Discussion Paper:

Maritime Capabilities in VBS2

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A. VBS2 Whitepaper (http://www.bisimulations.com/whitepaper)

Classification

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Revision History

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1. Executive Summary

Bohemia Interactive Simulations, Inc. is pleased to provide this Discussion Paper on maritime capabilities in Virtual Battlespace 2 (VBS2).

Bohemia Interactive is dedicated to the development, delivery and support of serious game products to Government and Industry clients worldwide. We deliver affordable simulation platforms that provide vast, dynamic, high-fidelity virtual environments that are supported by easy-to-use development tools. Our most prolific and successful title, VBS2, is used primarily for tactical training and mission rehearsal, but has potential for employment in other domains, including maritime.

VBS2 delivers a unique “Open Platform” that simulates many different types of characters, vehicles, aircraft and naval platforms to varying levels of fidelity. As a game-based virtual simulation, VBS2 represents a fantastic opportunity for the maritime domain because:

- VBS2 already includes a wide range of maritime assets including military and civilian vessels and aircraft, and a variety of weapon platforms;

- A holistic “virtual battlespace” is represented, allowing previously stand-alone simulated training tasks such as bridge simulation to be practiced as part of a wider collective training event; and

- VBS2 offers an extendable and affordable virtual environment that can deliver a broad range of maritime training capabilities, from amphibious ops to bridge simulation, and from naval gunfire support through to search and rescue operations.

VBS2 is already the “game-for-training” of choice for Government organizations all around the world, and new capabilities are continually added. This Discussion Paper firstly provides an accurate summary of current VBS2 maritime capabilities and limitations (as at VBS2 v1.40), and then presents the possibilities for the future, given the versatility of the VBS2 game engine and ongoing development work.

VBS2 offers the maritime domain a simulation capability that can represent all aspects of the real world: seamless, first-person simulation from the deck of a ship through to aircraft and land ops, coupled with a powerful Development Suite and large, geo-specific environments.
2. History of the Virtual Battlespace

2.1 Operation Flashpoint – the game engine behind the US Army’s DARWARS Ambush!

Until the release of Virtual Battlespace 1 (VBS1) in 2004, the primary focus of Bohemia Interactive was the development of computer games for entertainment. Czech-based Bohemia Interactive Studio (BIS) released Operation Flashpoint (OFP) in 2001, a landmark title that was the first to allow Players to explore massive, 3D, geo-typical virtual environments from the first person perspective. In OFP, Players were free to use any means at their disposal to defeat the virtual enemy, including attacking from any direction and using a wide range of vehicles and aircraft.

The game engine underlying OFP was titled Real Virtuality, and was built from the ground up by BIS software engineers. All aspects of the simulation including AI, physics, weather, day/night cycles, vehicles, aircraft, animation systems and networking were developed internally. It should also be noted that the majority of the programmers who started the development of the initial game engine in 1997 still work for Bohemia Interactive today.

Operation Flashpoint is the basis for the military training application DARWARS Ambush! developed by US-based BBN Technologies in 2004. DARWARS Ambush! aimed to provide a flexible training environment for soldiers to learn important lessons regarding both mounted and dismounted operations in conflict zones such as Iraq and Afghanistan. DARWARS Ambush! is widely considered a great success and this positive outcome was only possible due to the flexibility and extendibility of the OFP game engine.

2.2 Virtual Battlespace 1 (VBS1) – a successful game-based training tool for the USMC

The Australian branch of Bohemia Interactive, Bohemia Interactive Australia (BIA), was formed in 2001 with the mandate to develop “serious games” based on the Operation Flashpoint game engine. BIA released Virtual Battlefield Systems 1 (VBS1) in 2004, and delivered it to the United States Marine Corps (USMC) who used the product in a similar manner to the way the US Army was using DARWARS Ambush!. VBS1 was a successful game-based 3D
virtual environment tailored for “serious” usage; suitable for military tactical training and mission rehearsal, despite serious limitations. VBS1 mission editing and after-action review (AAR) features were limited, it did not support real-world terrain import, and it wasn’t HLA or DIS compliant.

Both the US Army and USMC have used Bohemia Interactive’s game engines as the basis for their desktop tactical training simulations since 2004.

Despite the early success of VBS1 in the USMC, it was Australian Defence Force (ADF) funding that enabled VBS to succeed as a training tool. The ADF was first exposed to the potential of VBS “serious game” technology during the Headline Experiment in 2003, when an early version of VBS1 was used to analyse the effectiveness of various sized Infantry Section structures (the Virtual Infantry Section Experiment1).

In 2005, the Australian Defence Simulation Office (ADSO) funded a range of improvements in VBS1 to make the product more suitable for mission rehearsal and training, as part of Mission Rehearsal Exercises (MRE) for deployments to Iraq. At this time, VBS1 was renamed to Virtual Battlespace 1, the AAR system was improved, the Instructor Interface was developed, and HLA/DIS compliance was implemented over a 12 month period of development. The majority of this development was sponsored by ADSO through a Deed of Standing Offer for the provision of Software and Software Support Services.

ADSO also contracted Bohemia Interactive to develop a VBS1-based military history training product titled ‘Australians in Vietnam’, designed to teach soldiers, sailors and airmen about the Battles of Long Tan and Coral. The end product was highly successful: a stand-alone computer game tailored for education.

2.3 Aircrewman Virtual Reality Simulator– a revolutionary aircrewman training tool

In 2006, Bohemia Interactive was selected by the ADF to develop six Aircrewman Virtual Reality Simulators (AVRS), which combined VBS1 simulation technology with the latest in Virtual Reality tracking and display systems. Over a 12 month period of development, Bohemia Interactive developed and delivered a system

1 See http://www.itee.adfa.edu.au/research/vesl/Papers/viseSimTecT04.pdf for more information
that is arguably the most successful simulation project in ADF Army Simulation Wing history: an affordable turnkey solution for aircrewman training – delivered on time and on budget.

This development is notable because it highlights the capability of Bohemia Interactive to provide turnkey simulator solutions in addition to commercial off-the-shelf (COTS) software development services.

2.4 Virtual Battlespace 2 (VBS2) – a worldwide benchmark in simulated training

BIA began developing Virtual Battlespace 2 (VBS2) after the ADF purchased an enterprise license of VBS1 in 2005. Building on three years of feedback regarding VBS1, VBS2 represents a powerful “serious game” platform that is now the worldwide benchmark for desktop-based simulation for tactical training and mission rehearsal.

Many requirements for VBS2 were derived from ADF experience with VBS1 during mission rehearsal exercises conducted in 2005. For example, the requirement for geo-specific terrain was paramount, but it took over six months to develop the city of As Samawah in VBS1. In contrast, it took only a few hours to generate the same terrain in the armor simulation ‘Steel Beasts’, because it supported VMAP (shape data) import. The need for run-time authoring became obvious due to time constraints during MREs: only a short amount of time was available for simulated training, and offline scenario editing would cost valuable minutes (bringing down the network session, modifying the scenario and restarting the network session). This need for rapid scenario modification resulted in the requirement for the VBS2 Real Time Editor. In addition, a robust AAR capability was important to allow the instructors to reinforce learning points.

VBS2 development commenced in December 2006 and was largely completed after 18 months. During development, Bohemia Interactive partnered with Calytrix Technologies to develop the VBS2 HLA/DIS gateway. In 2007, a second Czech-based development team was established to focus on improving the VBS2 Development Suite to support real-world terrain import.

In 2006, the USMC purchased an enterprise license of VBS1, with an upgrade to VBS2 upon release. Following initial delivery of VBS2 in 2007, they funded a range of enhancements that resulted in the development of the VBS2 Virtual Training Kit (VTK). Notably, the USMC did not provide any data for the
VBS2 VTK development: Bohemia Interactive relied instead on publically available reference information for all aspects. The USMC was then provided with full access to VBS2 configuration files and unencrypted models to allow them to incorporate classified or export controlled data as required.

This flexible development model has proven very successful: it allows Bohemia Interactive to conduct independent research and development from a relatively generic requirement, and allows the customer to configure settings to suit real-world and often classified data.

The VBS2 VTK was delivered to the USMC on time and budget in June 2008, and rolled out later that year to all USMC simulation centers and on all DVTE laptops. VBS2 quickly became the simulation of choice for USMC mission rehearsal and tactical training up to the combat team level. Bohemia Interactive was then awarded a sizable three year follow-on contract to continue enhancing the VBS2 product as an “Open Platform” that the USMC could tailor to their needs. Development commenced in June 2008 and the first VBS2 VTK2 release occurred in June 2009, again on time and budget.

While the ADF and USMC have been central to the success of VBS2, enterprise licenses have also been purchased by the United Kingdom Ministry of Defence (UK MoD), the US Army and the Canadian Forces. In all cases, Bohemia Interactive has modified the VBS2 product to suit the requirements of these organizations, while still maintaining a common international baseline. VBS2 is also in daily use by NATO, the Singapore Armed Forces and many countries across Europe.

VBS2 has become a defacto simulation standard, and a market is rapidly forming as industry begins to employ VBS2 for research and development. VBS2 includes development tools, an Application Programming Interface (API) and a scripting language in every release. The VBS2 International User Group meets bi-annually and VBS2 is a key component of upcoming joint simulation exercises.

2.5 Software development in non-military domains

VBS2 is not designed solely for military use. In addition to developing and supporting the VBS series for military training and mission rehearsal, Bohemia Interactive has experience in developing
applications outside the military training domain, using the baseline VBS2 product. Bohemia Interactive supplied VBS2 for Project Canary\(^2\), a game-based training product that instructs on occupational health and safety for the Australian mining sector. In addition to VBS2 software, Bohemia Interactive provided support and on-site training for the software developer.

Bohemia Interactive also developed the VBS2-based Virtual Responder Trainer, a version tailored for first responders. This product simulated events such as fires and floods and included police, ambulance and fire-fighting vehicles.

2.6 Real Virtuality 3 – continued development for the entertainment market

At the same time as developing the Virtual Battlespace series, Bohemia Interactive has improved the Real Virtuality engine for the entertainment market. Real Virtuality 3 (RV3) is the result: a state-of-the-art game engine that is recognized worldwide as a leading next-generation software platform for first-person simulation. RV3 is the game engine behind the highly successful ArmA2, released in 2009, and also the recently released ArmA2: Operation Arrowhead. The most obvious improvement is graphical fidelity – years of effort have been applied to making the virtual environment as visually realistic as possible – but in addition to amazing graphics, the new engine has many other improvements including animation enhancements and multi-core support. Multi-core support enables the engine to be highly efficient, as simulation tasks are spread over multiple processor cores.

![Screenshots from ArmA2: Operation Arrowhead, using Real Virtuality 3](http://www.projectcanary.com)

\(^2\) [http://www.projectcanary.com](http://www.projectcanary.com)

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3. Current Maritime Capability in VBS2

VBS2 is a game-based tactical training and mission rehearsal tool that is tailored for networked, collective training. VBS2 allows groups of trainees to practice their tactics, techniques and procedures in a virtual environment, and employ weapon systems and platforms in a similar manner to how they are employed in the real world.

A good description of the general capabilities of VBS2 v1.40 can be found in the VBS2 Whitepaper, available from http://www.bisimulations.com/whitepaper (Reference A). If you are unfamiliar with the product then it is recommended that you first review this Whitepaper as it provides a good overview of the inherent capabilities of VBS2. A 30 minute video showing VBS2 capabilities can be downloaded here, and a shorter 5 minute version is available online at the VBS2 website.

Please note, on numerous occasions this Paper refers to “scripting”, stating for example that a certain capability “can be scripted”. VBS2 includes a verbose scripting language with over 1,400 script commands, allowing a suitably trained person to influence a scenario in many different ways. However, scripting is a skill that must be learnt, so the reader should acknowledge that while scenario editing using VBS2 mission editors is quite easy, scripting can be relatively complex.

3.1 Simulation of maritime (and related) assets in VBS2

VBS2 is known as a “first-person” virtual simulation in which human participants “play” as a character within scenarios and perform tasks such as fire and movement, operating a personal weapon or piloting a ship. VBS2 also includes artificially controlled entities that can perform such actions, including operating vehicles. One key difference between VBS2 and other military simulations is that vehicles in VBS2, including ships, must be operated by one or more avatars (simulated characters); for example, an M1 tank has a crew of four avatars – the commander, driver, gunner and loader – and all ships must have at least one avatar to act as the driver.
VBS2 is capable of simulating almost any real-world weapon platform, from individual soldiers through to AC-130 gunships and from tanks through to armed hovercraft. VBS2 includes a base set of simulation classes, e.g. car, tank, eight-wheeled vehicle, helicopter, hovercraft etc, and these are configured for specific entity types to fine-tune the simulation to be as realistic as possible.

The present release of VBS2 is intentionally “ground-centric” because its computer game heritage lies in the simulation of ground combat, i.e. simulation of infantry and armored warfare. Air and maritime assets are generally employed to support the ground force: through the provision of fire support or transport in the case of air, and provision of naval gunfire and amphibious capability in the case of maritime. However, as will later be discussed, it is actually the high-fidelity ground capability of VBS2 that offers untapped potential for the maritime domain.

It is much easier (and cost-effective) to improve the maritime capability of VBS2 than to add high fidelity ground warfare capability to any other game-based maritime simulation.

In the maritime domain, the relevant simulation classes available in VBS2 v1.40 are:

- Small ship
- Large ship
- Rotary wing aircraft (including MV-22)
- Fixed wing aircraft (including STOL and VTOL)
- Hovercraft
- Missile

All simulation classes can be configured to a high level of detail through text-based configuration files, including performance specifications such as ship speed and turn rate and also weapon characteristics.
3.1.1 Ship simulation

VBS2 provides ships that can be either human or AI controlled, that generally move and behave like real ships; they have a defined rate of acceleration and maximum velocity and turn rate. They roll in accordance with sea state and can be run aground. Ships have a single human or AI “driver” that steers the vessel using relatively simple forward / back / left / right controls. VBS2 presently only supports simulation of a single engine (a catamaran steers exactly the same as a mono-hull, for example). VBS2 already includes a wide range of military and civilian vessels, including:

- Speed boats
- Fishing trawlers
- Cruise liners
- Ferries
- Cargo ships
- Fuel tankers
- Small boats (e.g. RHIB, RAC, SURC)
- LCAC (Hovercraft)
- Type 45 (Daring) class destroyer
- ANZAC class frigate
- Heavy transporters including HMAS Kanimbla and HMNZS Canterbury
- Landing craft including the US Army LCU-2000 class
- Collins class submarine
- US guided missile destroyer

See [http://resources.bisimulations.com/content](http://resources.bisimulations.com/content) for a complete listing of all VBS2 content, ordered by nationality. Also note included naval aircraft and unmanned vehicles.

AI controlled ships are directed through waypoints placed in either the VBS2 Offline or Runtime Mission Editor. Both human and AI controlled ships will use their weapon systems to engage OPFOR appropriately – they may use missiles to engage aircraft, or their guns to engage other ships. Small boats can load or unload troops and helicopters can land on larger ships. Presently, no aircraft carrier for fixed wing operations is included but there is no reason why one or more
could not be added if required.

Ships in VBS2 have animated parts such as moving radars, hangar doors that open and shut, and robotic arms that lower and raise small boats into the water that are then capable of being controlled by either human controlled or AI entities. Ships can be modeled both externally and internally to any required level of fidelity, and through render to texture (video-in-video) technology VBS2 is capable of displaying both 2D and 3D graphics on virtual monitors and computers inside a ship (in a simulated bridge, for example). The Type 45 development for the UK MOD (see Paragraph 3.3.4 below) is a good example of a ship modeled both internally and externally in VBS2. Ships in VBS2 can display International Maritime Signal Flags that can be raised and lowered through scripting and also on-board lighting that can be turned on and off (again through scripting).

VBS2 only supports a very basic simulation of submarine operations, allowing a submarine to operate above or below the water. A simulated periscope can be raised or lowered and unguided torpedoes fired. AI units are not presently capable of controlling submarines in VBS2.

There are currently some limitations to the ship simulation that should be noted: it is presently not possible for simulated human characters (avatars) to walk around on moving ships, however they may walk around on static ships (static ships are those that remain stationary for the entire scenario and cannot be moved, even with a driver). Helicopters are presently unable to land on moving ships. Also, it is presently not possible for avatars to...
walk below the water line on either moving or static ships.

3.1.2 Hovercraft simulation
Hovercraft capability was introduced in VBS2 v1.40 with the LCAC for the USMC. A new simulation type was added and the performance of the LCAC modeled to a high level of fidelity. Like the real hovercraft, the vehicle can operate on water or land and can load and unload both vehicles and avatars.

3.1.3 Aircraft simulation
VBS2 supports both fixed and rotary wing aircraft piloted by both human and AI controlled entities, but from a maritime perspective functionality is presently limited. Aircraft can take off, fly and land on both maritime vessels and the ground, and they can transport troops and (in the case of large cargo aircraft such as the C-130) also vehicles. It is possible for Special Forces entities to fast-rope from simulated helicopters and aircraft can engage targets using machine guns, unguided rockets and guided missiles. Complex naval guided weapons such as Harpoons and Torpedoes are not presently simulated to full fidelity, and it is not presently possible to conduct realistic submarine warfare (sonar buoys are not available, for example). Helicopters can carry slung loads and be scripted to perform basic search and rescue (SAR) operations.

3.1.4 Weapon and sensor simulation
VBS2 supports turreted machine guns on maritime vessels, which can be configured to a high level of detail (firing arcs, rate of fire, muzzle velocity, ballistics etc). VBS2 provides a realistic representation of tracer rounds. Basic guided missile simulation for engaging air, naval and ground targets is included but the
simulation provides a basic direct flight path only (from the launching platform directly to the target). Complex missile flight paths, e.g. for Harpoon missiles, is not presently supported.

A generic naval radar capability has been developed in VBS2, which represents terrain as well as moving and static ships, vehicles and aircraft. The radar simulation was developed to support boat crew and gunnery training as described in Paragraph 3.3.1 below.

VBS2 includes simulation of day/night vision and thermal imaging optical devices. From VBS2 v1.40, the product supports dynamic view distance which means that objects can be detected out to 15 or more nautical miles through binoculars depending on the processing power of the host computer.

### 3.2 The VBS2 maritime environment

As is described in Paragraph 3.2.6 of Reference A, VBS2 includes a full Development Suite that allows new terrains to be created without the involvement of Bohemia Interactive. New terrains are based on DTED which generally describes both surface and subsurface terrain, meaning VBS2 can model the ocean floor at correct depths if provided with suitable data during terrain generation. VBS2 terrains also support rivers, lakes and dams, upon which vessels can operate.

VBS2 does not presently support currents (although such a capability could be scripted relatively easily), and does not presently simulate fluid dynamics beyond a basic simulation of friction. Sea state is modeled to a low level of fidelity but the strongest sea state is still relatively flat when compared to the real world. Sea state is presently a function of the overcast value as defined in scenario settings. Sea state does affect ship roll, but not presently ship speed.

VBS2 supports simple ship wakes, firstly through modifying the 3D appearance of water (for large ships) and secondly by using particle effects for smaller craft. The 3D ship wakes available in v1.40 are a prototype only and further work is required to fine-tune the system (see Paragraph 4.3.2 for more information).
VBS2 supports beaches and simulates basic waves rolling up the shore. VBS2 entities can enter the water and swim; however underwater swimming is not presently supported. VBS2 supports loading and unloading from boats and amphibious vehicles such as the AAVP7A1 are fully supported. The LAV-25, for example, has animated propellers when moving through water and has the correct performance characteristics.

It is possible to model harbors in VBS2 to a high level of detail including surrounding features (cities, vegetation etc) and shore lighting. VBS2 terrains can presently be up to 200km x 200km in size but they use a fixed terrain grid, meaning that the larger the terrain the further the distance between terrain points. See Paragraph 3.2.6 of Reference A for more information on present terrain limitations, but note that VBS2 should support full terrain paging (for much bigger terrain areas) and multi-resolution terrain grids by the end of 2011. As of VBS2 v1.40 curved earth simulation is supported, meaning that ships will disappear over the horizon as per the real world.

3.3 Case studies

VBS2 has previously been used for maritime training and visualization by the US Navy, ADF and UK MOD.

3.3.1 VBS2 for boat gunnery training in the US Navy

VBS2 provides the virtual environment for the highly successful Laser Shot boat crew and gunnery trainer, presently employed by the US Navy. The boat crew and gunnery trainer includes a full motion platform that is driven by VBS2 ship motion (which is in turn dependant on sea state), and large projection screens to provide an immersive environment. Trainees operate heavy machine
guns and shoot at projected images. Scenarios are all maritime based and involve trainees engaging a range of targets and practicing rules of engagement. The boat crew and gunnery trainer also includes a basic radar screen (driven by VBS2) for trainee situational awareness.

For more information on the Laser Shot boat crew and gunnery trainer visit the Laser Shot website.

3.3.2 VBS2 for visualization in the Australian Defence Force Warfare Center (ADFWC)

The ADFWC funded a range of maritime-related VBS2 enhancements in 2008, primarily for visualization in support of joint exercises. These enhancements included:

- Inclusion of the ANZAC class destroyer, including basic naval gunfire capability
- Visualization of air-to-air refueling from a KC-130
- A basic Collins class submarine that can dive, use a periscope and fire unguided torpedoes
- An unmanned submersible that can be deployed and recovered from a Huon class ship
- A basic simulation of a Harpoon that included a realistic launch but limited guidance (the Harpoon flies directly from the launch platform to a target)

Note that VBS2 is regularly used as a visualization tool for constructive simulations such as JSAF and OneSAF. VBS2 supports both HLA and DIS through a robust gateway titled LVC Game, and correlated terrain can be generated through either the TerraSim TerraTools or Presagis TerraVista products.

3.3.3 VBS2 evaluation by the UK MOD for boat gunnery

The UK MOD sponsored a concept demonstrator to integrate VBS2 with a low-cost boat gunnery trainer, involving an instrumented weapon tracked in 3DOF, a projection system displaying VBS2 on a large screen
and a motion platform based upon D-Box\(^3\) technology. The system is not yet used in daily training however it again proved the potential for VBS2 to operate in the boat gunnery training role.

### 3.3.4 VBS2 for Aircrewman Training in the ADF

BIA won a contract to deliver six Aircrewman Virtual Reality Simulators (AVRS) to the ADF in 2006, and added a wide range of new functionality to VBS2 to support the Aircrewman training requirement. The AVRS provides a reconfigurable helicopter mockup in which up to three Aircrewman can operate, all wearing virtual reality headsets through which they see the VBS2 virtual environment. Trainees are tracked in 6DOF and are free to move about the cabin and also use virtual door guns.

The AVRS supports maritime training primarily in the SAR domain – helicopters may deploy from a ship to a downed pilot or a sailor overboard, deploy a hoist and a cage (or stretcher), and recover the individual from the water. VBS2 was upgraded to support full PhysX\(^4\) rope simulation in order to meet the load carrying requirement of Aircrewman training. This type of SAR capability is available in the standard version of VBS2 as well as in the full AVRS.

A version of the AVRS has also been delivered to the Royal Australian Air Force (RAAF) for use in marshalling training. The marshalling simulator is not currently used by naval personnel but it could easily be used for marshalling aircraft on the decks of simulated ships without modification.

### 3.3.5 VBS2 for ship familiarization in the UK MOD

The UK MOD funded a representation of the Type 45 “Daring” destroyer in VBS2, with a focus on ship familiarization. The ship is modeled to a high level of fidelity externally and naval guns can provide fire support. Internally, the key components are modeled, including the hangar, the bridge and a control room. It is possible to launch and recover small

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\(^4\) PhysX is a physics engine developed by Nvidia that is being integrated into VBS2
boats using hydraulic arms and these can be crewed by either human controlled or AI entities.

3.3.6 Naval gunfire support in VBS2Fires

VBS2 supports a generic simulation of naval gunfire support through the VBS2 Real Time Mission Editor, but this capability is much enhanced through the new VBS2Fires add-on module.

VBS2Fires is a professional call-for-fire module that “plugs-in” to VBS2 to provide a highly sophisticated yet easy-to-use training system for Forward Observers (or any other trainee for whom an understanding of call-for-fire procedures is relevant). VBS2Fires allows offensive support specialists to construct a call-for-fire which is then processed accordingly within VBS2. The system simulates exterior and terminal ballistics to a high level of detail and supports a wide array of munitions, fuse types and firing platforms. For more information on VBS2Fires visit http://www.simcentric.com.au/wiki/index.php?title=Fires.

VBS2Fires supports both static and self propelled artillery, mortars, MLRS and naval gunfire. The UK MOD is considering using VBS2Fires in warfare officer training to provide a visualization of naval gunfire effects on a target.
4. Future Plans and Opportunities

Bohemia Interactive is unique. It sits squarely between the game and simulation industries, with each component of the Bohemia Interactive Group providing additional value to the others.

The game developers within Bohemia Interactive Studio strive to deliver cutting-edge graphics and innovation, while Bohemia Interactive Simulations exploits these technologies on a daily basis to deliver a state-of-the-art, highly immersive virtual environment within a robust simulation framework tailored for Government use: VBS2.

Since 2007, Bohemia Interactive has been promoting the concept of VBS2 as an “Open Platform”. Not to be confused with Open Source, an Open Platform can be highly modified or customized without the involvement of the original application developers. Thanks to its computer game heritage, VBS2 is designed to be completely modified from the ground up. **User interfaces can be changed, new content added (3D models, terrain), and complex scripted systems developed,** thanks to the inclusion of over 1,400 script commands. VBS2 is bundled with all of the same tools that Bohemia Interactive developers use to create the product, including terrain creation and 3D modelling applications. **The result is a consolidated solution that includes 3D simulation, after-action review, scenario editing capability, HLA/DIS gateway and an ASI,** tailored for a range of users as shown in the image below.

The success of VBS2 has shown that the Open Platform concept is highly viable. Simulation companies all over the world have embraced VBS2 and are becoming experts at delivering VBS2-based solutions. However, Bohemia Interactive is yet to realize its vision:

**To provide a game-based simulation tool for training and analysis, that can be used across the entire virtual simulation spectrum.**
Bohemia Interactive firmly believes that one game-based simulation solution can solve virtual simulation interoperability issues and provide better quality of training, at a very affordable price when compared to all available alternatives.

Whereas constructive simulation begins at the macro environment, VBS2 focuses on the details (e.g. what a soldier, sailor or airman sees through simulated eyes) and is now being rapidly extended through Government and Industry funding to provide much more. There are many high-fidelity virtual simulations available, but very few provide a first person perspective while supporting almost any imaginable weapon platform. There are many possibilities for maritime in VBS2, as for the first time discrete training tasks such as bridge simulation can be practiced alongside boarding, SAR missions, close range weapon training and/or amphibious operations, for example.

Clearly, VBS2 has the foundations of an excellent maritime training capability with vast potential, already simulating a wide range of naval vessels and weapon systems at varying levels of fidelity. The present focus, however, is on maritime assets supporting the ground force – but much more is possible, if a few new key features are implemented.

The maritime community is encouraged to exploit the full potential of VBS2, and fund further enhancements that will see this versatile tool improved for all users.

The previous section described maritime capabilities available in VBS2 v1.40, scheduled for release in September 2010. However, work on maritime capability is ongoing and Bohemia Interactive plans to continue improving fidelity as demanded/funded by our customers. Note that the majority of new VBS2 capability is provided to all existing enterprise licensees that have a valid software maintenance arrangement.

4.1 Extending VBS2 via VBS2Fusion or the ASI

The VBS2 product is highly extendable through either VBS2Fusion, which is a separate module available through Bohemia Interactive, or the ASI that is included with every copy.

VBS2Fusion is a full-featured API that allows external applications to interface with VBS2 through access functions. For example, VBS2 may be connected to an external radar simulator, a weather server, an external physical ship model or any other program that needs to receive data from or send data to VBS2.

The VBS2 ASI is a lightweight API provided with every copy of the product. It allows external applications to interact with VBS2 via script commands. The ASI is slower than VBS2Fusion and not as robust, but is an affordable alternative that provides similar possibilities.

4.2 Contracted development

Bohemia Interactive is presently contracted to improve VBS2 by several military organizations. Improvements that are both contracted and likely to be contracted are summarized below.

4.2.1 Improved damage modeling

Currently the concept of VBS2 damage is very simple, with entities having an overall “damage” value that is measured from 0 to 1. When damage reaches 1, the entity dies or is destroyed. The USMC has funded improvements to this system however, whereby components of vehicles can have different damage properties tied to scripted event handlers. For example, it will be possible to define weak or vulnerable parts of a ship; the engine room or fuel tank, for example, that will have a realistic effect when hit – perhaps the ship will be disabled or explode.

Other improvements include the implementation of PhysX for simulating sinking ships, with the rate and location of water entry affecting the speed and angle of the ship as it sinks.

4.2.2 Scuba and small boat simulation

An existing VBS2 customer is very likely to fund scuba and small boat simulation in the near future, which will first and foremost enable underwater swimming in VBS2. Full dive kit will be simulated, including mask, fins, TAC board, Secumar Vest, Draeger, weight belt, uniform, kitted equipment, dive tool, flare and

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buddy line. It will be possible to conduct a tactical peek and also conduct shore breach, including removal of dive gear. Divers will also be able to exit and board small boats when wearing dive kit.

4.3 Further improving maritime capability

Following extensive discussion with stakeholders in the maritime domain, Bohemia Interactive has compiled the following list of suggested maritime improvements, ordered by customer priority. Maritime users interested in funding any of the described capabilities should contact Bohemia Interactive for an itemized quotation.

Bohemia Interactive is proud to serve our Government customers, and stands ready to further support the maritime training requirement through funded enhancements to VBS2.

4.3.1 Entity and helicopter interaction with ships

These enhancements would improve the VBS2 simulation to allow both human and AI controlled entities to walk on moving ships, and also walk below the waterline. Helicopters would also be able to land on moving vessels. These enhancements would facilitate more immersive ship familiarization scenarios, amphibious operations, boarding missions and more realistic helicopter operations in VBS2.

4.3.2 Maritime environment

This improvement primarily involves the simulation of more realistic sea states in VBS2 (from 1 to 6), through a new sea state option to scenario settings. It will ensure that waves are much taller in strong sea states and whitecaps are represented. The effect of sea state on boat speed and rolling (physics simulation) would also be improved.

The second component of this improvement is more realistic ship wakes. As discussed, VBS2 already supports ship wakes to a very crude level of detail, whereby small waves are represented in 3D within the simulated water (as shown in the previous image). The present implementation is a prototype
only and Bohemia Interactive proposes to improve the simulation by smoothing the waves – at the moment they are very jagged – and applying a white color so the wakes are more obvious and realistic. In addition, high quality particle-effect based wakes would be implemented to simulate waves created close to the bow and stern of in-game vessels.

4.3.3 Maritime AI

Currently maritime AI is limited to following waypoints and performing scripted actions, which are relatively complex to generate in the VBS2 Offline Mission Editor. Bohemia Interactive proposes to improve maritime AI as follows:

- Behaviors for autonomous ambient AI would be added, allowing civilian craft to automatically act in a realistic manner without needing waypoints. This would include vessels moving to and from port.
- New editor objects for automatically deploying and recovering units from and to maritime vessels would be developed. Such actions would include amphibious assaults, boarding missions and helicopter operations (e.g. SAR, ASW, CASEVAC).
- Simulation of AI-controlled ship weapons including close-in weapon systems (CIWS) and SAMs would be added or improved as needed.

4.3.4 Guided missile and torpedo framework

This improvement would see a framework for guided missiles and torpedoes created, allowing missiles and torpedoes with complex flight paths and guidance systems to be added to the simulation relatively easily. The framework would be fully documented and added to the VBS2 Development Suite, allowing other organizations to add new (or classified) weapons to VBS2 as required.

As part of this development Bohemia Interactive would add Harpoon missiles and both ship and helicopter launched guided torpedoes to VBS2.
4.3.5 Additional in-game maritime-specific interfaces

Bohemia Interactive proposes to develop a more realistic bridge simulation in VBS2, allowing a human controlled character to access new interfaces that inform the trainee, in order to stimulate maritime-related decisions. These interfaces may include radar, sonar, damage, and weapons status screens. The interfaces created would be generic (the same for all ship types), but Bohemia Interactive would also provide a framework for other developers to add new VBS2 interfaces that may be classified in nature.

4.3.6 Enhancing the underwater environment

Although scuba diving capability is very likely to be contracted in the near future (as described in Paragraph 4.2.2 above), improvement of the graphical representation of the underwater environment is yet to be funded. Bohemia Interactive proposes to implement the latest Shading technology for a highly realistic visualization of being underwater (at varying depths), as well as implement detailed 3D underwater features such as rocks, coral and sea life.

4.4 Real Virtuality 3

As described in Paragraph 2.6, Bohemia Interactive has continued development on the core Real Virtuality game engine that underpins VBS2. The latest version, Real Virtuality 3 (RV3), provides extremely high-fidelity graphics using the very latest rendering technology. If the graphical level of detail in VBS2 is insufficient, then Bohemia Interactive may be able to offer RV3 to maritime customers on a per-case basis or select capabilities may be converted back to VBS2 at minimal cost.
5. Contact

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## Appendix A: Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3DOF:</td>
<td>Three Degrees of Freedom</td>
</tr>
<tr>
<td>6DOF:</td>
<td>Six Degrees Of Freedom</td>
</tr>
<tr>
<td>AI:</td>
<td>Artificial Intelligence</td>
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<tr>
<td>ADF:</td>
<td>Australian Defence Force</td>
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<tr>
<td>ADFWC:</td>
<td>Australian Defence Force Warfare Center</td>
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<tr>
<td>ANZAC:</td>
<td>Australian and New Zealand Army Corps</td>
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<tr>
<td>API:</td>
<td>Application Programming Interface</td>
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<tr>
<td>ASI:</td>
<td>Application Scripting Interface</td>
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<tr>
<td>ASW:</td>
<td>Anti-Submarine Warfare</td>
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<tr>
<td>AVRS:</td>
<td>Aircrewman Virtual Reality Simulator</td>
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<tr>
<td>CIWS:</td>
<td>Close-In Weapon System</td>
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<tr>
<td>DIS:</td>
<td>Distributed Interactive Simulation</td>
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<tr>
<td>DTED:</td>
<td>Digital Terrain Elevation Data</td>
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<tr>
<td>HLA:</td>
<td>Higher Level Architecture</td>
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<tr>
<td>HMAS:</td>
<td>His/Her Majesty's Australian Ship</td>
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<tr>
<td>HMNZS:</td>
<td>His/Her Majesty's New Zealand Ship</td>
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<tr>
<td>JSAF:</td>
<td>Joint Semi Automated Forces</td>
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<tr>
<td>LCAC:</td>
<td>Landing Craft Air Cushion</td>
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<tr>
<td>LCU:</td>
<td>Landing Craft Utility</td>
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<tr>
<td>LVC:</td>
<td>Live Virtual Constructive</td>
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<tr>
<td>MLRS:</td>
<td>Multiple Launch Rocket System</td>
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<tr>
<td>OneSAF:</td>
<td>One Semi-Automated Force</td>
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<tr>
<td>OPFOR:</td>
<td>Opposing Force</td>
</tr>
<tr>
<td>RAAF:</td>
<td>Royal Australian Air Force</td>
</tr>
<tr>
<td>RAC:</td>
<td>Riverine Assault Craft</td>
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