Testbed for Integrated GCS Experimentation and Rehearsal (TIGER) development summary II

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Abstract

The Testbed for Integrated Ground Control Station (GCS) Experimentation and Rehearsal (TIGER) is being jointly developed by United States Airforce Research Laboratory (AFRL) and Defence Research and Development Canada (DRDC) Toronto Research Centre. This report documents challenges and successes in developing TIGER knowledge acquisition and management process, involving aspects of installation, site preparation, equipment procurement and tracking, human resourcing, training, and technical documentation. The objective is to support future system maintenance, asset management, experimentation and trials, and maintaining and training team and crew members using lessons learned and reference materials created for this purpose.

Significance to defence and security

The purpose of the testbed is to provide the Royal Canadian Air Force (RCAF) with the capabilities and scientific evidence to address UAS GCS functional requirements, airworthiness certification, human systems integration, crew configuration, and operator training issues. TIGER initial analysis, development, and empirical studies clearly demonstrated the need for RCAF to build the capability to address these issues.

Résumé

L’Air Force Research Laboratory (AFRL) des États-Unis et le Centre de recherches de Toronto de Recherche et développement pour la défense Canada (RDDC) travaillent conjointement à l’élaboration du banc d’essai pour l’expérimentation et la préparation intégrées des postes de contrôle au sol (PCS) (Testbed for Integrated Ground Control Station Experimentation and Rehearsal [TIGER]). Le présent rapport fait état des difficultés et des réussites durant l’élaboration du processus d’acquisition et de gestion du savoir sur TIGER, ce qui comprend les aspects que sont l’installation, la préparation du terrain, l’achat et le suivi de l’équipement, le recrutement des ressources humaines, la formation et la documentation technique. L’objectif est de soutenir la maintenance, la gestion des biens, l’expérimentation et les essais relatifs au futur système, ainsi que de former et tenir à jour les membres d’équipes et d’équipages à l’aide des leçons retenues et des documents de référence élaborés à cette fin.

Importance pour la défense et la sécurité

Le banc d’essai est destiné à fournir à l’Aviation royale canadienne (ARC) les capacités et les observations scientifiques dont elle a besoin pour répondre aux exigences fonctionnelles des PCS des systèmes d’aéronefs sans pilote (UAS), ainsi qu’aux questions relatives à la certification de navigabilité, l’intégration des systèmes humains, la composition des équipages et la formation des opérateurs. Les analyses, les travaux de développement et les études empiriques de TIGER effectués au départ démontrent clairement que l’ARC a besoin de se doter des capacités nécessaires pour s’attaquer à ces questions.

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1 Introduction

The Testbed for Integrated Ground Control Station (GCS) Experimentation and Rehearsal (TIGER) is being jointly developed by United States Airforce Research Laboratory (AFRL) and Defence Research and Development Canada (DRDC) Toronto Research Centre. The purpose of the testbed is to provide the Royal Canadian Air Force (RCAF) with the capabilities and scientific evidence to address UAS GCS functional requirements, airworthiness certification, human systems integration, crew configuration, and operator training issues. TIGER initial analysis, development, and empirical studies clearly demonstrated the need for RCAF to build the capability to address these issues [1].

TIGER is a complex system consisting of numerous hardware and software components in six crew stations: Air Vehicle Operator (AVO), Payload Operator (PO), and Image Analyst (IMA-A), Image Reporter (IMA-R), Electronic Warfare Analyst (EW-A), and Electronic Warfare Reporter (EW-R). In addition, it includes three exercise management stations, Instructor Operating Station (IOS), Computer Generated Forces (CGF) station, and Role Player (RP) station, as well as two manned stations for data collection (Experimenter 1 and 2). Each station is equipped with a standard communication suite, Situation Awareness (SA) display, and planning / reporting tools, in addition to individual software suited to each operator's role.

During the installation of the testbed, the DRDC team encountered and addressed many challenges due to complexities and intricacies of setting up and running the simulator. This led to a concerted effort to consolidate all individual software and hardware component manuals into a single repository, document the steps and procedures to operate TIGER, and create tracking mechanisms to manage and maintain all other aspects of TIGER. This report documents challenges and successes in developing TIGER knowledge acquisition and management process, involving aspects of installation, site preparation, equipment procurement and tracking, human resourcing, training, and technical documentation. The objective is to support future system maintenance, asset management, experimentation and trials, and maintaining and training team and crew members using lessons learned and reference materials created for this purpose.

2 Statement of results

2.1 TIGER installation

TIGER was installed by United States Air Force (USAF) L3 contractors at DRDC Toronto in July 2015 with assistance from a team of four DRDC Toronto technical team members and two pilots in training. The installation did not go without challenges and there were lessons learned from the start. One example is the malfunction of the computer at the AVO station. The contractor installed the CentOS 6 operating system on a virtual machine at the PO station to demonstrate dual display capabilities of the Vehicle Control Station (VCS™) software, one method TIGER uses to control a UAS. On their last day on site, contractors were expected to repeat the CentOS 6 and VCS installation at the AVO station, but the system did not boot. The team spent the day formatting the AVO hard-drive and re-installing the AVO station software, as well as CentOS 6 and VCS. VCS was then demonstrated to be working in dual display mode at the AVO station. As a result, monthly automated backups, saved to the TIGER server, were set up for each TIGER station.

Shortly thereafter, the AVO station refused to boot again, due to an error associated with the hard-drive. Attempts to format the AVO station's hard-drive failed and as a result it had to be replaced. The team learned that restoring the hard-drive over the network did not work, as the network setup could not be performed as part of the installation process of a new hard-drive. Instead, the backup files from the server were copied to a USB hard-drive, which was used to restore the AVO station. However, the backup of the AVO station did not include all of its partitions; the missing D partition was copied from the PO station to complete the restoration of the AVO station. Due to the differences between the software configurations for the AVO and PO stations, a number of settings had to be changed when copying the D partition to the AVO. The team corrected and documented these issues for future reference.

Most of the TIGER software was pre-installed when received with the hardware. Additional challenges the team encountered were: identifying each software component needed to run TIGER, locating the associated documentation, and learning its functionality, configuration, and its interface with other components. While some relief was available from the contractor through training during installation, the learning curve was substantial as each team member worked at attaining higher levels of operational and/or technical proficiency on various components at the same time. Some software-related issues remain outstanding and continue to be monitored, such as a procurement hold-up for the renewal of MetaVR's Virtual Reality Scene Generator (an image generator used to create the 3D scene the crew views through UAS sensors), and a "jitter" problem of the second image generator, Diamond Visionic's Genesis.

Since the original installation, the DRDC team worked on integrating and displaying high resolution maps on all crew stations and into the CGF station software Modern Air Combat Environment (MACE), installing screen capture software capable of recording multiple monitors simultaneously, debugging Coalition Performance Evaluation and Tracking System (CPETS) on the experimenter stations, and using the software to develop and implement new TIGER training and evaluation mission scenarios for future experiments.

2.2 System and user manuals

TIGER was received with manuals for individual software packages, but no overarching document that described the configuration, networking and steps to stand up and operate the simulator. The team gathered their individual knowledge from the week long installation by USAF L3 contractors, and their subsequent experience trialing the system. The objective was to develop manuals that document software and hardware configurations in the Systems manual, and describe the steps to getting TIGER up and running for each operator station in the User manual. The manuals are essential in assisting the current team in developing scenarios and running trials, and will also serve as valuable tools for training operators and new TIGER team members. These manuals are available on the TIGER server (Z:\POST-Installation TIGER Documents\TIGER Manuals).

The manuals evolved in stages as the team learned more about the systems, and was validated in its final stages both with subjects who were familiar with the system (i.e., team members) as well as those who were naïve to the capabilities of the system or the operator tasks. Validation involved step by step start up and operation of the system based solely on the instructions from the manuals. This ensured that the documents were comprehensive and the information was accurate and sufficient to run the simulator.

The manuals include the list and description of hardware and software components installed on each computer, how to start the system, detailed operator instructions for each individual station, the location of important files such as backups, the admin credentials, etc.; both are augmented by screenshots for better visualization. The Appendix in both manuals contains a list of all available manuals and guides for all the components of the system, and their location. Both manuals also include the list of current TIGER team members, their expertise, and contact information. Details of the individual software packages are not included in the main Manuals; instead they are consolidated in one directory on the server for easy access by users, indicated in the manuals. One team member is designated to continuously updating pertinent information.

2.3 Storage and security management of information assets

Given the complexity of the TIGER system, creation of a single point of storage for information in both electronic (e.g., install files, configuration files, other system-related information) and text (e.g., manuals, Standard Operating Procedures, product information, reference material) formats, was critical to enhance the integrity and traceability of such assets. Depending on the format and sensitivity levels, these are stored on TIGER machines or DRENet machines, at pre-defined directory locations, or in storage cabinets.

The Z:\POST-Installation Tiger Documents directory on the TIGER server acts as the master location to store information documents generated after TIGER's initial installation (e.g., training notes, trouble logs, video/photo clips, instructions, and the manuals mentioned above). This means that a current version of the documents (and revisions where applicable) must be copied onto this drive if created or changed on DRENet or an alternate location. This directory has been created as an interim measure to establish some form of control and tracking mechanism for new documents while the capability goes through its "growing pains", at which point, the documents can then be ported and integrated with TIGER's existing directory structure.

TIGER information assets received from AFRL are deemed UNCLASSIFIED; however, as the testbed installation progressed certain elements, such as AFRL-related material that were identified as SENSITIVE (i.e., administrative credentials and certain technical testbed configuration parameters); remain on TIGER equipment that cannot be accessed by any other network. Should the need to operate outside these parameters arise, approval for storage and/or distribution will be sought through the Principle Investigators. All external media is scanned by ITS when transferring files between TIGER and other computer systems (e.g., laptop, DRENet).

To address the need to track all components of the TIGER system and facility, an Excel-based assets tracker was developed and populated for that purpose. The existing Centre's MS-Access Inventory tracking system was not deemed appropriate for the level of granularity required to carry out more comprehensive TIGER Project and assets Life Cycle Management (LCM) activities (e.g., software assets and project information). The life cycle manager also contains costs to stand up TIGER and its life cycle costs. The file contains macros which must be executed before being able to do any work on the file. Only authorized individuals will be able to add and change the data. All newly acquired items, or changes to the existing TIGER assets repository, is to be reported and recorded in this spreadsheet. Individuals receiving new assets are to place a copy of the packing slip or shipping record, software license certificates / activation key (printed copy of e-mail message if sent electronically), or any other document (text copy) accompanying acquired items, in the designated filing tray in the simulator area. These will be collected periodically and processed by one of the authorized individuals. Contract (maintenance, support, development, installation, training, other) and asset information is also recorded to support project and life cycle management activities (e.g., total project costs). While only few individuals have the ability to apply changes to the "MASTER-TIGER.xlsm" spreadsheet, everyone will be able to create a non-protected copy of the file and have the flexibility to perform search, sort, and reporting functions best suited to their requirements (e.g., a list of all assets belonging to the Intelligence Analyst workstation, license expiry dates).

2.4 Procurement

A number of items were procured throughout the TIGER installation process to address immediate needs such as a more comprehensive backup and recovery process (e.g., additional RAID backup hard drives and accessories), as well as additional items to build the Centre's UAV capability (e.g., table displays, furniture, computers, briefing areas) to test various operator-layout configurations and for longer-term experimentation. One key challenge experienced in this area was the extraordinarily long timeframe to complete many of the acquisitions due to procedural changes in the procurement process, which ultimately resulted in items not being obtained using current year's budget, thus impacting the following year's budget allocations. It is anticipated that this risk will be mitigated upon the resolution of the procurement process.

3 Discussion of results

Using the System and User manuals, TIGER can be easily started up and each workstation can be configured in an operational mode providing displays pertinent to TIGER crew members. An exercise can be started and operated to completion. The manuals provide useful support and operational information.

Continuous refresher training of the team on a periodical basis is essential to maintain expertise. Even with the manuals, hands-on experience is invaluable. Cross-training is advisable to cover team members in unforeseen circumstances.

TIGER is currently a robust system requiring little maintenance. Only one hardware failure was recorded since the installation—and that was an exacerbation of the problem encountered on the last day of installation (a failing hard disk). It has been operating without issues since.

The installation incident demonstrated the necessity for regular backups. For example, for individual computers, these include: the original software install files for each server and each computer—as they were when delivered and powered on (e.g., Windows, CentOS, and VCS install media); system start-up and recovery disks, system image and system repair disks (for added contingency).

Asset and security management are essential components of life cycle management for a system of this size and complexity. The data needs to be regularly updated by designated personnel. One example is the licencing and support requirements of a number of Commercial-Off-The-Shelf products that have to be monitored and anticipated to avoid losing system functionality.

The clear and specific assignment of responsibilities within the team based on their expertise is critical to maintain the functionality of the system. Responsibilities include: TIGER facility access and administration; asset management (asset inventory and lifecycle management); network & systems administration (network, hardware, software\OS, media, and system security credentials); back-up & disaster recovery; and technical documentation and maintenance.

There are many factors that are outside of the team's control (e.g., asset procurement, contracting, product licencing terms and conditions). However, if anticipated with sufficient lead time, the effect on operations can be minimized.

4 Conclusion

TIGER is currently in operational state and has been used successfully in two trials to date. The team documented the efforts and established a knowledge acquisition and management process, involving all aspects of installation, site preparation, equipment procurement and tracking, human resourcing, training, and technical documentation. This is an ongoing effort dedicated to support current and future system maintenance, asset management, experimentation and trials, and maintaining and training team and crew members.

References

[1] Hou, M. (2015). Testbed for Integrated GCS Experimentation and Rehearsal (TIGER) Development Summary I. Defence Research and Development Canada, DRDC-RDDC-2015-L282, 2015.

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