road segments for which probe data is available. Figure 1 shows the steps in the VDT 3.0 process.



Figure 1. VDT 3.0 Processing Steps

The input files used are summarized in the list below.

* Road Segment Data. This input file defines the geography of the road segments over which VDT calculations will be performed. The VDT uses the geographic points in this file to identify probe data that apply to each road segment (based on geographic proximity), produces summary statistics for the probe data over each segment, and estimates road conditions from the probe data.
* *Clarus* Climatology Data. This input file defines the expected range for a set of weather variables. A different range is defined for each grid of a pre-defined grid network and for each month of the year. The VDT uses these values to produce range-based quality checks. The WxDE includes an analogous set of data to support WxDE quality check calculations.
* Probe Message Data. This input file includes probe data for a specific period of time. Each record in this file includes the observed values at a specific point in time, as well as the geographic position of the vehicle when the observations were made at the observation time. The VDT quality checks this data and uses it to produce (a) statistical summaries of observations along road segments and inside geographical grids, (b) inferred weather conditions, and (c) estimates for road conditions for road segments.
* MADIS data. This input file includes weather observations from fixed observation stations. Each record includes observed values for a specific station at a specific point in time. The VDT uses this data to quality check the Probe Message Data and as part of the weather condition inference process.
* METAR data. This input file includes weather observations from fixed observation stations, mostly at airports (ASOS/AWOS). Each record includes observed values for a specific station at a specific point in time. The VDT uses this data to quality check the Probe Message Data and as part of the weather condition inference process.
* Radar data. This input file includes Doppler radar observations for each point in a rectangular grid. The VDT uses this data as part of the weather condition inference process, mostly to help estimate where precipitation is occurring.
* RTMA data. This input file includes forecast weather conditions from the Real-Time Mesoscale Analysis performed for the National Digital Forecast Database. [Need information on how this is used in the VDT.]
* Probe Message Historical Data. The file includes recently received probe data and is used by the VDT for some quality check calculations. Strictly speaking, this file is not an input to the VDT process – it is produced by the VDT for use during future VDT runs. The VDT creates historical probe data files as it processes new data. It adds probe messages into the appropriate history files based on the observation time from the probe messages and the timestamp of the history files.

The VDT processes these input files to produce four types of outputs.

* Quality-checked Probe Data. The VDT computes quality check values for each record in the Probe Message Data.
* Grid Cell Statistics. The VDT associates each record in the Probe Message Data to a geographical grid in which the record is located and produces summary statistics for the probe data observations in each grid cell.
* Segment Statistics Data. The VDT associated records in the Probe Message Data to road segments defined in the Road Segment Data. (Not all Probe Message Data records are associated with a road segment – only those geographically close to a defined road segment.) Then, the VDT produces summary statistics for the Probe Message Data for each road segment.
* Segment Assessment Data. The VDT assesses the Probe Message Data for each road segment and produces a summary of road weather conditions on each segment.

As noted above, the VDT also produces probe message historical data files. But, these files are meant to support internal VDT process rather than as outputs of the VDT.

# Overview of the WxDE-VDT Integration

The WxDE-VDT integration will proceed through a series of phases, with the first phase designed to achieve as quickly as possible a fully operational VDT instance operating in conjunction with the WxDE, obtaining inputs from the WxDE and exporting data to the WxDE for integration in the WxDE data archives. Later phases will integrate additional VDT outputs into the WxDE database and simplify the VDT configuration process, eventually leading to a configuration process that would allow a WxDE user to define configuration information for the VDT and create customized VDT runs. The following list summarizes the proposed phases, with details given in later sections.

* Phase 1. A VDT wrapper will be developed that gathers the required input data from the WxDE and external sources and from static files prepared for the VDT (e.g., for the road data). The wrapper will periodically download required data, run the VDT software, and push the VDT probe data into the WxDE database.
* Phase 2. The VDT wrapper routines that gather input data will be migrated to the WxDE in order to prepare for being able to configure VDT operations from the WxDE and WxDE APIs will be developed so the VDT wrapper can gather the required data from the WxDE. The approach for integrating additional VDT results – either in the WxDE database or as standalone files (similar to the RDE) – will also be determined.
* Phase 3. The VDT road segment data outputs will be integrated with the WxDE. This will require changes to the design of the WxDE database to store both the road segment data and the VDT segment summary statistics. The approach for allowing for custom configurations of the VDT will also be determined – either through actions taken by a WxDE Administrator or by allowing individual WxDE users to specify VDT configuration data. Another possibility is to support a WxDE user in obtaining VDT inputs from the WxDE while running a VDT instance on their own servers.
* Phase 4. VDT custom configuration capabilities will be implemented that will allow a WxDE user to establish VDT operations configured to meet their specific needs, per the approach agreed on in the previous phase. VDT grid segment data outputs will also be integrated with the WxDE.
* Phase 5 (optional). VDT capabilities will be exposed through the WxDE query interface, so that a WxDE user can specify VDT configuration information and receive results produced by the VDT as a query result.

# WxDE-VDT Integration Details

The sections below describe the plans for each phase of the WxDE-VDT integration. The steps required in the first phase are listed in detail, with steps for later phases shown in less detail – detailed steps will be identified as the time to implement each phase nears. The steps themselves will be presented in four categories:

* VDT Wrapper. These are steps related to developing or enhancing the VDT wrapper (i.e., the software that integrates VDT operations with the WxDE).
* WxDE Database. These are steps related to enhancing the WxDE database to accommodate VDT data.
* WxDE Software. These are steps related to enhancing the WxDE software to accommodate the VDT integration.
* WxDE Configuration. These are steps related to modifying WxDE configuration data to support VDT integration.
* VDT Server. These are steps related to installation and operation of the VDT on the server intended to host the VDT.
* WxDE Documentation. These are steps related to enhancing the WxDE documentation to accommodate the VDT integration.

## Phase 1 – Initial VDT Integration

During this phase, the VDT will be integrated with the WxDE. At the end of this phase, the VDT will obtain inputs from the WxDE and other sources, run periodically to produce outputs, and the probe data point outputs from the VDT will be integrated with the WxDE (e.g., be visible on the WxDE maps, be available via WxDE queries). Some of the key characteristics of the Phase 1 VDT integration are:

* The VDT will be configured with static definitions for the road segments and climatology quality checks.
* The VDT will obtain weather observation data from the WxDE.
* The VDT will obtain IMO data from the MN IMO provider.
* The VDT may obtain METAR data from the WxDE, or may obtain it directly from external sources, depending on the difficult in obtaining that data from the WxDE.
* The VDT will obtain radar and RTMA data from external sources.
* The VDT will run periodically and the VDT probe data outputs will be ingested by the WxDE.
* The VDT probe data outputs will be visible in the WxDE data maps in a manner analogous to the approach currently used for mobile data.
* The VDT probe data outputs will be available via WxDE queries and subscriptions in a manner analogous to the approach currently used for mobile data.

The steps required during Phase 1 are listed below.

| Required Changes | |
| --- | --- |
| Changes | Status |
| VDT Wrapper Changes | |
| Create VDT wrapper project. We will create a separate project for the VDT wrapper software. We need to create that project and import standard libraries we will need to use in it. | George  Completed 9/25/2013 |
| Integrate netCDF capabilities into VDT wrapper project. The VDT relies on netCDF files for input and output. We need to include this functionality in the VDT wrapper. | George  Completed 9/25/2013 |
| Prepare VDT road segment data. We need to prepare a VDT road segment file for use by the WxDE VDT instance. We will start with the MN roads file already prepared by VDT. | Bobby  Completed 9/25/2013 |
| Prepare VDT climatology quality check data. We need to prepare a file containing configuration values for the climatology quality checks. We will use the same values provided by NCAR for VDT testing (which might be different from those used by WxDE). | Bobby  Completed 9/25/2013 |
| Develop tool to format IMO data into VDT format. We will obtain the IMO data from the MN IMO source re-format this into netCDF format.  ***Note: The original plan was to pull the MN IMO data directly from the WxDE. However, the WxDE does not currently ingest all of the data required by the VDT. During Phase 1, we will obtain the data for the VDT directly from the MN IMO provider. During Phase 2, we will update the WxDE to ingest all the required IMO data and update the VDT to obtain data from the WxDE.***  ***Note: Tool used to obtain MN IMO data and format into netCDF format. Formatted data was used to successfully run standalone VDT.*** | George  Completed 10/14/2013 |
| Develop tool to format fixed platform data into VDT format. We will extract fixed platform data from the WxDE for use by the VDT by (a) establishing a WxDE subscription for that data (addressed under WxDE Configuration Changes), (b) obtaining this data from the WxDE subscription area, and (c) re-formatting the data into netCDF format.  ***Note: The VDT does not require quality-checked WxDE data, and the additional latency of waiting for quality checked could impact the timeliness of the data produced by the VDT. We will consider whether other approaches should be used to obtain this data from the WxDE for the VDT.*** | Bryan  Scheduled for 10/21/2013 |
| Develop METAR data collector. The VDT requires METAR data, which the WxDE already obtains. We will determine whether it is easier to re-collect the data or re-use the already collected data and implement the selected approach. | Bryan  Scheduled for 10/21/2013 |
| Develop tool to format METAR data into VDT format. The VDT requires that the METAR data be presented in netCDF format. We will develop routines to re-format the METAR data so that it can be used by the VDT.  ***Note: We hope to use NCAR tools for this, so this step involves working with NCAR to obtain that tool*** | Bobby  Scheduled for 10/21/2013 |
| Develop radar data collector. The VDT requires radar data, which the WxDE does not currently collect. We will develop routines to collect the radar data. | George  Scheduled for 10/21/2013 |
| Develop tool to format radar data into VDT format. If necessary, we will reformat the radar data from its native format to the netCDF format expected by the VDT.  ***Note: We hope to use NCAR tools for this, so this step involves working with NCAR to obtain that tool.*** | Bobby  Scheduled for 10/21/2013 |
| Develop RTMA data collector. The VDT requires RTMA data, which the WxDE does not currently collect. We will develop routines to collect the radar data. | George  Scheduled for 10/21/2013 |
| Develop tool to format RTMA data into VDT format. If necessary, we will reformat the RTMA data from its native format to the netCDF format expected by the VDT.  ***Note: The RTMA data is a GRIB file exactly as downloaded from NWS. Bobby verified that the downloaded format does not require modification.*** | Bobby  Completed 10/4/2013 |
| Develop tool to process VDT probe data outputs and present to the WxDE for ingestion. The VDT prepares four output files: (1) VDT output that includes enhanced probe data, (2) road segment statistics data summarizing data along road segments, (3) segment assessment data summarizing road conditions for pre-defined segments, and (4) grid statistics data summarizing data for geographic grids. During Phase 1, the VDT Wrapper will process the VDT output file and insert it into the WxDE database. | George  Scheduled for 10/28/2013 |
| Develop software to schedule and manage the VDT runs. The VDT is a batch process that is initiated through a batch script and a series of configuration and data files. The VDT wrapper will include methods to schedule the data collection and preparation activities, prepare the appropriate batch script, run the batch script, and process the resulting VDT outputs. | George  Scheduled for 10/28/2013 |
| Test the software that schedules and manages the VDT runs and presents VDT probe data to the WxDE. | George  Scheduled for 10/28/2013 |
| WxDE Database Changes | |
| Update the WxDE database to accommodate additional IMO data required by the VDT, but not currently stored in the WxDE database. The WxDE already process IMO data. However, it does not include all IMO data in the WxDE database. We will review the VDT inputs to identify IMO data fields required by the VDT but not currently available from the WxDE and update the WxDE database to accommodate those changes.  ***Note: Reviewed VDT requirements versus WxDE database and determined no changes are required – the IMO data is compatible with the WxDE database design. We will need to add metadata for new observation types.*** | George / Bobby  Completed 10/7/2013 |
| Update the WxDE database to accommodate VDT probe data. The VDT wrapper will provide VDT probe data outputs for inclusion in the WxDE database. This step is to assess database changes that might be required to accommodate this data and implement those changes.  ***Note: We do not currently believe this will require any database changes. It will only requires changes to WxDE metadata, such as defining new observation types for some VDT output fields. The main concern is with the VDT quality checks and integrating those with the WxDE quality checks.*** | George / Bobby  Completed 10/14/2013 |
| WxDE Software Changes | |
| Enhance the Data Observation Map Page to show VDT data locations in the map display (using a new color). The VDT probe data integrated into the WxDE database should appear in the Data Observation Map in a manner similar to how mobile data appears in that map. | Chuck  Scheduled for 10/21/2013 |
| Enhance the Data Observation Map Page to include VDT data as a third type of data (along with Mobile and Non-mobile). Add a check box and filter the map display based on these check boxes. We plan on treating the VDT data in a manner analogous to the way mobile data is treated, as a separate type of data. This check box will allow the user to include or exclude VDT data from the display. | Chuck  Scheduled for 10/21/2013 |
| Enhance the Data Observation Map Page to show VDT data when a VDT data location dot is clicked on the map. The Data Observation Map displays data when a “dot” on the map is clicked. This should occur for VDT data, also. | Chuck  Scheduled for 10/21/2013 |
| Enhance the IMO data collectors to collect additional data required by the VDT. The VDT requires some fields in the IMO data not currently stored in the WxDE database. We believe that the IMO data collectors are flexible enough to extract this data from the IMO sources via configuration changes. This change is included in case software changes are required. | George  Completed 10/14/2013 |
| WxDE Configuration Changes | |
| Add the VDT as a third type of data collected by the WxDE – the three types being fixed platform observations, mobile data, and VDT mobile data. The WxDE currently differentiates between two types of data: data from fixed and mobile platforms. The VDT data is a third type of data.  ***Note: Must be rescheduled for completion during next sprint.*** | George  Partially complete 10/14/2013 |
| Add required metadata to allow the WxDE to support additional observation types used in the IMO data, required by the VDT, but not currently stored in the WxDE database. The IMO data includes data fields required by the VDT, but not currently included in the WxDE database. Metadata must be added defining those new observation types.  ***Note: To expedite Phase 1, IMO data collection for the VDT will be integrated with the VDT wrapper. Pulling IMO data from the WxDE will occur during Phase 2.*** | Moved to Phase 2 |
| Update the IMO data collector configuration data so that the additional observation types are extracted from the IMO data and inserted into the WxDE database. This extraction and insertion is controlled by metadata, which must be updated so that it works with the additional IMO data fields.  ***Note: To expedite Phase 1, IMO data collection for the VDT will be integrated with the VDT wrapper. Pulling IMO data from the WxDE will occur during Phase 2.*** | Moved to Phase 2 |
| Add required metadata to support new observation types for data generated by the VDT in the VDT probe data outputs. The output produced by the VDT will require definition of new metadata (e.g., for new observation types) to support its inclusion in the WxDE database. The required metadata will be integrated into the WxDE database during this activity. | George  Scheduled for 10/21/2013 |
| Develop WxDE IMO data subscription for VDT operations. The VDT operations will rely on IMO data obtained from the WxDE database. We anticipate doing this by establishing a WxDE data subscription that extracts the required data and makes it available to users and applications.  ***Note: It may be necessary to develop a different method for accessing the subscription data, rather than relying on the subscription ftp space. If so, that method will be designed and developed as part of this activity.***  ***Note: To expedite Phase 1, IMO data collection for the VDT will be integrated with the VDT wrapper. Pulling IMO data from the WxDE will occur during Phase 2.*** | Moved to Phase 2 |
| Develop WxDE fixed platform data subscription for VDT operations. The VDT operations will rely on fixed platform data obtained from the WxDE database. We anticipate doing this by establishing a WxDE data subscription that extracts the required data and makes it available to users and applications.  ***Note: It may be necessary to develop a different method for accessing the subscription data, rather than relying on the subscription ftp space. If so, that method will be designed and developed as part of this activity.*** | Bryan  Scheduled for 10/21/2013 |
| VDT Server Changes | |
| Install and test VDT software. We need to install and test the VDT software provided by NCAR to verify it functions as expected.  ***Note: We have only run the software against a single example dataset, and that example included limited input data, so the output produced was likewise limited. It is possible that additional VDT operating problems will be discovered when the VDT is operated against a broader set of real-time data.*** | Bobby  Completed |
| Install and test VDT software on the VDT server. We will install and test the VDT software on the specific server that will be used to support the VDT as part of the WxDE Production Instance. The biggest concern is that we are using a different operating system than the one used by NCAR. We do not want to introduce a new OS into the WxDE environment, so need to verify that the VDT will operate under the WxDE environment OS. | Rhian / George  Completed for 10/7/2013 |
| Install VDT patches. Since we received the initial version of the VDT, one of the input sources has changed. This required a change to the VDT source code to accommodate. Once we verify that the WxDE VDT server will run the previous version of the VDT, we need to update the VDT to the latest version. | Rhian  Completed 10/14/2013 |
| WxDE Documentation Changes | |
| Update the WxDE FAQ sections to include elements related to the VDT and how it is integrated with the WxDE. | Cara / Bobby  Scheduled for 10/28/2013 |
| Update the WxDE FAQ “how to” sections to reflect changes made to the WxDE UI to accommodate the VDT integration. | Cara / Bobby  Scheduled for 10/28/2013 |

## Phase 2 – Enhancing WxDE Data Services

During this phase, most of the data collection activities implemented within the VDT Wrapper will be migrated to the WxDE and WxDE APIs will be developed to expose that data to the VDT. This step is necessary to allow greater control of the VDT operations through the WxDE. It will also make the WxDE environment better able to support other VDT-like applications that USDOT may later elect to support. For example, the radar data collection process will be migrated from the VDT Wrapper to the WxDE with the collected data exposed to the VDT Wrapper. The part of the VDT Wrapper that converts this data into the netCDF format required by the VDT will still be part of the VDT Wrapper.

We will also review the other outputs produced by the VDT – the road segment statistics, the road segment assessments, and the grid statistics – and identify the most appropriate way to integrate those types of data into the WxDE. We expect to select one of the following approaches:

* Integrate directly into the WxDE database. This approach would allow us to make the data visible via the Observation Map Display and available through queries. However, the data is quite a bit different than the other data currently contained in the WxDE database. For example, road segment statistics apply over a segment of road rather than at a point, so the point-based presentation of the data in the map may not be appropriate. Appropriate methods for addressing these differences will need to be identified.
* Integrate the data using file-based methods. This approach would be similar to that used by the RDE, where the VDT outputs would be saved as time-stamped data files that could be downloaded by WxDE users. The data values could not be queried and would not be available through the map interface, though we could represent the locations at which VDT data was available in the map interface.

The changes to the key characteristics resulting from Phase 2 VDT integration are:

* The VDT will obtain METAR, radar, and RTMA data from the WxDE.

The steps required during Phase 2 are listed below.

| Required Changes | |
| --- | --- |
| Changes | Status |
| VDT Wrapper Changes | |
| Replace the METAR data collection capabilities in the VDT Wrapper with capabilities to obtain that data from the WxDE. |  |
| Replace the radar data collection capabilities in the VDT Wrapper with capabilities to obtain that data from the WxDE. |  |
| Replace the RTMA data collection capabilities in the VDT Wrapper with capabilities to obtain that data from the WxDE. |  |
| WxDE Database Changes | |
| Update the WxDE database to track data related to METAR, radar, and RTMA data.  ***Note: We do not expect this data to be stored directly in the WxDE database. Instead, file-based storage will be used with entries in the database necessary to track these files.*** |  |
| WxDE Software Changes | |
| Migrate the METAR data collection capabilities from the VDT Wrapper to the WxDE. |  |
| Develop an API to make METAR data available through the WxDE. |  |
| Migrate the radar data collection capabilities from the VDT Wrapper to the WxDE. |  |
| Develop an API to make radar data available through the WxDE. |  |
| Migrate the RTMA data collection capabilities from the VDT Wrapper to the WxDE. |  |
| Develop an API to make RTMA data available through the WxDE. |  |
| WxDE Configuration Changes | |
| Add required metadata to allow the WxDE to support additional observation types used in the IMO data, required by the VDT, but not currently stored in the WxDE database. The IMO data includes data fields required by the VDT, but not currently included in the WxDE database. Metadata must be added defining those new observation types. |  |
| Update the IMO data collector configuration data so that the additional observation types are extracted from the IMO data and inserted into the WxDE database. This extraction and insertion is controlled by metadata, which must be updated so that it works with the additional IMO data fields. |  |
| Develop WxDE IMO data subscription for VDT operations. The VDT operations will rely on IMO data obtained from the WxDE database. We anticipate doing this by establishing a WxDE data subscription that extracts the required data and makes it available to users and applications.  ***Note: It may be necessary to develop a different method for accessing the subscription data, rather than relying on the subscription ftp space. If so, that method will be designed and developed as part of this activity.*** |  |
|  |  |
| Update configuration data to track configuration information about where and how to obtain METAR data. |  |
| Update configuration data to track configuration information about where and how to obtain radar data. |  |
| Update configuration data to track configuration information about where and how to obtain RTMA data. |  |
| VDT Server Changes | |
| Install the updated VDT Wrapper software on the VDT Server. |  |
| Review the VDT climatology file. During Phase 1, we used the climatology file provided by NCAR for the range quality checks. We’ll compare that file to the one used by the WxDE and, if different, replace it with the WxDE climatology values. |  |
| WxDE Documentation Changes | |
| None required – all changes are to underlying infrastructure and will not be visible to WxDE users. |  |

## Phase 3 – Integrating VDT Road Segment Outputs

During this phase, the VDT road segment data outputs will be integrated with the WxDE. This will require changes to the design of the WxDE database to store both the road segment data and the VDT segment summary statistics. The approach for allowing for custom configurations of the VDT will also be determined – either through actions taken by a WxDE Administrator or by allowing individual WxDE users to specify VDT configuration data. Another possibility is to support a WxDE user in obtaining VDT inputs from the WxDE while running a VDT instance on their own servers.

The steps required during Phase 3 have not been determined, as indicated in the table below.

| Required Changes | |
| --- | --- |
| Changes | Status |
| VDT Wrapper Changes | |
| TBD |  |
| WxDE Database Changes | |
| TBD |  |
| WxDE Software Changes | |
| TBD |  |
| WxDE Configuration Changes | |
| TBD |  |
| VDT Server Changes | |
| TBD |  |
| WxDE Documentation Changes | |
| TBD |  |

## Phase 4 – Supporting VDT Configuration Through the WxDE

During this phase, VDT custom configuration capabilities will be implemented that will allow a WxDE user to establish VDT operations configured to meet their specific needs, per the approach agreed on in the previous phase. VDT grid segment data outputs will also be integrated with the WxDE.

The steps required during Phase 4 have not been determined, as indicated in the table below.

| Required Changes | |
| --- | --- |
| Changes | Status |
| VDT Wrapper Changes | |
| TBD |  |
| WxDE Database Changes | |
| TBD |  |
| WxDE Software Changes | |
| TBD |  |
| WxDE Configuration Changes | |
| TBD |  |
| VDT Server Changes | |
| TBD |  |
| WxDE Documentation Changes | |
| TBD |  |

## Phase 5 – The VDT as a Query Tool

During this phase, VDT capabilities will be exposed through the WxDE query interface, so that a WxDE user can specify VDT configuration information and receive results produced by the VDT as a query result.

The steps required during Phase 5 have not been determined, as indicated in the table below.

| Required Changes | |
| --- | --- |
| Changes | Status |
| VDT Wrapper Changes | |
| TBD |  |
| WxDE Database Changes | |
| TBD |  |
| WxDE Software Changes | |
| TBD |  |
| WxDE Configuration Changes | |
| TBD |  |
| VDT Server Changes | |
| TBD |  |
| WxDE Documentation Changes | |
| TBD |  |

# Questions and Answers

How much modification will happen to the VDT software?

Very little or none. The VDT operates as a stand-alone process that can be run in a batch mode by setting up a set of input and configuration files, then issuing a command to execute the VDT software against these input and configuration files. We will build “wrapper” software that prepares inputs for the VDT, submits the command to run the VDT, and reads the VDT output files and submits them to the WxDE for inclusion in the WxDE database. We will not significantly modify the VDT software itself.