Microsoft® ESP™

Microsoft ESP SDK:
Enabling Customized and Immersive Simulation Experiences
White Paper

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Abstract

Microsoft® ESP™ is a visual simulation platform that brings immersive experiences to training and learning, decision support, and research and development modeling for government and commercial organizations. The Microsoft ESP Software Development Kit (SDK) enables developers and partners to affordably create compelling simulation solutions for their customers.

This white paper examines the key advantages of Microsoft ESP and the features and components of the Microsoft ESP SDK.

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Introduction

The need for affordable, versatile, and effective simulation experiences has emerged as a critical need in government and commercial organizations alike. High-fidelity simulation systems have long been used as a supplement to high-cost real-world training. However, most of these systems carry their own set of costs that can restrict the frequency of access. For example, fixed-location simulation systems are not only costly to develop, they are found in only a limited number of locations and require the on-site participation of students and instructors, with the associated complication and expense of scheduling and travel. These systems are also generally proprietary and extremely difficult to modify and extend for specialized equipment, scenarios, or related applications. Additionally, these and other modeling and simulation platforms and tools do not integrate easily with other training-related systems and tools. Lastly, they can lack the detail and realism required to fully engage today's computer-savvy aviation students to maximize learning outcomes or improve on-the-job performance.

Microsoft ESP

Microsoft ESP is a visual simulation platform that brings powerful, high-fidelity simulations to widely available, low-cost Microsoft Windows®-based PCs. Organizations that rely on Microsoft ESP can improve their workforce readiness more efficiently and cost-effectively than with traditional computer-based animation or simulation tools. Combined with its developer-friendly Software Development Kit (SDK), Microsoft ESP provides government and commercial entities and modeling and simulation specialists with an affordable, portable, and highly extensible platform for training and learning, decision support, and research and development modeling.

Simulations built on Microsoft ESP can engage users in immersive experiences with very realistic land, sea, and air environments—making them ideal tools for training. With a high-speed Internet connection, up to 30 users, including students, instructors, and support personnel, can participate simultaneously in Microsoft ESP simulations from any location in the world. In addition, the platform's built-in analysis and full playback capabilities facilitate evaluations of crew performance, mission planning, and decision-making.

Microsoft ESP SDK

The Microsoft ESP SDK is designed to help organizations, developers, and training specialists economically create customized line-of-business simulation solutions. The SDK consists of a client runtime simulation engine along with a wide assortment of tools, procedures, tutorials, documentation, file formats, configuration files, and samples combined in a comprehensive and familiar development toolset.

Using the Microsoft ESP SDK, organizations and partners can:
- Customize or augment scenery, terrain, airports, cityscapes, and weather systems with highly detailed renderings of features across the entire globe.
- Create custom missions involving air, land, and sea scenarios.
- Seamlessly integrate new aircraft, marine vessels, ground vehicles, buildings and other structures, as well as gauges and other instrumentation, into simulations.
- Incorporate third-party hardware devices that support immersive experiences, including head- and eye-movement tracking devices, yokes, joysticks, pedals, and more.
- Create add-ons and extensions to their own or third-party solutions or incorporate expansion packs that accommodate additional vertical industries.
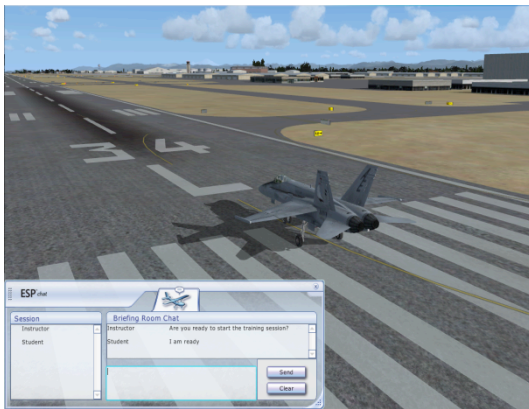
Using the tools contained in Microsoft ESP SDK, developers and designers can create a wide variety of scenery and objects.

Microsoft ESP SDK Organization and Capabilities

The Microsoft ESP SDK is organized into four primary systems, some of which contain their own SDKs for specific projects. The four include a programming system, a terrain and scenery system, a mission system, and a simulation object system.

Programming System

Known within the SDK as the Core Utilities Kit, the programming system provides the programmer's interface to Microsoft ESP in the form of the SimConnect SDK. Many add-ons for Microsoft ESP can be built without programming. However, for add-on modules that do require a programming language, the SimConnect SDK provides the tools and documentation for writing and linking them to the simulator.

The SimConnect SDK contains a Dynamic Link Library (DLL) of nearly 80 managed API calls that enable access to hundreds of data parameters as well as functionality used to control the simulation experience. Add-on components can be written in C, C++, or any .NET language such as Microsoft Visual C#® .NET or Microsoft Visual Basic® .NET. Example uses of the SimConnect interface include writing add-ons to control the weather system or manage artificial intelligence-controlled vehicles. SimConnect also includes functions to add items to the menu system, control

cameras, or request airport facilities data, among many others. It uses a client-server model to enable communications between a client written by a third party and the simulator. Multiple clients can be running at one time and can also communicate remotely with the server.

Terrain and Scenery System

This system enables developers to control and customize the dynamic, high-fidelity 3-D immersive environments found in Microsoft ESP. The platform models the entire world using a combination of World Geodetic System (WGS)-84 data, satellite raster imagery, digital elevations, and vector data (for roads, rivers, streams, coastlines, and so forth). Microsoft ESP provides a global model ranging from 100 million feet in altitude down to the Earth's surface. Elements such as mountains, landscapes, near real-time Meteorological Aviation Report (METAR) weather, time of day, seasons, roads, and traffic can be manipulated as needed.

- **Modeling SDK**
  All objects displayed in Microsoft ESP simulations—for example aircraft, ships, airport ground vehicles, trees, and buildings—require a 3-D model in the correct format. The Modeling SDK provides the steps and documentation needed for developers and modeling and simulation specialists to successfully import new 3-D models. The Microsoft ESP SDK includes exporting and content manipulation tools as plug-ins to the Autodesk 3ds Max® third-party modeling tool.

- **Terrain SDK**
  Microsoft ESP simulations support real-time rendering from 100 million feet down to the Earth's surface. The ability to provide the right level of detail at the right time is a key reason why Microsoft ESP is able to generate such lifelike simulations. The platform natively renders terrain and scenery with approximate detail for most areas of the world, using more than 120 land classifications and more than 60 water classifications as well as population density, cultural, and regional classifications. Precision data is provided for only a select number of areas, though the rendering engine supports 3-centimeter/pixel resolution worldwide. Among its many capabilities, the Terrain SDK enables developers and simulation specialists to replace existing source data with extremely detailed photo or satellite imagery of specific locations, such as the skyline of a given city, the detailed terrain resolution of a mountainous region, or the coastline of a specific country.

- **Living World SDK**
  With the Microsoft ESP SDK, developers can adjust the overall environment of specific locations in the world. The Living World system generates such elements as traffic patterns for recreational boats, freeways, and airport ground equipment, using the population density settings from the terrain system. The Living World SDK enables customizations to these traffic patterns, as well as extending the behaviors of land and water based animals.
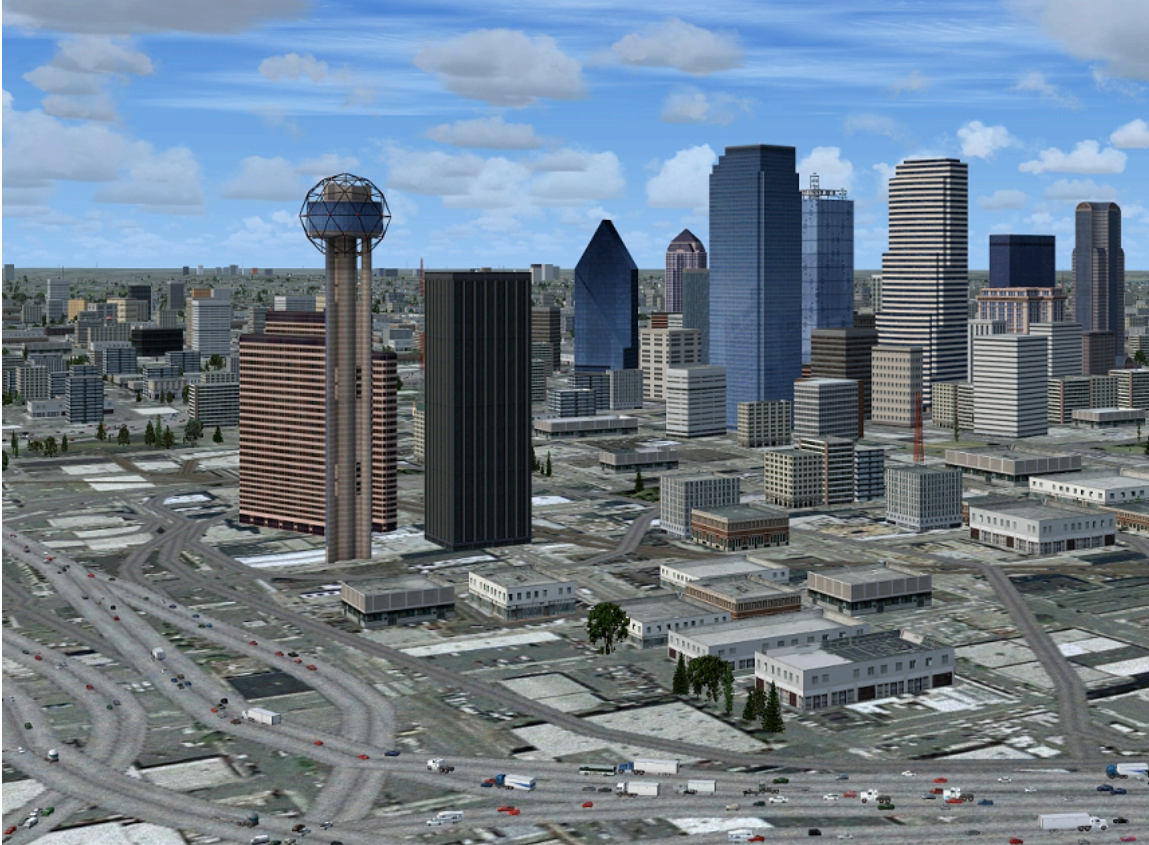
The Microsoft ESP SDK enables developers to manipulate traffic to enhance the immersive experience.

Mission System

Within Microsoft ESP, a mission is a structured flight with a starting point, a set of tasks to complete, and one or more specific goals. Missions can be single or multiplayer and can involve simple or complex challenges, tutorials, tests of knowledge and skill, special situations, or whatever mission designers wish to create. Microsoft ESP contains scores of missions, including government, emergency and rescue, and commercial scenarios. The Mission Creation Kit enables developers and training vendors to build new missions for inclusion in the simulator.

All missions are stored in XML files and numerous examples are included in the SDK. Creating missions involves the use of a tool supplied with the SDK called the Object Placement Tool. The SDK contains a step-by-step tutorial for installing and using the tool and for adding new missions to the simulation.

Example Missions
- **Checklists:**
  - ○ Description: Custom checklists created for specific aircraft or flight sequences (e.g., pre-flight, 10,000-ft, and 18,000-ft).
  - ○ Methodology: Build using the mission system to prompt the student; combine with SimConnect API to evaluate student performance for each step.
- **Airspace:**
  - ○ Description: Mission sequence in which a pilot must land at a smaller airport within a larger airport's airspace.
  - ○ Methodology: Create using the mission system; augment with SimConnect API programming to track whether airspace infringements have occurred; use SimConnect to integrate with external performance evaluation tools.


Entirely new missions can be created from existing or new elements imported into the platform.

Simulation Object System

This system consists of the SimObject Creation Kit. To be accessible to the simulator, each object—a fighter jet, a helicopter, a skyscraper, a fuel truck—requires a consistent folder and file structure. The SimObject Creation Kit contains descriptions of this structure along with the required and optional content for each file. Among several components of this kit, two of the most important are the Panels and Gauges SDK and the SimObject Container SDK.

- **Panels and Gauges SDK**
  In the world of Microsoft ESP, a gauge is any device that might appear in an aircraft cockpit or vehicle control station, from a simple altimeter or clock to a GPS system, weather radar, or radio stack. Gauges can be added to the cockpit panel of any vehicle. To a large degree, the development of gauges and panels is an exercise in skilled artwork. Many examples of panel artwork ship with the Microsoft ESP SDK.

While there is only one way to create a panel for Microsoft ESP, there are several ways to build gauges. Which method to use depends on the complexity of the gauge to be added and the programming skill of developers. Tutorials are provided for each method. The simplest option is to create XML-based gauges using tools contained in the SimObject Creation Kit; this requires no coding. For more complex gauges, designers have the option of building gauges entirely in code. For greater flexibility, they can also link XML code to a code library to create highly complex gauges in a shorter amount of time.
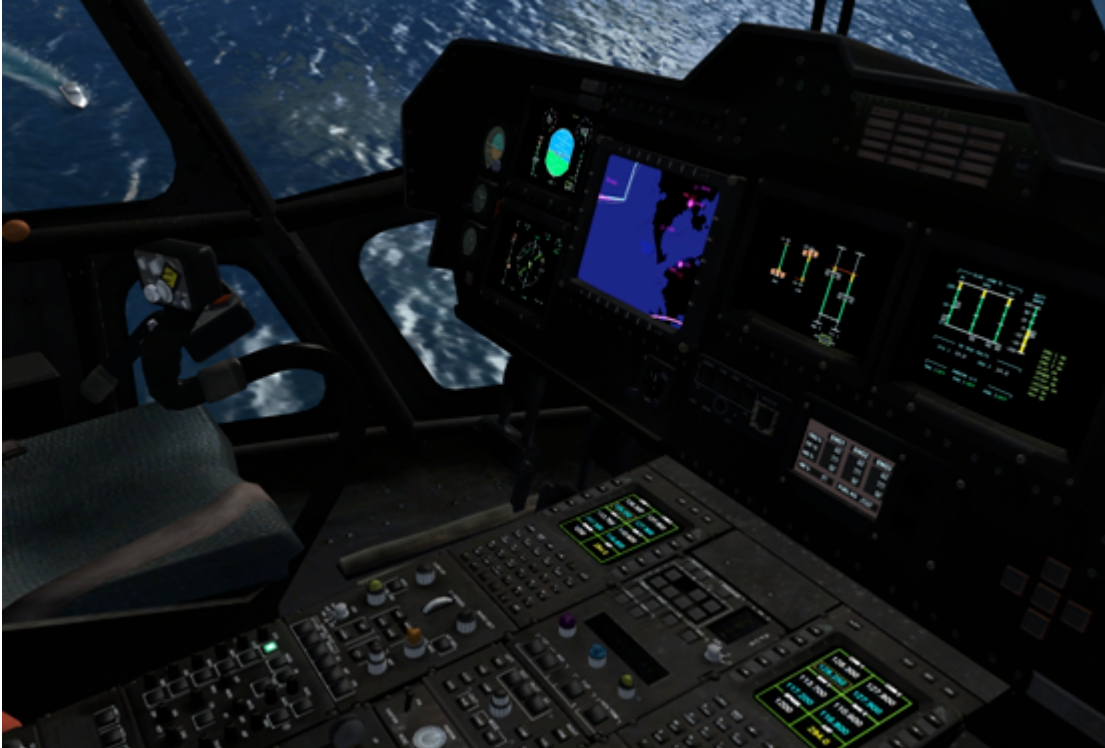
Tools contained in the Microsoft ESP SDK enable developers to build custom gauges for use by the simulator.

SimObject Container SDK
This SDK provides guidance on the requirements of configuration files associated with each object used by Microsoft ESP. All objects require configuration files, which are text files that are easily viewed and updated. For example, the aircraft configuration file specifies the version (or versions) as well as the attributes (name, color, sound, panels, gauges, and so on) for each aircraft and where to find the files that define those attributes. The configuration file includes details on the aircraft's systems, such as engines, fuel, avionics, landing gear, physical dimensions, aerodynamics, and many other details such as camera view positions and special effects.

In addition, sample source files and a compiler are provided for generating the physics models needed to enable the proper behavior of vehicles in the simulation. A robust 6-degrees-of-freedom (6DoF) model is employed when simulating vehicles to ensure high fidelity across the entire range of supported vehicles.

Recommended Skill Sets and Tools

The Microsoft ESP SDK includes a broad range of tools and guidance to help accelerate the development of new simulation objects, visual content, add-ons, and extensions. To take full advantage of the resources and capabilities contained in the SDK, organizations, developers, and vendors will need to bring a range of skills and tools to the often complex tasks of designing new missions or building new vehicle models from scratch. Recommended skills and tools include:

- **Mission Creation Skills**
  Mission design requires a strong logical approach to designing the actions and triggers that a specific mission would require. Familiarity with vehicle operational procedures and simulation is suggested. Additional recommendations include the ability to read and edit XML files and work with 3-D graphics.

- **Programming Skills**
  While programming skills are not required to create individual missions for Microsoft ESP, they are necessary for linking those missions to client applications developed for the platform, and for developing certain objects such as complex gauges. Programming skills required may include C, C++, C#, and XML. An understanding of client-server architecture and experience developing solutions with a Microsoft SDK are also recommended.

- **Design Skills**
  The Microsoft ESP SDK provides numerous means for importing new vehicles and other objects created in external modeling tools into the simulator. However, designers should be aware that significant design expertise is required to create these models. In addition, designers should have a solid background in using modeling tools, along with an understanding of complex meshes, textures, animations, and vehicle components and construction.

- **Additional Tools**
  To complement the numerous individual tools found in the ESP SDK, designers and developers may also need some or all of the following external tools:
    - Microsoft Visual C++® (or Visual C#) 2005
    - Microsoft Visual C++ (or Visual C#) 2005 Express Edition
    - Microsoft Visual C# .NET or Microsoft Visual Basic .NET
    - Autodesk 3ds Max
    - Adobe® Photoshop® or similar quality graphical program
    - Shape file editing tools for working with vector data

Conclusion

Microsoft ESP is a visual simulation platform that brings immersive experiences to training and learning, decision support, and research and development modeling for government and commercial organizations. A comprehensive platform, it is an all-in-one set of simulation engine, tools, and content, enabling developers to affordably create compelling simulation solutions for their customers. Simulations built on ESP using the Microsoft ESP SDK can engage users in immersive experiences with very realistic land, sea, and air environments—making them ideal tools for training, evaluating, and preparing personnel for optimal performance in the real world. Microsoft ESP, along with the SDK, enables organizations to create, deliver, and realize the enormous benefits of immersive simulations while gaining a strong return on investment that's not readily available from other platforms today.

For more information on Microsoft ESP and the Microsoft ESP SDK, or to order, please visit http://www.microsoft.com/esp.