Strengthening
University-Industry
Partnerships

Energy Information Nexus: An (NSF) Industry University Cooperative Research Center Webinar (2020)

August 26, 2020 | The webinar will begin momentarily

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  Webinar ID: 764-094-915

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Strengthening University-Industry Partnerships

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Introducing the NIST Extended Reality (XR) Community of Interest (COI)

Shelly Bagchi

Bill Bernstein

Matt Hoehler

Scott Ledgerwood

Jeremy Marvel

NIST National Institute of Standards and Technology
U.S. Department of Commerce

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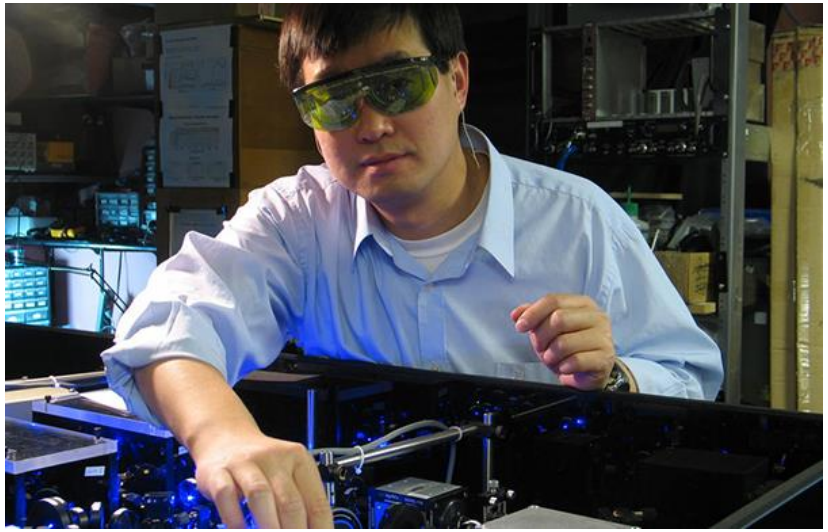
NIST's Mission

To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.



NIST AT A GLANCE

3,400+
FEDERAL EMPLOYEES

5
NOBEL PRIZES

2 CAMPUSES
GAITHERSBURG, MD [HQ]
BOULDER, CO

3,500+
ASSOCIATES

10
COLLABORATIVE INSTITUTES

400+
BUSINESSES USING NIST FACILITIES

ManufacturingUSA
NATIONAL OFFICE COORDINATING 14 MANUFACTURING INSTITUTES

51
MANUFACTURING EXTENSION PARTNERSHIP CENTERS

U.S. BALDRIGE PERFORMANCE EXCELLENCE PROGRAM

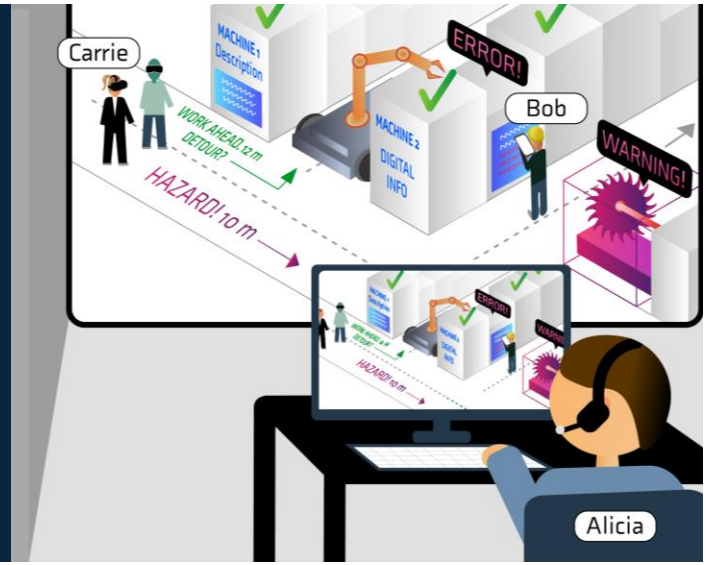
What's the NIST XR COI?

We are researchers across the NIST labs working in augmented (AR), mixed (MR), and virtual reality (VR). Our work ranges from visualizing crystalline structures to simulating public safety situations, performing usability testing, and creating standards.

https://www.nist.gov/topics/information-technology/extended-reality

Today's Presentation

Addressing the interoperability of industrial AR systems in ***smart manufacturing***



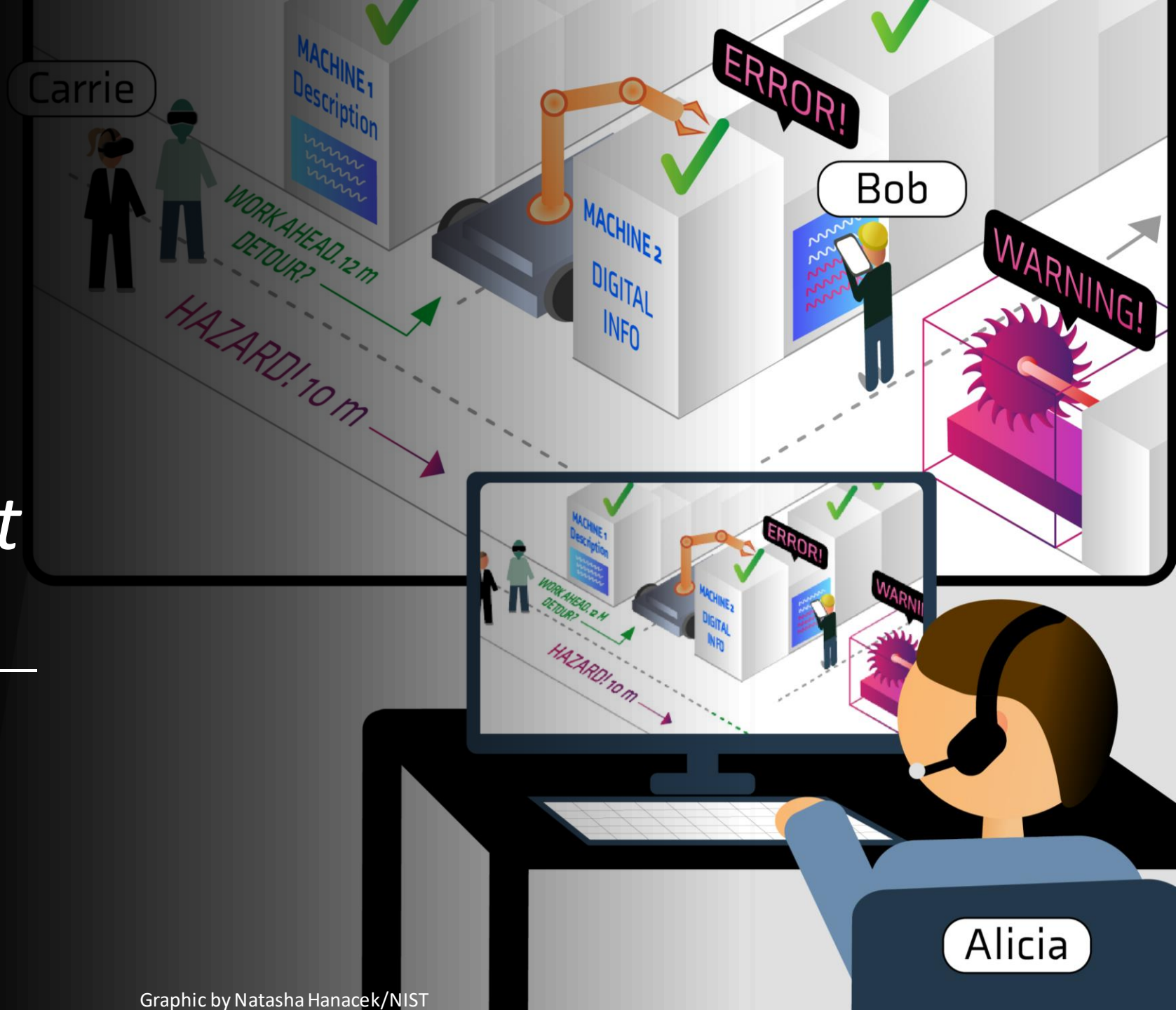
Enabling immersive visualization of ***severe fire environments***

Designing and evaluating XR tools for ***first responders***

Leveraging XR to develop and evaluate metrology for ***human-robot interaction***

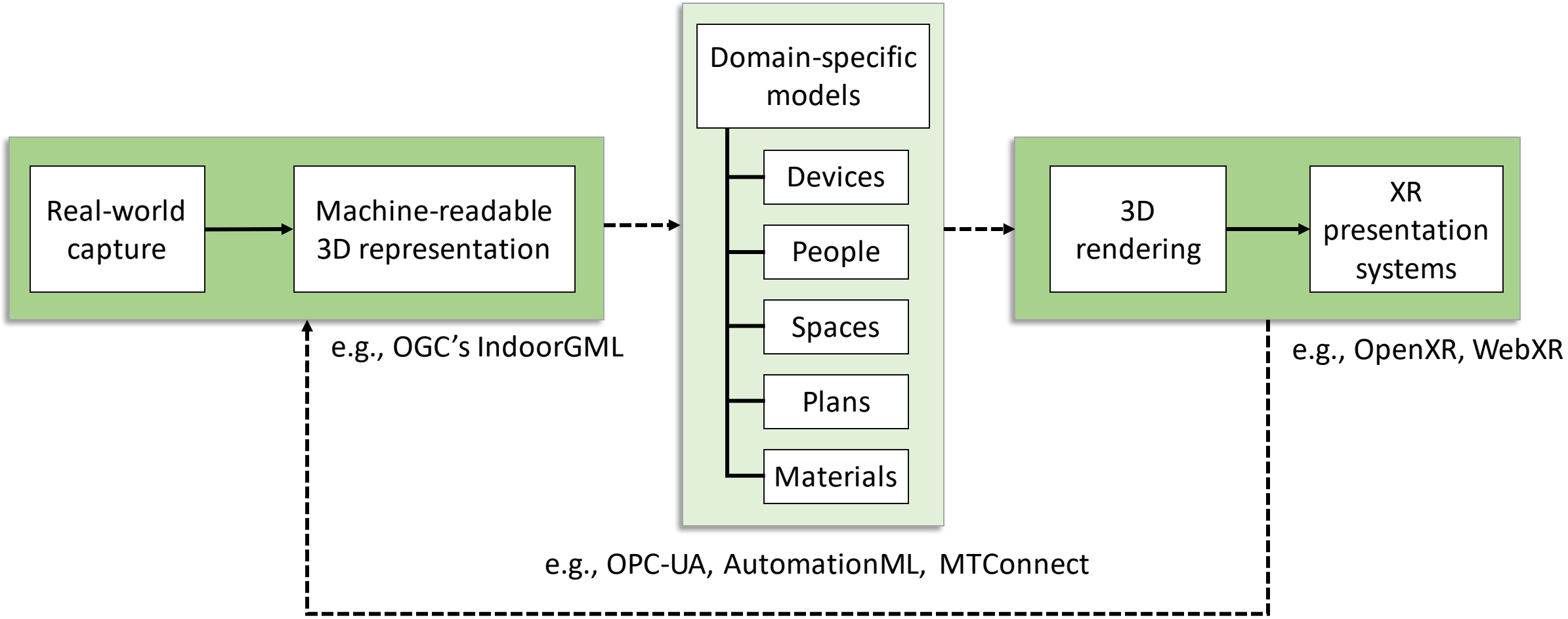
Addressing the interoperability of industrial AR systems in smart manufacturing

Bill Bernstein, PhD



Graphic by Natasha Hanacek/NIST

Using XR for Smart Manufacturing Systems



Research Goal

Test or append standard representations of geospatial definitions for production systems to facilitate quicker, more adaptable AR application development

A few standards of interest

W3C's WebXR Device API

Scalable XR with the browser

- Support rendering 3D scenes to hardware designed for presenting virtual worlds, or for adding graphical imagery to the real world
- Key capabilities:
  - Find compatible VR or AR output devices
  - Render a 3D scene to the device at an appropriate frame rate
  - (Optionally) mirror the output to a 2D display
  - Create vectors representing the movements of input controls

OGC's Geopose Standards WG

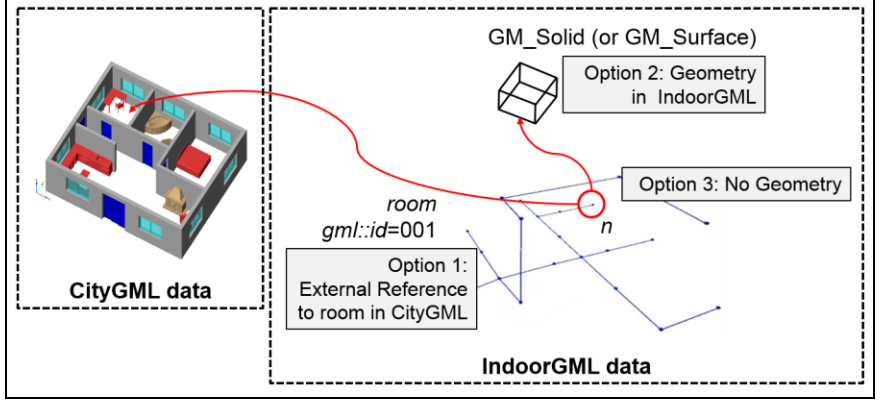
Description for AR device pose

- A shared frame of reference enables interoperability between different techniques to obtain geopose for AR devices
- Possibility to place content relative to the real world declaratively
- Possibility to display digital objects relative to a moving frame of reference simultaneously as displaying digital objects placed relative to the stationary world

OGC's IndoorGML

Formal Representation of the Indoors

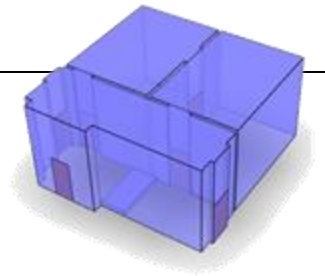
- Define a framework of indoor spatial information to locate stationary or mobile features in indoor space
- Provide spatial information services referring their positions in indoor space, instead of representing building architectural components



Testing IndoorGML with MTConnect

OGC IndoorGML

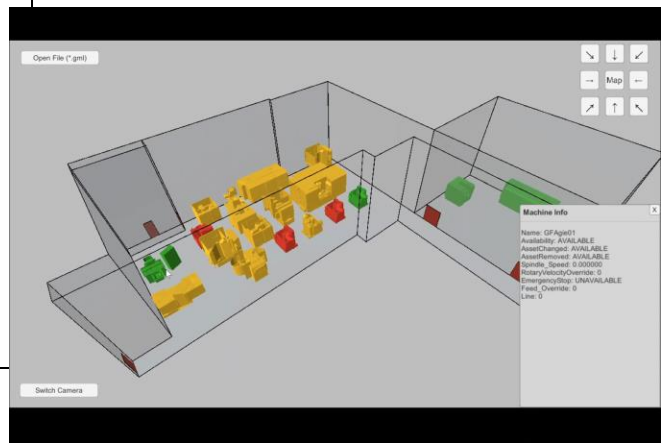
- Standard for describing **indoor spaces**
- Open **XML**-format
- Provides **semantic** and **geometric** representation of indoor spaces



MTConnect

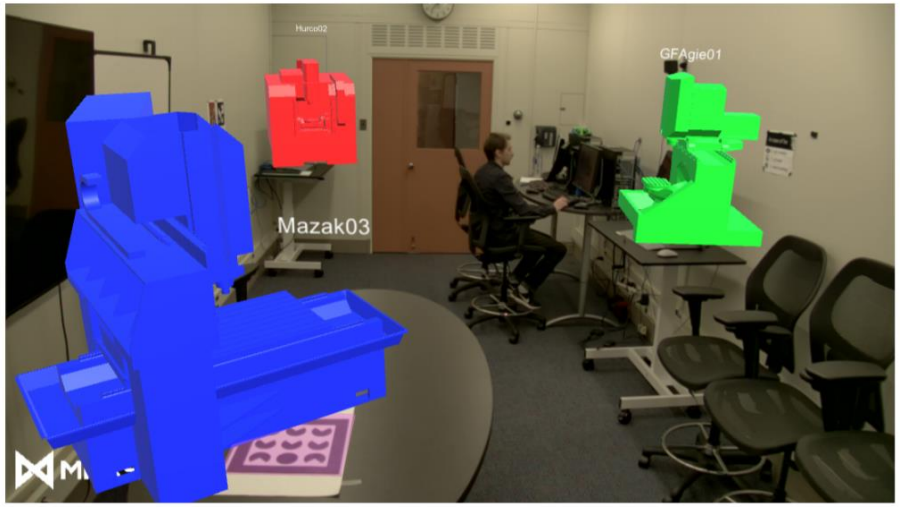
- Standard **semantic vocabulary** for manufacturing equipment
- **Structured**, **contextualized** data
- No proprietary format

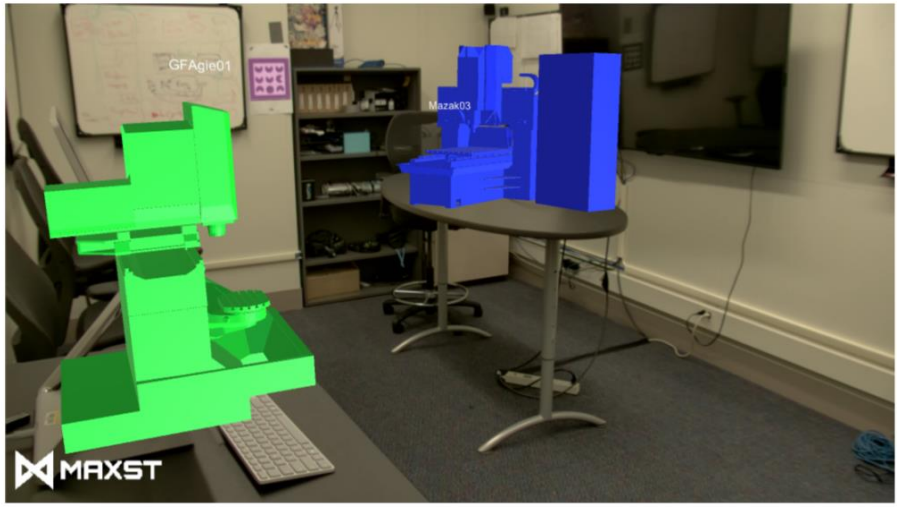
- Creating **IndoorGML-data** from **workshops**
- 3D-visualization for IndoorGML-data and combining it with data from MTConnect
- Creating a standardized way of creating **geospatial representations** of workshops with a relationship to **actual machine data**

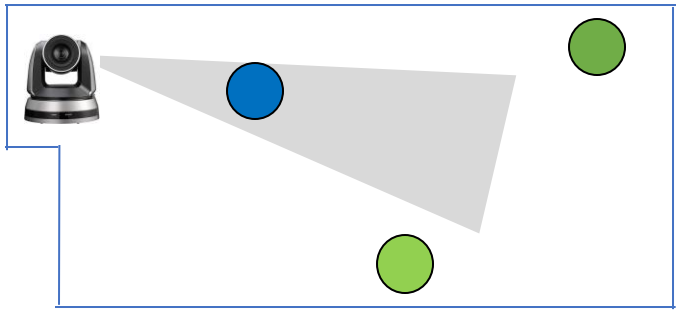


https://github.com/usnistgov/sms-test-bed-unity-demo

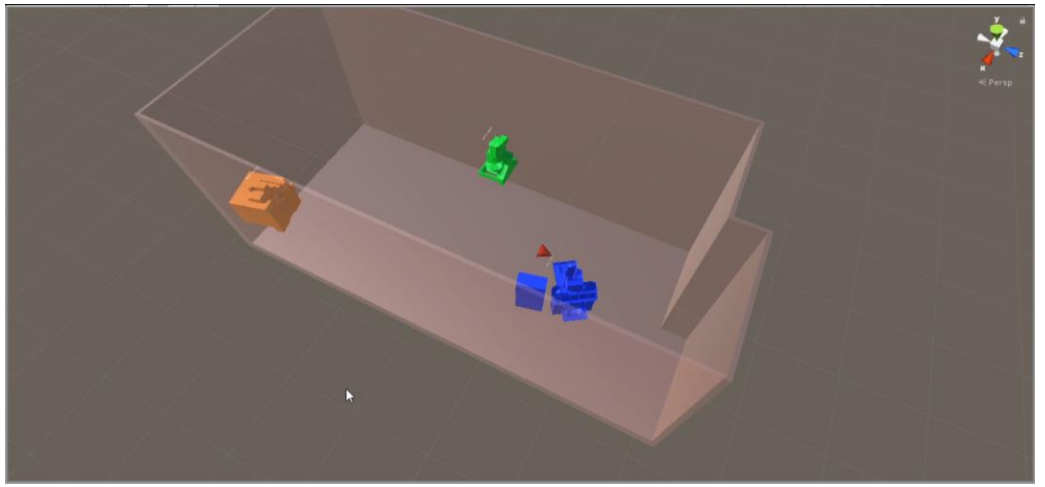
Experimenting with geospatial definitions





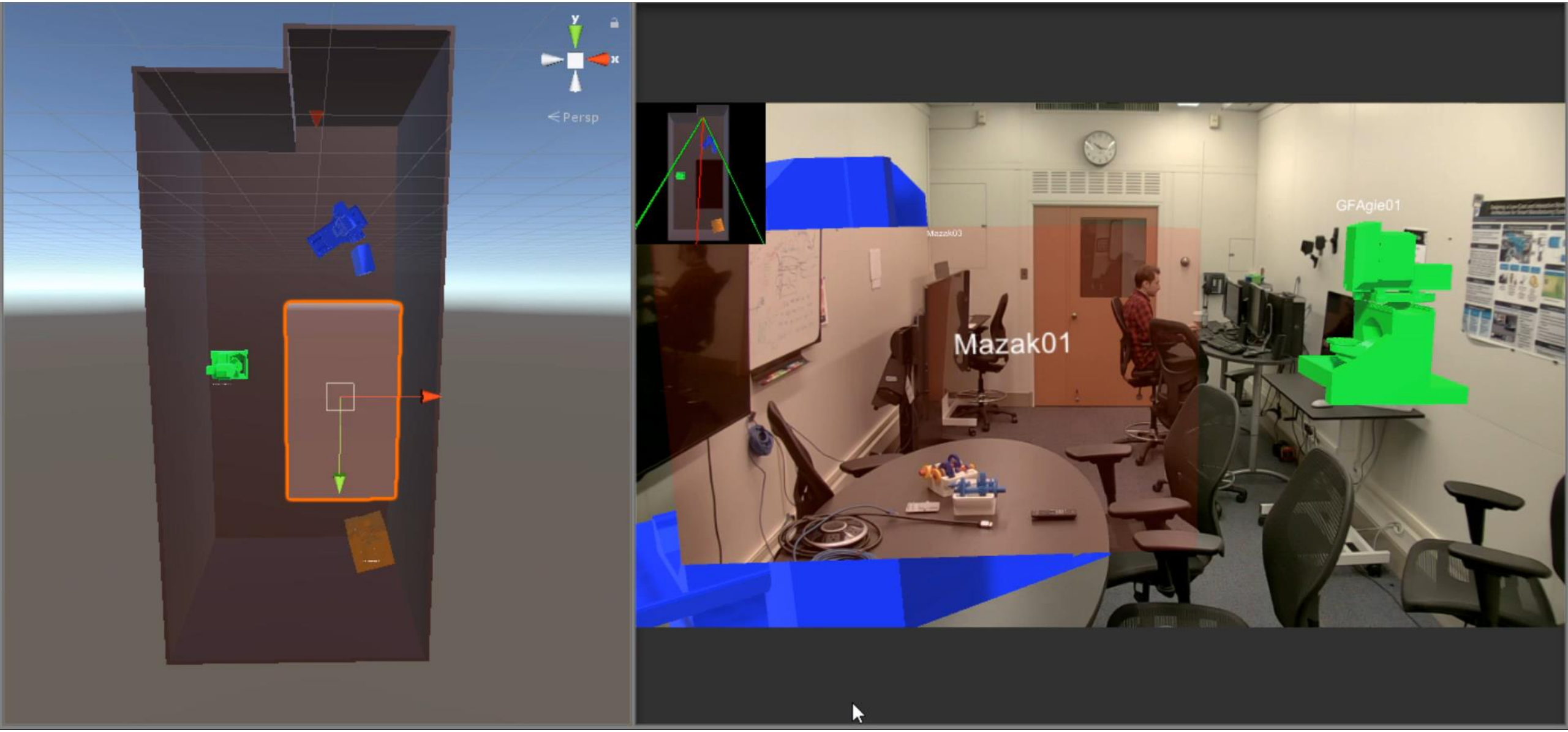


MiniMap



Digital Representation of DIVE Lab

Defining a “no-render zone” to avoid hazards



Multi-user capability: agnostic of framework/device

View from Wikitude Camera

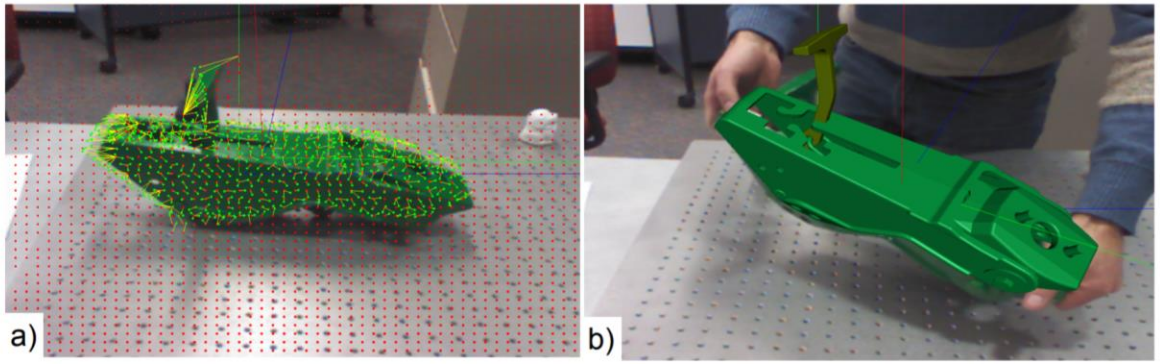
View from Vuforia Camera

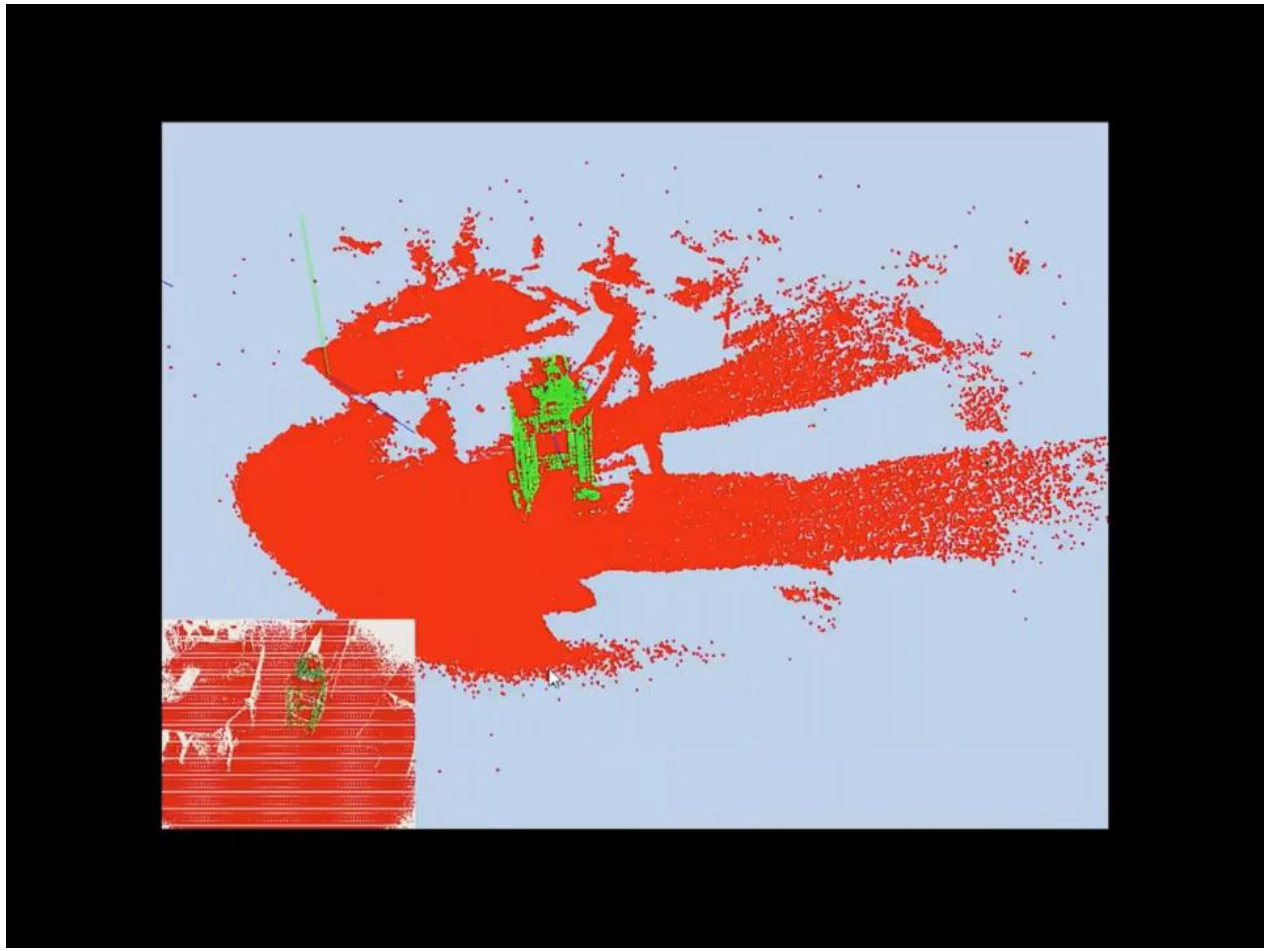
AR Framework	Wikitude SDK	Vuforia SDK
Tracking	Instant tracking (marker-less)	Marker tracking
Camera	PTZOptics PT12X-USB	Logitec Webcam

TrackingExpert+ : Open Object Tracking Toolkit

NIST

Tracking_
Expert+





https://github.com/usnistgov/TrackingExpertPlus

On-going and Future Work

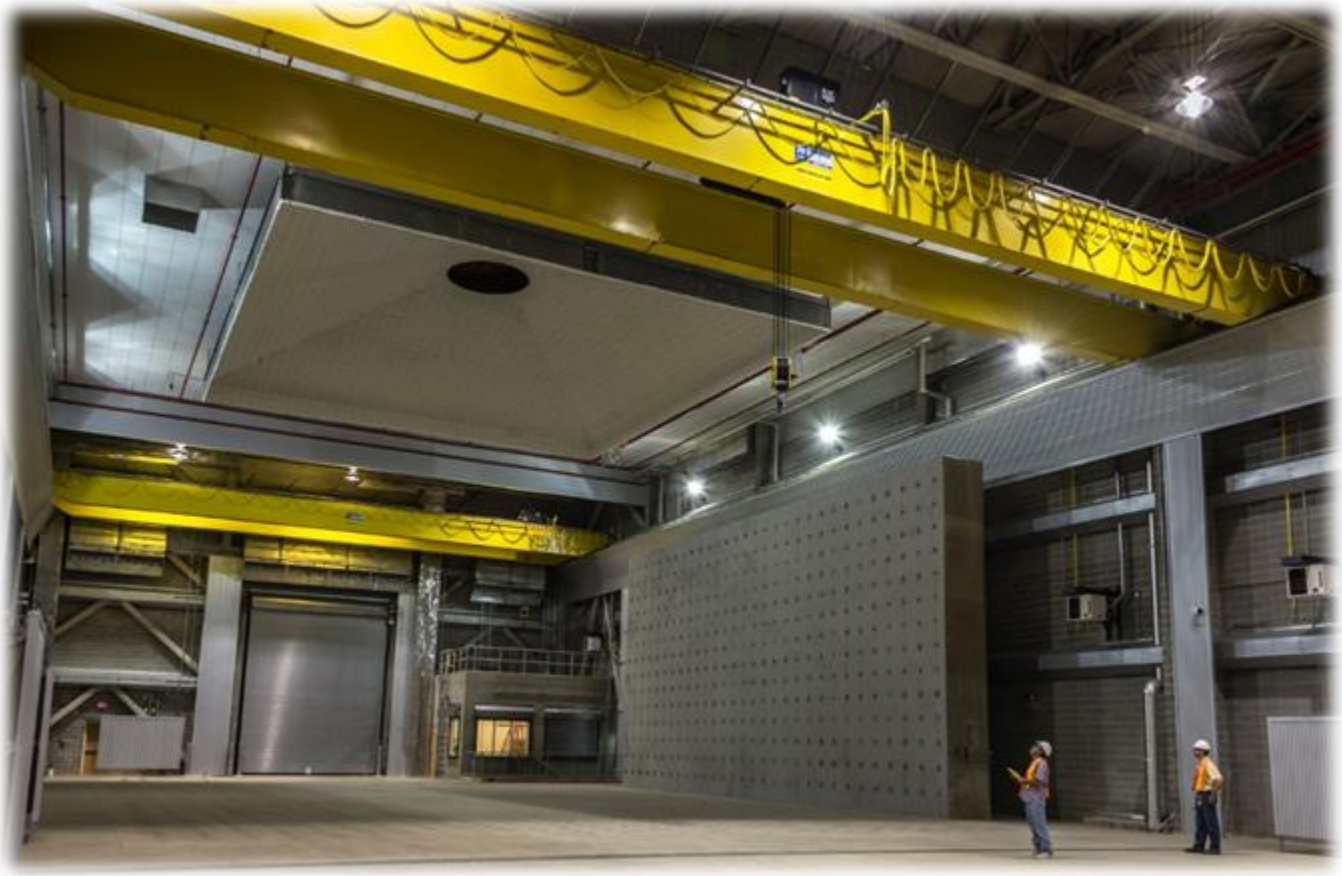
- **Geotagging manufacturing assets**
  - OGC SensorThings API integration into NIST SMS Test Bed
- **Spatially aligning as-executed to as-planned data**
  - Automated mapping of MTConnect data with NC code
- **Integrating the *digital thread* with XR platforms**
  - Using knowledge graphs to thread STEP, QIF, and MTConnect data into XR
- **Discovering research gaps / opportunities in industrial XR**
  - Working with the AREA Research Agenda committee via a data-driven approach
  - Multi-institutional report on opportunities in merging GIS and SMS
- **Uncovering standard opportunities for XR content management**

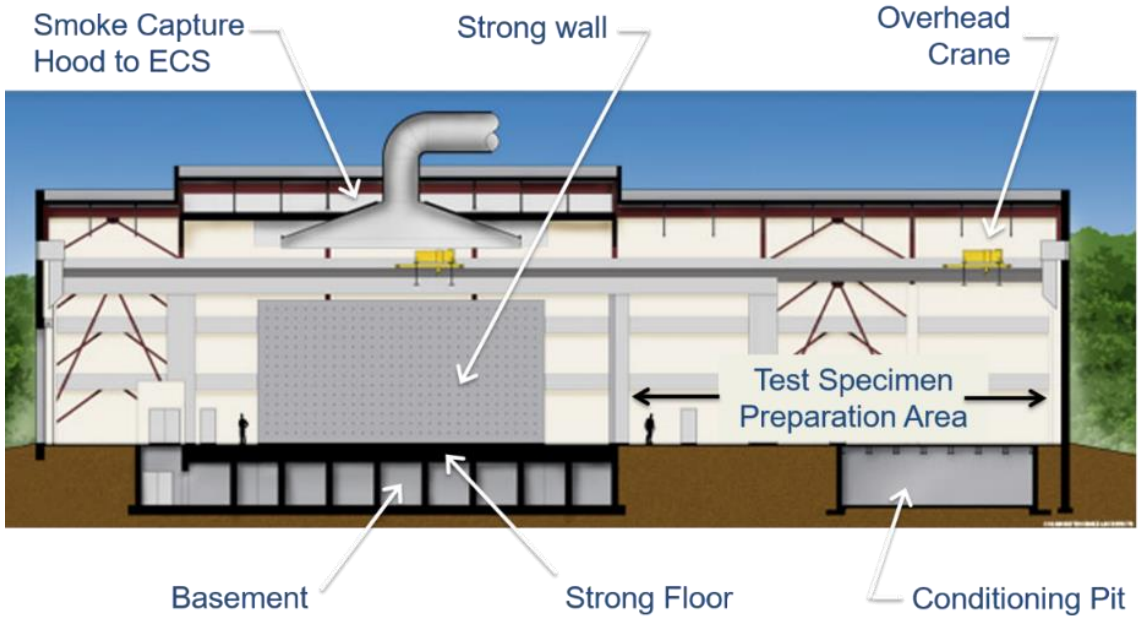
Enabling immersive visualization of severe fire environments

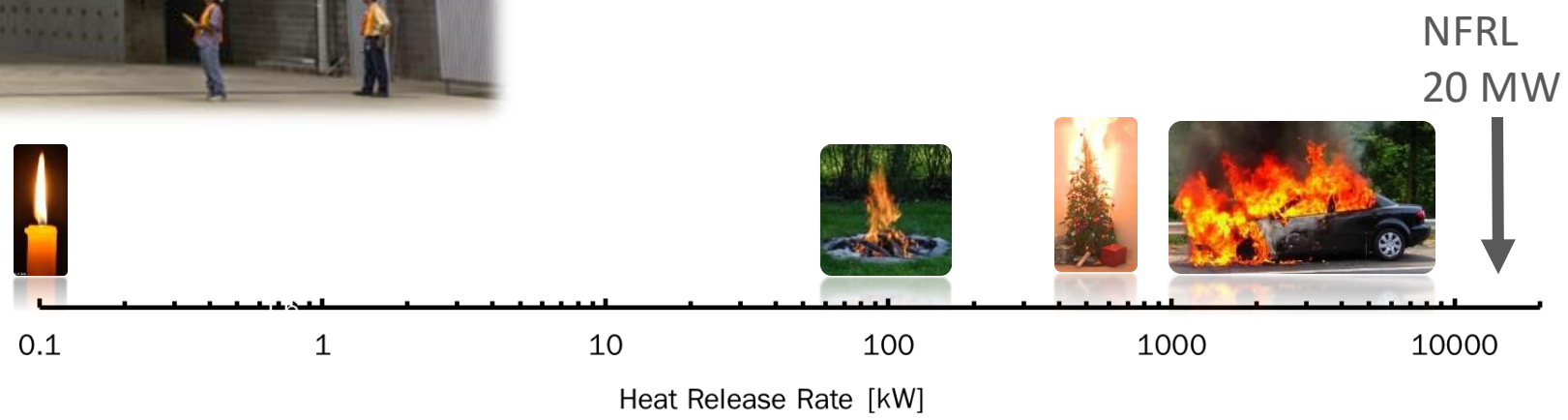
Matthew Hoehler, PhD, PE

Fire Research Division

The National Fire Research Laboratory







High-resolution omni-directional cameras are rapidly getting smaller, better and cheaper

120 mm^3
2.7K res
$4000

GoPro OMNI (launched 2016)[a]

75 mm tall
5.2K res
< $300

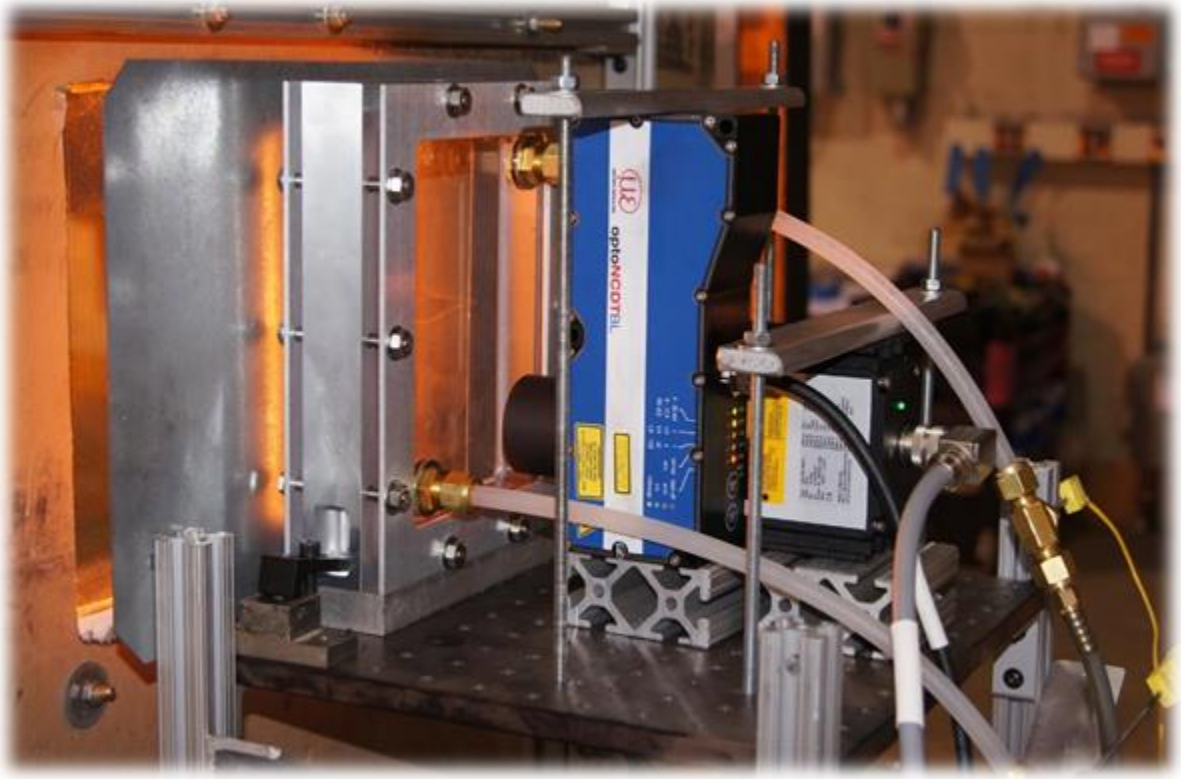
GoPro Fusion (launched 2017)

[a] Certain commercial products are identified in this presentation to specify the materials used and the procedures employed. In no case does such identification imply endorsement or recommendation by the National Institute of Standards and Technology, nor does it indicate that the products are necessarily the best available for the purpose.

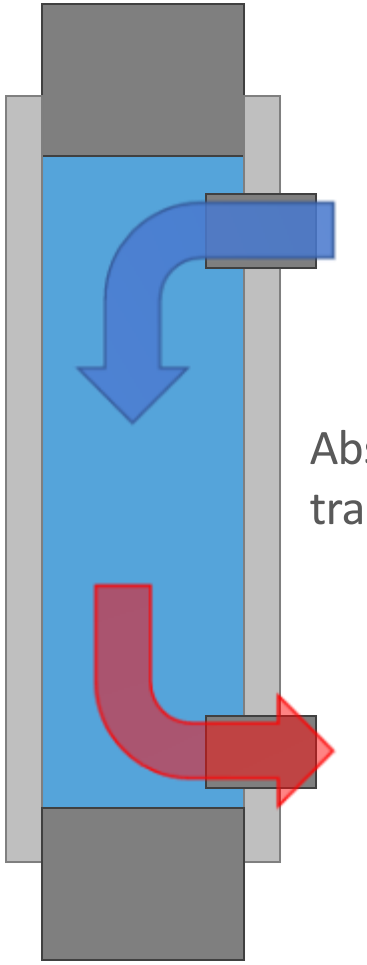
360-degree image of furnished compartment taken using GoPro OMNI at the National Fire Research Laboratory in 2017

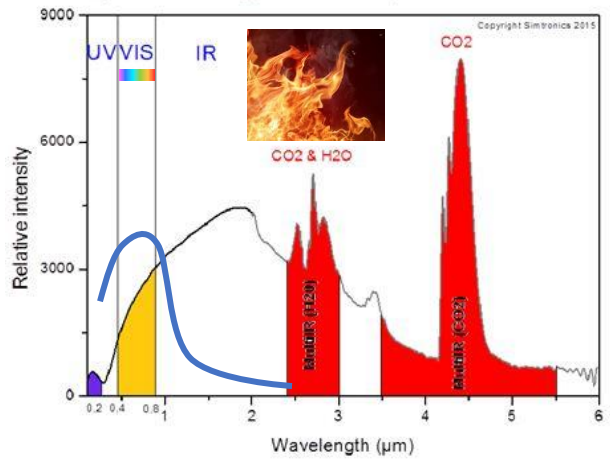
For video in fire, the challenge is twofold: **keep the camera cool** and filter the **intense thermal radiation**

Water absorbs thermal radiation but transmits visible light



Thermal radiation

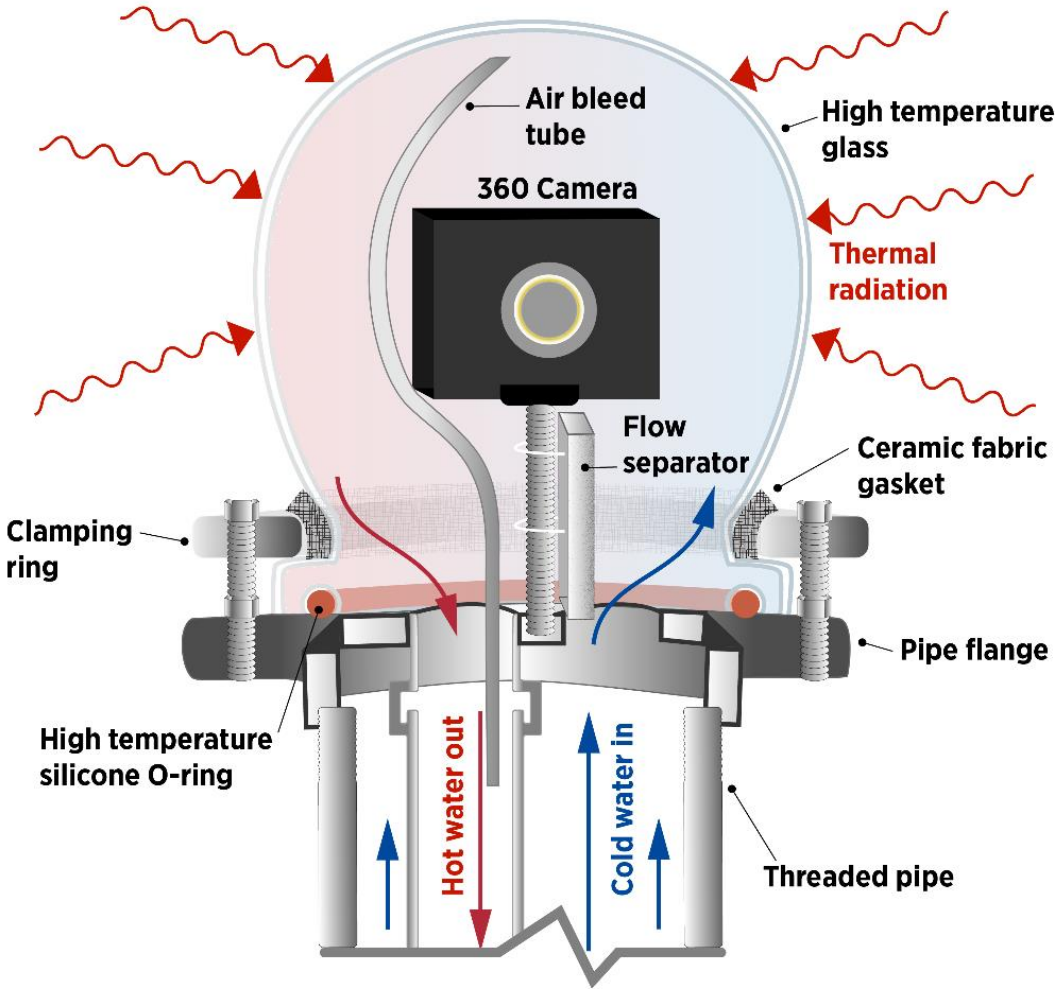




Absorption & transport

Hoehler, M. S.; Smith, C. M.: "Application of Blue Laser Triangulation Sensors for Displacement Measurement Through Fire." Measurement Science and Technology, 27(11) 2016, doi: 10.1088/0957-0233/27/11/115201.

Burn Observation Bubble (BOB) prototype version 1.0



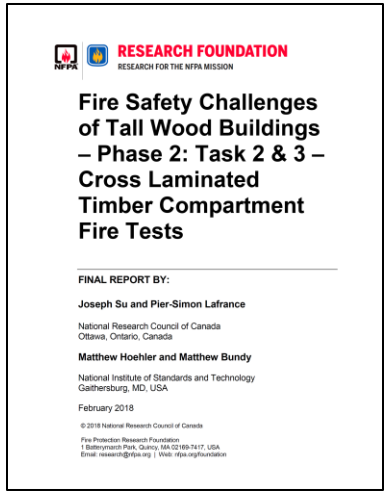
Credit: N. Hanacek/NIST

Hoehler, M. S. "On the Development and Characterization of a Transparent Enclosure for 360° View Video Cameras to Observe Fire Dynamics in Situ." Fire Safety Journal, 2020, https://doi.org/10.1016/j.firesaf.2020.103024.

Prescribed forest management fires in the New Jersey Pine Barrens

Prescribed forest management fires in the New Jersey Pine Barrens

Understanding data from a report is time consuming


RESEARCH FOUNDATION
RESEARCH FOR THE NFPA MISSION

Fire Safety Challenges of Tall Wood Buildings – Phase 2: Task 2 & 3 – Cross Laminated Timber Compartment Fire Tests

FINAL REPORT BY:

Joseph Su and Pier-Simon Lafrance

National Research Council of Canada
Ottawa, Ontario, Canada

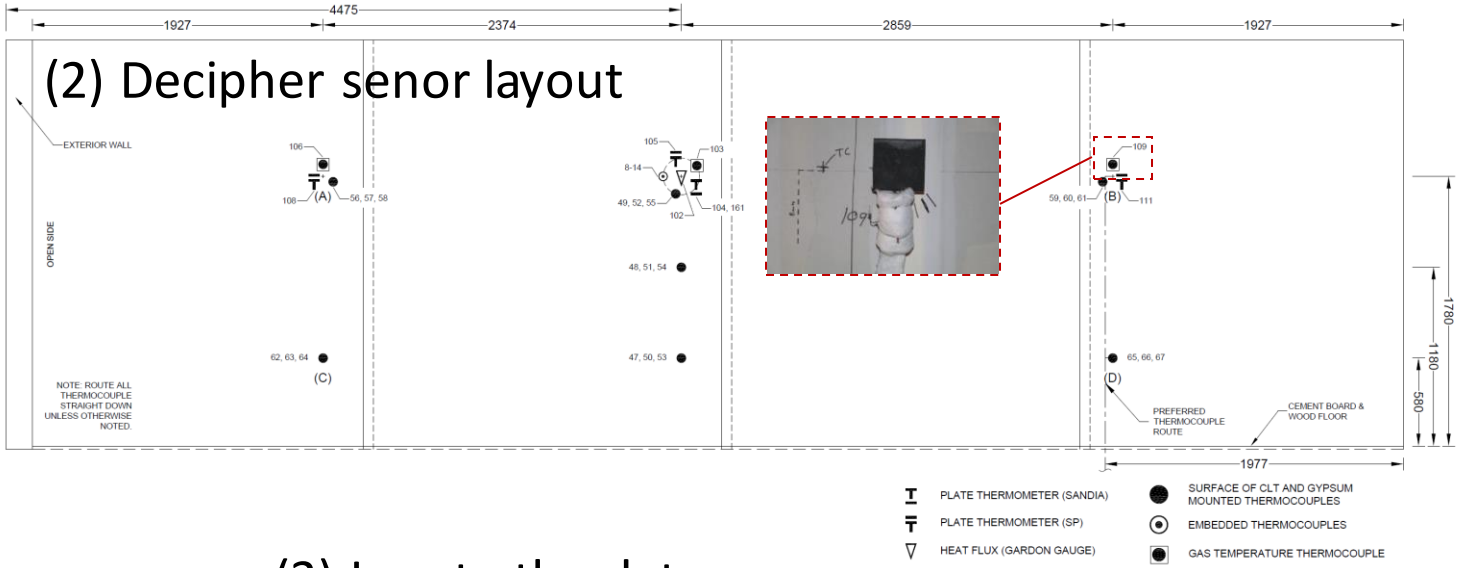
Matthew Hoehler and Matthew Bundy

National Institute of Standards and Technology
Gaithersburg, MD, USA

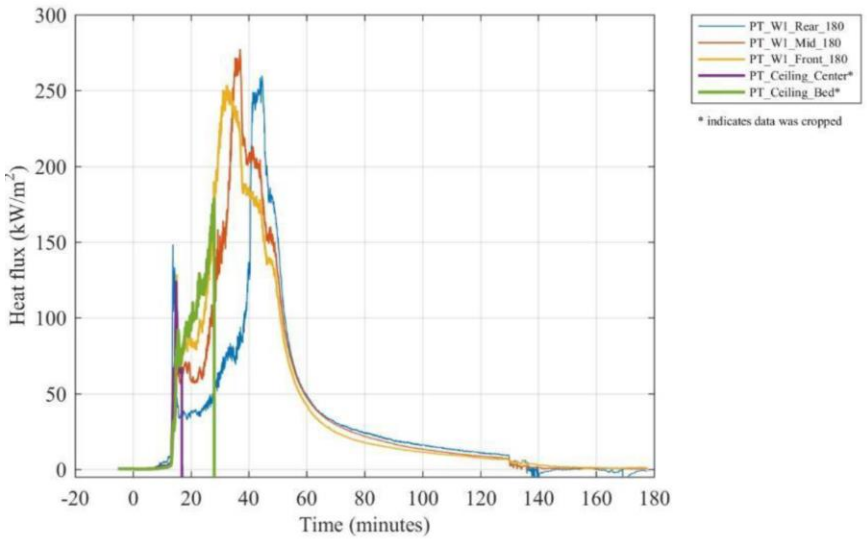
February 2018

Fire Protection Research Foundation
1 Batterymarch Park, Quincy, MA 02169-7417, USA
Email: research@nfpa.org | Web: nfpa.org/foundation

396 pg.
test report



(3) Locate the data

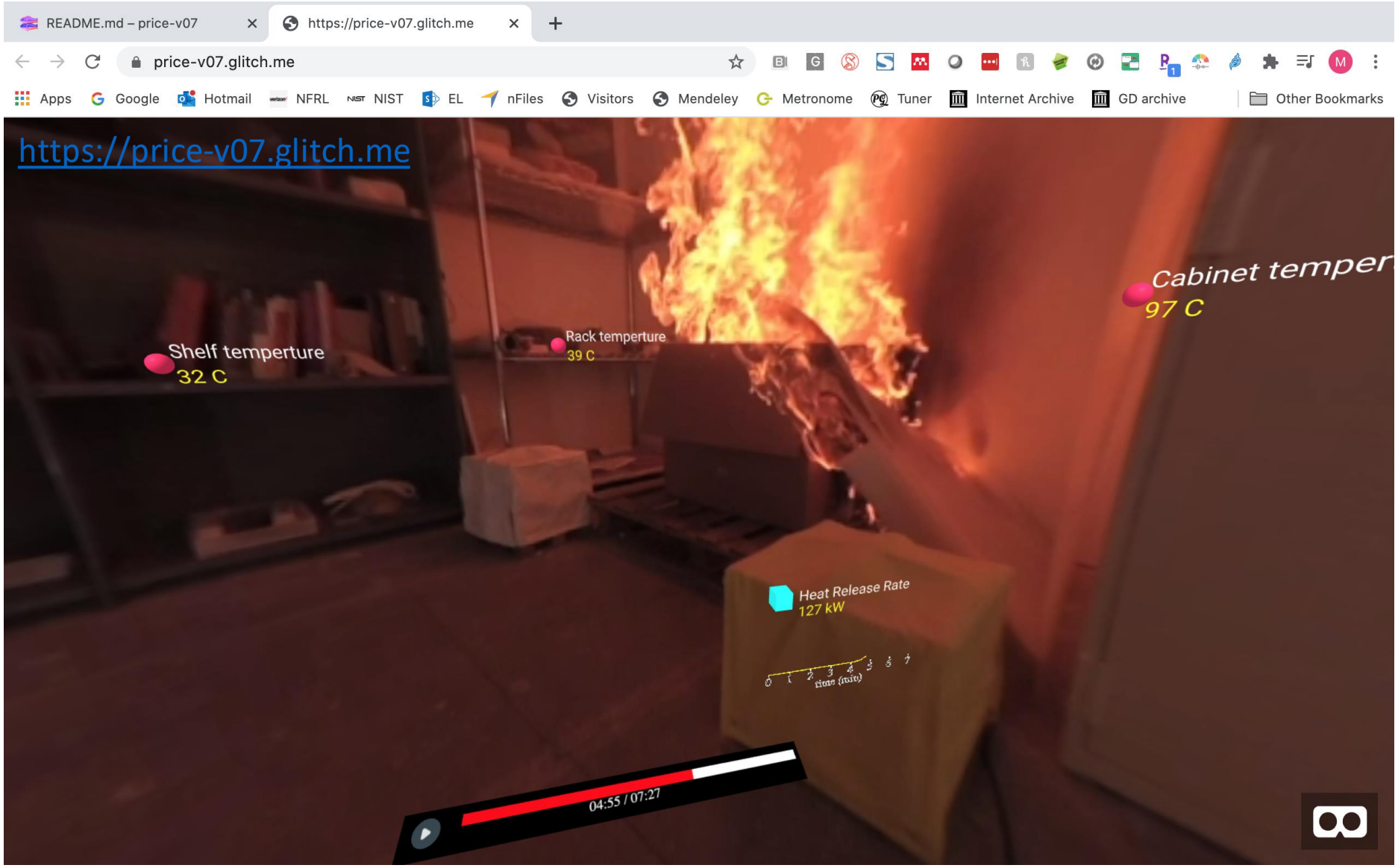


Example of web-based 360° video playback with interactive data overlays

Data augmented 360° video automatically provides the spatial and temporal context for data

Why WebXR?

- Browser-based or HMD viewing (no hardware required)
- Easy distribution
- Opensource code



The team

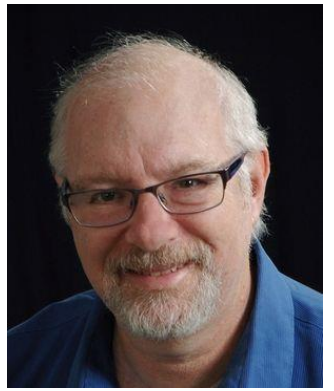
Matthew Bundy

Matthew Hoehler

Artur Chernovsky

XR guys…

Frank Willard (SHIP)



Sandy Ressler

Audio & Video support

Andrew Mundy

Jose Garcia

Adam Lenker (SURF)

Tom Roth & DJ Anand

Special thanks to Arron Kirchoff & Jeffrey Anderson (Master Glassblowers), Falko Kuester (UCSD/Calit2 Professor for Visualization and Virtual Reality), NIST Shops, William (Tre) Harrison, David Stewart, Norris Ng

Public Safety Communications Research Division

Scott Ledgerwood

PSCR Overview

Primary federal laboratory conducting research, development, testing, and evaluation for public safety communications technologies

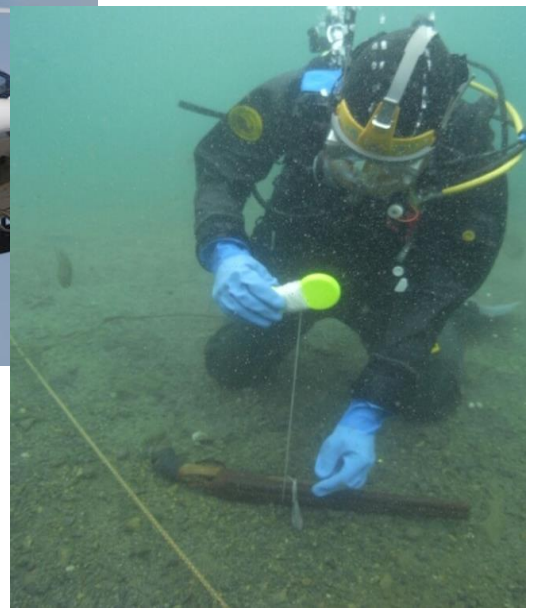
Technology Challenges for Public Safety: The Environment

Public safety personnel are tasked with performing in a variety of challenging environments.

In the heat

and the cold

In the air



and in the water

Technology Challenges for Public Safety: The Environment

Surrounded by noise

and in complete silence

In low-visibility environments…

Technology Challenges for Public Safety: The Environment and the Equipment

…and high above the ground

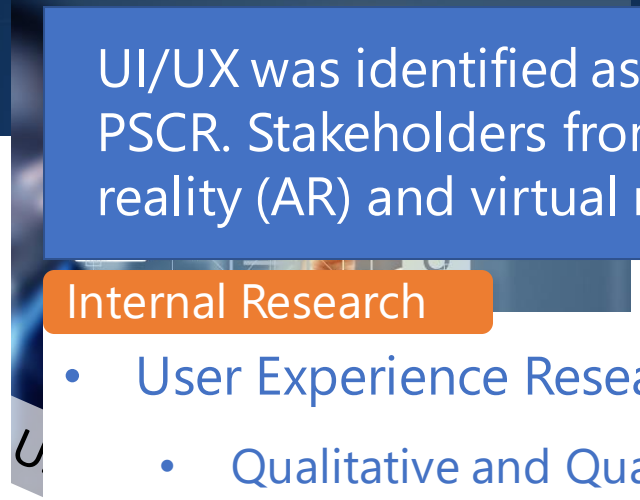
Equipment is often restrictive

and frequently makes communication difficult.

Technology Challenges for Public Safety: The Environment and the Equipment

Hands are frequently occupied.

Dexterity and ergonomics matter.



UI/UX was identified as a priority research area for PSCR. Stakeholders from across the US identified augmented reality (AR) and virtual reality (VR) as the R&D areas.

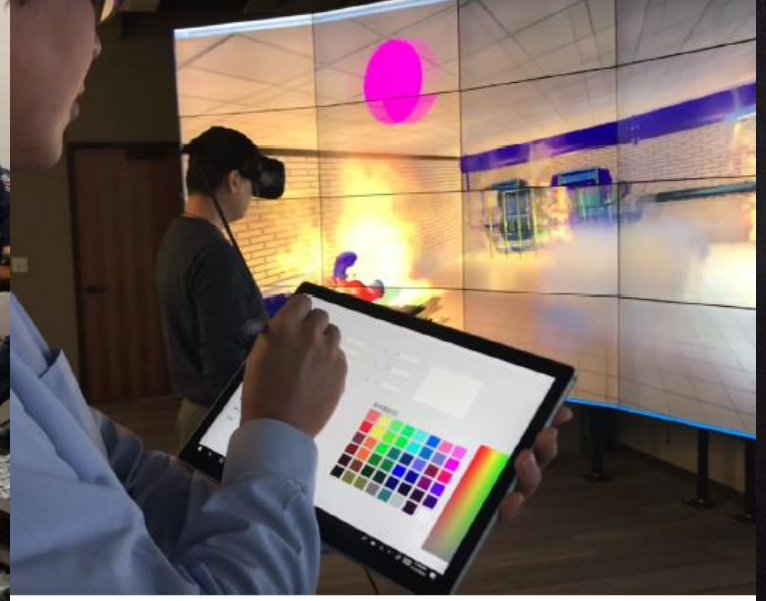
Internal Research

- User Experience Research and Testing Methodologies
  - Qualitative and Quantitative Surveys
  - Technology Needs and Wants for First Responders
- Virtual and Augmented Reality Public Safety Testbed
  - Multiple Environments, Scenarios, and Tasks
    - Highway Scene, Parking Structure, and Office Buildings
    - Mass Causality Incident, Active Shooter, and Fire
    - Patient monitoring, situational awareness, and navigation
  - Instrumented to measure performance of technology/user interface prototypes

UI/UX was identified as a priority research area for PSCR. Stakeholders from across the US identified augmented reality (AR) and virtual reality (VR) as the R&D areas.

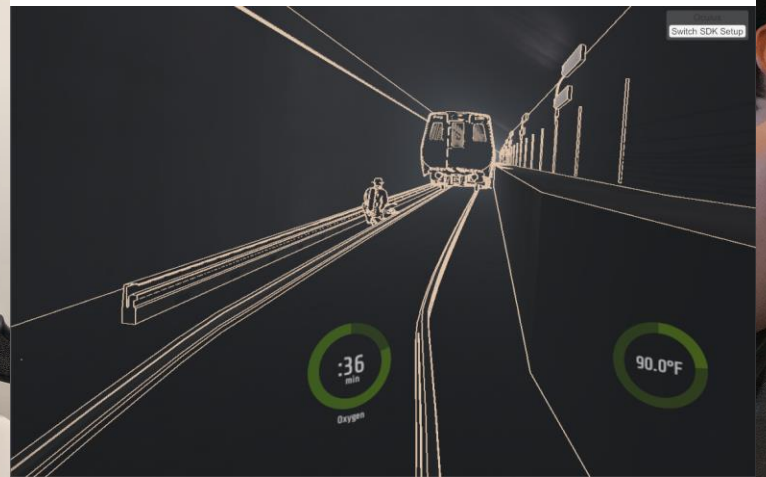
External Research

- Grants
  - PSIAP-2018–UI – 7 Awardees and Cooperative Agreements, $6.4 Million
- Prize Challenges
  - 2018 - VR NAV HUD Prize challenge – 6 Finalist, $125,000 Prize Purse
  - 2019 - UI/UX Haptic Interfaces Prize Challenge – $425,000 Prize Purse
  - 2020 – CHARIoT Challenge



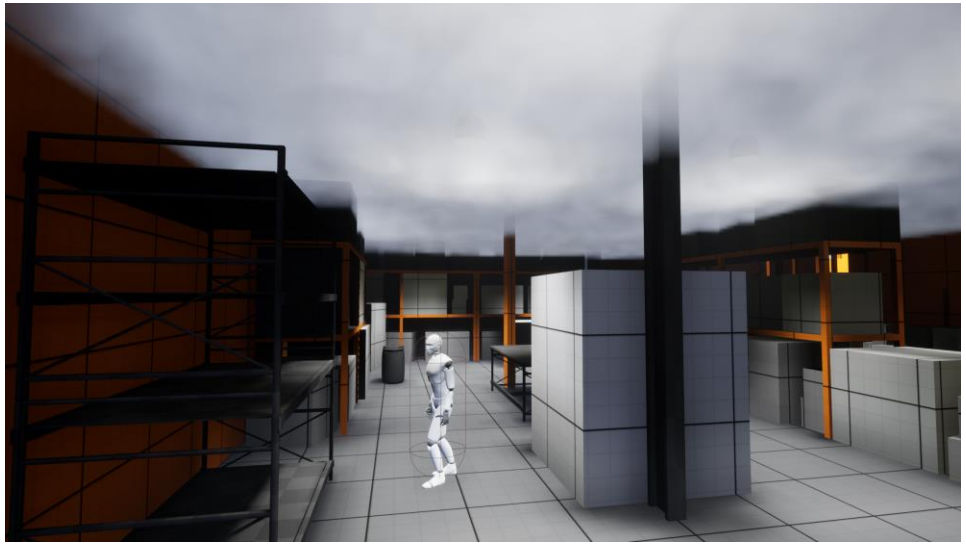
HOSE NOZZLE CONTROLLER PROTOTYPE

ENHANCED
USER INTERFACE
USER EXPERIENCE

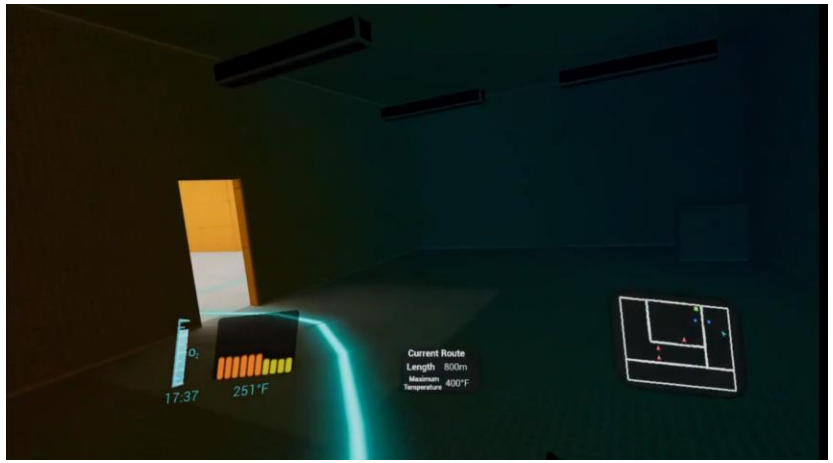


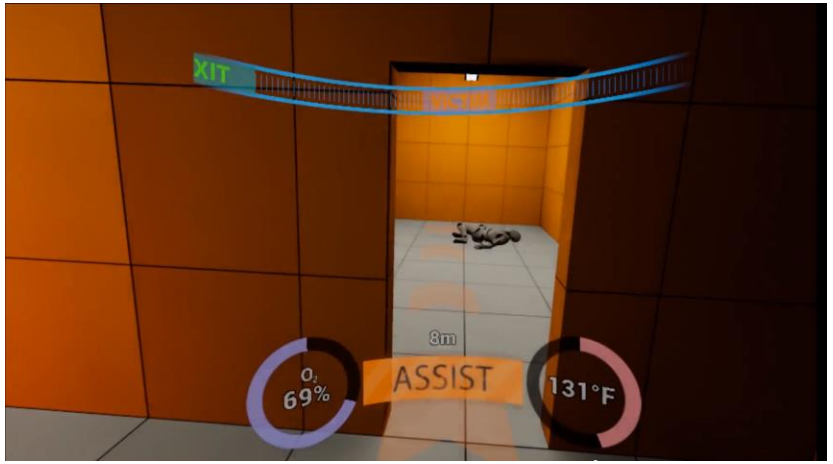

Call Origin
AED
Entry Poi

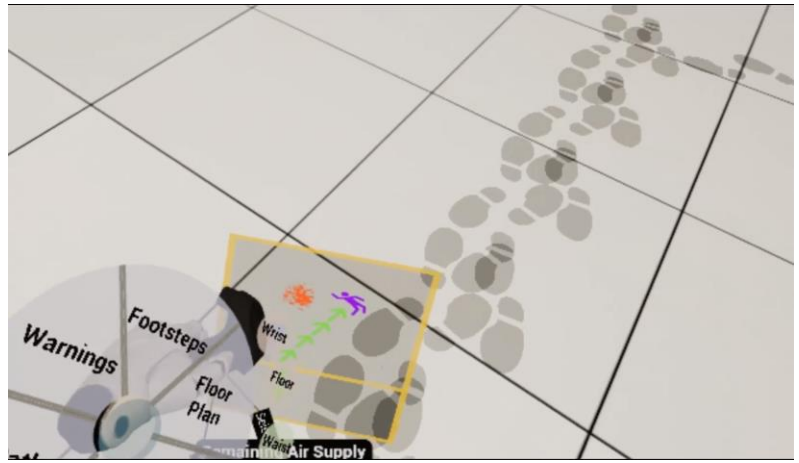
PSCR Virtual Reality Testbed



2018 - Heads-up Display Navigation

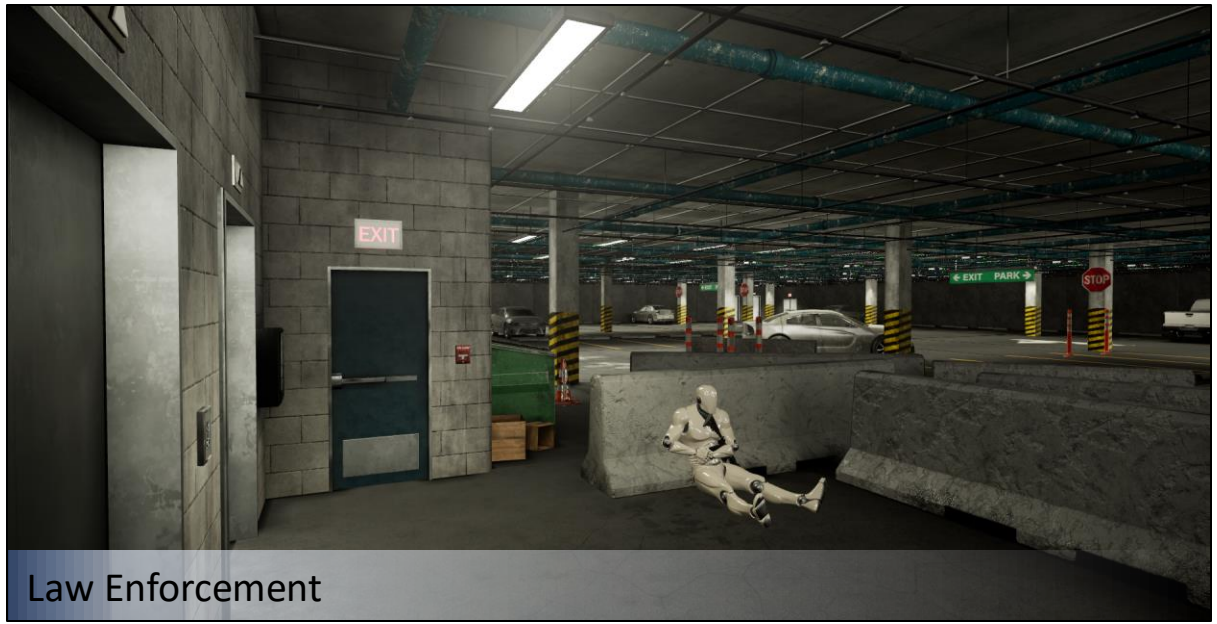






2019 – Haptic Interfaces for Public Safety

Emergency Medical Services



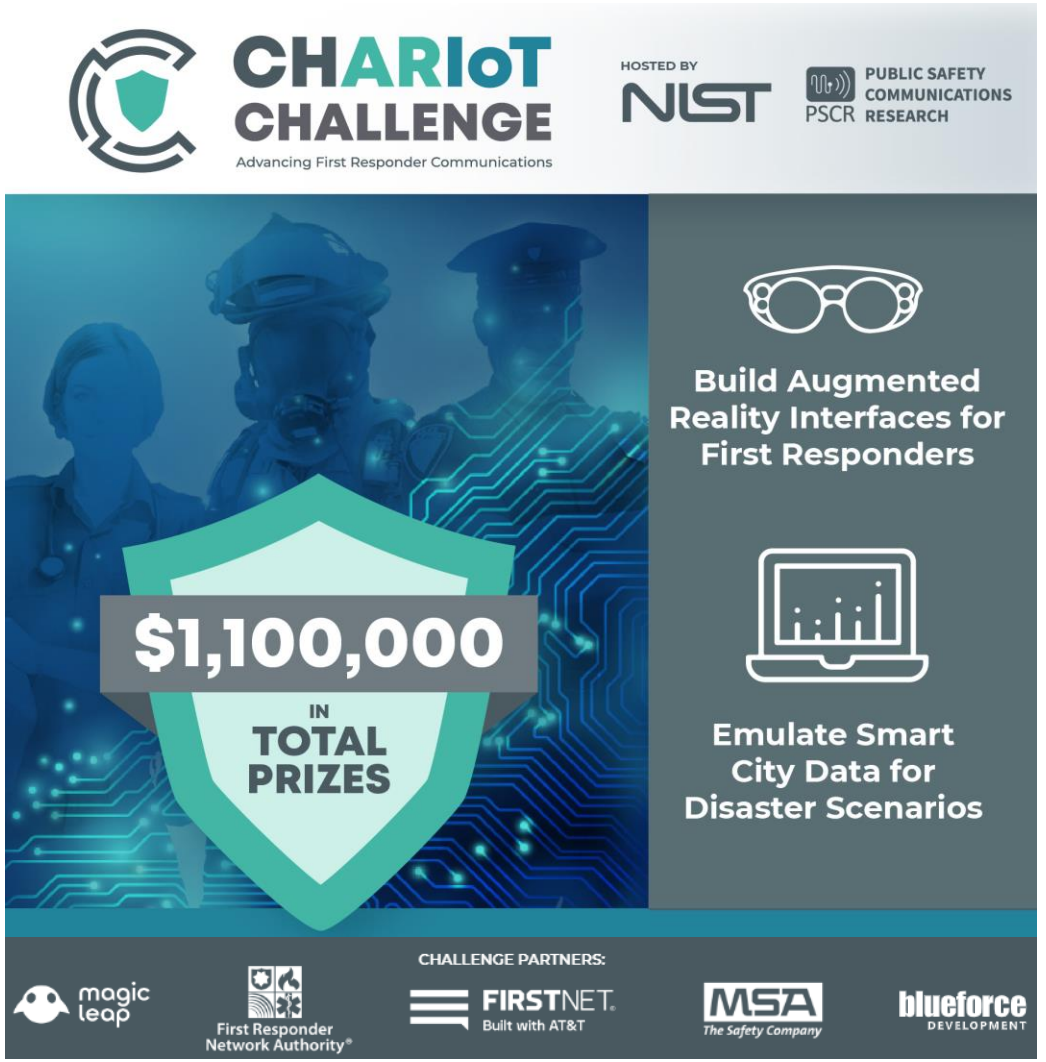
Law Enforcement

Fire

2019 – Haptic Interfaces for Public Safety

2019 – Haptic Interfaces for Public Safety

Our plan for what's next:



Visit PSCR.gov for move info!

Leveraging XR to Develop and Evaluate Metrology for Human-Robot Interaction

Jeremy A. Marvel, Ph.D.
Project Leader, Performance of Human-Robot Interaction
Co-PI, Tools for Collaborative Robots within SME Workcells

U.S. Department of Commerce
National Institute of Standards and Technology
Engineering Laboratory, Intelligent Systems Division

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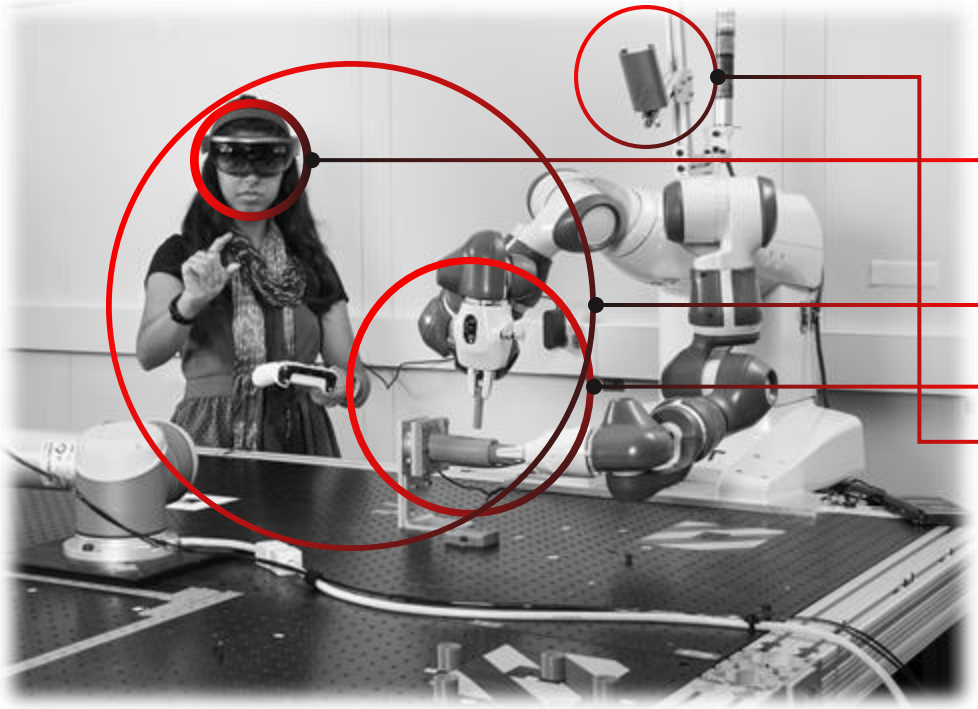
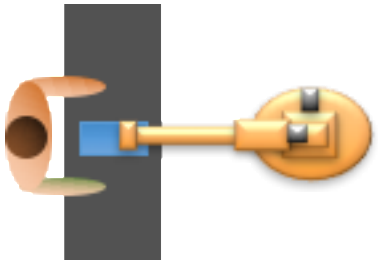


- Establishing trust
- World modeling
- Human-specific sensing
- Effective teaming and interaction



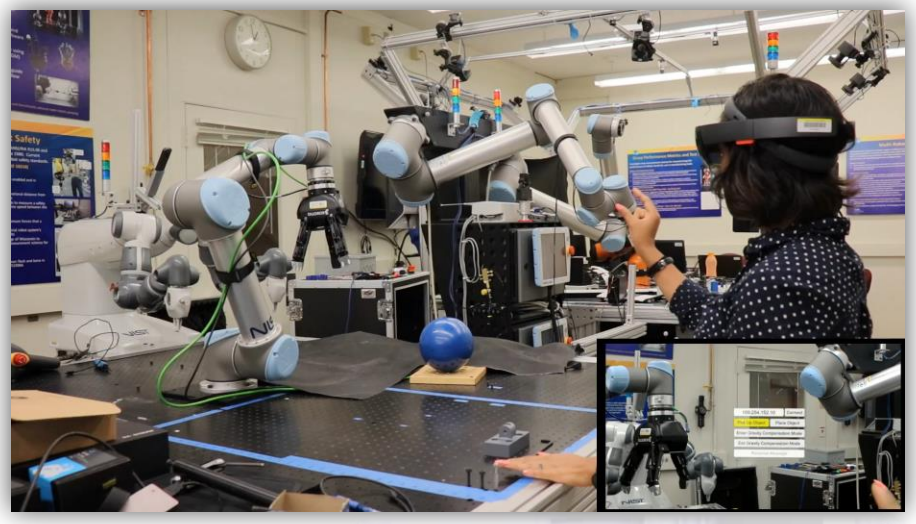
Objective: To deliver a suite of test methods, protocols, and information models to enable effective, human-robot collaboration in manufacturing, and advance interactive robot technologies to facilitate the safe and efficient teaming of people and robots that maximally leverages the strengths and capabilities of each toward meeting production goals.

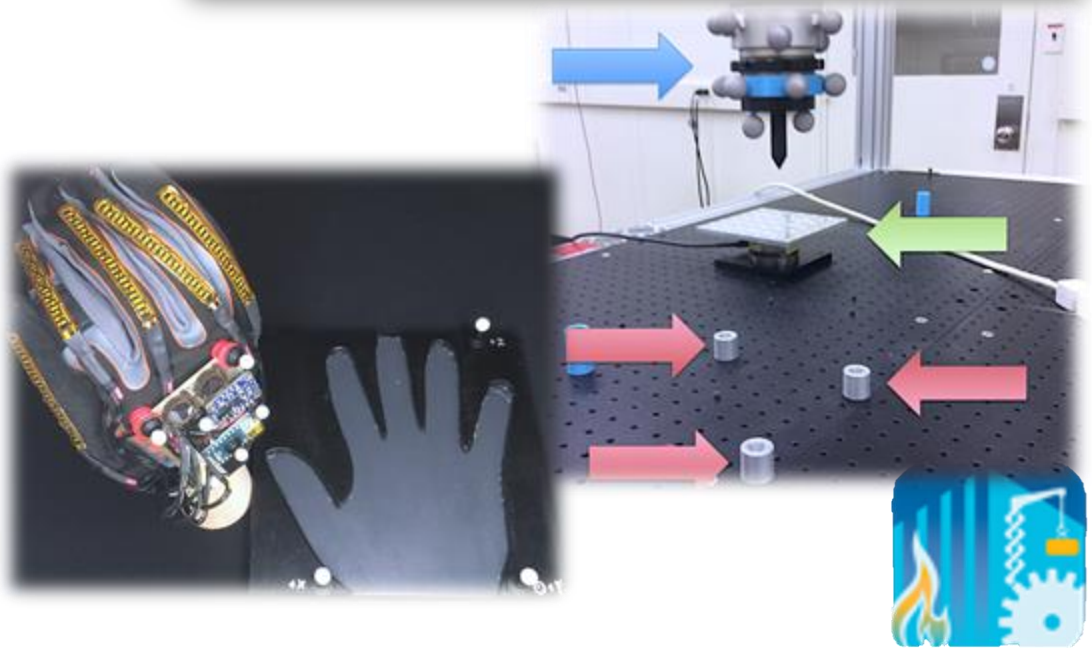
Technological Challenges in HRI

- Industrial robots are notoriously difficult to use
  - Extensive training required to use
  - Even ”collaborative” robots have steep learning curves
  - Interfaces are purpose-driven, and not user-friendly
- Situation awareness is nonexistent
  - Operators have little feedback about robot’s actions
  - Robots have no concept of humans in the area
  - Communications limited to sparse information, and is largely one-way
- Robots as collaborative tools
  - Humans can be unpredictable, and are bad at predicting robots
  - Sensing and feedback in real-time is a challenge
  - Lack of understanding of complex processes and the roles of collaborators in the task
  - Complacency and inattention can lead to loss and injury

Applications of XR

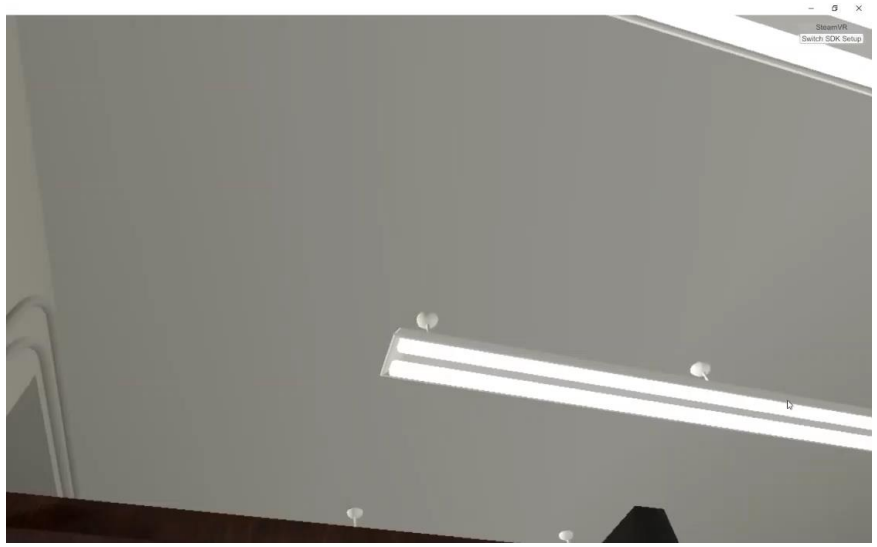
- Teleoperation
- Offline programming
- System/process diagnostics
- Maintenance and error handling
- Training
- Workcell verification and inspection
- Human-robot collaboration
- System commissioning
- Safety and workspace awareness



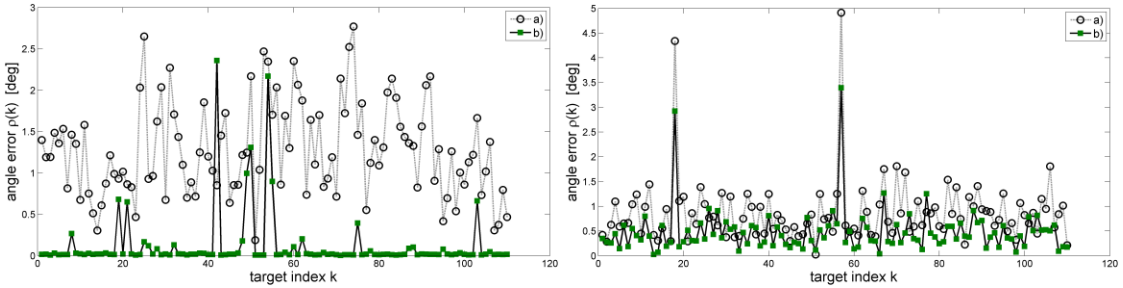


Metrics of XR in HRI

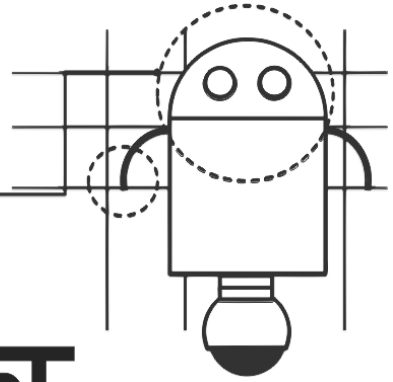
- Real/virtual registration
  - Temporal
  - Spatial
- Coordination & synchronization actions
- Ease of use
  - Mental & physical effort
  - Learnability
  - Functionality
- Effectiveness and efficiency
- Interface utility
- Personal preferences and perceptions
  - Realism
  - Intelligence
  - Usability



Simulation vs. reality



Performance of Human-Robot Interaction



NIST
National Institute of Standards and Technology
U.S. Department of Commerce

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Q&A

Please ask questions in the questions tab on the webinar screen.

Thank you

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Purdue University

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