



CHARIoT CHALLENGE

Advancing First Responder Communications

the Official Rules document:

the CHARIoT Challenge: Advancing First Responder Communications

Challenge Host:



PUBLIC SAFETY
COMMUNICATIONS
RESEARCH

The National Institute of Standards and Technology's
Public Safety Communications Research Division

March 2020 – November 2020

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Introduction

Overview:

NIST's Public Safety Communications Research (PSCR) Division is hosting the *Augmented Reality and Internet of Things-based Challenge, Making Data Accessible to First Responders*, comprised of two competitions for contestants that will together improve public safety operations. PSCR and its challenge partners will award prizes valued up to \$1,100,000 to the groups of contestants. A complete list of the challenge partners can be found on the Challenge website and Challenge.gov. The contestants, consisting of Augmented Reality (AR) developers and Internet of Things (IoT) data contestants, will offer examples of how providing first responders access to relevant data streams from IoT devices, smart buildings and smart cities - presented through augmented reality interfaces - could improve communication for public safety personnel while they save lives and property.

Challenge Background:

Public safety officials perform tasks in a variety of environments that severely limit their senses and ability to communicate. Since 2002, PSCR has collaborated with first responders, stakeholders, and innovators to ensure the development of reliable, intuitive, and mission-focused technologies for the public safety community. This challenge consists of the following two contests:

Contest 1 - Emulate Smart City Data for Disaster Scenarios. Emulate accurate smart city data under extreme conditions for each of the four emergency scenarios. Determine what building and personal area network sensors (a minimum of 5 per scenario) would be most useful for first responders to successfully complete their tasks in the provided scenarios. Timestamp the data and tell us the accurate data that would broadcast during the emergency scenarios that will be simulated at the live competition at a public safety training center. Data should be provided in a JSON format. Configure the emulated data on an appliance that must provide additional configuration capabilities to modify message types (e.g., JSON, XML, MQTT), as well as additional network settings modifications (e.g., TCP, UDP, Unicast, Multicast). The appliance must provide a configurable interface for emulating additional sensor data types in the future.

Contest 2 - Building Augmented Reality Interfaces for First Responders. Share and then create augmented reality interfaces for public safety that would improve communication during up to four emergency scenarios. Earn points by creating interfaces for first responders (heads-up displays) or incident command (holograms) utilizing smart building and personal area network sensor data. The top contestants, in collaboration with a local public safety agency, will have opportunities to work with Magic Leap and receive acceleration services while they prepare for

the final phase – design and integrate streams of live data into augmented reality interfaces at a live competition at a public safety training center.

Challenge Goals and Objectives:

The purpose of this challenge is to assess the potential of using augmented reality interfaces that present integrated, relevant streams of data from buildings, city structures and first responders’ themselves to aid communication ability for public safety officials. This challenge also seeks to convene members of the data science community and developers to advance the state of augmented reality interfaces for public safety. After this challenge, PSCR plans to utilize the emulated data transmitters and augmented reality interfaces for research and to demonstrate the possibility of improved communications if first responders were to have access to streamed data from various IoT sensors.

Each of the two contests within this challenge consists of multiple phases. The phases of each the two contests follow:

Emulate Smart City Data for Disaster Scenarios: Up to \$212,000 in prizes

Phases	Review Criteria Summary	Number of Contestants Eligible to Compete	Awards	Total \$
Phase 1 - Concept Paper	Best approach, strongest concept, methodology for data acquisition, proposed hardware, transmission capabilities, and write up.	Open to all eligible contestants	Up to 12 contestants will be awarded: a) invitation to Phase 2; and b) \$5,000 for prototype development	Up to \$60,000

<p>Phase 2 - Demonstration of Data Streams</p>	<p>Pass/Fail Evaluation: video conference demonstration of solution for a minimum of 2 out of the 4 emergency scenarios</p>	<p>Open to up to 12 contestants</p>	<p>Up to 12 teams will be awarded \$4,000 for prototype development.</p>	<p>Up to \$48,000</p>
<p>Phase 3 - Evaluation of Data Streams</p>	<p>Accuracy of data transmitted; implementation of network protocols; and implementation of data types.</p>	<p>Open to up to 12 contestants</p>	<p>Up to 4 teams (1 selected per scenario) will be awarded: a) \$5,000 for 2021 demonstration opportunity; and b) \$7,500 for prototype development.</p>	<p>Up to \$50,000</p>
<p>Phase 4 - Live Competition at a Public Safety Training Center</p>	<p>Ability to access competition location network; and ability to interface with AR developers.</p>	<p>Open to up to 4 contestants</p>	<p>1st place cash prize: \$25,000. 2nd place cash prize: \$12,500.</p> <p>Most Flexible Design for Public Safety Use Case and Research prize: \$4,500</p> <p>Most Creative Sensor Utilization for Smart Cities Data prize: \$4,000</p> <p>PSCR will also provide \$2,000 per</p>	<p>Up to \$54,000</p>

			team who open sources their solution.	
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Building Augmented Reality Interfaces for First Responders: Up to \$888,000

Phases	Review Criteria Summary	Number of Contestants Eligible to Compete	Awards	Total \$
Phase 1 - Concept & Video	Best approach, strongest concept, augmented reality capabilities, collaboration with first responder, and write up.	Open to all eligible contestants	Up to 30 contestants will be awarded an invitation to Phase 2. Contestants will also be loaned a Magic Leap headset to be utilized during the competition and returned at the final event or during the contestants' last participation in the Challenge.	-
Phase 2 - Augmented Reality Interfaces and Public Safety Use Case	Evaluation: demonstration of augmented reality prototypes	Up to 30 contestants	Up to 30 contestants will be awarded: a) invitation to Phase 3; b) \$7,500 for further prototype development; c) \$2,000 for support of their matched public safety representative participation; d) up to \$5,000 in provided business technical	Up to \$525,000

			assistance; e) offline support with MSA Safety; and f) \$3,000 in funding to spend time conducting joint training and prototyping with public safety partner.	
Phase 3 - AR Heads-Up Displays & Holograms	Test and evaluation of augmented reality heads-up display and holograms.	Up to 30 contestants	Up to 15 contestants will be awarded: a) \$7,500 for prototype development; b) \$2,000 for support of their matched public safety representative participation; d) \$5,000 for 2021 demonstration opportunity; e) online support with Magic Leap; and f) online support from MSA Safety. The judging panel may elect to offer two optional prizes: Best Presentation of Actionable IoT Analytics for First Responders (\$8,750) and Best Visual Interface for First Responders (\$8,750).	Up to \$190,000
Phase 4 - Live Competition at a Public Safety	Interactive test of augmented reality interfaces at public safety training course. The Judging panel will utilize	Up to 15 Contestants	1 st : \$25,000; 2 nd : \$20,000; 3 rd : \$15,000; 4 th : \$10,000; 5 th : \$7,500. The judges will also award \$2,500 for the top AR HUD and Hologram	Up to \$128,000

<p>Training Center</p>	<p><u>AR interfaces to complete a first responder task during the simulated emergency scenario.</u></p>		<p>for each of the 4 emergency scenarios (up to 8 prizes).</p> <p>Most creative method of interaction with AR prototype: \$5,000</p> <p>Best Demonstration of Public Safety Use Case: \$4,000</p> <p>Continued Technical Assistance Award: \$10,000</p> <p>Optional prize: Challenge partner Magic Leap may elect to award five headsets, each with an estimated value of \$2,300.</p>	
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Definitions

The following is a summary of the various roles and definitions of the contestants and other Challenge participants:

IoT Data Contestant:

- Responsible for identifying sensor types (at least 5 per scenario) and data ranges that can be used to inform first responders in the four PSCR-specified emergency scenarios.
- Developing the structure of the sensor data in a specified format.
- Developing software capable of transmitting this data to emulate a Smart City environment.
- Creating a transmitter that will be able to provide networked data streams.
- Participants may only submit a concept paper for either the Emulate Smart City Data for Disaster Scenarios contest or the Augmented Reality Interfaces for Smart City Disaster Scenarios contest, but not both.

AR Developers:

- Responsible for creating AR interfaces for both incident command and first responder perspectives (heads-up display for first responder and hologram for incident command) surrounding as many as four of the scenarios (up to eight interfaces total).
- Individuals or teams of programmers, hackers, and/or, thinkers that seek to create innovative solutions using AR headsets. Developers should have a strong background in user interfaces and user experience. They should also have a general familiarity with the Unity Engine and be able to integrate their AR interface prototypes with the IoT data streams. An AR Development Team will create up to eight AR interface prototypes for use with the IoT data provided by IoT Data Contestants and NIST PSCR.
- Participants may only submit a concept paper for either the Emulate Smart City Data for Disaster Scenarios contest or the Augmented Reality Interfaces for Smart City Disaster Scenarios contest, but not both.

Emergency Scenarios: This Challenge will involve the following four emergency responder scenarios - a tunnel/subway collapse; a flood; a wildfire; and an active shooter. The emergency scenario descriptions, data requirements, timeframe requirements for the incident command and the first responder perspectives for the emergency scenario, and corresponding first responder tasks, will be posted on the Challenge website and used for all phases of both contests. IoT data contestants will create emulated data that corresponds to the four emergency scenarios, and the AR contestants will create augmented reality holograms for the incident command perspective and/or heads-up display for the first responders that would aid in communication and completion of their tasks during the four emergency scenarios.

Official Representative: Each contestant's designated point of contact for interaction with PSCR. The Official Representative (individual or team lead, in the case of a group project) must be age 18 or older and a U.S. citizen or permanent resident of the United States or its territories. That designated individual will be responsible for meeting all entry and evaluation requirements. NIST will award prizes in a single dollar amount to the Official Representative. The Official Representative is solely responsible for allocating any prize amount among its member contestants as they deem appropriate.

Subject Matter Expert (SME): An expert in their respective field, either from NIST or from an entity collaborating with PSCR. Subject matter experts will conduct independent reviews of the submissions received during the Challenge. The subject matter experts are not judges and, as such, will provide recommendations based on the evaluation criteria to the Judging panel.

Judging panel: The Director of NIST, Dr. Walter Copan, will select members from the public safety industry, first responders, and PSCR to test and evaluate the submissions for the Challenge. The Judging panel will take subject matter expert recommendations into consideration when evaluating contestants' submissions. The Judging panel will make the final determination of awards for the Challenge.

Program Email Address

For questions about the Official Rules contact psprizes@nist.gov.

Summary of Important Dates (all in 2020 unless otherwise indicated)

Emulate Smart City Data for Disaster Scenarios

Phase	Start Date	Due Date	Judge and Notification Date
Phase 1 - Concept & Recorded Presentation	March 11	May 6	May 15
Phase 2 - Demonstration of Data Streams	May 16	June 17 -18	June 24
Phase 3 - Evaluation of Data Streams	June 25	August 27	September 9
Phase 4 - Final Evaluation at a Public Safety Training Center	September 10	Emulated Sensor & Data: October 5 Transmitters: November 16	TBD*

Building Augmented Reality Interfaces for First Responders

Phase	Start Date	Due Date	Judge and Notification Date
Phase 1 - Concept & Video	March 11	May 6	May 22
Phase 2 - Demonstration of Augmented Reality and Public Safety Use Case	May 23	June 12	June 16
Phase 3 - AR Heads-Up Displays & Holograms	June 17	September 1	September 15
Phase 4 - Final Evaluation at a Public Safety Training Center	September 16	November 16	TBD*

TBD* For the final evaluation, NIST PSCR is currently targeting three different timeframes throughout 2020 and early 2021, of which will be finalized as soon as the criteria are present to safely and effectively host an in-person event with the Judging panel. NIST PSCR will announce the finalized dates to the final contestants no later than 15 days in advance of the evaluation to ensure the contestants will be able to virtually participate in aspects of the final evaluation.

Official Rules of Emulate Smart City Data for Disaster Scenarios

Phase 1: Concept Paper

Introduction:

The Concept Paper phase invites all eligible participants to submit a concept paper outlining their proposed team's solution, approach, capabilities, knowledge and skills for this contest.

Participants must document their proposed solution structure for each of the four emergency scenarios, including the list of sensor data they would provide and a corresponding justification for their selection; their methodology for data acquisition and sources; and proposed physical hardware.

Participants will also need to demonstrate their experience with networking and socket programming and other abilities to create the hardware device that will transmit the emulated data in phases 3 and 4. Note, the network client must operate on an x86 platform, such as Raspberry PI, Windows, Linux or MacOS laptop computer. However, the proposed hardware for Phases 3 and 4 must operate on a system compatible with Raspberry Pi 4, Linux-based OS.

Participants' concept papers will be reviewed by a panel of subject matter experts; the Judging panel will evaluate and select up to 12 contestants to move forward to the next phase of the contest and to receive an award of \$5,000 for prototype development.

Important Dates:

Concept Paper: Launch on March 11, 2020 and concept papers due May 6, 2020; Contestants will be notified by May 15, 2020.

How to Enter:

Visit Challenge.gov to review the phases and Official Rules; review the emergency scenarios and desired corresponding public safety tasks provided on the Challenge website. By the May 6th deadline, submit a concept paper through the Challenge website.

- Review each of the four PSCR-provided emergency scenarios included on the Challenge website.
- Complete the submission requirements for the Concept Paper phase; submit the required concept paper as your entry on the Challenge website and register as a contestant via Challenge.gov by the required date.
- Additional information on how to complete a contestant entry is available on Challenge.gov.
- Note: Participants may only submit a concept paper for either the Emulate Smart City Data for Disaster Scenarios contest or the Building Augmented Reality Interfaces for First Responders contest, but not both.

Concept Paper Content Requirements

The concept paper must conform to the following content requirements:

SECTION (Start each section on a new page)	PAGE LIMIT	DESCRIPTION
Cover Page and Abstract (required)	1 page maximum	<p>The cover page must include:</p> <ul style="list-style-type: none"> Participant’s Name (Team, Organization or Company Name) and list of individual team member(s), Participant’s Location (City, State/Region and Country). Team Logo Official Representative and their preferred contact information (including email, phone, and physical mailing address). <p>Describe succinctly (500-word MAXIMUM): The unique aspects of the participant’s approach and the potential impact that the proposed approach could have in achieving the goals of the challenge.</p> <p>Note: Do not include proprietary or sensitive information in this summary.</p>

<p>Project Description (required)</p>	<p>6 pages maximum</p>	<p>Addressing the scoring criteria should be your primary objective; therefore, create your concept paper to address the criteria. Below are a few points to consider:</p> <p>The participant’s knowledge, skills, and capabilities as they relate to the goals of the challenge.</p> <p>The participant’s proposed solution for each of the four emergency scenarios, including a list of sensors’ data you would provide, proposed frequency for sensor to update its data within the emergency scenario; and a corresponding justification for their selection;</p> <p>The methodology for data acquisition and sources;</p> <p>Your proposed physical hardware;</p> <p>The competitive advantage offered by the participant’s approach or solution.</p>
<p>Information about Key Team Members (required)</p>	<p>2 pages</p>	<p>The key team members and why they are well-suited to accomplish the project, with supporting information on their qualifications, skills and capabilities.</p>

NIST makes an independent assessment of each concept paper based on the evaluation criteria. NIST will not review or consider incomplete concept papers. During the review, each subject matter expert and Judging panel member will review entire concept papers to which they are assigned. The review is not done in sections with different reviewers responsible for different assigned sections. Therefore, it is not necessary to repeat information in every part of the concept paper. Do not include sensitive materials in the concept paper, for example, personally identifiable information like social security numbers, nor business sensitive information like tax identification numbers, etc.

Concept Paper Evaluation Criteria

Concept Paper will be evaluated based on the following criteria:

Scoring Criterion #1: Strategic Alignment & Technical Outcome (70%)

This criterion involves consideration of the following factors:

- **Strategic Alignment** – The extent to which the proposed approach meets the objectives listed in the goals of the challenge; the likelihood the contestant’s solution, if successfully implemented, will have a significant real-world impact on public safety operations.
 - **Proposed Sensors & Justification**– Participant’s planned emulated sensors and data streams justification aligns with the challenge goals.
 - **Methodology Data Acquisition** – Participant’s demonstrated understanding of first responder requirements, task and emergency scenario data based on research and interviews conducted.
 - **Proposed Hardware** – Participant’s planned hardware (types of hardware software/platform) and how it aligns with the challenge goals.
- **Technical Outcome** – Extent to which the proposed approach will result in significant improvement in commercially available technology and will potentially result in a technical outcome which enables considerable progress toward the challenge goals.

Scoring Criterion #2: Feasibility & Team (30%)

This criterion involves consideration of the following factors:

- **Team** – The extent to which the capability of the participant(s) can address all aspects of the proposed project with a high chance of success, including, but not limited to, qualifications, relevant expertise, and time commitment of the participant(s). Reviewers will evaluate: (a) The relevance of the qualifications and experience of the key staff, leadership, and technical experts. (b) The extent of the participants’ prior experience and the quality of the results in similar projects or programs relate to the purpose, scope or tasks of this Challenge.
- **Approach** – Participant’s plan to manage the limited schedule, resources, project risks and other challenges, and produce high quality project outcomes, in pursuit of the challenge goals.

The concept papers will be evaluated based on the criteria above. Each concept paper will be reviewed by at least two subject matter expert reviewers and members of the Judging panel. The concept papers will be assigned a score between 0-10 for each criterion. Scores will not be provided to the contestants. In the case of a tie, the Judging panel will make a determination on the winners invited to compete in Phase 2.

Scoring for Concept Papers

10	Contestant has strong potential to aid in the achievement of the goals of the challenge
1-9	Varying degrees of certainty that the contestant may have the potential to aid in the achievement of the goals of the challenge
0	Contestant does not have the potential to aid in the achievement of the goals of the challenge

Weighting of Criteria for Concept Papers

Criterion 1: Strategic Alignment & Technical Outcome	70%
Criterion 2: Feasibility & Team	30%

Phase 2: Demonstration of Data Streams

Introduction:

Invited contestants will participate in a challenge kickoff webinar, during which PSCR will describe the four emergency scenarios, the corresponding public safety tasks for each emergency scenario, and how the emulated data would be utilized in Phase 3 and Phase 4 of the Challenge. The rest of Phase 2 is focused on contestants' creation of the emulated sensor data and demonstrating the transmission of these data streams for at least 2 of the 4 emergency scenarios.

Contestants will later sign up for a recorded video webinar and screen share with SMEs and members of the Judging panel to demonstrate their emulated data, proposed frequency of sensor data updates and appliances for the minimum of 2 of the 4 emergency scenarios.

The Judging panel will select up to 12 contestants to advance to Phase 3 and receive \$4,000 for prototype development.

Important Dates:

Phase commences May 16, 2020; recorded webinars will occur on June 17th and June 18th; contestants will be notified by June 24th.

* PSCR anticipates hosting the Challenge Kickoff Webinar on May 18th. Participants who submit a concept paper will receive a tentative notice with the time and date of the Challenge Kickoff Webinar. However, only successful contestants from Phase 1 will be invited to the Challenge Kickoff Webinar.

How to Enter:

- Invited contestants to Phase 2 will receive an email with the information about Phase 2 of the Challenge, such as how to access the prize challenge platform and how to sign-up for their webinar and screen share session to demonstrate their Phase 2 solution.
- Kickoff Webinar Requirements: each invited contestant must have their Official Representative attend the Challenge Kickoff Webinar, currently scheduled on May 18, 2020 (time TBD). Other team members are invited to attend.

Requirements of the Demonstration of Solution through Recorded Video Webinar and Screen Share: During the webinar and screen share session, contestants must demonstrate their solution to a minimum of two of the four emulated data streams and their transmitter/appliance to the SMEs and members of the Judging panel. Contestants should also expect a brief question and answer session with the SMEs and members of the Judging panel as part of their webinar and screen share session.

Evaluation Criteria and Judging:

PSCR will initially review submissions for compliance with the objectives and Official Rules of this contest. A submission that fails to meet the compliance criteria will be disqualified and will be ineligible to compete in this contest.

Scoring Criterion: Compliance Testing (Pass/Fail)

- Contestant should provide a brief overview of the system, the scenarios that will be demonstrated, and the proposed functionality.
- Contestant should show software initialization process and any configuration required to begin transmission of data.
- Contestant should display terminal output of streaming data (and, optionally, a graphical user interface). NOTE: The GUI will be for demonstration purposes only and is outside of the scope of the challenge.
- Contestant will create a demonstration terminal to show networked reception of the streaming data.

Phase 3 - Evaluation of Data Streams

Introduction:

The IoT data contestants are encouraged to collaborate with external public safety mentors and advisors to finalize their emulated data for the four emergency scenarios. Contestants will submit a wireless network router and their data transmitters pre-configured for all four emergency scenarios for evaluation by the Judging panel.

The Judging panel will evaluate and select the top IoT data contestant team per the four emergency scenarios, up to 4 contestants, to be awarded an invitation to the Phase 4 - Live Competition at a Public Safety Training Center. Invited contestants will also be awarded \$7,500 for prototype development and \$5,000 in funding to support their team's demonstration of their final submissions at a 2021 public-safety focused event. NIST PSCR will contact each awardee to discuss their availability and their interest in demonstrating at 2021 in-person public-safety focused events, such as the NIST PSCR 2021 Public Safety Stakeholder Meeting, a public safety institute or another conference hosted by one of the Challenge partners or NIST PSCR collaborators.

Important Dates:

Phase commences June 25, 2020; data streams and emulator are due to PSCR by August 27, 2020; contestants will be notified by September 9, 2020.

How to Enter:

Invited contestants will receive an email with additional instructions, including submission instructions to NIST PSCR for the contestants' Phase 3 solutions. Each contestant will send/provide NIST PSCR a wireless network router and no fewer than 1 data transmitter per scenario that are transmitting the emulated data (minimum of 5 streams per scenario), and a README file (e.g., instructions on wireless router use and data transmitters, as well as a data dictionary with descriptions for each data element) to PSCR for test and evaluation of their work by the subject matter experts and the Judging panel.

PSCR will return the wireless network router and data transmitters submitted during Phase 3 to the IoT data contestants.

The IoT data generator supports an IPv4 or IPv6 based network: must be configurable to interoperate on an ethernet 802.11 wireless network. The device IP address must be configurable either DHCP or static IP address using the device's native operating system or configurable interface.

The IoT data generator must support data transmission to both single (one-to-one) and multiple (one-to-many) network clients. In the latter, the IoT data generator acts as a serving entity to provide generated data to networked devices or clients. All devices will reside on a single “flat” IP network. The wireless network router shall be assumed to operate in an isolated environment with no internet connectivity.

Networking protocol components must support:

- Configurable IPv4/IPv6 connectivity using 802.11 wireless
- Data transmission protocol must be configurable for client reception, including:
 - Configurable TCP or UDP streams (destination IP and socket/port)
 - Utilization of both unicast and multicast architecture (direct communication with single client or multicast data to multiple clients)
- A networkable client must be configured to demonstrate the reception of data from the IoT generator for demonstration, judging and evaluation purposes
 - The client must support the same networkable protocols described for the IoT generator
 - The client must operate on an x86 platform, such as Raspberry PI, Windows, Linux or MacOS laptop computer
 - The client OS can be determined by the contestant, but must be able to display data received over the network from the IoT generator in a clear and concise manner
- All devices must operate without internet connectivity or cloud-based services
 - Development may occur in environments of the contestant’s choice
 - Demonstrations and final deliverables must run in an isolated (offline) environment utilizing the elements described in the challenge
- Additional network devices, architecture, software or middleware solutions not explicitly defined will be considered in the judging criteria; however, contestants must provide the base requirements, as described in the challenge. Additional devices, architecture, software or middleware will be considered as part of the contestant’s solution for the IoT generator.

Evaluation Criteria and Judging:

PSCR will initially review submissions for compliance with the objectives and Official Rules of this contest. A submission that fails to meet the compliance criteria will be disqualified and will be ineligible to compete in this contest. Submissions that pass the initial compliance review will be evaluated and scored by the Judging panel. An evaluation of a submission by the Judging panel does not constitute the NIST’s final determination of contestant or submission eligibility.

Scoring Criterion #1: Accuracy of Data Transmitted (Max 20/100)

The quality of the data representation (e.g., temperature, blood pressure, air quality, threat location) integrated into the device prototypes:

- Data is sent at intervals consistent with sensor type / scenario limitations;
- Data ranges are consistent with scenario specifications; and,
- Data must have specified low, medium and high severity ranges.

Scoring Criterion #2: Implementation of Network Protocols (Max 30/100)

- IoT Data Generator implements IPv4 or IPv6 connectivity using 802.11 wireless.
- Device(s) are configurable and can support a basic wireless network (e.g., WPA2 PSK).
- Device can transmit to a single client (i.e., unicast) and to multiple clients (i.e., multicast) using TCP or UDP.
- The provided x86 based network client is configurable and can receive data from IoT Data Generator.
- Devices operate without internet connectivity or cloud-based services.
- Additional features are clearly integrated, documented, and align with the goals of this phase of the challenge.

Scoring Criterion #3: Implementation of Data Types (Max 40/100)

Sensor types were properly configured to accomplish the emergency tasks defined in the scenarios.

- Data enables users to make decisions based on the scenario.
- Data appropriately interfaces with operational tasks.
- Emulator makes use of various data types (e.g., sensor, actuator, smart cities, smart building) to accomplish milestones.
- Emulator is able to configure additional sensor types for future use.
- Emulator is able to configure additional messaging protocols for additional flexibility.

Scoring Criterion #4: Ease of Use (10/100)

- Submission was easy to deploy and the README file thoroughly documented all aspects of the solution.

Phase 4 - Final Evaluation at a Public Safety Training Center

Introduction:

During this phase, IoT data contestants' emulated live streamed data will be made available to the Augmented Reality developers. IoT data contestants should note that the AR developers will not be able to record the streamed data from the data transmitters nor will they be able to access the IoT-based contestants' data streams after Phase 4. In advance of the live evaluation, each IoT data contestant will have the opportunity to present their emulated data sensors (a minimum of 5 per emergency scenario) to the Augmented Reality developers during a webinar.

As part of the final evaluation, the IoT data contestants will receive scores based on the number of Augmented Reality developers that elect to use their data streams and their corresponding feedback, and their transmitters and data will be tested and evaluated by the subject matter experts and the Judging panel. Each of the up to four contestants will compete for the first-place prize award of \$25,000; the second-place prize of \$12,500; Most Flexible Design for Public Safety Use Case and Research prize: \$4,500 and Most Creative Sensor Utilization for Smart Cities Data prize: \$4,000. PSCR will also provide \$2,000 per contestant who is willing to open source their data streams on the NIST PSCR Github account. NIST PSCR will retain the data transmitters and README files for demonstration purposes.

Important Dates:

The phase launches on September 10, 2020, and IoT data contestants will each have virtual meetings to discuss their Phase 3 submissions and any modifications for supporting the Final Evaluation Phase of the Challenge for their emergency scenario. The contestants will then have until October 5th to submit their finalized Phase 4 data.

IoT data contestants will first share their sensor data and data streams through a webinar with the AR developers, currently scheduled for October 7, 2020. The final data appliances must be sent to PSCR by November 16, 2020. NIST PSCR is currently targeting three different timeframes for the final evaluation throughout 2020 and early 2021, which will be finalized as soon as the criteria are present to safely and effectively host an in-person evaluation by the Judging panel. NIST PSCR will announce the finalized dates to the final contestants no later than 15 days in advance of the evaluation to ensure the contestants will be able to virtually participate in aspects of the final evaluation.

How to Enter:

- Each invited IoT data contestant will also participate in individual meetings with the CHARIoT Challenge organizers to discuss information on the objectives, structure, and conditions of the final evaluation at a public safety training center. The individual meetings will occur on September 10th.
- The discussion will focus on their selected data, the CHARIoT Challenge provided data and the final tasks that will be supported by the data. Contestants will then have until October 5th at 3pm MT to submit, and therefore lock their final data streams from any additional modifications. Contestants will then submit the final element structure file and a README file (e.g., operational instructions) to PSCR through NIST's secure file collaboration site (<https://nfiles.nist.gov/>) for test and evaluation by the subject matter experts and the Judging panel.
- Invited IoT data contestants will first interact with and describe their emulated data elements for their emergency scenario to the Augmented Reality developers during a

webinar, currently scheduled for October 7, 2020. Invited contestants will receive the confirmed date, log-in instructions and other information for the webinar in an email.

- IoT data contestants should be prepared to share a sample of each emulated data element (a minimum of 5) in JSON format; additionally, they should submit a data dictionary that defines the JSON structure, the ranges of data (for example, the data ranges should have a low, medium and high severity), and their planned intervals for the data, and any additional information they would like to share with AR developers.
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- AR developers will not be able to record the streamed data from the data transmitters nor will they be able to access the IoT-based contestants' data streams after the Phase 4.
- At the end of the final evaluation, PSCR will retain the IoT contestants' final hardware. Contestants must submit their hardware and a README file (e.g., operational instructions) to PSCR by November 16th for test and evaluation by the subject matter experts and the Judging panel.
- The IoT data contestants will receive scores based on the number of and feedback from the Augmented Reality developers, in addition to the test and evaluation conducted by the subject matter experts and the Judging panel.

Evaluation Criteria and Judging:

PSCR will initially screen submissions for compliance with the objectives and Official Rules of this contest. A submission that fails to meet the compliance criteria will be disqualified and will be ineligible to compete in this contest. Submissions that pass the initial compliance review will be evaluated and scored by the Judging panel. An evaluation of a submission by the Judging panel does not constitute the NIST's final determination of contestant or submission eligibility.

Scoring Criterion #1: Compliance Testing (Pass/Fail)

The compliance testing includes:

- Transmitters work and data is sent properly
- Data is present for both incident command and first responders
- Network protocols supported are consistent with Phase 3 scoring criterion #2, and the requirements of the Phase 4 live demonstration location
- Additional sensor types are able to be configured
- Additional messaging encapsulation protocols are able to be used

Scoring Criterion #2: AR Developers Utilization and Satisfaction (Max 40/100)

- The quality of the data provided during the emergency scenario:
 - Data enables users to make decisions
 - Data interfaces with operational tasks
- Effectiveness of the streamed data aided in completion of the first responders' tasks

- Accurate and complete data definition
- Data is able to be consumed in the AR interfaces
- Sensor data ranges are clearly defined
- Sensor data intervals are realistic and consumable

Scoring Criterion #3: Judges' Satisfaction (Max 50/100)

- Milestones are able to be accomplished using data provided
- Users are able to make the correct operational decisions using the data provided
- Data is reflective of a real-world scenario
- Data provided is relevant to the specific responder type (boots-on-the-ground responder or incident command)

Scoring Criterion #4: Q&A and Presentation (10/100)

Each IoT data contestant will complete a short, virtual presentation to the Judging panel, followed by Q&A from the panel. The Judging panel will award points based on the quality of the presentation and the team's ability to answer questions.

After the judging panel has reviewed each contestant using the above evaluation criteria, the judging panel has two additional awards to recognize contestants in specific requirements for outstanding achievement or contribution to advancing the challenge goals. All Contestants in Phase 4 who pass Criterion 1-4 are eligible for these awards. The Judging panel will vote on all eligible Contestants and use a simple majority to select a winner:

- Most Flexible Design for Public Safety Use Case and Research prize: \$4,500:
Judges will utilize results from Criterion #2.
- Most Creative Sensor Utilization for Smart Cities Data prize: \$4,000:
Judges will utilize results from Criterion #3.

Official Rules of Building Augmented Reality Interfaces for First Responders

Phase 1: Concept Paper & Video

Introduction:

The Concept Paper and Video phase invites all eligible contestants to submit a concept paper and video outlining their team's proposed solution, approach, capabilities, knowledge and skills for this contest. Contestants must document their proposed augmented reality (AR) interfaces - holograms for incident command perspective and heads-up displays for first responders - for the four emergency scenarios. Contestants must either include a first responder as part of their team or sign a statement that they would be willing to collaborate with a partnered first responder agency to ensure applicability and alignment of their AR interfaces during the challenge.

Contestants will also need to demonstrate their augmented reality proficiency through a 3-minute (maximum) recorded video of either their AR portfolio or a sample AR interface created for this Challenge.

Contestants’ concept papers and recorded videos will be reviewed by a panel of subject matter experts; the Judging panel will evaluate and select up to 30 contestants for awards. Awardees will receive: a) invitation to Phase 2; b) Contestants will also be loaned a Magic Leap headset to be utilized during the competition and returned at the final event or during the contestants’ last participation in the Challenge.

Important Dates:

Concept Paper: Launch of March 11, 2020; papers and recorded presentations due May 6, 2020; contestants will be notified by May 22, 2020.

How to Enter:

Visit Challenge.gov to review the phases and Official Rules. Review the emergency scenarios and desired corresponding public safety tasks provided on the Challenge website. By the May 6th deadline, submit a concept paper and link to a recorded video through the Challenge website.

- Review the PSCR provided four emergency scenarios included on the Challenge website.
- Complete the submission requirements for the Concept Paper phase; submit the required concept paper and link to a recorded video as your entry on the Challenge website and register as a participant via Challenge.gov by the required date.
- Additional information on how to complete a participant entry is available on Challenge.gov.
- Note: Participants may only submit a concept paper for either the Emulate Smart City Data for Disaster Scenarios contest or the Building Augmented Reality Interfaces for First Responders contest, but not both.

Concept Paper Content Requirements

The concept paper must conform to the following content requirements:

SECTION (Start each section on a new page)	PAGE LIMIT	DESCRIPTION
Cover Page and Abstract (required)	1 page maximum	The cover page must include:

		<p>Participant’s Name (Team, Organization or Company Name) and list of individual team member(s),</p> <p>Participant’s Location (City, State/Region and Country).</p> <p>Team Logo</p> <p>Official Representative and their preferred contact information (including email, phone, and physical mailing address).</p> <p>Describe succinctly (500-word MAXIMUM): The unique aspects of the participant’s approach and the potential impact that the proposed approach could have in achieving the goals of the challenge.</p> <p>Note: Do not include proprietary or sensitive information in this summary.</p>
<p>Project Description (required)</p>	<p>6 pages maximum</p>	<p>Addressing the scoring criteria should be your primary objective; therefore, create your concept paper to address the criteria. Below are a few items to consider:</p> <p>The participant’s knowledge, skills, and capabilities as they relate to the goals of the challenge.</p> <p>The participant’s proposed augmented reality interfaces - holograms for incident command perspective and heads-up displays for first responders - for the four emergency scenarios;</p> <p>The competitive advantage offered by the participant’s approach or solution.</p>
<p>Information about Key Team Members (required)</p>	<p>2 pages</p>	<p>The key team members and why they are well-suited to accomplish the project, with supporting</p>

		information on their qualifications, skills and capabilities.
Information about Public Safety Collaboration (required)	1 page	<p>Information describing the first responder point of contact, a description/details of the collaboration (including acknowledgement of prizes reserved for the collaborating public safety agency) with a public safety agency or entity. This information should be signed by the project’s point of contact at the collaborating public safety entity.</p> <p>Should the participant not submit their concept paper with a named collaborating agency, the participant must discuss its willingness to collaborate with a public safety agency contact provided by the Challenge partners (including acknowledgement of prizes reserved for the collaborating public safety agency).</p>
Informational Sheet or Concept Sketches and Mockup Video (required)	1-2 pages 1-3 min	A concept sketch (1-2 pages) in a PDF format and a single, 1-3 min video provided through an accessible online link within the application materials highlighting their concept, team skill set, and showcasing a virtual or augmented reality project.

NIST makes an independent assessment of each concept paper based on the evaluation criteria. NIST will not review or consider incomplete concept papers. During the review, each subject matter expert and Judging panel member will review entire concept papers to which they are assigned. The review is not done in sections with different reviewers responsible for different assigned sections. Therefore, it is not necessary to repeat information in every part of the concept paper. Do not include sensitive materials in the concept paper, for example, personally identifiable information like social security numbers, nor business sensitive information like tax identification numbers, etc.

Concept Paper and Video Evaluation Criteria

Concept Paper and Video are evaluated based on the following criteria:

Scoring Criterion #1: Strategic Alignment & Technical Outcome (70%)

This criterion involves consideration of the following factors:

- Strategic Alignment – The extent to which the contestant’s proposed augmented reality interfaces - holograms for incident command perspective and heads-up displays for first responders - for the four emergency scenarios meet the objectives listed in the goals of the challenge; the likelihood the contestant’s solution, if successfully implemented, will have a significant real-world impact on public safety operations;
- Technical Outcome – Extent to which the proposed approach will result in significant improvement in commercially available technology and will potentially result in a technical outcome which enables considerable progress toward the challenge goals.

Scoring Criterion #2: Feasibility & Team (30%)

This criterion involves consideration of the following factors:

- Team – The extent to which the capability of the contestant(s) can address all aspects of the proposed project with a high chance of success, including, but not limited to, qualifications, relevant expertise, and time commitment of the contestant. Reviewers will evaluate: (a) The relevance of the qualifications and experience of the key staff, leadership, and technical experts. (b) The extent of the key staff’s prior experience and the quality of the results achieved in leading programs similar in nature to the purpose, scope, and goals of the Challenge.
- Collaboration with Public Safety Entity - Contestant demonstrates and details planned collaboration with public safety to ensure their proposed interfaces align with public safety tasks, use cases and needs.
- Approach – Contestant’s plan to manage the limited schedule, resources, project risks and other challenges, and produce high quality project outcomes, in pursuit of the challenge goals.

The concept papers and recorded presentations will be evaluated based on the criteria above. Each concept paper will be reviewed by at least two subject matter expert reviewers and the Judging panel members and be assigned a score for each criterion, 0-10 for each criterion. Scores will not be provided to the contestants. In the case of a tie, the Judging panel will make a determination on the winners invited to compete in Phase 2.

Scoring for Concept Papers

10	Applicant has strong potential to aid in the achievement of the goals of the challenge
1-9	Varying degrees of certainty that the participant may have the potential to aid in the achievement of the goals of the challenge
0	Applicant does not have the potential to aid in the achievement of the goals of the challenge

Weighting of Criteria for Concept Papers

Criterion 1: Strategic Alignment & Technical Outcome	70%
Criterion 2: Feasibility & Team	30%

Phase 2: Augmented Reality and Public Safety Use Case Training

Introduction:

Invited contestants will focus their attention during Phase 2 on attending virtual Magic Leap training sessions as they develop/augment their AR interface(s).

Invited contestants that indicated in their concept papers that they need to be partnered with a public safety entity may have additional webinars or conference calls from May 25 to June 7 in order to be matched with a public safety organizations. Invited contestants that a) demonstrate their participation their attempts to contact local public safety organizations and participate in webinars or conference calls arranged by PSCR and its Challenge partners, but b) end up being unable to be successfully matched with a public safety organization may submit a waiver to the judging panel.

Up to 30 contestants will receive: a) invitation to Phase 3; b) the prize of \$7,500 for prototype development; c) \$2,000 for support of their matched public safety representative participation; d) up to \$5,000 in provided business technical assistance; e) offline support with MSA Safety; and f) \$3,000 in funding to spend time conducting joint training and prototyping with public safety partner.

Contestants, after receiving feedback from public safety stakeholders and spending time with their safety agency organization, may submit a proposal for the optional prize of joint training

and prototyping opportunities. If awarded by the judging panel, they will receive \$3,000 for funding to spend time conducting joint training and prototyping with public safety partner.

Important Dates:

Phase 2 launches on May 23, 2020. The Challenge Kickoff Webinar is currently scheduled for May 25, 2020. Invited contestants will attend the virtual Magic Leap training sessions, held starting the week of June 7, 2020.

Contestants, who seek a waiver for the required public safety team member, must submit a proposal documenting their attempts at collaboration by June 8, 2020. The judging panel will evaluate and notify the contestants if their waiver is accepted by June 12, 2020. Contestants that have received a waiver will be eligible to advance in the competition, but will not be eligible for the \$2,000 for support of their matched public safety representative prizes in Phase 2 and Phase 3, nor the \$3,000 in funding to spend time conducting joint training and prototyping with public safety partner as part of Phase 2.

Contestants who seek to propose additional joint training and prototyping opportunities with their public safety point of contact must submit a proposal by June 8, 2020. After evaluation, contestants may be awarded \$3,000 for funding. Contestants will be notified by June 9, 2020.

* PSCR anticipates hosting the Challenge Kickoff Webinar on May 25, 2020. Contestants who submit a concept paper will receive a tentative notice with the time and date of the Challenge Kickoff Webinar. However, only awarded contestants from Phase 1 will be invited to the Challenge Kickoff Webinar.

How to Enter:

- Invited contestants to Phase 2 will attend a Challenge Kickoff Webinar to learn more about Phase 2, such as how to access the prize challenge platform; how to receive a loaned Magic Leap headset; the virtual Magic Leap training sessions; the date and log-in information for the webinar with MSA Safety the four emergency scenarios and access to corresponding data; and discuss collaboration opportunities with public safety entities.
- Invited contestants, that did not compete with a public safety entity, but indicated a willingness to collaborate with a public safety entity introduced by NIST PSCR and its Challenge partners, will:
 - Be sent additional emails and potentially need to participate in additional webinars or calls from May 25 to June 7, 2020.
 - Should these contestants be unable to be matched with a public safety organization, they may submit a waiver, documenting their attempts to locate a public safety entity partner, for consideration by the Judging panel. The waiver may be up to three-page document and must submitted by June 8, 2020.

- For contestants that do match with a public safety entity, they will also need to submit a signed one-page document by June 8, 2020, describing the first responder point of contact, a description/details of the collaboration with their selected public safety agency or entity, including acknowledgement of prizes reserved for the collaborating public safety agency. This document should be signed by both parties.
- Kickoff Webinar Requirements: each invited contestant must have their Official Representative attend the Challenge Kickoff Webinar, currently scheduled for May 25, 2020 (time TBD). Other team members are invited to attend.
- Invited contestants should attend the virtual Magic Leap training sessions in addition to the webinar with MSA Safety. Invited Contestants will also be able to access focused, offline support with MSA Safety through an online portal. MSA Safety's responses to contestants will be provided equitably across the contestants each phase. Contestants will be informed by challenge organizers should they are reaching their max allotted collaboration time with MSA Safety for Phase 2.
- If the contestant and the collaborating public safety entity would like to receive the optional prize of \$3,000 in funding to spend time conducting joint training and prototyping, they must submit a narrative, budget and a timeline for their proposed collaboration by June 8, 2020 (maximum of 3 pages).
- Each contestant will create or enhance one augmented reality interface. Each contestant must submit one interface - a hologram for incident command or a heads-up display for first responders for any given emergency scenario. On June 12, 2020, contestants will submit their one developed or an enhanced augmented reality interface prototype for evaluation by the judging panel.
- To submit the augmented reality interface, each contestant will submit one Unity project folder (in the form of a .zip) containing the emulated AR heads-up display or hologram prototype and README files to PSCR through NIST's secure file collaboration site (<https://nfiles.nist.gov/>) for test and evaluation of their work by the subject matter experts and the Judging panel.

Evaluation Criteria and Judging:

PSCR will initially screen submissions for completeness and compliance with the objectives and Official Rules of this contest. A submission that fails to meet the compliance criteria will be disqualified and will be ineligible to compete in this contest. Submissions that pass the initial compliance review will be evaluated and scored by the Judging panel. An evaluation of a submission by the Judging panel does not constitute the NIST's final determination of contestant or submission eligibility.

Scoring Criterion #1: Compliance Testing (Pass/Fail)

The compliance testing includes:

- Augmented reality interface prototype can be detected by user.

- Augmented reality interface does not pose a risk to the user (e.g., user will not experience simulator sickness).

Scoring Criterion #2: Demonstration of Augmented Reality Heads-Up Display or Hologram (10/10)

- **Strategic Alignment** – The extent to which the demonstrated augmented reality prototype meets the objectives listed in the goals of the challenge; the responsiveness to the selected emergency scenario; the likelihood that successful implementation of the prototype will have a significant real-world impact.
- **Technical Outcome** – Extent to which the prototype will result in significant improvement in current status quo and will potentially result in a technical outcome which enables considerable progress toward improved operations and communications for first responders.

Scoring Criterion for the Waiver of the Requirement to Have a First Responder Entity as Part of Their Team (Pass/Fail)

The proposal from the participants who elect to submit a waiver for the requirement to have a first responder entity as part of their team will be evaluated as follows:

- Contestants’ waiver documents their personal attempt to match with a public safety entity along with attempts to match with a first responder entity introduced by NIST PSCR and/or its Challenge partners.
- Contestants’ narrative A) demonstrates how they plan to supplement a team member’s active involvement to ensure AR prototypes reflects knowledge of current status quo/public safety communication strategies under the emergency scenarios for which they plan to create heads-up display(s) and/or hologram(s); and B) explains how they believe their Augmented Reality solution(s) will still improve first responders’ status quo without prototyping with a public safety entity.

Scoring Criterion for the Optional Prize: Demonstration of Public Safety Use Case in Emergency Scenario(s) (Pass/Fail)

The proposals from the participants who elect to submit for the optional prize of \$3,000 in travel funding for joint prototyping and training will be evaluated as follows:

- Contestants’ proposed narrative, budget and timeline align with contest requirements.
- Contestants’ narrative A) demonstrates knowledge of current status quo/public safety communication strategies under the emergency scenarios for which they plan to create heads-up display(s) and/or hologram(s); B) explains how they propose their Augmented Reality solution(s) will improve first responders’ status quo; and C) describes how their proposed joint prototyping and training will increase the efficiency and effectiveness of their Phase 3 AR interfaces.

Phase 3: AR Heads-Up Displays and Holograms

Introduction:

Contestants' AR interfaces should be designed to be utilized by public safety, with holograms for the incident command perspective and heads-up display for use by first responders. The AR interfaces should be developed using the NIST PSCR provided IoT Disaster Scenario Dataset. The AR interfaces will be reviewed by a panel of subject matter experts as well as the Judging panel, which will evaluate and select up to 15 contestants for awards. Awardees will receive: a) online support with Magic Leap; b) online support by MSA Safety; c) \$7,500 for prototype development; d) \$2,000 for their matched public safety representative; and e) \$5,000 in funding to support their team's demonstration of their final interfaces at a 2021 public-safety focused event. NIST PSCR will contact each awardee to discuss their availability and their interest in demonstrating at 2021 in-person public-safety focused events, such as the NIST PSCR 2021 Public Safety Stakeholder Meeting, a public safety institute or another conference hosted by one of the Challenge partners or NIST PSCR collaborators.

The Judging panel may elect to offer two optional prizes: Best Presentation of Actionable IoT Analytics for First Responders (\$8,750) and Best Visual Interface for First Responders (\$8,750).

Important Dates:

Phase starts on June 17, 2020. Augmented Reality interfaces are due by September 1, 2020. Contestants will be notified by September 15, 2020.

How to Enter:

- Invited Contestants will attend another webinar with MSA Safety, and will be able to access focused, offline support with MSA Safety through an online portal. MSA Safety's responses to contestants will be provided equitably across the contestants each phase. Contestants will be informed by challenge organizers should they be reaching their maximum allotted collaboration time with MSA Safety for Phase 2.
- Each contestant will create augmented reality interfaces. Each contestant may submit up to eight interfaces - one hologram for incident command and one heads-up display for first responders per emergency scenario.
- To submit the up to eight augmented reality interfaces, each contestant will submit one Unity project folder (in the form of a .zip) containing all emulated AR heads-up display and hologram prototypes and README files to PSCR through NIST's secure file collaboration site (<https://nfiles.nist.gov/>) for test and evaluation of their work by the subject matter experts and the Judging panel.

Evaluation Criteria and Judging:

PSCR will initially screen submissions for completeness and compliance with the objectives and Official Rules of this contest. A submission that fails to meet the compliance criteria will be disqualified and will be ineligible to compete in this contest. Submissions that pass the initial compliance review will be evaluated and scored by the Judging panel. An evaluation of a submission by the Judging panel does not constitute the NIST's final determination of contestant or submission eligibility.

Each hologram and heads-up display will first undergo a compliance test, and then will be evaluated by subject matter experts and the Judging panel. Contestants will receive a maximum of 10 points per interface (3 points for the efficiency and effectiveness, 5 points for user satisfaction, 2 points for ease of use). The Judging panel will then rank the contestants on their total points and select up to the top 15 contestants to advance in the contest. In the case of a tie, the judging panel will make a determination on the contestants invited to compete in Phase 4.

Scoring Criterion #1: Compliance Testing (Pass/Fail)

- All required components of Phase 3 were submitted (i.e., Unity project folder, in the form of a .zip, containing emulated AR heads-up display and hologram prototypes and README files).
- The prototypes are built using Luminoso platform on Unity 2019.1 with MagicLeap SDK v0.22.0 or newer.
- The AR prototype provides feedback to the user based on IoT sensor data from the various scenarios.

Each interface will be evaluated, and contestants will receive a maximum of 10 points per user interface for a maximum score of 80 points (3 points for the efficiency and effectiveness; 5 points for user satisfaction; 2 points for ease of use per user interface).

Scoring Criterion #2: Efficiency and Effectiveness of AR Interfaces (Max 3/10)

- Assessment of the potential of the contestants' submissions in assisting with the scenarios' tasks for Phase 4 using the PSCR IoT data.
 - Assistance towards each of the objectives laid out in each milestone (e.g., situational awareness, temperature, blood pressure, air quality, threat location)
 - Cumulative task time; how long did it take to complete the objectives in the scenarios
- The quality of the data representation (e.g., temperature, blood pressure, air quality, threat location) integrated into the AR prototypes:
 - Data enables users to make decisions
 - Data interfaces with operational tasks
- Effectiveness of the AR interface prototype aided in completion of the task.
 - Effectiveness of the data analysis

- Ability to calculate scenario parameters (i.e., threat location, navigational routes, vitals)
- Ability to convey task information through the interface

Scoring Criterion #3: User satisfaction of AR interfaces (Max 5/10)

- Elements are clearly visible and account for various usability considerations (e.g., color blindness).
- The interface elements are intuitive, appropriate for data type and easy to use. The AR interface should not interfere with the user's primary task.
- Integration of key data into the AR interface prototypes that supports critical elements of the public safety mission including each contestant's demonstrated knowledge of public safety requirements, missions, operations, and tasks.

Scoring Criterion #4: Ease of Use (2/10)

- Submission was easy to deploy, and the README file thoroughly documented all aspects of the solution.

Phase 4: Final Evaluation at a Public Safety Training Center

Introduction:

Phase 4 will consist of an interactive evaluation of augmented reality interfaces at a public safety training center. The Judging panel will utilize the contestants' augmented reality interfaces to complete multiple first responder tasks across the four simulated emergency scenarios.

Contestants' interfaces will be tested and evaluated by the subject matter experts and the Judging panel. Contestants will compete for up to sixteen (16) final prize awards: 1st- \$25,000; 2nd- \$20,000; 3rd- \$15,000; 4th- \$10,000; 5th- \$7,500; \$20,000 total for the top AR Heads-Up Display and Hologram per scenario (\$2,500 award per scenario); Most Creative Method of Interaction with AR prototype: \$5,000; Best Demonstration of Public Safety Use Case: \$4,000; and Continued Technical Assistance Award: \$10,000.

Challenge partner Magic Leap may elect to award five headsets, each with an estimated value of \$2,300.

Important Dates:

The phase launches on September 16, 2020, and AR developers will participate in a webinar with the CHARIoT Challenge organizers to discuss information on the objectives, structure, and conditions of the final evaluation at a public safety training center. The discussion will focus on how their selected Phase 4 interfaces will be tested and evaluated, in addition to the components of their virtual participation. This webinar is currently scheduled for September 16th.

AR developers will also participate in a webinar with the IoT data contestants, currently scheduled for October 7th. During the webinar, the IoT data contestants will share their sensor data and data streams, of which the AR developers will have access to, in addition to the emulated data available from NIST PSCR. AR developers should note that they will not be able to record the streamed data from the data transmitters nor will they be able to access the IoT-based contestants' data streams after Phase 4.

The final interfaces are due on Monday, November 16 at 3pm MT. NIST PSCR is currently targeting three different timeframes for the final evaluation throughout 2020 and early 2021, of which will be finalized as soon as the criteria are present to safely and effectively host an in-person event with the Judging panel. NIST PSCR will announce the finalized dates to the final contestants no later than 15 days in advance of the evaluation to ensure the contestants will be able to virtually participate in aspects of the final evaluation.

How to Enter:

- Invited contestants will attend a webinar with the IoT data contestants to learn more about the IoT data contestants' solutions that will be available to the AR developers during Phase 4. Contestants will also learn more about the Phase 4 requirements and details of the final evaluation.
- AR developers should note that while designing user interfaces for the Incident Command perspective, they may utilize controllers, verbal and gesture-based commands, while designing heads-up displays for the first responder perspective, they may utilize eye gaze, verbal and gesture-based commands.
- By November 16 at 3pm MT, each contestant must submit for test and evaluation by the subject matter experts and the Judging panel:
 - their Unity project folder (in the form of a .zip), a .mpk build, and a README file (e.g., instructions on use) to PSCR through NIST's secure file collaboration site (<https://nfiles.nist.gov/>);
 - their completed evaluation of what data elements from the IoT contestants they utilized for their interface to PSCR through NIST's secure file collaboration site (<https://nfiles.nist.gov/>); and
 - One 3-minute instructional video per interface selected to be played for each member of the Judging panel before donning and evaluating your interface to PSCR through NIST's secure file collaboration site (<https://nfiles.nist.gov/>); and
 - their privately shared interfaces through the Magic Leap platform to PSCR.
- PSCR will keep all project builds submitted during Phase 4 for public safety demonstration purposes.
- AR developers that utilized IoT data contestants' data streams must complete an evaluation form that will be applied as part of the evaluation of IoT data contestants' submissions. AR developers will not be able to record the streamed data from the data transmitters nor will they be able to access the IoT-based contestants' data streams after the final evaluation.

- Once the timeframe of the final evaluation has been confirmed, AR Contestants will be notified of the timeframes during which they should be available for any troubleshooting of the user interfaces, followed by the specific timeframe of their virtual Q&A Session with the Judging panel.

Evaluation Criteria and Judging:

PSCR will initially screen submissions for completeness and compliance with the objectives and Official Rules of this contest. A submission that fails to meet the compliance criteria will be disqualified and will be ineligible to compete in this contest. Submissions that pass the initial compliance review will be evaluated and scored by the Judging panel. An evaluation of a submission by the Judging panel does not constitute the NIST's final determination of contestant or submission eligibility.

The Judging panel will evaluate the AR Development Teams based on scoring criteria #1-#3 below. The Judging panel will don the AR prototypes and complete trials across the various scenarios. An average score will be calculated based on the performance of the contestants' AR heads-up displays and holograms across the up to four scenarios they competed in. If a submission fails Scoring Criterion #1: Compliance Testing, the Judge will assign a zero (0) for that particular evaluation round and the submission will not be evaluated on scoring Criteria #2 and #3. Scores from Criterion #4, Q&A and Presentation, will be added to the contestants' final average score for their submitted heads-up displays and holograms across the four scenarios.

Scoring Criterion #1: Compliance Testing (Pass/Fail)

- The AR prototype is functional at the start of the judge evaluation trial for a given scenario.
- AR headset applications utilize live data streams during competition.
- The contestants' heads-up displays and holograms are viewable by the user donning headset.
- Virtual elements do not obscure or pose a safety risk to users.

Scoring Criteria #2 and #3: an average of the two scores obtained in Scoring Criterion #2 and Scoring Criterion #3 will be calculated from the criteria below. The combined max average score possible for each contestant for Scoring Criteria #2 and #3 is 10. That combined max average score will be added to the contestant's awarded points for Scoring Criterion #4 in order to obtain the final score for that contestant.

Scoring Criterion #2: Efficiency and effectiveness of AR Interfaces (Max 6/10)

- Assessment of the ability of the contestants' submissions in assisting with the scenarios' tasks using the PSCR IoT data.

- Assistance towards each of the objectives laid out in each milestone (e.g., situational awareness, temperature, blood pressure, air quality, threat location)
- Cumulative task time; length of time to complete the objectives in the scenarios
- The quality of the data representation (e.g., temperature, blood pressure, air quality, threat location) integrated into the AR prototypes:
 - Data enables users to make decisions
 - Data interfaces with operational tasks
- Effectiveness of the AR interface in conveying and utilizing IoT data
 - Effectiveness of the data analysis
 - Ability to calculate scenario parameters (i.e., threat location, navigational routes, vitals)
 - Ability to convey task information through the AR interface

Scoring Criterion #3: User satisfaction of AR interface prototypes (Max 4/10)

- Integration of key data into the AR interface prototypes that supports critical elements of the public safety mission: including each contestant’s demonstrated knowledge of public safety requirements, missions, operations, and tasks.
- The interface is intuitive and does not cause physical discomfort. The interface does not interfere with the user’s primary task.

Scoring Criterion #4: Q&A and Presentation (10 points possible)

- Each AR Development Team will complete a short, virtual presentation to the Judging panel, followed by Q&A from the panel. Each AR Development Team will only conduct one presentation and the points received under Scoring Criterion #4 will be added to the combined Scoring Criteria #2 and #3 max average score of that AR Development Team’s augmented reality interface submissions. The Judging panel will award points based on the quality of the presentation and the ability to answer questions.

After the judging panel has reviewed each contestant using the above evaluation criteria, the judging panel has three additional awards to recognize contestants in specific requirements for outstanding achievement or contribution to advancing the challenge goals. All Contestants in Phase 4 who pass Criterion 1-4 are eligible for these awards. The Judging panel will vote on all eligible Contestants and use a simple majority to select a winner:

- Most Creative Method of Interaction with AR prototype: \$5,000:

Judges will evaluate the effectiveness, efficiency, and user satisfaction of presenting and interacting with data through an interface other than the AR controller (e.g., gesture, vocal).

- Best Demonstration of Public Safety Use Case: \$4,000:

Judges will determine which solutions showcase a strong alignment to and knowledge of the public safety use case.

- Continued Technical Assistance Award: \$10,000:

Judges will determine which contestant has the highest likelihood of commercial success based on use of their solutions in the evaluation trials and through the presentations and Q&A.

General Submission Requirements for All Phases of both Emulate Smart City Data for Disaster Scenarios and Building Augmented Reality Interfaces for First Responders Contests

In order for submissions to be eligible for review, recognition and award, contestants must meet the following requirements:

- Deadline - The submission must be available for evaluation by the end date noted in the "Important Dates" section of these rules.
- No NIST logo - submission(s) and participant(s) must not use NIST's logo or official seal and must not claim NIST endorsement.
- Each submission must be original, the work of the contestant, and must not infringe, misappropriate or otherwise violate any intellectual property rights, privacy rights, or any other rights of any person or entity.
- It is an express condition of submission and eligibility that each contestant warrants and represents that the contestant's submission is solely owned by the contestant, that the submission is wholly original with the contestant, and that no other party has any ownership rights or ownership interest in the submission. The Participant must disclose if they are subject to any obligation to assign intellectual property rights to parties other than the contest Participant, if the Participant is licensing or, through any other legal instrument, utilizing intellectual property of another party.
- Each contestant further represents and warrants to NIST that the submission, and any use thereof by NIST shall not: (i) be defamatory or libelous in any manner toward any person, (ii) constitute or result in any misappropriation or other violation of any person's publicity rights or right of privacy, or (iii) infringe, misappropriate or otherwise violate any intellectual property rights, privacy rights or any other rights of any person or entity.
- Each submission must be in English.
- Submissions will not be accepted, evaluated, or considered for award if they contain any matter that, in the sole discretion of NIST, is indecent, obscene, defamatory, libelous, in bad taste, demonstrates a lack of respect for public morals or conduct, promotes discrimination in any form, or which adversely affects the reputation of NIST. NIST shall have the right to remove any content from the Event Website in its sole discretion at any time and for any reason, including, but not limited to, any online comment or posting related to the Challenge.

- If NIST, in its discretion, finds any submission to be unacceptable, then such submission shall be deemed disqualified.

Judging Panel

The submissions will be judged by a qualified panel of expert(s) selected by the Director of NIST. The panel consists of Department of Commerce, National Institute of Standards and Technology and non- Department of Commerce, National Institute of Standards and Technology experts who will judge the submissions according to the judging criteria identified above in order to select winners. Judges will not (A) have personal or financial interests in, or be an employee, officer, director, or agent of any entity that is a registered contestant in a contest; or (B) have a familial or financial relationship with an individual who is a registered contestant.

The decisions of the Judging panel for the contest will be announced in accordance with the dates noted in the "Important Dates" section of these rules. NIST PSCR will not make all contestants' evaluation results from the Judging panel available to contestants or the public.

Verification of Winners

ALL CONTEST WINNERS WILL BE SUBJECT TO VERIFICATION OF IDENTITY, QUALIFICATIONS AND ROLE IN THE CREATION OF THE SUBMISSION BY THE DEPARTMENT OF COMMERCE, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY.

Participants must comply with all terms and conditions of the Official Rules. Winning a prize is contingent upon fulfilling all requirements contained herein. The winners will be notified by email, telephone, or mail after the date of winning results. Each winner of a monetary or non-monetary award, will be required to sign and return to the Department of Commerce, National Institute of Standards and Technology, within ten (10) calendar days of the date the notice is sent, an ACH Vendor/Miscellaneous Enrollment Form (OMB NO. 1510-0056) and a Contestant Eligibility Verification in order to claim the prize.

In the sole discretion of the Department of Commerce, National Institute of Standards and Technology, a potential winner will be deemed ineligible to win if: (i) the person/entity cannot be contacted; (ii) the person/entity fails to sign and return an ACH Vendor/Miscellaneous Enrollment Form (OMB NO. 1510-0056) and a Contestant Eligibility Verification within the required time period; (iii) the prize or prize notification is returned as undeliverable; or (iv) the submission or person/entity is disqualified for any other reason. In the event of a disqualification of a winner, the Department of Commerce, National Institute of Standards and Technology, in their sole discretion, may award the applicable prize to an alternate winner, when applicable.

Eligibility Requirements:

A participant (whether an individual, team, or legal entity) must have registered to participate and complied with all of the requirements under section 3719 of title 15, United States Code as contained herein. At the time of entry, the Official Representative (individual or team lead, in the case of a group project) must be age 18 or older and a U.S. citizen or permanent resident of the United States or its territories. In the case of a private entity, the business shall be incorporated in and maintain a place of business in the United States or its territories.

Contestants may not be a Federal entity or Federal employee acting within the scope of their employment. Employees and contractors of the Challenge Partners (as identified on the Challenge website) are not eligible to enter. Any other individuals or legal entities involved with the design, production, execution, distribution or evaluation of the Challenge are not eligible to enter. Former NIST PSCR Federal employees or Associates are not eligible to compete in a prize challenge within one year from their exit date. NIST Associates are eligible to enter, but may not utilize NIST funding for competing in this challenge, nor are they eligible to receive a cash prize award. Individuals currently receiving PSCR funding through a grant or cooperative agreement are eligible to compete, but may not utilize the previous NIST funding for competing in this challenge. Previous and current PSCR prize challenge contestants are eligible to compete. Non-NIST Federal employees acting in their personal capacities should consult with their respective agency ethics officials to determine whether their participation in this competition is permissible. A Participant shall not be deemed ineligible because the Participant consulted with Federal employees or used Federal facilities in preparing its entry to the Challenge if the Federal employees and facilities are made available to all Participants on an equitable basis.

Contestants, including individuals and private entities, must not have been convicted of a felony criminal violation under any Federal law within the preceding 24 months and must not have any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability. Contestants must not be suspended, debarred, or otherwise excluded from doing business with the Federal Government.

Multiple individuals and/or legal entities may collaborate as a group to submit a single entry and a single individual from the group must be designated as an Official Representative for each entry. That designated individual will be responsible for meeting all entry and evaluation requirements.

Teams:

Contest submissions can be from an individual or a team(s). Individuals or members of a team may only be selected to participate on one contestant group and cannot participate on multiple teams nor contestant categories. If a team of individuals, a corporation, or an organization is selected as a prize winner, NIST will award a single dollar amount to the Official Representative.

The Official Representative is solely responsible for allocating any prize amount among its member contestants as they deem appropriate. NIST will not arbitrate, intervene, advise on, or resolve any matters between entrant members. It will be up to the winning team(s) to reallocate the prize money among its member contestants, if they deem it appropriate.

Submission Rights:

Any applicable intellectual property rights to a submission will remain with the contestant. By participating in the prize challenge, the contestant is not granting any rights in any patents, pending patent applications, or copyrights related to the technology described in the entry. However, by submitting a contest submission, the contestant is granting the Department of Commerce, National Institute of Standards and Technology certain limited rights as set forth herein.

- The contestant grants to the Department of Commerce, National Institute of Standards and Technology the right to review the submission, to describe the submission in any materials created in connection with this competition, and to screen and evaluate the submission. The Department of Commerce, National Institute of Standards and Technology will also have the right to publicize contestant's name and, as applicable, the names of contestant's team members and/or organizations which participated in the submission following the conclusion of the competition.
- As part of its submission, the contestant must provide written consent granting the Department of Commerce, National Institute of Standards and Technology, a royalty-free, non-exclusive, irrevocable, worldwide license to display publicly and use for promotional purposes the contestant's entry ("demonstration license"). This demonstration license includes utilizing the contestant's entry for future research purposes and posting or linking to the contestant's entry on the Department of Commerce, National Institute of Standards and Technology websites, including the competition website and inclusion of the contestant's submission in any other media, worldwide.

Warranties:

By submitting an entry, each contestant represents and warrants that the contestant is the sole author and copyright owner of the submission; that the submission is an original work of the contestant and that the contestant has acquired sufficient rights to use and to authorize others, including the Department of Commerce, National Institute of Standards and Technology, to use the submission, as specified throughout the Official Rules, that the submission does not infringe upon any copyright or upon any other third party rights of which the contestant is aware; and that the submission is free of malware.

By submitting an entry, the contestant represents and warrants that all information submitted is true and complete to the best of the contestant's knowledge, that the contestant has the right and

authority to submit the entry on the contestant's own behalf or on behalf of the persons and entities that the contestant specifies within the entry, and that the entry (both the information and materials submitted in the entry and the underlying technology/method/idea/treatment protocol/solution described in the entry):

- is the contestant's own original work, or is submitted by permission with full and proper credit given within the entry;
- does not contain trade secrets (the contestant's or anyone else's);
- does not knowingly violate or infringe upon the patent rights, industrial design rights, copyrights, trademarks, rights of privacy, publicity or other intellectual property or other rights of any person or entity;
- does not contain malicious code, such as viruses, malware, timebombs, cancelbots, worms, Trojan horses or other potentially harmful programs or other material or information;
- does not and will not violate any applicable law, statute, ordinance, rule or regulation, including, without limitation, United States export laws and regulations, including but not limited to, the International Traffic in Arms Regulations and the Department of Commerce Export Regulations; and
- does not trigger any reporting or royalty or other obligation to any third party.

By making a submission to this prize competition, each contestant agrees that no part of its submission includes any Trade Secret information, ideas or products. All submissions to this prize competition are deemed non-proprietary. Since NIST does not wish to receive or hold any submitted materials "in confidence" it is agreed that, with respect to the contestant's entry, no confidential or fiduciary relationship or obligation of secrecy is established between NIST and the contestant, the contestant's team, or the company or institution the contestant represents when submitting an entry, or any other person or entity associated with any part of the contestant's entry.

Additional Terms and Conditions

This document outlines the Official Rules for the *Augmented Reality and Internet of Things based* Challenge. Nothing within this document or in any documents supporting the *Augmented Reality and Internet of Things based* Challenge shall be construed as obligating the Department of Commerce, NIST or any other Federal agency or instrumentality to any expenditure of appropriated funds, or any obligation or expenditure of funds in excess of or in advance of available appropriations.

Contest Subject to Applicable Law

All contests are subject to all applicable federal laws and regulations. Participation constitutes each contestant's full and unconditional agreement to these Official Rules and administrative

decisions, which are final and binding in all matters related to the contest. Eligibility for a prize award is contingent upon fulfilling all requirements set forth herein. This notice is not an obligation of funds; the final award of prizes is contingent upon the availability of appropriations.

Participation is subject to all U.S. federal, state and local laws and regulations. Contestants are responsible for checking applicable laws and regulations in their jurisdiction(s) before participating in the prize competition to ensure that their participation is legal. The Department of Commerce, National Institute of Standards and Technology shall not, by virtue of conducting this prize competition, be responsible for compliance by contestants in the prize competition with Federal Law including licensing, export control, and nonproliferation laws, and related regulations. Individuals entering on behalf of or representing a company, institution or other legal entity are responsible for confirming that their entry does not violate any policies of that company, institution or legal entity.

Resolution of Disputes

The Department of Commerce, National Institute of Standards and Technology is solely responsible for administrative decisions, which are final and binding in all matters related to the contest.

In the event of a dispute as to any registration, the authorized account holder of the email address used to register will be deemed to be the contestant. The "authorized account holder" is the natural person or legal entity assigned an email address by an Internet access provider, online service provider or other organization responsible for assigning email addresses for the domain associated with the submitted address. Contestants and potential winners may be required to show proof of being the authorized account holder.

Publicity

The winners of these prizes (collectively, "Winners") will be featured on the Department of Commerce, National Institute of Standards and Technology website, newsletters, social media, and other outreach materials.

Except where prohibited, participation in the contest constitutes each winner's consent to the Department of Commerce, National Institute of Standards and Technology's and its agents' use of each winner's name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media, worldwide, without further permission, payment or consideration.

Payments

The prize competition winners will be paid prizes directly from the Department of Commerce, National Institute of Standards and Technology. Prior to payment, winners will be required to verify eligibility. The verification process with the agency includes providing the full legal name, tax identification number or social security number, routing number and banking account to which the prize money can be deposited directly.

All cash prize awarded to Participants by the Department of Commerce, National Institute of Standards and Technology are subject to tax liabilities, and no withholding will be assessed by the Department of Commerce National Institute of Standards and Technology on behalf of the Participant claiming a cash prize.

Liability and Insurance

Any and all information provided by or obtained from the Federal Government is without any warranty or representation whatsoever, including but not limited to its suitability for any particular purpose. Upon registration, all contestants agree to assume and, thereby, have assumed any and all risks of injury or loss in connection with or in any way arising from participation in this contest, development of any application or the use of any application by the contestants or any third-party. Upon registration, except in the case of willful misconduct, all contestants agree to and, thereby, do waive and release any and all claims or causes of action against the Federal Government and its officers, employees and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential and whether foreseeable or not), arising from their participation in the contest, whether the claim or cause of action arises under contract or tort. Upon registration, all contestants agree to and, thereby, shall indemnify and hold harmless the Federal Government and its officers, employees and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential and whether foreseeable or not), including but not limited to any damage that may result from a virus, malware, etc., to Government computer systems or data, or to the systems or data of end-users of the software and/or application(s) which results, in whole or in part, from the fault, negligence, or wrongful act or omission of the contestants or contestants' officers, employees or agents.

Contestants are required to demonstrate liability insurance coverage of \$100,000 for this Challenge for claims by a third party for death, bodily injury, or property damage, or loss resulting from an activity carried out in connection with participation in phase 4 of this Challenge and for claims by the Federal Government for damage or loss to Government property resulting from such an activity. The Federal Government shall be named as an additional insured under the contestant's insurance policy. Depending on the site for phase 4 of the Challenge, the public safety training center may also be a required named additional insured under the

contestant's insurance policy. Each contestant will be required to complete the phase 4 public safety training center's waiver document.

Records Retention and FOIA

All materials submitted to the Department of Commerce, National Institute of Standards and Technology as part of a submission become official records and cannot be returned. Any confidential commercial information contained in a submission should be designated at the time of submission. Submitters will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26.

508 Compliance

Contestants should keep in mind that the Department of Commerce, National Institute of Standards and Technology considers universal accessibility to information a priority for all individuals, including individuals with disabilities. In this regard, the Department is strongly committed to meeting its compliance obligations under Section 508 of the Rehabilitation Act of 1973, as amended, to ensure the accessibility of its programs and activities to individuals with disabilities. This obligation includes acquiring accessible electronic and information technology. When evaluating submissions for this contest, the extent to which a submission complies with the requirements for accessible technology required by Section 508 will be considered.

General Conditions

This prize competition shall be performed in accordance with the America COMPETES Reauthorization Act of 2010, Pub. Law 111-358, title I, § 105(a), Jan. 4, 2011, codified at 15 U.S.C. § 3719 and amended by the American Innovation and Competitiveness Act of 2016 (Pub. L. No. 114-329) (hereinafter "America COMPETES Act").

The Department of Commerce, National Institute of Standards and Technology reserves the right to cancel, suspend, and/or modify the contest, or any part of it, if any fraud, technical failures, or any other factor beyond the Department of Commerce, National Institute of Standards and Technology's reasonable control impairs the integrity or proper functioning of the contest, as determined by the Department of Commerce, National Institute of Standards and Technology in its sole discretion. The Department of Commerce, National Institute of Standards and Technology is not responsible for, nor is it required to count, incomplete, late, misdirected, damaged, unlawful, or illicit votes, including those secured through payment or achieved through automated means.

ALL DECISIONS BY The Department of Commerce, National Institute of Standards and Technology ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE CONTEST.