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Human Machine Teaming

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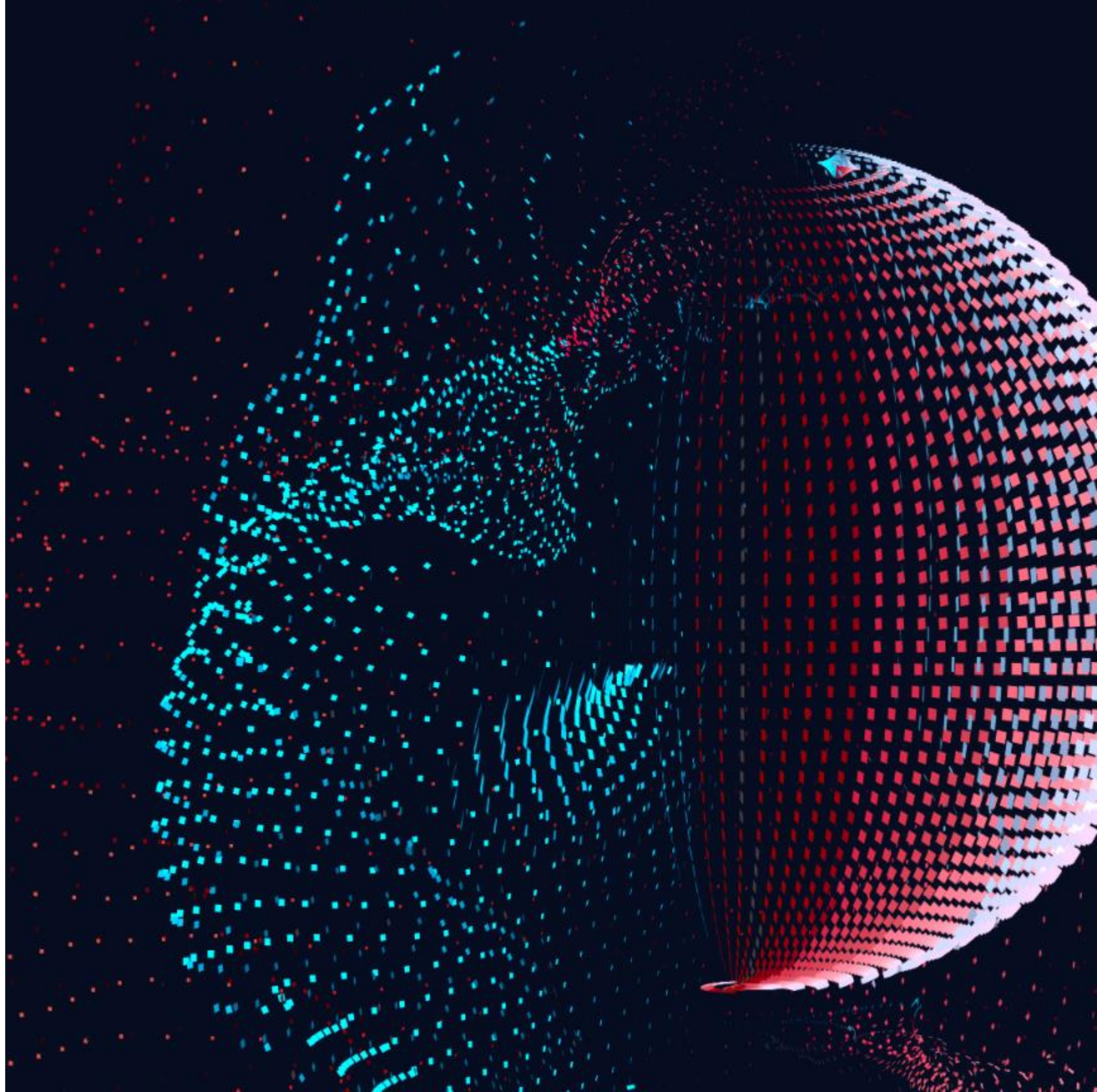
Visual Analytics



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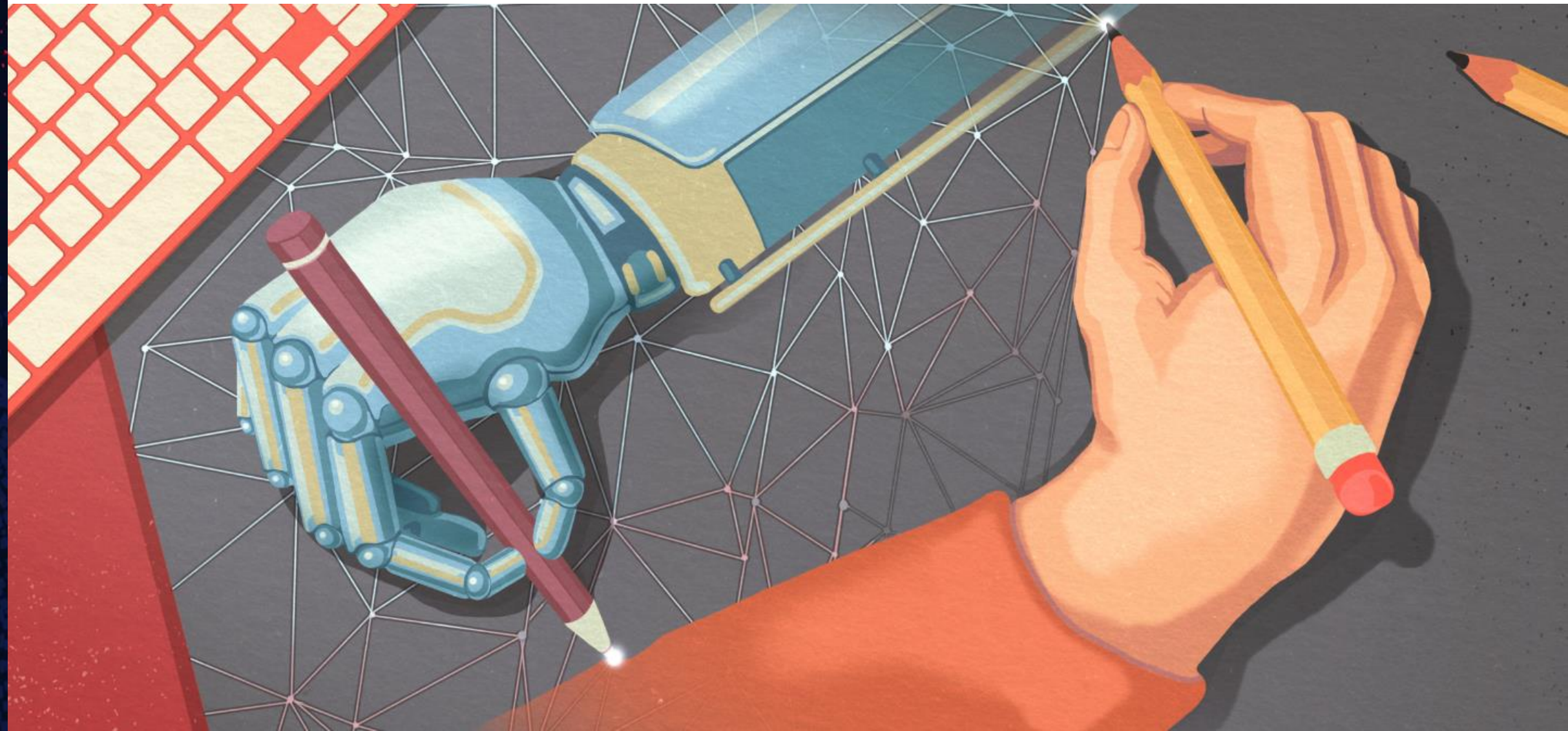
From Tools to Teammates



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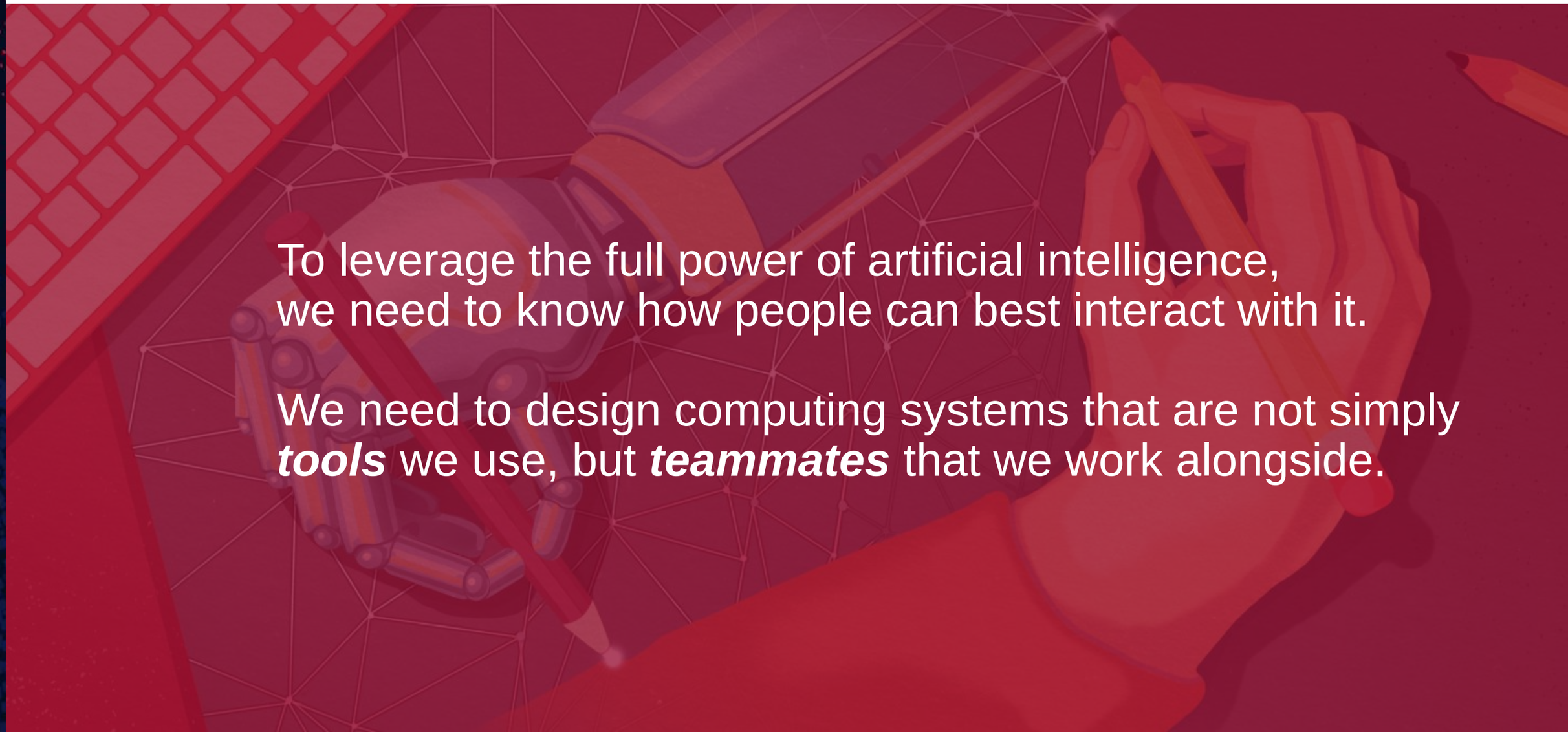
From Tools to Teammates

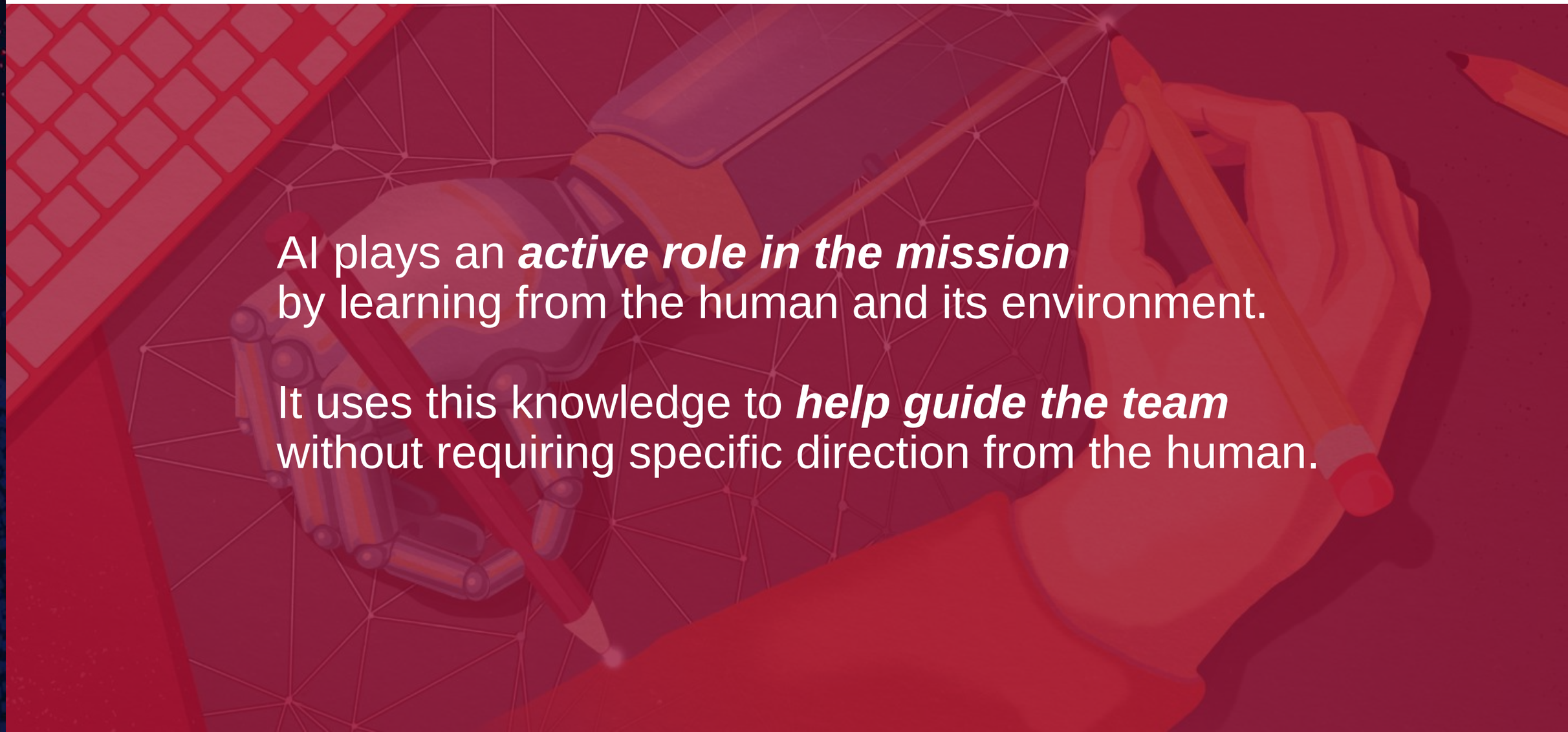


To leverage the full power of artificial intelligence,
we need to know how people can best interact with it.

We need to design computing systems that are not simply ***tools*** we use, but ***teammates*** that we work alongside.

What makes a good teammate?

Human-Machine Teaming



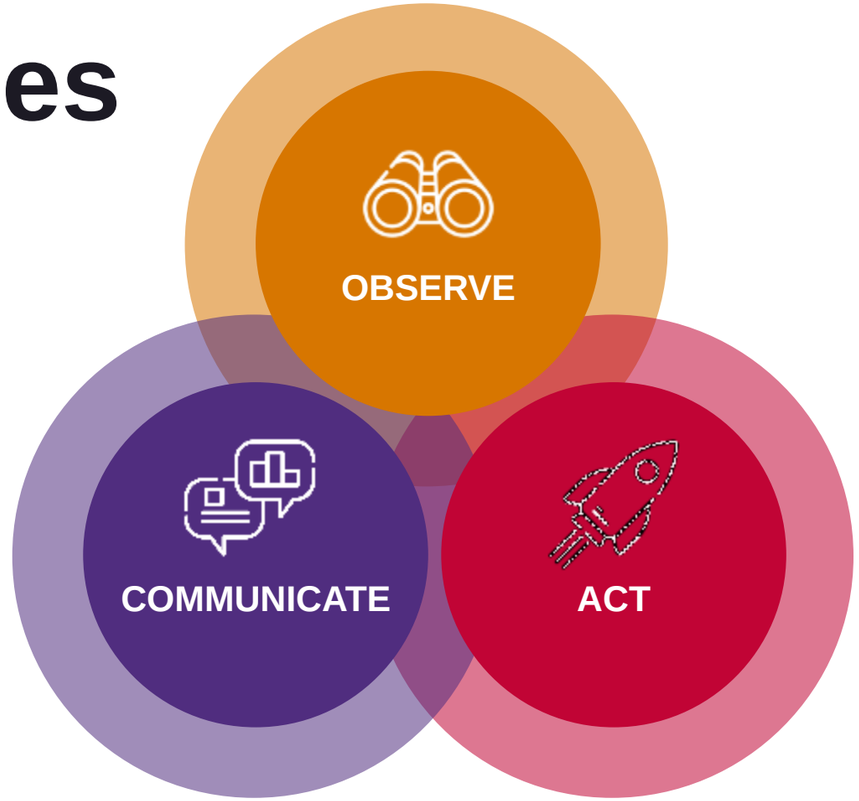
AI plays an ***active role in the mission***
by learning from the human and its environment.

It uses this knowledge to ***help guide the team***
without requiring specific direction from the human.

Foundations of a Digital Teammate

HMT Design Guidelines

We developed a set of HMT Design Guidelines based on the literature to aid designers and developers of Digital Teammates



HMT Design Guidelines…

- have a different focus from existing guidelines such as Nielsen's usability heuristics
- specifically address automated assistants designed to support analytic tasks
- are based on our review of the Human-Machine Teaming literature
- useful for software system design, development and evaluation during the lifecycle

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HMT Design Guidelines

Observe

Monitor

The machine should be able to monitor its own performance, changes in the operational environment, progress toward task goals and resources available to complete the tasks.

Learn

The machine teammate should have the ability to learn task goals, new ways of performing a task and human's work preferences both implicitly through interaction with the human and through explicit instructions from the human.

Predict

The machine should be able to anticipate the human's actions, needs and upcoming events based on what it monitors and learns about the human's preferences and the task environment.

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HMT Design Guidelines

Communicate

Practice Etiquette	The machine's communication with the human should be consistent with the norms, expectations and terminology used by the human.
Control Cost	The cost in time and energy required for the human to communicate with the machine teammate should be minimal.
Be Observable	The machine should be able to communicate its rational for its actions and recommendations as well as its status, knowledge of the team, task and environment to the human teammate in multiple modalities.
Adapt Consistently	When the machine must adapt to new events or challenges in the task environment, it should communicate its change in a predictable way.

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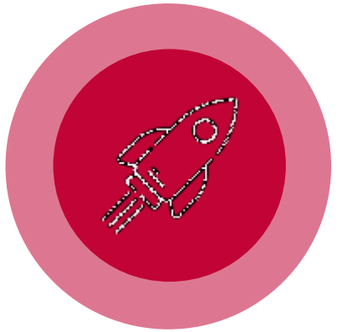
HMT Design Guidelines

Act



Direct	The machine should be able to direct the human when appropriate, including directing the human's attention to important developments.
Be Directable	The machine should be able to flexibly take direction from the human such as responding to new goals and task assignments administered by the human.
Take Initiative	The machine should be given autonomy to offer support and act without specific, explicit instructions and oversight from the human when task demands require the machine's unique strengths.

DHS / HMT Use Cases

Border Patrol Inspection

Border Patrol Inspection

Border patrol examines a commercial freight truck at an official point of entry.

Human Attention

While one agent contacts the driver to obtain more information, two others begin an assessment of the vehicle’s trailer.

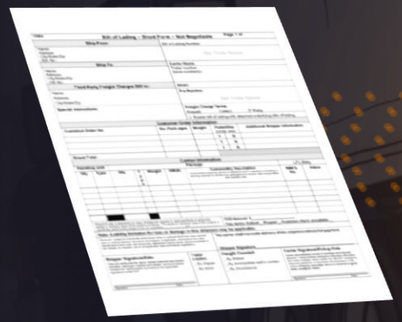
One of them uses an AR headset to review data from sensors located under and to the sides of the vehicle. The other uses a new type of handheld radiation detector they were just trained on.

Digital Teammate

OBSERVE

The BITS (Border Inspection Teammate System) monitors the officers as they go about their work.

After the agent scans the driver's paperwork, BITS checks that information against databases maintained by several agencies involved in interstate commerce, homeland security, federal and state commercial truck enforcement, and others. Data and camera video from commercial truck weigh stations are also reviewed. Traffic data and weather on the truck's route are also looked at.



Bill of Lading

BITS

Analyzing

Fed/State/Local Law Enforcement

Traffic

Weather

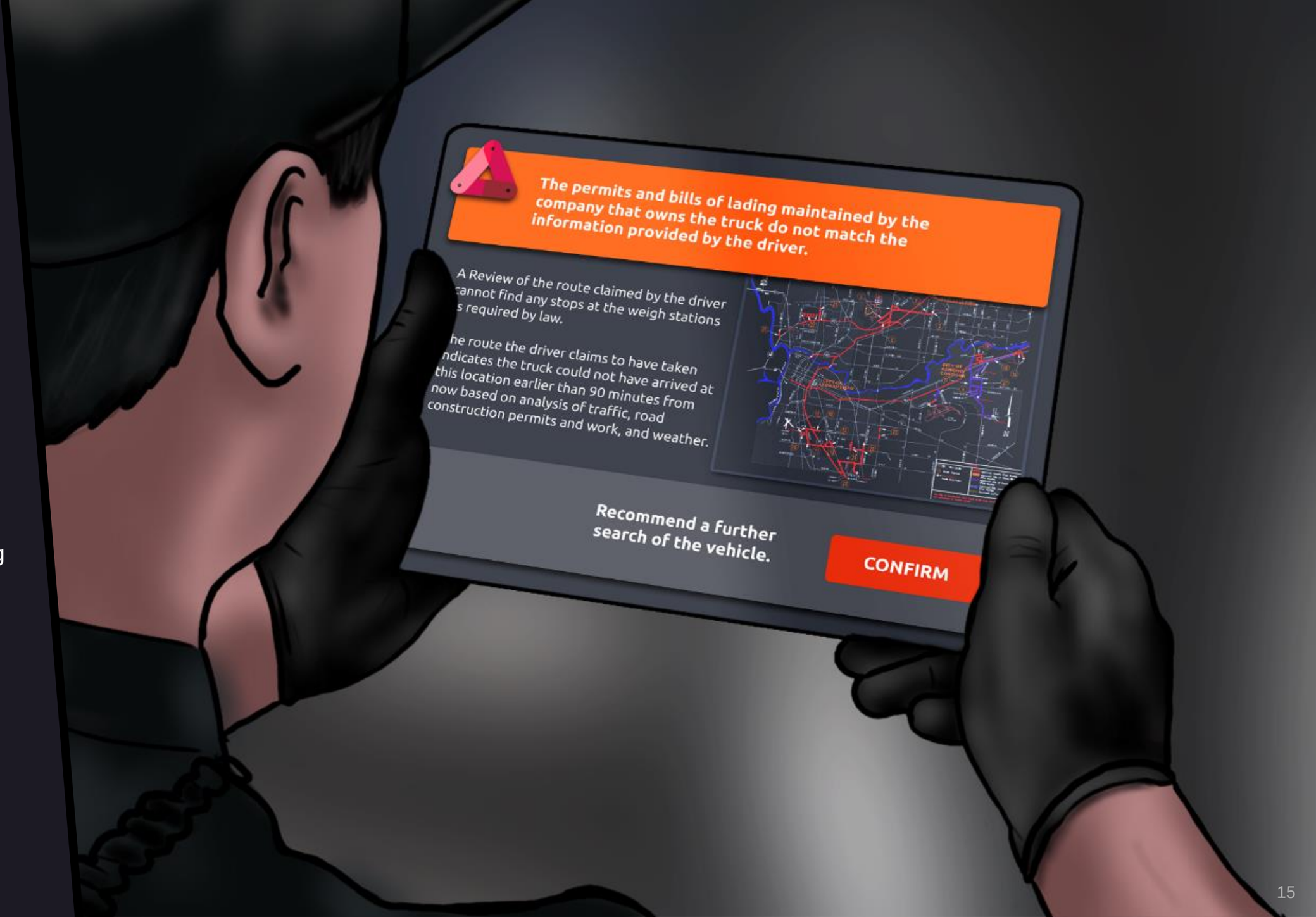
Digital Teammate

COMMUNICATE

BITS takes initiative to push the findings to the team leader.

Team leader accepts BITS' recommendation to do an additional search of the vehicle.

BITS displays the search pattern of each officer looking for areas that are missed.



Digital Teammate

COMMUNICATE

The data and information collected are organized and then displayed by BITS on the officer’s AR headset.

Images from x-rays and other sensors are analyzed and compared against thousands of searches conducted on other similar trucks to aid officers in interpreting the results.

Digital Teammate

COMMUNICATE

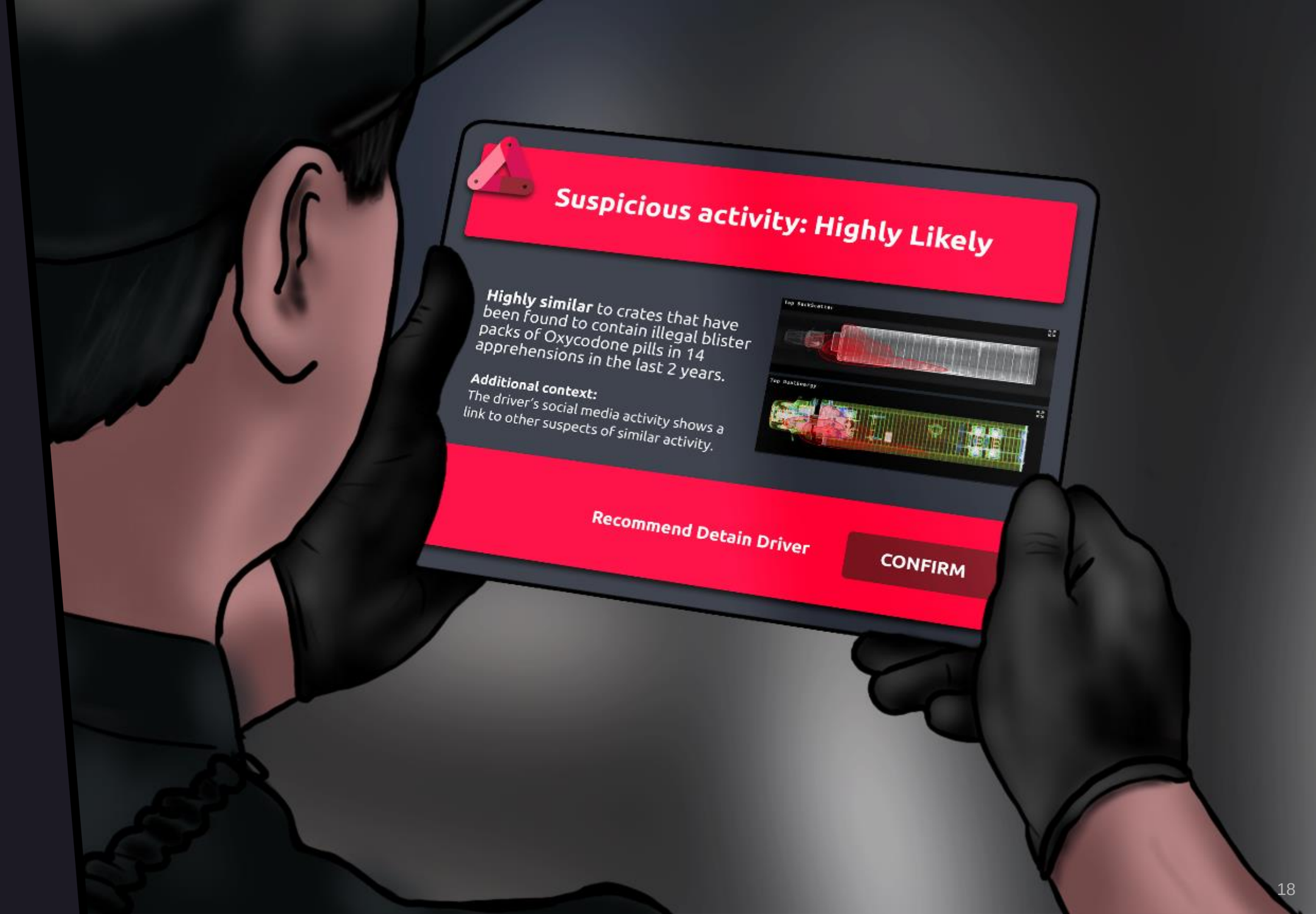
The agent using a new model radiation detector asks BITS for assistance with operating the device.

Acting as a coach, the BITS guides the agent through the proper use of the detector.

Digital Teammate

COMMUNICATE

BITS shares findings with the team leader.



Digital Teammate

COMMUNICATE

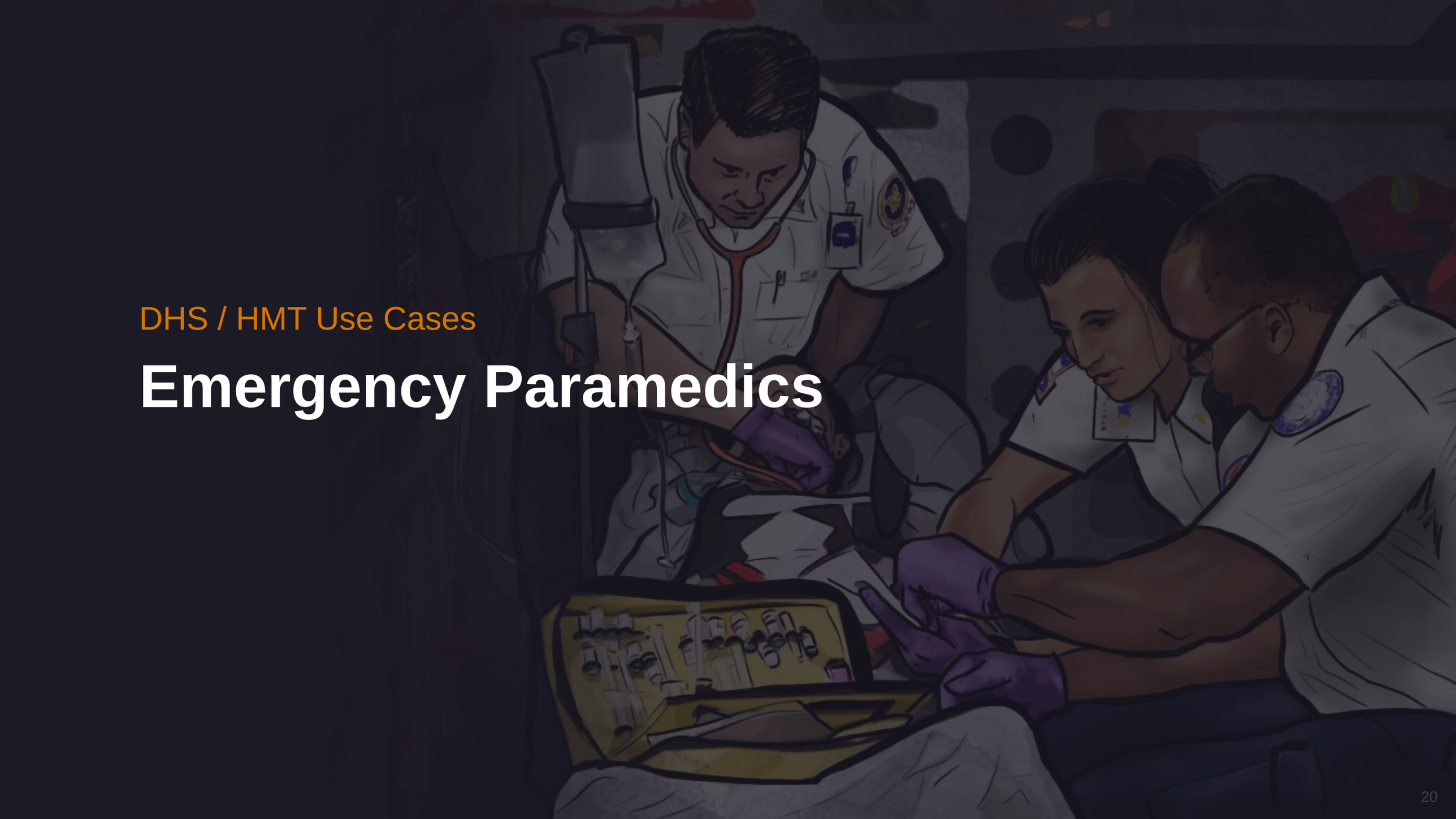
The agent using the handheld inspector sees something suspicious and forwards to it the team leader. The team leader asks some additional probing questions.

The team leader recognizes the driver’s story isn’t adding up.

The team leader considers all information from BITS and the rest of the inspection team to make the decision to detain the driver and conduct a full search of the truck.

DHS / HMT Use Cases

Emergency Paramedics



Medics in Ambulance

Medics respond to an 80-year-old female complaining of chest pain and shortness of breath.

Human Attention

The Medics are monitoring the patient's vitals. One of the medics is asking the patient basic questions to determine her mental state and general responsiveness.

The medics notice that the patient is disoriented, and her systolic pressure is below 100.

Digital Teammate

OBSERVE

The Emergency Medical Assistant (EMA) is also supporting the medics.

EMA is an artificial intelligence-based teammate that can be reached through multiple devices including the ambulance on-board computer, the medics mobile devices and through voice commands.

Digital Teammate

OBSERVE

EMA is able to monitor the environment using cameras, microphones, and the vital sign sensors in the ambulance.

EMA observes the medics work and keeps a record of their action. Just like the medics, EMA observes the patient's disorientation, low blood pressure, and labored breathing.

EMA accesses the patient's medical records and sees that she visited her physician yesterday because of chest pain.

Digital Teammate

OBSERVE

EMA compares the electrocardiogram taken in the doctor's office yesterday with the current electrocardiogram obtained by the medics and notes significant changes have occurred.

Digital Teammate

COMMUNICATE

First, EMA displays the patient's recent electrocardiogram on its display and highlights the recent visit to the physician.

Next, EMA verbally communicates to the Medics.

EMA – “The patient’s ECG from today compared to the ECG taken yesterday show changes consistent with a possible myocardial infarction.”

Lead Medic – “I agree”

Digital Teammate

ACT

EMA takes the initiative and sends the electrocardiogram and suspected diagnosis to the receiving hospital.

EMA – 'I have a reported our concern about changes to the electrocardiogram to the receiving hospital Emergency Department and their Cardiac Catheter Laboratory'

Lead Medic - 'Thanks EMA'

DHS / HMT Use Cases

Law Enforcement

Police Response

911 Center receives multiple calls reporting that a large fight has broken out between several individuals attending a birthday party.

Dispatch’s digital assistant verifies the calls are connected to a single incident and identifies nearby patrol units that can respond.

The human operator dispatches the units to the scene.

Officer Miller and D-PO

Patrol Officer Miller and her Digital Police Officer (D-PO) receive the message from dispatch.

D-PO is an artificial intelligence-based partner that can be reached through multiple devices including the patrol car’s on-board computer and Officer Miller’s mobile devices.

D-PO has access to multiple data sources including live security camera feeds.

Digital Teammate

OBSERVE

While Officer Miller drives to the scene, D-PO monitors camera footage from an autonomous police drone circling the scene.

The footage shows several individuals outside of the structure who appear to be in a violent altercation.

Next, D-PO uses its deep learning image recognition to detect a firearm in the hand of one of these individuals.

Digital Teammate

COMMUNICATE

D-PO reports to Officer Miller that it has a high-confidence that at least one of the individuals is armed and requests to take over driving so the officer can study the video footage.

The officer accepts the request and D-PO shares the video footage of the scene on the patrol car’s display. D-PO has highlights features on the video and explains what led to its high-confidence rating.

Office Miller acknowledges the warning and asks D-PO to share the information with other responding officers.

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Digital Teammate

ACT

D-PO quickly calculates what it believes is the best route to reach the scene and presents it to Officer Miller for review.

Officer Miller activates the lights and siren and follows the suggested route to the scene. D-PO continues to monitor the scene while simultaneously scouting the route ahead for any hazards and traffic congestion using traffic cameras and other sensors.

Human Machine Teaming @ PNNL

To learn more about Human-Machine Teaming or to speak with one of our experts, please email….
nwrtc@pnnl.gov

Or visit Northwest Regional Technology Center (https://www.pnnl.gov/projects/nwrtc).