Distributed Wargaming Visualization and Data Collection

90th MORS Symposium (MORSS)

13-16 June 2022

Purpose and Agenda

Purpose: Discuss wargame design elements and provide an overview of the Visualization Application and Data Collection in R (VADR) wargaming tool.

Agenda

- Background.
- Critical Elements of Analytic Wargame Design.
- Methods, Models, and Tools (MMT).
- VADR Description.
- VADR in the 2020 Capstone Wargame Series.
- VADR in the Optionally Manned Fighting Vehicle (OMFV) Phase II Map Exercise (MAPEX).
- VADR Current and Future Efforts.
- Summary.

Background

- The Research and Analysis Center-White Sands Missile Range (TRAC-WSMR) was tasked with conducting a region-specific Capstone Wargame, as part of a Capstone Wargame Series to address calibrated force posture and United States (U.S.) Army 31+4 emerging capabilities.

- Due to the nature of the study requirements, the wargame had to be conducted in a classified setting.

- Corona Virus Disease 2019 (COVID-19) presented challenges to the execution of the 2020 Capstone Wargame Series that required:

  - Distributed role-players.

  - Updates to, and development of new MMTs and wargaming processes.

Challenge: Providing *distributed participants* with an interactive operational picture accounting for *unique visualization information* required to facilitate *independent* planning.
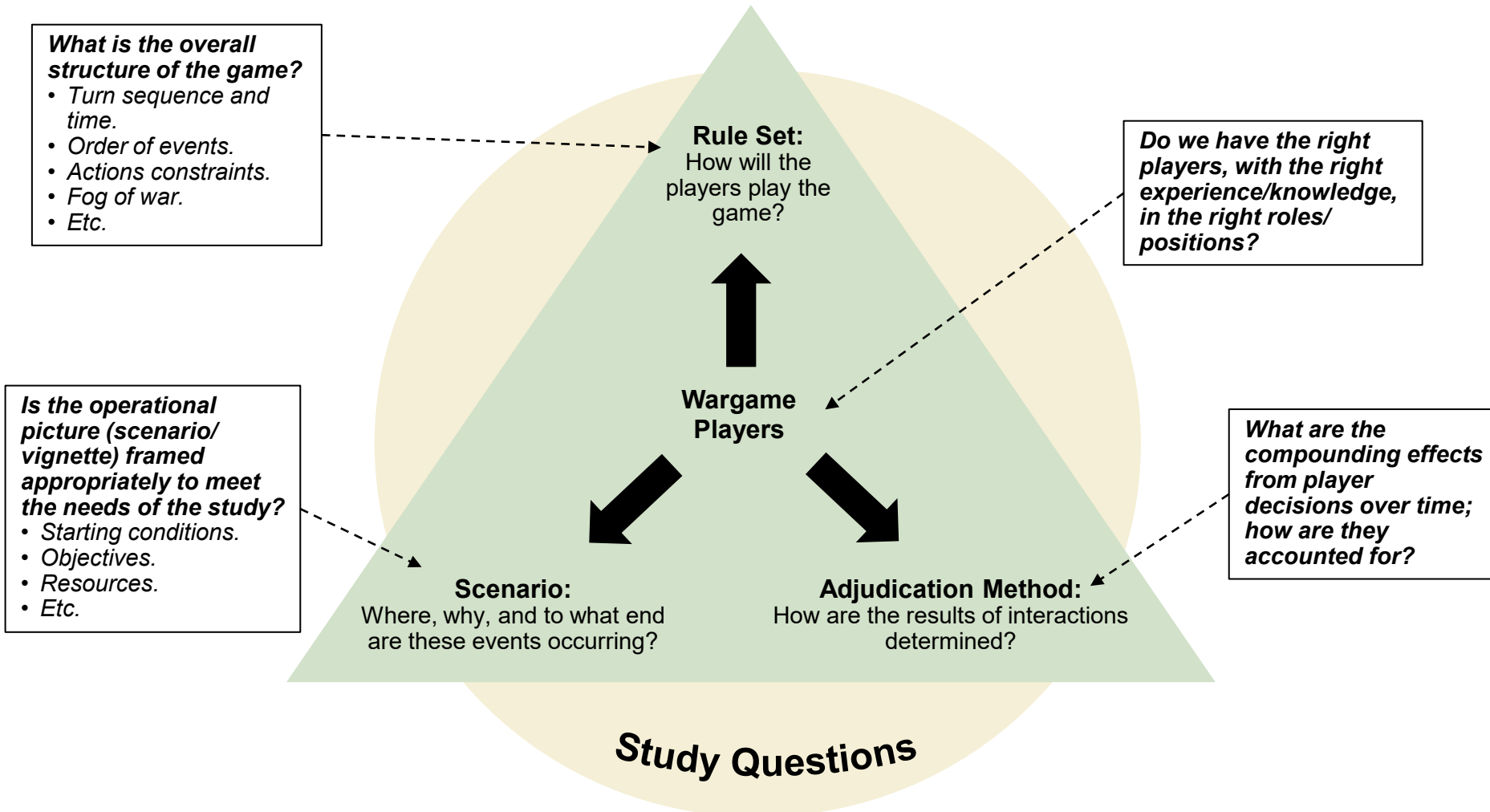
Critical Elements of Analytic Wargame Design

The graphic* depicts the *four critical parts* of a wargame that must be *properly designed* to meet the sponsor's analytical questions.

What is the overall structure of the game?
- Turn sequence and time.
- Order of events.
- Actions constraints.
- Fog of war.
- Etc.

Do we have the right players, with the right experience/knowledge, in the right roles/positions?

Is the operational picture (scenario/vignette) framed appropriately to meet the needs of the study?
- Starting conditions.
- Objectives.
- Resources.
- Etc.

What are the compounding effects from player decisions over time; how are they accounted for?

Rule Set: How will the players play the game?

Wargame Players

Scenario: Where, why, and to what end are these events occurring?

Adjudication Method: How are the results of interactions determined?

Study Questions

Graphic from Phalanx-December 2018, The Four Critical Elements of Analytic Wargame Design, LTC Brian Wade, Center for Army Analysis (CAA).
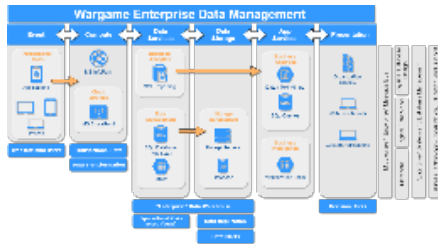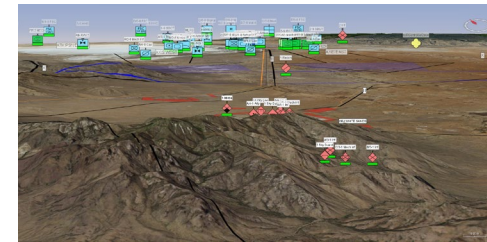
MMT
TRAC Wargaming Tools

Numerous "in-house" wargaming tools were developed to account for the critical elements of an analytical wargame design.

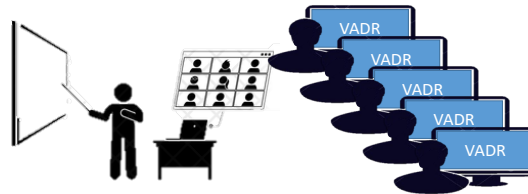### Wargame Analytical Repository Network (WARnet)*

WARnet allowed for data collection and information transfer across a distributed, classified network.

Versatile Assessment Simulation Tool (VAST)**

VAST accounted for adjudication between players' actions.

Visual Augmentation Distributed with R (VADR definition for 2020 Capstone Wargame Series)

VADR provided participants:
- *Common operational picture (i.e., scenario).*
- *Distributed planning capability.*

*WARnet: Cloud-based (MS SharePoint) tool, hosted on multiple networks, to enable data collection and information sharing.

**VAST: Software application designed to assist in the execution of map exercises and wargames.

MMT
Visualization and Planning Challenge   (2 of 2)

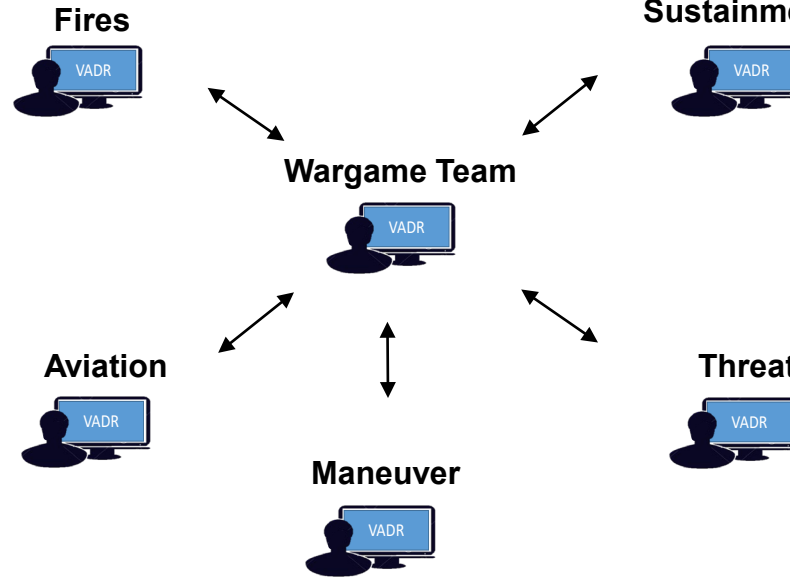## Notional Representation of Participants/Warfighting Functions (WfF)*

Fires Visualization Reqs:
- *Fires units by echelon.*
- *Friendly/Threat maneuver units.*
- *Friendly/Threat direct/indirect fires and SS missile range rings.*
- *Preplanned targets.*
- *Firing units' movement rings.*
- *PAAs and alt PAAs.*

Fires

VADR

Wargame Team

VADR

Sustainment

VADR

Sustainment Visualization Reqs:
- *Sustainment units by echelon.*
- *Friendly/Threat maneuver units.*
- *Friendly/Threat direct/indirect range rings.*
- *Sustainment movement rings.*
- *MSR, ASRs, bridges, RONs.*
- *APODs, SPODs, DSAs, BSAs.*

Aviation Visualization Reqs:
- *All aviation units.*
- *Friendly/Threat maneuver units.*
- *Threat SA range rings.*
- *Aviation weapon range rings.*
- *FARPs, airfields.*

Aviation

VADR

Maneuver

VADR

Threat

VADR

Threat Visualization Reqs:
- *All threat units by echelon.*
- *Friendly/Threat maneuver units.*
- *Friendly/Threat direct/indirect fires, SA and SS missile range rings.*
- *Threat maneuver range rings.*
- *Threat maneuver corridors.*
- *MSRs, ASRs, and bridges.*

Maneuver Visualization Reqs:
- *Friendly maneuver units by echelon.*
- *Friendly/Threat maneuver units.*
- *Friendly/Threat direct/indirect fires and SS missile range rings.*
- *Friendly maneuver range rings.*
- *Friendly maneuver corridors.*
- *MSRs, ASRs and bridges.*

APOD – aerial port of debarkation
ASR – alternate supply route
BSA – brigade support area
DSA – division support area
FARP – forward arming and refueling point
MSR – main supply route
PAA – position area for artillery
RON – remaining overnight
SA – surface-to-air
SPOD – seaport of debarkation
SS – surface-to-surface

***Participants depicted are examples and do not comprise an all-inclusive list. Friendly WfFs were represented by one or more participants, each generally represented by teams from the Army capability development integration directorates.**

Participants *must* be able to select (see) *unique* information that will allow for efficient and effective *independent planning* in a timely manner.

VADR Description

VADR is a wargaming tool designed using the R programming language and the RStudio Integrated Development Environment (IDE).

VADR was initially designed to:

- Provide an operational visualization capability for the 2020 Capstone Wargame Series under COVID-19 conditions.

- Allow analysts to efficiently modify, test, and refine visualization needs to meet 2020 Capstone Wargame Series requirements.

- Deploy across secure internet protocol router (SIPR) government network.

- Provide an electronic record of unit dispositions throughout the wargame.

VADR addressed the following challenges:

- Ability for multiple players/subject matter experts (SME), across the continental United States (CONUS), to *independently* visualize the operational picture, at specific locations, and at specific resolutions.

- Ability for all players/SMEs to visualize the requirements *unique* to each of their warfighting functions.

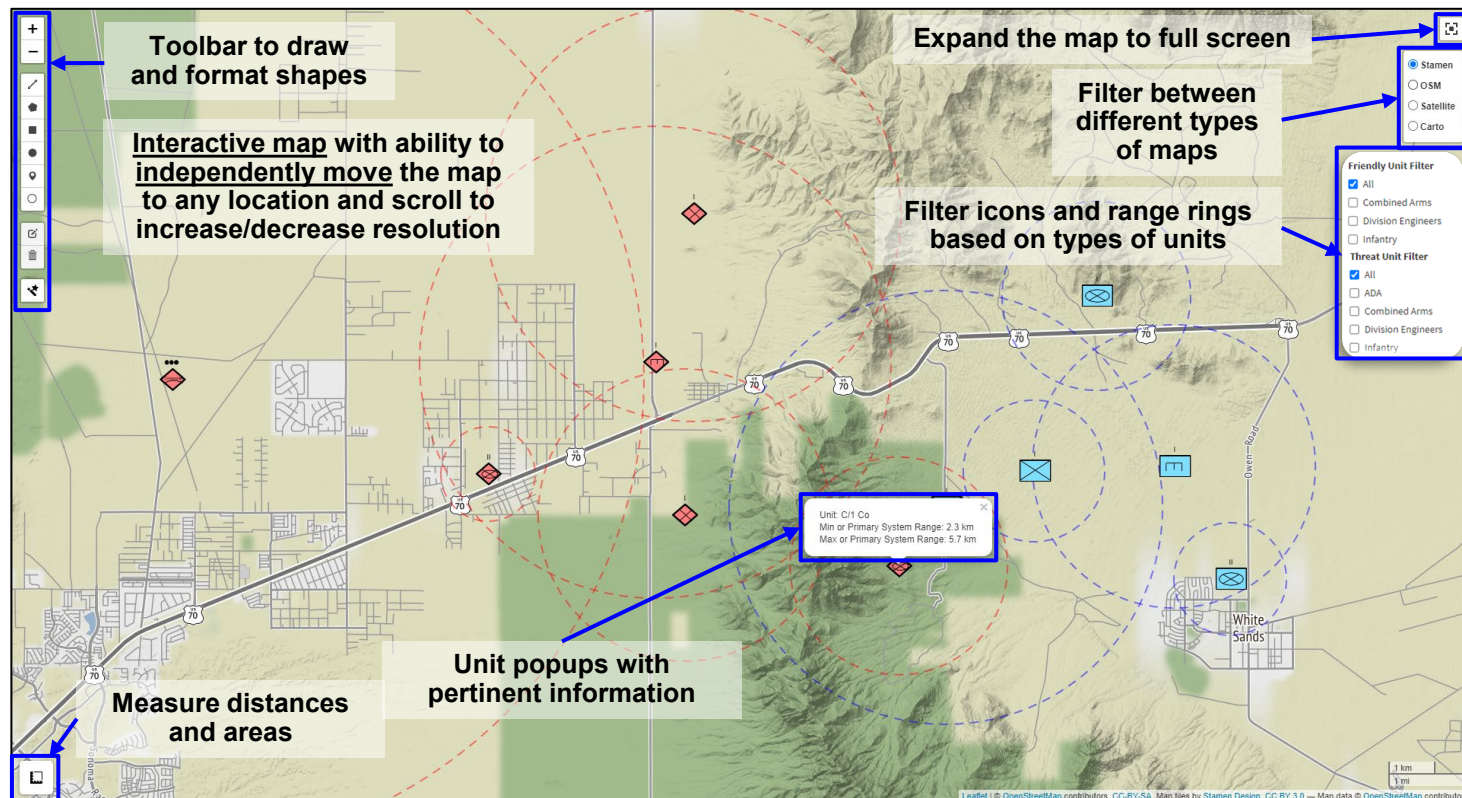- Ability to adjust and modify player/SME visualization requirements in a *timely* manner.

VADR in the Capstone Wargame Series

Challenge: Use VADR as a lightweight visualization tool, hosted on the SIPR network to support planning in a distributed environment. The **R** programming language, **RStudio** IDE and **leaflet*** package were used to build the visualization tool.

Notional Area of Operations

- Toolbar to draw and format shapes
- **Interactive map** with ability to **independently move** the map to any location and scroll to increase/decrease resolution
- Expand the map to full screen
- Filter between different types of maps
- Filter icons and range rings based on types of units
- Unit popups with pertinent information
- Measure distances and areas

Unit: C/1 Co
Min or Primary System Range: 2.3 km
Max or Primary System Range: 5.7 km

VADR provided players/SMEs an _interactive operational picture_, presenting the _appropriate context**_ to allow for visualization and planning operations.

*Leaflet is a leading open-source JavaScript library for interactive maps.

**Appropriate context refers to providing only the essential elements of the user interface/experience needed to produce timely output requirements.
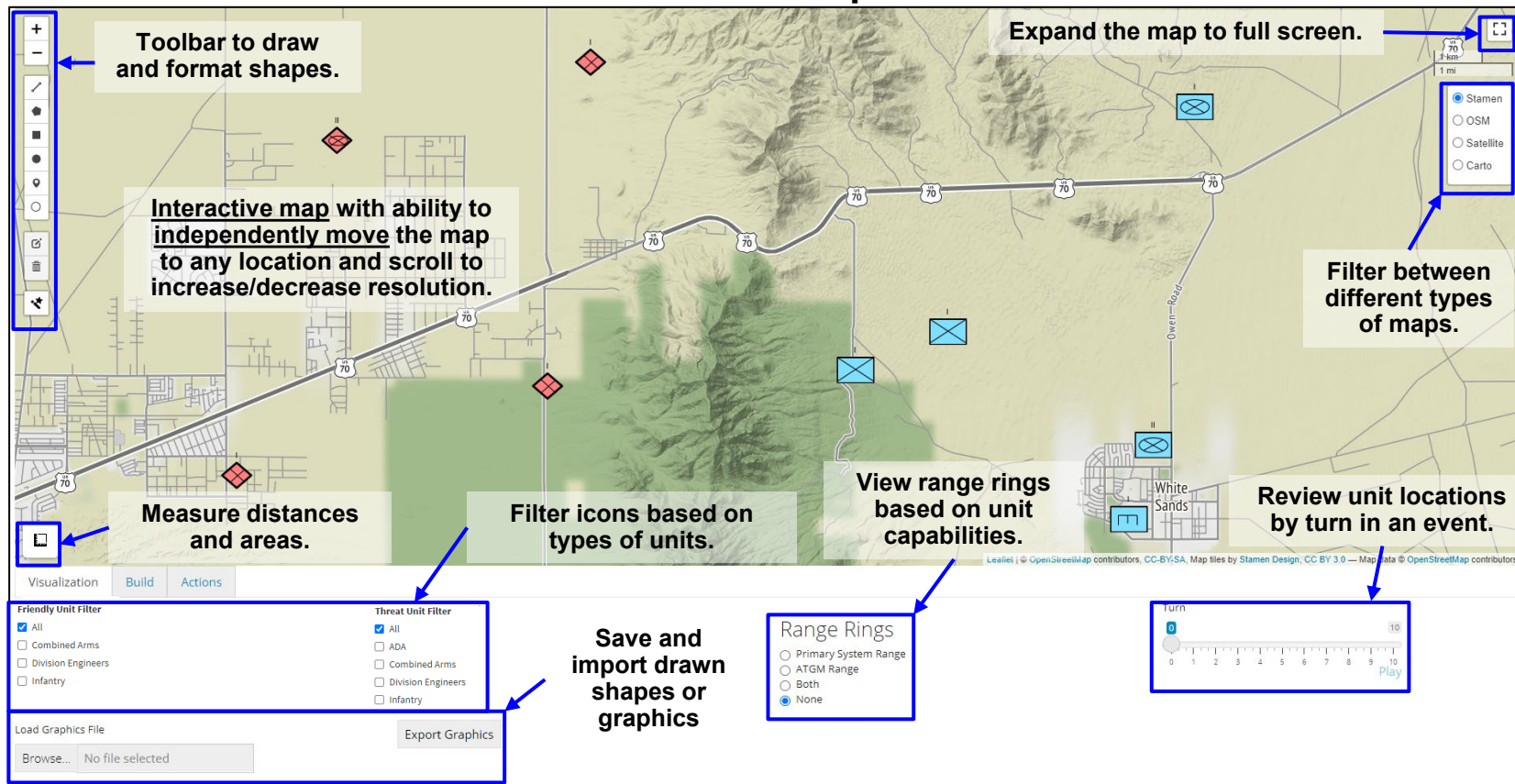
VADR in the OMFV Phase II MAPEX
(1 of 2)

Challenge: Use VADR as a customizable visualization and data collection tool to capture, store, organize, share, and review information. R, RStudio, and leaflet were used, with shiny* to collect data and provide an "interactive" user interface .

Notional Area of Operations

Toolbar to draw and format shapes.

Expand the map to full screen.

Interactive map with ability to **independently move** the map to any location and scroll to increase/decrease resolution.

Filter between different types of maps.

Measure distances and areas.

Filter icons based on types of units.

View range rings based on unit capabilities.

Review unit locations by turn in an event.

Save and import drawn shapes or graphics

Friendly Unit Filter
- [x] All
- [ ] Combined Arms
- [ ] Division Engineers
- [ ] Infantry

Threat Unit Filter
- [x] All
- [ ] ADA
- [ ] Combined Arms
- [ ] Division Engineers
- [ ] Infantry

Range Rings
- ( ) Primary System Range
- ( ) ATGM Range
- ( ) Both
- (•) None

Turn: 0 — 10 — Play

Visualization | Build | Actions

Load Graphics File
Browse... No file selected   Export Graphics

VADR provided players/SMEs an *interactive operational picture*, presenting the *appropriate context** to allow for visualization, planning operations, and data collection.

*Shiny is a package that makes it easy to build interactive web apps using R.

**Appropriate context refers to providing only the essential elements of the user interface/experience needed to produce timely output requirements.

VADR in the OMFV Phase II MAPEX
(2 of 2)

As role players planned and executed their unit moves, VADR prompted them to input specific information for each unit move, allowing for multiple methods to *capture, update, store, share*, and *review* information.

Enter unit data for this turn:

Task
Occupy BP 1 IVO Aguirre Springs

Purpose
Conduct survivability/CM operations in p

Movement Technique
Traveling Overwatch

Formation
Company Wedge

Speed in kph
25

Coordination
Ensure CL IV drops are completed NLT 2!

Additional Notes
Receive 2x D7 Blade Teams from ENG CC

The user moves an icon and is prompted to:
- **Confirm unit moves.**
- **Record required unit information (by turn or phase).**

Note: This information is completely customizable and was tailored to feed directly into TRAC combat simulations.

Interactive spreadsheet that:
- **Provides transparency to all player inputs.**
- **Allows for changes/updates to player inputs.**

Search and filter spreadsheet for specific units or actions.

Confirm Unit Move? | Submit or Resubmit Unit Info
Close Window

Save Actions
Show 10 entries
Search:

	Entity.Name	New.Latitude	New.Longitude	Task	Purpose	Movement.Technique	Formation	Speed	Coordination	Notes
1	A Co	32.4106900152077	-106.527900695801	121443FEB21		Tactical Road March		0		
2	B Co	32.3335589486411	-106.430053710938	221316FEB21	Occupy BP 2					
3	C Co	32.4437260285722	-106.523780822754	Occupy BP 1 IVO Aguirre Springs	Conduct survivability/CM operations in preparation for deliberate defense	Traveling Overwatch	Company Wedge	25	Ensure CL IV drops are completed NLT 291300FEB24	Receive 2x D7 Blade Teams from ENG CO to begin survivability efforts upon occupation of BP 1
4	1 BN	32.4043132514061	-106.408081054688	test		Tactical Road March		0		
5	A/1 Co	32.4008348267222	-106.614074707031							

VADR provided the study team a *complete* record* of *synchronized* graphics and *exportable* data throughout the event in a *timely and accurate* manner.

* Complete implies that all graphics and data collected are sufficient to meet the study requirements. It allows the ability to immediately review, refine/update all participant inputs, in a transparent manner.

VADR Current and Future Efforts

Tool

- Upgrading (1) a visualization and data collection tool in support of multiple *MAPEXs to develop vignettes for combat simulation model integration* and (2) *codifying user, developer and facilitator documentation* for VADR.

Version Control

- Using the *GitLab* distributed development and version control system*, which helps facilitate streamlined development and tool management, allowing study teams to easily fork and customize for specific requirements.

*VADR Project in GitLab

UNCLASSIFIED

VADR Current and Future Efforts

Cloud Usage

- Hosting VADR on unclassified network servers to allow for *simple containerization and ease of use* for role players in a distributed environment.
- Exploring *future cloud capabilities and solutions on both unclassified and classified networks* by utilizing current environments like Army Future Command's (AFC) MADE.*

Future Development

- Representing the fog of war concept to restrict what role players can realistically detect.
- Investigating lightweight combat simulation (based on map entities and dynamic attributes).
- Developing lightweight adjudication using COF/COFM or other available data.
- Incorporating utility of VADR into VAST-R** development.

VADR Deployed on AFC's MADE Cloud Environment*
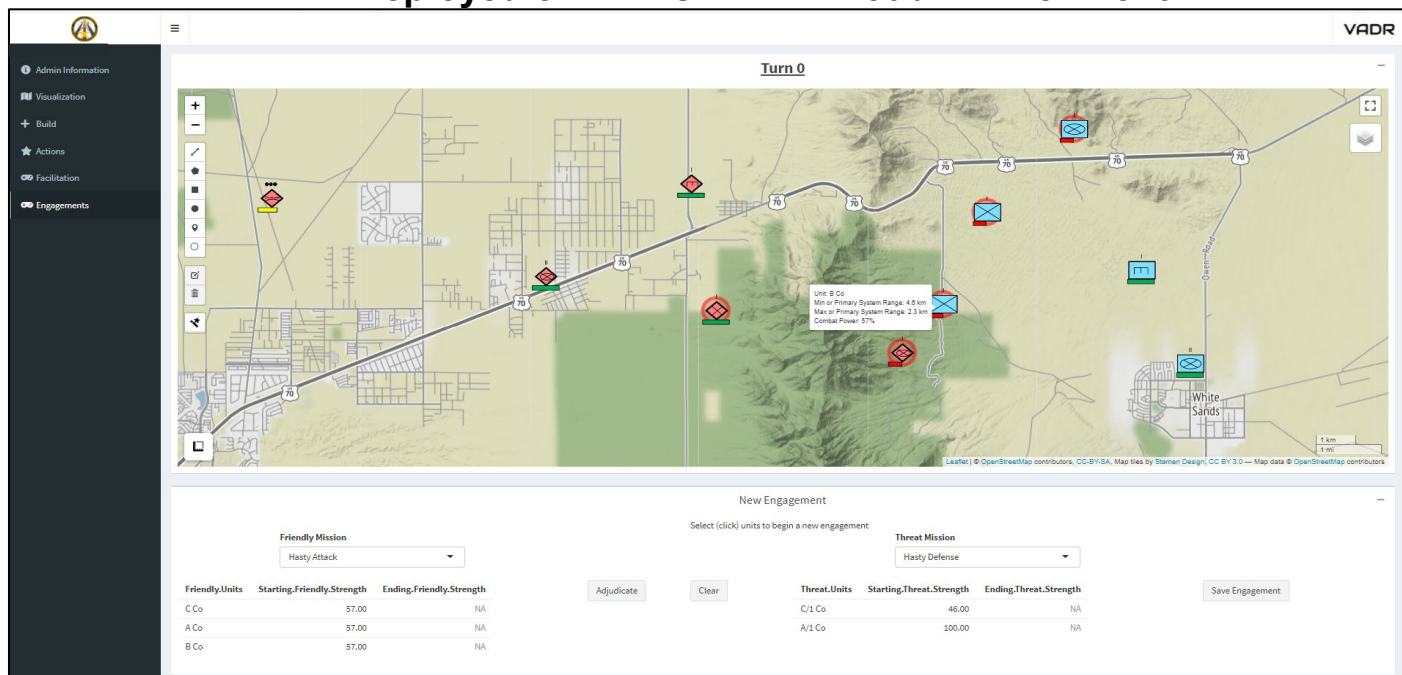
*MADE is AFC's Modernization Application and Data Environment, a cloud environment with features such as RStudio Server Pro, RStudio Connect, and Microsoft Azure.

COF – correlation of forces
COFM – Correlation of Forces and Means

**VAST-R – TRAC's VAST refactored in the R programming language as a shiny web application, with increased functionality to give it an all-inclusive, distributed wargaming and data collection capability with the ability to support everything from simple map exercises to wargames with multiple computer aided algorithms.

Summary

VADR:

- Demonstrates ability to *customize the interface* for visualization, planning, and data collection.

- Designed to be *tailored and used by analysts*, *flexible to adapt* to study timelines ("*just enough*" design philosophy).

- *Increases data collection and processing/efficacy* through real-time, interactive, and accessible collection method.

- Allows *more efficient allocation* of resources.

- Operates on *classified and unclassified* networks, within onsite, partially distributed, and fully distributed environments.

Questions

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