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# Starship: Supporting the Testing of Developing Army Technologies as a Test Command and Control Platform

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*A primary mission of the U.S. Army Electronic Proving Ground (EPG) is to perform command, control, communications, computers and intelligence (C<sup>4</sup>I) developmental test and evaluation (DT&E) for the Army. With Department of Defense focus on finding more effective ways to perform DT&E, the Army is acquiring increasingly complex digital C<sup>4</sup>I equipment, with a resulting dependence on increased automation, modeling and simulation. In order to conduct C<sup>4</sup>I DT&E more efficiently, EPG has developed a vast array of hardware and software tools that keep it on the DT&E technology forefront worldwide. One such effort is the Starship project, an intuitive, expandable collection of tools to control and monitor EPG and non-EPG testing and test instrumentation.*

**S**tarship consists of an object-oriented simulation engine and a collection of user applications to monitor and control a test or training exercise and the individual instrumentation contained within the test or training exercise. The underlying components and eXtensible Markup Language (XML) technology implemented within Starship are industry-standard and provide maximum extensibility, scalability, flexibility and reusability. Starship's user interfaces are highly customizable, employing the industry-accepted Microsoft Windows Explorer Internet browser and Outlook Express mail client.

The Starship suite includes:

■ **StarGen**—a tool that allows users to graphically build a series of interrelated events, execute those events, monitor the successful completion of those events, graphically display reported status and generate real-time and post-event reports.

■ **Master Controller**—a tool that allows both fine and aggregate-level control of any controllable aspect of the testing or training exercise. The Master Controller allows users to customize displays and

establish threshold display criteria.

■ **Record and Playback Manager**—a video cassette recorder-like tool that allows users to review events at the speed at which they occurred or up to 64 times their normal speed.

■ **Starship Console**—the command center for the simulation engine.

■ **Entity Status Display**—a display and print tool that shows the behavior of instrumentation over time.

■ **Incident Log**—an interactive tool that allows users to manually supplement automatically logged information.

## Background

The U.S. Army Electronic Proving Ground (EPG), constrained by a shrinking budget in the mid-1990s, analyzed the trends within the Department of Defense (DoD) and realized that its existing instrumentation and software suite needed to evolve. EPG's next-generation test instrumentation suite had to be able to effectively monitor systems under test, while capturing and recording rele-

vant data and remotely controlling test instrumentation configured within increasingly complex, comprehensive test scenarios. The test instrumentation suite would become sufficiently versatile to integrate with simulation systems in a laboratory environment, to deploy in geographically dispersed test exercises, to provide ground and test range locations and to operate easily. Late in Fiscal Year 1997, EPG decided to upgrade its software architecture to retain the organization's developmental test and evaluation (DT&E) technology position.

In 1998, EPG initiated the Virtual EPG (VEPG) Architecture Project. The VEPG Architecture Project is an umbrella program consisting of complementary development projects to enhance existing technology and to develop new technology with reusable software components. VEPG architecture applications were designed and built to be flexible, extensible, scalable and robust to facilitate stand-alone use or to be easily integrated into a system of systems. One VEPG initiative was to replace the existing EPG UNIX-based test and control center with a Windows NT-based test instrument monitoring system. The project was given the name Starship.

## Starship project background

The Starship development project began in November 1998. The vision of the Starship project was to develop an intuitive, expandable collection of tools (consistent with the EPG software architecture project goals) to control and monitor EPG and non-EPG testing and test instrumentation.

1) Operationally, Starship was developed to automate any partial or complete process, including:

- *Planning*
- *Execution*
- *Real-time monitoring*
- *Real-time control*
- *Real-time and post-process analysis*
- *Real-time and post-process reporting*

2) Technically, Starship project goals included:

■ *Extensibility*—the ability to add capabilities or new test instruments and other hardware to Starship without having to modify existing code.

■ *Scalability*—the ability to increase the number of Starship users or the number of test instruments and other resources Starship monitored and controlled without having to modify existing code.

■ *Reuse*—the attempt to leverage existing commercial and government components before developing them in-house.

■ *Best commercial practices*—the use of system

designs and processes that have yielded the most success in the industry.

The overall software design was initially called the "Starship Enterprise." This design consisted of a collection of loosely coupled and highly cohesive components that provided maximum flexibility and performance. Nine months after project inception, the evolving Starship, including the Virtual Exercise and the Master Controller, was initially released in August 1999.

Since then, the development team has added products identified within, and compatible with, the initial architecture and design. These products now include the Starship Console, the Record and Playback Manager, the Pinger Status Chart, the Entity Status Display, StarGen and the Incident Log.

Together, these tools provided the means to:

■ Conceive and graphically represent the (test or training) process.

■ Designate event handling.

■ Create and display macro/micro views of instrumentation and network(s) status and event handling.

■ Perform fine and aggregate-level control.

■ Record and play back all (test or training) events.

■ Manually enter key additional information that helps document (test or training) events.

From Starship's inception as a PC-based, Microsoft Windows program developed to command, control and display the status of any acquisition (for example: instrument, control, live battlefield system, simulated battlefield entity), EPG designed the project to be the next-generation test control center (NGTCC).

## Capability description model: Starship NGTCC-2002

*Figure 1* contains a simplified view of the Starship architecture. The figure depicts the tiered design that is industry-standard and that enables flexibility, adaptability and expansion. The four tiers are:

- 1) Presentation
- 2) Business
- 3) Data
- 4) Communications

The Presentation Tier consists of an exposed interface and a Presentation Client Manager through which any presentation-level client can interact with the Virtual Exercise.

The Business Tier is called the Virtual Exercise. The Virtual Exercise consists of components designed to instantiate virtual entities and expose interfaces to allow:

- 1) Presentation Client applications to access the virtual entities to monitor status (or state) information.
- 2) Presentation Client applications to control entities by applying methods to their virtual counterparts.
- 3) External simulations to create and interact with virtual entities.
- 4) The recording of state change data to any Structured Query Language (SQL) and Open Database Connect (ODBC)-compliant data repository.

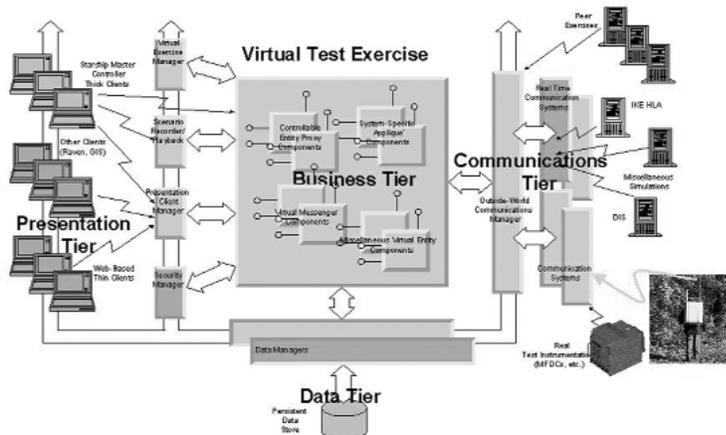


Figure 1. Starship tier concept

The Data Tier accommodates any SQL-compliant Relational Database Management Systems (RDBMSs). Starship's interface to the database is through Microsoft's ActiveX Data Objects (ADO). Presently, Starship is installed with Microsoft's SQL server. Due to the flexibility of ADO, Starship easily interfaces with other RDBMSs such as ORACLE.

The Communications Tier allows Starship to interact with real and virtual systems and entities. Within the communications tier, Starship developers can add a communication system to enable interoperability with new real and virtual systems and entities with minimal or no modification to the major Starship components. Using standard personal computer communications cards, Starship is able to communicate over local area networks (LANs), wide area networks, Defense Research Engineering Network, Internet, dedicated T-1 lines, radios, secured radios, encrypted LANs and others.

Starship components are easily reusable. In 2000, Starship system communication components were used to create two new applications: Proxy Server and LAN Multiplexer. These applications, not

included as part of the original design, are used to minimize the number of radios used during testing and to connect Starship to the instruments under its control using a Mobile Subscriber Equipment network. Original Starship XML documents are, and can be used as, templates to extend Starship to interact with other test instruments.

The Starship NGTCC-2002 also is easily extensible. In multiple C<sup>4</sup>I tests, it has been used to remotely monitor and control various data collection instruments, including EPG's Multifunction Data Collector (MFDC), Modular Covert Remote Electronic Warfare Simulator and Ground Track Vehicle Tracker; Operational Test Command's Improved Function Data Collector (IFDC); White Sands Missile Range's radar feeds; Yuma Proving Ground's PC-104 "plugger" man-packs; and Aberdeen Proving Ground's Advanced Distributed Modular Acquisition System. Starship is being integrated with other systems using Distributed Interactive Simulation, High-Level Architecture and Test and Training ENabling Architectural standard protocols.

## The Virtual Exercise: Composition and design

At the core of Starship is the Virtual Exercise consisting of virtual entities, which are memory-resident representations of real or simulated, internal or external items of interest (for example, test instruments, radios, simulations, communication systems and application programs).

The business of the Virtual Exercise is to ensure that all of the virtual entities are synchronized to their Internet or external counterparts. Therefore, the Virtual Exercise reflects the exercise or test "ground truth." Synchronization occurs when the properties of the virtual entities are based on data transferred over the Communications Tier from the internal or external counterparts.

Access into the Virtual Exercise is accomplished through public interfaces or through the Starship Presentation Client Manager. This approach facilitates the integration of different presentation-layer clients with Starship and, thus, readily supports special-purpose user interfaces and views.

The Virtual Exercise leverages carefully crafted XML documents that describe to Starship the properties and commands of external entities. Starship can additionally interface to an entity source using its driver, similar to the way in which a personal computer employs a printer driver to print.

## Communications

To maximize performance and scalability, Starship communicates with “outside world” entities asynchronously. Using LANs and radios, Starship communicates with any test instrument in use, including: EPG’s MFDCs and Operational Test Command’s IFDCs. Communications can be unencrypted or encrypted using special software and hardware.

Most legacy test instruments require polling from Starship. A command is sent from Starship to request the status of the device. The response is provided to the virtual entity to update its properties.

Starship works with new test equipment that employs “autonomous agent” technology such as EPG’s Government Technical Test. After powering on, these devices automatically initiate communication with Starship, which acknowledges their presence, creates corresponding virtual realities, remotely sets their configuration and accepts device changes automatically.

The Starship Communications Tier incorporates two main MSMQ message queues, one for outgoing and one for incoming messages. *Figure 2* depicts the Starship messaging process.

Starship is a mainstay of EPG C<sup>4</sup>I testing for the Army. Additionally, Starship has been selected by FI 2010 for evaluation as a standard test range tool for distributed test events. The Joint Global Positioning System Combat Effectiveness Program office selected Starship as the command, control and status display system to support field testing over the next two years. The Simulation Training and Instrumentation Command selected Starship to be the “glue” for C<sup>3</sup> driver applications. Starship

controls C<sup>3</sup> driver applications that simulate and monitor the Army Battlefield Command and Control Systems under T&E scenarios.

The Starship project is one of many VEPG architecture development projects. The project team developed a collection of user tools to plan, monitor, control and report a test or training exercise and the individual instrumentation contained within the test or training exercise. Starship and its components are being integrated in creative ways to provide additional functionality and improved systems. The Starship suite is being used at many test centers and on a number of key programs in DoD. Numerous joint and Army testing and training organizations are using the Starship to leverage their capabilities.

EPG tests systems that facilitate, support and promote the C<sup>4</sup>I focus of the Army transformation stratagem. EPG tests these systems from beginning to end to further their growth and refinement, particularly the digitalization requirements for the Army. EPG, through testing these systems, has improved the military commander’s situational awareness by creating the Starship testing platform for EPG’s distributed system-of-systems testing archetypes. Starship will continue to significantly contribute to the Army’s purposeful and significant mission: protecting U.S. citizens, while defending national security interests. □

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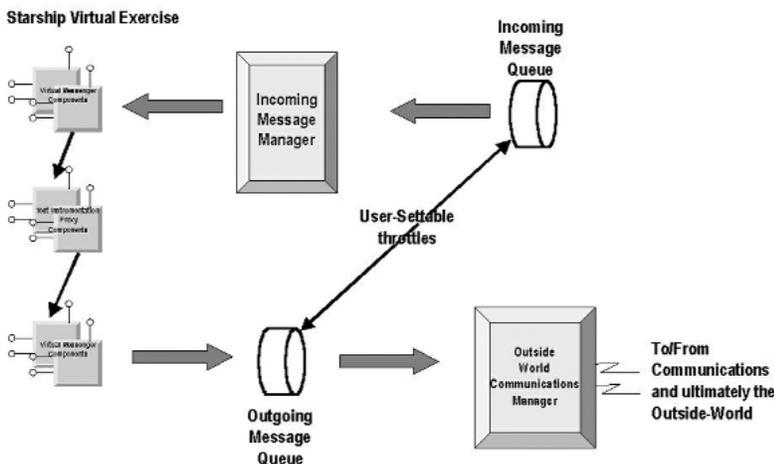


Figure 2. Starship messaging