

# The Future of Inspections

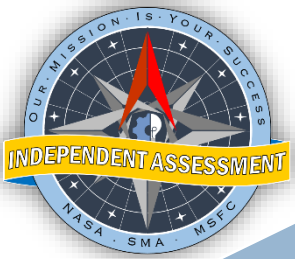
## Using Mixed Reality for Remote Verifications

NASA Quality Leadership Forum

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# Purpose & Scope

The Office of Safety & Mission Assurance (OSMA) tasked MSFC SMA with establishing general direction & guidelines for effective use of digital remote presence. The MSFC Independent Assessment (IA) Team was chosen to lead this effort for the purpose of identifying tools and processes available for virtual presence and providing considerations and guidance on appropriate uses. This guidance will allow for more options when evaluating risk-informed decision making. This will help determine where and when in-person vs. virtual presence is an option.



## Policies & Procedures

NAS413 Industry Standard  
NASA Handbook



## Remote Inspection Use Cases

### Basic Inspections:

Video Camera (GoPro)  
Digital Camera  
Microphone  
Headset  
Smart Phone

### Emerging Technologies:

Virtual/Augmented/Mixed Reality

- HoloLens2 (HL2)
- RealWear HMT-1



# Policies & Procedures Development

## NAS413 – Remote Verification Industry Standard

Create an interagency, "joint-use" standard for the execution and storage of remote oversight and inspection technologies and a common data ontology and data architecture.

Develop a standard based approach to data interoperability with common, non-competitive solutions.

Provides a baseline for leveraging Supplements or Addendums for NASA use.

Enact strategic documentation and develop robust processes to mitigate associated risks



FAA



DLA

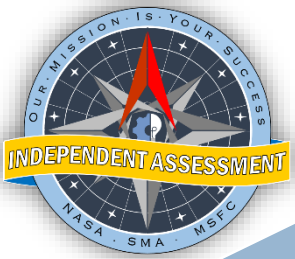


NASA



DCMA





# Mixed Reality for Remote Inspections

## Mixed Reality: A New Dimension of Work Harvard Business Review – 2018

“Every 10 or 15 years, there’s an impactful shift in the way people use and interact with technology and data. After the PC, the internet, and the mobile revolution, mixed reality is going to be the fourth shift, and it will be as big as each one of those earlier shifts.”  
- Allan Cook, managing director for Deloitte Consulting

## WHAT IS MIXED REALITY?



Source: *Mixed Reality and Safety and Mission Assurance*, T. Grubb, GSFC, Sept. 2020

## MIXED REALITY GLOSSARY

### AUGMENTED REALITY

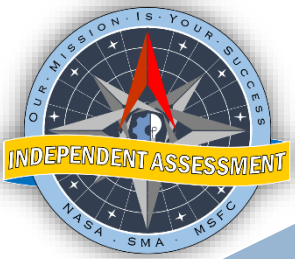
The layering of digital content onto physical reality, enabling users to see both at the same time through a smart display such as glasses, a headset, or a mobile device.

### VIRTUAL REALITY

A fully immersive, occluded experience in which users interact with digital objects and environments instead of with the physical world.

### MIXED REALITY

A spectrum that represents the blending of the physical and digital worlds, spanning from augmented reality at one end to virtual reality at the other. Like augmented reality, it can be experienced on a variety of devices, including head-mounted displays, PCs, and mobile devices.



# Detailed Inspections – Remote Inspection Applications

## Dynamics 365 Remote Assist

### Solve problems in real-time

Collaborate remotely by sharing your real-time view with collaborators to get the help you need. Solve issues faster, reduce costs, and increase efficiencies with a heads up, hands-free experience.

### Bring critical information into view

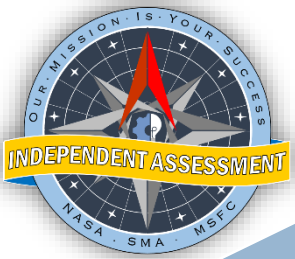
Resolve issues quickly with remote access to documentation and work order information in your real-world environment, hands-free or with mobile application.

### Walk the site without being on location

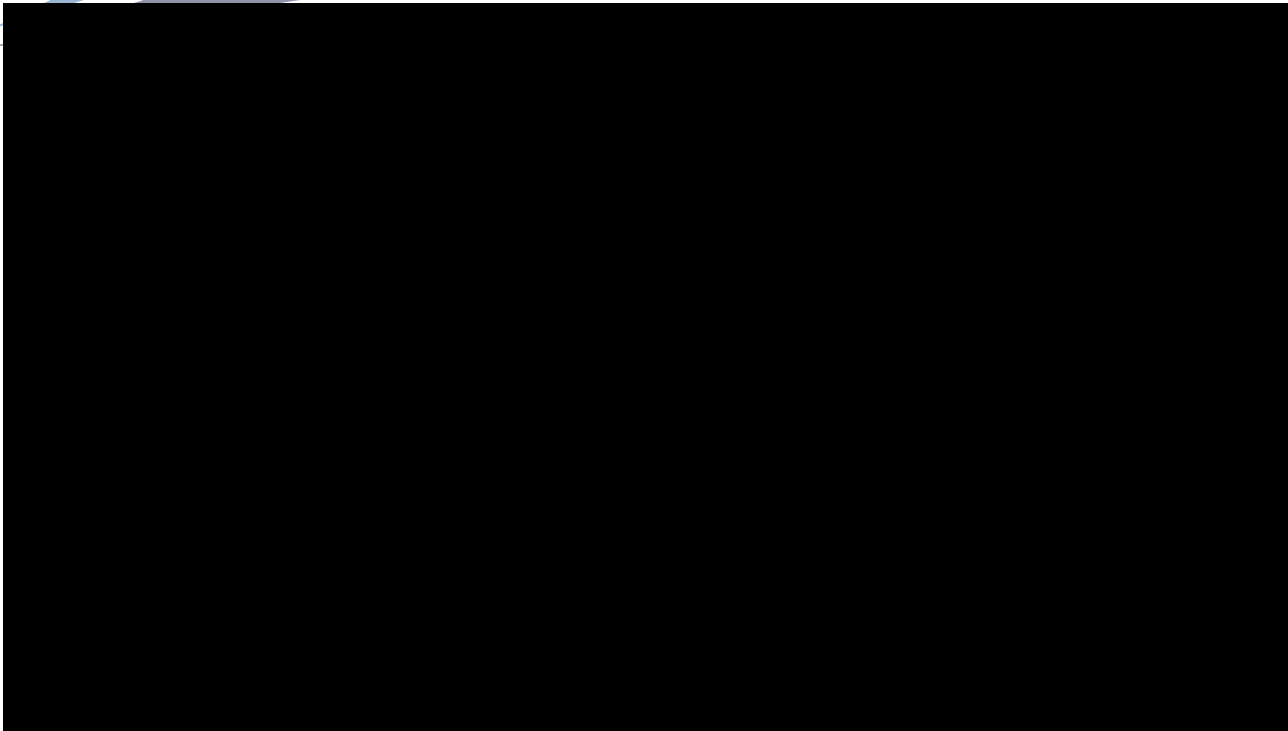
Reduce costs of routine inspections by combining video, screenshots, and holographic annotations. Use data captured with Remote Assist to streamline workflows and processes and empower employees.



Source: Microsoft's HoloLens & Mixed Reality Services – NASA Overview – August 2020



# HoloLens 2 on Orion



❖ [HoloLens Video Link - Lockheed Martin – Orion](#)  
(\*Lockheed has been using HoloLens for over 2 years on shop floor)

## Dynamics 365 Guides

[link to video overview](#)

### Reduce errors and help increase safety

Provide employees with step by step guided instruction to reduce errors and showcase warnings and safety hazards in place so they know what to avoid while they work.

### Standardize skills and reinforce compliance

Capture best practices in standardized instructions that move with employees as they work, so no step is missed. Equip managers to create guides, with no coding or mixed reality experience required.

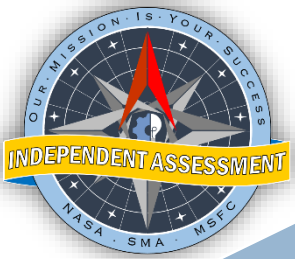
### Increase retention and close knowledge gaps

Quickly deploy skill-building initiatives that target a specific gap within a team and create consistency across locations enabling employees to have confidence with new tasks and processes.

### Improve training and processes

Onboard employees and aggregate their task performance data into real-time Microsoft Power BI dashboards, making it easier to identify where process improvements are needed.

Source: Microsoft's HoloLens & Mixed Reality Services – NASA Overview – August 2020



# Rationale for Evaluating Multiple Devices

**Price: ~\$3700 + Licenses**  
 HL2 Intrinsically safe option yet to be released.  
 Price: ~\$4950

## Microsoft HoloLens 2

Digital Focus 1<sup>st</sup>, Real World Focus 2<sup>nd</sup>

Focused on Digital Training & Immersion

Guides the wearer through physical space in their real environment: If the worker needs to retrieve an object from across the room, the HoloLens will point them to the right spot

3D Eyewear – More Immersive Experience

Memory: 4 GB DRAM  
 Storage: 64 GB USF

Camera: 8MP and 1080p30 video

## RealWear HMT-1

Real World Focus 1<sup>st</sup>, Digital Focus 2<sup>nd</sup>

Focused on Manufacturing Applications use it in wet, dusty, hot, dangerous & loud industrial environments.

Specifically designed for integration with PPE

2D Eyewear -Display adjacent to the wearer's field of view: doesn't block the environment. LCD viewable in direct sunlight.

Memory: 16gb internal / 2 GB RAM  
 Storage: 16gb + 128gb microSD

Camera: 16MP and 1080p60 video with digital zoom & stabilization

Longer battery life (8-10 hrs) and more lightweight than HL2

**Price: \$2500 + Licenses**  
 RealWear HMT-1Z1 is intrinsically safe for use in explosive environments.  
 Price: \$6020

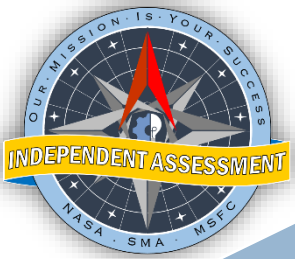
Hands-free  
 Delivers work instructions  
 Remote Mentor  
 Video Calling  
 Document Navigation  
 Guided Workflow  
 Data Collection & Reporting

**Drawbacks of HL2:**

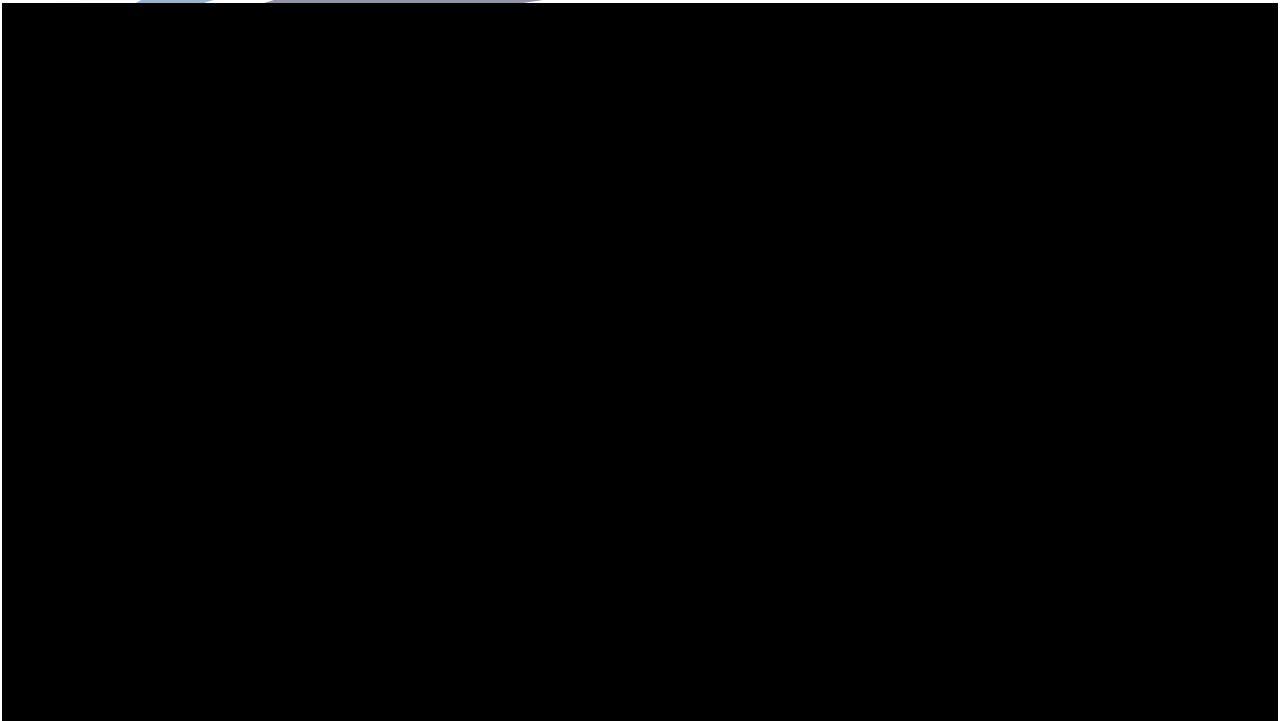
- Not optimal for use in dark environments or cramped spaces
- Users have expressed issues with lighting and sunlight
- Migraines
- Not drop proof
- Short battery life (2-3 hrs)
- Camera is lower quality & has no zoom function

**Drawbacks of RealWear:**

- Not as immersive as HL2
- Lacks spatial-awareness functionality: Doesn't guide user through physical space while performing tasks
- Voice commands only (no gestures)



# SGS QiiQ app with RealWear HMT-1



[SGS Video Link](#)

As shown, SGS, the world's leading inspection, verification, and certification company, uses the RealWear HMT-1 device with their QiiQ app for a Remote Inspection.

In 2018, SGS conducted 30,000 inspections remotely using their QiiQ app. Due to COVID-19, SGS recorded a 30% increase in the use of this application.

SGS QiiQ can be installed on any mobile device (tablet, mobile phone or smart glasses).

The app can record and share audio and video streams and enables the real-time exchange of images and documents.

Other notable apps for Remote Inspections:

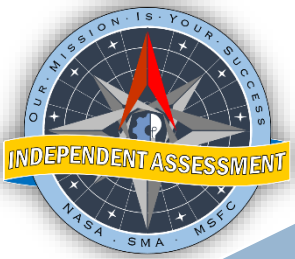
[Librestream Onsite Connect](#)

[Honeywell Connected Worker Platform \(Forge\)](#)

[Ubimax \(Airbus Example\)](#)

(IT Security becomes the key to success – How to securely transfer/store SBU/ITAR/sensitive data)





# Extending Beyond COVID-19

- COVID-19 has pushed the need and demand for Remote Technologies ahead by a solid 3 years. RealWear ended 2020 hitting sales that they did not expect to see until end of 2023.

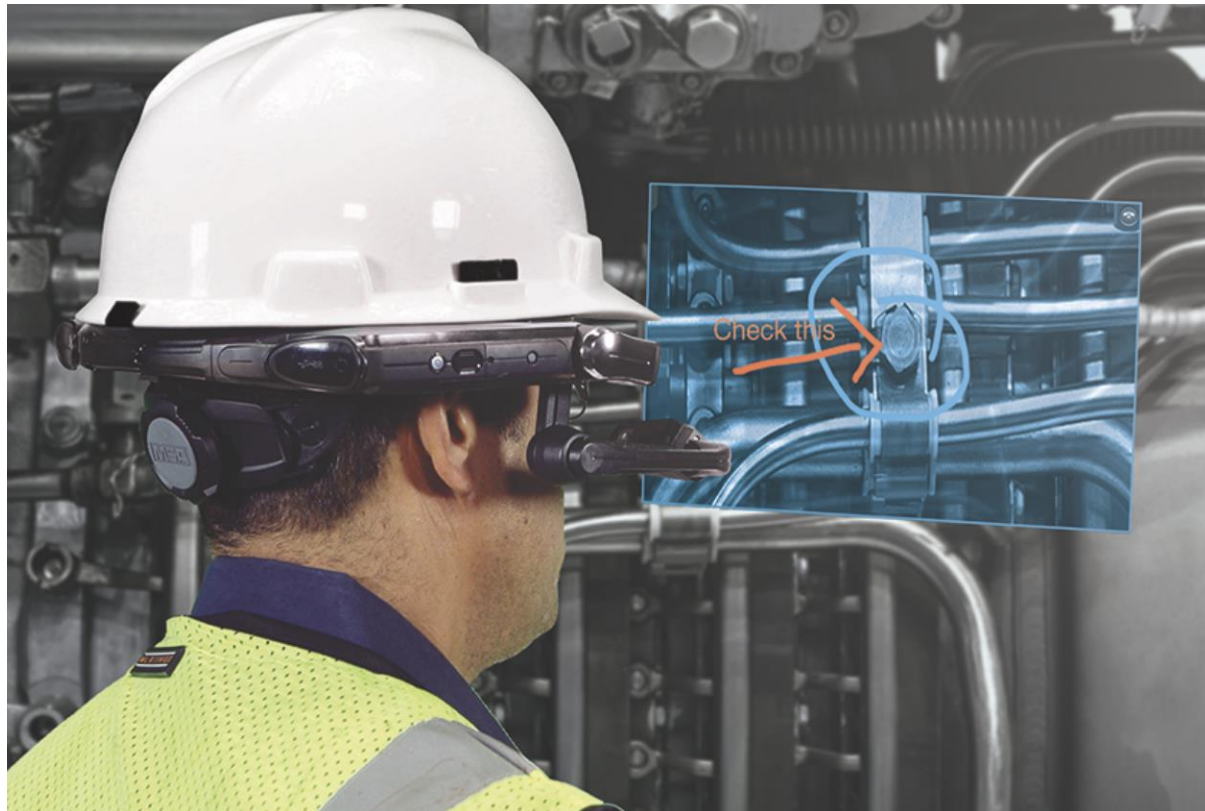
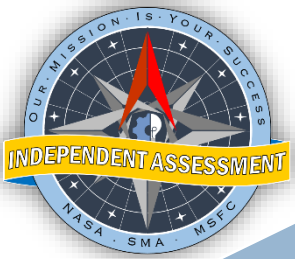


Image: RealWear's HMT Device with LibreStream Onsite Platform for Remote Interactions  
(Source: RealWear.com)



[Survey from Librestream](#), a global provider of augmented worker enterprise solutions, in conjunction with Worldwide Business Research (WBR), the world leader in B2B research.

"In addition, 82% of organizations plan to increase investments in augmented-reality (AR) by over 20% in 2021. Librestream's user growth supports these findings; from 2019 to 2020, the company saw customer license growth of over 838%, indicating expanded deployment across business units and use cases."



# Integrated Visual Augmentation System (IVAS)

## US Military's special version of the HoloLens 2

- 2018: US Army Awarded Microsoft \$480 million contract to supply military with up to 100,000 HL2 devices for training & combat
- 2020: Army increased Microsoft HL2 deal to \$641 million. DoD Budgeted \$906 million for IVAS in fiscal 2021 and \$1 billion for fiscal 2022 for IVAS program
- 2021:



Image courtesy Microsoft

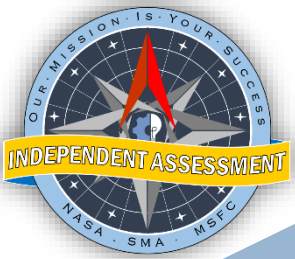
**Microsoft Signs \$22B Contract with US Army to Bring HoloLens 2 Tech to the Battlefield**



This contract is worth more than the entire VR/AR industry was in 2019.

“The Army’s IVAS process is not following the rather complex and convoluted process traditionally used by the Army for developing and acquiring systems. The traditional processes work well for fighter planes and tanks; however, it fared poorly when dealing with fields that are much more dynamic, such as electronics. By the time that the Army can field an electronic system, it is often clunkier and less capable than similar devices that can be procured from Alibaba.com. The novel process used for the IVAS development shows that the Army is serious about modernizing. By moving away from the traditional acquisition practices, they have found a way to move at the speed of technology. But even more impressive is how rapidly the Army managed to develop and field this system. The Army seems to have finally cracked the code on how to get cutting-edge technology onto the battlefield before it becomes obsolete.”

- Forbes



# Department of Defense (DoD) - Defense Innovation Unit (DIU)

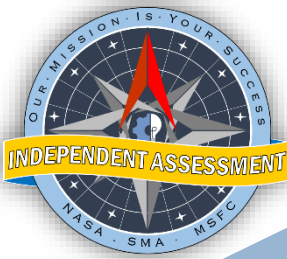
- 2015 – US Secretary of Defense established the DIU as the bridge between the DoD & the commercial world
- The DoD recognized game changing technology development was happening in the commercial sector but the DoD was not positioned to understand what was going on or leverage those advancements
- Recognized a need to work quickly through Rapid Prototype Contracts to get to work fast and efficiently

## Defense Innovation Unit Mission and Purpose

**DIU is a fast-moving, cross-DoD organization focused exclusively on commercial companies to solve national security problems.**

- **ACCELERATE**  
DoD adoption of commercial technology
- **TRANSFORM**  
Military capacity and capabilities
- **STRENGTHEN**  
The national security innovation base

Source: CAPT John Zerr, Defense Innovation Unit (DIU) Presentation from 2021 TEAR3M Conference



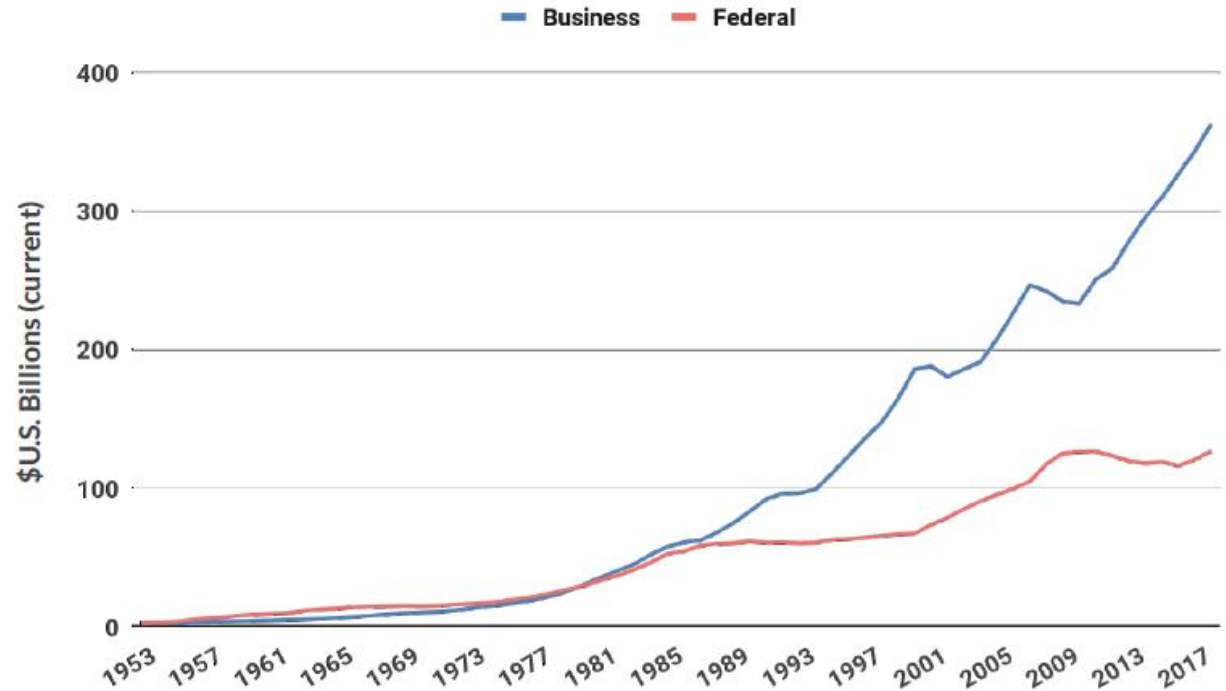
# WHY COMMERCIAL

**Top Tech Companies  
Outspend Defense Primes  
11x in R&D**



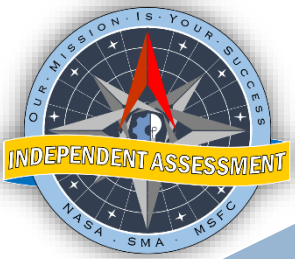
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## U.S. R&D Expenditures by Source: 1953 - 2018



Source: National Science Foundation, National Patterns of R&D Resources

Source: CAPT John Zerr, Defense Innovation Unit (DIU) Presentation from 2021 TEAR3M Conference



# HoloLens Approaches at MSFC

## HoloLens Implementation Project (HIP)

### GOALS

#### **MAKE HOLOLENS 2 AN ORDERABLE THROUGH NEST**

(Timeline: Available on catalogue mid-June)

### HIP LIMITATIONS FOR SMA

- Using an all Microsoft Solution, not evaluating other platforms for secure data transfer
- Evaluating one hardware solution
- Having a per-user license on Remote Assist makes the license non-transferrable to other users
  - Users will change by audit, inspection, mishap investigation, quality surveillance, etc.
- Aspects SMA needs evaluated but aren't included in HIP deployment:
  - Transferrable licenses, VPN, secure data transfer, etc.

## SMA Remote Inspection (IA Team)

### GOALS

- **TO DEVELOP NASA REMOTE INSPECTION GUIDANCE AND PROCESSES** (National Aerospace Standard, NASA Handbook)
- **TO EVALUATE DEPLOYMENT OF AR/VR EQUIPMENT** (Remain hardware agnostic. Multiple HW devices & secure SW platforms)

### NEEDS

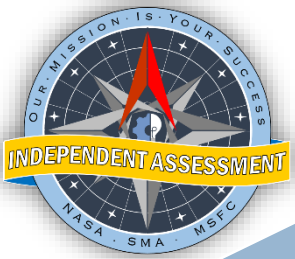
#### **TO GAIN APPROVAL & FUNDING**

- To connect to NASA Network/VPN
- To purchase/use SMA HoloLens device
- To purchase/use/evaluate multiple HW devices
- To evaluate additional Meeting Interfaces, and secure SW for data streaming, transfer and storage (ex: Librestream)

### BENEFITS


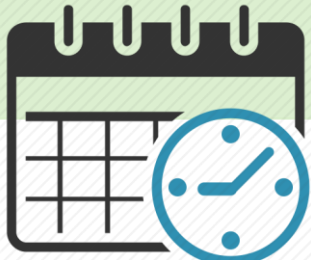


#### **ESTABLISH BEST PRACTICES FOR VR/AR SOLUTIONS**

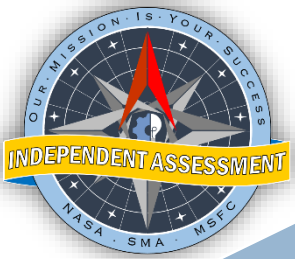
- Multiple VR/AR Hardware solutions available for use internal and external to NASA
- Secure transfer, streaming and storage for SBU/ITAR data
- Establish criteria for external facilities (i.e. at Suppliers)



# Importance

## Optimize the Process with Risk-Informed Remote Inspection

COST	SCHEDULE	SAFETY	RISK
<p>Reduced long-term manpower and travel cost associated with Supplier Source Inspections.</p>	<p>Faster inspection response time since inspector doesn't need to travel. Inspector can attend multiple sites/inspections in one day.</p>	<p>Increased Safety for the Inspector. Reduced time spent in Hazardous work environments: Pressure Vessel, Energized Equipment, Pyro devices, etc.</p>	<p>Significant uncertainty &amp; risk exists for Remote Inspection applications. Unknown potential loss of accuracy &amp; reliability. Each inspection process will need to be evaluated to determine applicability for remote application. Proceeding at risk until processes are in place.</p>
			



# Importance

## Why its important?

Expanding SMA's oversight is key to mission success, even before the world was hit with a global pandemic. COVID-19 has increased the demand for these types of technologies/services, thus, NASA must be vigilant in adapting to these demands.

Understanding the applicability and limitations of these technologies in remote verification, allows us to mitigate any uncertainty and reduce risk where possible. Currently, numerous remote inspections have been taking place throughout the industry. However, without proper protocols, policies, and procedures, the Agency is proceeding at risk. The risk is inherent with current and ongoing remote verifications and without any defined requirements or process controls.

## Digital Transformation

Crawl

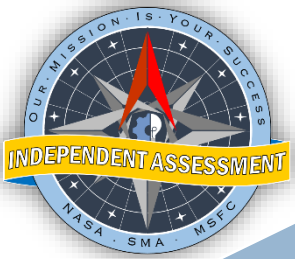
2D Capture &  
Real-Time

Walk

3D Interactive

Run

Augmented Reality  
(Modeling and Overlays)



# Challenges Encountered & Future Roadblocks

## Challenges

- No pre-existing Processes or Documentation
- Covid-19 Restriction for onsite Use Cases
  - Limited site access
  - Limited personnel
- Waivers
  - Procurement
  - Authority to Operate (ATO)
- Equipment Limitations
  - Limited Funding
  - Can't connect device to NASA network
    - Restricted to using only public Wi-Fi
    - VPN connection still to be evaluated
    - Can't connect to supporting "Remote Assist" software
- Security protocols
- Ability to support broad range of mobile/VR/AR devices
- Lack of communication between groups doing similar work

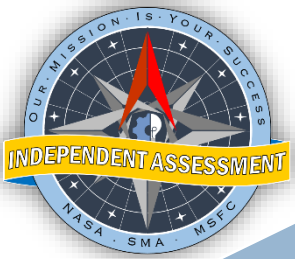
## Biggest Struggles/Roadblocks Moving Forward

- Seamless Interactions
  - Easy to use and manage
  - Hands-free capability
  - Seamless transfer of data to not slow work down excessively
- Secure transfer of SBU/ITAR data\*\*
  - Cloud Environments (FedRAMP, ISO 27001)
  - Storage
  - Traceability
- IT/security roadblocks
  - Current procurement process is SLOW
  - Cultural shift\*\*
    - Need to adapt DoD's "Rapid Prototype Agreement" mindset
    - Government has to be ready to adapt quickly to figure out how to protect themselves against cyber insecurities
    - Remaining open to new technologies – device agnostic, quick to evaluate/adapt/deploy





# Back-up Slides



# Use Case Trials

## In Person (Baseline)

### Receiving Inspection

- Visual (ID&D)
- ADP (documentation)

### Testing

- Witness/Verify Test Set Up
- Traceability
- Workorder/Test Plan Review
- Equipment/Tooling Cal
- Run/Test System Profile (Test System Inputs)

### Special Process (Welding, NDE, etc.)

- Visual Inspection
- Traceability
- Workorder Review
- Equipment/Tooling Cal
- Process Controls
- Samples

### General Manufacturing (Assembly, Drilling, etc.)

- Visual Inspection
- Traceability
- Workorder Review
- Equipment/Tooling Cal
- Process Controls

## Generic Remote Inspection Basic Equipment

### Visual

- Distinguish Colors
- Size of Object/Geometry
  - Depth perception
  - 3 dimensional specifics
- Quality or Pixilation
- Lighting

### Documentation

- Distinguish Colors
- Quality or Pixilation
- Lighting (If not scanned)

### Security

- Data Transfer
- Store Data
- Secured Streaming

### IT

- Interface with the Inspection Equipment
- Transfer Media
- Equipment Updates (as applicable)

**Note:** Will be expanded upon once Use Cases Begin

## Detailed Remote Inspection Advanced Technologies

After determination of capabilities with Basic Inspection Equipment. Determine if any limitations can be reduced or eliminated by use of Advanced Technologies.

Examples: Improvements on Visuals, Audio, Securities, and Data Transfers.

