

THE HITVICE VV&A ENVIRONMENT

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ABSTRACT

VV&A process needs to be systematically organized and costs heavy workload. Conventional VV&A tools are mostly designed for special simulation needs, and are lack of flexible workflow processing, CSCW support and integrated resource managing etc. The simulation community needs a synthetic environment more than scattered tools to speed the process of VV&A. In this paper, we introduce our HITVICE VV&A environment for totally facilitating VV&A. The system can realize workflow automation, hierarchical evaluation, CSCW, lifecycle data management and flexible authority control etc. External VV&A tools can also be integrated into HITVICE and interchange data with it. HITVICE has been applied by a large different-placed simulation coded 40301. The system proved to be effective in VV&A assistance, and it's being improved to satisfy new requirements from prospective users.

1 INTRODUCTION

VV&A (Verification, Validation & Accreditation) is applied to ensure acceptable fidelities of simulation systems. It contains relatively complex process and tasks, especially for large-scale simulations, as the DMSO VV&A RPG (Recommended Practices Guide) suggests (DMSO 2000). The VV&A process usually companies with the simulation development process, and it's not just waterfall-styled, but complicated with conditional and backward paths. In practical simulation projects, scheduling and tailoring VV&A process and performing inside jobs are usually time consuming. When the project comes large, the resource management, information flow, cooperative work and authority control become problematic as well.

By this time many tools have been developed to facilitate VV&A, such as DMSO FVT (Federation Verification Tool), EE (Evaluation Environment) (Osman and Robin 2002) and VV&A Turbo Tool (Jennifer and David 2002) etc. These tools are useful for some specific VV&A

jobs or relatively fixed process. However, they cannot handle flexible workflow automation, CSCW(Computer Supported Cooperative Work) and integrated resource management etc. Moreover, it is hard to persuade all tool developers to abide a universal architecture (as CAFDE suggests, Stephen and Paul 1998) to realize tool integration, although this integration can gain higher level interaction among tools. To satisfy the need of total VV&A facilitation, we develop a VV&A environment named HITVICE (Harbin Inst. of Tech. VV&A Integrated Collaborative Environment). In this paper, we give an introduction of the environment first, then present a practical application. The paper is organized as follows. Section 2 gives a system overview of HITVICE. Section 3 explains the subsystems. Section 4 gives an example application of HITVICE use, and finally section 5 gives a summary.

2 SYSTEM OVERVIEW

HITVICE is developed via Lotus Domino Designer and run in Lotus Notes environment. The system is a synthetic environment consisting of several interlinked subsystems. Figure 1 shows the system's functional structure. Each rectangle represents a subsystem, plus the core circle of Workflow Manager Subsystem (WMS).

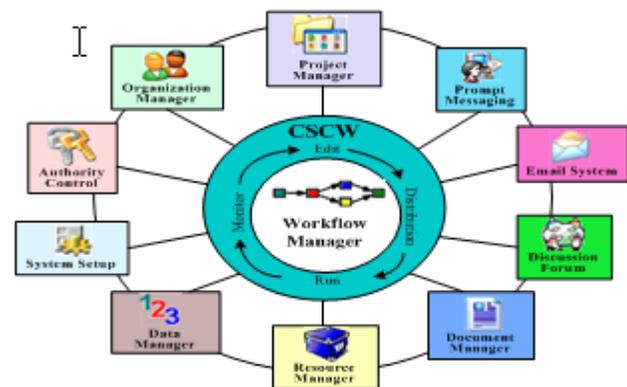


Figure 1: HITVICE System Functional Structure

HITVICE is operated under LAN or WAN network, and supports both C/S (Client/Server) and B/S (Browser/Server) models. Users may choose LAN and C/S to operate for local-placed VV&A projects, or choose internet connection and B/S to operate for different-placed projects. Figure 2 shows the system's network structure.

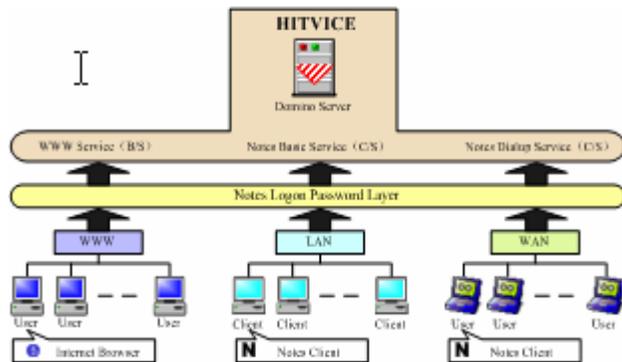


Figure 2: HITVICE System Network Structure

3 HITVICE SUBSYSTEMS

3.1 WMS

WMS applies workflow technique to realize flexible VV&A tailoring and process automation. It adopts IBM FlowMark workflow model, and matches WfMC (Workflow Management Coalition) workflow standards (WfMC 1995-1996). The principals can frame and tailor VV&A workflows with WMS, and can distribute the inside jobs to the corresponding performers. When the workflows are running, the principals can monitor and control the running as well. WMS allows tailoring the workflows even when they are running.

WMS has stored all types of VV&A jobs that we extract from the standard VV&A processes (DMSO, Jean, and Simone 1999-2000). Users can create workflows based on standard templates, or can frame a new workflow from beginning to end. WMS supports coupling among workflows, thus it can realize automated simulation development and VV&A process simultaneously, if the job types are expanded for simulation development tasks.

The VV&A job performers have their Workflow Clients (WC) each, where they receive VV&A jobs and accomplish them with the aid of WMS. WCs give unique interfaces to job performers, which contains only the concerned information of each performer. In order to give material help to performers, WC embeds the Activity Performing Engine (APE) and the CSCW Engine (CSCWE) inside. When a VV&A job is being executed, APE searches the HITVICE code depository and integrated tools to provide processing methods and assistance. If the job is assigned to multiple performers, CSCWE supplies

cooperation methods, collateral control and collaboration perception.

Because VV&A has many types of work, it is unadvisable to provide each work a tool inside system. HITVICE integrates external tools for common activities, and provides own tools for the rest ones. These tools are automatically launched for the job performers by WMS according to the job type. HITVICE uses 4 ways to exchange data between integrated tools and itself, as the following says:

- DIF: Applied to exchange formatted data in ASCII text with specific tools, such as OMDT (Stephen and Steven 2000).
- ODBC: Applied to exchange data stored in ODBC databases (MS Access, FoxPro etc.) with specific tools, such as RTI Verifier (Susan and Joseph 2000).
- XML: Applied to exchange data in XML format with specific tools, such as SMS (Chen and Hu 2004).
- VBA: Applied to exchange data with Word, Excel, PowerPoint and Outlook.

3.2 Prompt Messaging and Email System

Prompt Messaging allows the VV&A staff to make instant intercourse by sending and receiving messages. The tool is embedded on the top lines of the screen. It is just like ICQ inside system and is ready to use at any time.

Lotus Notes has a perfect built-in email system, which supports internal and internet emails. HITVICE users can benefit from the email system to send and receive emails. However, it is unnecessary to exchange work materials via email. Corresponding HITVICE components will take the charge of automated data flow and resource supply.

3.3 Discussion Forum

Discussion Forum allows the VV&A staff to communicate if the information exchange is not required right away, or the discussion is time consuming. The tool is an article-posting space similar to a BBS (Bulletin Board System). Communicators can post technical subjects and make replies. The tool supports multimedia content and allows a reminding message sent to the subject owner if there are new replies.

3.4 Project Manager

HITVICE separately stores data for different projects to support multiple projects. Project Manager (PM) can help principals create new VV&A projects, switch projects, monitor projects and reset project parameters. PM only

holds general project information. Detailed project data are stored in corresponding subsystems inside projects, whose entrance links are set in the PM window.

3.5 Organization Manager

Organization Manager (OM) can help principals appoint the VV&A staff and manage their archives. OM adopts role, team and staff structure to describe an organization, and supports tree-like hierarchical modeling with infinite levels. It possesses all necessary information of a VV&A personnel, such as name, ID, major, phone number etc., especially his belonged project role(s) and team(s). For specially HLA assistance, OM also provides functions to create federates in the system, and can assign persons to federates. Figure 3 is an example view of a personnel archive.



Figure 3: A Personnel Archive in OM

3.6 Data Manager

Data Manager helps users collect product data in numeral format, which are mainly extracted from ODBC databases or simply text files, and then store them in HITVICE as resource to share. Users can perform data view, edit, index, search, compare, import and export with Data Manager. Moreover, other subsystems and engines rely on Data Manager to provide users their required data automatically.

3.7 Document Manager

Document Manager automatically archives report documents as resource. It provides similar functions of Data Manager, plus version control and document tracing. HITVICE has realized seamless combination with Word, Excel and PowerPoint via OLE and VBA, and can provide users convenient interface to edit and review documents.

3.8 Resource Manager

Resource Manager (RM) is a huge universal container for all kinds of data. It absorbs appointed resource from Data Manager and Document Manager, and stores other reusable project products (such as workflows, authority setups etc.) for simulation reuse. RM classifies resource according to its usage to speed the index and search process, but does not concern about data type. All VV&A projects inside system can access RM to find usable resource and extract them.

3.9 System Setup

System Setup (SS) is used to set document type and templates, V&V objects, V&V index trees and authority control settings (see the following sections). The V&V object is the target to be verified or validated. HITVICE uses the Hierarchical Evaluation Method (HEM) to perform V&V. HEM uses index tree to lead the evaluation path. The index tree regulates from what point and direction the evaluator evaluates the target, and how much these points and directions weight (Fang and Yang 2005). This subsystem can only be accessed by the project principal.

3.10 Authority Control

HITVICE adopts C/S or B/S network model and center-concentrated database framework. Each user has a certification file installed on his client computer, and must type in his unique ID and password to log on the system. IDs and passwords are supervised by appointed system administrators.

Besides the system entrance, the subsystem entrance, system operation and sensitive data are under authority control in HITVICE. HITVICE relies on the Authority Control Subsystem (ACS) to guarantee the security of these objects, and ACS shares the interface with SS. ACS registers controlled objects and holds security levels and lists of authorized persons for them. The authorization list can be described by staff, role (most often used), team and a mix of them. When a user is attempting to access controlled objects, ACS can perceive it and searches its lists for the operator to give a permission or block. Moreover, it can also record accessing behaviors to create log files.

4 HITVICE APPLICATION OF 40301

4.1 Project 40301

Project 40301 is a large-scaled HLA simulation that is used to access the effectiveness of missile attack and defense. The simulation contains tens of federates and hundreds of entities, which contains missiles, satellites, radars, command and control structures, etc. The weather and terrain

effects are considered. The tactics are varied to evaluate the missile destruction and interception effects. 40301 has a large project team, and the members come from several institutes and departments. We are responsible for providing a synthetic environment to facilitate the project's VV&A, and this environment must be flexible on process tailoring, automated on information flowing and reliable on authority controlling. Thus the HITVICE system is applied in 40301. The project started in 2001, and is finished in 2005.

4.2 Locate Server and Create Project

40301 locates his headquarter in Beijing, thus we also locate the HITVICE system server there. All client computers can access the environment with normal Lotus Notes client software, after we register the node users and distribute the certificate id files.

After the server location, the system administrator launches PM to create a new project for 40301's VV&A (abbreviated as 40301 below). The project principal is appointed and the project's private databases are generated. Now the project is ready to start. Figure 4 is the main window of PM representing 40301.



Figure 4: PM Main Window of 40301

4.3 Create Project Roles

The 40301 activities use project role to assign job performers, and the authority control subsystem also needs it to keep the authorization lists. Table 1 shows the 40301 project roles and their responsibilities. The project principal uses OM to create them, and the project staff possess these roles after they are appointed. Figure 5 is the role page of 40301.

Table 1: 40301 VV&A Roles

Role	Responsibility
Project Principal	create roles, create document types, assign authorities, create V&V objects, create V&V index trees, manage workflow
Coordinator	coordinate project user and staff
Federation V&V Principal	appoint federation V&V member, lead federation V&V
Federation V&V Member	perform federation V&V
Federate V&V Principal	appoint federate V&V member, lead federate V&V
Federate V&V Member	perform in federate V&V
Accreditation Principal	appoint accreditation member, lead accreditation
Federation Accreditation Member	perform accreditation
SME	participate in VV&A activities



Figure 5: The 40301 Role Page

4.4 Create Document Types and Assign Authorities

40301 has several VV&A document types. They are Accreditation Requirements, V&V Requirements, Acceptability Criteria, Accreditation Plan, V&V Plan, V&V Results Report and Accreditation Report. The project principal uses SS to create these document types, and each document type has a corresponding template assigned. When the author writes the document, HITVICE opens its template to give a document structure. Figure 6 is the document type page of 40301.

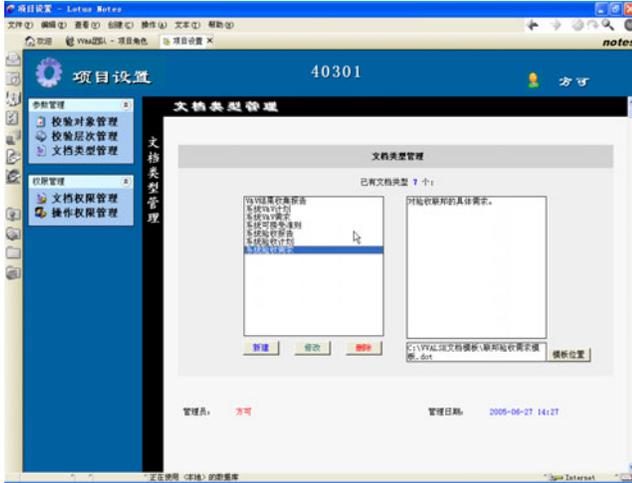


Figure 6: The 40301 Document Type Page

The project principal uses SS to assign corresponding roles for accessing documents and system operations. 40301 follows the principle of “The need determines the authority”. If the staff who possess one role need to work with a document, this role is assigned to access that document type. The system operations (such as “Create Workflow” in WMS) authority are generally set to the project principal, besides some specific persons and system administrators. Figure 7 is the page of setting 40301 document authority.

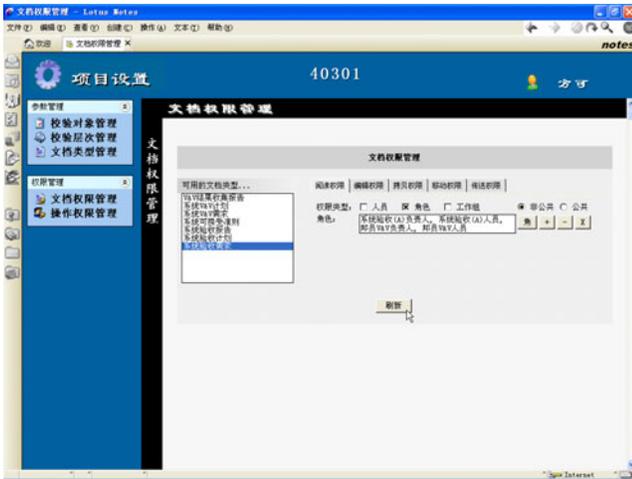


Figure 7: The 40301 Document Authority Page

4.5 Create V&V Objects and Index Trees

40301 has many verification and validation activities. Before framing the VV&A workflow, the project principal uses SS to create V&V objects. All 40301 V&V objects are listed in Table 2, and Figure 8 is the page of creating them.

Table 2: 40301 V&V Objects

Phase	V&V Object
1	System Overall Requirements
	Scenario & Entity Requirements
	System Function & Performance Requirements
	System Security Requirements
	System Development Plan
	System Test Plan
	System Security Plan
2	Simulation Scenario (multiple)
	FCM
	Updated System Overall Req.
	Updated Scenario & Entity Req.
3	Updated System Function & Performance Req.
	Updated System Security Req.
3	Entity Mathematical Model (multiple)
4	Federation Division
	Federate Function (multiple)
	Federate Development Plan (multiple)
	Federate Test Plan (multiple)
5	Federate Security Plan (multiple)
	FOM
	Background Information Agreement
	Time and Space Agreement
	Data Format Agreement
6	Other Agreements
	Federate Implementation (multiple)
	RTI
	FEPW
	System Preliminary Integration
	Simulation Interaction
	FCM Implementation
7	Scenario Implementation
	System Function Implementation
	System Performance Implementation
7	System Credibility

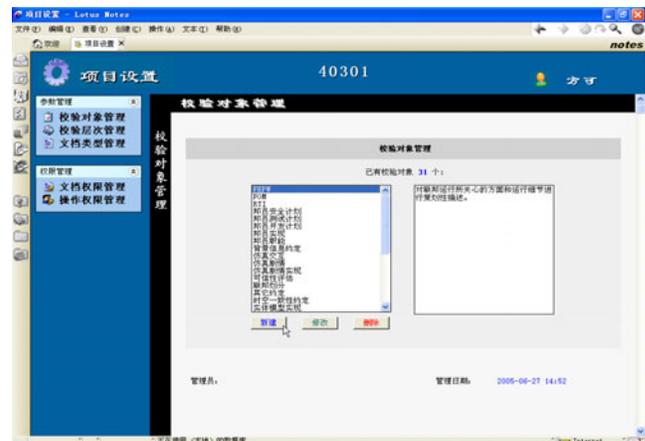


Figure 8: The 40301 V&V Objects Page

Using SS, the project principal consults SME for reference and create reasonable index trees for each V&V object. This is a time consuming work, but must be done patiently and carefully, since it may influence the final VV&A conclusion to a great extent. Figure 9 shows an example of the V&V index tree for the 40301 FCM.

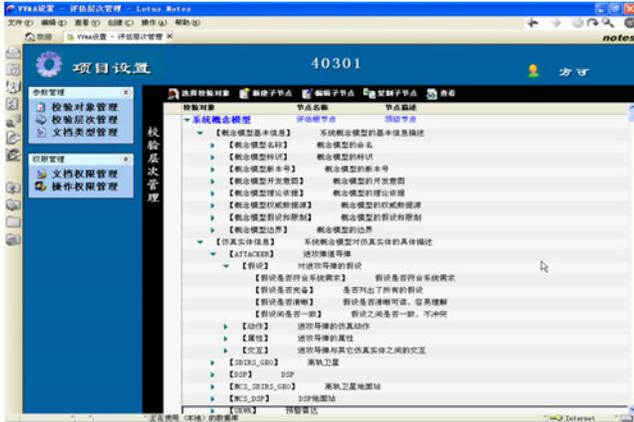


Figure 9: The V&V Index Tree For The 40301 FCM

4.6 Frame The VV&A Workflow

Then the project principal is ready to access WMS to frame the VV&A workflow for 40301. 40301 is a rigorously HLA-based simulation, so the principal starts with the standard HLA VV&A workflow template and tailors it to meet the project requirements. The workflow has 3 task types, which are Staff Appointment, Document Submission and System V&V. The project roles, document types, V&V objects and index trees described in the last sections are available to assign in VV&A activities now. All workflow activities' performers are assigned by project roles.

Figure 10 shows the "Scenario Verification" activity page. It contains information of activity name, description, type, validation object, performers, input, output, reference, etc. in 4 tabs. Figure 11 is the workflow window of 40301. The final workflow contains 7 phases and 56 activities.

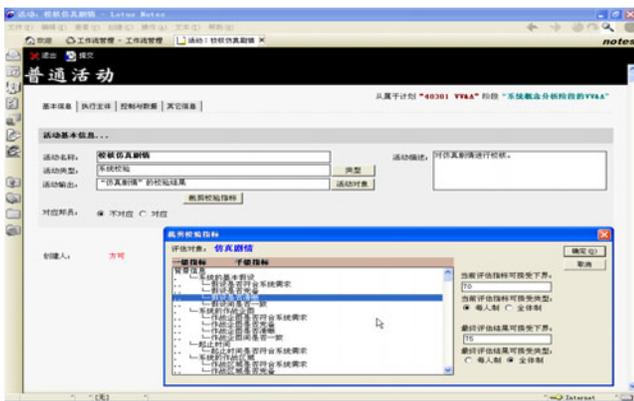


Figure 10: The Scenario Verification Activity of 40301



Figure 11: The Workflow Window of 40301

4.7 Run The VV&A Workflow

After the VV&A workflow modeling is done, the project principal set it running and HITVICE automatically interprets the execution sequence and distributes the activities inside to the corresponding performers. This moment is roughly the time when the 40301 simulation development starts.

When the workflow is running, the project principal still monitors the work progress. Sometimes he also need to halt the specific parts of the workflow and modify them according to the change of the VV&A schedule. To such a large project like 40301, the alteration of the schedule here and there is unavoidable after the project starts.

Normal VV&A job performers do not have to concern about those things above, they just enter their WC every day to receive jobs belonging to themselves, and finish the jobs in HITVICE. Via the workflow technique, the 40301 information flow is highly automated so that all resource and achievements are flowed to the persons who need them automatically. The 40301 staff can focus on the VV&A jobs and save the energy to acquire or transfer data.

The following sections describe 3 types of VV&A jobs in 40301.

4.7.1 Appoint VV&A Personnel

We put the jobs of appointing VV&A personnel in the 40301 workflow. This can guarantee the staff exists in the system when his jobs come. HITVICE opens OM for the appointer, and he appoints the person who possesses corresponding roles (see Table 1) defined in the job. Then the following jobs that take the person as the performer can be activated.

4.7.2 Submit VV&A Documents

40301 mainly takes the document as its resource and achievement. When VV&A members are performing document submission jobs, HITVICE provides a Word embedded interface, and stores the final document in the system as Notes document format, but not a Word file. In order to standardize the document structure, all types of 40301 document have templates each (see Section 4.4).

40301 values teamwork. All jobs of document submission are assigned to multiple performers. When an author is editing his document, he can view other cooperators' documents at any time, and can change opinions with them via Prompt Messaging. When an author's document comes to a final version, he pre-publish it. If other cooperators agree to submit it as the job achievement, the document is published in the system, and the job is accomplished. Figure 12 shows the interface of editing "Accreditation Requirements" document of 40301.

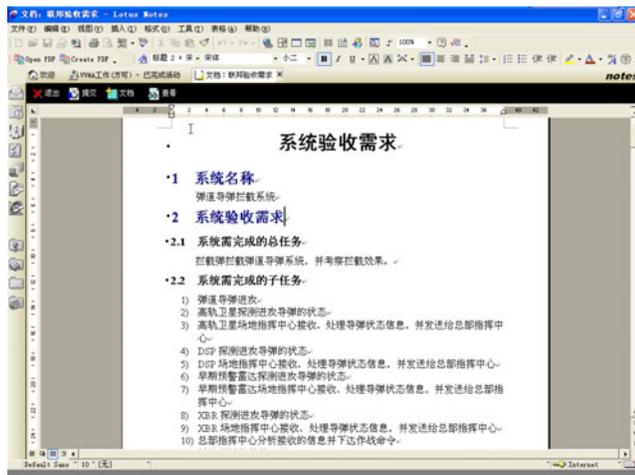


Figure 12: Editing "Accreditation Requirements" of 40301

4.7.3 Perform V&V Evaluation

40301 VV&A workflow is mainly composed by V&V activities. When a member is doing his job, the V&V object and reference is opened on the screen, and HITVICE collects the V&V indexes for the object (see Section 4.5 for V&V objects and index trees). The evaluator sets the weights of index nodes and scores them. HITVICE uses the same scoring system to EE (Osman and Robin 2002). Figure 13 shows a V&V performer's screen of FOM verification of 40301.

All 40301 V&V activities are assigned to multiple performers to collect a wide range of opinion. The performers are V&V members and SMEs. After all job performers finish evaluating, the V&V principal sets weights for the performers and HITVICE calculates final results to create a report.



Figure 13: FOM Verification of 40301

The report contains activity information, the final scores for index nodes, the final scores of evaluators, and the last final score for the V&V object.

4.7.4 Other Subsystems Usage

Besides the main subsystems described above, 40301 staff use others to aid their work as well. They access Data Manager, Document Manager and Resource Manager frequently to get their required information. Although the automated information flow can almost meet their demands, they have to get documents manually for some special needs, and this can also alleviate the principal's workload of modifying the information flow inside the workflow. Definitely, these data accesses are in the range of authority control.

40301 staff like to enter the Discussion Forum casually to check and post articles. These articles are mostly for the exchange of technical ideas. The Email System is rarely used because the transfer of information is well done by other subsystems.

4.8 Finish The Project and Maintain Achievements

40301 is accomplished after the last "Final Accreditation Report" is submitted. The project principal can view any achievement in WMS by just clicking the activity. All project documents and V&V reports are archived in the Document Manager. The resource maintainer makes database backups and keeps them on CDs. The documents and reports are also printed out to make hard copies.

5 SUMMARY

As the simulation objectives are getting higher and higher, a synthetic environment can give much more VV&A facilitation than scattered tools. We develop HITVICE system to interlink every aspect of VV&A assistance and aim to

totally resolve the problems. Adopting the workflow and CSCW technique to drive VV&A process automation is the key innovation of the system. Meanwhile, to help improve VV&A work efficiency and alleviate the workload, HITVICE allows each personnel to focus on his jobs and save the work on peripheral affairs (such as document transfer or resource acquisition). Having had the applications in Project 40301, the HITVICE system is being further developed to add project templates and wizards, provide graphical workflow modeling and integrate more automation tools. We hope HITVICE can serve for more and more VV&A projects in the future, especially for large-scale ones.

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