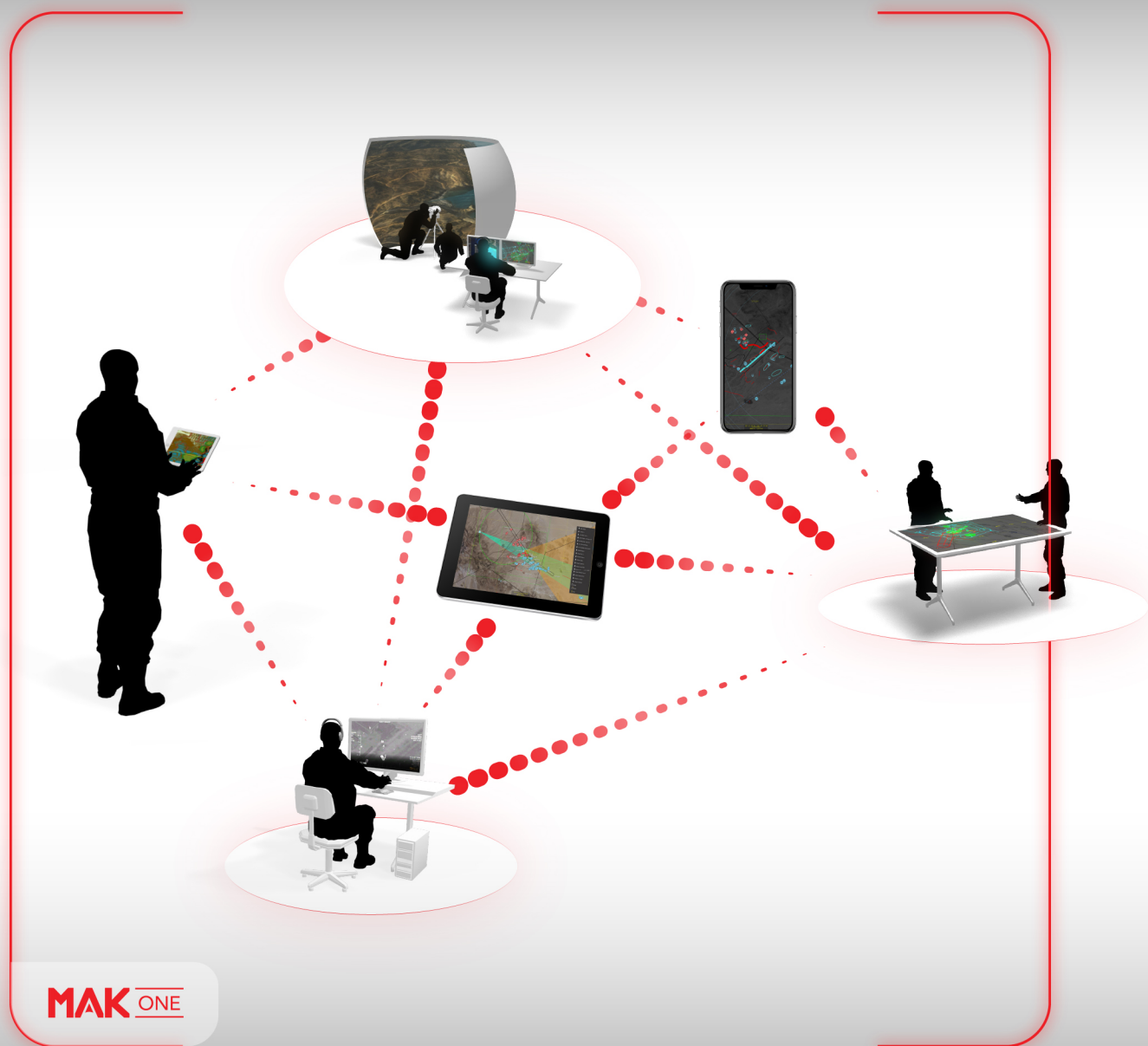




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Preface

This manual is written for persons who need to write WebLVC applications. The manual assumes that you are familiar with your operating system and windowing environment.

See the MAK WebLVC Server Release Notes for updates to this manual and the latest information about your version of WebLVC Server.

How the Manual is Organized

This manual is organized as follows:

"Chapter 1. The WebLVC Specification" on page 17 introduces the WebLVC specification.

"Chapter 2. The Standard WebLVC Object Model" on page 33 introduces the Standard Object Model.

"Chapter 3. MAK Extensions to the Standard WebLVC Object Model" on page 47 describes WebLVC messages that are specifically for use with MAK applications.

MAK Products

The MAK Technologies product line includes:

- **VR-Link® Network Toolkit.** VR-Link is an object-oriented library of C++ functions and definitions that implement the High Level Architecture (HLA) and the Distributed Interactive Simulation (DIS) protocol. VR-Link has built-in support for the NETN FOM and RPR FOM and allows you to map to other FOMs. This library minimizes the time and effort required to build and maintain new HLA or DIS-compliant applications, and to integrate such compliance into existing applications.
VR-Link includes a set of sample debugging applications and their source code. The source code serves as an example of how to use the VR-Link Toolkit to write applications. The executables provide valuable debugging services such as generating a predictable stream of HLA or DIS messages, and displaying the contents of messages transmitted on the network.
- **MAK RTI.** An RTI (Run-Time Infrastructure) is required to run applications using the High Level Architecture (HLA). The MAK RTI is optimized for high performance. It has an API, RTIsby®, that allows you to extend the RTI using plug-in modules. It also has a graphical user interface (the RTI Assistant) that helps users with configuration tasks and managing federates and federations.
- **VR-Forces®.** VR-Forces is a computer generated forces application and toolkit. It provides an application with a GUI, that gives you 2D and 3D views of a simulated environment.

You can create and view entities, aggregate them into hierarchical units, assign tasks, set state parameters, and create plans that have tasks, set statements, and conditional statements. You can simulate using entity-level modeling, which focuses on the actions of individual people and vehicles, and aggregate-level modeling, which focuses on the interaction of large hierarchical units.

VR-Forces also functions as a plan view display for viewing remote simulation objects taking part in an exercise. Using the toolkit, you can extend the VR-Forces application or create your own application for use with another user interface.

- **VR-Vantage™.** VR-Vantage is a line of products designed to meet your simulation visualization needs. It includes VR-Vantage and the VR-Vantage Toolkit.

- VR-Vantage displays a realistic, 3D view of your virtual world, a 2D plan view, and an exaggerated reality (XR) view. Together these views provide both situational awareness and the big picture of the simulated world. You can move your viewpoint to any location in the 3D world and can attach it to simulation objects so that it moves as they do.
- SensorFX. SensorFX is an enhanced version of VR-Vantage that uses physics-based sensors to view terrain and simulation object models that have been materially classified. It is built in partnership with JRM Technologies.
- The VR-Vantage Toolkit is a 3D visual application development toolkit. Use it to customize or extend MAK's VR-Vantage applications, or to integrate VR-Vantage capabilities into your custom applications. VR-Vantage is built on top of OpenSceneGraph (OSG). The toolkit includes the OSG version used to build VR-Vantage.
- MAK Data Logger. The Data Logger, also called the Logger, can record HLA and DIS exercises and play them back for after-action review. You can play a recorded file at speeds above or below normal and can quickly jump to areas of interest. The Logger has a GUI and a text interface. The Logger API allows you to extend the Logger using plug-in modules or embed the Logger into your own application. The Logger editing features let you merge, trim, and offset Logger recordings.
- VR-Exchange™. VR-Exchange allows simulations that use incompatible communications protocols to interoperate. For example, within the HLA world, using VR-Exchange, federations using the HLA RPR FOM 1.0 can interoperate with simulations using RPR FOM 2.0, or federations using different RTIs can interoperate. VR-Exchange supports HLA, TENA, and DIS translation.
- VR-TheWorld™. VR-TheWorld is a simple, yet powerful, web-based streaming terrain server, developed in conjunction with Pelican Mapping. Delivered with a global base map, you can also easily populate it with your own custom source data through a web-based interface. The server can be deployed on private, classified networks to provide streaming terrain data to a variety of simulation and visualization applications behind your firewall.
- DI-Guy™. DI-Guy is an SDK that allows you to embed the DI-Guy library in your real-time application and populate your world with lifelike human characters. DI-Guy provides high-fidelity human characters that move realistically, respond to simple high-level commands, and travel throughout the environment as directed by the hosting visual application. It comes with thousands of ready-to-use characters, appearances, and motions. DI-Guy character simulation is an integral part of all MAK's visual applications, including VR-Engage, VR-Forces, and VR-Vantage.
- RadarFX. RadarFX is a client-server application that simulates synthetic-aperture radar (SAR). The server application, which is based on VR-Vantage and SensorFX, loads a terrain database and, optionally, connects to simulations. A client application requests SAR images from the server. RadarFX includes a sample client application.
- VR-Engage. VR-Engage is a multi-role virtual simulator that lets users play the role of a first person human character, a ground vehicle driver, gunner or commander, a sensor operator, or the pilot of a fixed wing aircraft or helicopter. It incorporates

the VR-Force simulation engine and the VR-Vantage graphics rendering capabilities.

- **WebLVC Server.** WebLVC Server implements the server side of the WebLVC protocol so that web-based simulation federates can participate in a distributed simulation. It is part of the WebLVC Suite, which includes the server and several sample applications that work with VR-Forces and VR-Vantage.
- **MAK Legion.** MAK Legion is a collection of applications and an SDK designed to support simulations with millions of simulation objects.

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For technical support, information about upgrades, and information about other MAK products, you can contact us in the following ways:

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License key requests:	https://www.mak.com/mak-one/support/portal
Technical support:	https://www.mak.com/mak-one/support/portal
Product version and platform information:	https://www.mak.com/mak-one-specs
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Post

Send postal correspondence to:	MAK Technologies 10 Fawcett Street, Suite 204 Cambridge, MA 02138 USA
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When requesting support, tell us the product you are using, the version, and the platform on which you are running. If you are using VR-Vantage, VR-Forces, VR-Engage, or DI-Guy, please also include your data compatibility version and date.

Document Conventions

This manual uses these typographic conventions:

Sans Serif Bold	Indicates a key on the keyboard or menu options. Mentions of letter keys do not require you to press the Shift key. If Shift is necessary, that will be included, for example, Shift+Q . Also indicates parameters.
Monospaced	Indicates values you enter such as commands or arguments.
<i>Monospaced</i>	Indicates command variables that you replace with appropriate values.
<i>Italic</i>	
{ }	Indicates required arguments.
[]	Indicates optional arguments.
	Separates options in a command where only one option may be chosen at a time.
()	In command syntax, indicates equivalent alternatives for a command-line option, for example, (-h --help).
/	Indicates a directory. Since MAK products run on both Linux and Windows PC platforms, we use the / (slash) for generic discussions of pathnames.
<i>Italic</i>	Indicates a file name, pathname, or a class name.
►	Indicates a procedure.
Menu > Option	Indicates a menu choice. For example, an instruction to select the Save option from the File menu appears as: Choose File > Save .
	Indicates supplemental or clarifying information.
	Indicates additional information that you must observe to ensure the success of a procedure or other task.

Directory names are preceded with dot and slash characters that show their position with respect to the WebLVC Server home directory. For example, the directory `./webLVC1.8/doc` appears in the text as `./doc`.

Mouse Button Naming Conventions

An instruction to click the mouse button refers to clicking the primary mouse button, usually the left button for right-handed mice and the right button for left-handed mice. The context-sensitive menu, also called a popup menu or right-click menu, refers to the menu displayed when you click the secondary mouse button, usually the right button on right-handed mice and the left button on left-handed mice.

Third-Party Licenses

MAK software products may use code from third parties. This section contains summary license information and, where required, specific license documentation required by these third parties.

Third-Party Libraries Supported

WebLVC Server 1.8 uses the indicated versions of these libraries:

- VR-Link 5.9.1
- Qt 5.15.2 (VC 15 and Red Hat 8)

- OpenSceneGraph 3.6.4
- Boost 1.84.0
- FreeGlut 2.4.0 (Windows), 2.6.0 (Linux)
- GL Studio 8.2
- DI-Guy 13.7.1 (development version)
- Triton 4.43
- SilverLining 6.20
- SpeedTree 6.3.2
- CDB API 2.2 (Windows), 2.1 (Linux)
- osgEarth 3.2
- CUDA 12.5 (Windows), 12.4.1 (Linux)

Library Licensing

These libraries are covered by the GNU Lesser General Public License (LGPL) license:

- CIGI
- DevIL
- GEOS
- GStreamer
- LibIconV
- LibWebSockets
- OP CODE
- OpenAL
- OSG
- OsgEarth
- Pthread
- Qt
- Qwt

These libraries are covered by the ZLib license:

- Bullet Physics
- LibPNG
- LibSDL
- Minizip
- Zlib

These libraries are covered by the MIT license:

- Expat
- FreeGLUT
- GDAL
- GeoTIFF
- GLM
- HarfBuzz
- LibCURL
- LibSquish
- LibXML
- LUA
- LuaBind
- Proj
- SMHasher
- TCLAP
- Qt Visual Graph Editor
- ZeroBrane Studio

These libraries are covered by the BSD license:

- FreeType
- GLEW
- JPEG
- LibTiff
- Protobuf
- PCRE
- Ogg Vorbis
- WebP

These libraries are covered by the commercial licenses:

- FLEXlm
- Gameware
- GLStudio
- JRM Technologies SenSimRT and SigSimRT
- OpenFlight
- SpeedTree
- Sundog Triton
- Sundog SilverLining
- CDB API

These libraries are covered by custom licenses:

- NVIDIA CG Toolkit
- FreeImage (FreeImage Public License)
- Boost (Boost Software License)
- Poco (Boost Software License)

COLLADA DOM is covered by the SCEA Shared Source license.

Thread Building Blocks is covered by the GPL license:

SQLite is in the public domain.

SWIG is covered by the GPL license.

Boost License

VR-Link, and all MAK ONE products that use VR-Link, uses some code that is distributed under the Boost License. All header files that contain Boost code are properly attributed. The Boost website is: www.boost.org.

Boost Software License - Version 1.63 - August 17th, 2003

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libXML and libICONV

VR-Link, and all MAK ONE products that use VR-Link, links in libXML and libICONV. On some platforms the compiled libraries and header files are distributed with MAK products. MAK has made no modifications to these libraries. For more information about these libraries, see the following websites:

- The LGPL license is available at: <http://www.gnu.org/licenses/lgpl.html>.
- Information about IconV is at: <http://www.gnu.org/software/libiconv>.
- Information about LibXML is at: <http://xmlsoft.org>.



1. The WebLVC Specification

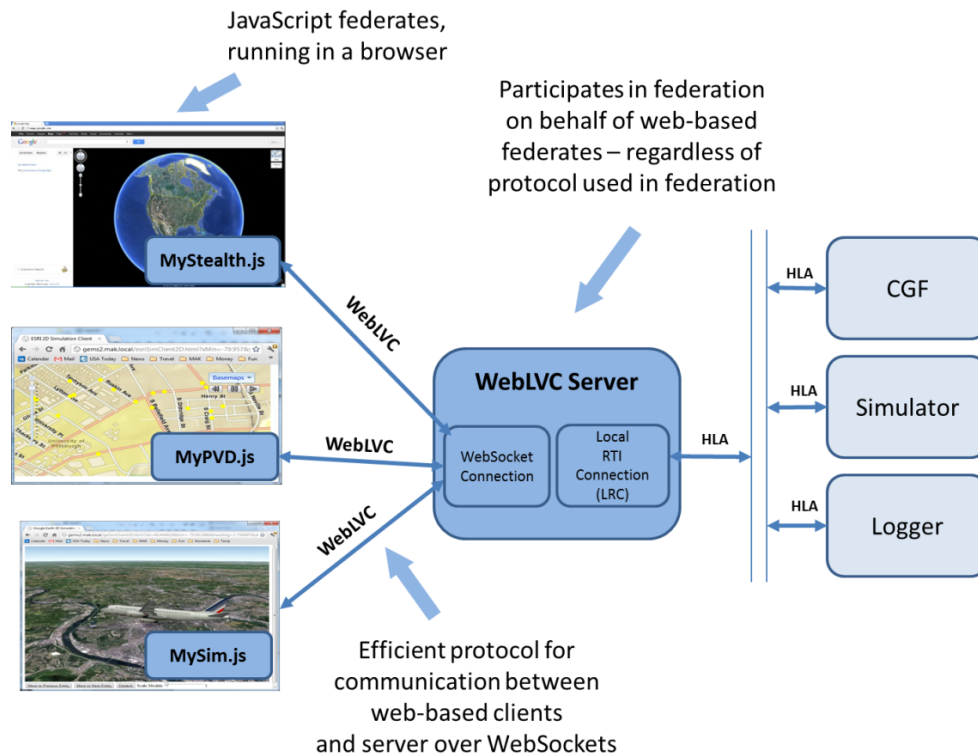
This chapter is an introduction to the WebLVC specification as implemented in MAK WebLVC.

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1.1. Introduction to WebLVC

WebLVC is an interoperability protocol that enables web-based applications (typically JavaScript applications running in a web browser) to interoperate in modeling and simulation (M&S) federations. WebLVC client applications communicate with the rest of the federation through a WebLVC server, which participates in the federation on behalf of one or more clients. The WebLVC protocol defines a standard way of passing simulation data between a web-based client application and a WebLVC server, independent of the protocol used in the federation. Thus, a WebLVC client can participate in a DIS exercise, an HLA federation, a TENA execution, or other distributed simulation environment.

Figure 1. WebLVC protocol



The WebLVC protocol specifies a standard way of encoding object update messages, interaction messages, and administrative messages as JSON (JavaScript Object Notation) objects, which are passed between client and server using WebSockets. WebLVC is flexible enough to support representation of arbitrary types of objects and interactions (that is, arbitrary object models). However, WebLVC includes a Standard Object Model definition based on the semantics of the DIS protocol and HLA's RPR FOM. Users can extend the Standard Object Model by adding new types of objects, attributes, interactions, and parameters, or can choose to represent the semantics of entirely different object models (for example, other HLA FOMs, ANDEM models, and so on.)

1.1.1 Introduction to JSON

A JSON object is a collection of unordered name/value pairs, expressed in text, using the syntax of JavaScript. For example, a JSON object representing a can of soda might look like this:

```
{
  "ContainerType" : "can",
  "SizeInLiters" : 0.33,
  "Brand" : "Coca Cola",
  "Flavor" : "Cherry"
}
```

JSON is the natural way of encoding structured data that is intended to be used by web-based JavaScript federates, because a JSON object is a string-literal representation of a JavaScript object. The JavaScript language has built-in serialize and parse functions that generate JSON strings from JavaScript objects, and vice versa, without the need for data marshaling or conversion.

Upon receiving the soda can object described above, a JavaScript federate can directly query the object for its attribute values:

```
var numLiters = sodaCan.SizeInLiters;
```

1.1.2 A WebLVC Example

The WebLVC specification defines a standard mechanism for representing simulation interoperability messages as JSON objects by specifying property names, data types, enumeration values, and conventions. For example, in order to represent a valid WebLVC attribute object message, a JSON object must include a property called `MessageKind`, a property called `ObjectType`, and a variety of other properties defined by the object model being used and the object type of the object being updated. The WebLVC Standard Object Model uses attributes names, types, and enumerated values dictated by DIS, the RPR FOM, and the SISO Enumerations Document.

For example, a web-based flight simulator using WebLVC with the Standard Object Model might convey the current state of the aircraft it is simulating by sending this WebLVC message:

```
{
  MessageKind : 1,
  ObjectName : "F-16 Alpha",
  ObjectType : "WebLVC:PhysicalEntity",
  EntityIdentifier : [1,2,1],
  EntityType : [1,2,225,1,3,0,0],
  worldLocation : [4437182.0232, -395338.0731, 873923.4663],
  velocityVector : [57.04, 32.77, 89.263],
  Orientation : [-1.65, 2.234, -0.771],
  Marking : "F-16",
  DamageState : 0
}
```

A MessageKind of 1 indicates that this message is conveying an AttributeUpdate. F-16 Alpha is the name of the WebLVC Object being updated, and the object is of type WebLVC:PhysicalEntity – one of the types in the Standard WebLVC Object Model.



- The various attribute names match those in the RPR FOM.
- The DIS and RPR FOM (DIS/RPR) style EntityIdentifier and EntityType structures are encoded as arrays of enumerated values.
- The same units and coordinate systems as DIS/RPR are used for WorldLocation, VelocityVector, and Orientation.
- Any given WebLVC AttributeUpdate may contain values for only a subset of the object's properties, for example, values that have changed since the last update.

1.2. Basic Protocol Specification

This section defines the basic, object-model-independent elements of the WebLVC protocol. It includes specifications for the following:

- Header information that is common to all WebLVC messages.
- Administrative messages, such as Connect and ObjectDeletion messages, which do not depend on the object model being used.
- Common properties, such as ObjectName and TimeStamp that may be included in Attribute Update and Interaction messages regardless of what kinds of objects and interactions they are describing.

1.2.1 Header Information

Since WebLVC messages are simply JSON objects, there is no concept of a "message header" per se. Header information, such as the type of message a JSON object represents, is encoded just like the rest of the data in a message – through named properties and values.

Required Properties

MessageKind. All WebLVC messages must include the MessageKind property. MessageKind is a number that indicates what kind of WebLVC message an object represents:

- 0 – Other.
- 1 – AttributeUpdate message (updates the values of attributes of a WebLVC object).
- 2 – Interaction message (describes the parameters of an event or interaction).
- 3 – Connect message (simple handshake to connect client to server).
- 4 – ObjectDeletion message (informs recipient that a WebLVC object no longer exists).

A client or server may check the value of the MessageKind property to determine what kind of message it has received, and therefore determine what additional properties it can expect the message to contain.

1.2.2 The Connect Message

A client application is not required to send a Connect message to the server in order to connect. The client can start sending AttributeUpdates and Interactions immediately upon opening its WebSocket to the server. However, it is often desirable to provide the server with additional information about the client, so that the server can pass such information along to the rest of the federation.

Required Property

- **ClientName.** ClientName is a string representing the name of the client federate.

Optional Property

- **WebLVCVersion.** A number representing the version of WebLVC to be used for communication between the connecting client and server. If WebLVCVersion is omitted, it is assumed that the client is using the default version of the WebLVC standard supported by the server.

Example Connect Message

```
{
  MessageKind : 3,
  ClientName  : "MyFederate",
  WebLVCVersion : 0.1
}
```

1.2.3 The ObjectDeletion Message

An application must send an ObjectDeletion message to inform the recipient that an object it has been updating no longer exists.

Required Property

- **ObjectName.** ObjectName is a string representing the name of the object that has been deleted.

Example ObjectDeletion Message

```
{
  MessageKind : 4,
  ObjectName  : "F-16 Alpha",
}
```

 There is no corresponding ObjectCreation or ObjectRegistration message defined in WebLVC. This is because the first AttributeUpdate sent for an object can serve to inform the recipient that an object exists with the specified name. (This is similar to the DIS protocol, where a recipient is informed that a particular simulation object exists when it receives its first Entity State PDU from a previously-unknown simulation object.)

1.2.4 AttributeUpdate Message

AttributeUpdate messages are used to convey values of the attributes of a WebLVC object. While the names of the properties that carry the object's state depend on the object model, there are several common properties, such as `ObjectName` and `TimeStamp`, whose definitions are independent of the type of object being updated. The rules that dictate when, or how frequently, an AttributeUpdate shall be sent depend on the Object Model being used, and the type of object being updated.

Required Property

- **ObjectName.** The value of the `ObjectName` property is a string that uniquely identifies the WebLVC object for which the message is conveying an update. It is the responsibility of the application that is sending updates for an object (which might be either a client or the WebLVC Server) to ensure that it chooses a name that is not already in use.

Optional Properties

- **ObjectType.** A string that indicates the Object Type of the WebLVC object for which the message is conveying an update (similar to the concept of HLA `ObjectClass` or DIS `PDU Kind`). Based on the value of the `ObjectType` property, an application can determine what other properties it can expect the message to contain. For example, updates for objects of type `WebLVC:PhysicalEntity` may contain a `WorldLocation` property.

Strings are used to represent object types (rather than enumerated numbers), to support easy extensibility. Strings allow naming conventions that make collisions unlikely among different users' extensions and avoid the need for a central repository of enumeration-to-string mappings for user extensions. By convention, object types defined by the Standard WebLVC Object Model have the prefix `WebLVC:` (for example, `WebLVC:PhysicalEntity`), while user extensions have a prefix that indicates the origin of an object model (for example, `MyProject:MyObjectKind` or `MyCompany:MyObjectKind`).

Although the `ObjectType` property is quite important, it is not considered to be required, because it need not be included in every WebLVC message. The first AttributeUpdate for each WebLVC object must include the `ObjectType` property to inform the receiving application of the object type associated with each WebLVC object. The receiving application can then store that association, so that subsequent AttributeUpdate messages do not need to include the `ObjectType` property. As is the case with all optional properties, an application may choose to include `ObjectType` in every AttributeUpdate (for example, to relieve the receiver of the responsibility to look up the type of each object by name in order to know how to interpret the update).

- **Timestamp.** The time at which the data is valid, using the DIS timestamp field format converted into hexadecimal ASCII character representation as defined by the RPR FOM. If `Timestamp` is missing, the message is assumed to be valid at the time of receipt.

1.2.5 Interaction Message

Interaction messages send parameters of a simulation event or interaction. While the names of the properties that carry the interactions parameters depend on the object model, there are several common properties, such as `TimeStamp`, whose definitions are independent of the type of interaction being sent. The rules that dictate when, or how frequently, an interaction must be sent depend on the object model being used and the type of interaction in question.

Required Property

- **InteractionType.** A string that indicates the type of the interaction sent by a WebLVC message (similar to HLA `InteractionClass` or DIS `PDU Kind`). All interaction messages must include the `InteractionType` property. Based on the value of the `InteractionType` property, an application can determine what other properties it can expect the message to contain. For example, interactions of type `WebLVC:WeaponFire` may contain a `MunitionType` property.

Strings are used to represent interaction types (rather than enumerated numbers), to support easy extensibility. Strings allow naming conventions that make collisions unlikely among different users' extensions, and avoid the need for a central repository of enumeration-to-string mappings for user extensions. By convention, interaction types defined by the Standard WebLVC Object Model have the prefix `WebLVC:` (for example, `WebLVC:WeaponFire`), while user extensions have a prefix that indicates the origin of an object model (for example, `MyProject:MyInteractionKind` or `MyCompany:MyInteractionKind`).

Optional Property

- **Timestamp.** The time at which the data is valid, using the DIS timestamp field format converted into hexadecimal ASCII character representation as defined by the RPR FOM.

1.3. Extending the WebLVC Protocol

The WebLVC standard includes a Standard Object Model based on a subset of the DIS/RPR object model. However, the WebLVC standard can be easily extended to facilitate the exchange of data that is outside of the Standard Object Model.

- You can define new `ObjectTypes` and `InteractionTypes`, and define various properties associated with each new message type.
- You can add new properties to existing `StandardObjectModel` message types.

JSON (and JavaScript) is naturally extensible in a backwards compatible way. When a client receives a message, it can check the message type against types it knows about, and ignore messages of unknown types. Similarly, when a client receives a message of a type it knows about, it can query the message for values for properties it expects, and ignore properties whose names are unexpected.

1.3.1 Extending WebLVC Automatically, Based on DIS

Imagine that a DIS application has extended the DIS protocol (or is using some of the built-in extension capabilities of DIS 7) to add new attributes to the Entity State PDU. If you want to pass that attribute to a WebLVC client, you can define a WebLVC (JSON) representation of the attribute, and define a new property of WebLVC:PhysicalEntity to convey it.

There is no formal meta-model in WebLVC to represent object model extensions – you can document extensions in a way similar to the way this manual defines the standard WebLVC Object Model. To implement the use case in the previous paragraph, extend your WebLVC server to support the mapping of the new DIS attribute to the new WebLVC property. Depending on how the WebLVC server is built and distributed, this extension might be accomplished through editing source code, using a plug-in API, or through a run-time configuration mechanism. However it is accomplished, the point is that user intervention is required in order to "teach" the WebLVC server which DIS field or new PDU type should be mapped to which WebLVC property or message type.

1.3.2 Extending WebLVC Automatically, Based on an HLA FOM

If you have defined an object model in the form of an HLA FOM, a WebLVC server can automatically extend the WebLVC protocol to include WebLVC elements that directly correspond to custom HLA Object Classes, Interaction Classes, Attributes and Parameters. This is because unlike typical DIS extensions, HLA FOM elements are machine readable in a standard way. A FOM provides information about class names, as well as attribute and parameter names and datatypes – everything that an application needs to know how to build corresponding JSON elements within a WebLVC object model.

Not only is it possible for a WebLVC Server to extend the WebLVC protocol, it is also possible for a WebLVC server to automatically know how to translate between the new FOM elements and the corresponding new WebLVC elements – without requiring user extension of server capabilities. In order to achieve this, there must be a well-documented set of rules for mapping between HLA data types and structures and their corresponding WebLVC representations. If all WebLVC servers map a specific HLA data type to the same representation on the WebLVC side, client developers will know exactly what to expect, and can write client code accordingly.

Table 1 lists data types used by the JSON format.

Table 1. JSON type examples

JSON type	Examples
Number	3.14
String	"my name"
Boolean	true, false
Array	[1, 2, "3"]
Object	{ a: 1, b: "a string" }
null	Null

Because JSON has only a few types, there might be many valid mappings from simulation data models with a greater set of more specific types. Should a WebLVC number be mapped as an integer or some floating point type? Should a JSON string map as an array of characters, or does it correspond to some enumerated value? Starting from the more specific data model should simplify the conversion.

1.3.3 Standard Mapping Rules for HLA and the RPR FOM

The High-Level Architecture uses a meta-model called an object model template (OMT) to encode simulation data into a Federation Object Model (FOM). The OMT organizes data type definitions into tables. Rules and recommendation for mapping between standard HLA and RPR FOM datatypes, and WebLVC datatypes are described in the following sections.

The RPR FOM includes datatypes intended only as padding, to ensure correct alignment of data. These padding datatypes do not map to corresponding WebLVC datatypes and are omitted from WebLVC datatypes.

Basic Data Representation Table

The OMT describes representations of data separately from their types. Unless a more specific mapping applies, OMT simple datatypes should use the mapping of their representation. Basic data representations probably map as either Number, String or Boolean data types.

Table 2 lists the basic data representations for HLA.

Table 2. HLA basic data representation

OMT name	WebLVC type
HLAinteger16BE	Number
HLAinteger32BE	Number
HLAinteger64BE	Number
HLAfloat32BE	Number
HLAfloat64BE	Number
HLAoctetPairBE	Number (unsigned)
HLAinteger16LE	Number
HLAinteger32LE	Number
HLAinteger64LE	Number
HLAfloat32LE	Number
HLAfloat64LE	Number
HLAoctetPairLE	Number (unsigned)
HLAoctet	Number (unsigned)
RPRunsignedInteger8BE	Number (unsigned)
RPRunsignedInteger16BE	Number (unsigned)
RPRunsignedInteger32BE	Number (unsigned)

Table 2. HLA basic data representation (continued)

OMT name	WebLVC type
RPRunsignedInteger64BE	Number (unsigned)
Unsignedinteger16BE	Number (unsigned)
Unsignedinteger32BE	Number (unsigned)
Unsignedinteger64BE	Number (unsigned)
OMT13any	Number (unsigned)

Simple Datatype Table

OMT character datatypes should map as single character strings.

Table 3 lists scalar data types.

Table 3. HLA simple datatype table

OMT name	WebLVC type
HLAASCIIchar	String (single character)
HLAunicodeChar	String (single character)
HLAbyte	Number (unsigned)
HLAinteger64Time	Number
HLAfloat64Time	Number
HLAfederateHandle	Number
HLAmsec	Number
HLAseconds	Number
HLAcstring	String
HLAstring	String
HLAcount	String
handle	String
timeType	String
string	String
int	Number
long	Number
long long	Number
octet	Number (unsigned)
short short	Number
unsigned int	Number (unsigned)
unsigned long	Number (unsigned)
unsigned long long	Number (unsigned)
unsigned short	Number (unsigned)

Table 3. HLA simple datatype table (continued)

OMT name	WebLVC type
double	Number
float	Number

Enumerated Datatype Table

Table 4 lists enumerated datatypes.

Table 4. HLA enumerated datatype table

OMT name	OMT Enumerator	WebLVC type	WebLVC value
HLAboolean	HLAfalse	Boolean	false
	HLAtrue	Boolean	true
RPRboolean	HLAfalse	Boolean	false
	HLAtrue	Boolean	true
OMT13boolean	HLAfalse	Boolean	false
	HLAtrue	Boolean	true

Except for the Boolean enumerations explicitly listed in , map the values of enumerators as numbers. Using the enumerator name as a string would require updating intermediating software (for example, gateways) as the strings change. Numbers can be passed without translation, so new enumerations names are ignored.

Table 5 is an example of enumerated datatypes for HLA.

Table 5. Example HLA enumerated datatype table

OMT name	OMT Enumerator	OMT value	WebLVC type	WebLVC value
HLAboolean	HLAfalse	0	Boolean	false
	HLAtrue	1	Boolean	true
AntennaPatternTypeEnum32	OmniDirectional	0	Number	0
	Beam	1	Number	1
	SphericalHarmonic	2	Number	2

Array Datatype Table

Standard HLA arrays are converted to either strings or arrays as shown in Table 6.

Table 6. HLA array datatype table

OMT name	WebLVC type
HLAASCIIstring	String
HLAunicodeString	String
HLAopaqueData	Array (of unsigned Number)
HLAtoken	n/a
MarkingArray11	String
MarkingArray31	String
OctetArray {all variations}	Array (of unsigned Number)

HLAtoken is a zero-length array and is not converted to a WebLVC representation because JSON already has termination rules for strings and arrays.

WebLVC does not distinguish between fixed and variable length arrays.

OMT arrays should convert to WebLVC arrays, except character arrays (where array element representations map as characters, or octets intended as characters). Character arrays should convert to WebLVC strings.

Fixed Record Datatype Table

Fixed records are mapped as JSON objects. Each field in the OMT is mapped to a JSON object name/value pair, where the name is the OMT field name and the value depends on the OMT field type.

Table 7. Example HLA fixed record datatype table

Record name	Field			Encoding	Semantics
	Name	Type	Semantics		
MessageLocation	X	HLAfloat64BE	X coordinate of message origination.	HLAfixed-Record	Coordinates where the message originates.
	Y	HLAfloat64BE	Y coordinate of message origination.		

A fixed record datatype would map as:

```
{
  "X" : 2.78,
  "Y" : 3.14
}
```

Variant Record Datatype Table

Variant records are mapped as an array of length 2. The first element is the enumerator in string representation. The second element is the value of the corresponding alternative. Table 8 and Table 9 are an example of the information in a variant record datatype table.

(The information is broken up into two tables to fit on the page.)

Table 8. Example HLA variant record datatype table

Record Name	Encoding	Semantics
Waiter Value	HLAvariantRecord	Datatype for waiter performance rating value.

Table 9. Example discriminant and alternative for Waiter Value record

Discriminant				Alternative		
Name	Type	Enumerator	Value	Name	Type	Semantics
Val Index	Experience Level	Trainee	0	Course Passed	HLAboolean	Ratings scale for employees under training.
		[Apprentice ... Senior], Master	1	Rating	RateScale	Ratings scale for permanent employees.
		HLAother	2	NA	NA	All others.

Possible mappings:

- [0, true] – a trainee that has passed the course.
- [1, 8.0] – depends on the definition of RateScale.

For a more comprehensive example, Table 10 defines the RPR FOM fixed record SpatialStruct (semantics omitted).

Table 10. SpatialStruct definition

Record name	Field	Encoding
	Name	Type
SpatialStruct	DeadReckoningAlgorithm-A-Alternatives	SpatialStruct- DeadReckoningAlgorithm

It contains a single field, DeadReckoningAlgorithm-A-Alternatives, which is the variant record SpatialStruct-DeadReckoningAlgorithm (semantics omitted).

Table 11. SpatialStruct-DeadReckoningAlgorithm definition

Record Name	Discriminant		Alternative		Encoding
	Name	Type	Enumerator	Value	
SpatialStruct-DeadReckoningAlgorithm	DeadReckoningAlgorithm	DeadReckoningAlgorithmEnum8	Other	0	HLAvariantRecord
			Static	1	
			DRM_FPW	2	
			DRM_RPW	3	
			DRM_RVW	4	
			DRM_FVW	5	
			DRM_FPB	6	
			DRM_RPB	7	
			DRM_RVB	8	
			DRM_FVB	9	

The fixed record SpatialStruct would be mapped to a JSON object containing a single property named DeadReckoningAlgorithm-A-Alternatives. That property would be an array of length 2, corresponding to the variant record SpatialStruct-DeadReckoningAlgorithm.

As a further example, assuming the discriminant enumerator was DRM_FVB, then the alternative would be of type SpatialFVStruct. The required definitions are shown in Table 12.

Table 12. SpatialFVStruct and dependencies definitions

Record name	Field		Encoding
	Name	Type	
SpatialFVStruct	WorldLocation	WorldLocationStruct	HLAfixedRecord
	IsFrozen	OMT13boolean	
	Orientation	OrientationStruct	
	VelocityVector	VelocityVectorStruct	
	AccelerationVector	AccelerationVectorStruct	
WorldLocationStruct	X	Double	HLAfixedRecord
	Y	Double	
	X	Double	

Table 12. SpatialFVStruct and dependencies definitions (continued)

Record name	Field		Encoding
	Name	Type	
OrientationStruct	Psi	Float	HLAfixedRecord
	Theta	Float	
	Phi	Float	
VelocityVectorStruct	XVelocity	Float	HLAfixedRecord
	YVelocity	Float	
	ZVelocity	Float	
AccelerationVectorStruct	XAcceleration	Float	HLAfixedRecord
	YAcceleration	Float	
	ZAcceleration	Float	

OMT13boolean would be mapped as WebLVC boolean because the enumerators are part of the HLA specification (they begin with the HLA prefix). Otherwise they would be mapped as their numeric values.

Table 13. OMT13boolean definition

OMT name	OMT Enumerator	OMT value	WebLVC type	WebLVC value
OMT13boolean	HLAfalse	0	Boolean	false
	HLAtrue	1	Boolean	true

This full example has comments after the slashes (//).

```
{ // SpatialStruct object
  "DeadReckoningAlgorithm-A-Alternatives" : // only attribute
    [9, // discriminant DRM_FVB converted as number
    { // SpatialFVStruct converted as object
      "worldLocationStruct": {
        "X": 4437182.0232,
        "Y": -395338.0731,
        "Z": 873923.4663 },
      "IsFrozen": false,
      "OrientationStruct": {
        "Psi": -1.65,
        "Theta": 2.234
        "Phi": -0.771 },
      "velocityVectorStruct": {
        "X": 57.04,
        "Y": 32.77,
        "Z": 89.263 },
      "AccelerationVectorStruct": {
        "XAcceleration": 0.0,
```

```
        "YAcceleration": 0.0,  
        "ZAcceleration": 0.0 }  
    } // end of SpatialFVStruct object  
] // end of DeadReckoningAlgorithm-A-Alternatives array  
} // end of SpatialStruct object
```

Assume spatialObj contains the above SpatialStruct object. Access to the X position would look like:

```
    spatialObj.DeadReckoningAlgorithm-A-Alternatives[1].  
worldLocationStruct.X
```

For comparison, consider access to the X position of a WebLVC Coordinates object coordObj:

```
    coordObj.worldLocation[0]
```



2. The Standard WebLVC Object Model

This document is an introduction to the WebLVC specification as implemented in MAK WebLVC.

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2.1. The Standard WebLVC Object Model

The WebLVC specification is flexible enough to allow the representation of arbitrary object models by defining appropriate object types, interaction types, and appropriate properties of specific kinds of AttributeUpdate messages and Interaction messages.

WebLVC includes a Standard Object Model, which was developed to serve the needs of web-based federates that require semantics similar to those in the DIS protocol or HLA's RPR FOM. The Standard WebLVC Object defines a set of object types, interaction types, and corresponding AttributeUpdate and Interaction messages based on the DIS/RPR definitions. Wherever possible, the Standard Object Model uses attribute names, parameter names, data types, and enumerations that match the corresponding elements in DIS/RPR.

Although in general the WebLVC Object Model mirrors DIS/RPR very closely, there is not always a direct mapping between RPR FOM classes, attributes, and parameters and their WebLVC counterparts. This is because the WebLVC specification attempts to represent data in a way that is consistent with JSON conventions, efficient to convey in JSON messages, and easy to parse and use in JavaScript applications.¹ For example, the EntityType property of a PhysicalEntity object uses the familiar 7-element SISO enumeration, but it encodes that 7-tuple as a simple JSON array of 7 numbers – for example, [1,1,225,1,1,0,0] – rather than using the 8-byte binary "struct" used in DIS and the RPR FOM. As another example, WebLVC uses a single WebLVC:PhysicalEntity type regardless of which kind of simulation object is being simulated, rather than the RPR FOM's fairly deep hierarchy of subclasses of the PhysicalEntity class. (Many of the reasons for choosing a deep hierarchy in the RPR FOM do not apply in WebLVC, where there is no real concept of classes, inherited attributes, object promotion, and so on.)

That being said, the similarities between the WebLVC Object Model and the RPR FOM are far more numerous than the differences.

The object types defined by the Standard WebLVC Object Model are WebLVC:PhysicalEntity and WebLVC:AggregateEntity.

The interaction types defined by Standard WebLVC Object Model are: WebLVC:WeaponFire and WebLVC:MunitionDetonation.

The following sections define the required and optional properties for AttributeUpdate messages and Interaction messages associated with each of the standard object and interaction types.

¹The fact that some intelligent analysis is needed in order to decide on an appropriate JSON representation for each concept is the reason why the WebLVC specification directly defines a Standard Object Model, rather than defining set of automated rules for generating the Standard Object Model from the HLA RPR FOM.

2.2. Standard AttributeUpdate Messages

This section describes the following attribute update messages:

- WebLVC:AggregateEntity
- WebLVC:PhysicalEntity
- WebLVC:EnvironmentalEntity
- WebLVC:RadioTransmitter.

2.2.1 WebLVC:PhysicalEntity Attribute Update Message

The WebLVC:PhysicalEntity attribute message is used to represent the DIS/RPR concept of an individual simulated vehicle or human.

Optional Properties

- EntityIdentifier. DIS-style simulation object identifier expressed as an array of three numbers representing SiteID, ApplicationID, and EntityNumber, for example, [1,2,3].
- EntityType. DIS-style simulation object type expressed as an array of seven numbers representing EntityKind, Domain, CountryCode, Category, Subcategory, Specific, and Extra, as defined by the SISO Enumerations document, for example, [1,2,225,1,6,0,0]. Required only in the first update sent for a particular simulation object, or upon change.
- DeadReckoningAlgorithm. A number representing the dead-reckoning algorithm to use for the simulation object, as defined by the SISO Enumerations document, for example, 4 for "DRM (RVW)".
- WorldLocation, VelocityVector, AccelerationVector. Arrays of three numbers representing the X, Y, and Z components of world location, velocity, and acceleration, as defined by DIS/RPR, for example, [4437182.0232, -395338.0731, 873923.4663].
- Orientation. An array of three numbers representing the psi, theta, and phi components of the simulation object's orientation as defined by DIS/RPR, for example, [-1.65, 2.234, -0.771].
- AngularVelocity. An array of three numbers representing the X, Y, and Z components of angular velocity, as defined by DIS/RPR, for example, [0.37, 1.30, -1.43].
- ForceIdentifier. A number representing the ForceIdentifier of the simulation object, as defined by DIS/RPR.
- Marking. A string representing the marking text of the simulation object, as defined by DIS/RPR.

Appearance Attributes

The RPR FOM defines a large number of appearance attributes as attributes of the PhysicalEntity class or its subclasses. The appearance attributes are defined in the RPR FOM either as Booleans, or as having various enumeration types. For example, DamageState is defined as an enumeration, and IsConcealed is defined as a Boolean. Rather than repeat them all here, this specification includes them by reference. Any of

these appearance attributes can be included in a WebLVC entity AttributeUpdate message by including a property with the same name as the corresponding RPR FOM attribute. Use numbers to represent the desired values of attributes that are defined as enumerations, as defined by the SISO Enumerations documents. Use the Boolean values true or false to represent the desired values of attributes that are defined in the RPR FOM as Booleans.

Example Message

This example WebLVC message defines an attribute update for an object named "F-16 Alpha", which is of type WebLVC:PhysicalEntity.

```
{
  MessageKind : 1,
  ObjectName : "F-16 Alpha",
  ObjectType : "WebLVC:PhysicalEntity",
  EntityIdentifier : [1,2,1],
  EntityType : [1,2,225,1,3,0,0],
  WorldLocation : [4437182.0232, -395338.0731, 873923.4663]
  VelocityVector : [57.04, 32.77, 89.263],
  Orientation : [-1.65, 2.234, -0.771],
  Marking : "F-16",
  DamageState : 1,
  EngineSmokeOn : true,
  IsConcealed : false
}
```

Notice that this message contains only a subset of the possible properties of physical entities, and that the order of the properties does not matter.

2.2.2 WebLVC:AggregateEntity Attribute Update Message

The WebLVC:AggregateEntity attribute message is used to represent the DIS/RPR concept of a hierarchical unit.

Optional Properties

- **EntityIdentifier.** DIS-style simulation object identifier expressed as an array of three numbers representing SiteID, ApplicationID, and EntityNumber, for example, [1,2,3].
- **EntityType.** DIS-style simulation object type expressed as an array of seven numbers representing EntityKind, Domain, CountryCode, Category, Subcategory, Specific, and Extra, as defined by the SISO Enumerations document, for example, [1,2,225,1,6,0,0]. Required only in the first update sent for a particular unit, or upon change.
- **DeadReckoningAlgorithm.** A number representing the dead-reckoning algorithm to use for the simulation object, as defined by the SISO Enumerations document, for example, 4 for "DRM (RVW)".
- **WorldLocation.** An array of three numbers representing the X, Y, and Z components of the center of mass of the unit, as defined by DIS/RPR, for example, [4437182.0232, -395338.0731, 873923.4663].

- **VelocityVector.** An array of three numbers representing the X, Y, and Z components of world velocity, as defined by DIS/RPR, for example, [89.0232, -38.5, 42.322]
- **Orientation.** An array of three numbers representing the psi, theta, and phi components of the simulation object's orientation as defined by DIS/RPR, for example, [-1.65, 2.234, -0.771]. Orientation is computed as the average orientation of its subordinates.
- **AngularVelocity.** An array of three numbers representing the X, Y, and Z components of angular velocity, as defined by DIS/RPR, for example, [0.37, 1.30, -1.43].
- **ForceIdentifier.** A number representing the ForceIdentifier of the simulation object, as defined by DIS/RPR.
- **Marking.** A string representing the marking text of the simulation object, as defined by DIS/RPR.
- **AggregateState.** A number representing the aggregation/disaggregation state of the unit, as defined by DIS/RPR.
- **Formation.** A number representing the formation of the unit, as defined by DIS/RPR.
- **Dimensions.** An array of three numbers representing the bounding box that the unit occupies, as defined by DIS/RPR. The values are measured from the center of mass of the unit to the edge of the X, Y, and Z axes of the body coordinate system of the unit, where the axes are aligned with the unit's orientation, for example, [2.0, 2.5, 1.75].
- **Subordinates.** An array of ObjectName values for those constituent entities that are also represented by individual object instances.
- **AggregateSubordinates.** List of ObjectName values for those constituent sub-units that are also represented by individual object instances.
- **SilentEntities.** An array of objects of the form {ObjectType, count} that represent the type and number of subordinate entities that are not represented by individual object instances.
- **SilentAggregates.** An array of objects of the form {ObjectType, count} that represent the type and number of subordinate units that are not represented by individual object instances.
- **SilentEntitiesDamageState.** An array of objects of form {ObjectType, DamageState, count} representing the damage status of unpublished subordinate simulation object types. DamageState is the DIS/RPR enumerated value for damage state. Only entries with a damage state other than the default DamageStateNone need to be specified.

Example Message

This example defines an attribute update for a unit object named "Platoon 1", which is of type WebLVC:AggregateEntity.

```
{  
  MessageKind : 1,  
  ObjectName : "Platoon 1",  
  ObjectType : "WebLVC:AggregateEntity",  
  EntityIdentifier : [1,2,3],
```

```
EntityType : [1,1,225,3,2,0,0],
WorldLocation : [4437182.0232, -395338.0731, 873923.4663]
Orientation : [-1.65, 2.234, -0.771],
Marking : "Platoon 1",
Dimensions : [10.0, 20.0, 1.0],
Subordinates : ["Tank1", "Tank2", "Tank3"],
Formation : 3
}
```

2.2.3 WebLVC:EnvironmentalEntity Attribute Update Message

The WebLVC:EnvironmentalEntity attribute message is used to represent the DIS/RPR concept of an environmental process object.

Initial Property

- **Type.** DIS-style entity type expressed as an array of seven numbers representing EntityKind, Domain, CountryCode, Category, Subcategory, Specific, and Extra, as defined by the SISO Enumerations document, for example, [1,4,0,0,0,0,0]. Required only in the first update sent for a particular environmental entity, or upon change.

Optional Properties

- **ProcessIdentifier.** DIS-style identifier expressed as an array of three numbers representing SiteID, ApplicationID, and EntityNumber, for example, [1,2,3].
- **ModelType.** An unsigned integer identifier for the model used for generating this environmental process. The value is exercise-specific.
- **EnvironmentProcessActive.** Boolean status of the environment process, indicating whether or not it is active.
- **SequenceNumber.** An integer value used in tagging a series of attribute update messages with unique values. If used, the value should start with zero and increment by one for each update sent. If not used, the value should be set to EP_NO_SEQUENCE.
- **GeometryRecords.** An array of one or more GeometryRecords, used to describe the physical extent of the object. A GeometryRecord is a JSON object containing these fields:
 - **Type.** A string identifying the type of geometry record, "LineString", "Polygon", "Point", or "Line".
 - **coordinates.** The coordinates of the vertex or vertices of the object. The format of the contents of this field depends on the type and the coordinate reference system. Each coordinate vertex is expressed as an array of three numbers, either
[x, y, z] for geocentric Cartesian coordinate reference systems, or [latitude, longitude, altitude] for geodetic coordinate reference systems.

Case 1: "Type" = "LineString"

coordinates. An array of vertices representing multi-segmented line in world coordinates. Each coordinate is expressed as an array of three numbers.

Case 2: "Type" = "Polygon"

coordinates. An array of vertices that describe a polygon in world coordinates. Each coordinate is expressed as an array of three numbers.

Case 3: "Type" = "Point"

coordinates. A location in world coordinates, expressed as an array of three numbers.

Case 4: "Type"= "Line"

coordinates. An array of 2 vertices representing a line segment in world coordinates. Each coordinate is expressed as an array of three numbers.

Example Message

This example defines an attribute update for an environmental process object with the type `LineString`:

```
{
  "ProcessIdentifier" : [1, 2, 3],
  "Type" : [1, 4, 0, 0, 0, 0, 0],
  "ModelType" : 1,
  "EnvironmentProcessActive" : true,
  "SequenceNumber" : 5,
  "GeometryRecords" : [
    "Type" : "LineString",
    "coordinates" : [
      [4437182.0232, -395338.0731, 873923.4663],
      [4437124.1523, -395341.2841, 873922.5517]
    ]
  ]
}
```

2.2.4 WebLVC:RadioTransmitter Attribute Update Message

The `WebLVC:RadioTransmitter` attribute update message is used to represent a device that transmits electromagnetic energy in the radio frequency range.

Optional Properties

- **HostObjectName.** String representing the object that this radio is attached to. This identifier is unique across the simulation.
- **EntityIdentifier.** DIS-style entity identifier expressed as an array of three numbers representing SiteID, ApplicationID, and EntityNumber, for example, [1,2,3]. Identifies the ID of the radio. This is the same as the host object name when the radio is coming from DIS.
- **RadioIndex.** A number used to identify the radio transmitter within the scope of the entity.
- **RadioEntityType.** DIS-style radio type expressed as an array of six numbers representing entity kind domain, country, category, nomenclature version, and nomenclature. See Radio in the SISO Enumerations document.

- **TransmitState.** A number indicating the state of the transmitter (whether it is off, on but not transmitting, or on and transmitting), as defined by the SISO enumerations document (see Transmit State).
- **InputSource.** A number representing the source of the radio transmission (for example, pilot, copilot, driver, and so on), as defined in the SISO Enumerations document (see Input Source).
- **WorldAntennaLocation.** An array of three numbers representing the world location of the radiating portion of the transmitter, as defined by the coordinate reference system, for example, [4437182.0232, - 395338.0731, 873923.4663] for ECEF as in DIS/RPR.
- **RelativeAntennaLocation.** Arrays of three numbers representing the X, Y, and Z components of relative location of the radiating portion of the transmitter, as defined by DIS/RPR, for example, [1.0, 0.0, -3.0].
- **AntennaPatternType.** A number representing the radiation pattern of the antenna, as defined in the SISO Enumerations document (see Antenna Pattern Type). Its value determines the content of the AntennaPatternParameters property.
- **Frequency.** A number representing the center frequency used by the radio in transmission. Expressed as a positive integer number in units of hertz.
- **TransmitBandwidth.** A number representing the bandpass of the radio, expressed as a position floating point number in units of hertz.
- **Power.** A number representing the average power being transmitted in units of decibel-milliwatts.
- **ModulationType.** A JSON object representing the type of modulation used for radio transmission. The properties of this object are:
 - **SpreadSpectrum.** A number representing the spread spectrum technique in use, as defined in the SISO Enumerations document.
 - **Major.** A number representing the major classification of the modulation type, as defined in the SISO Enumerations document.
 - **Detail.** A number representing certain detailed information depending on the major modulation type, as defined in the SISO Enumerations document.
 - **System.** A number used to specify the interpretation of the Modulation Parameter fields in the RadioTransmitterUpdate message, as defined in the SISO Enumerations document.
- **CryptoMode.** A number representing the crypto mode (baseband or phase), as defined in the SISO Enumerations document.
- **CryptoSystem.** A number representing the use of crypto or secure voice equipment, as defined in the SISO Enumerations document.
- **CryptoKey.** A number representing the encryption key (if encryption is in use), zero otherwise.

- **AntennaPatternParameters.** A JSON object that may be present, depending on the value of the **AntennaPatternType** property (DIS/RPR Beam Antenna Pattern record):
 - **BeamDirection.** An array of three numbers representing the psi, theta, and phi components of the beam direction as defined by DIS/RPR, e.g. [-1.65, 2.234, -0.771].
 - **AzimuthBeamwidth.** A number representing the full width of the beam to the -3 dB power density points in the x-y plane of the beam coordinate system, in radians.
 - **ElevationBeamwidth.** A number representing the full width of the beam to the -3 dB power density points in the x-z plane of the beam coordinate system, in radians.
 - **ReferenceSystem.** A number specifying the reference coordinate system with respect to which the beam direction is specified, as defined in the SISO Enumerations document.
 - **Ez.** A number representing the DIS/RPR concept of the magnitude of the Z-component (in beam coordinates) of the Electrical field.
 - **Ex.** A number representing the DIS/RPR concept of the magnitude of the X-component (in beam coordinates) of the Electrical field.
 - **Phase.** A number representing the phase angle between Ez and Ex in radians.
- **FrequencyHopInUse.** A Boolean indicating whether or not frequency hopping is in use.
- **PseudoNoiseInUse.** A Boolean indicating whether or not pseudo noise is in use.
- **TimeHopInUse.** A Boolean indicating whether or not time hopping is in use.

Example Message

```
{
  "MessageKind" : 1,
  "EntityIdentifier" : [1, 1, 3001],
  "RadioIndex" : 1,
  "RadioEntityType" : [225, 2, 3, 4],
  "TransmitState" : 1,
  "RadioEntityType" : [1, 1, 225, 3, 4, 5],
  "InputSource" : 2,
  "WorldAntennaLocation" : [4437182.0232, -395338.0731, 873923.4663],
  "RelativeAntennaLocation" : [1.0, 0.0, -3.0],
  "AntennaPatternType" : 1,
  "Frequency" : 44056,
  "Power" : 50.5,
  "ModulationType" : {
    "SpreadSpectrum" : 1,
    "Major" : 2,
    "Detail" : 3,
    "System" : 4
  },
  "CryptoMode" : 1,
```

```
"CryptoSystem" : 4,
"CryptoKey" : 2348238752,
"AntennaPatternParameters" : {
  "BeamDirection" : [-1.65, 2.234, -0.771],
  "AzimuthBeamwidth" : 0.25,
  "ElevationBeamwidth" : 0.78,
  "ReferenceSystem" : 2,
  "Ez" : 2.533,
  "Ex" : 1.29,
  "Phase" : 0.707
},
"FrequencyHopInUse" : true,
"PseudoNoiseInUse" : false,
"TimeHopInUse" : true
}
```

2.3. Standard Interaction Messages

This section describes the following interaction messages:

- WebLVC:WeaponFire
- WebLVC:MunitionDetonation
- WebLVC:StartResume
- WebLVC:StopFreeze
- WebLVC:RadioSignal

2.3.1 WebLVC:WeaponFire Interaction Message

The WebLVC:MunitionDetonation message represents the firing of a weapon.

Optional Properties

- AttackerId. The ObjectName of the object that fired the weapon.
- TargetId. The ObjectName of the object that was targeted by the attacker, if applicable.
- MunitionType. The type of the munition object. A DIS-style simulation object type expressed as an array of seven numbers representing EntityKind, Domain, CountryCode, Category, Subcategory, Specific, and Extra, as defined by the SISO Enumerations document, for example, [1,2,225,1,6,0,0].
- MunitionId. The ObjectName of the munition, if it is simulated as an entity.
- EventId. A string identifier generated by the issuing federate, used to associate related fire and detonation events.
- WarheadType. A number representing the type of warhead fitted to the munition being fired, as defined by DIS/RPR.
- FireMissionIndex. A unique number to identify the fire mission. Used to associate weapon fire interactions in a single fire mission.

- FuseType. A number representing the type of fuse on the munition, as defined by DIS/RPR. This field may be omitted if undefined.
- Quantity. The number of rounds fired in the fire event. A value of zero indicates a single round.
- Rate. A number representing the rate at which munitions are discharged in rounds per minute.
- Range. A number, representing the range in meters assumed by the firing simulation object in computing the fire control solution.
- Location. The location in geocentric coordinates from which the munition was launched, expressed as an array of three numbers, for example, [4437182.0232, -395338.0731, 873923.4663].
- Velocity. The velocity of the munition in geocentric coordinates, at the point of the muzzle flash, represented as an array of three numbers, for example, [89.0232, -38.5, 42.322].

Example Message

This example defines an interaction of WebLVC:WeaponFire.

```
{
  MessageKind : 2,
  InteractionType : "WebLVC:WeaponFire",
  AttackerId : "Tank1",
  TargetId : "Tank2",
  MunitionType : [2,2,225,2,3,0,0],
  Location : [4437182.0232, -395338.0731, 873923.4663],
  Velocity : [57.04, 32.77, 89.263]
}
```

2.3.2 WebLVC:MunitionDetonation Interaction Message

The WebLVC:MunitionDetonation message represents the detonation of a munition.

Optional Properties

- AttackerId. The ObjectName of the object that fired the weapon.
- TargetId. The ObjectName of the object that was targeted by the attacker. For indirect fire this field may be omitted.
- MunitionId. The ObjectName of the munition, if it is simulated as an entity object. If not, then this field may be omitted.
- MunitionType. The type of the munition object. A DIS-style simulation object type expressed as an array of seven numbers representing EntityKind, Domain, CountryCode, Category, Subcategory, Specific, and Extra, as defined by the SISO Enumerations document, for example, [1,2,225,1,6,0,0].
- EventId. A string identifier generated by the issuing federate, used to associate related fire and detonation events.

- **Velocity.** The velocity of the munition in geocentric coordinates, at the time of detonation, expressed as an array of three numbers, for example, [89.0232, -38.5, 42.322].
- **WorldLocation.** Location of the detonation with respect to the world in geocentric coordinates, expressed as an array of three numbers, for example, [4437182.0232, -395338.0731, 873923.4663].
- **EntityLocation.** Location of the detonation with respect to the target simulation object's coordinate system, expressed as an array of three numbers, for example, [-1.4, 2.7, 0.6].
- **Result.** A number representing the result of the detonation as specified by DIS/RPR.
- **FuseType.** A number representing the type of fuse on the munition, as defined by DIS/RPR.
- **Quantity.** The number of rounds fired in the fire event. A value of zero indicates a single round.
- **Rate.** A number representing the rate at which munitions are discharged in rounds per minute.
- **WarheadType.** A number representing the type of warhead fitted to the munition being fired, as defined by DIS/RPR.

Example Message

This example defines an interaction of WebLVC:MunitionDetonation.

```
{
  MessageKind : 2,
  InteractionType : "WebLVC:MunitionDetonation",
  AttackerId : "Tank1",
  TargetId : "Tank2",
  MunitionType : [2,2,225,2,3,0,0],
  WorldLocation : [4437182.0232, -395338.0731, 873923.4663],
  Result : 1
}
```

2.3.3 WebLVC:StartResume Interaction Message

The WebLVC:StartResume message directs one or more simulators to start or resume simulating, or start or resume simulation of a specific entity.

Required Properties

- **ReceivingEntity.** The DIS/RPR simulation ID of the receiving simulations, or the entity ID of a specific entity, expressed as an array of three numbers. The allowable values for the ID follow the DIS/RPR rules.
- **RequestIdentifier.** An integer used to identify a particular request. The value should be incremented for each request.
- **RealWorldTime.** A number representing the real world time of the request, as defined by DIS/RPR.

- **SimulationTime.** A number representing the time of day in simulation time of the request, as defined by DIS/RPR.

Optional Property

- **OriginatingEntity.** The DIS/RPR simulation ID (Site ID, Application ID) of the simulator requesting the start/resume action, expressed as an array of two numbers.

2.3.4 WebLVC:StopFreeze Interaction Message

The WebLVC:StopFreeze message directs one or more simulators to stop simulating, or stop simulation of a specific entity.

Required Property

- **ReceivingEntity.** The DIS/RPR simulation ID of the receiving simulation(s), or the entity ID of a specific entity, expressed as an array of three numbers. The allowable values for the ID follow the DIS/RPR rules.

Optional Properties

- **OriginatingEntity.** The DIS/RPR simulation ID (Site ID, Application ID) of the simulator requesting the stop/freeze action, expressed as an array of two numbers.
- **RealWorldTime.** A number representing the real world time of the request, as defined by DIS/RPR.
- **Reason.** A number indicating the reason for stopping the simulation. Allowed values are an enumeration defined by DIS/RPR.
- **ReflectValues.** A Boolean indicating whether the entity or entities should continue to reflect attributes while frozen.
- **RunInternalSimulationClock.** A Boolean indicating whether the entity or entities should continue to run their internal simulation clocks while frozen.
- **UpdateAttributes.** A Boolean indicating whether the entity or entities should continue to update attributes while frozen.

2.3.5 WebLVC:RadioSignal Interaction Message

The WebLVC:RadioSignal interaction message represents the wireless transmission and reception of audio or digital data via electromagnetic waves.

Optional Properties

- **RadioIdentifier.** A string representing the particular transmitter that is transmitting. This identifier is unique across the simulation.
- **EncodingClass.** A number representing the encoding scheme being used, as defined by the SISO Enumerations document (see the Radio signal encoding class).

- **EncodingType.** A number representing the type of TDL message. If set to zero, this is not a TDL message. When this is a positive number, the number represents the type of TDL message, as defined by the SISO Enumerations document scheme being used, as defined by the SISO Enumerations document as (see the Radio signal encoding type).
- **TDLType.** A number representing the type of TDL message included in the signal message, as defined by the SISO Enumerations document (see TDL Type).
- **SampleRate.** A number representing sample rate in samples per second for audio data. The data rate is in bits per second for digital data.
- **SampleCount.** A number representing the number of samples in the audio data.
- **SampleData.** A base64-encoded string representing the data content of the message.
- **DatabaseIndex.** A number representing the index of a prerecorded audio file that is to be looked up in a known database for playing.
- **UserProtocolID.** The protocol ID of the data stream.

Example

```
{
  "MessageKind" : 2,
  "InteractionType" : "WebLVC:RadioSignalInteraction",
  "RadioIdentifier" : "[1, 1, 3001]-1",
  "EncodingClass" : "Tank2",
  "EncodingType" : 0,
  "SampleRate" : 44056,
  "SampleData" : "base64:..."
}
```



3. MAK Extensions to the Standard WebLVC Object Model

MAK has extended the standard WebLVC object model with generic messages and application-specific messages.

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3.1. Introduction

MAK has extended the Standard WebLVC Object Model to support communication with specific simulation applications. The data exchanged by these applications is not general enough in some cases to be incorporated in the standard object model. Therefore, MAK has defined a set of extensions to the Standard WebLVC Object Model to facilitate control of specific applications, including MAK Logger, VR-Forces, and VR-Vantage.

i To distinguish between the MAK-specific messages and the standard WebLVC object model messages, by convention all object and interaction type strings are prefaced by the string MAK: instead of WebLVC:.

3.2. The MAK Data Logger Control Message

The MAK:LoggerControl interaction message is used to control the MAK Data Logger application.

3.2.1 Required Properties

- **Target.** The DIS/RPR simulation ID (Site ID, Application ID, Remote Control ID) of the MAK Logger application to be controlled, expressed as an entity identifier string.
- **Command.** The Logger control command to execute, expressed as a string. Table 14 describes the commands that a Logger message can send and provides an example for each one.

Table 14. Logger commands

Name	Description
loggerPlayback	Play the current Logger file. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCPlay", "Target" : "1:1:1" }</pre>
loggerPause	Pause the current Logger action. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCPause", "Target" : "1:1:1" }</pre>

Table 14. Logger commands (continued)

Name	Description
loggerStart	Start recording. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCStart", "Target" : "1:1:1" }</pre>
loggerPlayFile	Load and play a Logger file. By default the path is logger_tapes. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCPlayFile", "Target" : "1:1:1", "Filename" : "WebLVCFFile.lgr" }</pre>
loggerRecordFile	Initialize an empty file and start recording. By default the path is logger_tapes. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCRecordFile", "Target" : "1:1:1", "Filename" : "WebLVCFFile.lgr" }</pre>
loggerDelFile	Delete a Logger file. By default the path is logger_tapes. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCDelFile", "Target" : "1:1:1", "Filename" : "WebLVCFFile.lgr" }</pre>
loggerEmpty	Unloads any existing files. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCEmpty", "Target" : "1:1:1" }</pre>

Table 14. Logger commands (continued)

Name	Description
loggerQuit	Shut down the Logger. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCQuit", "Target" : "1:1:1" }</pre>
loggerEnd	Jump to the end of the loaded Logger file. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCEnd", "Target" : "1:1:1" }</pre>
loggerStop	Stop playback or record. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCStop", "Target" : "1:1:1" }</pre>
loggerRecord	Begin recording. A file must be loaded. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCRecord", "Target" : "1:1:1" }</pre>
loggerSetTime	Set the time in seconds of the currently loaded file in the Logger. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCSetTime", "Target" : "1:1:1", "Time": 5.0 }</pre>

Table 14. Logger commands (continued)

Name	Description
loggerSkipTime	Skip a number of seconds in the currently loaded file. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCSkipTime", "Target" : "1:1:1", "Time": 5.0 }</pre>
loggerTimeScale	Set the playback speed of the Logger. Time is a speed multiplier, where 1 is real time. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCTimeScale", "Target" : "1:1:1", "TimeScale": 2.0 }</pre>
loggerPlayAction	Tells a Logger what action to take initially when set to playback mode. Valid values are '0' for play and '3' for stop. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCPlayAction", "Target" : "1:1:1", "Action": 0 }</pre>
loggerRecordAction	Tells a Logger what action to take initially when set to record mode. Valid values are '2' for record and '3' for stop. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCRecordAction", "Target" : "1:1:1", "Action": 2 }</pre>
loggerEofAction	Tells a Logger what action to take when a played file reaches the end of the file. Valid values are '5' for loop and '3' for stop. <pre>{ "MessageKind": 2, "InteractionType": "MAK:LoggerControl", "Command" : "LCEofAction", "Target" : "1:1:1", "Action": 5 }</pre>

3.3. MAK:VRFBBackend Attribute Update Message

MAK adds one object type, MAK:VRFBBackend. It represents a VR-Forces simulation engine application.

Optional Properties

- **ControlState.** A number representing the simulation's run/pause state. Allowed values are:
 - 1. Simulation engine is paused.
 - 2. Simulation engine is running.
- **ExerciseStartTime.** A number indicating the simulation start time of the current scenario, in seconds.
- **GuiTerrainName.** The path to the terrain database file loaded by the VR-Forces graphical user interface (GUI). The path can be absolute or relative to the location of the VR-Forces simulation engine executable.
- **InetAddr.** A string representing the IP address of the VR-Forces simulation engine (for example, "192.168.1.101").
- **IsCurrentParameterDb.** Boolean indicating whether or not the VR-Forces object parameters database in use is in the current file format.
- **IsLoaded.** Boolean indicating whether or not the VR-Forces simulation engine has a scenario loaded.
- **IsResourceMonitorEnabled.**
- **IsTimeManaged.** Boolean indicating whether or not the VR-Forces simulation engine is running in time-managed mode.
- **LoadedNewScenario.** Boolean indicating whether a new scenario has just been loaded by the VR-Forces simulation engine. It is set to true upon loading a scenario, and published exactly once for the duration of that scenario being loaded in VR-Forces. Any subsequent updates will have this value set to false.
- **Port.**
- **ScenarioFilename.** The path to the VR-Forces scenario file. The path can be absolute or relative to the location of the VR-Forces simulation engine executable.
- **ScenarioName.** The descriptive name of a VR-Forces scenario. This data is only informative and is not to be used as an identifier for the scenario.
- **SimEngineId.** The DIS/RPR simulation ID (Site ID, Application ID) of the VR-Forces simulation engine, expressed as an array of two numbers.
- **SimStartTime.** The simulation start time of the current scenario, in seconds.
- **SimTime.** The current simulation time in seconds.
- **TerrainName.**
- **TimeMultiplier.** A number used to scale simulation time for faster or slower than real-time simulation.

3.4. VR-Forces Interaction Messages

MAK has added these messages for making requests from, responding to, or controlling VR-Forces:

VR-Forces control messages:

- MAK:VrfChangeGlobalWeather
- MAK:VrfChangeTimeOfDay
- MAK:VrfCreateObject
- MAK:VrfControl
- MAK:VrfDeleteObject
- MAK:VrfScenario
- MAK:VrfScriptedTask
- MAK:VrfSensorData
- MAK:VrfSet
- MAK:VrfTask
- MAK:VrfTextReport

VR-Forces request and response messages:

- MAK:VrfCurrentResourceRequest
- MAK:VrfResourceMonitorResponse
- MAK:VrfSensorDataRequest

i VR-Forces uses the following terminology to refer to the objects it simulates:

- Entity. An individual object such as a truck, airplane, or human.
- Unit. A group of individual entities or other units treated as one organizational unit, such as a platoon, a company, or a crowd.
- Simulation object. Generically refers to both entities and units.

3.4.1 MAK:VrfChangeGlobalWeather

The MAK:VrfChangeGlobalWeather message changes the weather in VR-Forces. For full details on what each setting does, see the DtChangeWeatherCommand documentation in VR-Forces. All of the settings are optional. You can select only a subset of these and only that subset of weather will change.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrfChangeGlobalWeather",
  "AirTurbidity" : 1.0,
  "AmbientAirTemperature" : 1.0,
  "CloudState" : 1,
```

```

"PrecipitationIntensity" : 1.0,
"PrecipitationType" : 1,
"Visibility" : 1.0,
"WindDirection" : 1.0,
"WindSpeed" : 1.0,
"UnderwaterVisibility" : 1.0,
"SurfaceTransparency" : 1.0,
"WaterCurrentSpeed" : 1.0,
"WaterCurrentDirection" : 1.0,
"AmbientWaterTemperature" : 1.0,
"TidalOffset" : 1.0,
"TidalDirection" : 1.0,
"SwellState" : 1,
"SwellStateDirection" : 1.0,
"SeaState" : 1,
"SeaStateDirection" : 1.0,
"WindDrivenSeaStateEnabled" : true,
"Choppiness" : 1.0,
"SurgeDepth" : 1.0,
"ThermoclineLayer1Depth" : 1.0,
"ThermoclineLayer1Permeability" : 1.0,
"ThermoclineLayer2Depth" : 2.0,
"ThermoclineLayer2Permeability" : 2.0,
"ThermoclineLayer3Depth" : 3.0,
"ThermoclineLayer3Permeability" : 3.0,
"ThermoclineLayer4Depth" : 4.0,
"ThermoclineLayer4Permeability" : 4.0,
"ThermoclineLayer5Depth" : 5.0,
"ThermoclineLayer5Permeability" : 5.0
}

```

3.4.2 MAK:VrfChangeTimeOfDay

The MAK:VrfChangeTimeOfDay message changes the current time of day inside VR-Forces.

Required Properties

- SecondsPastMidnight. Highlights the new time of day.
- TimeOfDayAdvanceSpeed. Set to 1 if the scenario is currently running or 0 if the scenario is paused.

Example Message

```

{
  "MessageKind": 2,
  "InteractionType": "MAK:VrfChangeTimeOfDay",
  "SecondsPastMidnight": 3600,
  "TimeOfDayAdvanceSpeed": 1.0
}

```

3.4.3 MAK:VrfCreateObject

The MAK:VrfCreateObject message creates a VR-Forces object.

Required Properties

- **Address.** A DtSimulationAddress identifying the particular VR-Forces sim. engine to create the object.
- **ForceType.** The force value for the new simulation object. 0 is other, 1 is friendly, 2 is opposing, 3 is neutral.
- **Label.** A string associated with the new object. This string provides an additional means to identify an object without the strict uniqueness requirement of object name.
- **Name.** A string used to uniquely identify the object. This string must be unique for all objects in the exercise.
- **ObjectType.** The type of the new simulation object. This is a 7-tuple number that matches the DIS/RPR Entity Type value.
- **Vertices.** A list of the vectors that make up the object's geometry (for example, the vertices that make up the points along a route). For simulation object position, the position is just an alias for the first vertex. Vertices must be specified in geocentric coordinates.

Optional Properties

- **ClosedFigure.** A bool flag indicating whether the object's vertices make up a closed figure (that is, does the last vertex connect with the first). A control area is an example of an object that is a closed figure. Default: false.
- **CreateSubObjects.** A bool flag indicating whether or not you want to create a sub-object. The parameter file may contain a list of subobjects. When building from the bottom up (for example, using AggregateAs or explicitly calling addSubordinate) then the subobjects in the parameter list should be ignored. Default: false.
- **Heading.** A double value that is the initial heading of the object in radians. A value of 0.0 is north and positive values are clockwise. Default: 0.0.
- **Projection.** A bool flag indicating whether or not the Z elements in the object's vertex list have meaning. For example, phase lines do not have meaningful Z elements. Default: false.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrfCreateObject",
  "Address" : [1,3001],
  "Name" : "M1A2 1",
  "ObjectType" : [1,1,225,1,1,3,0],
  "ForceType" : 1,
  "Label" : "My Tank",
  "Heading" : 0.0,
  "Vertices" : [[1526692.0817458, -4464873.1812864, 4276853.4378026]],
```

```
"Projection" : false,  
"ClosedFigure" : false,  
"CreatesubObjects" : false  
}
```

3.4.4 MAK:VrfControl

The MAK:VrfControl message controls the current scenario state of VR-Forces. A scenario must be loaded for this to work.

Required Property

- **ControlType.** Possible ControlTypes are Pause, Run, Rewind, Step, RunDuration, and RunComplete.

Optional Property

- **Time.** RunDuration and RunComplete require a Time value. Otherwise, it is not used.

Example Message

```
{  
  "MessageKind": 2,  
  "InteractionType" : "MAK:VrfControl",  
  "ControlType" : "Rewind",  
  "Time": 0.0  
}
```

3.4.5 MAK:VrfDeleteObject

The MAK:VrfDeleteObject messages deletes a VR-Forces object.

Required Property

- **Name.** A string used to uniquely identify the object. This string must be unique for all objects in the exercise.

Example Message

```
{  
  "MessageKind": 2,  
  "InteractionType": "MAK:VrfDeleteObject",  
  "Name" : "M1A2 1"  
}
```

3.4.6 MAK:VrfScenario

The MAK:VrfScenario message changes the current scenario in VR-Forces.

Required Property

- **Command.** The action to take. Options are new, load, save, and close.

Optional Property

- **ScenarioFilename.** Specifies a scenario. If a scenario name is specified, the server tries to find that scenario in the current path. If it fails, it looks for an environment variable `MAK_VRFScenarioDir` or `MAK_VRFTerrainDir` (for new calls). If that variable does not exist, it looks for the default installation location of VR-Forces.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrfScenario",
  "Command" : "load",
  "ScenarioFilename" : "RaidDemo/Raid Demo.scn"
}
```

3.4.7 MAK:VrfScriptedTask

The `MAK:VrfScriptedTask` message is used to direct a VR-Forces simulation object to perform a task, such as move-to-location or fire-weapon. The message has a flexible format and can represent a wide range of tasks provided by VR-Forces.

Required Properties

- **ReceivingApplicationName.** A string containing the object name of the simulation object to be tasked.
- **Subtask.** A Boolean indicating whether or not the task should be executed as a subtask. This flag is set to `True` when the task to be executed is to be done in support of a higher-level task, and is typically issued by a VR-Forces simulation object to itself. An external application sending a `MAK:VrfScriptedTask` should always set this value to `False`.
- **ScriptedTask.** A JSON object that contains the data for the task. The object contains these properties:
 - **ScriptID.** A string that identifies the type of VR-Forces task. See the "Scripted Task" documentation in the *VR-Forces Developer's Guide* for details on the types of tasks available. See the list of values for the `MAK:VrfTask` message's `ScriptID` property (page 62).
 - **ScriptVariables.** An array of zero or more objects representing the parameters associated with a given task type (identified by the `ScriptID`). The content of this array varies according to the type of task. For information about the parameters expected for a given task type, see "Starting and Processing C++ and Scripted Tasks" under Tasks and Sets in Section 3. Simulation Object Design of the *VR-Forces Developer's Guide*.

An object in the ScriptVariables array represents a task parameter and is comprised of these properties:

- name. A string that identifies the name of the task parameter.
- type. A string that identifies the type of data for the task parameter. See "Starting and Processing C++ and Scripted Tasks" in the *VR-Forces Developer's Guide* for details about the types of tasks available.
- value. A string, number, object, Boolean, or array that holds the value of the task parameter. The kind of JSON object used in this property depends on the value of the type property. Table 15 lists types and JSON property types.

Optional Property

- OriginatingApplicationName. A string identifying the sending application.

Table 15. Types referenced to JSON property types

Type	Type of JSON Object	Range	Meaning
Boolean	Boolean	true or false	
ChoiceDropDownList	Number	A positive number starting with zero.	Index into a list of options.
ChoiceOptionButton	Number	A positive number starting with zero.	Index into a list of options.
DIGuyAnimation	Number		
Emitter	Number		
Force	Number		
Integer	Number		
MunitionResource	Number		
Resource	Number		
LocationWithAltitude	Array of three numbers representing world coordinates.		
LocationWithoutAltitude	Array of three numbers representing world coordinates.		
OffsetLocation	Array of three numbers representing world coordinates.		
BombResource	String		
String	String		
SimulationObjectSingle	String		
SimulationObjectMultiple	String		
EntityType	String		
AggregateFormation	String		
AltitudeMSL	Number		
DepthMSL	Number		

Table 15. Types referenced to JSON property types (continued)

Type	Type of JSON Object	Range	Meaning
Distance	Number		
Heading	Number		
Real	Number		
Speed	Number		
Time	Number		
TurnRate	Number		
Unknown	Undefined		

3.4.8 MAK:VrfSensorData

The MAK:VrfSensorData message encapsulates the internal state of a single sensor, including the entity that owns the sensor, the sensor's name and type, and a list of current targets.

Required Properties

- **SensorEnabled.** Boolean that indicates whether the sensor is enabled.
- **SensorName.** A string that defines the name of the sensor.
- **SensorType.** An integer enumeration that indicates the type of sensor.
- **SourceEntity.** A string that specifies the entity using the sensor.

Optional Properties

- **CombatIdentificationLevel.** An integer enumeration that indicates the identification level of the contact (combat identification level). The level of identification that can be determined given the apparent signature of an object and the length of time it has been observed (detection level of the sensor).
- **ContactType.** A string that specifies the type of contact.
- **ContactSuperType.** The object supertype field defined using an integer enumeration. Valid enumerations are in **DtObjectSuperType** in *objectTypeEnum.h*.
- **ForceType.** The force of the contact defined using an integer enumeration. The default forces are friendly, opposing, neutral, and other. They are in **DtForceType** in *disEnums.h*.
- **SensorDataList.** List of sensor data attributes. See **DtPortalVrfSensorDataEntryList**.
- **Target.** A string that defines the destination entity.

3.4.9 MAK:VrfSet

The MAK:VrfSet message is used to direct a VR-Forces simulation object to set some aspect of its state.

Required Properties

- **ReceivingApplicationName.** The object name of the VR-Forces simulation object whose state is to be set, or the string `DtBroadcast` to designate all VR-Forces simulation objects.
- **DataVariables.** An array of one or more objects. Each object represents an individual request to set state in a VR-Forces simulation object. An object in this array contains this required property:
 - **name.** A string identifying the particular aspect of state to be set. The allowed values are:
 - **Destroy.** Set the damage status of the simulation object to destroyed.
 - **Restore.** Restore the simulation object to full health and replenish resources.
 - **Speed.** Set the ordered speed of the simulation object. The simulation object will attempt to maintain this speed in any movement behaviors it executes.
 - **ReactiveTaskCancel.** Cancel the current reactive task the simulation object is executing (if any). For more information about reactive tasks, please see the *VR-Forces Users Guide*.

An object in this array may contain these optional properties:

- **type.** A string identifying the type of value to set for state. See the "Scripted Task" documentation in the *VR-Forces Developer's Guide*, for a list of the possible values for type.
- **value.** A string, Boolean, number, object, or array containing the value of the state to set. Table 16 lists the expected value/types for each of the given `MAK:VrfSet` name strings.

Optional Property

- **OriginatingApplicationName.** A string identifying the name of the sending application.

Table 16. Expected value/types for MAK:VrfSet strings

Name	Type	Value
Destroy	N/A (property not used)	N/A (property not used).
Restore	N/A (property not used)	N/A (property not used).
Speed	Speed	A positive real number in meters/second.
ReactiveTaskCancel	String	The ScriptId of the task to be canceled.

3.4.10 MAK:VrfTask

The MAK:VrfTask message directs a VR-Forces object to perform a task, such as move to a location or fire a weapon.

Required Properties

- ReceivingApplicationName. The DIS/RPR simulation ID (Site ID, Application ID) of the VR-Forces simulation engine responsible for simulating the simulation object that the caller is requesting resource information about. It is an array of two numbers.
- Task. An object that contains the ScriptID property:
 - ScriptID. A string that identifies the type of VR-Forces task. See the "Scripted Task" documentation in the *VR-Forces Developer's Guide* for details on the types of tasks available. The following ScriptID values are supported, beginning with VR-Forces 4.4:
 - AircraftHold
 - AircraftHold_Waypoint
 - animated-movement-task
 - Arm_Mine_At_Depth
 - Avoid_Other_Ships
 - Bombing_Mission
 - Bounding_Overwatch_Move_To
 - Create_and_Move_To_Waypoint
 - Delayed_homing
 - Delayed_homing_ASW
 - Deploy_Sonobuoy
 - Deploy_Sonobuoys_Along_Route
 - Drop_Naval_Depth_Charge
 - Drop_Naval_Depth_Charge_At_Location
 - Drop_Naval_Mine
 - Drop_Naval_Mines_Along_Route
 - Evade_Missile
 - Explode_Charge_At_Depth
 - Fixed_Wing_Land
 - Fixed_Wing_Takeoff
 - goto-depth
 - launch-munition
 - Launch_ASW_Missile

- Lower_Periscope
- Make_Way_for_Emergency
- Monitor_Terrain
- Move In Cover
- move-on-roads-to-location
- move-on-roads-to-waypoint
- move-to-location-path-plan
- move-to-waypoint-path-plan
- Move_to_Named_Street
- Naval_Mine_Sweep
- navigate-to-location
- navigate-to-waypoint
- Orbit_script_
- Place_IED
- Raise_Periscope
- SAR_Creep_Pattern
- SAR_Parallel_Pattern
- SAR_Sector_Search
- ship-navigate-to-location
- ship-navigate-to-waypoint
- Sonar_Dip
- stop-moving-ship
- Talk_To_Friends
- turn-move-sail-heading
- turn-move
- ZigHeading

- Subtask. A Boolean value indicating whether the task should be executed as a subtask. When the flag is true, the task is executed in support of a higher-level task and is typically issued by the VR-Forces simulation.

Optional Property

- OriginatingApplicationName. A string identifying the sending application.

3.4.11 MAK:VrfTextReport

The MAK:VrfTextReport message is used to send a VR-Forces DtTextReport message from one simulation object to another simulation object.

Required Properties

- **Message.** A string containing the message to be sent.
- **OriginatingEntity.** The object name of the VR-Forces simulation object sending the message.
- **ReceivingEntity.** The object name of the VR-Forces simulation object to receive the message, or the string DtBroadcast to designate all VR-Forces simulated entities.

3.4.12 MAK:VrfCurrentResourceRequest

The MAK:VrfCurrentResourceRequest interaction message is used to request information about a VR-Forces simulation object's resources (for example, fuel, munitions, and so on). A MAK:VrfResourceMonitorResponse message is sent in response by a VR-Forces simulation engine, containing the set of resources owned by the simulation object.

Required Properties

- **ObjectName.** The ObjectName of the simulation object for which the caller is requesting resource information.
- **OriginatingEntity.** The DIS/RPR simulation ID (Site ID, Application ID) of the application requesting the resource information, expressed as an array of two numbers.
- **ReceivingEntity.** The DIS/RPR simulation ID (Site ID, Application ID) of the VR-Forces simulation engine responsible for simulating the simulation object for which the caller is requesting resource information, expressed as an array of two numbers.
- **RequestIdentifier.** An integer used to identify a particular request. The value should be incremented for each request. The value of the RequestIdentifier will be included in the MAK:VrfResourceMonitorResponse message.

3.4.13 MAK:VrfSensorDataRequest

The MAK:VrfSensorDataRequest message specifies the interest in information of a sensed entity.

Required Properties

- **RequestedMarkingText.** A string that specifies the marking text of the object.
- **Subscribe.** Boolean that identifies whether it is requesting to be added to the subscription list. It indicates whether sensor data should be sent every time the data changes or it updates.

3.4.14 MAK:VrfResourceMonitorResponse

The MAK:VrfResourceMonitorResponse interaction message contains information about the resources maintained by a VR-Forces simulation object (for example, fuel, munitions, and so on). The VR-Forces simulation engine responsible for simulating the simulation object sends this message in response to a MAK:VrfCurrentResourceRequest message.

Required Properties

- **ObjectName.** The VR-Forces ObjectName of the simulation object for which the caller is requesting resource information.
- **Resources.** An array of objects containing information about the simulation object's resources. Each object contains information about a specific resource. The array may be empty, depending on whether or not resources are modeled for the simulation object. Consult the VR-Forces documentation for details about how resources are defined. The object is structured as follows:
 - **ResourceName.** A string name that identifies the resource, for example, "fuel".
 - **CurrentAmount.** A number representing the amount of the resource available to the simulation object. The unit of measure depends on the type of resource, as defined in the VR-Forces simulation engine. For example, the amount of a fuel resource is typically expressed in terms of liters, while the amount of an ammunition resource would typically be the number of rounds.
 - **FullAmount.** A number representing the maximum capacity for this resource on the simulation object. Its unit of measure is the same as that of CurrentAmount.
 - **ResourceType.** A string describing the numeric type of resource. ResourceType indicates whether or not the CurrentAmount and FullAmount properties represent integer or floating-point numbers. Values of `integer-resource` and `munition-resource` indicate that the resource amounts are expressed in terms of integers. A value of `munition-resource` is specified for an integer resource when the resource represents some type of munition. A value of `real-resource` indicates that resource amounts are expressed in terms of double-precision floating-point numbers.
 - **ResourceEntityType.** DIS-style simulation object type of the resource, expressed as an array of seven numbers representing Entity Kind, Domain, Country Code, Category, Subcategory, Specific, and Extra, as defined by the SISO Enumerations document, for example, [1,4,0,0,0,0,0]. Only those resources that are published as separate entities (such as missiles) specify this property.

3.5. VR-Vantage Messages

MAK has added these messages for controlling VR-Vantage:

- MAK:VrvMimicView
- MAK:VrvMimicTrackView
- MAK:VrvSensorMode
- MAK:VrvViewMagnification
- MAK:VrvObserverMode
- MAK:VrvUseSavedView
- MAK:VrvSetSystemState
- MAK:VrvModelSet
- MAK:VrvModelScaling
- MAK:VrvModelScaleFactor
- MAK:VrvKeyPress
- MAK:VrvFollowView
- MAK:VrvTetherView
- MAK:VrvMouseEvent
- MAK:VrvTrackHistories
- MAK:VrvDynamicOcean.



The VR-Vantage messages can also control a VR-Forces GUI.

3.5.1 MAK:VrvMimicView

The MAK:VrvMimicView message attaches an observer to a simulation object using Mimic mode.

Required Property

- AttachedEntity. The simulation object to attach to.

Optional Properties

- Observer. Specifies the active observer.
- Offset. Specifies an offset from the location of the simulation object you are attaching to. It is specified in body-centric coordinates with Z up, Y to the front, and X to the right.
- OffsetOri. Specifies an offset from the location of the simulation object you are attaching to. It is a body-centric taitBryan where psi rotates to the left, theta looks up, and phi rolls to the right.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvMimicView",
  "Observer": "Observer 1",
  "AttachedEntity": "M1A2 1",
  "Offset": [ 2.0, -10.0, 0.0 ],
  "OffsetOri": [ 0.0, 0.0, 0.0 ]
}
```

3.5.2 MAK:VrvMimicTrackView

The MAK:VrvMimicTrackView message attaches an observer to a simulation object using Mimic Track mode.

Required Properties

- AttachedEntity. The simulation object to attach to.
- TrackedEntity. The simulation object that is tracked.

Optional Properties

- Observer. Specifies the active observer.
- Offset. Specifies an offset from the location of the simulation object you are attaching to. It is specified in body-centric coordinates with Z up, Y to the front, and X to the right.
- OffsetOri. Specifies an offset from the location of the simulation object you are attaching to. It is a body-centric taitBryan where psi rotates to the left, theta looks up, and phi rolls to the right.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvMimicTrackView",
  "Observer": "Observer 1",
  "AttachedEntity": "M1A2 1",
  "TrackedEntity": "M1A2 2",
  "Offset": [ 2.0, -10.0, 0.0 ],
  "OffsetOri": [ 0.0, 0.0, 0.0 ]
}
```

3.5.3 MAK:VrvFollowView

The MAK:VrvFollowView message attaches an observer to an simulation object using Follow mode.

Required Property

- AttachedEntity. The simulation object to attach to.

Optional Properties

- Observer. Specifies the active observer.
- Offset. Specifies an offset from the location of the simulation object you are attaching to. It is specified in body-centric coordinates with Z up, Y to the front, and X to the right.
- OffsetOri. Specifies an offset from the location of the simulation object you are attaching to. It is a body-centric taitBryan where psi rotates to the left, theta looks up, and phi rolls to the right.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvFollowView",
  "Observer": "Observer 1",
  "AttachedEntity": "M1A2 1",
  "Offset": [ 2.0, -10.0, 0.0 ],
  "OffsetOri": [ 0.0, 0.0, 0.0 ]
}
```

3.5.4 MAK:VrvTetherView

The MAK:VrvTetherView message attaches an observer to an simulation object using Tether mode.

Required Property

- AttachedEntity. The simulation object to attach to.

Optional Properties

- Observer. Specifies the active observer.
- Offset. Specifies an offset from the location of the simulation object you are attaching to. It is specified in body-centric coordinates with Z up, Y to the front, and X to the right.
- OffsetOri. Specifies an offset from the location of the simulation object you are attaching to. It is a body-centric taitBryan where psi rotates to the left, theta looks up, and phi rolls to the right.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvTetherView",
  "Observer": "Observer 1",
  "AttachedEntity": "M1A2 1",
  "Offset": [ 2.0, -10.0, 0.0 ],
  "OffsetOri": [ 0.0, 0.0, 0.0 ]
}
```

3.5.5 MAK:VrvSensorMode

The MAK:VrvSensorMode message switches the sensor mode for an observer and a specific version of VR-Vantage.

Required Properties

- Vantage. Specifies the instance of VR-Vantage by the Site, App, and Exercise ID triple.
- SensorMode. The mode to change to. SensorMode options are **Sensor Off**, **NVG**, **IR**, and **IR (Black Hot)**.

Optional Property

- Observer. Specifies the active observer.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvSensorMode",
  "Observer": "Observer 1",
  "Vantage": [ 2, 1, 1 ],
  "SensorMode": "NVG"
}
```

3.5.6 MAK:VrvObserverMode

The MAK:VrvObserverMode message switches the observer mode for an observer.

Required Property

- ObserverMode. Specifies the observer mode: **Stealth**, **XR**, **Plan View**, and **Out-the-window**.

Optional Property

- Observer. Specifies the active observer.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvObserverMode",
  "Observer": "Observer 1",
  "ObserverMode": "XR"
}
```

3.5.7 MAK:VrvUseSavedView

The MAK:VrvUseSavedView message switches the observer to a saved view.

Required Properties

- SavedViewFilename. Specifies a saved view file (.osrx) relative to the working directory of your VR-Vantage software (typically *C:/MAK/VR-Vantage x.x/bin64*).
- SavedViewDisplayName. The name of a defined view in that file.

Optional Properties

- Observer. Specifies the active observer.
- SmoothTime. The amount of time in seconds to animate from the current view to the new view.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvUseSavedView",
  "Observer": "Observer 1",
  "SmoothTime": 3,
  "SavedViewFilename":
"..\\appData\\settings\\stealth\\savedViewFile.osrx",
  "SavedViewDisplayName": "IED View"
}
```

3.5.8 MAK:VrvViewMagnification

The MAK:VrvViewMagnification message sets the view magnification for an observer in VR-Vantage. Useful for views that involve zooming, such as binoculars or cameras.

Required Property

- ViewMagnification. The amount to magnify the view.

Optional Property

- Observer. Specifies the active observer.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvViewMagnification",
  "Observer": "Observer 1",
  "ViewMagnification": 2.0
}
```

3.5.9 MAK:VrvSetSystemState

The MAK:VrvSetSystemState message enables or disables global display settings in a specific version of VR-Vantage. Each of these settings corresponds to a button in the Display Settings Toolbar of VR-Vantage. The settings are all optional. If any field is left out of this message, the value is set to false.

Required Property

- Vantage. Specifies the instance of VR-Vantage by the Site, App, and Exercise ID triple.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvSetSystemState",
  "Vantage": [ 2, 1, 1 ],
  "EntityLabels": true,
  "TacticalGraphicsLabels": true,
  "HeightAboveTerrainLines": true,
  "FireDetonateLines": true,
  "TacticalGraphics": true,
  "RadioCommunications": true,
  "VaporTrail": true,
  "PlanarReflections": true
}
```

3.5.10 MAK:VrvModelSet

The MAK:VrvModelSet message changes the model set in VR-Vantage.

Required Properties

- Vantage. Specifies the instance of VR-Vantage by the Site, App, and Exercise ID triple.
- ModelSet. The model set to use. The options are:
 - 0 - 3D models.
 - 1 - 2D icons.
 - 5 - Colorized models (XR).

Optional Property

- ObserverMode. Specifies the observer mode: Stealth, XR, Plan View, and Out-the-window.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvModelSet",
  "Vantage": [ 2, 1, 1 ],
```

```
"ObserverMode": "Stealth",  
"ModelSet": 0  
}
```

3.5.11 MAK:VrvModelScaling

The MAK:VrvModelScaling message enables and disables model scaling.

Required Properties

- Vantage. Specifies the instance of VR-Vantage by the Site, App, and Exercise ID triple.
- ModelScaling. Set to true or false.

Optional Property

- ObserverMode. Specifies the observer mode: Stealth, XR, Plan View, and Out-the-window.

Example Message

```
{  
  "MessageKind": 2,  
  "InteractionType": "MAK:VrvModelScaling",  
  "Vantage": [ 2, 1, 1 ],  
  "ObserverMode": "Stealth",  
  "ModelScaling": false  
}
```

3.5.12 MAK:VrvModelScaleFactor

The MAK:VrvModelScaleFactor message sets the scale of the model if model scaling is enabled.

Required Properties

- Vantage. Specifies the instance of VR-Vantage by the Site, App, and Exercise ID triple.
- ModelScaleFactor. The amount to scale models.

Optional Property

- ObserverMode. Specifies the observer mode: Stealth, XR, Plan View, and Out-the-window.

Example Message

```
{  
  "MessageKind": 2,  
  "InteractionType": "MAK:VrvModelScaleFactor",  
  "Vantage": [ 2, 1, 1 ],  
}
```

```
"ObserverMode": "Stealth",
"ModelScaleFactor": 50
}
```

3.5.13 MAK:VrvKeyPress

The MAK:VrvKeyPress message causes VR-Vantage to act as if a key has been pressed or released.

Required Properties

- **Key.** Specifies the key. It follows the virtual key codes where 0 to 9 maps as 0x30 to 0x39 and a to z maps at 0x41 to 0x5A.
- **KeyState.** Set to true if a key is pressed or released.

Optional Properties

- **Observer.** Specifies the active observer.
- **Modifiers.** Specifies if the **Shift**, **Alt**, or **Ctrl** keys are pressed.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvKeyPress",
  "Observer": "Observer 1",
  "Key": 41,
  "KeyState": true,
  "Modifiers": {
    "Shift": false,
    "Alt": false,
    "Ctrl": false
  }
}
```

3.5.14 MAK:VrvMouseEvent

The MAK:VrvMouseEvent messages causes VR-Vantage to respond as if a mouse event has occurred.

Required Property

- **EventType.** The type of mouse action to send. Supported event types are Move, wheel, ButtonPress, ButtonRelease, and ButtonDoubleClick.

Optional Properties

- **Observer.** Specifies the active observer.
- **X and Y.** Specifies the current location of the mouse.
- **Wheel.** Specifies the state of the mouse wheel.

- **Modifiers.** Specifies if the **Shift**, **Alt**, or **Ctrl** keys are pressed.
- **Buttons.** Specifies the current state of the mouse buttons.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvMouseEvent",
  "Observer": "Observer 1",
  "EventType": "Move",
  "X": 100.0,
  "Y": 100.0,
  "Wheel": 0.0,
  "Modifiers": {
    "Shift": false,
    "Alt": false,
    "Ctrl": false
  }
  "Buttons": {
    "Left": true,
    "Middle": false,
    "Right": false
  }
}
```

3.5.15 MAK:VrvTrackHistories

The MAK:VrvTrackHistories message enables or disables track histories in a specific instance of VR-Vantage.

Required Properties

- **Vantage.** Specifies the instance of VR-Vantage by the Site, App, and Exercise ID triple.
- **TrackHistories.** Specifies true or false.

Optional Property

- **ObserverMode.** Specifies the observer mode: **Stealth**, **XR**, **Plan View**, and **Out-the-window**.

Example Message

```
{
  "InteractionType": "MAK:VrvTrackHistories",
  "Vantage": [2,1,1],
  "ObserverMode": "Stealth",
  "TrackHistories": false
}
```

3.5.16 MAK:VrvDynamicOcean

The MAK:VrvDynamicOcean message enables or disables the dynamic ocean in a specific instance of VR-Vantage.

Required Properties

- Vantage. Specifies the instance of VR-Vantage by the Site, App, and Exercise ID triple.
- DynamicOcean. Specifies true or false.

Optional Property

- ObserverMode. Specifies the observer mode: Stealth, XR, Plan View, and Out-the-window.

Example Message

```
{
  "MessageKind": 2,
  "InteractionType": "MAK:VrvDynamicOcean",
  "Vantage": [2,1,1],
  "ObserverMode": "Stealth",
  "DynamicOcean": true
}
```




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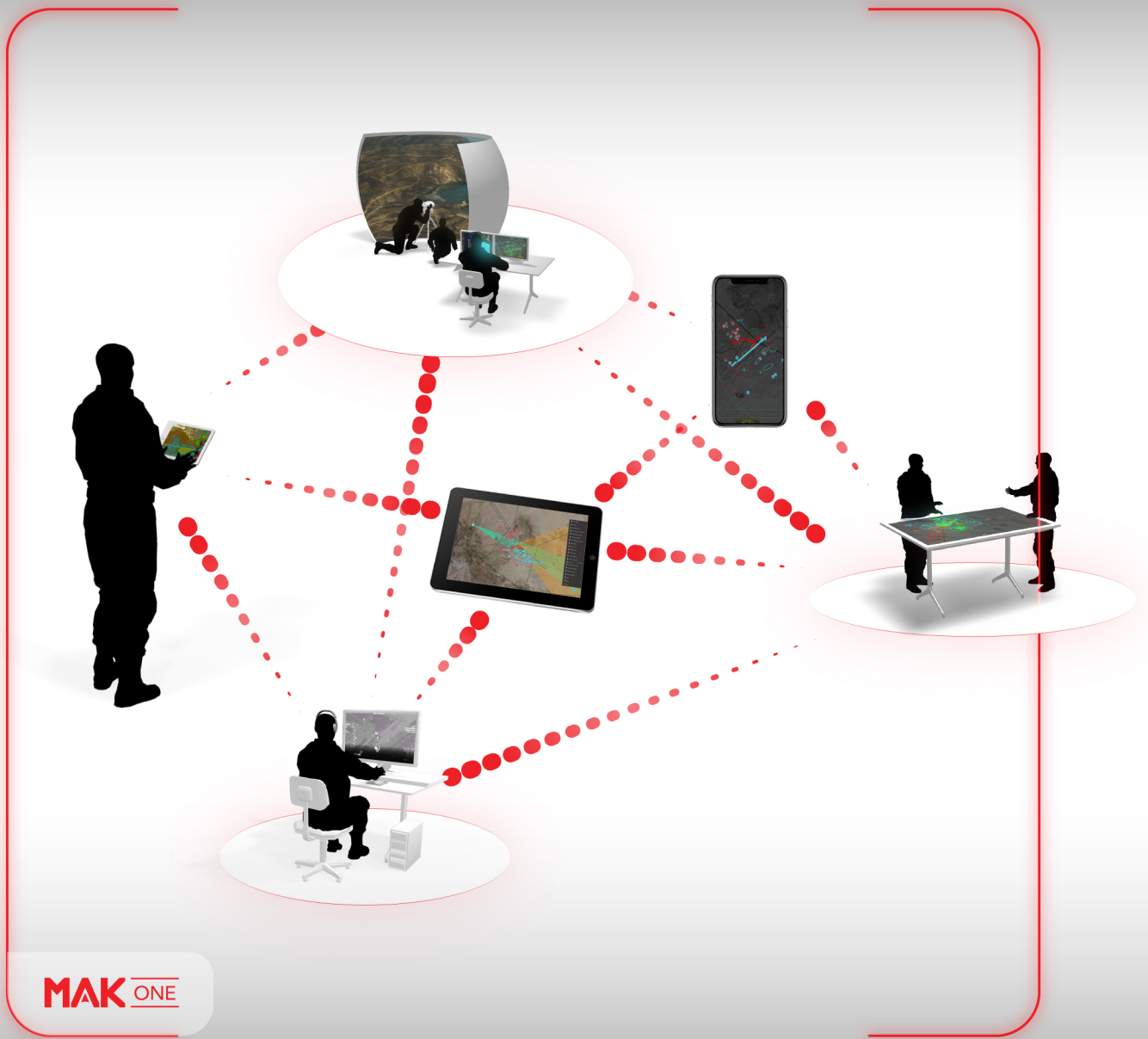
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