VIRTUAL REALITY IN SUPPORT OF NUCLEAR DISARMAMENT

INTERACTIVITY, CURVEBALLS, AND GAMEPLAY

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Revision 1b

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BACKGROUND

(REAL) INSPECTION EXERCISES

NuDiVe (Germany, France)

UKNI (Norway, United Kingdom)

Quad (UKNI, USA, Sweden)

Source: NuDiVe and FZ Jülich (top), ukni.info (bottom, left), quad-nvp.info (bottom, right)

VIRTUAL REALITY

AS A TOOL FOR THE JOINT DEVELOPMENT OF NEW VERIFICATION APPROACHES

THE ORIGINAL IDEA

Create open and flexible virtual environments to explore new verification concepts and approaches

(... which could also lay a basis for live exercises and new policy initiatives)

CURRENT MAIN FOCUS OF PROJECT

Examine fundamental questions related to interactivity, user experience, and presence in virtual environments; but also explore “cheating scenarios” relevant for assessing the effectiveness of different verification approaches

Source: Authors

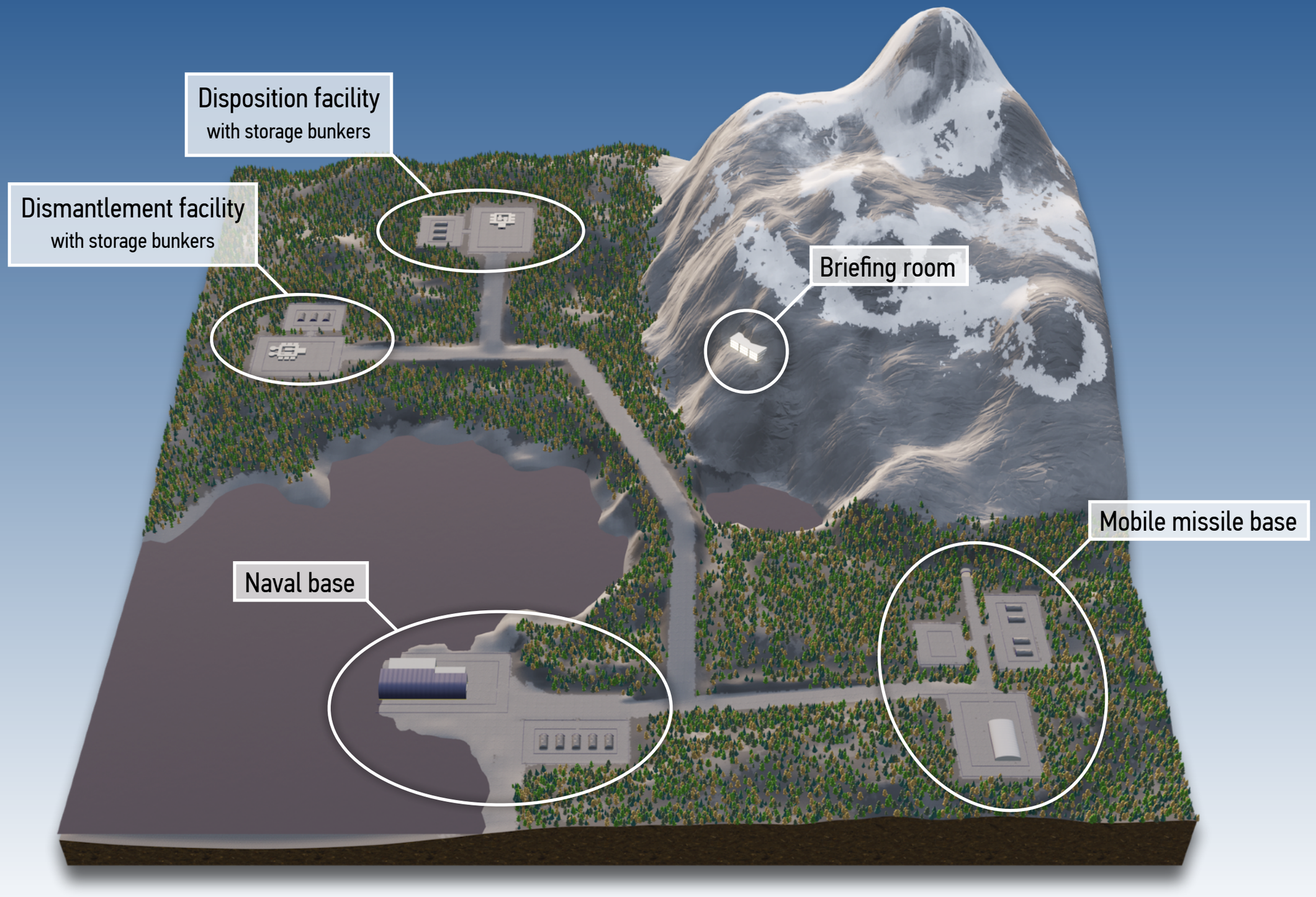
Demonstration of earlier project at the UN, Geneva

on the margins of a meeting of the Group of Governmental Experts on nuclear disarmament verification, Palais des Nations, May 2018

Source: Pavel Podvig

TECHNICAL

GEOGRAPHY OF OUR VIRTUAL WORLD



ROOM 1

PORTAL MONITOR INTERIOR

PORTAL MONITOR EXTERIOR

CCTV

MODAL TESTING

IBX

WARHEAD CONTAINER

LAVA LAMP

BUDDY TAG

COMMON SEAL

NEUTRON COUNTER

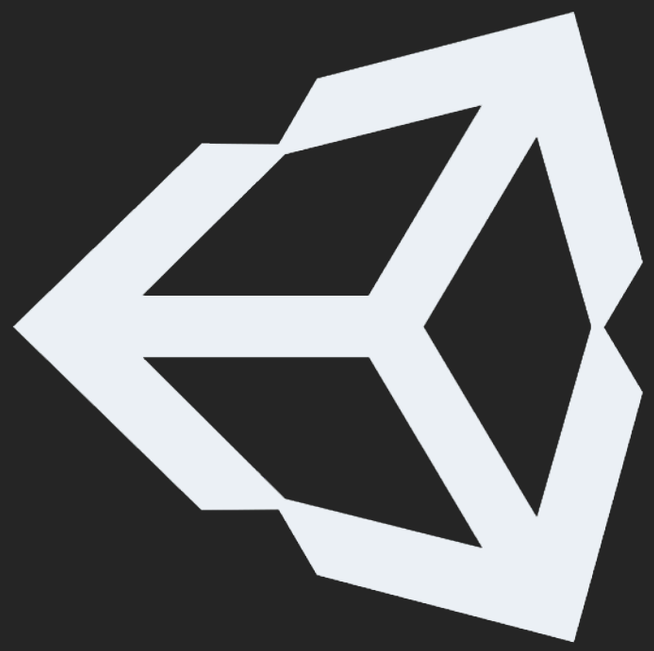
GEIGER COUNTER

MAGTAG BLANKET

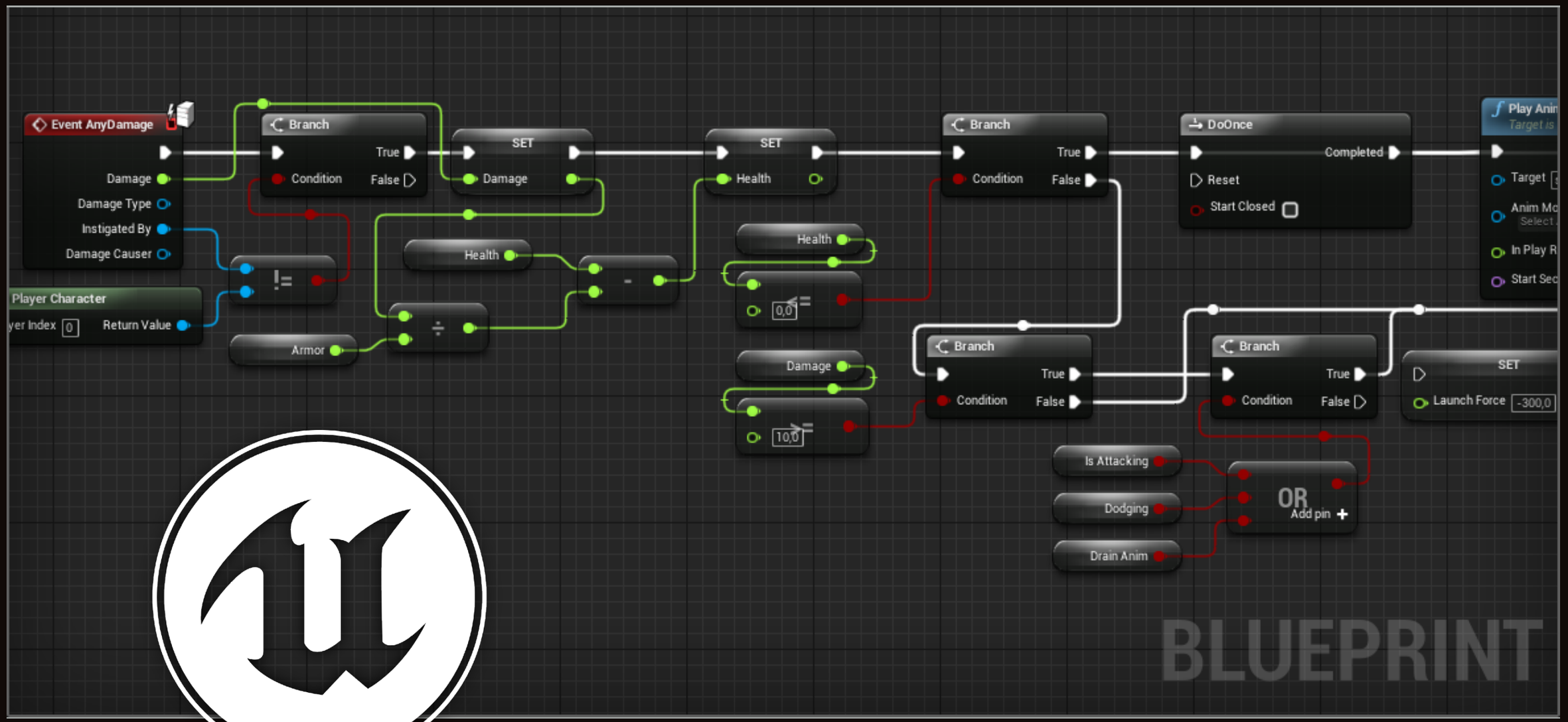
PROPS

COLLECTION

UNREAL
ENGINE



unity



UNREAL
ENGINE

DEFINING THE VIRTUAL WORLD

world1.json — UNREGISTERED

world1.json | world2.json

```
{
    "Environments": [
        {
            "Name": "Bunker",
            "ObjectList": [
                {
                    "Type": "Warhead",
                    "Name": "BP_RVWarhead_C_2147481951",
                    "Location": [ 747.0, 432.0,   0.0],
                    "Rotation": [   0.0,   0.0,   0.0],
                    "Scale":    [   1.0,   1.0,   1.0],
                    "ID": "87C27",
                    "Content": [
                        {
                            "Type": "PIT",
                            "ID": "68C5B",
                            "Valid": true,
                            "Materials": ["wpu", "heu"]
                        },
                        {
                            "Type": "SEC",
                            "ID": "B2A10",
                            "Valid": true,
                            "Materials": ["heu", "unat"]
                        },
                        {
                            "Type": "HEX",
                            "ID": "E7ADD"
                        },
                        {
                            "Type": "NNC",
                            "ID": "5EAD8"
                        }
                    ],
                    "Attached": [],
                    "Escort": false
                }
            ]
        }
    ]
}
```

Line 1, Column 1 Spaces: 4 JSON

world2.json — UNREGISTERED

world1.json | world2.json

```
{
    "Environments": [
        {
            "Name": "Bunker",
            "ObjectList": [
                {
                    "Type": "Warhead",
                    "Name": "BP_RVWarhead_C_2147481951",
                    "Location": [ 747.0, 432.0,   0.0],
                    "Rotation": [   0.0,   0.0,   0.0],
                    "Scale":    [   1.0,   1.0,   1.0],
                    "ID": "87C27",
                    "Content": [
                        {
                            "Type": "PIT",
                            "ID": "68C5B",
                            "Valid": false,
                            "Materials": ["unat"]
                        },
                        {
                            "Type": "SEC",
                            "ID": "B2A10",
                            "Valid": true,
                            "Materials": ["heu", "unat"]
                        },
                        {
                            "Type": "HEX",
                            "ID": "E7ADD"
                        },
                        {
                            "Type": "NNC",
                            "ID": "5EAD8"
                        }
                    ],
                    "Attached": [],
                    "Escort": false
                }
            ]
        }
    ]
}
```

Line 1, Column 1 Spaces: 4 JSON

AVATARS

Avatars are assigned randomly upon startup; chosen from a growing set of characters

New avatars can be created with vrchat.readyplayer.me/avatar (but must be post-processed for use in NuVR)

NON-PLAYER CHARACTERS

SCENES FROM THE VIRTUAL WORLD

A visual introduction to NuVR

CONFIRMING CORRECTNESS OF DECLARATIONS

AND SELECTING ITEMS FOR (FURTHER) INSPECTION

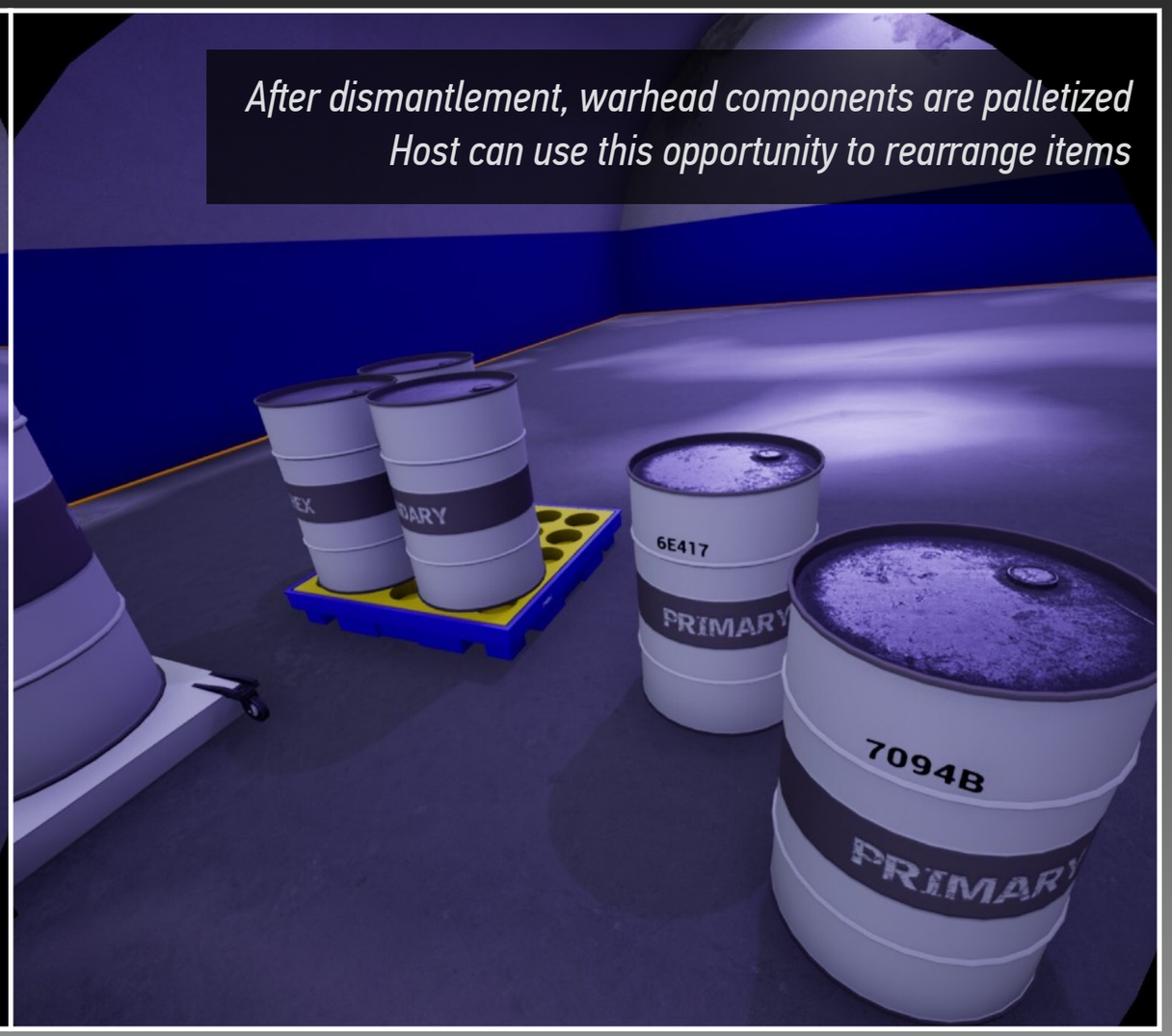
Overlooking a docked ballistic missile submarine

Personnel from the host and the inspector team during a visual inspection of treaty accountable items

“DISMANTLING WARHEADS”

(AND SETTING UP NON-COMPLIANCE SITUATIONS)

Warhead containers in a storage bunker



After dismantlement, warhead components are palletized
Host can use this opportunity to rearrange items

“DISMANTLING WARHEADS”

(AND SETTING UP POSSIBLE NON-COMPLIANCE SITUATIONS)

world3.json — UNREGISTERED

world3.json

```
{
    "Environments": [
        {
            "Name": "Bunker_001",
            "ObjectList": [
                {
                    "Type": "Pallet",
                    "Name": "BP_Pallet_C_2147482103",
                    "Location": [ 141, 74, 0 ],
                    "Rotation": [ 0, 0, 0 ],
                    "Scale": [ 1, 1, 1 ],
                    "ID": "1ACB9",
                    "Content": [],
                    "Attached": [
                        {
                            "Type": "PrimaryContainer",
                            "Name": "BP_PrimaryContainer_C_2147482111",
                            "Location": [ 111, 104, 20 ],
                            "Rotation": [ 0, 0, 0 ],
                            "Scale": [ 1, 1, 1 ],
                            "ID": "60987",
                            "Content": [
                                {
                                    "Type": "PIT",
                                    "ID": "7959F",
                                    "Valid": true,
                                    "Materials": [
                                        "wpu"
                                    ]
                                }
                            ],
                            "Attached": []
                        },
                        {
                            "Type": "SecondaryContainer",
                            "Name": "BP_SecondaryContainer_C_2147482097",
                            "Location": [ 111, 44, 20 ],
                            "Rotation": [ 0, 0, 0 ]
```

Line 1, Column 1 — Tab Size: 4 — JSON

"THE SCIENCE OF MAGIC"

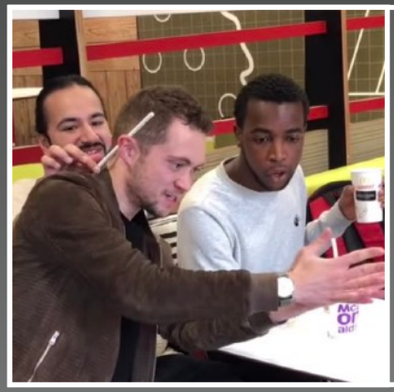
(Misdirection & Forcing)

www.magicresearchlab.com

MISDIRECTION & FORCING

INSPECTIONS AS A TWO-PLAYER GAME … WITH OR WITHOUT MAGIC TRICKS?

Inspections of nuclear facilities are complex and "highly scripted"; as warhead levels drop, parties may begin to worry more about deception efforts by the other side



MISDIRECTION TECHNIQUES

Misdirection involves the intentional deflection of attention for the purposes of disguise

Besides sleight of hand, examples include the illusion of spontaneity, the dead cat on the table, the falling chandelier of doom, and "the trick has not yet begun or is already over" situations

FORCING TECHNIQUES

Decision forces influence the inspector's choice without them becoming aware of this influence; alternatively, the decision is genuinely free, but (unknown to the inspector) this decision has no impact whatsoever on the outcome of the inspection (outcome forces)

Source: IAEA (top), @lucagallone (middle), authors (bottom)

CONTAINER SELECTION SCENARIO

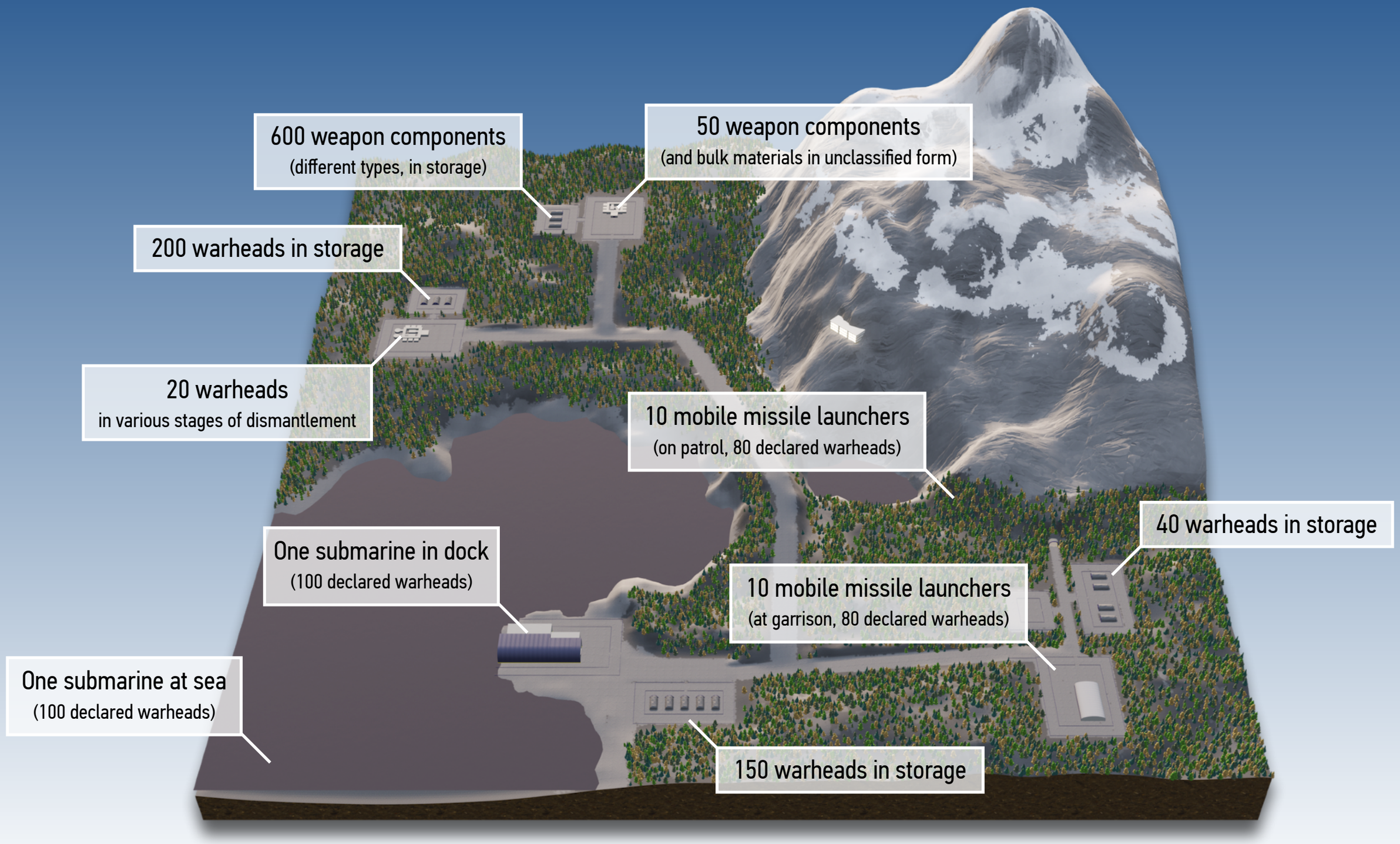
Storage bunker with uneven lighting

Radiation measurement using the neutron detector with a security guard standing nearby

WAY FORWARD

SIMULATING A WEAPONS COMPLEX

(OVER TIME & WITH SHORT-NOTICE INSPECTIONS



CONCLUSION & OUTLOOK

VR AS A NEW TOOL TO SUPORT NUCLEAR VERIFICATION

- Help develop new approaches relevant to nuclear arms control and verification
- Explore a larger space of possible verification approaches
- Offer levels of accessibility typically much more difficult to achieve
- Enables carefully controlled conditions (and offers perfect repeatability)

NEXT STEPS

Inspection exercise(s) with international partners planned for 2022

Please, reach out if interested in participating or contributing

For experiments, leverage recent advances in VR technologies

for example, by using VR headsets that offer eye-tracking and heart-rate monitoring

Source: Authors (top) and Michael Schöppner (bottom)

NuVR has been developed
with support from
NotionTheory